Structures Engineering

# Detailed Visual Bridge Inspection Guidelines for Concrete and Steel Bridges (Level 2 Inspections)

Document No: 6706-02-2233

## CONDITION ASSESSMENT – LEVEL 2
## DETAILED VISUAL BRIDGE INSPECTION GUIDELINES FOR CONCRETE & STEEL BRIDGES

This information is owned and controlled by the Senior Engineer Structures. The Bridge Condition Manager is a delegated custodian. All comments and requests for changes are to be submitted to the delegated custodian.

### AUTHORISATION

As head of Structures Engineering of Main Roads Western Australia, I authorise the issue and use of this document.

R F SCANLON

SENIOR ENGINEER STRUCTURES

Date: 21/05/2008

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REVISION STATUS

| Page No. | Revision No. | Revision Date | Revision Description | Approved By | Signature |
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| All | 1 | 13/12/10 | Document now includes details relevant to precast concrete box unit bridges | R F Scanlon | |
| All | 2 | 29/02/12 | General update and inclusion of information on confined spaces. New damage catalogue, bridge condition index and mark-up details. | R F Scanlon | |
| All | 3 | 18/06/13 | General update. Inclusion of vegetation clearance envelope; inspection of large signs/screens and their connections; new guardrail information sheet; substructure protection; and new arch bridge templates. | A Lim | |
| All | 4 | 1/04/17 | General Update, including changes to Condition State allocations, inspection templates | A Lim | |

**All controlled copies shall be marked accordingly**

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# 1.0 INTRODUCTION

This document is one of a set of documents, which together, prescribe and detail the management processes and procedures used by Main Roads Western Australia (MRWA) to manage its bridges.

The Level 2 Condition Assessment, often referred to as the Detailed Visual Bridge Inspection, enables the assessment of a bridge's condition and early detection of any damage or deterioration that may pose a safety hazard. Early detection can also prevent accelerated deterioration. It is an important mechanism for the determination of maintenance and refurbishment (or replacement) needs and to identify if further investigatory testing is required.

# 2.0 PURPOSE AND SCOPE

The purpose of this document is to detail how MRWA satisfies the requirement to undertake detailed visual bridge inspections on Concrete and Steel Bridges (Level 2). It outlines the condition assessment process and procedure in detail including the standard information and documentation required in completing the assessment report.

This document is intended to assist the Bridge Inspector when carrying out Detailed Visual Inspections on Concrete and Steel Bridges by providing the following:

- An explanation of terminology used in the Detailed Visual Bridge Inspection report forms, the Precast Box Unit Bridges Detailed Visual Inspection report forms and the Arch Bridges Detailed Visual Inspection report forms
- Guidance on document preparation needed prior to bridge inspection field trips
- Prompts and guidance on what aspects need to be considered in inspecting each component of the structure to enable a consistent approach to inspection, evaluation and condition assessment
- An explanation of work items, priorities, Condition States with a detailed damage catalogue and the overall Bridge Condition Index
- References to other relevant detailed information to assist with the assessment

The scope of this document also provides for a special category of bridge; large precast box structures which have an opening of greater than 3 metres (therefore excluding all pipes). These structures are managed in a similar manner to Bridges; however, they have separate condition assessment and inspection criteria. They are termed "Precast Box Unit Bridges". Similarly, arch bridges have separate condition assessment and inspection criteria. An arch bridge has loads carried outward along the curve of the arch to the supports at each abutment.

Note that when a bridge, containing both non-timber and timber components, is inspected the Inspector needs to follow these Guidelines for inspecting and reporting the non-timber components and report all timber components in the inspection report noting any major defects or apparent structural issues. The detailed assessment of these components will be subsequently managed by MRWA with a detailed assessment being undertaken in accordance with *Detailed Visual Bridge Inspection Guidelines for Timber Bridges (Level 2 Inspections),* document 6706-02-2231, as appropriate.

Details on the background and calculation of the overall Bridge Condition Index (refer Section 17 and Appendix D) are included in this document, however, this is typically not the role of the Inspector and will be performed during the review of the detailed inspection report.

# 3.0 OTHER REFERENCES

Other references relevant to this document are:

- Refer to the *Detailed Visual Bridge Inspection Guidelines for Timber Bridges (Level 2 Inspections),* document 6706-02-2231 for guidance on completing the *general* bridge information requirements in the inspection forms (e.g. Cover sheet, Sketch sheet, Photographic Record sheet and Photo sheet, or as a reference for assessing any timber components of the bridge).
- Refer to the *Sign Gantry Guidelines (Level 1 and Level 2 Inspections)*, document 6706-02-2239 for additional information on large static signs and variable message signs (VMSs) and their connections.

# 4.0 OBJECTIVE AND EXTENT OF A LEVEL 2 BRIDGE INSPECTION

## 4.1. Objective of Level 2 Bridge Inspection

The objective of the bridge inspection is to ensure that the bridge continues to perform its function under acceptable conditions of safety and with minimised cost of maintenance. The Level 2 bridge inspection is undertaken to ensure the following specific objectives:

- Ensure that the structure continues to satisfy present service and safety requirements for road users;
- Record the current physical and functional condition of the bridge;
- Confirm that any previous repairs carried out are functioning satisfactorily;
- Identify any inventory changes from the previous inspection;
- Provide feedback to design, construction and maintenance engineers;
- Provide information to determine the need for establishing or revising the load carrying capacity (load rating) of the bridge;
- Determine maintenance needs and identify anticipated future problems; and
- Establish a history of performance.

## 4.2. Extent of Level 2 Bridge Inspection

The Level 2 Detailed Visual Inspection is essentially a visual inspection and must cover all components of the bridge above ground and water level.

The individual components of the structure must be inspected at close range, i.e. from within 1 m of any surface of the component. The surface of the component shall be in sufficient good natural or artificial light to observe even the smallest cracks in concrete.

All bearings shall be inspected at eye level.

Steel components may require thickness gauge measurements to assess residual plate thickness if corrosion is reported as being active. If access is difficult or previous issues have been noted, inspection of structural welds shall be undertaken with specialist instruments and/or personnel as required.

Components that are *not* required to be inspected in Level 2 inspections are:

- areas behind abutments that are inaccessible; and
- components below ground level or below water level.

If required, these components may be inspected as part of a Special Inspection and Investigation (Level 3).

Where it is not possible to inspect a component of the bridge completely, this fact shall be recorded on the inspection report, stating the percentage of the component not inspected and the reason why it cannot be fully observed. (Refer to Section 7.1.2 viii).

Clear and precise photographs form an essential part of the inspection report. It is important that the location of the defect, its severity, size and extent are all identifiable. This may require multiple photographs – distant and close-up. An extension of a tape measure, a ruler or any other object allowing reasonable scaling of the defect shall be incorporated in the photograph. Photographs of components with Condition State rating of 3 or 4 shall be taken within 3 m of the surface of the component or equivalent using a telephoto lens. Further guidance on photographic requirements is provided in Section 10.

Refer to Sections 7 and on for further details of inspection requirements.

## 4.3. Outputs of Level 2 Bridge Inspection

The outputs of a Level 2 Detailed Visual Bridge Inspection include:

- A detailed condition assessment report on the condition of each element including the extent over which the particular Condition State rating applies for each component. The inspector should avoid detailing the need for upgrades or adding relating to substandard items in the detail report. Such comment may be included in the summary memo if desired.
- Identification of components of a structure which warrant a Special Inspection and Investigation (Level 3) because of a rapid change in structural condition or deterioration to Condition State rating 4. (Refer to Section 14.0 for explanation of Condition State rating);
- Identification of components rated at Condition States 3 and 4 with comments regarding possible maintenance or repair requirements and their urgency;
- Identification of components which require closer condition monitoring and observation at the next inspection because they have deteriorated to Condition State rating 3 or have shown rapid deterioration or other features which warrant reporting;
- Identification maintenance requirements through work items;
- Identification of supplementary testing as appropriate; and
- A photographic record of the structure.

# 5.0 PREPARATION FOR SITE INSPECTION

## 5.1. General

Prior to commencing site inspections, the Inspector must ensure that all the relevant documentation (e.g. reference manuals, inspection reports) is collected and the inspection and safety equipment is appropriately certified and tested, where applicable.

The operation of access equipment shall only be undertaken by suitably experienced personnel in accordance with the manufacturer's operating procedures.

Prior to commencing site inspections, the Inspector needs to create a new copy of the standard inspection forms and input the general bridge information from MRWA records. Each form is to be prepared in advance for the components relevant to the bridge to enable manual updating on site. This preparation is important for enabling a well prepared and efficient inspection that ensures all components of the bridge are properly identified and inspected, particularly to confirm the foundation type, bearings and expansion details.

Previous detailed visual inspections (Level 2) and special inspections and investigations (Level 3) should be reviewed prior to the site visit.

Certain types of steel structures with structural welds (e.g. welded box superstructures) require special planning. If, to enable Level 2 inspection, significant planning is required in relation to access and traffic management consideration shall be given through consultation with Asset Manager Structures as to whether a Level 3 inspection should be undertaken at the same time.

As part of preparing for the site inspection the scope of the inspection is required to be reviewed considering access equipment, lane closures required, etc. If during this planning phase it is identified that to undertake a full scope of inspection significant special access equipment and/or significant disruption to traffic Inspector shall consult with MRWA Bridge Condition Manager to determine an agreed scope of inspection.

## 5.2. Recommended Equipment

The following is a list of equipment that is recommended for the Level 2 inspection:

- personal protective equipment (PPE) including a high visibility safety vest and safety boots;
- rubber boots and waders;
- tools such as hammer(s), a long thin screwdriver, spirit level, shovel, small axe and a long stiff wire probe;
- inspection report proforma, notebook and clipboard;
- torch;
- tape measure;
- camera with flash;
- small foldable ladder;
- first aid kit;
- signage for traffic management purposes as required;
- GPS unit;
- chalk and permanent marker pens;
- compass;
- spray paint and number stencil kit; and
- crack gauge.

Other equipment, which can assist the Inspector, may include:

- binoculars;
- wire brush;
- radio unit and mobile phone;
- tool belt;
- gloves, both leather and plastic;
- tripmeter;
- bridge location books (available from Main Roads Internet site);
- special instruments to measure steel thickness, protective coatings and weld crack detection (for specific bridges only as outlined in Section 5.1);
- access equipment as required such as under bridge inspection unit, cherry picker, moveable scaffolding or safety harness/belt; and
- tool box with basic tools and fasteners.

## 5.3. Bridge Orientation

Refer to Appendix E for the terminology to be adopted for the various bridge components. All inspection report descriptions should be made consistent with this terminology.

The location of bridge components is based upon the direction of the road:

- The direction of SLK (refer to Section 7.1.1 for definition of SLK) for each road can be found within the relevant MRWA Region Structures Location Map Book. These can be found in www.mainroads.wa.gov.au selecting "Building Roads", "Standards and Technical", then "Structures Engineering", "Asset Management" and refer to the required Region's map book.
- Abutments are numbered in the direction of increasing SLK.
- Piers and Barrels are numbered along the bridge in ascending order from Abutment 1 to Abutment 2.
- Piles, Columns, Beams and Barrel Units are numbered across the bridge in ascending order from left to right when facing the direction of increasing SLK.

Diagrams showing this bridge orientation and component numbering are given on the cover sheets in Appendix H.

Pedestrian bridges spanning a road are treated slightly differently. Abutment 1 is located on the left hand side of the road when facing the direction of increasing SLK. All other references are then consistently taken once this first abutment has been located.

If, following the review of previous Inspection Reports (Level 1 or 2), Structural drawings or other reference documents, it is found that there is some confusion or discrepancy of the allocation of Abutment 1 the inspector is required to contact the Main Roads Bridge Condition Manager prior to commencing the bridge inspection to agree as to which Abutment is Abutment 1.

# 6.0 OPERATIONAL SAFETY

All inspection procedures and operations must comply with the relevant rules and regulations of the Occupational Safety and Health Act 1984 and appropriate MRWA operational safety guidelines and documents.

If inspection is required from water, any vessel used for this purpose and its operation must satisfy the legal obligations of the Western Australian Marine Act 1982, other relevant Acts, and associated regulations.

Where inspections are to be carried out on bridges located over or under the assets of other Authorities, the relevant regulations and Codes of Practice relating to work on or close to their assets must be adhered to, and where necessary, referred to in the safety procedures developed for the inspection. This is particularly important when inspecting bridges over railways.

As an example, for structures over a railway in the Perth Metropolitan Area, the Inspector must hold a Brookfield Track Access Permit (WMP01) for access to electrified rail, or a relevant permit for access to regional rail networks for similar country bridges.

## 6.1. Parking and Access

At some bridge sites it may be difficult to find a safe parking location especially at bridge sites on major roads and highways where the traffic volumes and speeds are high or where there is insufficient room within the roadside. It is important that the position of the Inspector's parked vehicle does not block road sight distances to motorists in both directions. In some situations, parking at the bridge site may not be safe and alternate parking locations and walking to the bridge site may be needed.

A standard "Site Conditions" form detailing the best parking location is completed for every bridge. The Inspector must review the Site Conditions form (when available) prior to the bridge inspection. An example of the "Site Conditions" form is located in Appendix G.

Access to all bridge components for inspection via bridge abutment embankments can potentially pose a safety risk to the Inspector due to steep embankments and loose surface material. The "Site Conditions" form describes the access conditions to the abutments and piers. The Inspector should take note of this information prior to arriving on site and make suitable arrangements for safe access as required.

## 6.2. Traffic Management

Prior to the commencement of any site inspection an appropriate Traffic Management Plan, in conjunction with a safety management plan, shall be prepared to ensure a safe workplace is maintained for both inspectors and travelling public.

## 6.3. Confined Spaces

The governing regulations for confined spaces are the ‘Occupational Safety and Health Regulations 1996’, Regulation 3.82 which provides a definition for how a ‘confined space’ is identified and these definitions are reproduced below:

*“Confined space means an enclosed or partially enclosed space which -*

- *(a) is not intended or designed primarily as a workplace, and*
- *(b) is at atmospheric pressure during occupancy, and*
- *(c) has restricted means for entry and exit,*

*and which either-*

- *(d) has an atmosphere containing or likely to contain potentially harmful levels of contaminant; or*
- *(e) has or likely to have an unsafe oxygen level; or*
- *(f) is of a nature or is likely to be of a nature that could contribute to a person in the space being overwhelmed by an unsafe atmosphere or a contaminant.”*

In addition, these Regulations make reference to Australian Standard AS 2865 ‘Confined Spaces’ with respect to work being done in a confined space. Note that AS 2865 also contains definitions of a confined space, however where there is a difference the Regulations will take precedent.

A number of the larger bridge structures within Western Australia have an enclosed space that would be covered by the definitions (a), (b) and (c), however MRWA Structures Engineering with its knowledge of the bridge infrastructure is unaware of a bridge space which meets the definitions (d), (e) or (f) of the Regulation. This means that there are no known bridges with a ‘confined space’ as defined in the Regulations.

If the Inspector feels the air quality in an enclosed or partially enclosed space is compromised and will impact the safety of inspection, the Inspector shall consider safety implications and make allowances in safety management plan. There are various light weight, hand-held instruments commercially available that could be used by inspector to monitor air quality if deemed appropriate.

However there are certain bridges such as Powis Street (Bridge 1018) where the access is difficult as illustrated in Figure 6.3a below. In an instance like this, the restricted access and confined space will be an additional component to consider when preparing for the inspection. The Inspector will be required to undertake a risk assessment to determine what the actual risks are and what control measures will be required to ensure the risk is at an acceptable level. AS 2865 contains information that may be used for this purpose.

**Figure 6.3a - POWIS STREET BRIDGE NO. 1018**

Bridges such as Mount Henry do have reasonable access portals which are not small or restricted, ventilation is adequate and the interior has lighting. This type of access is not considered to pose unusual or excessive risk to the inspector and no particular confined space risk assessment is required.

**Figure 6.3b - MOUNT HENRY BRIDGE NO. 1581**

Further, it is considered that bridges with greater than 0.8 m headroom are suitable for on site assessment of risk by the Inspector. Risk assessment for lower bridges shall consider alternative access equipment, the use of cameras/scopes and the need for full inspection depending on the condition of external components.

# 7.0 DETAILED BRIDGE INSPECTION FORMS

There are three sets of detailed visual bridge inspection forms that are relevant to concrete and steel bridges:

i) Detailed Visual (Level 2) Bridge Inspection Report
(used for Reinforced Concrete, Prestressed Concrete, Steel, Steel/Concrete Composite and Timber Hybrid Bridge types);

ii) Detailed Visual (Level 2) Bridge Inspection Report for Precast Box Unit Bridges
(used for precast box units only); and

iii) Detailed Visual (Level 2) Bridge Inspection Report for Arch Bridges
(used for arch bridges only).

Examples of completed Detailed Visual (Level 2) Bridge Inspection Reports for i), ii)and iii) are located in ***Appendix G***. Blank templates (available electronically from MRWA Structures Engineering Branch) for i), ii) and iii) are included in ***Appendix H*** to show the full listing of all of the standard components that can be used in the inspection report. The component names are standardised so that all components are recognised by Structures Engineering's computerised bridge asset management programmes.

## 7.1. Detailed Visual Bridge Inspection Report

The Detailed Visual Bridge Inspection Report is compiled on a series of standard forms or worksheets. They consist of:

- General bridge information sheet (Cover sheet) (most of this can be completed in the office prior to the inspection but must be verified on site). Refer to Section 7.1.1 for explanation of individual items.
- Site Access ("Site Conditions") sheet. Refer to Section 7.1.3 i) for explanation of individual items.
- Guardrail Information sheet for collating and recording bridge guardrail inventory. The condition of the guardrail is not recorded on this inventory sheet but on the appropriate inspection sheet. Refer to Section 7.1.3 ii) for explanation of individual items.
- Inspection sheets for each "Group" (i.e. each for Bridge, Approach, Deck, Abutment, Pier and Span). A "Group" can be deleted from the report if not present in the structure.
- Work Items – Summary
- Bridge Inspection Summary "Detailed Concrete and Steel Bridge Inspection Summary" sheet
- Location Map sheet
- Photo Sheets
- Sketch Sheet(s) as required

### 7.1.1. *General Bridge Information Sheet*

The general bridge information sheet requires the Inspector to input the details to identify the bridge and its precise location. The following information is required:

- Bridge Number
- Structure Type: Either: Reinforced Concrete, Prestressed Concrete, Steel, Steel/Concrete Composite or Timber Hybrid
- Superstructure (type): There are approximately 25 standard types. The listing is available from the General Bridge Inventory Information Form (available on MRWA's Internet site www.mainroads.wa.gov.au selecting "Building Roads", "Standards and Technical", then "Structures Engineering", "Asset Management" and refer to the "General Bridge Inventory Form" pdf document.)
- Responsibility Area: The MRWA Region responsible for the management of the bridge
- Road Name
- Road Number
- Crossing Name
- Owner
- Local Govt. (Authority)
- SLK: The Straight Line Kilometre (SLK) distance defines the location of a point on a road to reference items on or adjacent to the road. SLK is a distance measure (to 2 decimal places) that maintains an historical reference of road points as road realignments introduce changes to the true distance measure.
- Latitude: The Latitude Coordinate is to be taken in decimal degrees (to 5 decimal places) and must be noted as a minus number (i.e. -32.78472), measured from Abutment 1, LHS. Coordinates must be measured using Global Positioning System (GPS) equipment set to the GDA 94 datum.
- Longitude: The Longitude Coordinate is to be taken in decimal degrees (to 5 decimal places).
- Total Width: The total width of the bridge is the actual overall width of the structure between the extreme outer edges (excluding railing posts that may protrude outside the deck or kerb), perpendicular to the longitudinal centreline of the bridge, measured in metres to two decimal places.
- Length: The distance from centreline of abutment support to centreline of the other abutment support or from expansion joint to expansion joint where joints are present, measured along the bridge's longitudinal centreline and measured in metres to two decimal places.
- No. Spans: Number of spans

- Skew:  This is the angle between the longitudinal centreline of the bridge and a line perpendicular to the road centreline.  It is measured in degrees.  See Figure 7.1.1 below.

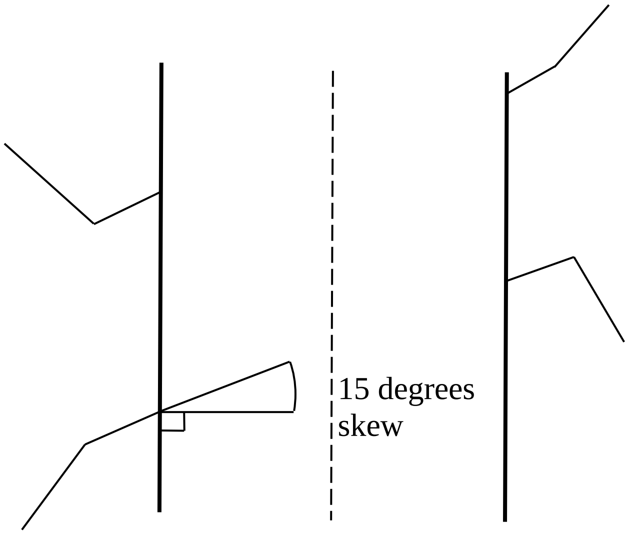



**FIGURE 7.1.1 - MEASUREMENT OF SKEW**

- Max. H/Room (Headroom):  The maximum clear height of the bridge, measured in metres to two decimal places.
- Min. H/Room (Headroom):  The minimum clear height of the bridge, measured in metres to two decimal places.  This information is necessary to assist planning for bridge inspections as to the appropriate methodology and access equipment applicable.  This shall be taken at the top of the spill-through abutment if applicable, to indicate the possibility of accessing abutment bearings.
- Width Between Kerbs:  When the road has kerbs and no median or central barrier, the width is measured between the inside face of the LH kerb, across the road to the inside face of the RH kerb, measured perpendicular to the flow of traffic and measured in metres to two decimal places.  If a median or central barrier is present, the width between kerbs becomes the minimum width available for a vehicle, measured perpendicular to the road between the inside face of the kerb to the inside face of the median or barrier.
- To:  For each direction away from the bridge give a landmark or intersection description to assist with the location and orientation of the bridge.  Usually the name of a close town or nearest road intersection is suitable for a description in each direction.
- Show North:  An arrow to show the direction of North is to be drawn in the circle provided.
- Show Flow Direction:  An arrow to show the direction of the water flow under the bridge is to be drawn in the rectangular box provided.  The arrow drawn will either be showing flow going to the right or to the left.  If flow direction is not evident during the site inspection, then this unknown shall be indicated.

### *7.1.2. Inspection Sheets - Definitions*

The detailed inspection forms (for each “Group”) have standardised headings. The headings are explained in i) to xv) below. Refer to Appendix G(i) for an example of a completed inspection report.

#### *i). Group*

The main structural aspects of the bridge are allocated a worksheet each and each worksheet is headed by “Group” type.

“Group” types are:

- Bridge
- Approach
- Deck
- Abutment
- Pier
- Span

#### *ii). Group Number*

Where a “Group” type has more than one present a “Group Number” is also used. For example: all bridges have two approaches, therefore there would be a worksheet each for “Group: Approach, Group Number: 1” and “Group: Approach, Group Number: 2”. Similarly for abutments. This would be similar for “Pier” and “Span” which may have multiple Group Numbers depending on the number of spans of the bridge.

#### *iii). Component Type*

A “Component Type” is essentially a component of the “Group”. For example: a wall is a Component Type of the Group: Abutment. A selection of “Component Type” from a drop down menu is provided on the worksheet. Each “Group” has its unique list of “Components”.

#### *iv). Component Number*

Where more than one “Component Type” exists for a particular Group, for example: a Pier (Group) having multiple columns (Component Type), each of the columns is designated a sequential Component Number (i.e. 1, 2, 3, 4 etc.).
Each component should be listed individually unless consecutive components have exactly the same comments, photos, condition states and work items.

#### *v). Component Material*

The material type used for the component type shall be entered.

### *vi). Modification Status*

A "Modification Status" is recorded for each Component. The "Modification Status" advises whether the component is a part of the original structure or otherwise. The "Modification Status" selection includes the following choices:

- Original - Where it can be seen that the component is part of the original structure, unchanged
- Existing - Where the component appears to be original but the Inspector is not certain or where the component was previously recorded as 'new'
- Modified - Where modifications to the component have occurred since it was initially built (e.g. a widening)
- New - A new component since the previous inspection, not previously recorded, e.g. a widening (in the next inspection this component shall be recorded as an 'existing' component)
- Replacement - Replaces an existing or original component
- Superseded - A component that has been made redundant by the placement of a new component

Note: Each widening shall be recorded separately and designated as left or right as viewed from Abutment 1. Components that are part of a widening are also to be indicated as such in the comments section of the inspection report.

### *vii). Unit*

Each Component has a specified basis for measurement. The "Unit" selection includes the following choices as the basis for measurement for that component:

- Each
- $m^2$
- linear m

Table B.1 outlines the applicable measurement unit for each component.

### *viii). Condition State*

The Inspector is required to assess the structural condition of the key components of the bridge. For guidance on how to determine the Condition State of the components refer to Section 14.0, Appendix A, Appendix B and Appendix C.

### *ix). Not Inspected (%)*

In some circumstances it may not be possible to inspect an entire component of the bridge. This may be due to water levels or debris build-up, for example. It is important that the Inspector accesses as much of the structure as possible for inspection. Where the Inspector has been unable to inspect the entire component, the estimated percentage *not* inspected must be recorded for each particular item and in the comments section give the reason why it cannot be fully observed. The Condition State recorded is that for the inspected area only and must still add up to 100%. If the entire component cannot be inspected, e.g. a buried footing, then no Condition State shall be assigned.

### *x). Comments*

The Inspector is required to give a full description of the component's condition including any defects – type, magnitude and extent (this includes details of crack widths and extents). If works have been proposed these "Comments" must also include enough details for the Asset Owner to determine scope of work, assess repair options and prepare estimated cost of repairs.

#### *xi). Sketch Number*

Where the Inspector considers that a sketch is useful to further show or explain an issue, the sketch is to be given a reference number (i.e. 1, 2, 3, etc.). The sketch's reference number(s) is to be written in the table in the appropriate location that is relevant to a particular item and comment.

#### *xii). Photograph Number*

All photographs taken of the bridge are to be given a reference number (i.e. 1, 2, 3, etc.). The photograph's reference number(s) is to be written in the table in the appropriate location that is relevant to a particular item and comment.

#### *xiii). Work Required (Y/N)*

Where a defect has been observed relating to a particular inspection item that requires repair, a "Y" for yes, is to be written in the "Work Required (Y/N)". If no work is required, an "N" is to be written in the "Work Required" section. This section may only be left blank for General Items on the Bridge sheet when that particular component is not present on bridge being inspected.

#### *xiv). Work Item Number*

Where the Inspector considers that maintenance or other further work is required, the standard work item description code(s) is to be written in this box. Information and background regarding work items is provided in Section 15.0. If multiple work item codes for the same component are considered appropriate comments (x) a work description and priority shall be provided for each work item.

#### *xv). Work Description*

Where the Inspector has designated that maintenance or further work is required, the standard work item description needs to be written in the "Work Description" box. This is automatically populated when using the electronic inspection report template. Further description and details required to be able to determine estimated costs shall be added to the "Comments" box.

#### *xvi). Priority*

For all work that has been reported as being required, a suitable priority needs to be allocated by the Inspector and written in the "Priority" box. Refer to Section 16.0 for details. The Inspector should note that any defect that has a critical safety deficiency (i.e. that has the potential of resulting in sudden failure and is of immediate threat to public safety) must have its work requirement allocated as a '0' Priority rating.

### *7.1.3. Attachments*

There are mandatory attachments that supplement the inspection form and other items that may be required to complete the report, depending on what has been identified in the inspection process (i.e. the level and/or severity of defects encountered).

#### *i). Site Conditions Sheet*

This is a mandatory requirement. The following information is required:

- Drive Through: The clear visible line of sight for a driver approaching the bridge from either direction.
- Traffic Control: Location of traffic management signage and controls from both abutments if different to details in the generic traffic management plan. Refer also Section 6.2.
- Parking Position: The safest position to park a vehicle close to the bridge, distance and location.

- Access to Abutments: Describe the access conditions and any special equipment used to access each wing of the bridge. General vegetation should be noted if impeding access.
- Access to Piers: Describe the access conditions and any special equipment used to access the piers along each side of the bridge. General vegetation should be noted if impeding access.
- Pier Headroom: The maximum and minimum headroom at piers (if present) to assist in determining the appropriate access equipment needed for inspection.
- Potential Hazards: Any hazards identified that may affect the safety of the bridge inspection.
- Fences: Details of any fences attached to or located near the bridge which prevent inspection or affect the safety of the bridge inspection.
- Water: Depth, flow, conditions and location of any water underneath the bridge at the time of the inspection.
- Powerlines: Proximity of powerlines that may impact the use of under bridge inspection units or other special access equipment in the safe inspection of the bridge.

### *ii). Guardrail Information Sheet*

This is a mandatory requirement. The following information is required:

- Barrier Type: Cross the applicable barrier type at each location it exists. Only indicate on this section of the sheet the existence of a barrier which was installed with the intent to protect vehicular traffic and contain errant vehicles within the bridge carriageway. Refer www.mainroads.wa.gov.au selecting "Building Roads", "Standards and Technical", then "Road and Traffic Engineering", "Roadside Items", "List of Approved Road Safety Barrier Systems" for the MRWA approved barrier types.
- Post Type: Cross the applicable post type at each location it exists. If steel posts are present, indicate the section type using the legend provided.
- Posts Off Bridge: The number of posts and length of barrier (recorded to 1 decimal place) off the bridge is that portion beyond the abutment centreline or expansion joint, if present, measured to the end of the guardrail. If the length of railing off Bridge is >40m inspection report shall indicate 20+ for number of posts or 40+m for length of barrier.
- Visibility Barrier: Cross the applicable visibility barrier type at each location it exists. A visibility barrier is a barrier intended to provide an indication of the extent of the bridge width but is not intended to provide protection to an errant vehicle.
- Top Rails: Cross the applicable top rail type at each location it exists.
- End Terminals: Cross the applicable end terminal type at each location it exists. Refer www.mainroads.wa.gov.au selecting "Building Roads", "Standards and Technical", then "Road and Traffic Engineering", "Roadside Items", "List of Approved Road Safety Barrier Systems" for the MRWA approved end terminal types.
- Structural Problem Found? (Y/N): If the guardrail is found to have major structural damage then the Inspector shall indicate this by placing a "Y" in the box provided along with a comment describing the specifics of the problem. If no issues are seen or damage is not considered serious "N" shall be placed in the box provided. (Note: Guardrail condition and work requirements are not detailed on this inventory sheet but on the appropriate inspection sheet.)

### *iii). Bridge Inspection Summary*

This is a mandatory requirement, to summarise the inspection findings in a one page summary.

### *iv). Work Items – Summary*

The Work Items – Summary sheet summarises all of the required work items identified throughout the report. Each work item listed is allocated a priority. The "Comments" field is to be used to identify the location for the required works.

### *v). Location Map Sheet*

This is a mandatory requirement. Map sheet or Location sheet must show the location of the structure on the road network. It should provide adequate information to ensure that the structure can be located from the map sheet. This should be extracted from the MRWA Structures Location Map Book, refer Section 5.3 for source.

### *vi). Photo Sheets*

This is a mandatory requirement. A photographic record is a very important part of the Level 2 inspection process. The Inspector must include as many photographs of the structure as necessary to adequately cover all damage or defects identified. It is very important to ensure appropriate quality of the photographs – clarity, focus, exposure and contrast. Refer to Section 10.0 for further details of photographic requirements.

### *vii). Sketch Sheet(s)*

To be used (usually in addition to photographs) where a sketch will be useful to help show a problem observed in detail. Sketches of cracking patterns are often useful. The sketch sheet should be titled with the bridge number and inspection date for reference.
Sketches can be hand drawn, computer generated or combination of, ensuring that issues are clearly identified for future reference.

### *viii). Other (specify)*

Any other additional useful information that provides further information regarding the current condition of the structure. This could, for example, be a page of additional comments, or additional pages for commenting on further components when there has been inadequate space on the standard form.

## 7.2. Detailed Visual Bridge Inspection Report for Precast Box Unit Bridges

The Detailed Visual Bridge Inspection Report for Precast Box Unit Bridges is also compiled on a series of standard forms or worksheets. They consist of:

- Site Access ("Site Conditions") sheet (Refer Section 7.1.3 i) for more details – although the terminology of 'piers' is not applicable to precast box unit bridges, the same sheet is to be used with 'piers' representing the next barrel leg
- Guardrail Information sheet for collating and recording bridge guardrail inventory. The condition of the guardrail is not recorded on this inventory sheet but on the inspection report sheets (Refer to Section 7.1.3 ii) for more details)
- Inspection Report sheets which consist of: General location and geometric information; Delineation; Road Surface; Guardrails/Barriers; Road Drainage; Footpaths; Waterways, Vegetation and Debris; Structure – Walls & Aprons; Structure – Barrels; and additional comments sections
- Work Items – Summary
- Bridge Inspection Summary sheet
- Location Map sheet
- Photo Sheets
- Sketch Sheet(s) as required

Refer to Appendix G(ii) for an example of a completed inspection report and Appendix H(ii) for the inspection report template.

### *7.2.1. General Details & Geometry (page 1)*

The first part of the inspection report is the identification information which requires the Inspector to input the details to identify the structure and its precise location. The following information is required:

General Details:

- Bridge Number
- Crossing Name
- Road Name
- Road Number
- SLK (Refer to Section 7.1.1 for definition)
- Local Govt. (Authority)
- Responsibility Area (Refer to Section 7.1.1 for definition)
- Owner
- Inspected By
- Inspection Date
- Latitude and Longitude (Refer to Section 7.1.1 for definition)

Geometry:

Geometric or location details are to be identified, checked and verified at the time of inspection and recorded in this section of the form so the computerised bridge asset management database (Integrated Road Information System (IRIS)) can be updated.

- No. Barrels: The number of barrels (cells or openings) underneath the road. Refer to Figure 7.2.1a below.

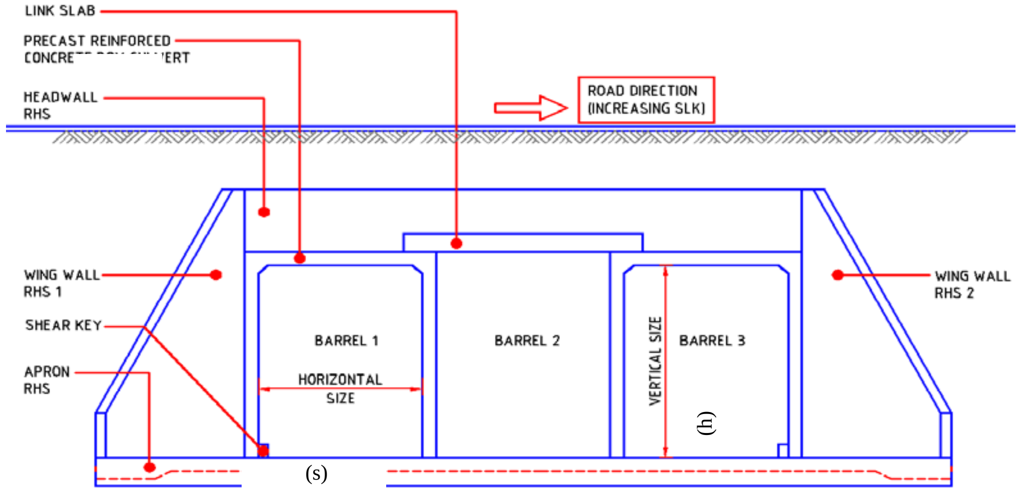



**FIGURE 7.2.1A - TYPICAL PRECAST BOX AND LINK SLAB, ELEVATION**

Total Width: The total width is measured from the left side edge of the box unit structure, across the road, to the right side edge of the box unit structure, perpendicular to the road centreline, measured in metres to two decimal places.

- Length: The distance from the outermost wall to outermost wall of the two end barrels (cells) of the structure, measured parallel to the road centreline and measured in metres to two decimal places. Refer to Figure 7.2.1b below.

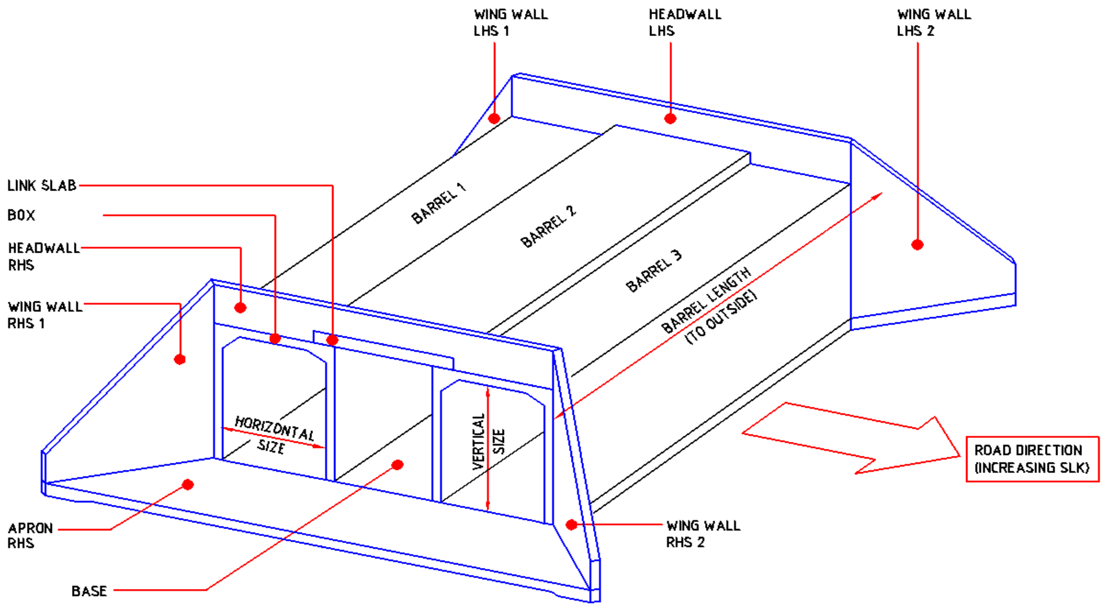



**FIGURE 7.2.1B – 3D PRECAST BOX AND LINK SLAB BRIDGE**

- Opening Size: The size of the box unit opening providing span measurement (s) (referred to as horizontal size in the above diagrams) and height measurement (h) (vertical size) measured in metres to two decimal places.
    - o The span dimension (s) is the internal width of the box unit. See Figure 7.2.1a above.
    - o The height dimension (h) is the vertical height from invert to obvert of the box unit. See Figure 7.2.1a above.
    - o There may be some variation in dimensions from one barrel to another in some structures. Where this occurs, report the barrel dimension of the box unit opening rather than dimension at link slab opening (where present).
    - o Where there are precast box units of different size, the largest size shall be recorded and notes describing the other dimension(s) shall be recorded in the additional notes section.
- Skew (Refer to Section 7.1.1 for definition)
- Width Between Kerbs (Refer to Section 7.1.1 for definition)

  or if there are no kerbs
- Formation Width: When no kerbs are present, the formation width is measured. This is the measurement from the edge of shoulder to edge of shoulder across the road. It is measured perpendicular to the road and is measured in metres to two decimal places.
- Structure Diagram:

The diagram is a useful reference for filling in some of the geometric information. It also requires the Inspector to fill in some additional information, as follows:

| | |
|---|---|
| To: | Refer to Section 7.1.1 for definition. |
| Show North: | Refer to Section 7.1.1 for definition. |
| Show Flow Direction: | Refer to Section 7.1.1 for definition. |
| Fill: | The height of fill above the box units (i.e. depth of soil from the top of the box unit to the road surface) is measured at the structure's inlet in metres to one decimal place. The measurement is to be written on the diagram at the inlet side of the structure (which depends on the direction of flow). |

- Inspector's Declaration Sign Off :

The last part of the inspection form requires the Inspector and Auditor to sign off the report on the basis that the structure has been inspected in accordance with the requirements of these guidelines. The Inspector and Auditor are also required to write in their position, organisation name and date.

### 7.2.2. Detailed Inspection Forms

The second part of the form is provided for the recording of defects and onsite observations made by the Inspection team. This part is structured to provide a consistent approach to the inspection and recording of information. It has eleven "Inspection Item" categories requiring comment: Delineation; Road Surface; Guardrails/Barriers; Road Drainage; Footpaths; Lights; Services; Walkway; Waterways, Vegetation and Debris; Structure – Walls & Aprons; Structure – Barrels.

#### i). Inspection Items

Comments about each of the Inspection Items should include details of the location and extent of defects, and should cover the following aspects. (Refer to Section 8.0 for details on what needs to be checked for each of the item categories.)

| | |
|---|---|
| Delineation: | The condition of the signs and delineators that indicate presence or edge of structure: whether missing, damaged, obscured, for each approach i.e. Approach 1 and Approach 2. |
| Road Surface: | The condition of the approaches and road surface: material defects, surface defects, settlement, depressions, joint transitions, kerbing, shoulders, line marking, and services. |
| Guardrails/Barriers: | The condition of the guardrails/barriers: damage, connections, alignment and material defects. |
| Road Drainage: | The condition of any spoon drains, drains, gully traps and erosion. |
| Footpaths: | The condition of the footpath (a path structurally connected to the bridge, traversing the same crossing) and the condition and effectiveness of the drainage, the evenness, surface condition and railing. |
| Lights: | List what lights are present and their location. The condition of the lights: visibility, damage, connections, stability and material defects. |
| Services: | List what services are present and their location. The condition of the services: damage, connections, fittings and material defects. |
| Walkway: | The condition of the walkway (a pedestrian path underneath the bridge) and the condition and effectiveness of the drainage, the evenness and surface condition. |
| Waterways, Vegetation: and Debris | The condition of the waterways and the vegetation control area: vegetation and debris in waterways and clearance envelope, embankment erosion, scour, silt build-up, blockages, damaged guide-banks, revetment mattresses and rock protection. The depth of silt build-up shall be recorded so as to be able to determine the remaining waterway depth of the box unit. |

Structure – Walls & Aprons: Comment is required on their condition and should include descriptions of: material type; condition of the item; defects, such as: impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining and settlement/movement. Comments should also describe the effectiveness and condition of previous repairs.

Separate comments are required for headwalls (LHS, RHS), wing walls (Abutment 1 LHS, RHS; Abutment 2 LHS, RHS), and aprons where these items are present.

Structure – Barrels: Comments should describe: material defects (e.g. impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining and settlement/movement. Comments should also describe the effectiveness and condition of previous repairs.

Comments are required for each barrel and joint making up the precast box unit bridge. It is common that multi cell construction of precast box units uses link slabs and base slabs. The link slabs span the gap equal to the span between adjacent units. The link slabs may be either precast, or cast on top of the base slab and simply lifted into position. These are treated as the soffit and base of a barrel, rather than a separate structural component, and are recorded as such in the inspection form.

The Inspector is to identify what Barrel No. and Unit No. is being commented on, for example Barrel No. 1, Unit No. 2. All barrels are to be commented on and each row in the table is set up for comments for one barrel. If the form has inadequate rows to cover all barrels (twelve are provided on the form), the Inspector should use an additional copy of page 4 of the form (blank) and use this for providing comments on the remaining barrels.

Each barrel will be made up of a series of connecting box units. Again, all units within each barrel should be inspected, where possible, and any defects encountered should be commented on including providing detail of what *unit number* the comment refers to.

#### ***ii). Supporting Information***

The table of the Inspection Forms also provides for the Inspector to add the following details for each of the Inspection Items 1 to 11, where applicable:

Sketch Number: Refer to Section 7.1.2 for definition.

Photograph Number: Refer to Section 7.1.2 for definition.

Work Required (Y/N): Refer to Section 7.1.2 for definition.

Work Item Number: Refer to Section 7.1.2 for definition. A list of Work Item codes is provided on page 6 of the Inspection Form for easy reference.

Work Description: Refer to Section 7.1.2 for definition.

Priority: Refer to Section 7.1.2 for definition. Guidance on Priority Codes is provided on page 6 of the Inspection Form for easy reference.

#### *iii). Special Requirements for Inspection Items 10 & 11, “Structure”*

Condition State: The Inspector is required to assess the structural condition of the key components of the box unit bridge. The components that require assessment are:

- Walls & Aprons: Headwalls, wing walls and aprons;
- Barrels: All barrels, link slabs and base slabs (and all units that make up each barrel).

Headwalls, wing walls and aprons shall only be assigned Condition States when they are considered structural components. Other non-structural walls and aprons (such as masonry wing walls) shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.

For guidance on how to determine the Condition State of the components refer to Section 14.0, Appendix A, Appendix B and Appendix C.

Not Inspected (%): In some circumstances it may not be possible to inspect the entire box unit structure. This may be due to water flow or blockages from large debris, for example. It is important that the Inspector accesses as much of the structure as possible for inspection. Where the Inspector has been unable to inspect the entire structure, the estimated percentage *not* inspected must be recorded for each particular item and in the additional comments section give the reason why it cannot be fully observed.

#### *iv). Additional Comments (page 5)*

The bottom part of page 5 of the inspection form allows for additional comments to be made, if required. This can be used if there is inadequate space in the “Comments” or “Work Description” Sections in the main table. In this case there needs to be clear reference to what item the comment refers to.

#### *v). Other Information Required*

Top of Page Information: Each page (pages 2 to 6) has at the top, information to fill in to ensure that it is possible to identify what bridge each page of the inspection report refers to. Information that is required is: Bridge Number, Road Name, and SLK.

## 7.3. Detailed Visual Bridge Inspection Report for Arch Bridges

Arch bridges are similar in component composition to precast box unit bridges and the Detailed Visual Bridge Inspection Report for Arch Bridges is almost identical to the series of standard forms or worksheets previously detailed in Section 7.2.

The terminology of ‘barrels’ for precast box unit bridges is replaced with ‘arches’ for arch bridges. Aprons are not features of arch bridges but footings at each abutment carry the load from the curved arch and keep the ends of the bridge from spreading outwards, so there are some minor differences in terminology and reporting requirements.

Refer to Appendix H(iii) for the inspection report template.

# 8.0 CHECKLIST FOR INSPECTING BRIDGE, BOX UNIT BRIDGE AND ARCH BRIDGE COMPONENTS

The comments, supporting photos and sketches that the Inspector provides throughout the bridge inspection report are critical to the recording of the bridge's current condition. This information is vital as it enables comparison of condition with previous inspections and it is used in the decision making process for any maintenance requirements, refurbishment, and replacement needs or load rating. Thorough and concise information must be provided in conjunction with accurate assessment of Condition State of the bridge's components.

The Inspector should refer to the following checklist and prompt items to ensure the condition of all the components has been reviewed thoroughly as part of the inspection process.

Refer to Appendix E for bridge component identification and terminology and typical concrete and steel bridge types. Refer to Appendix F for more information on common issues found in various bridge types and bridge components.

## *General*

The Inspector's comments for the following Sections (Sections 8.1 to 8.10) are input into either:

- The "*Group – Bridge*", "*Group – Approach*" or "*Group – Deck*" worksheet of the Detailed Bridge Inspection Report; or
- Items 1 to 9 of the Precast Box Unit Bridges or Arch Bridges Inspection Report.

### 8.1. Vegetation

Uncontrolled and excessive growth of vegetation under or adjacent to the bridge does not in itself cause damage. It can however create fire hazards, blockage to the waterway and build-up of debris and moisture and for these reasons excessive vegetation should be reported.

Vegetation Clearance Envelopes for bridges are outlined in MRWA Drawing No. 1230-1666, available on MRWA's Internet site www.mainroads.wa.gov.au selecting "Building Roads", "Standards and Technical", then "Structures Engineering", "Asset Management" and refer to the "Vegetation Clearance Envelopes" document.

Check encroaching vegetation near the structure. Consideration also needs to be given to encroaching vegetation that could obstruct the operation of the underbridge inspection unit, particularly on high bridges. Note that some vegetation within the bridge's embankments or edge of stream bed can provide embankment or bed stability and should not automatically be considered a hazard.

## 8.2. Drainage

Ineffective drainage may affect a bridge in several ways:

- flooding of the bridge deck which may create a serious traffic hazard
- water flowing uncontrolled through joints and over concrete, or steel surfaces, or bearings below deck level may result in corrosion or unsatisfactory performance of bearings
- debris carried by drainage flows will build-up in areas, retain moisture, and promote corrosion
- uncontrolled discharge from the deck can cause erosion of approaches, batters and possibly undermine foundations
- leakage from the bridge deck through joints and cracks may cause unsightly staining of beams, piers and abutments

Inadequate collection of runoff water from the bridge approaches can also cause erosion, piping, or scour of the approach embankment and batter slopes, particularly in areas where flows are concentrated at the end of the bridge around the end post and at ends of kerbs or service ducts. These areas should be inspected, particularly after heavy rain or flooding.

Check the drainage holes or scuppers on the bridge to see if they are blocked, scoured, or have good drainage. Any gravel or vegetation build-up along the kerbs should be noted as possible blockages to effective drainage. Check if there is any evidence of ponding on the bridge deck. Also check drainage at approaches (e.g. in gully traps, spoon drains) to ensure that they have good drainage, or if they are blocked or scoured.

## 8.3. Waterway Area and Scour

The build-up of debris on the upstream side of a bridge over a waterway prone to flooding can cause the following adverse effects on the bridge:

- blockage of the bridge waterway during flooding which can exacerbate problems of scour, undermining of foundations, flooding and, in extreme cases, total blockage and diversions of the watercourse; and
- impose loads on the bridge during flooding for which it was not designed.

The build-up of debris is dependent on upstream catchment conditions and is usually most severe in bridges with small openings or low freeboard.

Excessive scouring of foundations caused by stream flows or changes in the alignment of the stream channel can result in progressive undermining of abutments and piers, which if not rectified may ultimately cause total failure of the bridge.

Where evidence of scour, degradation or aggradations of the stream bed exists, this shall be noted by the Inspector as a record of the existing condition which then may be compared with the relevant data in the past and future inspections.

Check for and comment on:

- Stream bed condition
- Slope protection (e.g. revetment mattress, rock protection) and condition
- Embankment condition
- Evidence of overtopping and damage
- Bed scour around the structure, including abutments and piers and the extent (record scour depths)
- Check for possible causes of scouring
- Check abutments for undermining
- Obstructions and debris build-up
- Silt build-up

## 8.4. Signs and Lights

For signs, check for and comment on visibility to the road user, damage, cleanliness, any loose or missing bolts. List what signs are present and their location. Check the alignment of width markers relative to the kerb/guardrail to ensure they appropriately indicate the edge of the traffic lane.

For lights, check for damage and any loose or missing connections or fittings. Check for the stability and condition of light poles.

## 8.5. Fences

Check for fences and note what types are present (e.g. barbed wire, electrified, etc.). Note if they are attached to the bridge or causing debris build-up and scour around the base of piles or piers and if this is causing scour or blockage to the waterway. Comment shall be provided as to whether the fences impede access to abutments or pose a hazard to inspection.

## 8.6. Services

Check for and comment on any services attached to the bridge e.g. MRWA Intelligent Transport Systems (ITS), Telecommunications, Power, Water pipes, Gas etc. Check for damage and any loose or missing connections or fittings.

## 8.7. Substructure Protection

Check for and comment on the condition and the alignment of any bollards, barriers or other systems that have been built with the main purpose of protecting a particular substructure bridge component (i.e. barriers around footbridge pier columns to protect them from vehicular collision). Detail the type of protection present and check for and comment on details as per Section 8.8.

## 8.8. Guardrail, Kerbs and Railing

Check for and comment on the condition and the alignment of the railings and kerbs on the approaches and on the bridge. Detail the type of railing present (even if it is only visibility railing) including the terminal end types (if present).

Check for and comment on:

- Condition of guardrails/railing. Provide description of guardrail/railing present (including terminal end types)
- Alignment of railings (especially vertical). Note any dips in guardrailing that may be resulting from settlement of approach slabs, bridge supports or deflection in spans.
- Quality and condition of welds
- Orientation and condition of rail laps
- Post connection
- Rail condition
- Accident damage
- Accumulation of road debris along kerb face

A visibility railing is a barrier intended to provide an indication of the extent of the bridge width but is not intended to provide protection to an errant vehicle. This differs from a Guardrailing which has been installed with the intent (at the time of design) to protect vehicular traffic and contain errant vehicles within the bridge carriageway.

## 8.9. Road Surface on Bridge and Approaches

The ride ability of a bridge may give an indication of other problems to the structure. Particular attention should be given to bumps at joints or uneven road surface as these problems could be related to settlement or movement of the substructure. This can lead to over stressing and cracking of the components (due to high impact loading) and their subsequent deterioration.

Issues that may be observed at the bridge approaches can often be related to problems with the bridge embankments. The purpose of the embankment is to provide a stable road between the bridge and surrounding ground. Often it is also required for providing support for the abutment.

The most common defect of approach embankments is excessive settlement adjacent to the bridge abutment, which causes unsatisfactory riding condition and possible damage to deck and expansion joints. This can result from a poorly compacted embankment, and/or continuing settlement of the underlying ground. Instability of ground and embankment can also be observed in its early stages by excessive settlement or movement of the embankment.

Check for and comment on:

- The ride ability of the bridge and note any areas where changes in surface level causes impact to the bridge. A spirit level and tape measure can assist with measuring any significant changes in surface level (e.g. at expansion joints).
- Any settlement of the approaches to the bridge. Measure the amount of settlement and also comment on whether there has been any surface correction undertaken.
- Any excessive deformation of the road surface
- The condition of the road surface (i.e. loss of seal, cracks, shoulders where present, and line marking)

## 8.10. Footpath

Specifically for the footpath surface (a path structurally connected to the bridge, traversing the same crossing), check for and comment on:

- Drainage (refer to Section 8.2 for details)
- Evenness and condition of surface (also a consideration for pedestrian safety)
- Railing/Barriers (refer to Section 8.8 for details)

# *Superstructure*

## 8.11. Deck Slab and Box Unit Bridge Structural Components

For this item, Box Unit Bridge structural components include: Barrels (Item 11 in the inspection report) and Arch Bridge structural components include: Arches (Item 11 in the inspection report).

Check for and comment on:

- Spalled concrete and exposed reinforcement
- Type, size, extent and location of cracking. Its orientation with respect to steel reinforcement or prestressing.
- Cracking should be marked on the concrete surface with a representative area mapped
- Rusting, extent, location and comment to its relation to reinforcement or prestressing
- Leaching, efflorescence (calcium carbonate build-up)
- Liveliness of the deck
- Condition of shear key
- Deflections, fracture, warping
- Watertightness of holes in deck accommodating lighting, posts, guardrailing etc.
- Patches of dampness seen on the soffit
- Effectiveness of any repair details
- Alignment, settlement, movement
- Instability, deflected shape, impact damage
- Water wash and abrasion damage in legs of the barrels

## 8.12. Expansion / Deck Joint

Check for and comment on:

- Condition of holding down bolts, loose or missing bolts, where visible
- Condition of rubber or mastic seal
- Condition of steel components
- Looseness or movement of joint and components, any cracking evident and its size
- Difference in level between the two joint plates
- Whether the joint is overlain or blocked with bitumen seal or debris
- Does it appear that the cover plates at the kerbs and paths slide smoothly?
- Does the joint appear to be at the limit of its range? i.e. is there a noticeable excessive gap or; does it appear to be jamming? If so record gap and ambient temperature to allow future comparison.
- Is the seal loose and popping out?
- Water seepage through the joint and onto the substructure
- Cracking and breaking up of the concrete surrounding the steel angles

For clarification an Expansion Joint is a designed joint that is designed to accommodate longitudinal movement, whereas a Deck Joint is a formed joint between two components that is designed to be flexible but does not allow longitudinal movement.

In addition an Expansion Joint is generally at an abutment whereas a Deck Joint is usually at a Pier.

## 8.13. Beams and Tie Beams

Check for and comment on:

- Condition of steel or concrete (corrosion, fire, mechanical damage). Extent of major steel corrosion should be measured using a thickness gauge to assess residual plate thickness.
- Shear cracks in concrete beams near bearings, size and extent of cracks
- Deflections (i.e. movement or deformed shape) (excessive especially under traffic)
- Tension failures over supports and at mid spans
- Spalled concrete and exposed reinforcement
- Any other cracking evident, size and extent of cracks
- Crushing at load points
- Condition and tightness of bolted connections

## 8.14. Box Girders

Check for and comment on:

- Any leakage into box or other cellular forms
- Accumulation of water or debris inside the box (where access inside the box is possible)
- Condition of drainage holes (i.e. blockage)
- Extent of major steel corrosion should be measured using a thickness gauge to assess residual plate thickness
- Cracks due to corrosion or other causes, crack size and extent of cracking. Cracks in welds in steel boxes, their extent and location. Structural weld inspection may need to be undertaken for certain types of steel structures with specialist instruments and/or personnel, refer Section 5.1.
- Spalled concrete and exposed reinforcement
- Any other major damage

## 8.15. Prestressing

In prestressed concrete components, check for and comment on:

- Any evidence of longitudinal cracking, especially in the flanges, recording size and extent of cracking
- Any evidence of transverse cracking in beams
- Any evidence of spalling or cracking of concrete in soffits
- End blocks and anchorage recess locations of post-tensioned members for signs of distress, particularly for corrosion; unbonded and external tendons
- Water leaking behind the component which could affect anchorages
- Loose rendering, particularly on soffits and edge beams which may fall off and cause injury

## 8.16. Large Static Signs and Electrification Screens

This refers to large regulatory, advisory, warning signs, sign lights, electrification screens and their connections (including support brackets) connected to bridges.

Some specific aspects that should be checked for and reported where applicable include:

- Corrosion to steel work
- Broken sign lights
- Missing or loose connections to bridge superstructure, loose bolts or turnbuckles at connections
- Fading of reflective paint on sign and general readability of sign
- Condition of coatings/paintwork on electrification screens
- Presence of graffiti
- Impact damage to sign

## 8.17. Variable Message Signs (VMSs)

This refers to any variable message signs connected to bridges, their connections, hazards associated with electrical components (i.e. exposed wires) and protective coating systems.

Some specific aspects that should be checked for and reported where applicable include:

- Corrosion to steel work
- Missing or loose connections to bridge superstructure, loose bolts or turnbuckles at connections
- Obvious electronic safety hazards (exposed wires)
- General readability of sign (Some VMSs only operate at certain times and may not be operational at the time of inspection. This shall be noted in the report.)
- Presence of graffiti
- Impact damage to sign

# *Substructure*

## 8.18. Abutments, Piers, Footings, Capbeams, Pile Caps and Box Unit Bridge Structural Components

For this item, Box Unit Bridge structural components include: Headwalls, Wing Walls and Aprons (Item 10 in the inspection report) and Arch Bridge structural components include: Headwalls, Wing Walls and Footings (Item 10 in the inspection report).

'Piers' includes Columns and Piles that extend above ground level to the superstructure.

With footings and pile caps, a large proportion of these components may not be visible as they will most likely be partially (or possibly completely) buried. If the component is buried but is determined to be reasonably accessible (within 500mm of ground level), the Inspector is to dig to expose the top of the component. The Inspector is to report on the visible parts of the component(s) and ensure that the "Not Inspected (%)" is recorded in the report.

Movement of the piers and abutments may result from:

- scour of the stream bed
- movement of the ground due to land slips at or around the bridge abutment
- excessive earth pressure caused by movements or settlements of the approach fill
- lateral earth pressure from adjacent construction
- soil liquefaction
- collisions, in the case of bridges over navigable waterways, roads or railways
- 'freezing' up of bearings or expansion joints

Movements can usually be detected by observing the following:

- total closures or excessive openings of deck expansion joints
- misalignment of guardrails
- bearing or jamming up between the end of the superstructure and abutment back wall with associated cracking and spalling that may occur
- cracking or excessive settlement of the approach embankments or heaving at its toe
- scour causing undermining of the foundations
- out of verticality of columns or adjacent poles, fences etc.

These observations should be reported as the movements of the structure or approaches could continue over a period of time and comparisons with past and future inspections is important to assess whether it is on-going, seasonal or has ceased.

Check for and comment on:

- Any signs of instability or deflected shape
- Cracks in the walls, columns etc.; crack size and extent of cracking
- Proper functioning of weepholes
- Spalled concrete and exposed reinforcement
- Corrosion damage to steel piles. Extent of major steel corrosion should be measured using a thickness gauge to assess residual plate thickness.
- Permanent deformations such as buckling, kinking, warping and waviness
- Alignment, settlement, movement
- Water wash and abrasion damage
- Any other major damage

## 8.19. Bearings

Check for and comment on:

- Mechanical and fire damage
- Build-up of soil debris around bearings
- Condition of bolted joints, bearings and bearing plates
- Bearing seating for any signs of relative movement between the seating and the supporting structure and for any signs of cracking
- Seating and alignment of bearing
- Settlement
- With elastomeric bearings, check particularly for: horizontal cracks near the junction of the rubber pad and the steel laminate; splitting; tearing or cracking of the outer casing; for bulging and distortion; and excessive rotation.
- With low friction sliding material bearings (e.g. PTFE in pot bearings), check particularly for: effectiveness of the sliding surface; the bond between the PTFE layer and the base plate for soundness.

# 9.0 ON SITE MEASUREMENT AND MARK-UP

An important part of the inspection process is the measurement and mark-up of observed defects. Doing this on site at each inspection enables tracking of the rate of deterioration. This is particularly relevant to cracking.

Engineering judgement is required to decide the extent of mark-up. If the issue is widespread and each span (or component type) shows similar defects, instead of marking all areas in detail, the Inspector is to thoroughly detail a typical area with comments that the detail is typical to whichever other spans (components).

Marking up on the bridge is usually done with permanent marker pen but the Inspector should also consider the aesthetic impacts of this. Sketches should be considered as a viable alternative to on bridge mark-ups in such situations.

There are certain conventions to be used when marking up defects:

- A fret is marked by drawing a circle around the small fret close to the crack, refer Figure 9.1.
- A crack extent is marked by tracking the crack just to one side of the actual crack. The ends or extent of the crack are marked with a perpendicular line. Refer Figure 9.2.
- The size of the crack is measured at intervals along its length and marked using arrows or lines either side of the measurement with the crack size also recorded, refer Figure 9.2.
- A spall or area of defect (e.g. honeycombing) is marked by drawing around the defect area, refer Figure 9.3.

All defects marked on the bridge need to also include the date of the record (month and year, e.g. mm/yy).

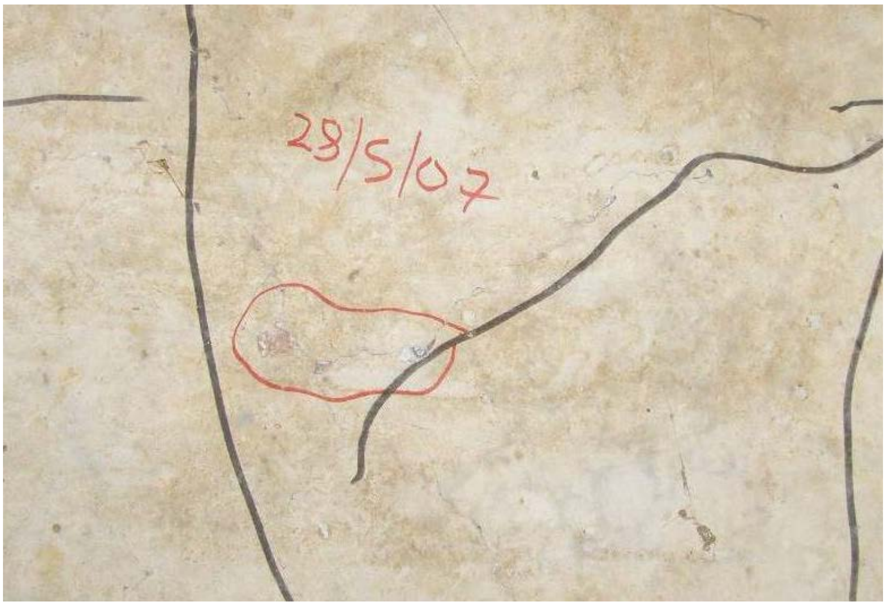



**FIGURE 9.1 - FRET MARK-UP**

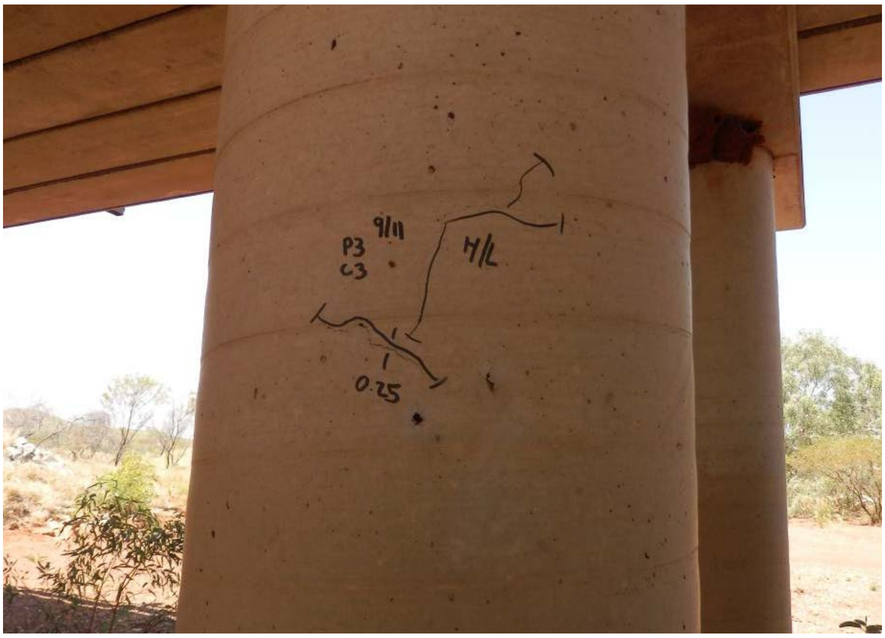



**FIGURE 9.2 - CRACK MEASUREMENT AND MARK-UP**


**FIGURE 9.3 - HONEYCOMBING (AREA DEFECT) MARK-UP**

# 10.0 PHOTOGRAPHIC REQUIREMENTS

Photographic records of the bridge inspection are a vital part of the inspection reporting process. Photographs are to be taken at the time of the bridge inspection. They are used to provide site information of the bridge and to support comments on the condition of the bridge reported by the Inspector.

The quality of the photographs must be ensured before leaving site. Clarity, focus, exposure and contrast are all important. Where a photograph is taken to identify the presence of cracking or defect consideration needs to be taken when composing the picture to ensure orientation, extent and location of the defect can be located and identified at a later date. This may necessitate the need for a sketch or "location map".

Each photograph is to be numbered. Photograph numbers are referenced in the "Photograph Number" column of the Bridge Inspection Report sheets for each Group. Where photographs of individual structural components are taken, details of Pier/Span numbers and Pile/Column/Beam (etc.) numbers must be recorded with comments.

Each photograph included on the Photo Sheet(s) must have a caption. The caption must provide a clear description of the photograph using terminology as outlined in Appendix E. It should also be as brief as possible. As a guide, the following photographs are to be taken and included in the Bridge Inspection Report.

The following photographs are mandatory and are to be taken and included in the Bridge Inspection Report.

## 10.1. Mandatory Photographs for Bridges

(i). Overall view from abutment 1.
(ii). Overall view from abutment 2.
(iii). Abutment 1 LHS approach railing configuration
(iv). Abutment 1 RHS approach railing configuration
(v). Abutment 2 LHS approach railing configuration
(vi). Abutment 2 RHS approach railing configuration
(vii). Left hand side view from abutment 1 (or 2).
(viii). Right hand side view from abutment 1 (or 2).
(ix). Left hand side wingwall at abutment 1.
(x). Abutment 1 face from LHS (or RHS).
(xi). Right hand side wingwall at abutment 1.
(xii). Left hand side wingwall at abutment 2.
(xiii). Abutment 2 face from LHS (or RHS).
(xiv). Right hand side wingwall at abutment 2.
(xv). Span __ layout (typical) from LHS (or RHS).
(xvi). Pier __ layout (typical) from LHS (or RHS).

## 10.2. Mandatory Photographs for Precast Box Unit Bridges and Arch Bridges

(i). View from approach 1 end
(ii). View from approach 2 end
(iii). View of the box unit bridge or arch bridge from the left hand side
(iv). View of the box unit bridge or arch bridge from the right hand side

## 10.3. Requirement for Additional Photographs

Additional photographs should be taken to clarify recorded defects and enhance the Bridge Inspection Report. Photographs are to be taken of all components in deteriorated condition. Map or widespread type defects should be captured using an overall photograph to show the extent as well as a close up photograph to show the detail. The photographs may also be used to supplement sketches drawn.

When photographing defects, include a reference object in the picture, e.g. a crack gauge or portion of a measuring tape to allow a better appreciation of the defect size and distribution.

Further photographs of the following items, where present, are also required:

(i). New repairs
(ii). Strengthening works (including propping)
(iii). Wing wall detail (typical)
(iv). Widening detail
(v). Expansion joint (typical)
(vi). Bearing (typical)
(vii). Accident, fire damage or vandalism
(viii). Services
(ix). Footpath details
(x). Scour or other waterway issues
(xi). Bridge and approach guardrail (typical)
(xii). Substructure protection

# 11.0 TYPES OF CONCRETE DETERIORATION

This section describes commonly found types of concrete defects. Brief explanations are given for the likely causes as a guide only. Further detailed evaluation may be required to fully assess the reason for deterioration or failure. Refer to Appendix F for more information on common issues found in various bridge types and bridge components.

Concrete is used in bridges as mass concrete or normally it is combined with steel reinforcement or with prestressing steel. Defects in concrete are often related to the lack of durability resulting from the composition of the concrete, poor placement practices, poor quality control, insufficient curing or the aggressive environment in which it is placed.

The Inspector should refer to the following deterioration checklist items to ensure that the condition of the materials has been reviewed thoroughly as part of the bridge inspection. Special attention also needs to be paid to the condition of any new repairs and strengthening works that may not have previously been reported.

It is important that photographs of any deteriorated areas identified are taken along with a description of the extent and severity of the problem. Refer to Section 10.0 for further details.

The Inspector should check for and comment on the following, where present in the structure:

(i). Cracking
(ii). Scaling and Disintegration
(iii). Delamination
(iv). Spalling
(v). Dampness
(vi). Leaching
(vii). Leaking Joints
(viii). Rust Stains
(ix). Surface Defects
(x). Patching or other repairs
(xi). "Wear and Tear" (abrasion, erosion, cavitation)
(xii). Fire Damage

A description of each of the defects is given below.

## 11.1. Cracking

A crack is a linear fracture in concrete which 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 the concrete cracks and the tensile force is transferred completely to the steel reinforcement. The crack width and distribution is controlled by the reinforcement in reinforced and prestressed concrete, whereas in plain concrete there is no such control.

The causes of cracking can be numerous. Cracking is expected in tension zones and some are considered harmless. Cracking may be indicative of a particular cause or it may be due to complex issues present that require careful evaluation. The types of cracking that are most likely to be observed are shown in Figure 11.1a.

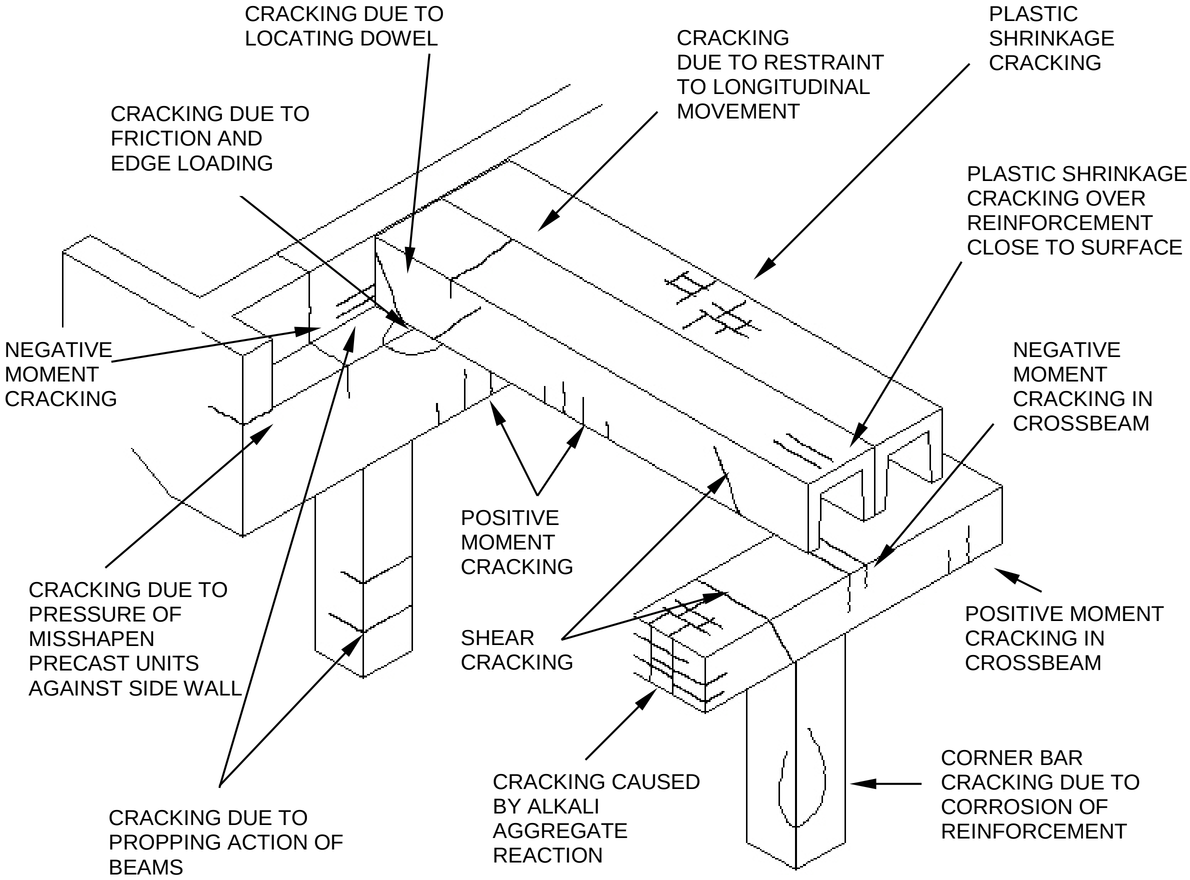



**FIGURE 11.1A - CRACKING IN CONCRETE BRIDGE STRUCTURES**

The significance of proper recording and monitoring of crack width is twofold. Firstly, increase in the crack size/width indicates that the effect that has caused it in the first place is getting more severe. And secondly, a wide crack removes the protective concrete cover around the reinforcement locally and enables the penetration of contaminants, which may induce corrosion.

Types of cracking and what it may be due to:

- Shrinkage cracking is often fine cracking that usually occurs in a structured pattern. Plastic shrinkage cracking usually appears when the concrete is still plastic, thirty minutes to six hours after placement. Drying shrinkage cracking forms weeks to months after placement and is caused by high water content or poor curing. Shrinkage cracking may be a reflection of poor quality of material or workmanship, usually inadequate curing.
- Temperature cracking usually appears between one day and three weeks after placement and is seen on top of exposed concrete decks. The cracks are caused by temperature differences between different parts of the concrete mass. The pattern may be either: diagonal; or perpendicular and/or parallel to the span. Cracks may resemble shrinkage cracks but are generally larger in size.
- Construction cracks from inadequate curing or cold joints (inadequate bonding of two segments). Often seen at the tops of columns where they join to the crossheads.

- Crazing is often confused with other types of cracking. Crazing occurs whenever a weak surface layer is formed on the surface and this weak surface layer is unable to withstand quite small stresses which result from the differential shrinkage between the surface and the bulk. Cracks are only surface deep and as such, the depth needs to be investigated to determine whether the visual cracks are only superficial.
- Corrosion of reinforcement.
- Diagonal cracking which may indicate developing shear failure occurring near supports.
- Vertical cracks which may indicate overstress due to bending. Cracks are wider at the tension face.
- Cracking in a substructure component may indicate excessive or differential foundation movement.
- Fretting is usually caused by movement of the concrete component and cracking off of edges of the concrete will be evident.
- Cracking due to Alkali Aggregate Reactivity (AAR), also known as Alkali Silica Reaction (ASR) in Australia because alkali carbonate reaction is not common, is usually small closely spaced map or block type cracking and can occur in areas of little or no stress. Cracking does not follow lines of reinforcement.

  ASR is the name given to the phenomenon where some aggregates react adversely with the alkalis in cement to produce a highly expansive alkali-silica gel. The expansion of the gel under moist conditions leads to cracking and deterioration of the concrete. The cracking occurs through the entire mass of the concrete. AAR is generally slow by nature, and the results may not be apparent for many years. They also require the juxtaposition of three contributing factors: reactive silica in the aggregate, moisture and significant alkalinity.

  AAR can be difficult to recognise and identify. AAR cracks can appear similar to other causes of cracking but its closeness can result in pattern type cracking and therefore be more severe for the bridge. It is advisable to undertake testing (Level 3 Inspection) to conclusively diagnose AAR.

  The appearance of concrete affected by AAR is shown in Figure 11.1b.

**FIGURE 11.1B - CRACKING CAUSED BY ALKALI AGGREGATE REACTION**

***Crack Size (Width) Guide***

To ensure consistent descriptions of size (width) of cracks, the following convention shall be used for all cracks in concrete or masonry components:

| Description | Width of Crack |
|---|---|
| Hairline | Up to 0.1 mm |
| Fine | > 0.1 mm and ≤ 0.3 mm |
| Medium | > 0.3 mm and ≤ 0.7 mm |
| Heavy | > 0.7 mm |

**Requirement:**

Cracks should be mapped (a map of the cracking pattern) and photographed. To assist seeing the cracking pattern in the photograph the cracks should be outlined with permanent marker alongside the crack. The end of the crack should be marked. The size and length of cracks should be recorded.

Where cracking is extensive throughout the bridge and each span (or component type) shows similar defects, instead of marking each span in detail, the Inspector is to thoroughly detail a typical area with comments, mapping, sketches and photographs and notate that the detail is typical to whichever other spans (components). The Inspector must also however, provide general descriptions for all spans.

Refer to Section 9 for further details regarding on site measurement and mark-up.

Where block cracking is present, measure the size of a typical “block”. Where possible, check where cracks are in relation to steel reinforcement or prestressing cables using simple detection techniques (e.g. magnets, or cover meter) and record this information in the report. This information is most valuable and will assist in determining the likely cause of cracking.

Cracks in beams visible on one face should be checked to see if they are visible on both sides or if there are matching cracks in beam legs adjacent to beam soffits. Applicable comments should be added to the inspection report.

All unusual cracks found in any component must be monitored or referred for further assessment. If cracks appear stable and are unlikely to worsen significantly prior to the next inspection, there is no need to create a work item for monitoring.

When photographing, include a reference object in the picture, e.g. a crack gauge or portion of a measuring tape to allow a better appreciation of the size and distribution of the crack pattern from the photographs.

## 11.2. Scaling and Disintegration

Scaling is the gradual and continuous flaking or loss of surface mortar and aggregate over irregular areas to a depth of approximately 5mm. It is prone to occur in poorly finished or overworked concrete where too many fines and not enough entrained air is found near the surface. Scaling of concrete is shown in Figure 11.2a.

Loss of this cement rich layer on the surface may lead to a significant reduction in overall durability of the member.

Scaling is distinguished from spalling due to the difference in concrete depth affected – scaling is rather superficial, whereas spalling extends through the entire cover to the reinforcement (and possibly deeper). It is most commonly found on horizontal surfaces exposed to the weather and to traffic, in splash and tidal zones near the ground line, but can also be present elsewhere.

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, results in disintegration.

Disintegration of concrete is illustrated in Figure 11.2b.

FIGURE 11.2A - SCALING OF CONCRETE

FIGURE 11.2B - DISINTEGRATION OF CONCRETE

***Requirement:***
Record the depth and size of scaling or disintegration so that the progression of the defect can be monitored.

For widespread defects (as shown in Figure 11.2b), select a couple of smaller areas to detail. Refer to Section 9 for further information.

## 11.3. Delamination

Delamination is defined as a discontinuity in the surface concrete which is substantially separated but not completely detached from the adjoining concrete. Visibly it may appear as a solid surface but can be identified by the hollow sound when tapping with a light hammer.

Delamination generally begins with the corrosion of reinforcement and subsequent cracking of the concrete parallel to the exterior surface.

***Requirement:***
Record the areas of delamination, outline with a permanent marker and take accompanying photographs.

## 11.4. Spalling

A spall is a fragment of concrete detached from the structure between fracture surfaces caused by an external force, thermal action, corrosion of reinforcing steel or local overstressing of the concrete member. The spalled area left behind is characterised by sharp edges.

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 localised high compressive load concentrations, such as at structure supports, or at anchorage zones in prestressed concrete. These latter causes are, however, rare.

Spalling of concrete is shown in Figures 11.4a and 11.4b.

**FIGURE 11.4A - SPALLING OF CONCRETE IN PILE CAP**

**FIGURE 11.4B - CORROSION OF REINFORCEMENT ACCOMPANIED BY SPALLING**

***Requirement:***
Record the areas spalling, extent and depth, with accompanying photographs.

## 11.5. Dampness

Areas of the concrete surface that are wet or damp without any obvious cause may be an indication of moisture penetration through the concrete. Porous or permeable concrete often occurs where the quality of the concrete or workmanship is poor, or in areas where good compaction of concrete is difficult to achieve. Ingress of water increases the risk of reinforcement corrosion and of concrete attack by chemicals. Further investigation may be needed.

***Requirement:***
Areas of dampness should be recorded.

## 11.6. Leaching

Leaching occurs as a result of water seeping through cracks or voids in the hardened concrete. Calcium hydroxide and other constituent materials may dissolve out of the concrete as deposits on the surface.

Deposits from leaching may appear as the following:

- efflorescence – a deposit of salts, usually white and powdery efflorescence (calcium carbonate). See Figure 11.6.
- exudation – a liquid or gel-like discharge through pores or cracks on the surface
- encrustation – a hard crust or coating formed on the concrete surface at cracks
- stalactite – in extreme cases, a downward pointing formation hanging from the concrete surface

Leaching presents a long-term corrosion threat to reinforcement due to gradual loss of alkalinity of the concrete. Leaching also results in a large reduction in concrete strength – when 20% of calcium hydroxide has been leached from the concrete, the strength is virtually zero. The effects of leaching are most evident on the soffits of decks and walls such as along cracks on vertical faces of abutments and wing walls.

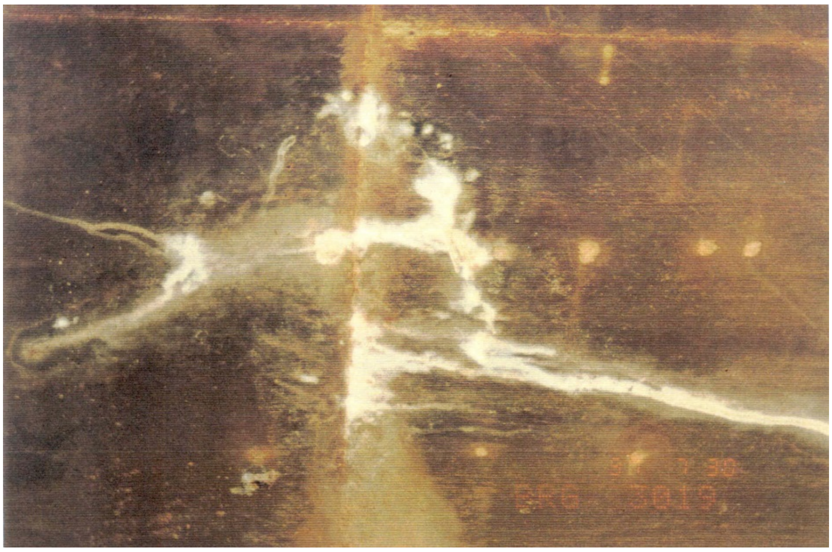


**FIGURE 11.6 - EFFLORESCENCE ON DECK SOFFIT**

***Requirement:***
Record the leaching areas with accompanying photographs. Make note if the crack has visibly sealed and leaching appears to have been only an issue in the new concrete.

## 11.7. Leaking Joints

Leaking of water takes place through concrete decks, particularly at construction joints and cracks. Leaking joints can lead to water and other contaminated fluids collecting and penetrating inaccessible parts of the structure. Leakage can lead to corrosion of the steel reinforcement or steel fixtures.

***Requirement:***
Record the locations where leaking joints are evident and support details and comments with adequate photographs.

## 11.8. Rust Stains

Surface rust stains can be the result of a variety of factors, some of which are not serious. Examples include staining from thin tie wire or from during construction, or in rare cases, from iron bearing aggregates. However, staining may also be an indication of a corrosion problem such as low concrete cover, and consequently all stains should be carefully inspected to assess if they relate to an underlying problem.

Corrosion of reinforcement is difficult to detect in the early stages, but it gradually leads to surface discolouration of the concrete and in extreme cases to cracking, then spalling exposing heavily corroded reinforcement. Rust seeks to occupy a much greater volume than the original steel and it is this expansion process that leads to concrete damage and disintegration. Pronounced damage caused by corrosion of the reinforcement is illustrated in Figure 11.4b.

In prestressed concrete structures, any indication of corroding prestressing steel is very serious as the failure of the strand or wire may lead to a non-ductile or catastrophic failure of the component.

***Requirement:***
Each rust stain should be carefully inspected (and photographed) and its precise location noted.

## 11.9. Surface Defects

Surface defects are not necessarily serious in themselves but are indicative of a potential weakness in the concrete.

***Honeycombing*** is indicated by a rough porous concrete surface where the cement paste has not adequately filled the spaces in between the aggregate. It occurs as a result of poor workmanship in concrete compaction or due to a loss of fine material in the mix from improperly sealed formwork joints. As a result of this defect, the effective concrete cover is reduced and there is risk of reinforcement corrosion and of concrete attack by chemicals. Depending on the location of the honeycombing zone in the concrete, it may cause serious structural implications over time.

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

***Cold Joints*** are produced when a delay occurs between the placement of successive pours of concrete, and therefore an incomplete bond develops at the joint due to the partial setting of concrete in the first pour.

***Requirement:***
Record the location and extent of the defect and provide photographs to show details.

## 11.10. Patching or Other Repairs

The condition of the repair or patch will indicate whether the underlying problem has been solved or if it has been merely covered up and is actively continuing under the repair. If the original problem has not been properly addressed it still may take some time for evidence of the original problem to show, so patched areas need to be monitored.

Cracking, delamination, rust stains or spalling in or around the patch indicates the problem still exists and further investigations (Level 3 Inspection) and repairs are needed.

***Requirement:***
Carefully inspect patched and repaired areas, check for cracking, delamination, rust stains or spalling around each one, record findings and the precise locations (and photograph).

## 11.11. "Wear and Tear"

Concrete components can be subjected to mechanical stresses at their surface in the course of their normal use that can result in "wear and tear". The main cause of this progressive loss of concrete mass from the surface is abrasion. However, other processes such as erosion and cavitation can also cause similar damage.

***Abrasion*** damage is caused by movement of solids over the surface wearing it away by rolling, rubbing and friction. The damage manifests itself in the form of a rough friable surface with grooving, pot holing or spalling, especially on the edges. Typical causes of abrasion are traffic movements on unsealed concrete decks and impact or friction caused by falling or moving objects. The extent of wear and resistance to skidding should be checked for unsealed surfaces. Deterioration of the deck can lead to reflection cracking but it may be difficult to distinguish between this type of failure and the failure in the surface material itself.

***Erosion*** is caused by the abrasive action of flowing water (or other liquids present), or more particularly, by the action of abrasive materials (e.g. suspended sand and other debris) carried in the water. Erosion due to water wash is generally an indication that the concrete is not durable enough for the environment in which it has been placed. Erosion damage to concrete will significantly reduce the overall durability, as it reduces the effective concrete cover. Erosion due to water wash of a concrete wall is shown in Figure 11.11.

***Cavitation*** damage is caused by the collapse of tiny vapour bubbles in fast flowing water. The collapse of these bubbles causes extreme localised pressure strong enough to wear (pit) the concrete surface.

The resistance of the surface concrete to this form of damage is a function of its compressive strength, aggregate properties, placement process and curing. The loss of cover to reinforcement threatens the longevity of the structure and if allowed to deteriorate, may eventually lead to structural failure.

**FIGURE 11.11 - EROSION OF CONCRETE DUE TO WATER WASH**

***Requirement:***
Record the areas where abrasion, erosion and/or cavitation are evident with accompanying photos.

## 11.12. Fire Damage

Sites should be actively searched for any signs of fire in the vicinity of the bridge. Due to its low thermal conductivity, concrete is often used for fireproofing of steel structures. However, concrete itself may be damaged by fire.

Concrete exposed to up to 100$^{o}$C is normally considered as healthy. Parts of a concrete structure exposed to temperatures above approximately 300$^{o}$C (dependent on water/cement ratio) turn pink, refer Figure 11.12. Hotter temperatures turn the concrete light grey and then yellow-brown over about 1,000$^{o}$C. One rule of thumb to remember is that all pink coloured concrete is damaged and should be removed and replaced.

The reinforcement or prestressing in the concrete may also be affected by fire. Yield stress and ductility can both be reduced by fire.

**FIGURE 11.12 - FIRE DAMAGE TO CONCRETE COLUMN**

***Requirement:***
Record the areas of fire damage with accompanying photos.

# 12.0 TYPES OF STEEL COMPONENT DETERIORATION

This section describes commonly found types of defects in steel components. Brief explanations are given for the likely causes as a guide only. Further detailed evaluation may be required to fully assess the reason for deterioration or failure. Refer to Appendix F for more information and common issues found in various bridge types and bridge components.

Steel as a structural material when not encased in concrete has defects related to poor quality control, loosening of connections or the aggressive environment in which it is placed.

The Inspector should refer to the following deterioration checklist items to ensure that the condition of the materials has been reviewed thoroughly as part of the bridge inspection. Special attention also needs to be paid to the condition of any new repairs and strengthening works that may not have previously been reported.

It is important that photographs of any deteriorated areas identified are taken along with a description of the extent and severity of the problem. Refer to Section 10.0 for further details.

The Inspector should check for and comment on the following, where present in the structure:

(i). Condition of protective coating (e.g. paint, galvanising)
(ii). Corrosion
(iii). Fracture
(iv). Cracking (including welds)
(v). Permanent deformations
(vi). Loose connections
(vii). Excessive wear
(viii). Condition inside closed members
(ix). Fire damage

A description of each of the defects is given below.

## 12.1. Condition of Protective Coating

Defects in the protective barrier system (e.g. paint, galvanising) are not necessarily serious or structural but they are indicative of potential weaknesses in the coating system and eventual loss of protection to the coated surface. It is rare for a protective coating system to outlast the life of the bridge and therefore it should be thoroughly inspected and asset managed accordingly.

The loss of topcoat through age is the main item requiring maintenance. Breakdown of paint or loss of galvanising is inevitable and should be anticipated. The rate of breakdown is dependent on a number of interrelated factors with "time of wetness" being the most important. This usually results from condensation and may be increased by absorption of the moisture by windborne salts settling as a residue in the areas not subjected to rain washing. Accumulations of debris, bird droppings, flaking paint etc., will all retain moisture and promote corrosion.

In addition to eventual failure of a coating system by weathering, premature failure may result from:

(i). loss of coating adhesion due to faulty specification or application
(ii). incompatibility of successive coats
(iii). subsurface rusting due to inadequate surface preparation
(iv). localised failure due to mechanical damage
(v). inadequate film build-up on sharp edges, welds and paint "shadow areas"

The protective coating can suffer from various forms of deterioration. Principal forms of deterioration for paint systems are: chalking, blistering, rust staining and flaking. Deterioration of galvanising may be seen in the form of: chalking, abrasion, blisters, spots of zinc oxidisation and rust staining.

In some cases expert advice may be required to establish the cause of the breakdown and recommend a suitable remedial action.

***Requirement:***
Record the overall condition of the protective coating and also record the condition of areas of deterioration giving detailed locations (e.g. bolts/rivets or post bases) and support with adequate photographs. Also note any areas with moisture build-up or debris retention.

AS 2312.1 - 2014 Figure 8.1 may be used as a guide for estimating and recording the rust percentage of protective coatings. A copy of this guide is shown below in Figure 11.3 for use during inspection.

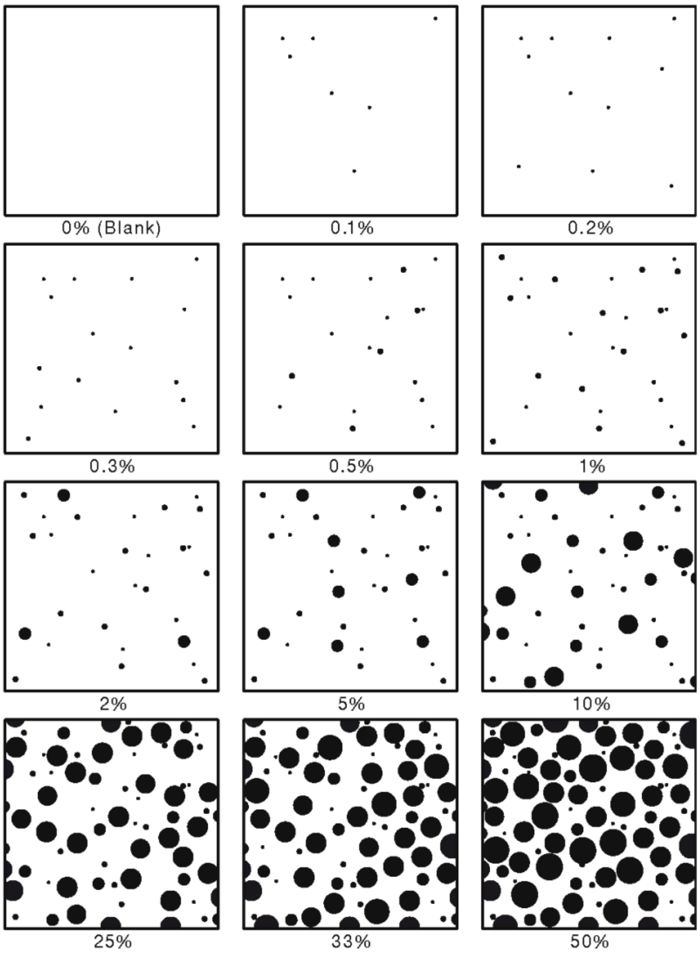



**FIGURE 11.3 - EXAMPLE DIAGRAMS FOR ESTIMATING RUST PERCENTAGES**

## 12.2. Corrosion

Corrosion, or rusting, will only occur if the steel is not protected or if the protective coating wears or breaks off. Corrosion on carbon steel is initially fine grained, but as rusting progresses it becomes flaky and delaminates, exposing a pitted surface. The process continues with progressive loss of section.

The degree, type and rate of corrosion are also highly dependent on the surrounding environment. This dominates both the rate of corrosion (steel bridge beams in the dry inland of Australia may be left uncoated), and the type of corrosion.

Assess the extent of corrosion of the steel components, the location and its form (e.g. blisters, flaking, scale, pitting, etc.). Give particular attention to: junctions of steelwork with masonry, concrete or other structural materials; and mating and rubbing surfaces.

***Requirement:***
Record the extent of corrosion, its form/appearance, the likely cause and its specific location(s). If possible, estimate the effective loss of section of corroded components (this will be difficult without having access to all sides of the component). Support with adequate photographs.

## 12.3. Fracture

Fractures are breaks in members and components and would be an indication of severe issues for the bridge. They are usually initiated at points of stress concentration (e.g. sharp corners, holes, connections and changes in cross-section).

***Requirement:***
Inspect carefully sharp corners, holes and changes in cross-section for fractures. Record findings and the precise location(s) of any fracture found. Support with adequate photographs and include sketches where photographs may not pick up adequate detail.

## 12.4. Cracking (including Welds)

Cracking, which usually occurs in welds and adjacent metals, is most often caused by stress concentration and stress fluctuation causing fatigue and can, under certain conditions, lead to brittle fracture. Members and connections subject to high stress fluctuations and stress reversal in service are most at risk.

Brittle fracture is a complete material disintegration through the component. This usually occurs without prior warning or plastic deformation. Brittle fracture may occur at fatigue prone details after initial fatigue cracking.

Cracks caused by fatigue usually occur at points of tensile stress concentrators, such as welded attachments, termination points of welds or holes. Cracks may also be caused or aggravated by overloading, vehicular collision or loss of section due to corrosion. In addition, stress concentrators due to the poor quality of fabricated details and low fracture toughness of materials are also common. Material fracture toughness has a significant influence on 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, so it is smooth or flush with the joined metal surfaces, improves fatigue resistance. Once cracking has occurred in a weld, it can propagate through the mother metal, and possibly lead to a brittle fracture.

Bolted or riveted connections may also develop fatigue cracking, as the holes may also become the stress concentrators. Bolted and riveted connections are also susceptible to cracking or tearing resulting from prying action, or from a build-up of splitting forces between parts of the connection due to corrosion.

Common locations susceptible to cracking are illustrated in Figures 12.4a and 12.4b.

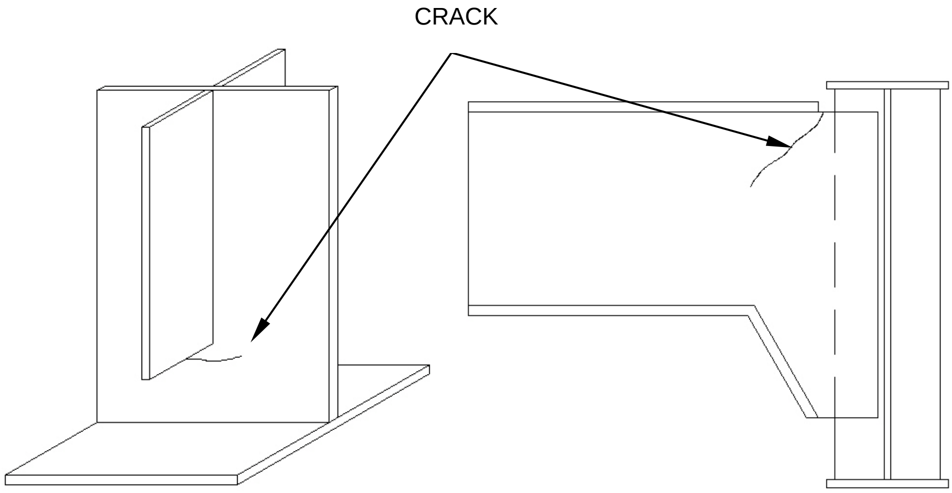
Since cracks may be concealed by rust, dirt or debris, the suspect surfaces should be cleaned prior to inspection.

Cracks that are perpendicular to the direction of stress are more serious than those parallel to the direction of stress. In either case, any cracks in steel should never be treated lightly, as parallel cracks may for a number of reasons turn into perpendicular cracks.

Any crack should be carefully noted and recorded as to its specific location in the member, and the actual member in the structure.

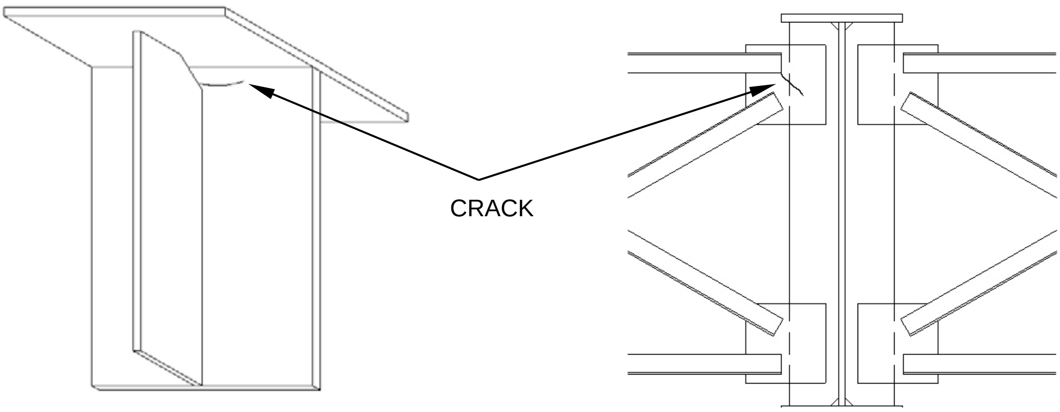
***Requirement:***
Look for all areas of potential stress concentrations (e.g. angles, brackets and joints) of varying quality of welds and sudden changes in cross-section of a member and inspect closely, as these are potential problem areas. Also look closely at the welds of attachments, particularly those carrying loads, such as bracing.

Record findings and the precise location(s) of any cracking found. The length, width (if possible) and direction of crack should also be recorded. Support with adequate photographs and include sketches where photographs may not pick up adequate detail.



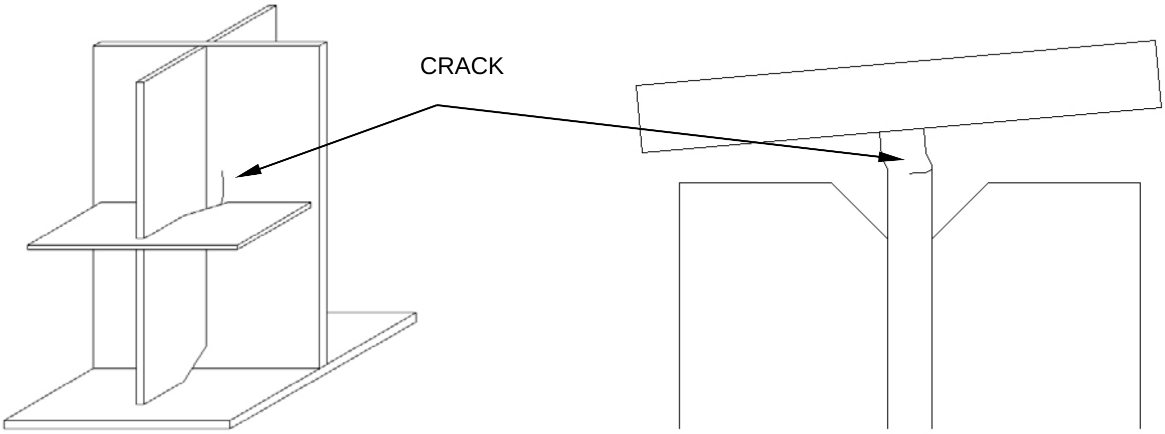

CRACK IN GIRDER WEB BETWEEN WEB SHORT STIFFENER AND TENSION FLANGE

CRACK IN TIE BEAM WEB IN FULL MOMENT CONNECTION BETWEEN TIE BEAM AND MAIN GIRDER




CRACK IN TENSION ZONE OF GIRDER WEB, INITIATING FROM WELD CONNECTING STIFFENER TO WEB

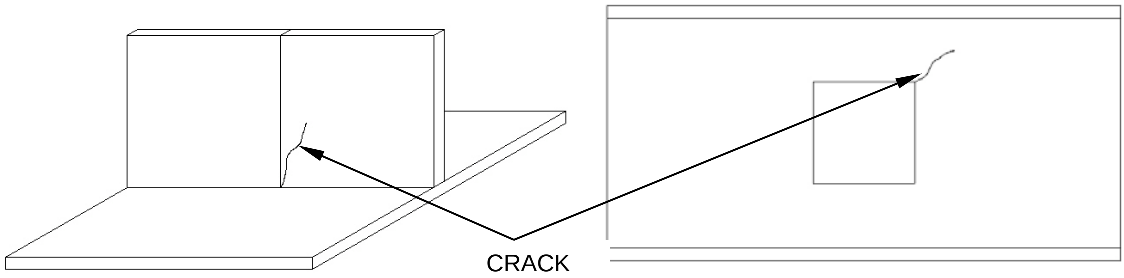
CRACK IN CROSS BRACING GUSSET PLATE




VERTICAL CRACK IN WEB BEHIND CHAMFER OF HORIZONTAL GUSSET PLATE

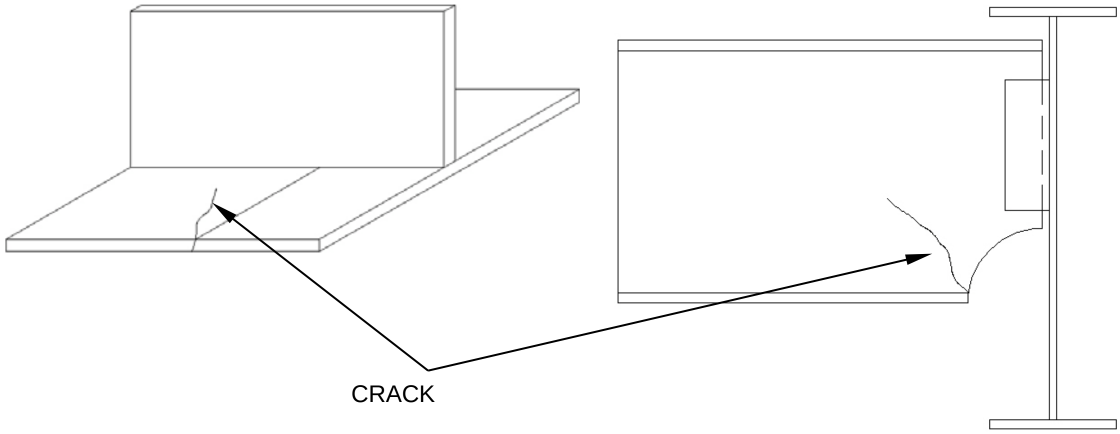
CRACK IN WEB CAUSED BY DEFORMATION OF TOP FLANGE UNSUPPORTED BY STIFFENERS

**FIGURE 12.4A - COMMON CRACK LOCATIONS IN STEEL STRUCTURES (SHEET 1)**



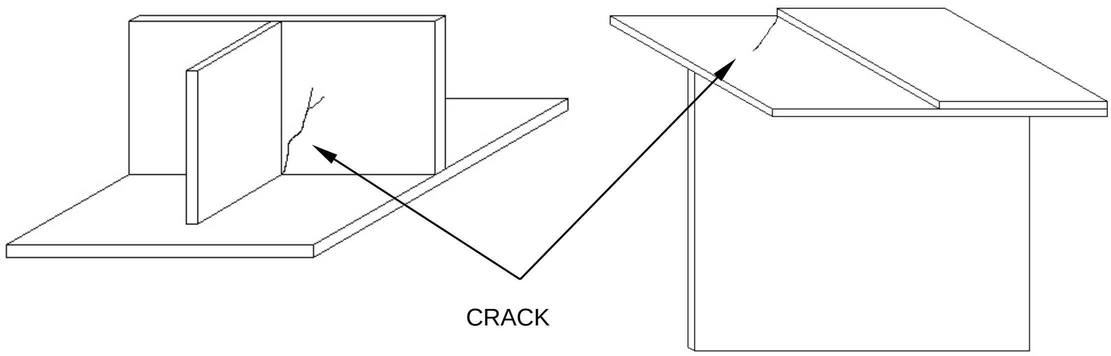

CRACK IN BEAM WEB AT SHOP SPLICE LOCATION

CRACK PROPAGATING FROM HOLE THROUGH WEB




CRACK IN BEAM FLANGE AT SHOP SPLICE LOCATION

CRACK IN COPE OF WEB




CRACK IN WEB AT STIFFENER

CRACK AT END OF FLANGE COVER PLATE

**FIGURE 12.4B - COMMON CRACK LOCATIONS IN STEEL STRUCTURES (SHEET 2)**

## 12.5. Permanent Deformations

Buckling, kinking, warping and waviness are forms of deformation associated with members in compression. Permanent deformations may be caused by overloading, vehicular collision as well as by buckling due to inadequate or damaged intermediate lateral supports (bracing).

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

Permanent buckling deformations normally occur in a direction perpendicular to the applied load and are usually associated with compression or flexural members. Permanent deformations due to buckling are particularly common in compressed bracing members (struts). Buckling may also produce local permanent deformations of webs and flanges of beams, plate girders and box girders. In this case it is termed “local buckling”. It is important to note that local buckling caused by loads often precedes global buckling of the entire member.

Permanent twisting deformations appear as a rotation of the member about its longitudinal axis and may be caused by:

- lateral-torsional buckling
- eccentric transverse loads on the member (or compatibility torque) resulting from differential rotations of the adjacent members connected to a perpendicular member

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

***Requirement:***
Record any form of deformation observed and give details of its location(s), orientation and magnitude (i.e. measure the amount of deformation, where possible). Support with adequate photographs that show location, direction/orientation and extent of deformation.

## 12.6. Loose Connections

Loose connections are pertinent to both bolted and riveted connections and may be caused by corrosion of the connector plates or fasteners themselves, excessive vibration, overstressing, cracking, or failure of individual components.

Loose connections may not always be detectable by a visual inspection but the indications should be investigated. Cracking, excessive corrosion of the connector plates or fasteners, permanent deformation of the connection or members framing into it, all may serve as an indication of a loose connection. Tapping the connection with a hammer is one method of determining if the connection is loose.

These will need close inspection to detect looseness unless there is some accompanying movement or noise. There can be symptomatic cracks that appear in the paint films between cover plates and main members.

***Requirement:***
Record exact location of any loose bolts or rivets. Also comment on their condition. Provide photographs if necessary.

## 12.7. Excessive Wear

Look out for this in members accommodating movement, such as pins in joints of trusses, or sliding plates of bearings.

***Requirement:***
Inspect closely members that accommodate movement and record any wear observed. Support with photographs.

## 12.8. Condition Inside Closed Members

Accumulation of water due to leakage or condensation needs to be checked as this can lead to potential corrosion. If a member has been sealed, comment on the effectiveness of the seal.

***Requirement:***
Record any evidence of water leakage and also record the condition of the seal (where present). Where leakage is observed, provide photographs.

## 12.9. Fire Damage

Sites should be actively searched for any signs of fire in the vicinity of the bridge. All materials are weakened with increasing temperature and steel is no exception.

On many occasions fire affected steelwork shows little or no distortion resulting in considerable uncertainty regarding re-useability. If the fire subsides before the steel component fails, the deformation will generally recover. Permanent deformation occurs when part of the component has been strained beyond its elastic limit. The cooling phase causes shortening in the steel component and dimensions should be rechecked.

***Requirement:***
Record the areas of fire damage with accompanying photos.

# 13.0 TYPES OF MASONRY DETERIORATION

Masonry is made of stones or bricks bonded together by mortar. Although not a common construction material for Western Australian bridges, masonry has been used in abutments, piers and wing walls.

Defects in masonry are mostly related to the breakdown of its components over time. A similar size crack in masonry and concrete is not indicative of equivalent concerns for structural stability and strength, with masonry having greater ability to withstand larger cracks and without underlying reinforcement to protect. This distinction should be considered when recording defects in masonry.

The following defects commonly occurring in masonry are described:

- Cracking;
- Splitting, spalling and disintegration; and
- Loss of mortar and stones.

## 13.1. Cracking

Cracks develop in masonry as a result of non-uniform settlement, thermal restraint and overloading. Cracks develop either at the interface between the mortar and stone, following a zigzag pattern when the bond between them is weak; or propagate through the joint and stone in a straight line when the mortar is stronger than the stone, as shown in Figure 13.1.

**FIGURE 13.1 - CRACK IN MASONRY WALL**

***Requirement:***
Record the location and extent of cracks, measure crack width and comment on whether the crack is through the mortar and/or the stone.  Provide photographs to show details.

## 13.2. Splitting, Spalling and Disintegration

Splitting is the opening of seams or cracks in the stone leading to the breaking of the stone into large fragments.

Spalling is the breaking or chipping away of pieces of the stone from larger stone.

Disintegration is the gradual breakdown of the stone into small fragments, pieces or particles.

These effects are caused by either the actions of weathering and abrasion; or by the actions of acids, sulphates or chlorides, which cause deterioration in certain types of stones, such as limestone.

***Requirement:***
Record the location and extent of the defects.  Support comments with photographs.

## 13.3. Loss of Mortar and Stones

Loss of mortar is the result of destructive action of water wash, plant growth or softening by water containing dissolved sulphates or chlorides.  Once the mortar has disintegrated it may lead to loss of stones.

Figure 13.3 shows a masonry wall with evidence of mortar loss.

**FIGURE 13.3 - MASONRY WALL WITH LOSS OF MORTAR**

***Requirement:***
Record the location and extent of the defects.  Test the strength of the mortar by resistance to scraping.  Support comments with photographs.

## 14.0 DETERMINATION OF CONDITION STATE

A Condition State rating of 1 to 4 or combination of ratings is to be assigned by the Inspector to bridge components of structural importance. As the condition of any component may be varied at different locations, there may be more than one Condition State for each component. The assignment of Condition States is an important part of the inspection process as it gives a qualitative and quantitative measure of the bridge components' individual condition and enables determination of the bridge's overall condition.

The bridge components that require assessment of a Condition State and recording in the bridge inspection sheets by the Inspector are as shown in the table below. For precast box unit bridges and arch bridges, the items listed relate to Items 10 and 11 in the Inspection Report.

| Condition State Assessment Required | | | |
|---|---|---|---|
| | **Group Type** | **Component** | **Appendix A(i) Reference** |
| Superstructure | Deck: | Expansion Joint | 6 or 7 |
| | Span: | Slab | 1 |
| | | Girder: Beam/Open Girder; Through Truss; Box Girder/Closed Web | 1 or 2 |
| | | Diaphragm/Bracing/Tie Rod/Bolt/Tie Beam | 1 or 2 |
| | | Cable/Hanger | 2 |
| | | External Strengthening | 8 |
| | | Large Static Sign Mounting Brackets | 2 |
| | | VMS Mounting Brackets | 2 |
| | | Electrification Screen Mounting Brackets | 2 |
| | Abutment and Pier: | Diaphragm/Bracing | 1 or 2 |
| | | Mast | 1 or 2 |
| Substructure | Abutment and Pier: | Bearing Unit | 5 |
| | | Capbeam / Sillbeam | 3 or 4a |
| | | Pile, Column, Footing | 3 or 4a |
| | | Bracing | 1 or 2 |
| | | Pile Cap | 3 or 4a |
| | | Wall, Wing Wall, Turndown Wall, Mechanically Stabilised Earth (MSE) Wall | 3 or 4a or 4b |
| | | External Strengthening | 8 |
| | **Group Type** | **Component** | **Appendix A(ii) Reference** |
| Precast Box Unit Bridges | Walls & Aprons: | Headwall | 1 |
| | | Wing Wall | |
| | | Apron | |
| | Barrels: | Box (units 1, 2, 3, 4, 5 etc.) | 2 |
| | | Base Slab | |

| | Group Type | Component | Appendix Reference |
|---|---|---|---|
| Arch Bridges | Walls & Footings: | Headwall | A(ii) 1 |
| | | Wing Wall | |
| | | Footing | A(i) 4a |
| | Arches: | Arch (units 1, 2, 3, 4, 5 etc.) | A(i) 1 or 2 |

Guidance in determining the Condition State of bridge components is provided in Appendix A with visual representation in the damage catalogue, refer Appendix C.

The measurement of the extent of each Condition State of components is also required. Refer to Appendix B for the appropriate method of measurement for components.

Supporting information gathered prior to the site visit, including previous special inspections and investigations (Level 3), may provide additional information to assist in assigning appropriate Condition States that will not be visible during a detailed inspection. This specific information shall be used to override visual inspection.

In the inspection report sheets, allocate the percentage of the component that is in each Condition State (leave blank for zero percent). The combined percentage in each Condition State must add up to 100% of the whole component.

## 14.1. 'Rule of Thumb' Description of Condition States

Some objective measures that should be used in determining the Condition State of bridge components are provided in Appendix A. These are important in aiding consistency of interpretation. However the Inspector will be faced with situations that require some subjective interpretation and to assist in that, the basic expectations when assigning Condition States should be kept in mind as follows:-

CONDITION STATE 1 – The component is in good condition with little or no evidence of deterioration. There are no apparent factors, such as durability, that may contribute to deterioration in the short to medium term.

CONDITION STATE 2 – The component is in good to fair condition with some deterioration expected. Such deterioration is stable and not expected to alter before the next inspection (short to medium term). If the deterioration does not appear stable, then a higher Condition State may be assigned.

CONDITION STATE 3 – The component exhibits deterioration and defects that are significant although imminent failure or reduced rating is not expected prior to the next inspection. The extent of defects may be such as to expect remedial repairs to be scheduled. If the deterioration does not appear stable, then a higher Condition State may be assigned.

CONDITION STATE 4 - Deterioration and defects are significant enough to warrant re-rating the capacity. Without intervention failure of the component may be expected in the short to medium term.

These 'Rule of Thumb' definitions are expanded on in the damage catalogue (Appendix C) for different materials and bridge types along with visual representation.

## 14.2. Specific Rules and Special Cases

Certain components can be considered special cases and there have been specific rules developed for the determination of Condition State for certain bridge components and bridge types.

### a) Permanent External Formwork (Slab, Pile or Column components only)

Where a component is concealed by permanent external formwork (e.g. Bondek under a deck slab, or steel casing around reinforced concrete piles/pile extensions) the Inspector will need to observe the condition of the external formwork to best determine the Condition State of the hidden component.

If the permanent formwork is providing full protection to the component it is covering, a Condition State of 2 shall be assigned to the concealed component.

If the permanent formwork is deteriorated, the condition of visible parts of the component could be used to determine the Condition State of the component using the guidelines in Appendix A.

Where possible, look at the condition of adjacent areas to the component where there is no permanent formwork (e.g. such as cantilevered edges of the slab which has no Bondek) to assign a Condition State to parts of the component that is concealed.

The Inspector should record the methodology used in the Inspection Report.

### b) Cannot Inspect a Component

If the entire component cannot be inspected (e.g. a buried footing) then no Condition State shall be assigned and the inspection report Condition States left blank. The percentage 'Not Inspected' is then 100% and recorded on the Inspection Form.

Note: Clause (a) above overrides requirements of Clause (b)

### c) Slabs

If a slab is fully supported by girders (or planks) (refer Figures E.2.2f(1) and E.2.2j(3)) such that is may be described as a 'topping slab', it shall be treated as part of the beam when determining Condition States. Individual components are still recorded in the inspection report and appropriate comments added but Condition States are not determined for the slab component. If the slab spans between girders (or beams) (refer Figure E.2.2c) individual components and Condition States for both beam and slab get assigned.

### d) Wide Precast Concrete Units

Wide precast concrete units (e.g. Deltacore) with an in situ topping (refer Figure E.2.2f(2)), behave like one slab rather than like beams and as such these components shall be combined with Condition States assigned to a slab component.

### e) Differing Defects on a Component

If the opposite sides of a component, e.g. capbeam, show differing defects, the Condition State shall be determined by averaging over the entire surface area of the component and not just using the one side.

### f) Using One Side of a Component

If only one side of a component is visible (e.g. slab soffit but the top surface is covered with bitumen or inside faces of an inverted u-beam visible only) this is sufficient to assign a Condition State.

#### *g) Bearing Units*

Bearing Units shall only be assigned Condition States when structural. In this instance, 'structural' means that the bearing is a rocker, elastomeric or pot bearing. Mortar pad, thin rubber or bituminous paper bearings shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.

#### *h) Wing Walls for Bridges*

For bridges, a wing wall can include structural walls connected to the main abutment wall as well as those that are not connected. Its main purpose is to retain soil or provide a wall to finish off the sides of the bridge and can exist in many forms.

#### *i) Precast Box Unit Bridges – Walls & Aprons*

For Precast Box Unit Bridges, wing walls, headwalls and aprons shall only be assigned Condition States when structural. In this instance, 'structural' means that the walls and aprons are designed with load bearing connections and are integral with the box units. Other non-structural walls and aprons shall be inspected with comments (including why the component has been assessed as non-structural) but the Condition State columns shall be greyed out in the inspection report template.

#### *j) Superseded Modification Status*

Any component identified as 'superseded', i.e. a component that has been made redundant by the placement of a new component, shall not be assigned a Condition State.

# 15.0 WORK ITEM CODES AND DESCRIPTIONS

The Work Descriptions in the worksheets (electronic version) have a drop down list for standard work items. These items have a number code that identifies them in the MRWA Bridge Management System (BMS). The table below lists all the standard work items and their codes. These codes are to be used in the worksheets by the Inspector where any works are identified.

Given the differing management arrangement between MRWA and other asset owners the Work Item Summary that is prepared differs. The Work Item Codes are only shown on Work Item Summary for the following Bridges:-

- General Supporting Activities - All Bridges
- Preventative Maintenance - MRWA Owned Bridges
- Routine Maintenance - MRWA Owned Bridges
- Specific Works - MRWA and LGA Bridges

## 15.1. General Supporting Activities

| Work Item No. | ITEM DESCRIPTION |
|---|---|
| G003 | Bridge - Detailed Inspection – Non-Timber (L2) |
| G005 | Bridge - Durability Survey (L3) |
| G008 | Bridge - Geotechnical Investigation |
| G009 | Bridge - Load Rating |
| G010 | Bridge - Monitor Defect |

## 15.2. Preventative Maintenance

| Work Item No. | ITEM DESCRIPTION |
|---|---|
| P102 | Bridge - Maintain Fastener |

## 15.3. Routine Maintenance

| Work Item No. | ITEM DESCRIPTION |
|---|---|
| R201 | Bearing - Maintain |
| R202 | Bridge - Remove Graffiti |
| R203 | Bridge - Repair Scour (Minor) |
| R205 | Bridge - Clear Debris and Vegetation |
| R206 | Deck Joint - Maintain |
| R207 | Deck Surface - Maintain |
| R208 | Drainage - Maintain |
| R209 | Expansion Joint - Maintain |
| R210 | Fence - Remove |
| R211 | Fence - Repair (Control of Access) |
| R212 | Guardrail - Maintain / Repair |

| Work Item No. | ITEM DESCRIPTION |
|---|---|
| R213 | Kerb - Repair (Minor) - Non Structural |
| R214 | Lighting - Maintain |
| R215 | Sign - Maintain |

### 15.4. Specific Works

| Work Item No. | ITEM DESCRIPTION |
|---|---|
| S501 | Abutment - Reconstruct |
| S504 | Abutment - Repair (Non-Timber) |
| S401 | Approach Slab - Install |
| S407 | Approach Slab - Repair |
| S701 | Apron - Repair |
| S411 | Arch - Repair |
| S716 | Barrel - Repair |
| S601 | Beam - Repair |
| S607 | Bearer - Repair |
| S619 | Bearing - Repair |
| S485 | Box Girder - Repair |
| S513 | Bracing - Replace |
| S324 | Bridge - Control Corrosion |
| S301 | Bridge - Repair Embankment |
| S350 | Bridge - Repair Scour (Major) |
| S308 | Bridge - Widen Embankment |
| S625 | Cable - Repair |
| S516 | Capbeam - Repair |
| S519 | Column - Repair |
| S413 | Deck - Repair |
| S419 | Deck - Shim |
| S425 | Deck Joint - Install |
| S431 | Deck Joint - Repair |
| S531 | Diaphragm - Repair |
| S443 | Drainage - Install |
| S449 | Drainage - Repair |
| S455 | Expansion Joint - Repair |
| S637 | External Strengthening - Repair |
| S534 | Footing - Repair |
| S461 | Footpath - Repair |
| S537 | Footpath Railing - Repair |
| S467 | Guardrail - Install |
| S731 | Headwall - Repair |

| Work Item No. | ITEM DESCRIPTION |
|---|---|
| S643 | Joist - Repair |
| S471 | Kerb - Extend |
| S473 | Kerb - Repair |
| S371 | Lighting - Install |
| S552 | Mast - Repair |
| S555 | Mechanically Stabilised Earth Wall - Repair |
| S558 | Pier - Repair |
| S564 | Pile - Repair |
| S567 | Pile Cap - Repair |
| S649 | Prestressed Anchorage - Repair |
| S378 | Services - Relocate |
| S385 | Services - Repair |
| S479 | Slab - Repair |
| S576 | Tie Back - Repair |
| S673 | Tie Beam - Repair |
| S679 | Tie Rod - Repair |
| S685 | Truss - Repair |
| S392 | Walkway - Repair |
| S578 | Wing Wall - Construct |
| S585 | Wing Wall - Extend |
| S588 | Wing Wall - Repair |

## 16.0 PRIORITY CODES FOR WORK REQUIRED

Work that is identified as being required must be allocated a priority code to assist the Asset Manager with suitable programming of the work.

| PRIORITY CODE | INDICATIVE TIMEFRAME REQUIREMENT |
|---|---|
| 0 - Critical<br>EMERGENCY action required | Immediate within 6 months |
| 1 - High Priority | Within 3 years |
| 2 - Medium Priority | Within 4-6 years |
| 3 - Low Priority (monitor) | Assess again at next Detailed (Level 2) Inspection (7 years for non-timber bridges) |

# 17.0 BRIDGE CONDITION INDEX

The Bridge Condition Index (BCI) is a numerical value that summarises the evaluation of the structure's overall condition and provides a relative condition comparison with other bridges.

The key purpose of the BCI is not as an individual structure condition indicator, but to contribute to the overall mean as an indicator of the overall asset condition throughout the network.

The BCI is derived using an algorithm which incorporates the Condition States for the designated structural components of the structure, weighting factors reflecting the importance of the component and the severity of the defects. The designated structural components are listed in Section 14.

The concept and the structuring of the BCI for concrete and steel bridges is similar to the BCI for timber bridges to maintain a level of consistency, although the actual algorithm is very different due to the vastly different nature of timber bridges.

The BCI has only been developed at this stage for standard bridge types and does not cover precast box unit bridges, arch bridges or hybrid bridges. A BCI cannot be determined for such bridges using this methodology.

Calculation of the BCI is not typically the role of the Inspector and will be performed during the review of the detailed inspection report.

## 17.1. Introduction

It is fundamental that the BCI is prepared by a structural engineer with broad experience in both bridge design and asset management.

There are a number of reasons for this including the following:-

- Notwithstanding that the condition states provide a subjective basis for the BCI calculation, the final BCI rating should be consistent with engineering judgement.
- The BCI preparation provides an opportunity to review and confirm the conditions states as assigned by the Inspector. The interpretation or significance of cracking for example, or the suspicion that latent hidden durability issues exist, may be cause for the condition states to be upgraded.

## 17.2. Methodology

Each component type is assigned to one of three component groups depending on its relative structural importance or in other words, the consequences to the structure if it failed. Each group is given a weighting factor to provide a multiplier to reflect that relative importance. The group and weighting factors are listed in Table 17.1a below.

<table>
<tr><th>Component Group</th><th>Components in this Group</th><th>Group Multiplier</th></tr>
<tr><td rowspan="8">1</td><td>Slabs</td><td rowspan="8">11</td></tr>
<tr><td>Beams</td></tr>
<tr><td>Box Girders</td></tr>
<tr><td>Columns, Piles</td></tr>
<tr><td>Capbeams, Pile Caps</td></tr>
<tr><td>External Strengthening</td></tr>
<tr><td>Masts, Cables/Hangers</td></tr>
<tr><td>Trusses</td></tr>
<tr><td rowspan="5">2</td><td>Walls</td><td rowspan="5">6</td></tr>
<tr><td>Footings</td></tr>
<tr><td>Diaphragms</td></tr>
<tr><td>Bearings</td></tr>
<tr><td>Bracing, Tie Beams, Tie Rods/Bolts</td></tr>
<tr><td rowspan="2">3</td><td>Expansion Joints</td><td rowspan="2">3</td></tr>
<tr><td>MSE Walls, Wing Walls, Turndown Walls</td></tr>
</table>

**TABLE 17.1A - GROUPS AND WEIGHTINGS TO CALCULATE THE BCI**

As a part of the Detailed Visual Bridge Inspection, each structural component of the bridge is given a Condition State rating of between 1 and 4 or combination of ratings. As the condition of any component may be varied at different locations, there may be more than one Condition State for each component. The proportion of the affected component in each Condition State rating is converted to a percentage of the total component. The sum of Condition States for each component is thus always 100%.

A weight is assigned for each Condition State to accentuate the relative seriousness of the different Condition States and to heighten sensitivity between them. The Condition State weighting factors are listed in Table 17.1b below.

| Condition State | Condition State Weighting |
|---|---|
| 1 | 1 |
| 2 | 5 |
| 3 | 25 |
| 4 | 50 |

**TABLE 17.1B - CONDITION STATE WEIGHTINGS**

The last step of the algorithm is to convert the accumulated weighted scores to a qualitative scale. As there was an existing timber BCI scale, the concrete and steel BCI was made equivalent to give a consistent network view and is shown below in Table 17.1c.

| Descriptor | BCI Range | | |
|---|---|---|---|
| Very Good | 0 –19 | ↑ better | ↓ worse |
| Good | 20 – 39 | | |
| Fair | 40 – 55 | | |
| Poor | 56 – 100 | | |
| Severe | 101 + | | |

**TABLE 17.1C - BCI DESCRIPTOR RANGE**

The methodology and each step in the process are described in more detail through partial examples in Sections 17.2 and 17.3 and a complete worked example in Appendix D.

## 17.3. Condition State Averaging

From the detailed inspection report each component has been assigned its own Condition State rating or combination of ratings if there is more than one Condition State. These are then converted into percentages of the total component. All components of the same type are averaged into one row of scores, taking a straight average of each Condition State.

$$CS\,x = \sum_{1}^{n} CS\,x \div n$$

where

x = Condition State percentage

Example – A 5 span solid flat slab bridge has the following Condition State percentages:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Span 1 Slab | 40 | 20 | 30 | 10 |
| Span 2 Slab | 100 | | | |
| Span 3 Slab | 100 | | | |
| Span 4 Slab | 50 | 50 | | |
| Span 5 Slab | 50 | | | 50 |
| **Overall ‘Slab’** | **68%** | **14%** | **6%** | **12%** |

The values for the total slab are then recorded as shown below. This process is repeated for all other components in each category.

| Component Group | COMPONENT | CS1 | CS2 | CS3 | CS4 | Group Multiplier |
|---|---|---|---|---|---|---|
| | *Condition Weight* | 1 | 5 | 25 | 50 | |
| 1 | Slabs | 68.0 | 14.0 | 6.0 | 12.0 | 11 |
| | Beams | | | | | 11 |
| | Box Girders | | | | | 11 |
| | Columns, Piles | | | | | 11 |
| | Capbeams, Pile Caps | | | | | 11 |
| | External Strengthening | | | | | 11 |
| | Masts, Cables/Hangers | | | | | 11 |
| | Trusses | | | | | 11 |
| 2 | Walls | | | | | 6 |
| | Footings | | | | | 6 |
| | Diaphragms | | | | | 6 |
| | Bearings | | | | | 6 |
| | Bracing, Tie Beams, Tie Rods/Bolts | | | | | 6 |
| 3 | Expansion Joints | | | | | 3 |
| | MSE Walls, Wing Walls, Turndown Walls | | | | | 3 |

## 17.4. Weighted Component Score

The next step is to calculate a Weighted Component Score wherein the Condition State is factored by the Condition Weight and the Group Multiplier as shown in the following formula:

$$\textit{Weighted Component Score} = GM \text{ x } \sum_{i=1}^{4} CS_i \text{ x } CW_i$$

where

GM = Group Multiplier
CS = Condition State
CW = Condition Weight

Calculating the Weighted Component Score for the above example:

| | CS1 | CS2 | CS3 | CS4 | Group Multiplier |
|---|---|---|---|---|---|
| **Condition Weight** | 1 | 5 | 25 | 50 | |
| Overall 'Slab' | 68% | 14% | 6% | 12% | 11 |

$$\textit{Weighted Component Score} = 11 \text{ x } [(68 \text{ x } 1) + (14 \text{ x } 5) + (6 \text{ x } 25) + (12 \text{ x } 50)] = 9{,}768$$

## 17.5. The Weighted Score

After this process, an algorithm combines the Weighted Component Score for each component into a single score. The algorithm is based on a weighted average approach, in which the sum of the weighted component scores will be divided by the sum of the importance factors.

$$Weighted\ Score = \sum_{i=1}^{n} Weighted\ Component\ Score_i \div \sum_{i=1}^{n} GM_i$$

As the Group Multiplier will cancel, the maximum score for all bridge types will be 50 (CS4) x 100 or a total of 5,000.

## 17.6. BCI Range

The final step of the process is to translate the Weighted Score into the qualitative BCI range as previously defined in Table 17.1c.

As a stage of developing the algorithm, many examples were evaluated and subjective judgement was used to create a link between BCI descriptive category (range) and the Weighted Score. Scaling equations were then calculated to transform the Weighted Score into the BCI Range. The scaling equation is a linear interpolation of the two points. This is shown in Table 17.5 below.

| BCI Range | Descriptor | Weighted Score Range | Scaling Equations |
|---|---|---|---|
| **0** | | **100** | |
| | **Very Good** | | $BCI = (WS - 100) \div 3$ |
| **20** | | **160** | |
| | **Good** | | $BCI = (WS + 180) \div 17$ |
| **40** | | **500** | |
| | **Fair** | | $BCI = (WS - 100) \div 10$ |
| **56** | | **660** | |
| | **Poor** | | $BCI = (9 \text{ x } WS + 9{,}068) \div 268$ |
| **101** | | **2,000** | |
| | **Severe** | | $BCI = (0.033 \text{ x } WS + 35)$ |
| **200** | | **5,000** | |

**TABLE 17.5 - SCALING EQUATIONS TO CONVERT WEIGHTED SCORES TO BCI RANGE**

# APPENDIX A

## CONDITION STATE ASSESSMENT CRITERIA

## FOR

## (i) CONCRETE AND STEEL BRIDGES (INCLUDING ARCH BRIDGES)

## (ii) PRECAST BOX UNIT BRIDGES AND ARCH BRIDGES

## APPENDIX A

## (i) CONDITION STATE ASSESSMENT CRITERIA FOR CONCRETE & STEEL BRIDGES (INCLUDING ARCH BRIDGES)

Table A.1 is to be used as a reference for determination of the appropriate Condition State (CS) for concrete and steel bridge components when undertaking a Detailed Visual Bridge Inspection (Level 2) or for the structural components of an arch bridge for arches and footings of the Arch Bridge inspection form.

**Table A.1**

| | **Condition States** | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **1. Superstructure**<br><br>***Concrete***<br>(Slab, Beam/Open Girder, Box Girder/ Closed Web, Tie Beam, Diaphragm/ Bracing, Arch, Mast) | In good condition with little or no deterioration. Hairline cracking (≤0.1 mm) may be present. Cracks are widely spaced and are very infrequent. | Fine cracking (>0.1 & ≤0.3 mm) and spalling may be present. There may be fine (and dry) longitudinal cracks and spalls but no exposure of reinforcement or strands. | Medium cracking (>0.3 & ≤0.7 mm), fretting and spalling may be present with active corrosion in reinforcement resulting in loss of section of reinforcement or prestressing strands. Isolated rust staining may be evident. | Heavy cracking (>0.7 mm) with fretting and spalling may be present. Severe corrosion of the reinforcement over large areas, resulting in substantial loss of section. Stressing strands (where present) may be broken or exhibit signs of advanced corrosion. |
| | | Damp patches and efflorescence may be visible. | Patches of dampness and efflorescence may be medium to large with numerous stalactites and lime leaching visible. | |
| | | | Shrinkage cracks along centre of flat slab may be medium with some moisture staining around the crack. | Shrinkage cracks along centre of flat slab may be heavy with excessive moisture penetration and heavy staining around the crack.<br><br>Deck may have extensive longitudinal cracking with differential movement between sections of the deck. |
| | There is no cracking in the fully prestressed component. | There is no cracking in the fully prestressed component. | Cracking is evident in the fully prestressed component. | |
| | There is no block cracking (see right for definition). | There is a block cracking pattern (i.e. joining up of longitudinal and transverse structural cracks) with hairline cracks (≤0.1 mm) in a grid. | Block cracking (see left for definition) may be present with fine cracking (>0.1 & ≤0.3 mm) in a grid. | Advanced block cracking (see left for definition) may be present with medium cracking (>0.3 & ≤0.7 mm) in a grid of approximately 0.3 m spacing. |
| | There is no pattern of tension cracking. | A pattern of tension cracks may be present with hairline cracks (≤0.1 mm). | A pattern of tension cracks may be present with fine cracking (>0.1 & ≤0.3 mm). | A pattern of tension cracks may be present with medium cracking (>0.3 & ≤0.7 mm). |

| Table A.1 | Condition States | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **2. Superstructure**<br><br>***Steel***<br>(Beam/Open Girder, Diaphragm/Bracing, Through Truss, Box Girder/ Closed Web, Tie Beam, Mast, Arch, Cable/Hanger, Tie Rod/Bolt, Mounting Brackets) | In good condition with little or no deterioration. | There may be surface corrosion. | There is active surface corrosion throughout and there is pitting in isolated areas with loss of section. | There is severe surface corrosion resulting in substantial loss of section. |
| | All welds, bolts, rivets, tie rods are in good condition with no movement of plates or sections in the component. | All welds and fasteners are in good condition with no cracking and only superficial surface corrosion. There may be very minor corrosion of connections but they are tight. | Welds may have non-continuous hairline cracks. Corrosion of fasteners is evident but connections remain tight. Riveted plates may have very minor movement of 1 mm to 2 mm but rivets are generally sound. | Welds are cracked. Fasteners are severely corroded with loss of section. Some may be loose or missing, allowing extensive movement. The girder/beam exhibits residual out-of-plane deformations. |
| | Cable/Hanger: No signs of distress at anchors, sockets or saddles. | Cable/Hanger: No signs of distress at anchors or sockets. Saddles may be slightly corroded. | Cable/Hanger: Anchors may have fine cracking, sockets may be loose or saddles may have fine cracks in the metal. The cables may have slackened off slightly. The hangers may be slipping on the cable. Cables may be beginning to abrade but there are no wire breakages. | Cable/Hanger: Hangers may be sliding along the cables. The cables may have slackened noticeably. Anchorages are severely cracked or have moved or slipped. Sockets may have loosened or saddles are badly damaged. Cables may be severely abraded with a number of broken wires. |
| | *Coating defects are not necessarily serious or structural but they are indicative of potential weaknesses in the coating system and eventual loss of protection to the coated surface. It is rare for a protective coating system to outlast the life of the structure and therefore it should be thoroughly inspected and asset managed accordingly.* | | | |

| Table A.1 | Condition States | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **3. Pier**<br><br>***Concrete/Masonry***<br>(Pile, Column, Pile Cap, Capbeam, Wall, Footing) | For steel refer to *2. Superstructure Steel* above. | For steel refer to *2. Superstructure Steel* above. | For steel refer to *2. Superstructure Steel* above. | For steel refer to *2. Superstructure Steel* above. |
| | **Concrete:**<br>Concrete member is in good condition and there may be only hairline cracking (≤0.1 mm). | **Concrete:**<br>Concrete member has some fine cracking (>0.1 & ≤0.3 mm) evident with some minor localised spalling. No reinforcement or prestressing strands are exposed. | **Concrete:**<br>Concrete member has medium cracking (>0.3 & ≤0.7 mm) and/or spalling with exposed reinforcement showing signs of advanced corrosion with some loss of section. Isolated rust staining may be evident. May be some exposed prestressing strands exhibiting signs of minor corrosion (surface rust only, no pitting). | **Concrete:**<br>Concrete member has heavy cracking (>0.7 mm) and/or spalling with advanced corrosion of reinforcement with substantial loss of section. Exposed prestressing strands show signs of advanced corrosion with pitting or some loss of section. |
| | No cracking in the fully prestressed component. | There is no cracking in the fully prestressed component. | Cracking is evident in the fully prestressed component. | |
| | There is no pattern of tension cracking. | A pattern of tension cracks may be present with hairline cracks (<0.1 mm). | A pattern of tension cracks may be present with fine cracking (>0.1 & ≤0.3 mm). | A pattern of tension cracks may be present with medium cracking (>0.3 & ≤0.7 mm). |
| | **Masonry:**<br>Hairline or fine cracking (≤0.3 mm) throughout the mortar joints. | **Masonry:**<br>Medium cracking (>0.3 & ≤1.0 mm) or heavy cracking, up to 1 mm, of the mortar between blocks. Blocks are still firmly in place. Non-grouted masonry or rubble is well stacked and is stable. | **Masonry:**<br>Heavy cracking (>1.0 & ≤2.0 mm) of the mortar. Some blocks may be loose. Non-grouted masonry rubble has moved with some loss of stone and minor loss of embankment fill. | **Masonry:**<br>Very heavy cracking (>2.0 mm) of the mortar. Non-grouted masonry rubble walls have moved appreciably and lost numerous rocks. Walls are no longer effective in retaining fill. |
| | | Gabions have minor settlement or minor loss of stone or a few broken wires. | Gabions may have distorted with moderate loss of stone with broken or corroded wires. | Gabions may be badly corroded and may have lost substantial filling or have numerous broken wires. |

| Table A.1 | Condition States | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **4a. Abutment**<br><br>***Concrete***<br>(Pile, Column, Pile Cap, Capbeam, Wall, Footing) | In good condition, little or no deterioration. Hairline cracking (≤0.1 mm) may be present. Cracks are widely spaced and very infrequent. | Fine cracking (>0.1 & ≤0.3 mm) with minor localised spalling may be evident. No reinforcement is exposed. | Medium cracking (>0.3 & ≤0.7 mm) and/or spalling. Exposed reinforcement exhibiting active corrosion with some loss of section. Rust staining is evident. | Heavy cracking (>0.7 mm) and/or spalling with advanced corrosion of reinforcement with substantial loss of section. |
| | There is no cracking in the fully prestressed component. | There is no cracking in the fully prestressed component. | Cracking is evident in the fully prestressed component. | |
| | There is no pattern of tension cracking. | A pattern of tension cracks may be present with hairline cracks (<0.1 mm). | A pattern of tension cracks may be present with fine cracking (>0.1 & ≤0.3 mm). | A pattern of tension cracks may be present with medium cracking (>0.3 & ≤0.7 mm). |

| Table A.1 | Condition States | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **4b. Abutment**<br><br>***Concrete/Masonry***<br>(Wing Wall, Turndown Wall Mechanically Stabilised Earth (MSE) Wall) | **Concrete:**<br>Fine cracking (>0.1 & ≤0.3 mm) with minor localised spalling may be evident. | **Concrete:**<br>Medium cracking (>0.3 & ≤0.7 mm) and spalling. | **Concrete:**<br>Heavy cracking (>0.7 mm) and/or spalling with advanced corrosion of reinforcement with substantial loss of section. | **Concrete:**<br>Multiple or frequent heavy cracking (>0.7 mm) and/or spalling with advanced corrosion of reinforcement with substantial loss of section and large areas of reinforcement exposed. |
| | No reinforcement is exposed. | Exposed reinforcement exhibiting advanced corrosion with some loss of section. Rust staining is evident. | No exposure of reinforcement in MSE walls. | Some reinforcement is exposed with signs of minor corrosion in MSE walls. |
| | Independent wing walls have no movement and embankment is stable. | Independent wing walls may have slight movement but not enough to cause loss of embankment fill material. | Independent wing walls may have moderate movement away from the abutments with some loss of embankment fill material evident. | Independent wing walls may have moved away from the abutment causing excessive loss of embankment fill material from behind the wall. |
| | In precast units there is no settlement or gaps between units allowing loss of embankment fill. There is no vegetation growing between the units. There is no movement of units. | Precast units may have minor movement or settlement enabling only minor loss of embankment fill. There is no vegetation growing between the units. | Precast units may have moderate movement, settlement or separation of units that may have resulted in medium loss of embankment fill. There may be some vegetation growing between the units indicating breakdown of the backing strip. | Precast units have excessive movement, settlement or separation of units which may be allowing heavy loss of embankment fill. There may be a lot of vegetation growing between the units indicating breakdown of the backing strip. |
| | **Masonry:**<br>Hairline or fine cracking (≤0.3 mm) throughout the mortar joints. | **Masonry:**<br>Medium cracking (>0.3 mm) or heavy cracking, up to 1 mm, of the mortar between blocks. Blocks are still firmly in place. Non-grouted masonry or rubble is well stacked and is stable. | **Masonry:**<br>Heavy cracking (>1.0 & ≤2.0 mm) of the mortar. Some blocks may be loose. Non-grouted masonry rubble has moved with some loss of stone and minor loss of embankment fill. | **Masonry:**<br>Very heavy cracking (>2.0 mm) of the mortar. Non-grouted masonry rubble walls have moved appreciably and lost numerous rocks. Walls are no longer effective in retaining fill. |
| | | Gabions have minor settlement or minor loss of stone or a few broken wires. | Gabions may have distorted with moderate loss of stone with broken or corroded wires. | Gabions may be badly corroded and may have lost substantial filling or have numerous broken wires. |

**Table A.1**

| Component | Condition States CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| **5. Bearing Units**<br><br>(Rocker, Elastomeric and Pot Bearings) | The bearing is in good condition showing minimal deterioration and appears to be performing its design function properly. | The bearing may have very minor cracks, splits or signs of weathering. | Medium to advanced corrosion in steel components. There may be minor cracks in welds. | Significant corrosion in steel components with heavy pitting. Welds may have cracked completely. There may be substantial loss of bearing area. |
| | There is minimal debris in the bearing. | Debris or corrosion may have a minor effect on the movement capability of the bearing. The joint is fully operational. | The ability of the bearing to perform its intended function is affected. Bearing may appear to be over-stressed. | The bearing is no longer functioning as was intended, it may be completely seized. |
| | The bearing support is sound. | The bearing support (e.g. mortar pad) may be cracked but is still structurally sound. | Bearing supports may show heavy cracking, crumbling of mortar or have sizeable spalling with some reduction in bearing support area. | The bearing support may have badly crumbled mortar or heavily spalled concrete with excessive reduction in bearing support. There may be localised crushing of the structural concrete underneath the bearing. |

| Table A.1 | Condition States | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **6. Expansion Joints**<br>**Small movement joints**<br><br>*Types:*<br>*pourable*<br>*compression*<br>*fixed* | In good condition with little or no deterioration. Joint material is held firmly in place. No adhesion or sealing problems. | Rigid components of the joint are in good to fair condition with little or minor deterioration. Joint may have lost adhesion with the deck or armouring allowing leaking of moisture. | The joint may have completely lost adhesion and is no longer operational. | The connectivity between the concrete deck and the edging angles is completely lost or pourable joint sealant is almost completely lost and the bitumen/cork filler may be broken up and being ripped out by traffic. |
| | The seal shows some deterioration and there may be some moisture penetration through the joint. | The seal has substantial wear and tear with possible cracking. It may have worked its way out in to the road surface and may have incurred damage due to traffic impact. Joint may have lost adhesion over a long length allowing moisture penetration. | The seal shows extensive damage or it has completely failed allowing extensive moisture penetration. | |
| | Edge angles (where present) are sound and show good connectivity with concrete. | The adjacent deck may have minor spalls or the edging angles may have lost some connectivity with concrete with cracks developing between them. | The adjacent deck may have moderate spalling or the edging angles may have lost connectivity with concrete and the surface is breaking away from the steel. | |
| | | Debris build-up in the joint is evident and has some effect on its function. | Debris build-up is severely affecting the performance of the joint and consequential damage is evident. | The joint is completely blocked with debris and is not functional. |

| Table A.1 | Condition States | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **7. Expansion Joints**<br>**Large movement type joints**<br><br>*Types:*<br>*modular*<br>*open steel*<br>*sliding steel* | The joint is free from debris and functions well. The joint's components and the surrounding concrete are in good condition. | Joint has minor amount of debris between seals which limits proper function. The seal has minor cracks or traffic-induced damage and surrounding concrete is slightly cracked or chipped. | There is a substantial amount of debris in the joint significantly affecting proper function. The seals are damaged and may not function properly. Some seals may have become dislodged and are subject to direct impact on the traffic. | The joint is completely blocked or the drainage system is completely blocked, severely damaged or missing. The seals are severely damaged and are unable to perform their design function. |
| | There may be only minor steel corrosion. | There may be steel corrosion throughout but with no discernible loss of section. Any fasteners are still tight. | Steel corrosion is well advanced with some surface pitting. Surrounding concrete is cracked and spalled. Minor cracks in steel may have developed. Some fasteners may be loose. | There is advanced corrosion of steel with significant surface pitting of steel components. Surrounding concrete is cracked and spalled throughout the length of the joint. Cracks in steel are well advanced. Localised failure of the joint may be evident. Fasteners have advanced corrosion and some are loose or missing. |
| | Drainage is unobstructed in open steel type joint. | In open steel type, joint may have some debris build-up without significant effect on joint performance. | | |

| **Table A.1** | **Condition States** | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **8. External Strengthening**<br><br>*Using:*<br>*concrete*<br>*steel*<br>*carbon fibre*<br><br>*Concrete:*<br>*For strengthening using concrete refer to 1. Superstructure Concrete above.* | *Steel:*<br>In good condition with little or no deterioration. All welds, bolts, rivets are in good condition with no movement of plates or sections in the component. | *Steel:*<br>There is localised surface corrosion.<br>All welds and fasteners are in good condition with no cracking or corrosion. There may be very minor corrosion of connections but they are tight. | *Steel:*<br>There is active surface corrosion throughout and there is pitting in isolated areas with loss of section.<br>Welds may have non-continuous hairline cracks. Corrosion of fasteners is evident but connections remain tight. Riveted plates may have very minor movement of 1 mm to 2 mm but rivets are generally sound. | *Steel:*<br>There is severe surface corrosion and pitting resulting in substantial loss of section.<br>Welds are cracked. Fasteners are severely corroded with loss of section. Some may be loose or missing, allowing extensive movement. |
| | *Carbon Fibre:*<br>In good condition, little or no deterioration.<br>The carbon fibre layers are fully adhered to the substrate. No fibre fractures or splitting of fabric. | *Carbon Fibre:*<br>Some minor deterioration is evident. There is evidence of some very minor delamination of the carbon fibre layers at some of the edges away from the substrate. No fibre fractures or splitting of fabric. | *Carbon Fibre:*<br>Carbon fibre layers are showing signs of breaking down and almost all of the edges have delaminated from the substrate.<br>There may be evidence of few fibre fractures or splitting of the fabric. | *Carbon Fibre:*<br>Carbon fibre layers have essentially broken down and they have almost completely delaminated from the substrate. There may be evidence of numerous fibre fractures or splitting of the fabric. There may be evidence of fire damage. |

## (ii) CONDITION STATE ASSESSMENT CRITERIA FOR PRECAST BOX UNIT BRIDGES AND ARCH BRIDGES

***Note: This information is applicable to and required for the Precast Box Unit Bridges Detailed Visual Inspection (Level 2) Report only.***

Table A.2 is to be used as a reference for determination of the appropriate Condition State (CS) for the structural components of a precast box unit bridge when undertaking a Detailed Visual Inspection (Level 2) for items 10 and 11 of the Precast Box Unit Bridge inspection form or for the structural components of an arch bridge for headwalls and wing walls of the Arch Bridge inspection form.

| **Table A.2** | **Condition States** | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **1. Structure – Walls & Aprons**<br><br>*Applicable to:*<br>• Headwall<br>• Wing Wall<br>• Apron<br><br>*Materials:*<br>• Cast In situ Concrete<br>• Precast concrete | ***General:***<br>In good condition with little or no deterioration. There is no movement of the headwall or the wing wall.<br><br>***And:***<br><br>**Concrete:**<br>Fine cracking (>0.1 & ≤0.3 mm) may be present. No spalling. Cracks are widely spaced and very infrequent. | ***General:***<br>The headwall or wing wall may exhibit minor movement (up to 10 mm) with respect to the barrels.<br><br>***And:***<br><br>**Concrete:**<br>Medium cracking (>0.3 & ≤0.7 mm), and minor localised spalling and isolated rust staining may be evident. No reinforcement is exposed. Damp patches and efflorescence may be visible. | ***General:***<br>The headwall or wing wall may exhibit moderate movement (up to 25 mm) with respect to the barrels.<br><br>***And:***<br><br>**Concrete:**<br>Heavy cracking (>0.7 mm), fretting and spalling may be present with extensive rust staining and active corrosion in reinforcement resulting in loss of section of reinforcement. Patches of dampness and efflorescence may be medium. | ***General:***<br>The headwall or wing wall may exhibit large movement (>25 mm) or the wing wall may be leaning due to earth pressure with possible loss of fill material behind it.<br><br>***And:***<br><br>**Concrete:**<br>Multiple or frequent heavy cracking (>0.7 mm), fretting and/or spalling may be present. Severe corrosion of reinforcement over large areas resulting in substantial loss of section of reinforcement. Patches of dampness and efflorescence may be large. |

| Table A.2 | Condition States | | | |
|---|---|---|---|---|
| **Component** | **CS1** | **CS2** | **CS3** | **CS4** |
| **2. Structure – Barrels**<br><br>*Applicable to:*<br>• Box<br>• Link Slab<br>• Base Slab<br><br>*Materials:*<br>• Cast In situ Concrete<br>• Precast concrete | ***General:***<br>In good condition with little or no deterioration.<br><br>***And:***<br><br>**Concrete:**<br>Hairline cracking (≤0.1 mm) may be present. No spalling. | ***General:***<br>The line of the barrels is straight but there is minor differential settlement (≤15 mm) which may have resulted in some water ponding in the barrels.<br><br>***And:***<br><br>**Concrete:**<br>Fine cracking (>0.1 & ≤0.3 mm) and minor localised spalling may be evident. Barrels may have edge spalling. No reinforcement is exposed. Damp patches and efflorescence may be visible. | ***General:***<br>There may be some deviation of the line of the barrels due to separation or differential settlement (>15 & ≤40 mm) which may result in a significant amount of water being retained in the barrels. Some damaged joints may leak water.<br><br>***And:***<br><br>**Concrete:**<br>Medium cracking (>0.3 & ≤0.7 mm), fretting and/or spalling may be present with extensive rust staining and exposed reinforcement exhibiting loss of section. Edge spalling of barrels is prominent. Patches of dampness and efflorescence may be 0.25 $m^2$ to 1 $m^2$ in any one unit. | ***General:***<br>There may be a large deviation of the line of the barrels. Separation and settlement (>40 mm) may have resulted in an excessive amount of water being retained in the barrels. Joint leakage may be substantial.<br><br>***And:***<br><br>**Concrete:**<br>Heavy cracking (>0.7 mm), fretting and/or spalling is evident along large delaminated areas. Edge spalling of barrels may be severe. Exposed reinforcement exhibits signs of severe corrosion over large areas resulting in substantial loss of section of reinforcement. Patches of dampness and efflorescence may be > 1 $m^2$ in any one unit. |

# APPENDIX B

# MEASUREMENT OF CONDITION STATE
# FOR
# CONCRETE AND STEEL BRIDGES
# AND
# PRECAST BOX UNIT BRIDGES
# AND
# ARCH BRIDGES

# APPENDIX B

## Measurement of Condition State

The extent of each Condition State in a component is measured as a percentage of the whole component. That is, the combined percentage in each Condition State (1, 2, 3 and 4) must add up to 100% of the whole component.

Percentages recorded are to be rounded up to the nearest 5% increment for all components, except walls, which are to be rounded up to the nearest 10% increment.

Where a component cannot be completely inspected (i.e. there is a "% not inspected") the Condition State recorded is that for the part of the component that can be inspected only. The combined percentage of the inspected section of the component must still add up to 100%.

The component type 'Pile' refers only to the portion of pile above ground level when considering the allocation of Condition State.

The *unit of measurement* applicable to each component for which a Condition State assessment is required is given in Table B.1. This is the basis for determining the percentage of each Condition State of the component.

The assessment of each component is quantified in terms of one of the following measurements:

### *a) Area of the Component ($m^2$)*

Where the unit of measurement is based on area, the percentage of the component in each Condition State is:

$$\frac{\textit{Area in Condition State}}{\textit{Total Area of Component}} \quad \textit{x 100 \%}$$

When assessing areas of deteriorated concrete, the damaged area shall be taken as an area of ¼ m all around the spall or crack. On this basis, cracking at 0.5m centres or less (unidirectional or block cracking) will effectively designate the entire area as the Condition State of the damaged area.

Example 1: a transverse crack is 1m long in a 7m wide concrete deck. The area affected is therefore: ¼ m on both sides of a crack x [length of the crack + ¼ m at both ends of the crack]. So the area affected is ½ m wide x 1½ m long = ¾ $m^2$. If the deck area is 35 $m^2$ say, the crack affects an area of (0.75/35) x 100%, i.e. approximately 2%, round up to 5%.

Example 2: a transverse crack is 2m long in a 3.1 m x 1.2 m concrete box unit (that is 1.2 m long). The area affected is therefore: ¼ m on both sides of a crack x [length of the crack + ¼ m at both ends of the crack]. So the area affected is ½ m wide x 2½ m long = 1¼ $m^2$. The box unit area for all faces of the barrel is 6.48 $m^2$, the crack affects an area of (1.25/6.48) x 100%, approximately 19%, round up to 20%.

See also (iv) Special Case.

### *b) Whole Component (each)*

This is a "per whole component" basis of measurement. The most severe condition observed in a component determines the Condition State for the whole component.

For example: A bearing unit is assessed as having small areas of Condition State 4, small areas of Condition State 2, with the remainder in Condition State 1. The overall assessment for this bearing unit is 100% Condition State 4.

### *c) Special Case*

Any component with measurements in linear metres or $m^2$, where the component is:

- badly cracked or broken; or
- has defects or cracks in welds

such that its strength is affected to the extent that the whole component requires replacing, the *entire component* is in this case considered damaged and is assigned a Condition State of 4 to the whole component (i.e. 100% in Condition State 4) with appropriate comments outlining this assignment.

This consideration needs to be made to components where replacement is the only solution appropriate and local repairs are not an option.

Judgement is obviously required as to whether a particular component meets this Special Case, what the likely repairs would be and whether this repair approach would be feasible. If there is any doubt, the Inspector shall assign Condition State 4 to the whole component and make comments supporting this decision.

| Component | Measurement Unit |
|---|---|
| **Superstructure** | |
| Beam/Girder (e.g. Closed Web/Box Girder, Open Girder<br>Truss (Through Truss)<br>Mast<br>Tie Beam<br>Cable/Hanger<br>Bracing<br>Tie Rod/Bolt<br>Mounting Brackets | Each |
| Slab<br>Diaphragm | $m^2$<br>See also *(iv) Special Case* |
| **Substructure** | |
| Column or Pile Extension (i.e. pile above ground level)<br>Pier Bracing | Each |
| Capbeam<br>Wall<br>Wing Wall<br>Turndown Wall<br>MSE Wall<br>Footing<br>Pile Cap | $m^2$<br>See also *(iv) Special Case* |
| **Precast Box Unit Bridges** | |
| Headwall<br>Wing Wall<br>Apron<br>Base Slab<br>Barrel | $m^2$<br>See also *(iv) Special Case* |
| **Arch Bridges** | |
| Headwall<br>Wing Wall<br>Footing<br>Arch | $m^2$<br>See also *(iv) Special Case* |
| **Other** | |
| Expansion Joint<br>Bearing Unit<br>External Strengthening | Each |

**Table B.1 - UNITS OF MEASUREMENT FOR DETERMINING PERCENTAGE OF CONDITION STATE FOR COMPONENTS**

# APPENDIX C

# DAMAGE CATALOGUE

# APPENDIX C

## Damage Catalogue – Condition State Assessment Criteria

### Introduction

This section of the Level 2 Inspection Guidelines provides guidance to the Inspector on the determination of a Condition State to match the varying levels of deterioration for different bridge types and components.

The Damage Catalogue is structured into a number of segments, each containing descriptions and photographs for the four Condition States appropriate to that segment.

Users should note that the Damage Catalogue is specifically for those components of a structure for which a Condition State is required.  These components have been previously described in Section 14 and are also marked on the inspection templates in Appendix H. However, the Inspector is required to report on the entire structure and for additional information on typical defects for other components; reference may be made to the *Routine Visual Bridge Inspection Guidelines (Level 1 Inspections) for Bridges*, document 6706-02-2234.

# CONDITION STATE ASSESSMENT CRITERIA

## 1 CONCRETE SUPERSTRUCTURE

**Applicable to slabs, beams, open girders, box girders, tie beams, diaphragms, bracing, arches, masts.**

<u>CONDITION STATE 1</u> - In good condition with little or no deterioration.

Hairline cracking (≤0.1 mm) may be present.  Cracks are widely spaced and are very infrequent.

There is no cracking in the fully prestressed component.

There is no block cracking (see below for definition).

There is no pattern of tension cracking.

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| Mild water staining inside of beams. | Superficial water stains only (diaphragm). | Slightly weathered, some minor surface grout loss and discolouration, however still in good condition. |

# CONDITION STATE ASSESSMENT CRITERIA

## 1 CONCRETE SUPERSTRUCTURE

CONDITION STATE 2 - In good to fair condition with relatively minor deterioration.

Fine cracking (>0.1 & ≤0.3 mm) and spalling may be present. There may be fine (and dry) longitudinal cracks and spalls but no exposure of reinforcement or strands.

Damp patches and efflorescence may be visible.

There is no cracking in the fully prestressed component.

There is a block cracking pattern (i.e. joining up of longitudinal and transverse structural cracks) with hairline cracks (≤0.1 mm) in a grid.

A pattern of tension cracks may be present with hairline cracks (≤0.1 mm).

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| Closely spaced hairline cracks as indicated by the efflorescence. | Widely spaced fine cracking. Water staining prevalent in more sheltered areas. | Staining indicates hidden issues and some minor deterioration. Warrants a CS2 even though there is no obvious cracking. |

# CONDITION STATE ASSESSMENT CRITERIA

## 1 CONCRETE SUPERSTRUCTURE

<u>CONDITION STATE 2</u> - Continued…

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| The crack shown by the leaching might still be CS1, however, there are additional hairline cracks forming a pattern making this CS2. | Example of permanent formwork. The covered concrete is rated on the condition of the formwork. As the permanent formwork is providing full protection to the concrete, CS2 is assigned. | Frequent closely spaced hairline cracks (forming a pattern) warrant CS2. |

# CONDITION STATE ASSESSMENT CRITERIA

## 1 CONCRETE SUPERSTRUCTURE

<u>CONDITION STATE 3</u> - Deterioration and defects are significant although imminent failure or reduced rating is not expected in the medium term. It is likely remedial repairs will be required to be scheduled.

Medium cracking (>0.3 & ≤0.7 mm), fretting and spalling may be present with active corrosion in reinforcement resulting in loss of section of reinforcement or prestressing strands. Isolated rust staining may be evident.

Patches of dampness and efflorescence may be medium to large with numerous stalactites and lime leaching visible.

Shrinkage cracks along centre of flat slab may be medium with some moisture staining around the crack.

Cracking is evident in the fully prestressed component.

Block cracking (see above for definition) may be present with fine cracking (>0.1 & ≤0.3 mm) in a grid.

A pattern of tension cracks may be present with fine cracking (>0.1 & ≤0.3 mm).

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| Spalling and exposed reinforcement indicates CS3. Concrete has other cracking as shown by staining. | Frequent cracking greater than 0.3 mm. | Single quite large spall. The spall is likely to have been caused by obstruction of movement and hence warrants CS3. |

# CONDITION STATE ASSESSMENT CRITERIA

## 1 CONCRETE SUPERSTRUCTURE

<u>CONDITION STATE 3</u> - Continued…

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| Exposed reinforcement due to localised spalling. Appears to have had low cover. | Exposed reinforcement, corrosion has caused concrete to spall. Corrosion appears severe but only in one isolated and edge area, thus still considered CS3. | Example of permanent formwork. The cracks are in excess of 0.3 mm and the formwork is no longer providing full protection to the slab, CS3 is assigned. |

# CONDITION STATE ASSESSMENT CRITERIA

## 1 CONCRETE SUPERSTRUCTURE

CONDITION STATE 3 - Continued…

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| Example of steel permanent formwork. The localised section of slab will be CS3 given the lack of protection to the slab. The remainder could be CS2. | Single medium crack <0.7 mm. Note that the crack is active and fretting. |

# CONDITION STATE ASSESSMENT CRITERIA

## 1 CONCRETE SUPERSTRUCTURE

CONDITION STATE 4 - Deterioration and defects are significant enough to warrant re-rating the capacity. Without intervention failure of the component may be expected in the short to medium term.

Heavy cracking (>0.7 mm) with fretting and spalling may be present. Severe corrosion of the reinforcement over large areas, resulting in substantial loss of section. Stressing strands (where present) may be broken or exhibit signs of advanced corrosion.

Shrinkage cracks along centre of slat slab may be heavy with excessive moisture penetration and heavy staining around the crack.

Deck may have extensive longitudinal cracking with differential movement between sections of the deck.

Advanced block cracking (see above for definition) may be present with medium cracking (>0.3 & ≤0.7 mm) in a grid of approximately 0.3 m spacing.

A pattern of tension cracks may be present with medium cracking (>0.3 & ≤0.7 mm).

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| Severe impact damage with total destruction of the beam. Immediate action required. | Substantial loss of section, spalling. | Substantial loss of reinforcement section and failure of beams. Note the absence of discolouration/staining. |

# CONDITION STATE ASSESSMENT CRITERIA

## 1 CONCRETE SUPERSTRUCTURE

CONDITION STATE 4 - Continued…

Deck slab block cracking, with cracks up to 0.6 mm.

# CONDITION STATE ASSESSMENT CRITERIA

## 2 STEEL SUPERSTRUCTURE

**Applicable to beams, open girders, box girders, tie beams, diaphragms, bracing, through trusses, arches, masts, cables, hangers, tie rods/bolts, mounting brackets.**

*Users will note that this section is also used for steel substructure components and some of the illustrative photographs are of substructure elements. Determination of Condition States is the same for superstructure and substructure steel components.*

<u>CONDITION STATE 1</u> - In good condition with little or no deterioration.

All welds, bolts, rivets, tie rods are in good condition with no movement of plates or sections in the component.

Cable/Hanger: No signs of distress at anchors, sockets or saddles.

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| Very minor, superficial discolouration near connections. | Old emergency bridging, still in good condition. | Steel beams in ‘as new’ condition. |

## 2 STEEL SUPERSTRUCTURE

CONDITION STATE 1 - Continued…

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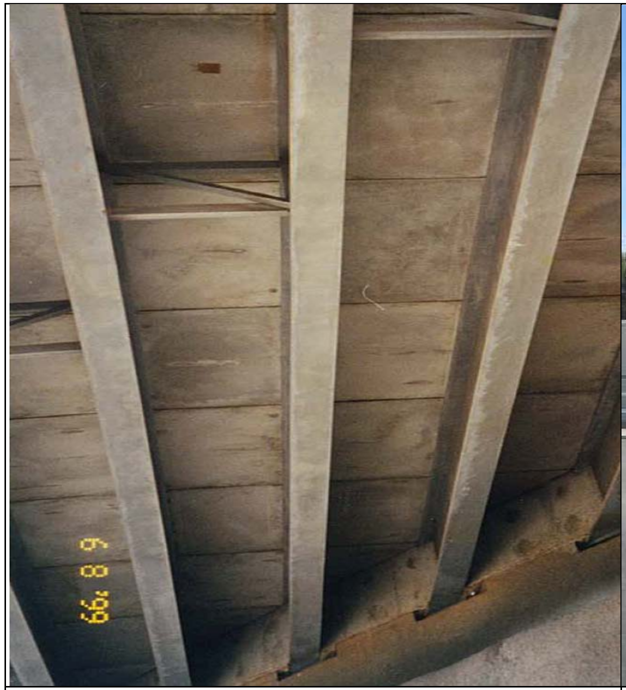
|  |  |
| Steel beams have some surface discolouration, but still 'as new'. | Mounting brackets to electrification protection screen on RHS are in perfect condition. |

# CONDITION STATE ASSESSMENT CRITERIA

## 2 STEEL SUPERSTRUCTURE

<u>CONDITION STATE 2</u> - In good to fair condition with little or minor deterioration.

There may be surface corrosion.

All welds and fasteners are in good condition with no cracking and only superficial surface corrosion. There may be very minor corrosion of connections but they are tight.

Cable/Hanger: No signs of distress at anchors or sockets. Saddles may be slightly corroded.

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| Minor corrosion in connections, localised surface corrosion. | Widespread surface corrosion which makes it marginal CS2. However still only surface corrosion and not active. | In good condition with some localised surface corrosion. |

# CONDITION STATE ASSESSMENT CRITERIA

## 2 STEEL SUPERSTRUCTURE

<u>CONDITION STATE 2</u> - Continued…

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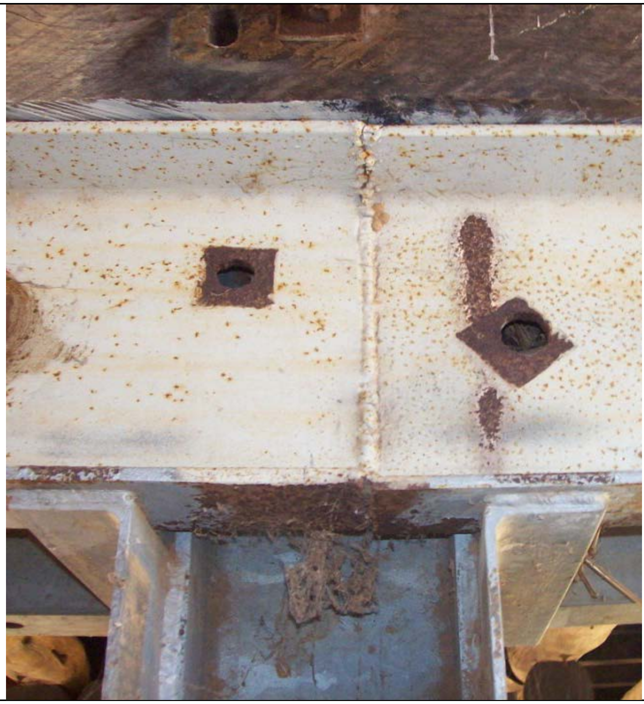
|  |  |  |
| Localised surface corrosion, more prevalent in areas of greater exposure, no section loss. | Localised minor surface pitting, no other section loss. | Quite widespread but superficial surface corrosion. |

# CONDITION STATE ASSESSMENT CRITERIA

## 2 STEEL SUPERSTRUCTURE

CONDITION STATE 3 - Deterioration and defects are significant although imminent failure or reduced rating is not expected in the medium term.  It is likely remedial repairs will be required to be scheduled.

There is active surface corrosion throughout and there is pitting in isolated areas with loss of section.

Welds may have non-continuous hairline cracks.  Corrosion of fasteners is evident but connections remain tight.  Riveted plates may have very minor movement of 1 mm to 2 mm but rivets are generally sound.

Cable/Hanger: Anchors may have fine cracking, sockets may be loose or saddles may have fine cracks in the metal.  The cables may have slackened off slightly.  The hangers may be slipping on the cable.  Cables may be beginning to abrade but there are no wire breakages.

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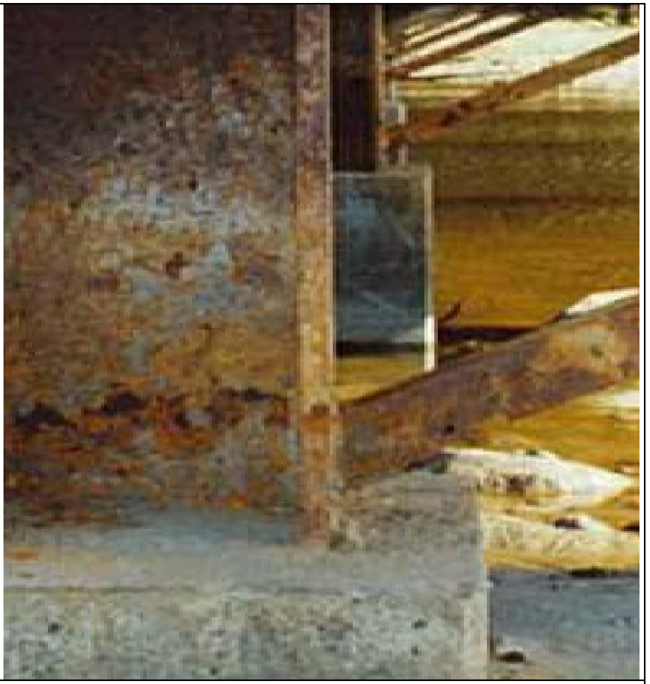
|  |  |  |
| Pitting in isolated areas and loss of section. | Moderate pitting with some section loss although still serviceable. | The flanges have only minor section loss, the flaking on the web indicates a greater loss of section. |

## CONDITION STATE ASSESSMENT CRITERIA

## 2 STEEL SUPERSTRUCTURE

CONDITION STATE 3 - Continued…

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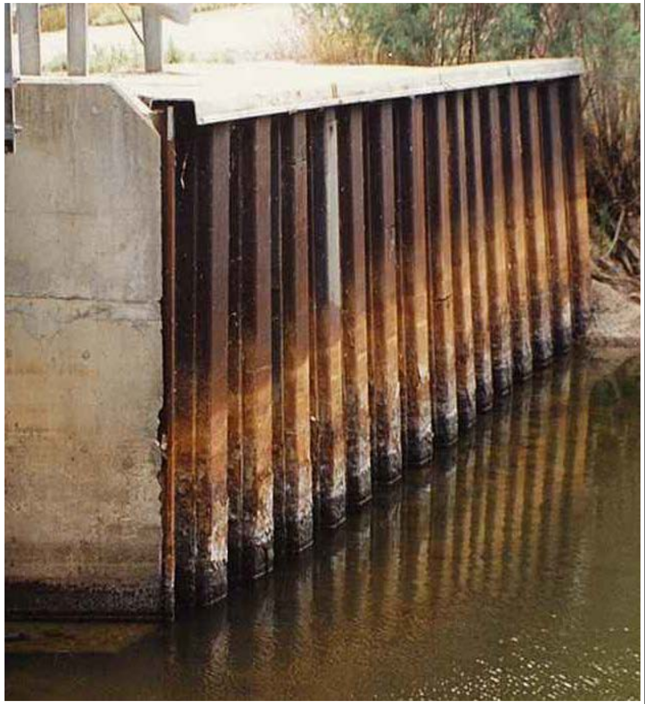
|  |  |  |
| Loss of section from flange and web evident. Note that the Inspector should consider if there is greater deterioration below current water level. | Surface corrosion on the weld with a non-continuous hairline crack. | Active surface corrosion and pitting in isolated areas of the wing wall with loss of section. |

# CONDITION STATE ASSESSMENT CRITERIA

## 2 STEEL SUPERSTRUCTURE

CONDITION STATE 4 - Deterioration and defects are significant enough to warrant re-rating the capacity. Without intervention failure of the component may be expected in the short to medium term.

There is severe surface corrosion resulting in substantial loss of section.

Welds are cracked. Fasteners are severely corroded with loss of section. Some may be loose or missing, allowing extensive movement. The girder/beam exhibits residual out-of-plane deformations.

Cable/Hanger: Hangers may be sliding along the cables. The cables may have slackened noticeably. Anchorages are severely cracked or have moved or slipped. Sockets may have loosened or saddles are badly damaged. Cables may be severely abraded with a number of broken wires.

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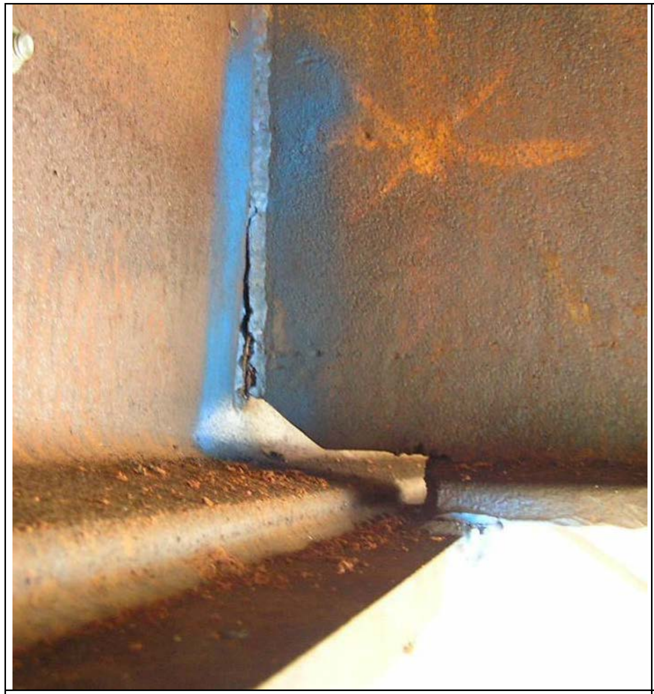
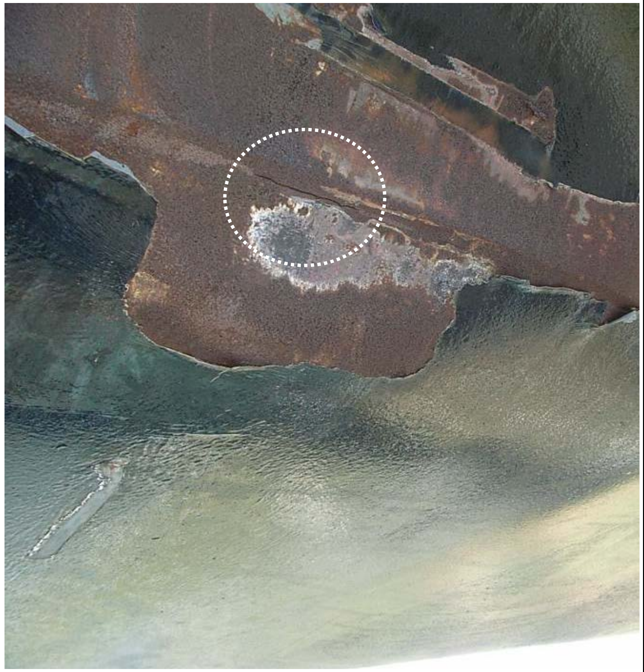
|  |  |  |
| Significant cracking of weld. Section could potentially fail. | Example of impact damage. This warrants a CS4 as the box section has been torn. | Severely corroded steel section. |

## 3 PIER and 4a ABUTMENT

**Applicable to piles, columns, pile caps, capbeams, walls, footings.**

*For steel components refer to Section 2 Steel Superstructure.*

<u>CONDITION STATE 1</u> - In good condition with little or no deterioration.

Concrete member is in good condition and there may be only hairline cracking (≤0.1 mm).

No cracking in the fully prestressed component.

There is no pattern of tension cracking.

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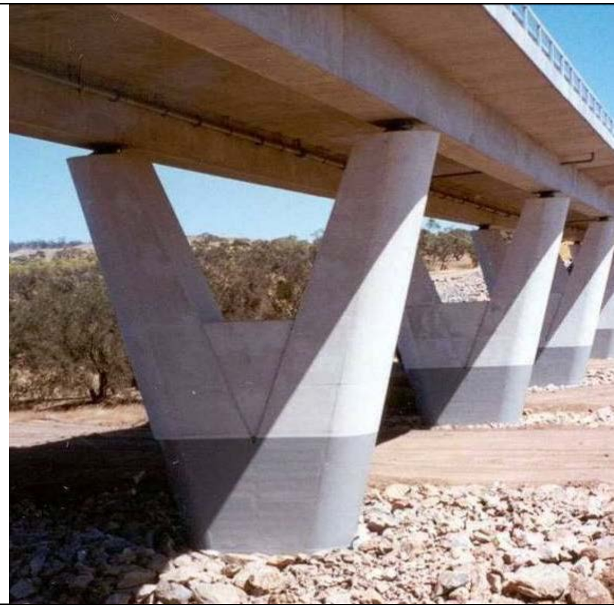
|  |  |  |
| The mortar pad is 'as new'. Note that this is part of a new intermediate pier and the performance of strengthening works is of great interest. | Hairline cracks near the top. Although the pile is prestressed and any cracks would be CS2, the very top section will be unstressed and may be considered as reinforced concrete. | Singular V-shaped concrete column forms the pier. As new. |

# CONDITION STATE ASSESSMENT CRITERIA

## 3 PIER and 4a ABUTMENT

CONDITION STATE 2 - In good to fair condition with little or minor deterioration.

Concrete member has some fine cracking (>0.1 & ≤0.3 mm) evident with some minor localised spalling. No reinforcement or prestressing strands are exposed.

There is no cracking in the fully prestressed component.

A pattern of tension cracks may be present with hairline cracks (<0.1 mm).

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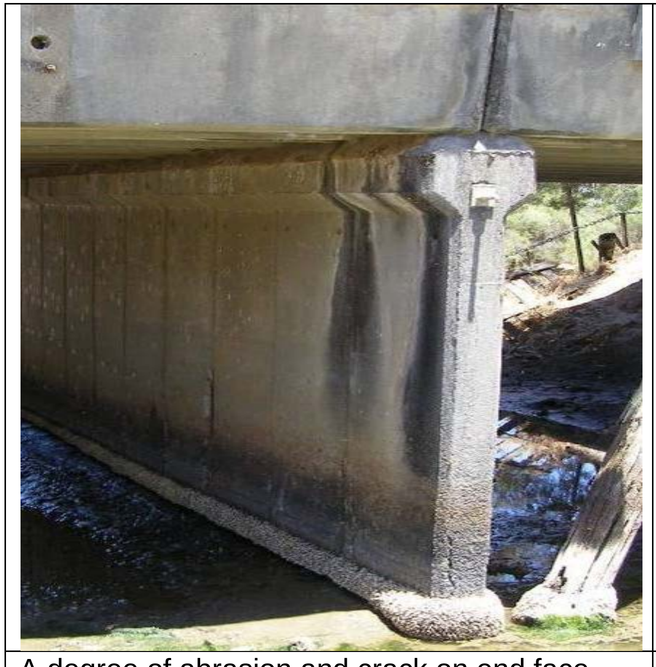
|  |  |  |
| A degree of abrasion and crack on end face. Note that the deterioration may be more advanced than is visible due to the aggressive environment. | Spall appears due to impact but is shallow. | Water staining, evidence of rust staining starting, particularly where the pier wall meets the deck and top of water line stain. |

# CONDITION STATE ASSESSMENT CRITERIA

## 3 PIER and 4a ABUTMENT

CONDITION STATE 3 - Deterioration and defects are significant although imminent failure or reduced rating is not expected in the medium term. It is likely remedial repairs will be required to be scheduled.

Concrete member has medium cracking (>0.3 & ≤0.7 mm) and/or spalling with exposed reinforcement showing signs of advanced corrosion with some loss of section. Isolated rust staining may be evident. May be some exposed prestressing strands exhibiting signs of minor corrosion (surface rust only, no pitting).

Cracking is evident in the fully prestressed component.

A pattern of tension cracks may be present with fine cracking (>0.1 & ≤0.3 mm).

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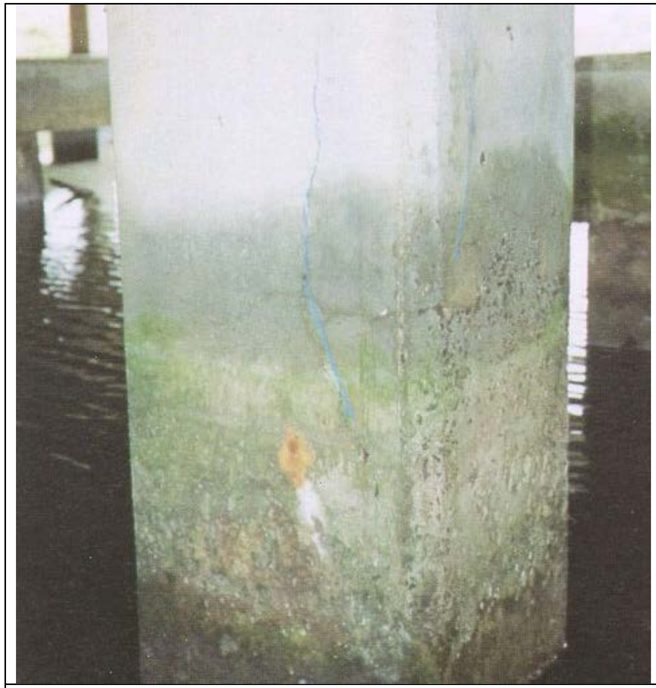
|  |  |  |
| Marginal CS3. However, aggressive environment and extent of capillary rise plus network of cracks indicate CS3. | Fire damage as noted from the pink discolouration. Medium cracking and tapping indicates delamination. | Spalling, exposed reinforcement, significant weathering of ends. Surface pitting. |

# CONDITION STATE ASSESSMENT CRITERIA

## 3 PIER and 4a ABUTMENT

CONDITION STATE 4 - Deterioration and defects are significant enough to warrant re-rating the capacity. Without intervention failure of the component may be expected in the short to medium term.

Concrete member has heavy cracking (>0.7 mm) and/or spalling with advanced corrosion of reinforcement with substantial loss of section. Exposed prestressing strands show signs of advanced corrosion with pitting or some loss of section.

A pattern of tension cracks may be present with medium cracking (>0.3 & ≤0.7 mm).

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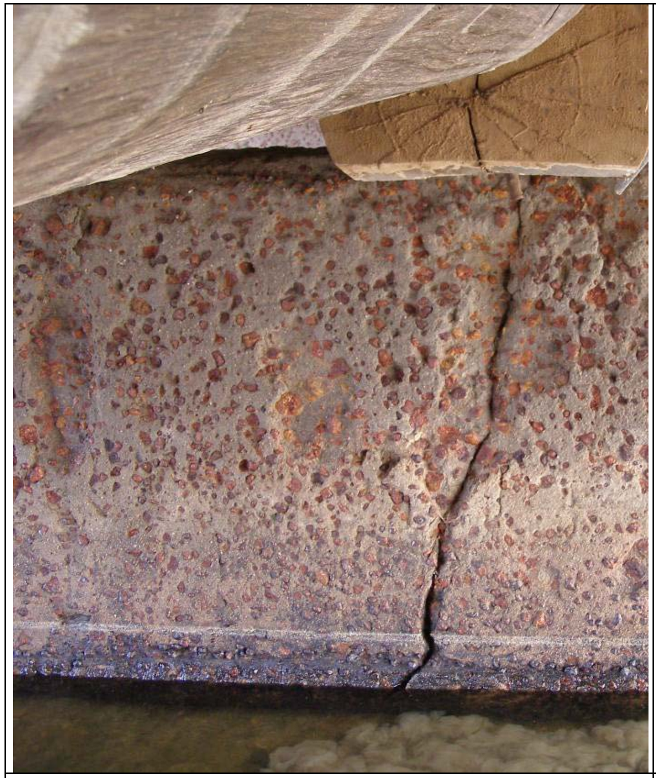
|  |  |
| Unreinforced mass concrete pier wall. Single heavy crack which appears stable. Some abrasion. | Reduced section capacity based on loss of section area from spalling, in tidal zone so assume deterioration will proceed rapidly. |

# CONDITION STATE ASSESSMENT CRITERIA

## 4b ABUTMENT

**Applicable to wing walls, mechanically stabilised earth (MSE) walls.**

<u>CONDITION STATE 1</u> - In good condition with minor deterioration.

Fine cracking (>0.1 & ≤0.3 mm) with minor localised spalling may be evident.

No reinforcement is exposed.

Independent wing walls have no movement and embankment is stable.

In precast units there is no settlement of units or gaps between units allowing loss of embankment fill. There is no vegetation growing between the units. There is no movement of units.

Masonry walls may have hairline or fine cracking (≤0.3 mm) throughout the mortar joints.

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| MSE wall in 'as new' condition. | MSE wing wall in excellent condition. | Only minor coating defects, structurally 'as new'. |

# CONDITION STATE ASSESSMENT CRITERIA

## 4b ABUTMENT

CONDITION STATE 2 - In good to fair condition with minor deterioration.

Medium cracking (>0.3 & ≤0.7 mm) and spalling.

Exposed reinforcement exhibiting advanced corrosion with some loss of section. Rust staining is evident.

Independent wing walls may have slight movement but not enough to cause loss of embankment fill material.

Precast units may have minor movement or settlement enabling only minor loss of embankment fill. There is no vegetation growing between the units.

Masonry walls may have medium cracking (>0.3 mm) or heavy cracking, up to 1 mm, of the mortar between blocks. Blocks are still firmly in place. Non-grouted masonry or rubble is well stacked and is stable.

Gabions have minor settlement or minor loss of stone or a few broken wires.

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| Minor movement of MSE wall panels. No significant loss of fill. | Medium cracks in the abutment wing wall, up to 0.4 mm. | Minor loss of embankment fill between the MSE wall panels. |

# CONDITION STATE ASSESSMENT CRITERIA

## 4b ABUTMENT

CONDITION STATE 3 - Deterioration and defects are significant although imminent failure or reduced rating is not expected in the medium term. It is likely remedial repairs will be required to be scheduled.

Heavy cracking (>0.7 mm) and/or spalling with advanced corrosion of reinforcement with substantial loss of section.

No exposure of reinforcement in MSE walls.

Independent wing walls may have moderate movement away from the abutments with some loss of embankment fill material evident.

Precast units may have moderate movement, settlement or separation of units that may have resulted in medium loss of embankment fill. There may be some vegetation growing between the units indicating breakdown of the backing strip.

Masonry walls may have heavy cracking (>1.0 & ≤2.0 mm) of the mortar. Some blocks may be loose. Non-grouted masonry rubble has moved with some loss of stone and minor loss of embankment fill.

Gabions may have distorted with moderate loss of stone with broken or corroded wires.

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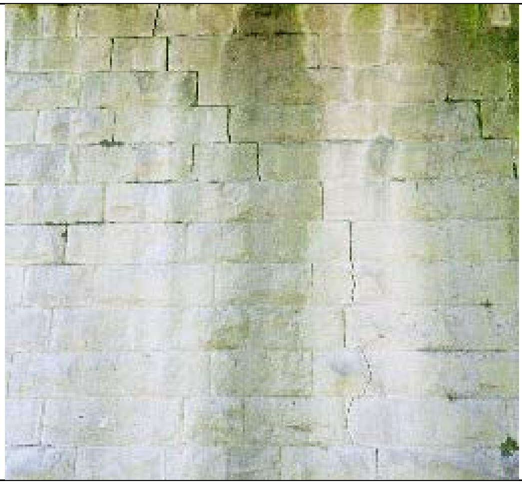
|  |  |  |
| Heavy cracking up to 2 mm of the wing wall with blocks coming loose. | MSE wall panels with moderate movement and vegetation growth indicating breakdown of the backing strip. | Heavy cracking of the wing wall up to 2 mm of the mortar. Cracks also extend through the blocks. |

# CONDITION STATE ASSESSMENT CRITERIA

## 4b ABUTMENT

CONDITION STATE 4 - Deterioration and defects are significant enough to warrant re-rating the capacity. Without intervention failure of the component may be expected in the short to medium term.

Multiple or frequent heavy cracking (>0.7 mm) and/or spalling with advanced corrosion of reinforcement with substantial loss of section and large areas of reinforcement exposed.

Some reinforcement is exposed with signs of minor corrosion in MSE walls.

Independent wing walls may have moved away from the abutment causing excessive loss of embankment fill material from behind the wall.

Precast units have excessive movement, settlement or separation of units which may be allowing heavy loss of embankment fill. There may be a lot of vegetation growing between the units indicating breakdown of the backing strip.

Masonry walls may have very heavy cracking (>2.0 mm) of the mortar. Non-grouted masonry rubble walls have moved appreciably and lost numerous rocks. Walls are no longer effective in retaining fill.

Gabions may be badly corroded and may have lost substantial filling or have numerous broken wires.

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| Wing wall has moved away from the abutment wall. | MSE wall panels have separated up to 50 mm. |

# CONDITION STATE ASSESSMENT CRITERIA

## 5 BEARING UNITS

**Applicable to rocker, elastomeric and pot bearings.**

<u>CONDITION STATE 1</u> - In good condition with little or no deterioration.

The bearing is in good condition showing minimal deterioration and appears to be performing its design function properly.

There is minimal debris in the bearing.

The bearing support is sound.

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| Bearing in ‘as new’ condition. | No bulging or deterioration of bearing. | The elastomeric bearing is showing some distortion but is well within the capacity of the bearing. The bearing condition is good. |

## 5 BEARING UNITS

<u>CONDITION STATE 2</u> - In good to fair condition with little or minor deterioration.

The bearing may have very minor cracks, splits or signs of weathering.

Debris or corrosion may have a minor effect on the movement capability of the bearing.  The joint is fully operational.

The bearing support (e.g. mortar pad) may be cracked but is still structurally sound and providing complete support.

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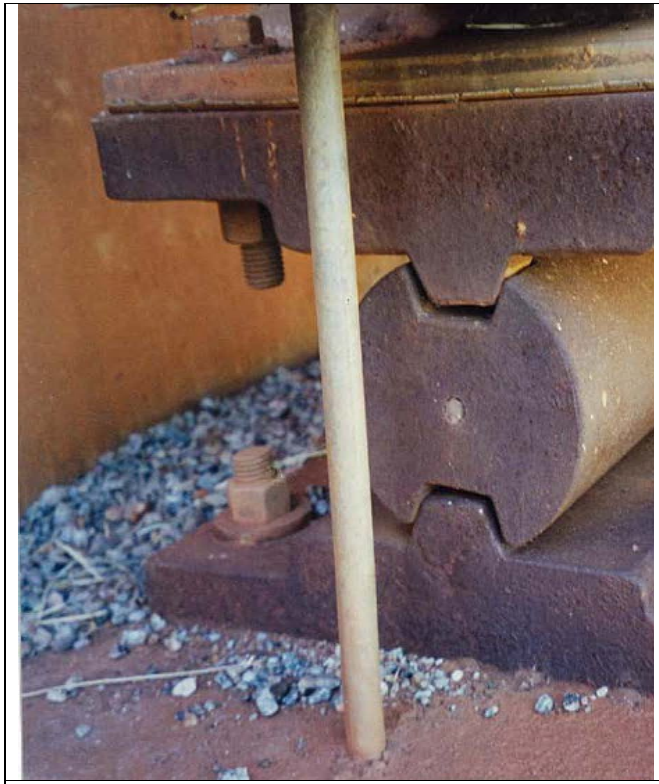
|  |  |  |
| Generally in good condition with some minor pitting and corrosion on the connections. | This bearing requires re-setting, however its condition is still good. | Slight bulging of elastomeric bearing. |

# CONDITION STATE ASSESSMENT CRITERIA

## 5 BEARING UNITS

CONDITION STATE 2 - Continued…

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| Minor corrosion only. | Hairline cracking of the mortar pad but still sound. Minor corrosion of connections. (Note: the packing plate is not considered part of the Bearing Unit.) |

# CONDITION STATE ASSESSMENT CRITERIA

## 5 BEARING UNITS

CONDITION STATE 3 - Deterioration and defects are significant although imminent failure or reduced rating is not expected in the medium term. It is likely remedial repairs will be required to be scheduled.

Medium to advanced corrosion in steel components. There may be minor cracks in welds.

The ability of the bearing to perform its intended function is affected. Bearing may appear to be over-stressed.

Bearing supports may show heavy cracking, crumbling of mortar or have sizeable spalling with some reduction in bearing support area.

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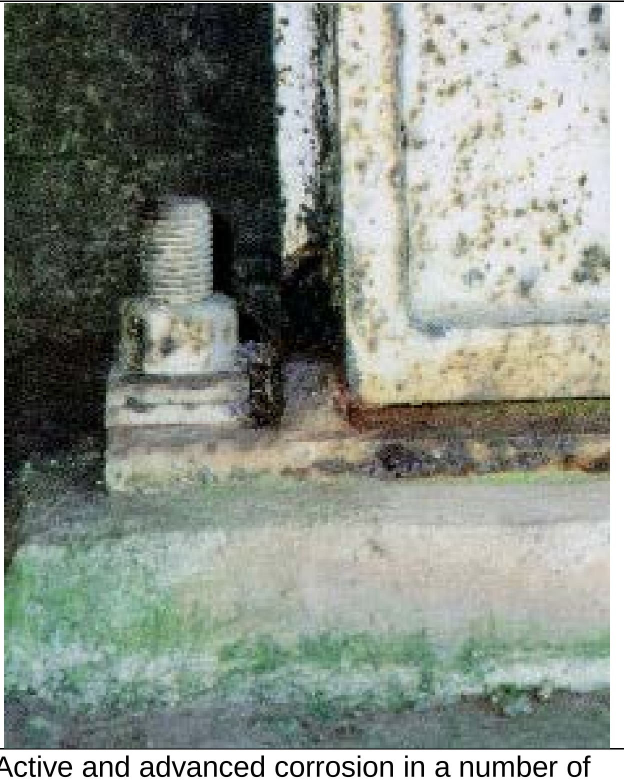
|  |  |  |
| Active and advanced corrosion in a number of locations. | Loss of rubber dust seal indicates the bearing needs prompt maintenance and warrants a CS3. | Bearing support showing heavy cracking and failure of the mortar. |

## 5 BEARING UNITS

CONDITION STATE 4 - Deterioration and defects are significant enough to warrant re-rating the capacity. Without intervention failure of the component may be expected in the short to medium term.

Significant corrosion in steel components with heavy pitting. Welds may have cracked completely. There may be substantial loss of bearing area.

The bearing is no longer functioning as was intended, it may be completely seized.

The bearing support may have badly crumbled mortar or heavily spalled concrete with excessive reduction in bearing support. There may be localised crushing of the structural concrete underneath the bearing.

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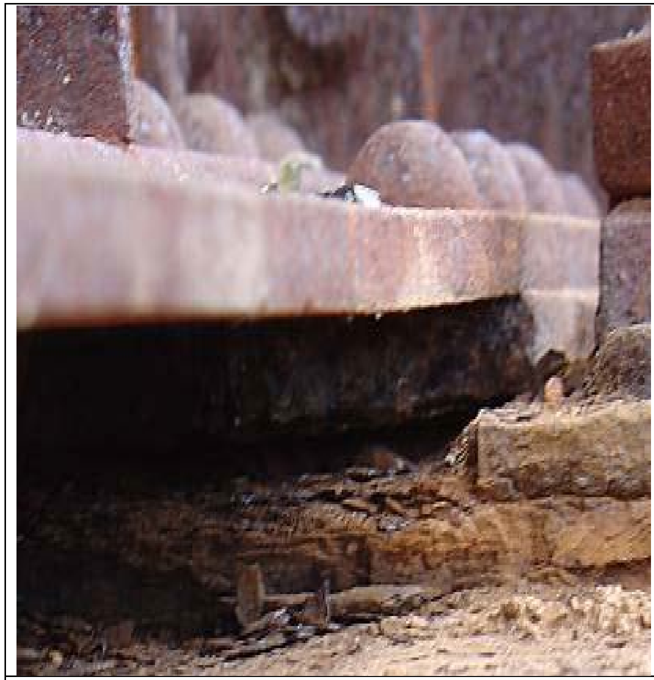
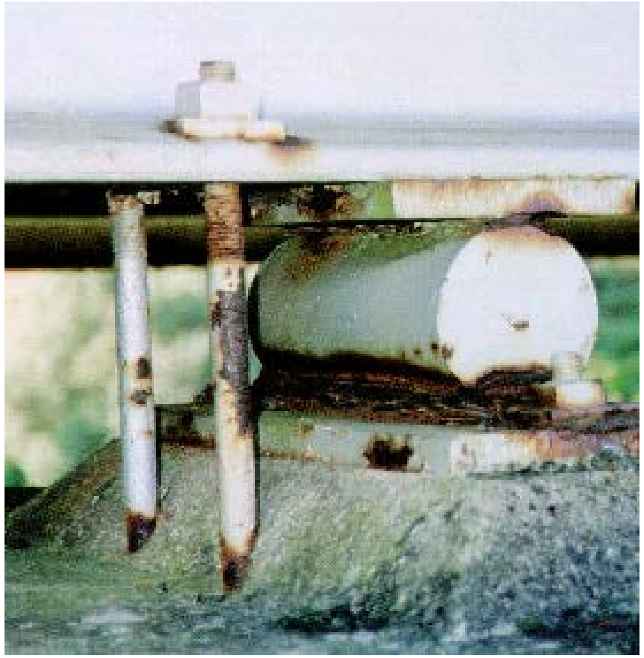
|  |  |
| Steel components and holding down connections with advanced corrosion and heavy pitting. | Roller bearing with advanced corrosion, preventing functioning. |

# CONDITION STATE ASSESSMENT CRITERIA

## 6 EXPANSION JOINTS – Small Movement Joints

**Applicable to pourable joints, compression seals and fixed joints.**

CONDITION STATE 1 - In good condition with little or no deterioration.

Joint material is held firmly in place.  No adhesion or sealing problems.

The seal shows some deterioration and there may be some moisture penetration through the joint

Edge angles (where present) are sound and show good connectivity with concrete.

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| Clean.  No obstruction in gap, rubber compression seal not inconsistent, concrete and road surface have no degradation issues. | Joint has not significantly degraded. | Neat edge maintained, nothing appears to be able to obstruct expanding/contracting of the pourable joint. |

# CONDITION STATE ASSESSMENT CRITERIA

## 6 EXPANSION JOINTS – Small Movement Joints

<u>CONDITION STATE 2</u> - Rigid components of the joint are in good to fair condition with little or minor deterioration.  Compression seal may require replacement in the short to medium term.

Joint may have lost adhesion with the deck or armouring allowing leaking of moisture.

The seal has substantial wear and tear with possible cracking.  It may have worked its way out in to the road surface and may have incurred damage due to traffic impact.  Joint may have lost adhesion over a long length allowing moisture penetration.

The adjacent deck may have minor spalls or the edging angles may have lost some connectivity with concrete with cracks developing between them.

Debris build-up in the joint is evident and has some affect on its function.

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| Steel angles and concrete surrounding are in fair condition.  Compression seal cracked and worn.  Some blockage of movement through debris build-up. | Wabo joint filled with road seal.  Build-up has some affect on its function. | Joint has lost adhesion over a long length. |

# CONDITION STATE ASSESSMENT CRITERIA

## 6 EXPANSION JOINTS – Small Movement Joints

CONDITION STATE 3 - Deterioration and defects are significant although imminent failure is not expected in the medium term. It is likely remedial repairs will be required to be scheduled.

The joint may have completely lost adhesion and is no longer operational.

The seal shows extensive damage or it has completely failed allowing extensive moisture penetration.

The adjacent deck may have moderate spalling or the edging angles may have lost connectivity with concrete and the surface is breaking away from the steel.

Debris build-up is severely affecting the performance of the joint and consequential damage is evident.

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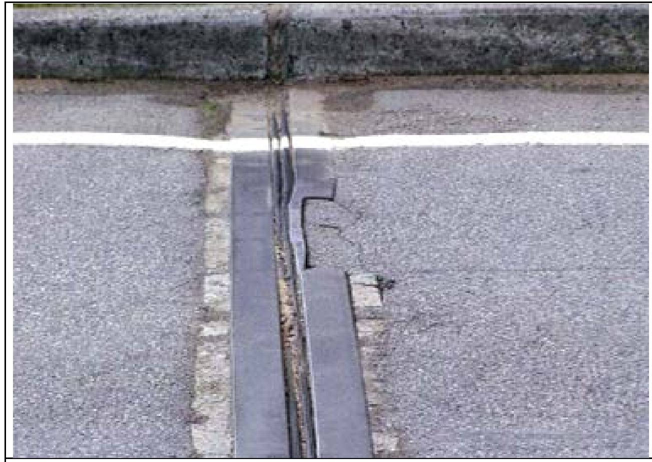
|  |  |
| Road level has warped, steel angle is very distorted and damaged, debris build-up and rubber deterioration, make it barely functional. | Chipping and spalling of the joint. |

## 6 EXPANSION JOINTS – Small Movement Joints

CONDITION STATE 4 - Without intervention failure of the component may be expected in the short to medium term.

The connectivity between the concrete deck and the edging angles is completely lost or pourable joint sealant is almost completely lost and the bitumen/cork filler may be broken up and being ripped out by traffic.

The joint is completely blocked with debris and is not functional.

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|---|---|
|  |   |
| Significant spall and loose nut with loss of connectivity between the deck and joint. | Significant loss of sealant. |

## CONDITION STATE ASSESSMENT CRITERIA

### 7 EXPANSION JOINTS – Large Movement Joints

**Applicable to modular joints, finger joints and sliding steel joints.**

<u>CONDITION STATE 1</u> - In good condition with little or no deterioration.

The joint is free from debris and functions well. The joint's components and the surrounding concrete are in good condition.

There may be only minor steel corrosion.

Drainage is unobstructed in open steel type joint.

| | |
|---|---|
|  |  |
| No damage to any components, no debris build-up, nothing to obstruct full working order. | Clean. No damage, in full working order. |

# CONDITION STATE ASSESSMENT CRITERIA

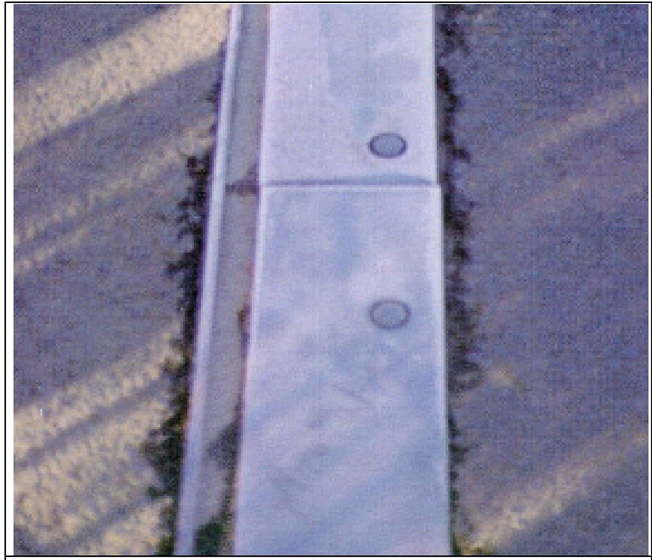
## 7 EXPANSION JOINTS – Large Movement Joints

CONDITION STATE 2 - Rigid components of the joint are in good to fair condition with little or minor deterioration.

Joint has minor amount of debris between seals which limits proper function. The seal has minor cracks or traffic-induced damage and surrounding concrete is slightly cracked or chipped.

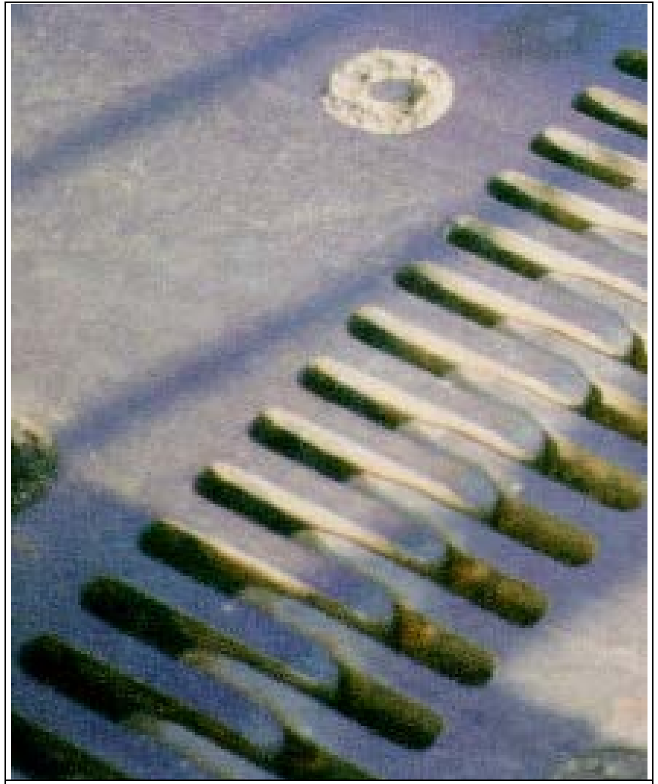
There may be steel corrosion throughout but with no discernable loss of section. Any fasteners are still tight.

In open steel type, joint may have some debris build-up without significant effect on joint performance.

| | | |
|---|---|---|
|  |  |  |
| The steel components are in good condition. The bitumen seal coat is frayed, but is not a major issue. Some build-up and minor reduction in functionality. | The components are all in good condition, this is given CS2 because of the reduced functionality caused by debris build-up. | The surrounding concrete has cracked, little bit of wear on the outer steel, little to no deterioration of the rubber. |

## 7 EXPANSION JOINTS – Large Movement Joints

CONDITION STATE 2 - Continued…



Minor displacement of fingers relative to one another (needs further investigation). Loss of waterproofing at bolted connection.

## 7 EXPANSION JOINTS – Large Movement Joints

CONDITION STATE 3 - Deterioration and defects are significant although imminent failure is not expected in the medium term. It is likely remedial repairs will be required to be scheduled.

There is a substantial amount of debris in the joint significantly affecting proper function. The seals are damaged and may not function properly. Some seals may have become dislodged and are subject to direct impact on the traffic.

Steel corrosion is well advanced with some surface pitting. Surrounding concrete is cracked and spalled. Minor cracks in steel may have developed. Some fasteners may be loose.

| | |
|---|---|
|  |  |
| The debris build-up would indicate a significant blockage to movement. | Significant spalling of concrete adjacent to the joint. |

## 7 EXPANSION JOINTS – Large Movement Joints

CONDITION STATE 4 - Without intervention failure of the component may be expected in the short to medium term.

The joint is completely blocked or the drainage system is completely blocked, severely damaged or missing. The seals are severely damaged and are unable to perform their design function.

There is advanced corrosion of steel with significant surface pitting of steel components. Surrounding concrete is cracked and spalled throughout the length of the joint. Cracks in steel are well advanced. Localised failure of the joint may be evident. Fasteners have advanced corrosion and some are loose or missing.

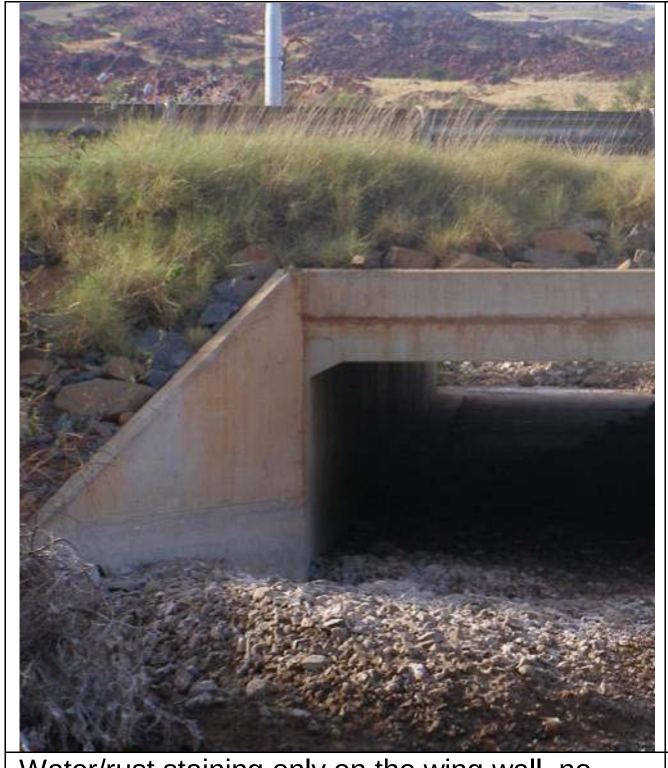
| | | |
|---|---|---|
|  |  |  |
| Joint appears to be completely closed and not functioning. | This isn't too good either! Fingers broken. | Road surface repaired, plate appears warped, and worn. Insufficient gap for movement. |

**Applicable to headwalls, wing walls and aprons.**

<u>CONDITION STATE 1</u> - In good condition with infrequent and minor deterioration.

There is no movement of the headwall or the wing wall.

The structural concrete may have fine cracking (>0.1 & ≤0.3 mm). No spalling. Cracks are widely spaced and very infrequent.

| | | |
|---|---|---|
|  |  |  |
| Water/rust staining only on the wing wall, no evidence of any degradation. | Concrete precast box unit bridge wing walls, apron and headwall in good condition. | Vertical hairline cracking in the LHS arch headwall. |

CONDITION STATE 2 - In good to fair condition.  All primary structural components are fit for purpose with relatively minor deterioration, cracking and/or settlement.

The headwall or wing wall may exhibit minor movement (up to 10 mm) with respect to the barrels.

The structural concrete may have infrequent and isolated medium cracking (>0.3 & ≤0.7 mm), and minor localised spalling and rust staining may be evident. No reinforcement is exposed.  Damp patches and efflorescence may be visible.

| | |
|---|---|
|  |  |
| Vertical medium cracking on the wing wall. | Widely spaced medium cracks in the structural head wall. |

CONDITION STATE 3 - In fair to poor condition.  All primary structural components are still functional with moderate deterioration, cracking, spalling and/or settlement.  At the upper limit of this condition state, it is likely that maintenance intervention and repairs will be required in the short term.

The headwall or wing wall may exhibit moderate movement (up to 25 mm) with respect to the barrels.

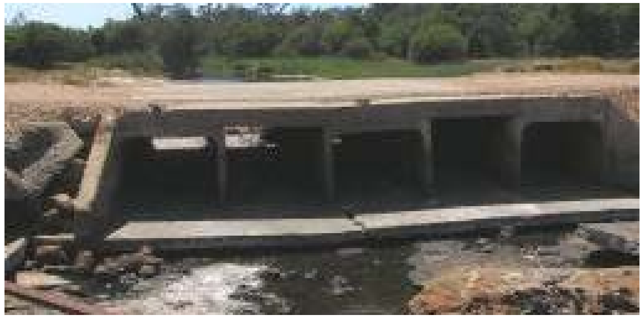
The structural concrete may have infrequent and isolated heavy cracking (>0.7 mm), fretting and spalling with extensive rust staining and active corrosion in the reinforcement resulting in some loss of section in the reinforcement.  Patches of dampness and efflorescence may be medium.

| | |
|---|---|
|  |  |
| Heavy cracking and spalling in the headwall and wing wall with efflorescence. | Heavy vertical crack in the wing wall but appears stable. |

CONDITION STATE 4 - In poor to critical condition.  At the upper limit of this condition state, failure is imminent and immediate intervention will be required.

The headwall or wing wall may exhibit large movement (>25 mm) or the wing wall may be leaning due to earth pressure with possible loss of fill material behind it.

The structural concrete may have multiple and frequent heavy cracking (>0.7 mm), fretting and/or spalling.  Severe corrosion of reinforcement over large areas resulting in substantial loss of section of reinforcement.  Patches of dampness and efflorescence may be large.

| | |
|---|---|
|  |  |
| Apron failure with potential loss of entire box unit bridge. | Heavy diagonal cracking of inlet wing wall. |

**Applicable to boxes, link slabs and base slabs.**

CONDITION STATE 1 - In good condition with little or no deterioration.

There is no relative movement of the precast units.

The structural concrete may have hairline cracking (≤0.1 mm).  No spalling.

| | |
|---|---|
|  |  |
| Barrel in ‘as new’ condition.  Only minor coating defect in the top of one unit. | Barrel wall in ‘as new’ condition with no movement of the decorative tiling. |

CONDITION STATE 2 - In good to fair condition.  All primary structural components are fit for purpose with relatively minor deterioration, cracking settlement and/or misalignment of the precast units.

The line of the barrels is straight but there is minor differential settlement (≤15 mm) which may have resulted in some water ponding in the barrels.

The structural concrete may have fine cracking (>0.1 & ≤0.3 mm) and minor localised spalling may be evident.  Barrels may have edge spalling.  No reinforcement is exposed.  Damp patches and efflorescence may be visible.

| | | |
|---|---|---|
|  |  |  |
| Minor rust staining and small areas of concrete section loss. | Single large delamination.  The Inspector should check how advanced the delamination is as it may warrant a CS3. | Out of alignment ≈15 mm, some rust staining, localised spalls evident.  Still CS2 although close to the upper end. |

<u>CONDITION STATE 2</u> - Continued…

This example is marginal CS2. Localised spalling, rust stains and no exposed reinforcement are CS2. However, the Inspector should consider the aggressive environment, the hidden deterioration and may then upgrade to CS3.

CONDITION STATE 3 - In fair to poor condition. All primary structural components are still functional with moderate deterioration, cracking, spalling, settlement and/or misalignment of the precast units. At the upper limit of this condition state, it is likely that maintenance intervention and repairs will be required in the short term.

There may be some deviation of the line of the barrels due to separation or differential settlement (>15 & ≤40 mm) which may result in a significant amount of water being retained in the barrels. Some damaged joints may leak water.

The structural concrete may have medium cracking (>0.3 & ≤0.7 mm), fretting and/or spalling with extensive rust staining and exposed reinforcement exhibiting loss of section. Edge spalling of barrels is prominent. Patches of dampness and efflorescence may be 0.25 $m^2$ to 1 $m^2$ in any one unit.

| | | |
|---|---|---|
|  |  |  |
| Example of marginal CS3. Spalling and corrosion evident although reinforcement is not exposed. Evidence of leakage through the barrel joints indicates CS3. | Badly damaged barrel (ends are typical of internal sections). | Exposed and corroded reinforcement with loss of section. |

<u>CONDITION STATE 3</u> - Continued…

| | |
|---|---|
|  |  |
| Structural failure, plenty of heavy cracks, bowing, exposed reinforcement, corrosion evident. External component only so not yet CS4. | Exposed reinforcement and significant spall, precursor of structural failure. |

CONDITION STATE 4 - In poor to critical condition.  At the upper limit of this condition state, failure is imminent and immediate intervention will be required.

There may be a large deviation of the line of the barrels.  Separation and settlement (>40 mm) may have resulted in an excessive amount of water being retained in the barrels.  Joint leakage may be substantial.

The structural concrete may have heavy cracking (>0.7 mm), fretting and/or spalling along large delaminated areas.  Edge spalling of barrels may be severe.  Exposed reinforcement exhibits signs of severe corrosion over large areas resulting in substantial loss of section of reinforcement.  Patches of dampness and efflorescence may be > 1 $m^2$ in any one unit.

| | | |
|---|---|---|
|  |  |  |
| Spalled concrete and widespread delamination. | Joints badly cracked with propping to reinstate stability. | Large scale spalling.  Advanced corrosion with substantial loss of section. |

CONDITION STATE 4 - Continued…

In this example, the corrosion is not as advanced, however the large scale spalling and loss of concrete section makes this CS4.

# APPENDIX D

# BRIDGE CONDITION INDEX CALCULATION EXAMPLE

# APPENDIX D

## Bridge Condition Index Calculation Example

This example to calculate the bridge condition index uses the detailed visual inspection report given in Appendix G(i) for Bridge No. 1355.

### Condition State Averaging

$$CS\,x = \sum_{1}^{n} CS\,x \div n$$

5 spans for the 'Slab' component:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Span 1 Slab | | 100 | | |
| Span 2 Slab | | 100 | | |
| Span 3 Slab | | 100 | | |
| Span 4 Slab | | 100 | | |
| Span 5 Slab | | 100 | | |
| **Overall 'Slab'** | **0%** | **100%** | **0%** | **0%** |

5 spans x 5 beams for the 'Beam' component:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Span 1 Beam 1 | 100 | | | |
| Span 1 Beam 2 | 100 | | | |
| Span 1 Beam 3 | 100 | | | |
| Span 1 Beam 4 | 100 | | | |
| Span 1 Beam 5 | 90 | 10 | | |
| Span 2 Beam 1 | 100 | | | |
| Span 2 Beam 2 | 100 | | | |
| Span 2 Beam 3 | 100 | | | |
| Span 2 Beam 4 | 100 | | | |
| Span 2 Beam 5 | 100 | | | |
| Span 3 Beam 1 | 100 | | | |
| Span 3 Beam 2 | 100 | | | |
| Span 3 Beam 3 | 100 | | | |
| Span 3 Beam 4 | 100 | | | |
| Span 3 Beam 5 | 100 | | | |
| Span 4 Beam 1 | 100 | | | |
| Span 4 Beam 2 | 100 | | | |
| Span 4 Beam 3 | 100 | | | |
| Span 4 Beam 4 | 100 | | | |
| Span 4 Beam 5 | 100 | | | |
| Span 5 Beam 1 | 100 | | | |
| Span 5 Beam 2 | 100 | | | |
| Span 5 Beam 3 | 100 | | | |
| Span 5 Beam 4 | 100 | | | |
| Span 5 Beam 5 | 100 | | | |
| **Overall 'Beam'** | **99.6%** | **0.4%** | **0%** | **0%** |

No ‘Box Girder’ components.

4 piers x 3 columns for the ‘Column, Pile’ component:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Pier 1 Column 1 | 50 | 50 | | |
| Pier 1 Column 2 | 50 | 50 | | |
| Pier 1 Column 3 | 40 | 50 | 10 | |
| Pier 2 Column 1 | 50 | 50 | | |
| Pier 2 Column 2 | 50 | 50 | | |
| Pier 2 Column 3 | 50 | 50 | | |
| Pier 3 Column 1 | 100 | | | |
| Pier 3 Column 2 | 100 | | | |
| Pier 3 Column 3 | 100 | | | |
| Pier 4 Column 1 | 100 | | | |
| Pier 4 Column 2 | 100 | | | |
| Pier 4 Column 3 | 100 | | | |
| **Overall ‘Column, Pile’** | **74.2%** | **25.0%** | **0.8%** | **0%** |

4 piers x 1 capbeam for the ‘Capbeam, Pile Cap’ component:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Pier 1 Capbeam | 100 | | | |
| Pier 2 Capbeam | 100 | | | |
| Pier 3 Capbeam | 100 | | | |
| Pier 4 Capbeam | 100 | | | |
| **Overall ‘Capbeam, Pile Cap’** | **100%** | **0%** | **0%** | **0%** |

No ‘External Strengthening’ components.

No ‘Mast, Cable/Hanger’ components.

No ‘Truss’ components.

Abutment walls for the ‘Wall’ component:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Abutment 1 Wall | 80 | 20 | | |
| Abutment 2 Wall | 10 | 80 | 10 | |
| **Overall ‘Wall’** | **45%** | **50%** | **5%** | **0%** |

No ‘Footing’ components.

Abutment and pier diaphragms for the ‘Diaphragm’ component:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Abutment 1 Diaphragm | 100 | | | |
| Abutment 2 Diaphragm | 100 | | | |
| Pier 1 Diaphragm | 100 | | | |
| Pier 2 Diaphragm | 100 | | | |
| Pier 3 Diaphragm | 100 | | | |
| Pier 4 Diaphragm | 100 | | | |
| **Overall ‘Diaphragm’** | **100%** | **0%** | **0%** | **0%** |

4 piers x 5 bearing units for the ‘Bearing’ component:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Pier 1 Bearing Unit 1 | 100 | | | |
| Pier 1 Bearing Unit 2 | 100 | | | |
| Pier 1 Bearing Unit 3 | 100 | | | |
| Pier 1 Bearing Unit 4 | 100 | | | |
| Pier 1 Bearing Unit 5 | 100 | | | |
| Pier 2 Bearing Unit 1 | 100 | | | |
| Pier 2 Bearing Unit 2 | 100 | | | |
| Pier 2 Bearing Unit 3 | 100 | | | |
| Pier 2 Bearing Unit 4 | 100 | | | |
| Pier 2 Bearing Unit 5 | 100 | | | |
| Pier 3 Bearing Unit 1 | 100 | | | |
| Pier 3 Bearing Unit 2 | 100 | | | |
| Pier 3 Bearing Unit 3 | 100 | | | |
| Pier 3 Bearing Unit 4 | 100 | | | |
| Pier 3 Bearing Unit 5 | 100 | | | |
| Pier 4 Bearing Unit 1 | 100 | | | |
| Pier 4 Bearing Unit 2 | 100 | | | |
| Pier 4 Bearing Unit 3 | 100 | | | |
| Pier 4 Bearing Unit 4 | 100 | | | |
| Pier 4 Bearing Unit 5 | 100 | | | |
| **Overall ‘Bearing’** | **100%** | **0%** | **0%** | **0%** |

No ‘Bracing, Tie Beam, Tie Rod/Bolt’ components.

2 expansion joints in the deck for the ‘Expansion Joint’ component:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Expansion Joint 1 | | 70 | 30 | |
| Expansion Joint 2 | | 50 | 50 | |
| **Overall ‘Expansion Joint’** | **0%** | **60%** | **40%** | **0%** |

Abutment wing walls for the ‘MSE Wall, Wing Wall, Turndown Wall’ component:

| | CS1 | CS2 | CS3 | CS4 |
|---|---|---|---|---|
| Abutment 1 LHS Wing Wall | 90 | 10 | | |
| Abutment 1 RHS Wing Wall | 100 | | | |
| Abutment 2 LHS Wing Wall | 100 | | | |
| Abutment 2 RHS Wing Wall | 100 | | | |
| **Overall ‘MSE Wall, Wing Wall, Turndown Wall’** | **97.5%** | **2.5%** | **0%** | **0%** |

**Weighted Component Score**

$$Weighted\ Component\ Score = GM \text{ x } \sum_{i=1}^{4} CS_i \text{ x } CW_i$$

Using columns/piles as an example:

| | CS1 | CS2 | CS3 | CS4 | Group Multiplier |
|---|---|---|---|---|---|
| **Condition Weight** | 1 | 5 | 25 | 50 | |
| Overall ‘Column/Pile’ | 74.2% | 25.0% | 0.8% | 0% | 11 |

$$Weighted\ Component\ Score = 11 \text{ x } [(74.2 \text{ x } 1) + (25.0 \text{ x } 5) + (0.8 \text{ x } 25) + (0.0 \text{ x } 50)] = 2{,}411.2$$

Similarly for other components and as summarised in the table below:

| Component Group | COMPONENT | CS1 | CS2 | CS3 | CS4 | Group Multiplier | Weighted Component Score |
|---|---|---|---|---|---|---|---|
| | *Condition Weight* | 1 | 5 | 25 | 50 | | |
| 1 | Slabs | 0.0 | 100.0 | 0.0 | 0.0 | 11 | 5500.0 |
| | Beams | 99.6 | 0.4 | 0.0 | 0.0 | 11 | 1117.6 |
| | Box Girders | 0.0 | 0.0 | 0.0 | 0.0 | 11 | 0.0 |
| | Columns, Piles | 74.2 | 25.0 | 0.8 | 0.0 | 11 | 2411.2 |
| | Capbeams, Pile Caps | 100.0 | 0.0 | 0.0 | 0.0 | 11 | 1100.0 |
| | External Strengthening | 0.0 | 0.0 | 0.0 | 0.0 | 11 | 0.0 |
| | Masts, Cables/Hangers | 0.0 | 0.0 | 0.0 | 0.0 | 11 | 0.0 |
| | Trusses | 0.0 | 0.0 | 0.0 | 0.0 | 11 | 0.0 |
| 2 | Walls | 45.0 | 50.0 | 5.0 | 0.0 | 6 | 2520.0 |
| | Footings | 0.0 | 0.0 | 0.0 | 0.0 | 6 | 0.0 |
| | Diaphragms | 100.0 | 0.0 | 0.0 | 0.0 | 6 | 600.0 |
| | Bearings | 100.0 | 0.0 | 0.0 | 0.0 | 6 | 600.0 |
| | Bracing, Tie Beams, Tie Rods/Bolts | 0.0 | 0.0 | 0.0 | 0.0 | 6 | 0.0 |
| 3 | Expansion Joints | 0.0 | 60.0 | 40.0 | 0.0 | 3 | 3900.0 |
| | MSE Walls, Wing Walls, Turndown Walls | 97.5 | 2.5 | 0.0 | 0.0 | 3 | 330.0 |

**The Weighted Score**

$$Weighted\ Score = \sum_{i=1}^{n} Weighted\ Component\ Score_i \div \sum_{i=1}^{n} GM_i$$

$$Weighted\ Score = [(5500.0 + 1117.6 + 2411.2 + 1100.0 + 2520.0 + 600.0 + 600.0 + 3900.0 + 330.0) \div (11 + 11 + 11 + 11 + 6 + 6 + 6 + 3 + 3)] \approx 265.86$$

**BCI Range**

For a Weighted Score of 265.86;

$$BCI = (WS + 180) \div 17$$

$$\Rightarrow BCI = (265.86 + 180) \div 17$$

$$\Rightarrow BCI \approx 26.2 \equiv$$ Good

**Overall Spreadsheet Calculation**

BRIDGE NUMBER 1355

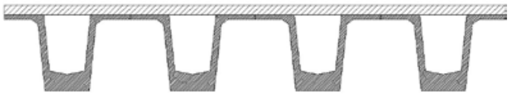
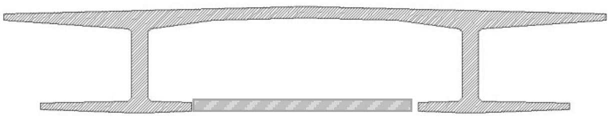
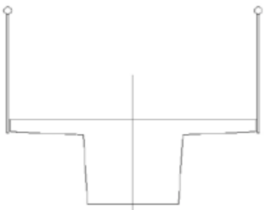
Weighted Score
265.86

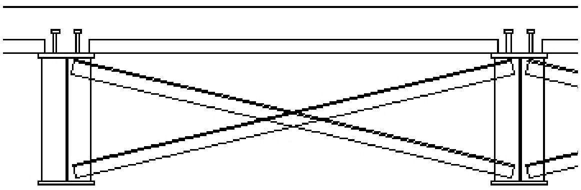
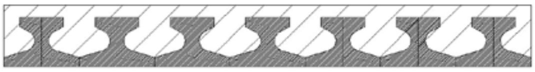
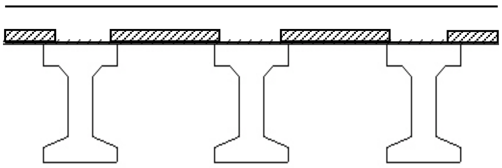
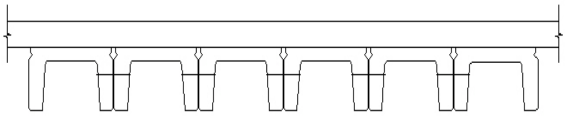
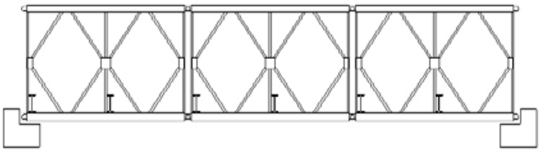
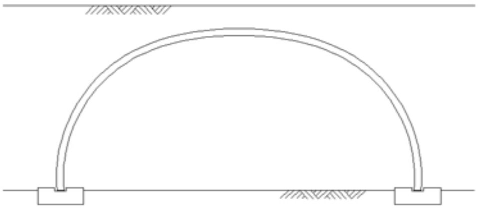
| | COMPONENT | CS1 | CS2 | CS3 | CS4 | Group Multiplier | Weighted Component Score | BCI | |
|---|---|---|---|---|---|---|---|---|---|
| | *Condition Weight* | 1 | 5 | 25 | 50 | | | | |
| 1 | Slabs | 0.0 | 100.0 | 0.0 | 0.0 | 11 | 5500.0 | 26.2 | Good |
| 1 | Beams | 99.6 | 0.4 | 0.0 | 0.0 | 11 | 1117.6 | | |
| 1 | Box Girders | 0.0 | 0.0 | 0.0 | 0.0 | 11 | 0.0 | | |
| 1 | Columns, Piles | 74.2 | 25.0 | 0.8 | 0.0 | 11 | 2411.2 | | |
| 1 | Capbeams, Pile Caps | 100.0 | 0.0 | 0.0 | 0.0 | 11 | 1100.0 | | |
| 1 | External Strengthening | 0.0 | 0.0 | 0.0 | 0.0 | 11 | 0.0 | | |
| 1 | Masts, Cables/Hangers | 0.0 | 0.0 | 0.0 | 0.0 | 11 | 0.0 | | |
| 1 | Trusses | 0.0 | 0.0 | 0.0 | 0.0 | 11 | 0.0 | | |
| 2 | Walls | 45.0 | 50.0 | 5.0 | 0.0 | 6 | 2520.0 | | |
| 2 | Footings | 0.0 | 0.0 | 0.0 | 0.0 | 6 | 0.0 | | |
| 2 | Diaphragms | 100.0 | 0.0 | 0.0 | 0.0 | 6 | 600.0 | | |
| 2 | Bearings | 100.0 | 0.0 | 0.0 | 0.0 | 6 | 600.0 | | |
| 2 | Bracing, Tie Beams, Tie Rods/Bolts | 0.0 | 0.0 | 0.0 | 0.0 | 6 | 0.0 | | |
| 3 | Expansion Joints | 0.0 | 60.0 | 40.0 | 0.0 | 3 | 3900.0 | | |
| 3 | MSE Walls, Wing Walls, Turndown Walls | 97.5 | 2.5 | 0.0 | 0.0 | 3 | 330.0 | | |

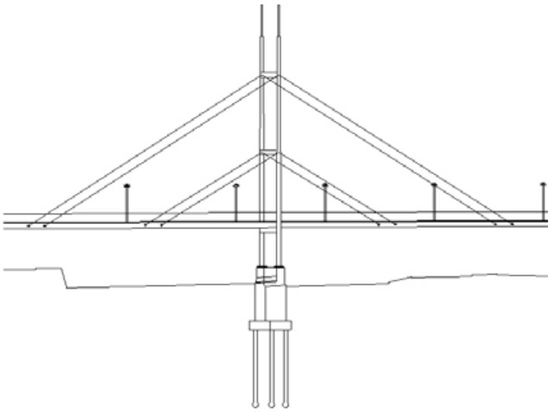
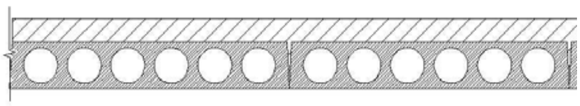
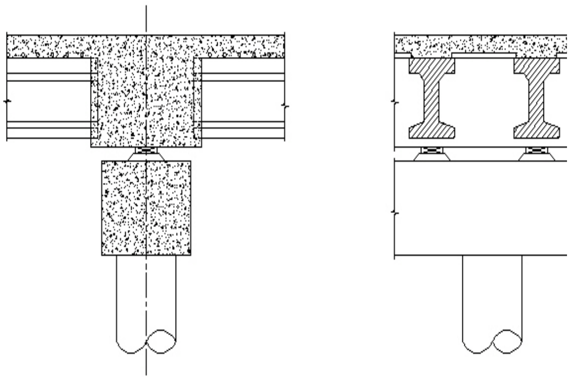
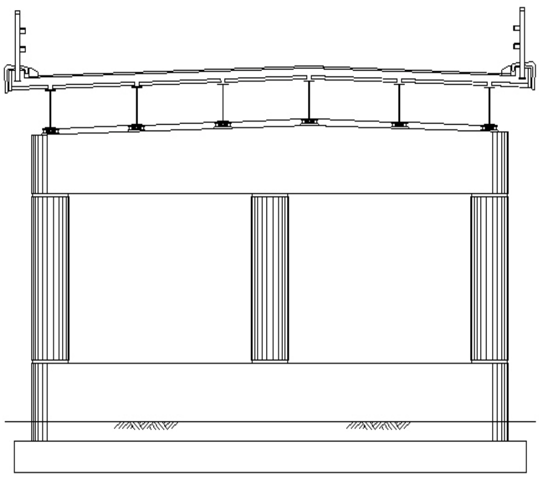
# APPENDIX E

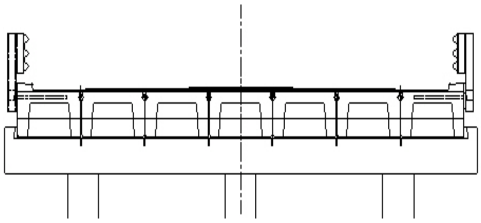
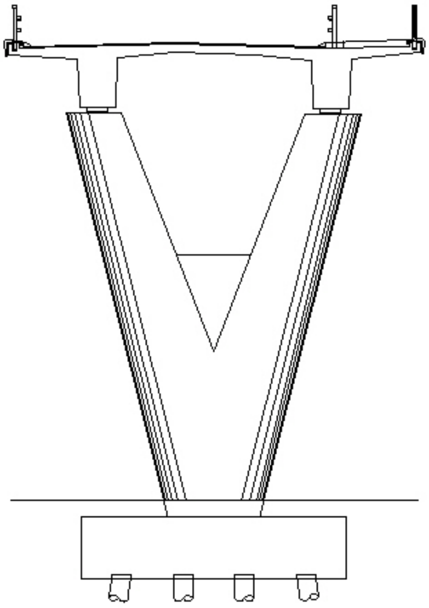
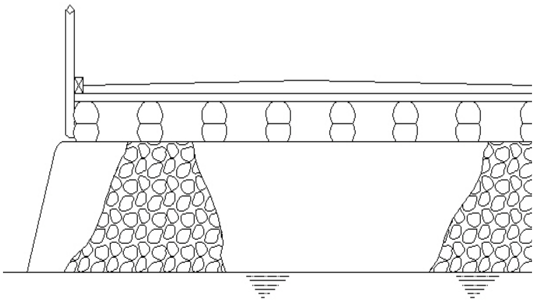
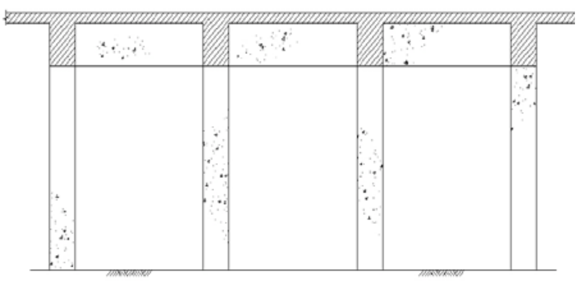
## BRIDGE COMPONENT IDENTIFICATION & TERMINOLOGY
## AND
## TYPICAL CONCRETE AND STEEL BRIDGE TYPES

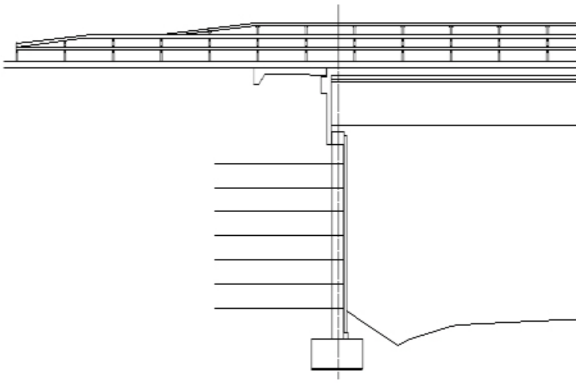
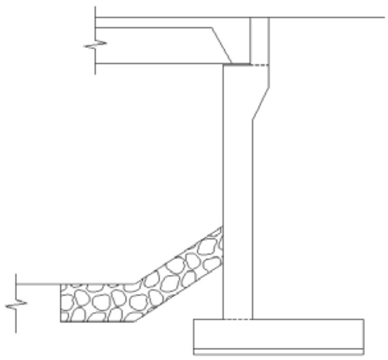
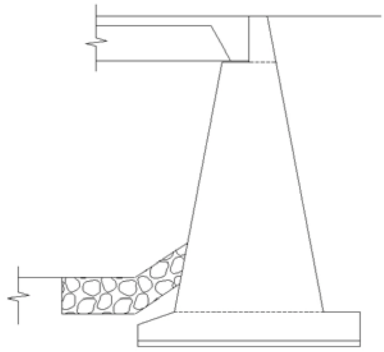
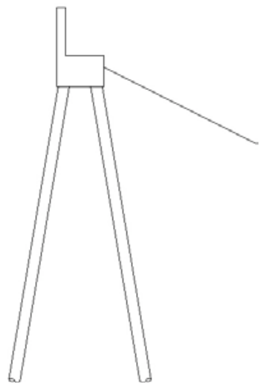
## E.1. BRIDGE COMPONENT IDENTIFICATION AND TERMINOLOGY

| COMPONENT SKETCH | COMPONENT DESCRIPTION |
|---|---|
|  | • Cast in situ deck slab<br>• Steel box girder |
|  | • Teeroff plank with cast in situ topping slab<br>*{Treated as a combined beam for determination of Condition States}* |
|  | • Cast in situ box girder |
|  | • Cast in situ kerb<br>• Cast in situ beam<br>• Cast in situ deck slab<br>*{Usually launched}* |
|  | • Cast in situ voided slab |
|  | • Double I-beam<br>• Tie beam |
|  | • Guardrail<br>• Cast in situ T-beam |

| COMPONENT SKETCH | COMPONENT DESCRIPTION |
| --- | --- |
|  | • Cast in situ slab<br>• Precast concrete permanent formwork<br>• Bracing<br>• Steel I-beam |
|  | • Precast plank with in situ concrete infill<br>*{Treated as a combined beam for determination of Condition States}* |
|  | • Cast in situ slab<br>• Steel permanent formwork<br>• Precast concrete I-beam |
|  | • Cast in situ slab<br>• Precast inverted U-beam<br>*{Treated as a combined beam for determination of Condition States}*<br>• Tie rod/bolt |
|  | • Bailey Bridge truss<br>• Cast in situ abutment wall |
|  | • Precast concrete arch<br>• Cast in situ footing |

| COMPONENT SKETCH | COMPONENT DESCRIPTION |
|---|---|
|  | • Cable/Hangers<br>• Steel mast<br>• Columns<br>• Cast in situ  pile cap<br>• Piles |
|  | • Cast insitu slab<br>• Deltacore prestressed concrete planks<br>*{Treated as a slab}* |
|  | • Cast in situ slab<br>• Steel permanent formwork<br>• Precast concrete I-beam<br>• Cast in situ diaphragm<br>• Bearing unit<br>• Pier capbeam<br>• Pier column |
|  | • Steel guardrail<br>• Cast in situ kerb<br>• Precast parapet (cladding)<br>• Cast in situ slab<br>• Precast permanent formwork<br>• Steel beam<br>• Cast in situ diaphragm<br>• Cast in situ pier capbeam<br>• Steel pier column with concrete infill<br>• Cast in situ pier wall<br>• Cast in situ footing |

| COMPONENT SKETCH | COMPONENT DESCRIPTION |
| --- | --- |
|  | • Steel guardrail<br>• Precast kerb<br>• Precast inverted U-beam<br>• Tie rod/bolt<br>• Precast pier capbeam<br>• Precast pier column |
|  | • Steel guardrail<br>• Steel footpath railing<br>• Precast parapet (cladding)<br>• Double T-beam<br>• Cast in situ deck footway<br>• Cast in situ V-column<br>• Cast in situ pile cap(when visible)<br>• Driven Piles |
|  | • Masonry abutment or pier wall |
|  | • Pier capbeam cast integral with superstructure<br>• Cast in situ pier columns |

| COMPONENT SKETCH | COMPONENT DESCRIPTION |
| --- | --- |
|  | • Steel bridge guardrail<br>• Steel approach guardrail<br>• Cast in situ approach slab<br>• MSE wall<br>• Cast in situ footing |
|  | • Abutment wall<br>• Abutment footing<br>• Stone pitched batter protection |
|  | • Mass concrete abutment wall<br>• Abutment footing<br>• Stone pitched batter protection |
|  | • Cast in situ abutment<br>• Driven raking Piles |

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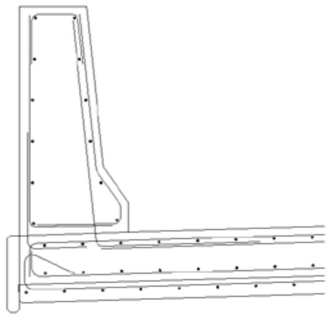
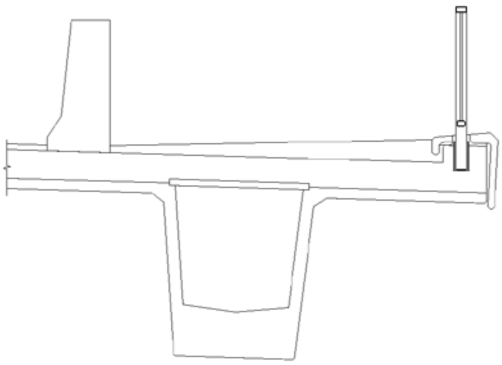
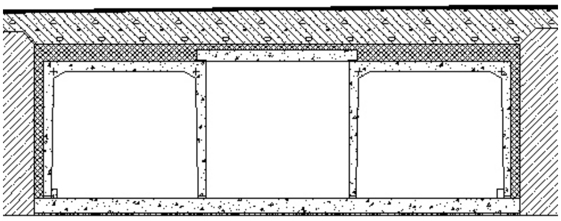
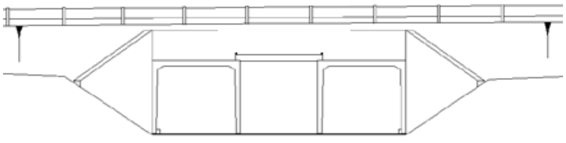
<tr><td></td><td>• Cast in situ barrier/guardrail</td></tr>
<tr><td></td><td>• Precast concrete barrier/guardrail<br>• Steel footpath railing<br>• Precast parapet (cladding)</td></tr>
<tr><td></td><td>• Precast box unit bridge with link slab<br>• Cast in situ base slab</td></tr>
<tr><td></td><td>• Precast box unit bridge with link slab<br>• Cast in situ headwall<br>• Cast in situ wing wall</td></tr>
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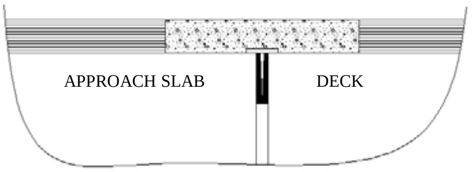
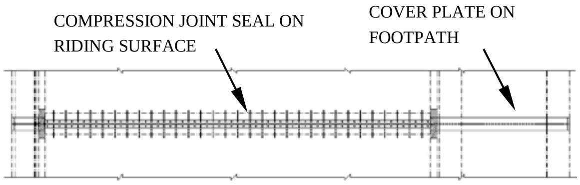
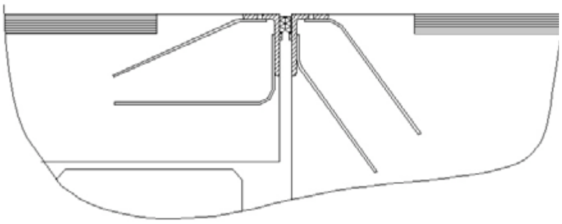
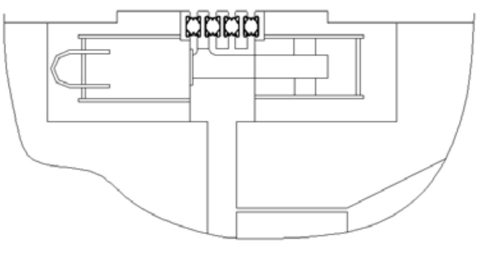
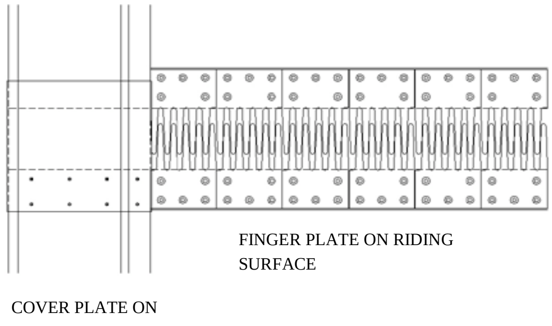
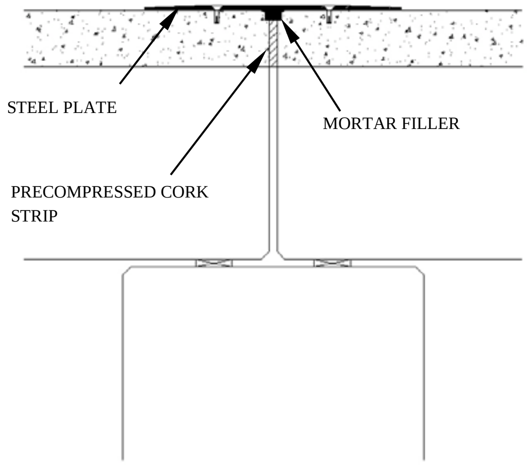
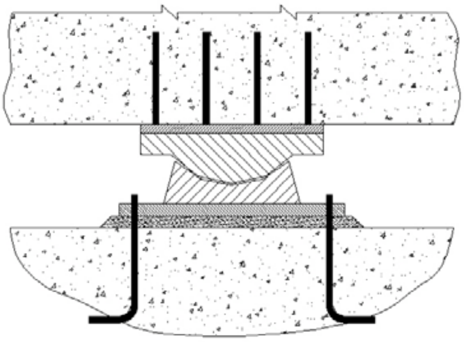
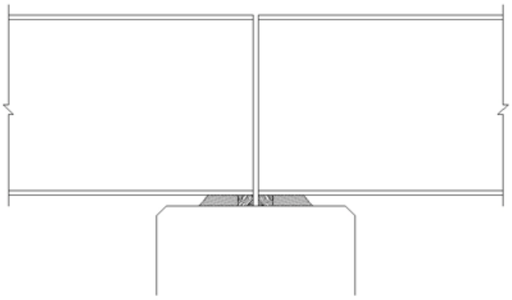
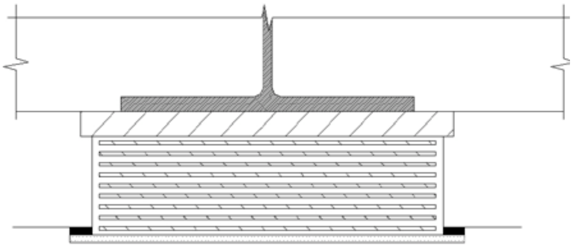
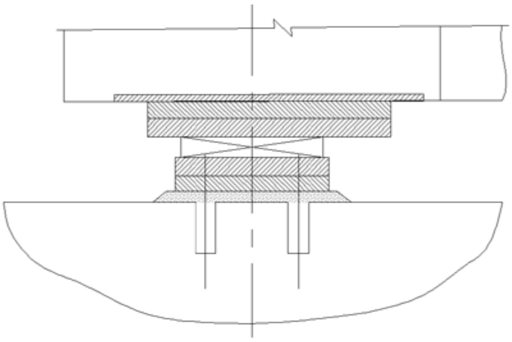
| COMPONENT SKETCH | COMPONENT DESCRIPTION |
|---|---|
|  | • Pourable joint seal (small movement expansion joint) |
| <br>PLAN<br><br>CROSS SECTION | • Compression joint seal (small movement expansion joint) |
| <br>CROSS SECTION | • Modular expansion joint (large movement expansion joint) |
|  | • Finger plate joint (large movement expansion joint) |

| COMPONENT SKETCH | COMPONENT DESCRIPTION |
|---|---|
|   | • Fixed joint (deck joint) |
|  | • Steel rocker bearing unit |
|  | Mortar pad bearing<br>*{Not assigned a Condition State}* |

| COMPONENT SKETCH | COMPONENT DESCRIPTION |
|---|---|
|  | • Elastomeric bearing unit |
|  | • Pot bearing unit |

# E.2. TYPICAL CONCRETE AND STEEL BRIDGE TYPES

## E2.1 REINFORCED CONCRETE BRIDGES

Reinforced concrete bridges are generally the most economic for small spans, and the following types are common in Western Australia.

### *a) Solid Slab*

A reinforced concrete solid slab (also termed a "flat slab") is considered to be the simplest superstructure type. The slab is cast in situ and acts as a wide membrane subjected to direct application of wheel loads. Reinforced concrete solid slab bridges are generally continuous structures. Figure E.2.1a shows a typical reinforced concrete solid slab bridge with columns/piles fixed into the deck slab.

Substructures can be reinforced concrete columns on spread footings, or, more commonly, prestressed concrete or steel piles and columns, as seen in Figure E.2.1a. This figure also shows the abutment columns in front of a turndown wall.

**FIGURE E.2.1A - TYPICAL REINFORCED CONCRETE SOLID SLAB**

### *b) Inverted U-beam*

Inverted U-beams (see Figures E.2.1b(1) and E.2.1b(2)) are precast concrete units with or without a cast in situ reinforced concrete topping. The beams are connected by concrete shear keys and usually by steel bolts (at 600mm intervals) through their webs. The in situ topping, the shear keys and the bolts enable better live load distribution through the superstructure.

FIGURE E.2.1B(1) - REINFORCED CONCRETE INVERTED U-BEAM

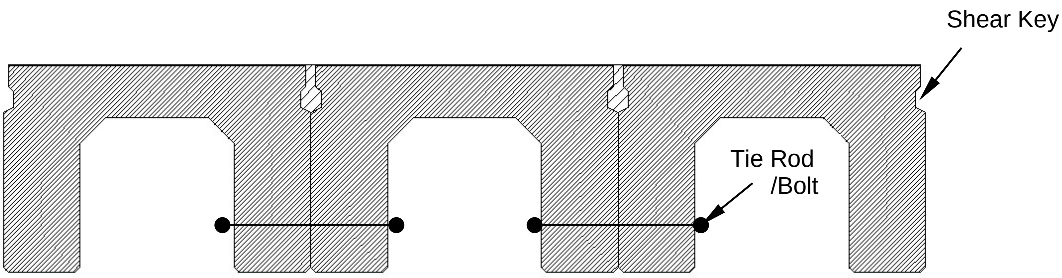



FIGURE E.2.1B(2) - TYPICAL CROSS SECTION OF INVERTED U-BEAMS

### c) Precast Plank, Precast Slab Panel

The superstructure of a reinforced concrete precast plank bridge consists of a series of solid precast concrete planks joined together by a system of shear keys. They may or may not have an in situ cast reinforced concrete topping. Sometimes, in order to enhance the live load distribution, they are stressed transversely. This type of construction is typically simply supported.

A reinforced concrete precast slab panel bridge is essentially similar, except the deck units are wider so that they behave more like a slab rather than a beam.

Figure E.2.1c below shows a typical precast plank bridge.

**FIGURE E.2.1C - REINFORCED CONCRETE PRECAST PLANK WITH IN SITU TOPPING**

### *d) Cast In Situ Reinforced Concrete Beam and Slab*

This type of superstructure comprises rectangular reinforced concrete spine beams cast monolithically with the deck slab. Figure E.2.1d shows this type of structure.

**FIGURE E.2.1D - REINFORCED CONCRETE BEAM AND SLAB, CAST IN SITU**

### e) *Box Girder*

A reinforced concrete box girder bridge (refer to Figures E.2.1e(1) and E.2.1e(2)) generally comprises a trapezoidal box shaped main member with top flange cantilever extensions. It may be a single cell or a multi-cell box. Box girders are normally continuous structures.

**FIGURE E.2.1E(1) - REINFORCED CONCRETE MULTI-CELL BOX GIRDER**

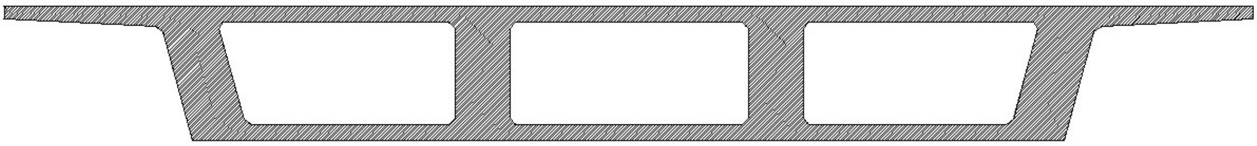


**FIGURE E.2.1E(2) - TYPICAL CROSS SECTION OF MULTI-CELL BOX GIRDER**

### f) *Filler Joist Bridge*

A filler joist bridge (refer to Figures E.2.1f(1) to E.2.1f(3)) consists of steel rails spread at approximately 300 mm to 600 mm centres encased in concrete. Sometimes the joist soffit may be exposed (as shown in Figure E.2.1f(2)). The rails essentially act as longitudinal tensile reinforcement with light steel mesh placed over the rails acting as transverse (distribution) steel.

This form of bridge construction is not widely used but is common in the Shire of Bruce Rock in which a number of filler joist bridges have been constructed relatively cheaply by making use of second-hand rails.

**FIGURE E.2.1F(1) - REINFORCED CONCRETE FILLER JOIST BRIDGE**


**FIGURE E.2.1F(2) - FILLER JOIST BRIDGE WITH EXPOSED JOISTS**

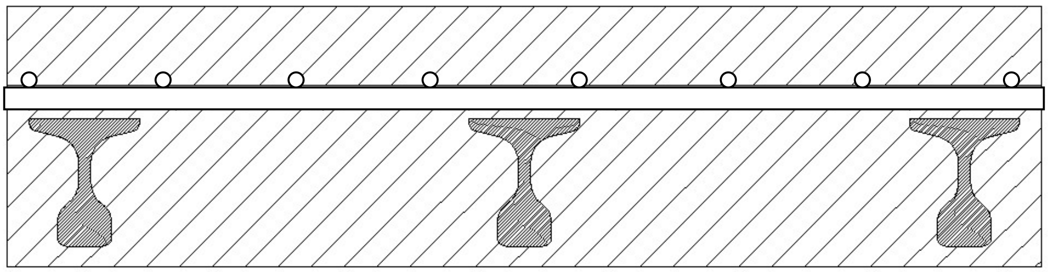


**FIGURE E.2.1F(3) - TYPICAL CROSS SECTION**

### g) Precast Beam with In Situ Slab

A reinforced concrete precast beam with in situ slab bridge (refer to Figure E.2.1g) consists of a series of precast beams of I or inverted T-beam sections acting compositely with a cast in situ reinforced concrete slab. Support diaphragms are quite common. Intermediate diaphragms may also be present.

**FIGURE E.2.1G - REINFORCED CONCRETE PRECAST BEAM WITH IN SITU SLAB**

### h) Precast Reinforced Concrete Arch

A reinforced concrete arch (refer to Figures E.2.1h(1) and E.2.1h(2)) is an effective type of small to medium span bridge construction, and may also be used for underpass and overpass construction. It relies on soil – structure interaction improving the live load distribution, and allows a rapid construction in an open cut. There are two proprietary products that have been widely used in WA (TechSpan® by Reinforced Earth Company; and Bebo™ Arch by Humes).

**FIGURE E.2.1H(1) - REINFORCED CONCRETE PRECAST ARCH UNDER CONSTRUCTION**

**FIGURE E.2.1H(2) - PRECAST ARCH OVERPASS COMPLETE**

### *i) Precast Box Unit Bridge*

This structure comprises an in situ ground slab combined with precast box units (refer to Figures E.2.1i(1) and E.2.1i(2)). Precast box unit bridges are widely used for bridging over small waterways and for pedestrian or stock underpasses. In areas of high public exposure (particularly for pedestrian underpasses), the headwalls and wing walls are typically 'dressed up' with limestone for a better presentation.

**FIGURE E.2.1I(1) - REINFORCED CONCRETE PRECAST BOX UNIT BRIDGE**

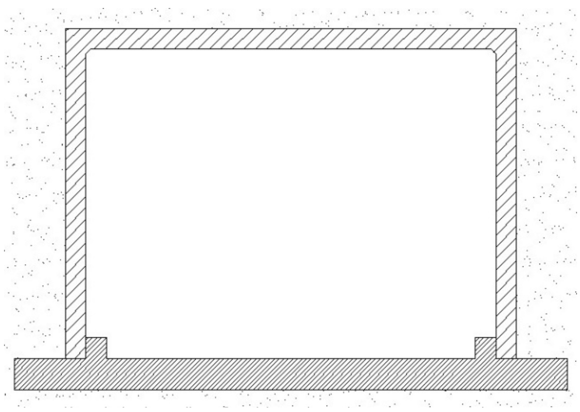


**FIGURE E.2.1I(2) - TYPICAL CROSS SECTION**

## E2.2 PRESTRESSED CONCRETE BRIDGES

Prestressed concrete bridges cater for medium to long span bridge construction. They may be simply supported or continuous, precast or cast in situ. Flexibility provided by the use of prestress allows incremental launching of most prestressed post-tensioned superstructure types, where launching (concentric) prestress is supplemented by profiled (eccentric) prestress for the permanent condition. The most common launched sections are double T-sections, boxes and voided slabs.

Precast pre-tensioned sections have been used widely in the past, typically as I-sections. More recently Teeroff sections are generally being used instead of I-beams in WA.

### *a) Solid Beam/Slab*

A prestressed concrete solid beam/slab bridge (refer to Figure E.2.2a) is normally cast in situ and is essentially the same as the reinforced concrete slab bridge except for the presence of prestressing steel. Introduction of prestressing tendons substantially increases the strength of the superstructure and, therefore, makes long spans more practical, while still providing an adequate level of crack control.

**FIGURE E.2.2A - PRESTRESSED CONCRETE SOLID BEAM/SLAB FOOTBRIDGE**

### b) Precast Inverted T-beam with In Situ Infill

This type of superstructure (refer to Figure E.2.2b) consists of a series of precast pretensioned inverted T-beams positioned alongside one another to generate a formwork for an in situ reinforced concrete infill that acts compositely with the beams. The final appearance is similar to a solid slab, except that the joints between the beams are clearly visible on the soffit. It is common for the beams to be transversely connected by either mild steel or high strength steel through rods at discrete intervals.

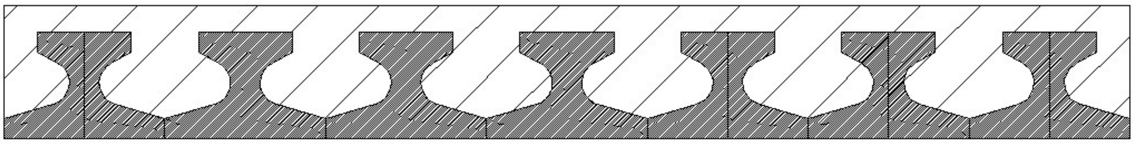


**FIGURE E.2.2B - PRESTRESSED CONCRETE PRECAST INVERTED T-BEAMS WITH IN SITU INFILL**

### c) Precast I-beam with In Situ Slab

Decks comprising precast I-beams with an in situ slab look similar to the reinforced concrete superstructure type (refer to Figure E.2.1g), and are quite common in WA for span lengths of 16 m to 24 m. The superstructure is made continuous for superimposed dead load and live loads by:

- casting a diaphragm at the support;
- placing structural reinforcement in the in situ slab over the internal supports; and
- providing for nominal positive moment continuity at the supports by a welded connection of bottom flange reinforcement.

Refer also Figure E.2.2c below.

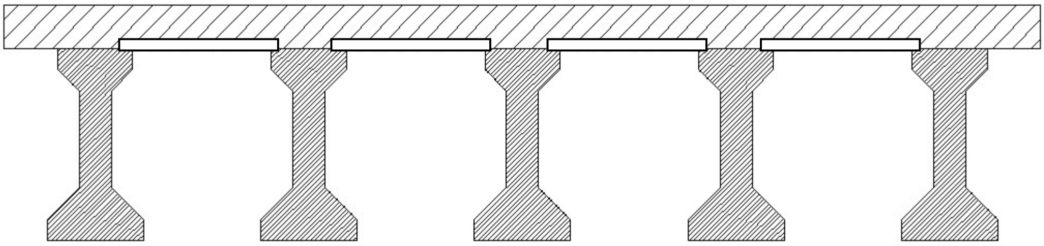


**FIGURE E.2.2C - TYPICAL CROSS SECTION OF PRECAST I-BEAM WITH IN SITU SLAB**

### d) Inverted U-beam

An inverted prestressed concrete U-beam deck looks similar to a reinforced concrete inverted U-beam (refer to Figures E.2.1b(1) and E.2.1b(2)). Application of prestress substantially increases its strength and facilitates better crack control under live load.

### e) Prestressed Box

Prestressed boxes (refer to Figures E.2.2e(1) and E.2.2e(2)) are a very common type of an incrementally launched superstructure, but may also be found cast in situ. Their popularity for launching is due to their large torsional rigidity and presence of at least two webs needed for launching. They also have relatively wide top and bottom flanges to economically spread the concentric prestress and provide sufficient concrete in compression to balance the large tensile forces in the reinforcing and prestressing steel at the Ultimate Limit State.

**FIGURE E.2.2E(1) - PRESTRESSED CONCRETE BOX**

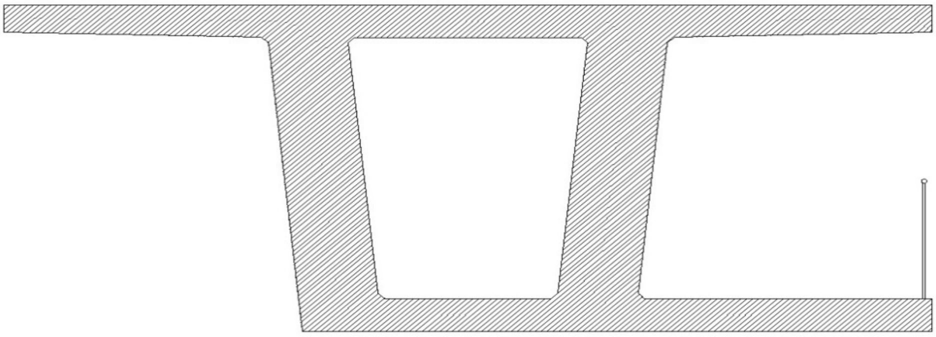


**FIGURE E.2.2E(2) - TYPICAL CROSS SECTION OF PRESTRESSED CONCRETE BOX**

### *f) Precast Plank and Voided Plank*

A prestressed precast plank bridge consists of a series of rectangular precast concrete planks, solid or containing voids, joined together by shear keys. It is essentially the same as a reinforced concrete precast plank bridge, except for presence of prestressing steel, refer to Figure E2.2f(1).

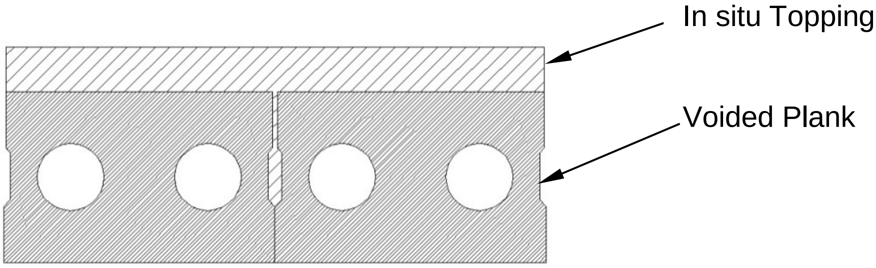



**FIGURE E.2.2F(1) - TYPICAL CROSS SECTION OF PRECAST VOIDED PLANK**

A variation to precast planks is precast slabs with in situ topping (refer to Figure E.2.2f(2)), such as, for instance, DELTACORE™, where the wider precast units behave like a slab rather than like a beam.

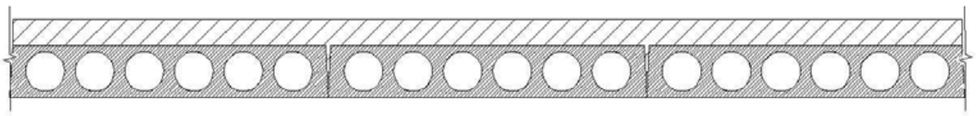


**FIGURE E.2.2F(2) - PRECAST "DELTACORE" PRESTRESSED CONCRETE SLAB WITH IN SITU TOPPING**

### *g) Multi T and Multi I-beam*

A multi T-beam superstructure (refer to Figures E.2.2g(1) to E.2.2g(4)) is a combination of two or more massive, almost rectangular, concrete beams combined with wide top flanges, essentially resulting in a number of T-type effective girders.

**FIGURE E.2.2G(1) - PRESTRESSED CONCRETE DOUBLE T-BEAM SUPERSTRUCTURE CAST IN SITU**

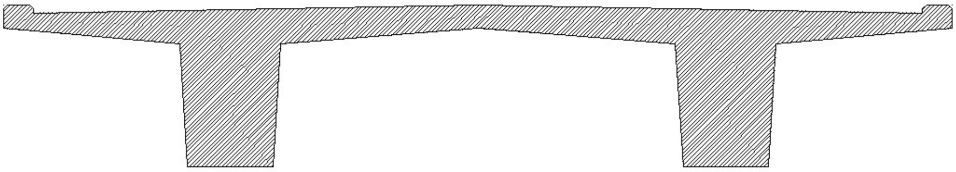


**FIGURE E.2.2G(2) - TYPICAL DOUBLE T-BEAM CROSS SECTION**

The double T-beam section is particularly effective for medium span prestressed concrete incrementally launched bridges of around 30 - 35 m span length (Figure E.2.2g(3)).

**FIGURE E.2.2G(3) - INCREMENTALLY LAUNCHED DOUBLE T-BEAM**

For longer spans a superstructure comprising of double I-beam (Figure E.2.2g(4)) has been used in the past as a sound alternative (Dawesville Channel Bridge).

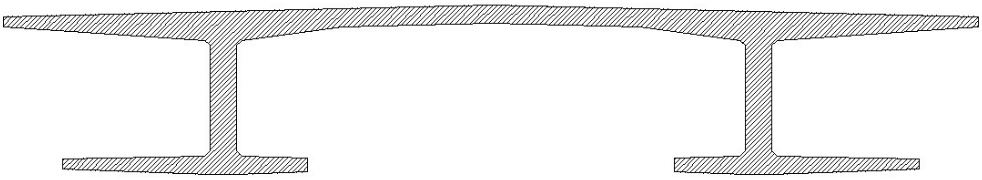


**FIGURE E.2.2G(4) - DOUBLE I-BEAM SECTION**

### *h) Voided Slab*

The external appearance of a voided slab superstructure is very similar to that of a multi-cell box superstructure. Instead of having rectangular cells, the openings are round voids, formed with sacrificial permanent formwork as shown in Figure E.2.2(h(1)).

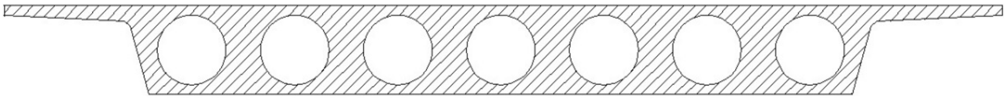


**FIGURE E.2.2H(1) - PRESTRESSED CONCRETE VOIDED SLAB WITH LONGITUDINAL VOIDS**

### *i) Precast Segmental Superstructure*

This type of construction is particularly effective for long bridges with a curved soffit, over waterways. WA examples include the original Narrows Bridge, Mt Henry Bridge (Figure E.2.2i) and Stirling Bridge. These bridges are fully prestressed and characterised by distinct joints between the precast segments visible on the superstructure's surface.

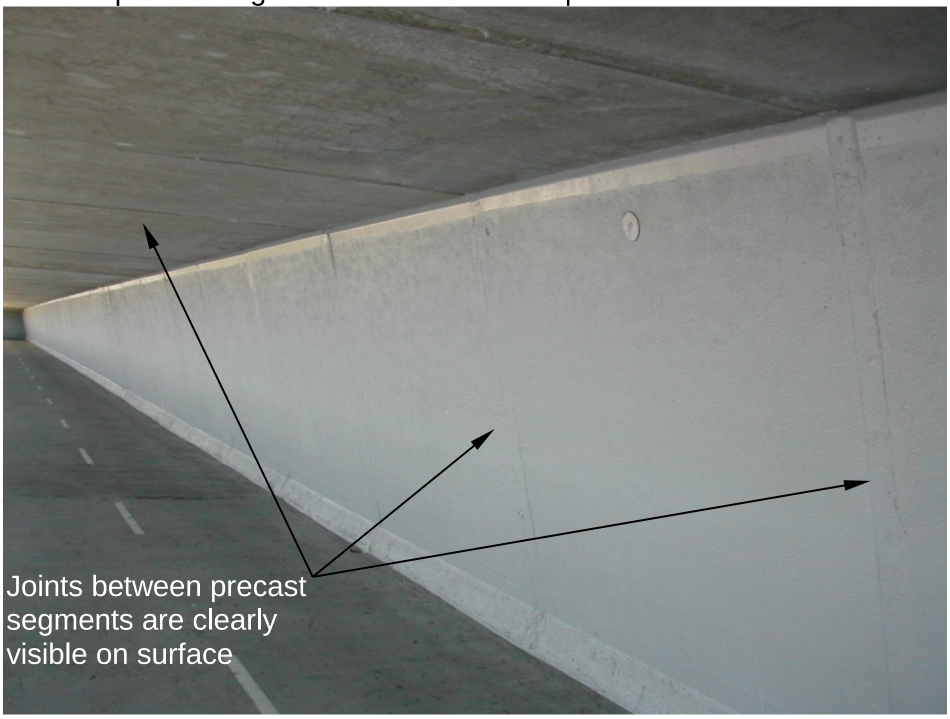



**FIGURE E.2.2I - PRECAST SEGMENTAL PRESTRESSED CONCRETE**

### *j) Teeroff*

A Teeroff section (Figures E.2.2j(1) to E.2.2(3)) is a precast pretensioned open box section with top flange cantilevers. The beams are positioned one next to another with the subsequent pouring of an in situ slab, which closes up the void and acts compositely with the box for superimposed dead and live loads. The Teeroffs are normally simply supported.

**FIGURE E.2.2J(1) - PRESTRESSED CONCRETE TEEROFF BRIDGE GIRDER**

**FIGURE E.2.2J(2) - COMPLETE TEEROFF SUPERSTRUCTURE**

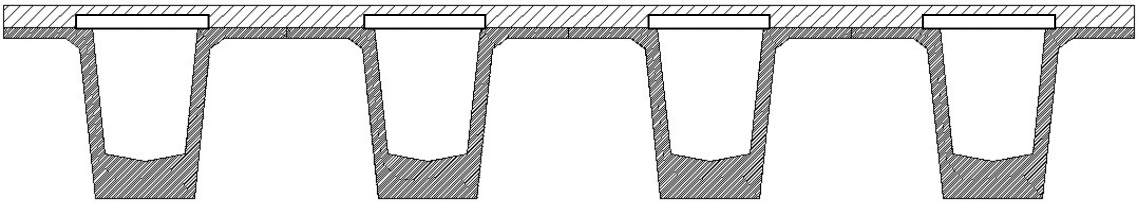


**FIGURE E.2.2J(3) - TYPICAL CROSS SECTION OF PRESTRESSED CONCRETE TEEROFFS**

## E2.3 STEEL BRIDGES

Bridge superstructures fully assembled out of steel sections with a steel riding surface do not exist in WA. The only type of essentially complete steel bridge structure is a steel corrugated arch buried in soil, serving as a single span bridge or a pedestrian underpass.

### *a) Steel Corrugated Arch – Structure Buried in Soil*

A steel corrugated arch buried in soil has been used on small span road and pedestrian underpasses in WA. A particular system, which has been rather popular, is the Multi-Plate™ Superspan Arch by Atlantic Civil Products (Figures E.2.3a(1) and E.2.3a(2)). The arches have thrust beam longitudinal stiffeners and may also have a cast in situ reinforced concrete cap for better distribution of wheel load, when the depth of the fill is inadequate.

**FIGURE E.2.3(1) - STEEL CORRUGATED ARCH UNDERPASS**

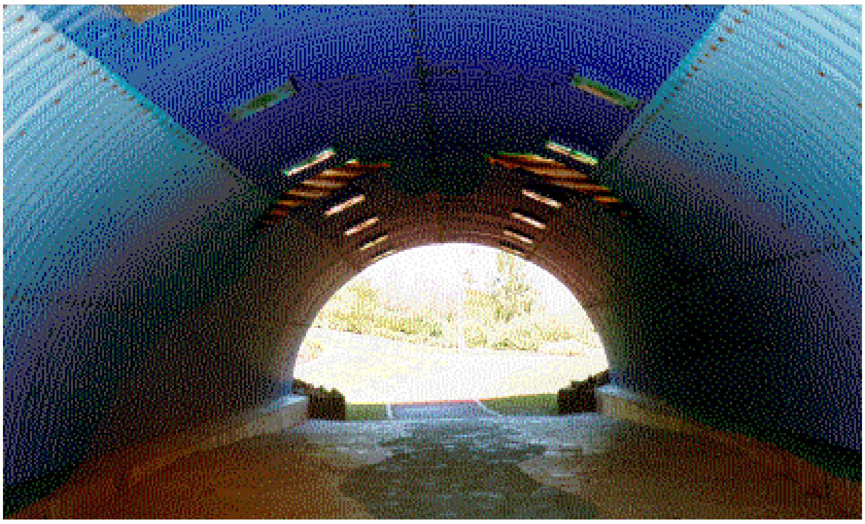


**FIGURE E.2.3A(2) - STEEL CORRUGATED ARCH UNDERPASS**

### b) *Steel Truss*

Steel truss road bridges (refer to Figure E.2.3b) are not generally used in WA, except occasionally in the form of a Bailey Bridge structure with some form of decking on steel transverse bearers. Whilst normally used as a temporary structure, a number have become semi-permanent.

**FIGURE E.2.3B - STEEL (THROUGH) TRUSS BRIDGE**

## E2.4 STEEL/CONCRETE COMPOSITE BRIDGES

A steel/concrete composite bridge superstructure comprises a number of steel girders acting compositely with a cast in situ reinforced concrete deck slab. In WA there are two types of steel girders used – an I-beam and a welded box section.

### *a) Steel/Concrete Composite I-beam*

Steel I-beams, made continuous by site splices and acting compositely with a cast in situ reinforced concrete slab, is a common type of bridge construction, particularly in remote areas of WA. As they are much lighter than concrete, steel beams combined with permanent formwork, such as Bondek® or TRANSFLOOR™, provide an economic form of bridge construction. Examples of steel I-beam/concrete composite superstructures are shown in Figures E.2.4a(1) and E.2.4a(2).

**FIGURE E.2.4A(1) - STEEL I-BEAM/CONCRETE COMPOSITE BRIDGE**

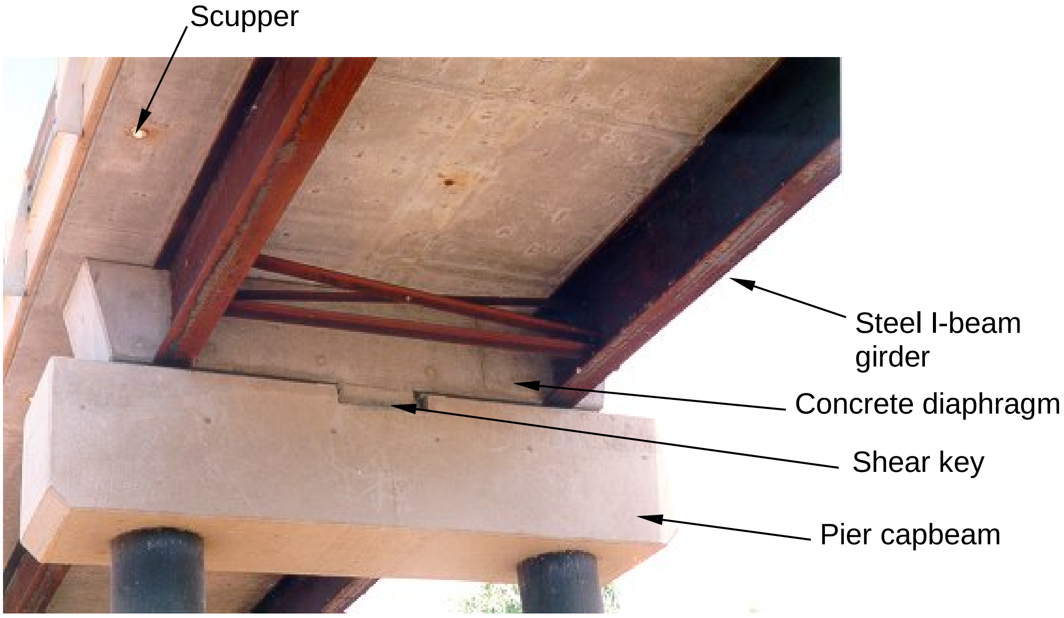



**FIGURE E.2.4A(2) - STEEL I-BEAM/CONCRETE COMPOSITE SUPERSTRUCTURE**

### *b) Steel/Concrete Composite Box*

Steel/concrete composite boxes are mainly used in WA in footbridge superstructures. They are only rarely used in road bridges.

The boxes provide an upper surface with minimum requirement for falsework. The deck slab is cast in situ to form a composite cross section (with longitudinal shear transfer provided by the use of shear connectors). Steel boxes feature superior lateral torsional buckling performance to I-beams, which is particularly important for cable stayed structures where significant cable induced compressive forces are combined with large bending moments. Examples of this type of design include the Mitchell Freeway footbridges and Claisebrook Footbridge over Graham Farmer Freeway in East Perth (refer to Figure E.2.4b(1)).

Road bridges with steel box superstructures include the Lord Street Grade Separation in East Perth (refer to Figure E.2.4b(2)) and the bridges carrying the Graham Farmer Freeway over the Mitchell Freeway in the Hamilton Interchange.

**FIGURE E.2.4B(1) - CABLE STAYED STEEL/CONCRETE COMPOSITE BOX STRUCTURE**

**FIGURE E.2.4B(2) - STEEL/CONCRETE COMPOSITE BOX ROAD BRIDGE**

## E2.5 CABLE STAYED BRIDGES

The majority of WA cable stayed bridges are footbridges of steel/concrete composite construction. The substructures are usually steel box columns with concrete infill, or reinforced concrete columns. Superstructures typically are:

- steel/concrete composite box;
- steel/concrete composite I-beam;
- steel I-beam with timber deck; or
- prestressed concrete slab.

An example of a cable stayed footbridge structure is shown on Figure E.2.4b(1).

## E2.6 TIMBER HYBRID BRIDGES

A combination of timber with either steel, concrete or both results in what is termed a timber hybrid bridge. The three most common types in WA are:

- timber substructure combined with reinforced concrete superstructure;
- a superstructure comprising timber decking on steel beams, supported by concrete, timber or steel substructure; and
- timber superstructure supported by a reinforced concrete substructure.

### *a) Concrete Superstructure on Timber Substructure*

Reinforced concrete slab on timber substructure bridges have been used in the south west of WA and combine a reinforced concrete deck supported by timber piers/piles built into the slab (refer to Figure E.2.6a). In multi span bridges the slab is continuous over the internal supports and is assumed to have no frame action developed with the piers.

The concrete superstructure may also comprise simply supported inverted u-beams or precast slab panels supported by timber piers/piles and halfcaps.

**FIGURE E.2.6A - REINFORCED CONCRETE SLAB ON TIMBER SUBSTRUCTURE**

### *b) Timber Decking on Steel Beams*

In this type of superstructure the closely spaced steel beams (or joists) support timber deck planks with the road surfacing applied directly to the planks. The planks are bolted to the beams. There is however, no composite action between the beams and the deck. A typical steel beam and timber deck bridge is shown in Figures E.2.6b(1) and E.2.6b(2).

**FIGURE E.2.6B(1) - TIMBER DECKING ON STEEL BEAMS**

**FIGURE E.2.6B(2) - TIMBER DECKING ON STEEL BEAMS – VIEW FROM UNDERSIDE OF BRIDGE**

### c) Timber Superstructure on Reinforced Concrete Substructure

There are a number of small timber bridges in WA where a timber superstructure rests on a reinforced concrete substructure (refer to Figure E.2.6c).

**FIGURE E.2.6C - TIMBER SUPERSTRUCTURE ON REINFORCED CONCRETE SUBSTRUCTURE**

# APPENDIX F

# COMMON ISSUES FOUND IN DIFFERENT BRIDGE TYPES AND THEIR COMPONENTS

# F.1 COMMON ISSUES FOUND IN DIFFERENT TYPES OF BRIDGES

Typical bridge types built in Western Australia are listed below and specific issues pertaining to each type of structure is provided based on observations made whilst bridges have been in service.

This Section is complementary to Sections 11.0 to 13.0.

## F.1.1 REINFORCED AND PRESTRESSED CONCRETE BRIDGES

The most common types of reinforced and prestressed concrete bridges built in Western Australia are included below.

### *a) Solid Slab*

Wide slab decks often have longitudinal cracks visible at the soffit around the centreline of the bridge (especially in skewed bridges). This may be due to an insufficient amount of transverse reinforcement, shrinkage or high thermal stresses during construction.

Cracking in the kerbs over the piers is common and the incidence of block cracking in the bridge soffit is increasing.

Solid slab continuous bridge decks commonly finish with a short cantilever from the pier with a curtain wall at the end. Moisture penetration through the deck/wall joint can also be a problem.

### *b) Inverted U-beams*

The most common defects in superstructures of this type are:

- tension cracks in the bottom of the legs at mid span due to overloading
- cracks through both legs
- loose or missing connection bolts
- corrosion of reinforcement in legs (due to insufficient cover), spalling of concrete
- cracks in the top corners of a U-beam.

### *c) Precast Plank, Precast Slab Panel and Voided Slab*

In precast plank superstructures, particularly those without in situ topping and/or transverse prestress, the longitudinal joints between units tend to open up due to the precast units moving apart. Transverse cracks at mid span may also be evident.

### *d) Box Girder*

Problems in the box girder superstructures can regularly occur during construction and at post-tensioning (in prestressed concrete construction).

The major maintenance concern for these bridges is where grouting around the post tensioning is incomplete and does not adequately protect the steel tendons. Rust staining around the anchorage areas, where accessible, signal a warning.

Some incrementally launched boxes may have cracks at the junction of the web with the bottom flange due to excessive eccentricity of the launching bearings.
In segmental post-tensioned construction, minor problems are associated with slight moisture penetration through the joints between segments.

### e) Filler Joist Bridge

These superstructures often display rust staining on the soffit of the concrete slab associated with rail corrosion.  Longitudinal cracking is a sign of deck disintegration due to expansion caused by rail corrosion.  Concrete quality is also generally poor, resulting in disintegration and delamination being evident in the side of the bridge deck of two rows in layers.  When the steel joists are exposed, they generally exhibit significant corrosion.

### f) Precast Beam and In Situ Slab

Precast concrete beams have generally performed well over the years but some of the older precast reinforced concrete beams have fine flexural cracking at mid span due to overloading.

Some multi-span superstructures comprising pre-tensioned I-beams with in situ slab and support diaphragms exhibit fine cracking near the internal supports.  This is likely to be caused by insufficient positive reinforcement provided in this area.

### g) Precast Arch

These structures generally perform well and are used commonly for underpasses.  Some maintenance problems however can be caused by the failure or the malfunctioning of the waterproofing membrane seal on the outside of the arch (i.e. in contact with the soil) between the precast units.  An indication of this is staining along the joints between the units visible from the inside of the arch.

### h) Prestressed Beam/Slab Bridge

These cast in situ, post-tensioned superstructures have been used extensively for long span pedestrian footbridges in WA.  These bridges have generally performed well to date.  The only known major maintenance problem so far is longitudinal cracking over the piers in haunched structures associated with thermal gradient caused by heat due to concrete hydration.

### i) Multi T-beam and Multi I-beam

These post-tensioned structures are very robust.  However, similar to post-tensioned boxes, problems may be associated with the protection of the prestressing steel around the anchors.

### j) Prestressed Voided Slab

Some problems with flotation and distortion of the void formers have been experienced during construction in the past.  Other known problems include honeycombing on the soffit due to inferior compaction under the void and longitudinal cracks in the top slab along the lines of the void due to slumping of the concrete between the void.

### k) Teeroff

Some issues have been experienced with transverse cracks appearing in the flanges, particularly at the ends of beams, soon after fabrication.

### l) Precast Box Units

Precast box unit bridges built over 20 years ago may have problems associated with cracking and spalling, due to inadequate cover to the reinforcement.

More recent precast concrete units generally appear robust and perform well, although there are some reinforcement corrosion problems in salt affected areas of WA.

### F.1.2 STEEL BRIDGES

#### *a) Steel Corrugated Arch*

This type of structure is commonly used for underpasses. There are two types of defects common to this type of structure: corrosion on the outside of the arch (i.e. in contact with the soil); and loose bolts in multi-plate arches.

Whilst loose bolts are detectable as they are exposed, the extent of corrosion on the soil side of the plates can only be properly determined by ultrasonic testing (a Level 3 inspection), if suspected.

#### *b) Steel Truss (Bailey Bridges)*

Although these structures were never intended to be permanent, some are known to have been in place for well over 10 years. Their long-term exposure to live loading may result in fatigue cracking, particularly around connections and bracing.

### F.1.3 STEEL/CONCRETE COMPOSITE BRIDGES

The steel beams or boxes in these structures may develop fatigue cracks around transverse stiffeners and at the splice welds, particularly if the welds are located in the high stress zones. If used, splice plates on the web, top flange (near an internal support) and bottom flange (at mid span) may develop weld cracking or separation from the beam plates.

Transverse cracking in the concrete slab cantilever sections of a cast in situ steel/concrete I-beam bridge are common.

Bolted connections may become loose and the protective cover can be damaged. Loose fasteners can sometimes be detected by cracks in the coating system, movement of the bracing or by noise while transient loads cross the deck.

Areas around the junction of members can build-up with debris, dirt and moisture. This can lead to the corrosion of connections and connecting members. Uncontrolled drainage through deck joints can often discharge onto the ends of beams, cross bracing and bearings.

Corrosion of girders, bracing and permanent formwork is pertinent to this type of superstructure.

### F.1.4 TIMBER HYBRID BRIDGES

#### *a) Reinforced Concrete Slab on Timber Substructure*

Similar to reinforced concrete solid slab bridges, longitudinal cracking in the slab due to insufficient transverse reinforcement may be evident on the slab soffit.

#### *b) Timber Decking on Steel Beams*

A common defect for these structures is loose or missing fasteners connecting the planks to the beams.

#### *c) Timber Superstructure on Reinforced Concrete Abutments/Piers*

Defects observed of reinforced concrete abutments/piers are similar to walls, refer Section F.2.

# F.2 COMMON ISSUES FOUND IN VARIOUS BRIDGE COMPONENTS

Common issues found in various bridge components that have been made through observation with bridges in service are included in this section.

This Section is complementary to Section 8.0.

## F.2.1 DIAPHRAGMS

Where commonly formed over the piers and abutments at the ends of discrete longitudinal girders, diaphragms may exhibit diagonal cracking due to compatibility torque applied to them by the girders caused by difference in their curvature under live load.

## F.2.2 ABUTMENTS

The most common types of abutments used in WA are:

- spill-through abutments using a reinforced concrete wall supported by driven piles or a frame type with reinforced concrete columns supported by a (single strip) footing below ground;
- retaining wall type reinforced concrete abutments;
- masonry walls; and
- reinforced earth wall (mechanically stabilised earth (MSE) wall).

***a) Spill-through Abutments***

Spill-through abutments are possibly the most common type to be found and usually have little or no cracking of the abutment wall or footing, except for shrinkage cracks. Loss of fill in front, beneath and behind the abutment wall or footing is a common problem. Over time the rock armouring can be reduced or lost. Inspections should note any sections where the armouring has been eroded.

The columns or piles are usually problem free, although cracking of the front face of piles has been noticed where the superstructure has propped the abutment against large movements induced from the embankment fill.

***b) Retaining Wall Abutments***

Differential movement between abutment walls and wing walls is the area where potential problems may exist, particularly for high abutments.

In long retaining walls (i.e. linear) with no regular contraction joints, restraint to the wall's longitudinal movements imposed by the footing may cause vertical cracking in the wall at approximately 3 m centres. It is, therefore, common in the design to deliberately provide regular vertical joints in long retaining walls.

***c) Masonry Walls***

Stone masonry abutment walls are found in concrete bridges when the original timber or filler joist superstructure has been replaced by a concrete superstructure. Care should be taken in assessing these walls for possible signs of settlement of the blocks, settlement cracking or cracking of the wall especially under heavily loaded areas. Where loads on the wall are at isolated points such as girders rather than a distributed load, a reinforced concrete cap may be cast on top of the wall to distribute the stress.

If this cap overhangs the masonry, such as in a bridge widening, particular attention should be given to the edge loading occurring on the masonry.

### *d) Mechanically Stabilised Earth (MSE) Wall*

This type of abutment construction is commonly used in bridge designs. It is essentially a wall type abutment, where a deck supporting framed structure buried in soil is complemented by soil retaining reinforced concrete panels with steel strips anchored back into the road embankment. The major concern with these abutments is the condition of the framed structure, which is largely concealed by soil and unavailable for inspections.

At this point in time there has not been any major defect identified pertinent to this type of abutment.

## F.2.3 PIERS

Piers exist in many shapes and forms including crossheads supported on piles or columns, wall piers as straight walls of constant or variable thickness, and V-shape columns.

Unprotected piers may be prone to vehicular impact. The significance of this damage should be assessed on an individual basis.

V-shaped columns have shown cracking at the vee junction and should be paid particular attention.

Many of the older structures over waterways have poor quality sandy concrete which can suffer severely from the action of water, sand, pebbles and grit as they wash past. This can significantly reduce the amount of cover concrete to the steel reinforcement.

Salt in the water is also detrimental for partially submerged piers, particularly, masonry structures.

## F.2.4 EXPANSION JOINTS

Various types of expansion joints have been used to cater for movement of bridge superstructures.

Early bridges had short simply supported spans and hence only small movements needed to be catered for. These joints included materials such as cork, bituminous impregnated fibreboard, butyl impregnated polyurethane foam, styrene and foam strips. Asphalt, rubberised bitumen or polyurethane was often poured on top in an effort to seal the joint from moisture penetration. Many of these joints failed to seal due to the joint material de-bonding or becoming inelastic. Also, if the sealant was placed too high in the groove, traffic tended to cause cracking and rip it out.

As spans increased, so did the width of expansion joint to cater for larger thermal movements. This required special seals to cater for the movements and to be resilient to wear and tear due to traffic. The earliest seal used was a neoprene “hose” but this product proved to be inelastic and often fell through the joint leaving it completely open. “Wabo” compression seals were then used, first in a concrete groove. They are currently used between steel plates or angles. One problem with this seal is that it has a tendency to gradually work its way to the very top of the joint where traffic induced damages render the seal unserviceable. A problem can also occur with the steel edging angles, which take high impact loadings from vehicle wheels. Older joints have insufficient or under-designed retaining straps and the welds break under repeated loading, causing the angles to come loose and create a potentially dangerous situation.
More recently, proprietary expansion joints have been used consisting of a neoprene seal anchored into aluminium blocks, which in turn are bolted down to the deck. These blocks

can break loose if bolting was provided via cored holes rather than bolts cast into the deck. These seals can also become damaged and require replacing.

On larger span bridges steel finger plates and steel sliding plate joints have traditionally been used. These joints are not watertight and the sliding plates can vibrate loose causing a danger to traffic. Loss of the surface seal can allow moisture to pond near the thread and accelerate corrosion. Any looseness becomes prone to fatigue failure. Heavy-duty rubber joints such as “Transflex” have also been used. A problem with these joints is possible de-bonding of the metal and rubber sections.

A modern solution to cater for very large movements is the use of modular joints. This joint type is an elaborate engineering structure and its proper functioning is very dependent upon correct installation. Common faults and deficiencies are blockage of the grooves within the rubber seal and seizing-up of the actual movement mechanism.

### F.2.5 BEARINGS

A large number of different bearing systems have been used on bridges in the past and only the more common types are covered here.

Initially, bridge types with precast and cast in situ beams usually sat directly on the crosshead with the only form of bond breaker between the two being a sheet of malthoid, or a thin plain rubber strip, or in some cases a sheet of lead. Locating dowels from the crosshead were used but these tended to break out the ends of the concrete beams, or in some instances, break out the top of the crosshead beneath the beam due to movement and edge loading.

Steel rollers and rocker bearings have been used on large steel I-beam spans. Dirt, grit and corrosion due to moisture are a continual problem with these types of bearings, with many rollers and rockers becoming completely seized by corrosion.

Large span, heavy concrete bridges such as box girders are usually supported on pot bearings or bearings with a PTFE (teflon) sliding disc. These are specialised high load bearings but the position of the PTFE strip should be noted, especially as it can tend to be squeezed out by overloading or vibration. Excessive rotations of the bearings is another issue that can occur.

The most common bearing in use today is the elastomeric bearing. It is used in two different forms; as a thin strip, usually 20 mm thick, of natural or synthetic rubber, or as a larger depth individual bearing with metal plates bonded within the elastomer.

The thinner bearing strips usually support small span beams and slabs and have few problems, although if the bearing mortar pads are poorly constructed then some areas of the pads may not carry load. The larger bearings can suffer from irregular bulging and shearing of the elastomer/metal plate surface if poorly designed or manufactured. Rotation and shear of the bearings can occur with bridge movement, and this can cause lift-off of the bearings at the edge, and hence over-stressing at the opposite edge. A problem associated with larger bearings is poor, uneven pedestal construction resulting in significant areas of the bearing pads being unstressed.

Creep, shrinkage and elastic shortening due to post-tensioning cause shear stresses on the bearings. These bearings may be reset by jacking of the structure, but this is rarely done unless shear is excessive.

“Walking” of elastomeric bearings from their design position can also occur especially in older structures where the bearings were not restrained.

### F.2.6 APPROACH SLABS

Reinforced concrete approach slabs are used to provide a smooth transition between the "soft" approach road, which may undergo settlement, and the "rigid" bridge superstructure.

Two types of approach slabs have been used: buried slabs or surface slabs.

A rigid load bearing approach slab is designed to span across to another support. Alternative light and non-rigid approach slabs are intended to crack and follow the ground profile. Approach slabs generally develop cracking if there is inadequate subgrade compaction.

# APPENDIX G(i)

## EXAMPLE OF

## DETAILED VISUAL BRIDGE INSPECTION REPORT FOR CONCRETE & STEEL BRIDGES (Level 2)

# DETAILED CONCRETE AND STEEL BRIDGE INSPECTION SUMMARY

| | | | |
|---|---|---|---|
| **Bridge No.:** | 1355 | **Region:** | Kimberley Region |
| **Crossing Name:** | Camel Creek | **SLK:** | 3,036.62 |
| **Road:** | Great Northern Hwy | **Road No.:** | H006 |
| **LGA:** | Wyndham - East Kimberley | | |

## 1.0 GENERAL

Bridge 1355 is a five span steel I-beam/ concrete slab composite structure carrying Great Northern Highway over Camel Creek in the Shire of Wyndham - East Kimberley. It was constructed in 1996 and is generally in good condition. Abutment 1 expansion plate cover at the kerb is missing and there is road debris collecting in the gap above the compressive rubber strip. There is some cracking and crazing to the concrete kerbs to the approaches and on the deck.

## 2.0 SUBSTRUCTURE

### 2.1 Abutments

Both abutments have various cracks to the capbeam and diaphragm. These appear to be no different to the last recorded crack widths in 2006.

### 2.2 Piers

All piers are in a good condition. Again there is cracking to the diaphragm and capbeam as previously recorded. All pier columns have minor hairline cracks/ crazing at the lower level, possibly due to early plastic shrinkage. There is minor fire damage to pier 1 column 3 and is as previously recorded but due to a large amount of flood debris gathered around the base of the pile, it was difficult to examine closely.

## 3.0 SUPERSTRUCTURE

Approximately 80% of the bridge deck slab soffit was hidden by the Condeck HP permanent formwork. Both exposed cantilever sections had numerous transverse hairline cracks. The steel beams were in good condition.

## 4.0 RECOMMENDATIONS

1. Clean out gap above compressive seal to abutment 1 free end deck joint.
2. Replace missing expansion joint cover plate to the left hand side kerb at abutment 1.

David Watts
BRIDGE CONDITION OFFICER
MAIN ROADS WESTERN AUSTRALIA

1st August 2013

# WORK ITEMS - SUMMARY
# CONCRETE & STEEL BRIDGES

**BRIDGE No.: 1355**

**(A) GENERAL SUPPORTING ACTIVITIES**

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| G005 | Bridge - Durability Survey (L3) | | | |
| G009 | Bridge - Load Rating | | | |
| G010 | Bridge - Monitor Defect | | | |

**(B) PREVENTATIVE MAINTENANCE**

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| P102 | Bridge - Maintain Fastener | | | |

**(C) ROUTINE MAINTENANCE**

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| R201 | Bearing - Maintain | | | |
| R203 | Bridge - Repair Scour (Minor) | | | |
| R205 | Bridge - Clear Debris and Vegetation | | | |
| R207 | Deck Surface - Maintain | | | |
| R206 | Deck Joint - Maintain | | | |
| R209 | Expansion Joint - Maintain | Y | 1 | Repairs to abutment 1 expansion joint. Clean out the expansion gap above the compressive seal and replace the missing kerb cover plate to the left hand side. |
| R210 | Fence - Remove | | | |
| R212 | Guardrail - Maintain / Repair | | | |
| R213 | Kerb - Repair (Minor) - Non Structural | | | |
| R215 | Sign - Maintain | | | |

**(D) SPECIFIC WORKS**

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| S504 | Abutment - Repair (Non-Timber) | | | |
| S407 | Approach Slab - Repair | | | |
| S601 | Beam - Repair | | | |
| S619 | Bearing - Repair | | | |
| S308 | Bridge - Widen Embankment | | | |
| S516 | Capbeam - Repair | | | |
| S519 | Column - Repair | | | |
| S413 | Deck - Repair | | | |
| S431 | Deck Joint - Repair | | | |
| S531 | Diaphragm - Repair | | | |
| S455 | Expansion Joint - Repair | | | |
| S534 | Footing - Repair | | | |
| S461 | Footpath - Repair | | | |
| S467 | Guardrail - Install | | | |
| S473 | Kerb - Repair | | | |
| S558 | Pier - Repair | | | |
| S564 | Pile - Repair | | | |
| S567 | Pile Cap - Repair | | | |
| S385 | Services - Repair | | | |
| S479 | Slab - Repair | | | |
| S588 | Wing Wall - Repair | | | |

| **PRIORITY CODE** | **INDICATIVE TIMEFRAME** |
|---|---|
| 1 - High Priority | Within 3 years |
| 2 - Medium Priority | Within 4-6 years |
| 3 - Low Priority (monitor) | Assess again at next Detailed (Level 2) Inspection (7 years for non-timber bridges) |

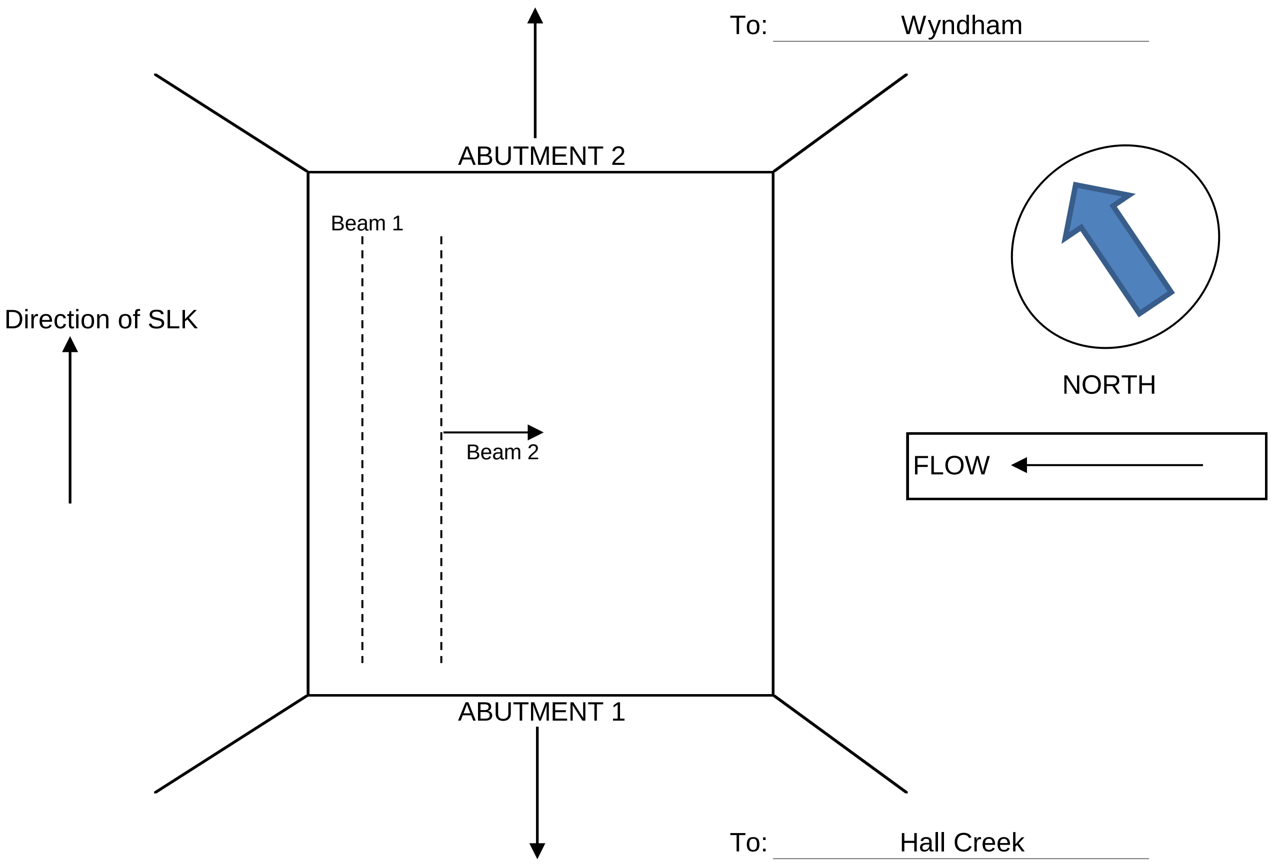
*Note: Add additional standard work items to the above lists as required.*
*Refer to Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges for full listing.*

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

| | | | |
|---|---|---|---|
| **Bridge Number:** | **1355** | **Date:** | 31-July-2013 |
| **Structure Type:** | Steel/Concrete Composite | **GPS Location Lat.:** | -16.61121 |
| **Superstructure:** | I-Beam | **Long.:** | 128.19655 |
| **Responsibility Area:** | Kimberley Region | **Road Number:** | H006 |
| **Road Name:** | Great Northern Hwy | **Owner:** | Main Roads |
| **Local Govt.:** | Wyndham - East Kimberley | **SLK:** | 3,036.62 |
| **Crossing Name:** | Camel Creek | **Skew:** | 25 degrees |

| | | | | | |
|---|---|---|---|---|---|
| **Total Width (m):** | 8.86 | **Max. H/Room (m):** | 4.61 | **Min. H/Room (m):** | 0.80 |
| **No. Spans:** | 5 | **Width Between Kerbs (m):** | 8.20 | **Length (m):** | 46.80 |

Abutments are numbered in the direction of increasing SLK.
Piers are numbered along the bridge in ascending order from Abutment 1 to Abutment 2.
Piles and Columns are numbered across the bridge in ascending order from left to right when facing the direction of increasing SLK.
Beams are numbered across the bridge in ascending order from left to right when facing the direction of increasing SLK.




Mark in widening and footpath locations.

This bridge has been inspected in accordance with the requirements of the Main Roads Western Australia Bridge Guidelines for Level 2 inspections of concrete and steel bridges.

| | | | |
|---|---|---|---|
| Inspected by: | David Watts | Checked by: | Jen Hesketh |
| Date: | 31-July-2013 | Date: | 17-September-2013 |

# SITE CONDITIONS
## Bridge No.: 1355

| | | | | |
|---|---|---|---|---|
| **DRIVE THROUGH** | **Visible Line of Sight from Abut. 1:** | | | ~ 200 metres into left hand bend. |
| | **Visible Line of Sight from Abut. 2:** | | | ~ 500 metres into left hand bend. |
| **TRAFFIC CONTROL** | **Abut. 1 end:** | | | One lane closed with Traffic Management to enable Under Bridge Inspection Unit to be utilised |
| (Describe if different to the generic TMP) | **Abut. 2 end:** | | | One lane closed with Traffic Management to enable Under Bridge Inspection Unit to be utilised |
| **PARKING POSITION** | > 3 m | | **Position:** | |
| | 1.2 to 3 m | X | **Position:** | Abutment 1 RHS behind guardrail. |
| | 0 to 1.2 m | | **Position:** | |
| **ACCESS TO ABUTMENTS** | **Abutment 1:** | | | |
| (Describe access conditions at each wing) | LHS: | | | Walking down loose rock/ grassed embankment. |
| | RHS: | | | Walking down loose rock/ grassed embankment. |
| | **Abutment 2:** | | | |
| | LHS: | | | Walking down loose rock/ grassed embankment. |
| | RHS: | | | Walking down loose rock/ grassed embankment. |
| | **Vegetation:** | | | Short grass and weeds. |
| **ACCESS TO PIERS** | **LHS:** | | | From adjacent ground level and underbridge inspection unit. |
| (Describe access conditions along each side of the structure) | **RHS:** | | | From adjacent ground level and underbridge inspection unit. |
| | **Vegetation:** | | | Ok. |
| **PIER HEADROOM** | **Minimum (m):** | | | 3.309 metres at Pier 4 |
| | **Maximum (m):** | | | 4.608 metres at Pier 1 |
| **POTENTIAL HAZARDS** | **Railing/Posts:** | | | |
| | **Bolts:** | | | |
| | **Services:** | | | |
| | **Other:** | | | Steep slopes and loose rock batter. |
| **FENCES** | **Timber:** | | **Location:** | None. |
| | **Wire/Mesh:** | | **Location:** | |
| | **Electrified:** | | **Location:** | |
| | **Barbed Wire:** | | **Location:** | |
| | **Other (Specify):** | | | **Location:** |
| **WATER** | **Depth (m):** | | | Dry at time of inspection. |
| | **Flow Rate:** | | | |
| | **Algae:** | | | |
| | {Access may be restricted by toxic algae} | | | |
| | **Tide:** | | | |
| | **Location:** | | | |
| **POWERLINES** | **Side of bridge:** | | | None. |
| | **Horizontal distance from edge of deck (m):** | | | |
| | **Estimated vertical height above deck (m):** | | | |

David Watts
Signature

31st July 2013
Date

**Bridge No.: 1355**

## Barrier Type

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| None | | | | | | | | | |
| RHS Rails No. of Rails (on bridge): _____ | | | | | | | | | |
| Thriebeam | | | | | | | | | |
| W Beam | X | | X | X | | X | X | | X |
| Tric-Bloc Concrete Barrier | | | | | | | | | |
| Reinforced Concrete Barrier (Type F) | | | | | | | | | |
| Constant Slope Concrete Barrier | | | | | | | | | |
| Other Concrete Profiles | | | | | | | | | |

## Post Type

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | |
| Concrete | | | | | | | | | |
| Timber | | | | | | | | | |
| Steel Type: _PFC__ | X | | X | X | | X | X | | X |

[Types: C Section (C), I Section (I), RHS (R), Square Hollow Section SHS (S), Tubular (T), Steel PFC (PFC), Steel Channel (Ch)]

*Off bridge:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of Posts off Bridge | 9 | | 5 | | | | 5 | | 9 |
| Length of Barrier off Bridge (m) | 18.0 | | 8.7 | | | | 8.9 | | 18.0 |

## Top Rails

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Steel Pipe | | | | | | | | | |
| Steel RHS/Channel | | | | | | | | | |
| Steel C Section | X | | X | X | | X | X | | X |
| Timber | | | | | | | | | |

## Visibility Barrier

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| Timber No. of Rails (on bridge): _____ | | | | | | | | | |
| Steel Pipe(s) No. of Pipes (on bridge): _____ | | | | | | | | | |
| Guide Posts | | | | | | | | | |
| Balustrade | | | | | | | | | |

## End Terminals

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |

*Approved End Terminal Types:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| WAMELT | | | | | | | | | |
| SKT-350 | | | | | | | | | |
| ET-2000 | | | | | | | | | |
| X Tension | | | | | | | | | |
| TAU II Crash Cushion | | | | | | | | | |
| Other: ________________________ | | | | | | | | | |

*Other End Terminal Types:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | |
| Turn-down | | | | | | | | | |
| Bullnose | X | | X | | | | X | | X |
| Fishtail | | | | | | | | | |
| Other: ________________________ | | | | | | | | | |

**Structural problem found? (Y/N)** [ ] If Yes, comment below.

**Bridge Number:** 1355 **Group:** BRIDGE **Group Number:** N/A

| General Items | Comments<br>Full description including details of:<br>* Location of defect/condition/item<br>* Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|
| Vegetation | Ok. Some mature trees approximately four metres from bridge. | | 2 | N | | | |
| Drainage | Scuppers through deck at kerb channel and spoon drains to all four corners. | | 14 | N | | | |
| Waterway Area | Good. | | 4 | N | | | |
| Scour | None evident. | | 5 | N | | | |
| Signs and Lights | Four width markers, one crossing signs and one bridge number. | | 2, 3 | N | | | |
| Fences | None. | | | N | | | |
| Services on Bridge (types, size, location) | None noted. | | | N | | | |
| Substructure Protection | N/A. | | | N | | | |

DETAILED VISUAL (LEVEL 2)
BRIDGE INSPECTION REPORT

***Bridge Number:*** ***1355*** ***Group:*** ***APPROACH*** ***Group Number:*** ***1***

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Comments*<br>*Full description including details of:*<br>* *Location of defect/condition/item*<br>* *Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Approach Kerb | LHS | Concrete | Original | Linear m | Crazing and cracking to the top surface of the kerbs from shrinkage/ curing. | | 6 | N | | | |
| Approach Kerb | RHS | Concrete | Original | Linear m | Crazing and cracking to the top surface of the kerbs from shrinkage/ curing. | | 8 | N | | | |
| Approach Guardrailing | LHS | Steel | Original | Linear m | Good condition. There is a crease in the w-beam where it has been bent to accommodate the flare for the end terminal. | | 6 | N | | | |
| Approach Guardrailing | RHS | Steel | Original | Linear m | Good condition. There is a crease in the w-beam where it has been bent to accommodate the flare for the end terminal. | | 7 | N | | | |
| Approach Slab | 1 | Concrete | Original | Item | Not visible. | | | N | | | |
| Road Surface on Approach | 1 | Bitumen | Existing | m^2 | Generally good condition. | | 2 | N | | | |
| | | | | | | | | | | | |

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

***Bridge Number:*** ***1355*** ***Group:*** ***APPROACH*** ***Group Number:*** ***2***

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Comments*<br>*Full description including details of:*<br>** Location of defect/condition/item*<br>** Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Approach Kerb | LHS | Concrete | Original | Linear m | Crazing and cracking to the top surface of the kerbs from shrinkage/ curing. | | 17 | N | | | |
| Approach Kerb | RHS | Concrete | Original | Linear m | Crazing and cracking to the top surface of the kerbs from shrinkage/ curing. | | 18 | N | | | |
| Approach Guardrailing | LHS | Steel | Original | Linear m | Good condition. There is a crease in the w-beam where it has been bent to accommodate the flare for the end terminal. | | 17 | N | | | |
| Approach Guardrailing | RHS | Steel | Original | Linear m | Good condition. There is a crease in the w-beam where it has been bent to accommodate the flare for the end terminal. | | 18 | N | | | |
| Approach Slab | 1 | Concrete | Original | Item | Not visible. | | | N | | | |
| Road Surface on Approach | 1 | Bitumen | Existing | m^2 | Generally good condition. | | 3 | N | | | |
| | | | | | | | | | | | |

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

***Bridge Number:* 1355** ***Group:* DECK** ***Group Number:* N/A**

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments: Full description including details of: * Location of defect/condition/item * Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kerb | LHS | Concrete | Original | Linear m | | | | | | Some cracking and crazing, but not as extensive as the approaches. | | 13 | N | | | |
| Kerb | RHS | Concrete | Original | Linear m | | | | | | Some cracking and crazing, but not as extensive as the approaches. | | | N | | | |
| Bridge Guardrailing | LHS | Steel | Original | Linear m | | | | | | Good condition. | | 14 | N | | | |
| Bridge Guardrailing | RHS | Steel | Original | Linear m | | | | | | Good condition. | | 15 | N | | | |
| Expansion Joint | 1 | Rubber | Original | Each | | 100 | | | | Abutment 1 end is the free end. The joint nosing (top of concrete abutment upstand wall) and steel angle are in good condition. The gap above the compressive rubber strip is partially full of road debris, bitumen overspray and aggregate. The expansion joint kerb cover plate is missing. Abutment 2 end is the fixed end. | | 9-11 | Y | R209 | Expansion Joint - Maintain | 1 |
| Road Surface on Bridge | 1 | Asphalt | Existing | m^2 | | | | | | The hot rolled asphalt surfacing over bridge deck is generally in a good condition. | | 12 | N | | | |
| | | | | | | | | | | | | | | | | |

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

***Bridge Number:*** ***1355*** ***Group:*** ***ABUTMENT*** ***Group Number:*** ***1***

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Percentage of Inspected Component in Each Condition State* 1 | 2 | 3 | 4 | *Not Inspected (%)* | *Comments* *Full description including details of:* * *Location of defect/condition/item* * *Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Column | 1-4 | Concrete | Original | Each | | | | | 100 | Not visible. | | | N | | | |
| Wing Wall | LHS | Concrete | Original | m^2 | 90 | | 10 | | 10 | There are several hairline cracks mainly concentrated to the top section of the wall and a single 0.4mm crack running parallel with the top surface. | | 19 | N | | | |
| Wing Wall | RHS | Concrete | Original | m^2 | 100 | | | | 30 | Good condition. Minor hairline crack to top of wall. | | 24 | N | | | |
| Capbeam | 1 | Concrete | Original | m^2 | 90 | 10 | | | 10 | The capbeam has infrequent cracks to its front face. These range from hairline to 0.25mm. These cracks were as previously recorded in 2006 with no change. | | 20-23 | N | | | |
| Diaphragm | 1 | Concrete | Original | m^2 | 95 | 5 | | | | The diaphragm has a 0.2mm and 0.25mm vertical crack between beams 2 and 3 at the shear key. | | 23 | N | | | |
| Footing | 1 | Concrete | Original | m^2 | | | | | 100 | Not visible. | | | N | | | |
| Bearing Unit | 1-5 | Rubber | Original | Each | 100 | | | | | All five elastomeric bearing pads in good condition. | | 21 | N | | | |
| Batter Protection | 1 | Rock Armour | Original | m^2 | | | | | | Loose rock batter protection is adequate. | | 25 | N | | | |
| | | | | | | | | | | | | | | | | |
| *{Bearing Units shall only be assigned Condition States when structural. In this instance, 'structural' means that the bearing is a rocker, elastomeric or pot bearing. Mortar pad or thin rubber bearings shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.}* | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

***Bridge Number:*** ***1355*** ***Group:*** ***ABUTMENT*** ***Group Number:*** ***2***

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State | | | | Not Inspected (%) | Comments<br>Full description including details of:<br>* Location of defect/condition/item<br>* Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | | | | | | | | |
| Column | 1-4 | Concrete | Original | Each | | | | | 100 | Not visible. | | | N | | | |
| Wing Wall | LHS | Concrete | Original | m^2 | 100 | | | | 30 | Good condition. Minor hairline crack to top of wall. | | 61 | N | | | |
| Wing Wall | RHS | Concrete | Original | m^2 | 95 | 5 | | | 10 | Good condition. Minor hairline crack increasing to 0.15mm to top of wall. | | 62 | N | | | |
| Capbeam | 1 | Concrete | Original | m^2 | 80 | 20 | | | 10 | The capbeam has numerous cracks to its front face. These range from mostly hairline through to 0.15mm, 0.25mm and 0.3mm and are probably due to internal stresses during initial cure. These cracks were as previously recorded in 2006 with no change. | | 59, 60 | N | | | |
| Diaphragm | 1 | Concrete | Original | m^2 | 100 | | | | | The diaphragm has some minor infrequent hairline cracks throughout its front face, mainly at the shear key. | | 60 | N | | | |
| Footing | 1 | Concrete | Original | m^2 | | | | | 100 | Not visible. | | | N | | | |
| Bearing Unit | 1-5 | Rubber | Original | Each | 100 | | | | | All five elastomeric bearing pads in good condition. | | | | | | |
| Batter Protection | 1 | Rock Armour | Original | m^2 | | | | | | Loose rock batter protection is adequate. | | 58 | N | | | |
| | | | | | | | | | | | | | | | | |
| *{Bearing Units shall only be assigned Condition States when structural. In this instance, 'structural' means that the bearing is a rocker, elastomeric or pot bearing. Mortar pad or thin rubber bearings shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.}* | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

***Bridge Number:* 1355** ***Group:* PIER** ***Group Number:* 1**

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments: Full description including details of: * Location of defect/condition/item * Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Column | 1-2 | Concrete | Original | Each | 100 | | | | | Concrete column is generally in good condition. Some dark staining and minor erosion at lower level (waterline). | | 29, 30 | N | | | |
| Column | 3 | Concrete | Original | Each | 100 | | | | | Concrete column is generally in good condition. The fire damage was not inspected due to the build-up of flood debris. Again, there was minor erosion at the lower level (waterline). | | 29, 30 | N | | | |
| Capbeam | 1 | Concrete | Original | $m^2$ | 100 | | | | | Good condtion. | | 29 | N | | | |
| Diaphragm | 1 | Concrete | Original | $m^2$ | 100 | | | | | Good condition. | | 31, 32 | N | | | |
| Footing | 1 | Concrete | Original | $m^2$ | | | | | 100 | Not visible. | | | N | | | |
| Bearing Unit | 1-5 | Rubber | Original | Each | 100 | | | | | Elastomeric bearing pads in good condition. | | 33 | N | | | |
| | | | | | | | | | | | | | | | | |
| *{Bearing Units shall only be assigned Condition States when structural. In this instance, 'structural' means that the bearing is a rocker, elastomeric or pot bearing. Mortar pad or thin rubber bearings shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.}* | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

**Bridge Number:** 1355 **Group:** PIER **Group Number:** 2

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments: Full description including details of: * Location of defect/condition/item * Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Column | 1-3 | Concrete | Original | Each | 100 | | | | | Generally in good condition. Some minor shrinkage cracking and erosion at ground level. | | 38 | N | | | |
| Capbeam | 1 | Concrete | Original | m^2 | 95 | 5 | | | | 0.2mm crack through top face of capbeam and a few minor hairline cracks to internal corners of shear key. | | 38 | N | | | |
| Diaphragm | 1 | Concrete | Original | m^2 | 100 | | | | | Infrequent vertical hairline cracks to diaphragm mainly at the shear key. | | 39-41 | N | | | |
| Footing | 1 | Concrete | Original | $m^2$ | | | | | 100 | Not visible. | | | N | | | |
| Bearing Unit | 1-5 | Rubber | Original | Each | 100 | | | | | Elastomeric bearing pads in good condition. | | | N | | | |
| | | | | | | | | | | | | | | | | |
| *{Bearing Units shall only be assigned Condition States when structural. In this instance, 'structural' means that the bearing is a rocker, elastomeric or pot bearing. Mortar pad or thin rubber bearings shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.}* | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

**Bridge Number:** 1355 **Group:** PIER **Group Number:** 3

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments: Full description including details of: * Location of defect/condition/item * Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Column | 1 | Concrete | Original | Each | 100 | | | | | Generally in good condition. Some minor shrinkage cracking and erosion at ground level. | | 46 | N | | | |
| Column | 2-3 | Concrete | Original | Each | 100 | | | | | Generally in good condition. Some minor shrinkage cracking and erosion at ground level. | | 46 | N | | | |
| Capbeam | 1 | Concrete | Original | $m^2$ | 100 | | | | | Minor hairline cracks to internal corners of shear key. | | 46, 48 | N | | | |
| Diaphragm | 1 | Concrete | Original | $m^2$ | 100 | | | | | Infrequent vertical hairline cracks to diaphragm mainly at the shear key. | | 47, 48 | N | | | |
| Footing | 1 | Concrete | Original | $m^2$ | | | | | 100 | Not visible. | | | N | | | |
| Bearing Unit | 1-5 | Rubber | Original | Each | 100 | | | | | Elastomeric bearing pads in good condition. | | 49 | N | | | |
| | | | | | | | | | | | | | | | | |
| *{Bearing Units shall only be assigned Condition States when structural. In this instance, 'structural' means that the bearing is a rocker, elastomeric or pot bearing. Mortar pad or thin rubber bearings shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.}* | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

**Bridge Number: 1355** **Group: PIER** **Group Number: 4**

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments<br>Full description including details of:<br>* Location of defect/condition/item<br>* Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Column | 1-3 | Concrete | Original | Each | 100 | | | | | Generally in good condition. Some minor shrinkage cracking and erosion at ground level. | | 53 | N | | | |
| Capbeam | 1 | Concrete | Original | $m^2$ | 100 | | | | | Minor hairline cracks to internal corners of shear key. | | 53 | N | | | |
| Diaphragm | 1 | Concrete | Original | $m^2$ | 100 | | | | | Infrequent vertical hairline cracks to diaphragm mainly at the shear key. | | 54 | N | | | |
| Footing | 1 | Concrete | Original | $m^2$ | | | | | 100 | Not visible. | | | N | | | |
| Bearing Unit | 1-5 | Rubber | Original | Each | 100 | | | | | Elastomeric bearing pads in good condition. | | | N | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| *{Bearing Units shall only be assigned Condition States when structural. In this instance, 'structural' means that the bearing is a rocker, elastomeric or pot bearing. Mortar pad or thin rubber bearings shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.}* | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

## DETAILED VISUAL (LEVEL 2)
## BRIDGE INSPECTION REPORT

**Bridge Number:** 1355 **Group:** SPAN **Group Number:** 1

**Span Length (m):** 11.174 *(CL to CL)* **Span Length (m):** 10.274 *(Clear Span)*

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments<br>Full description including details of:<br>* Location of defect/condition/item<br>* Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beam | 1-5 | Steel | Original | Each | 100 | | | | | Good condition. | | 26 | N | | | |
| Slab | 1 | Concrete | Original | $m^2$ | | 100 | | | 80 | The slab is hidden by the permanent formwork and only the two cantilever sections are visible. There are hairline cracks in the cantilevered sections at approximately 400mm centres. This combined with the fact 80% of the deck was hidden, a 100% CS2 has been given. | | 27, 28 | N | | | |
| Permanent Formwork | 1-4 | Steel | Original | $m^2$ | | | | | | Condeck HP (1.0 BMT) in good condition. | | 26 | N | | | |
| | | | | | | | | | | | | | | | | |

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

**Bridge Number:** 1355 **Group:** SPAN **Group Number:** 2

**Span Length (m):** 14.129 (CL to CL) **Span Length (m):** 13.529 (Clear Span)

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments<br>Full description including details of:<br>* Location of defect/condition/item<br>* Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beam | 1-5 | Steel | Original | Each | 100 | | | | | All five steel beams are in good condition. | | 34 | N | | | |
| Slab | 1 | Concrete | Original | m^2 | | 100 | | | 80 | The slab is hidden by the permanent formwork and only the two cantilever sections are visible. There are hairline cracks in the cantilevered sections at approximately 400mm centres. This combined with the fact 80% of the deck was hidden, a 100% CS2 has been given. | | 35, 37 | N | | | |
| Permanent Formwork | 1-4 | Steel | Original | m^2 | | | | | | Condeck HP (1.0 BMT) in good condition. | | 36 | N | | | |
| | | | | | | | | | | | | | | | | |

***Bridge Number:*** ***1355*** ***Group:*** ***SPAN*** ***Group Number:*** ***3***

***Span Length (m):*** ***14.186*** *(CL to CL)* ***Span Length (m):*** ***13.586*** *(Clear Span)*

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments<br>Full description including details of:<br>* Location of defect/condition/item<br>* Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beam | 1-5 | Steel | Original | Each | 100 | | | | | All five steel beams are in good condition. | | 42 | N | | | |
| Slab | 1 | Concrete | Original | m^2 | | 100 | | | 80 | The slab is hidden by the permanent formwork and only the two cantilever sections are visible. There are hairline cracks in the cantilevered sections at approximately 400mm centres. This combined with the fact 80% of the deck was hidden, a 100% CS2 has been given. | | 43-45 | N | | | |
| Permanent Formwork | 1-4 | Steel | Original | m^2 | | | | | | Condeck HP (1.0 BMT) in good condition. | | 42 | N | | | |
| | | | | | | | | | | | | | | | | |

**Bridge Number:** 1355 **Group:** SPAN **Group Number:** 4

**Span Length (m):** 14.273 *(CL to CL)* **Span Length (m):** 13.673 *(Clear Span)*

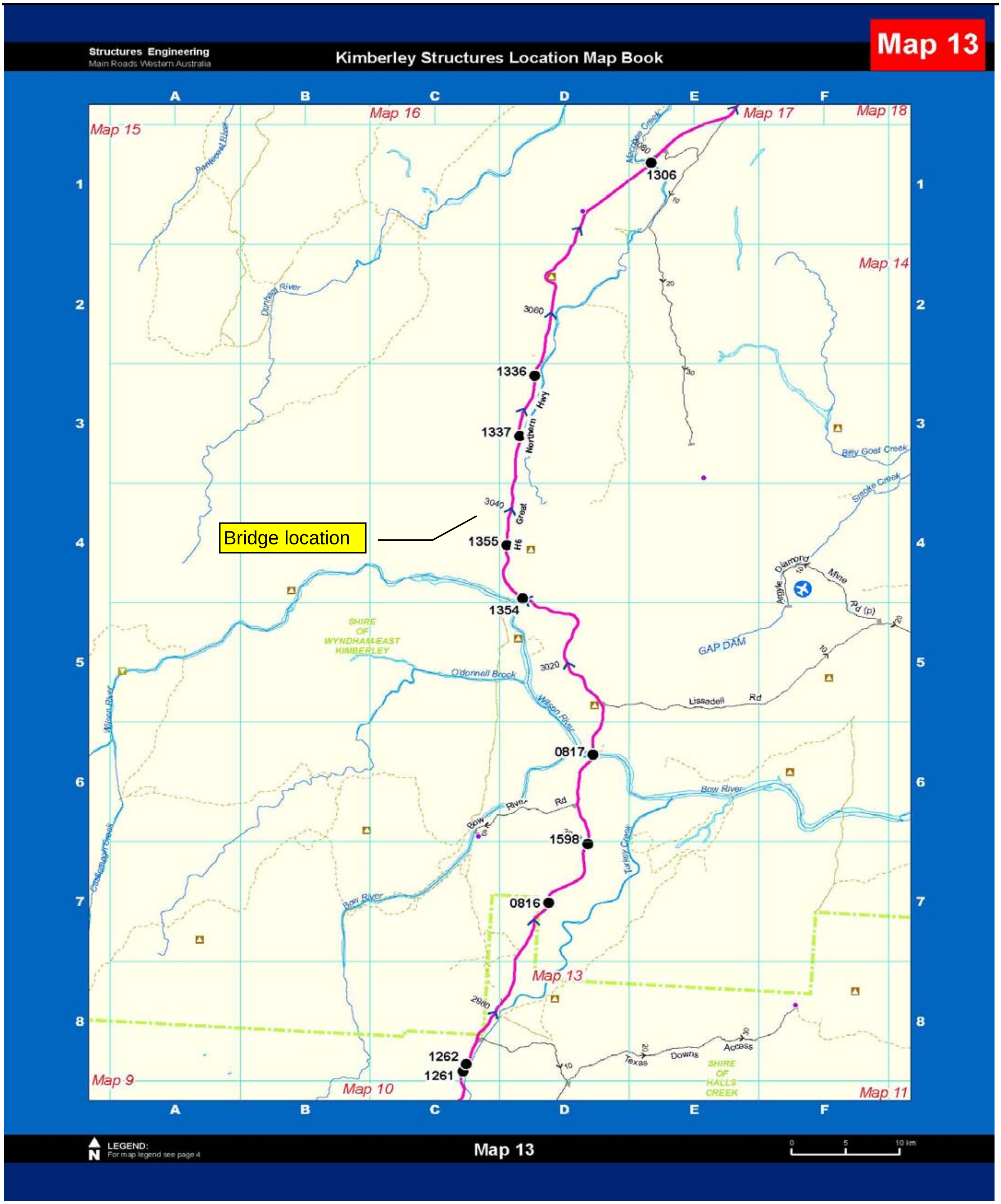
| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments<br>Full description including details of:<br>* Location of defect/condition/item<br>* Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beam | 1-5 | Steel | Original | Each | 100 | | | | | All five steel beams are in good condition. | | 50 | N | | | |
| Slab | 1 | Concrete | Original | m^2 | | 100 | | | 80 | The slab is hidden by the permanent formwork and only the two cantilever sections are visible. There are hairline cracks in the cantilevered sections at approximately 400mm centres. This combined with the fact 80% of the deck was hidden, a 100% CS2 has been given. | | 52 | N | | | |
| Permanent Formwork | 1-4 | Steel | Original | m^2 | | | | | | Condeck HP (1.0 BMT) in good condition. | | 51 | N | | | |
| | | | | | | | | | | | | | | | | |

***Bridge Number:*** ***1355*** ***Group:*** ***SPAN*** ***Group Number:*** ***5***

***Span Length (m):*** ***11.569*** *(CL to CL)* ***Span Length (m):*** ***10.669*** *(Clear Span)*

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments<br>Full description including details of:<br>* Location of defect/condition/item<br>* Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beam | 1-5 | Steel | Original | Each | 100 | | | | | All five steel beams are in good condition. | | 56 | N | | | |
| Slab | 1 | Concrete | Original | m^2 | | 100 | | | 80 | The slab is hidden by the permanent formwork and only the two cantilever sections are visible. There are hairline cracks in the cantilevered sections. This combined with the fact 80% of the deck was hidden, a 100% CS2 has been given. | | | N | | | |
| Permanent Formwork | 1-4 | Steel | Original | m^2 | | | | | | Condeck HP (1.0 BMT) in good condition. | | 57 | N | | | |
| | | | | | | | | | | | | | | | | |

| | | | |
|---|---|---|---|
| ***Bridge Number:*** | **1355** | ***Crossing:*** | **Camel Creek** |
| ***LGA:*** | **Wyndham - East Kimberley** | ***Road Name:*** | **Great Northern Hwy** |
| ***Inspector:*** | **David Watts** | ***SLK:*** | **3,036.62** |



# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |


Photo No. 1: Bridge identifier at abutment 1 end left hand kerb and rail. (Taken: 30-Jul-2013)

Photo No. 2: Abutment 1 approach. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 3: Abutment 2 approach. (Taken: 30-Jul-2013)

Photo No. 4: Left hand side elevation. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 5: Right hand side elevation. (Taken: 30-Jul-2013)

Photo No. 6: Abutment 1 left hand side approach. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 7: Abutment 1 right hand side approach. (Taken: 30-Jul-2013)

Photo No. 8: Various cracking to abutment 1 right hand side kerb.  Concrete is solid. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 9: Abutment 1 expansion joint cover plate to kerb missing.  Road debris filling joint gap. (Taken: 30-Jul-2013)

Photo No. 10: Abutment 1 expansion joint.  Compressive seal gap full of road debris. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 11: Abutment 1 end. Surfacing over buried approach slab. (Taken: 30-Jul-2013)

Photo No. 12: Bridge deck surfacing. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 13: Typical cracking to kerbs on bridge deck.  Left hand side shown here. (Taken: 30-Jul-2013)

Photo No. 14: Bridge deck, left hand side guardrail and kerb. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 15: Bridge deck, right hand side guardrail and kerb. (Taken: 30-Jul-2013)

Photo No. 16: Abutment 2 end of deck and approach surfacing.  (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 17: Abutment 2 left hand side approach. (Taken: 30-Jul-2013)

Photo No. 18: Abutment 2 right hand side approach. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

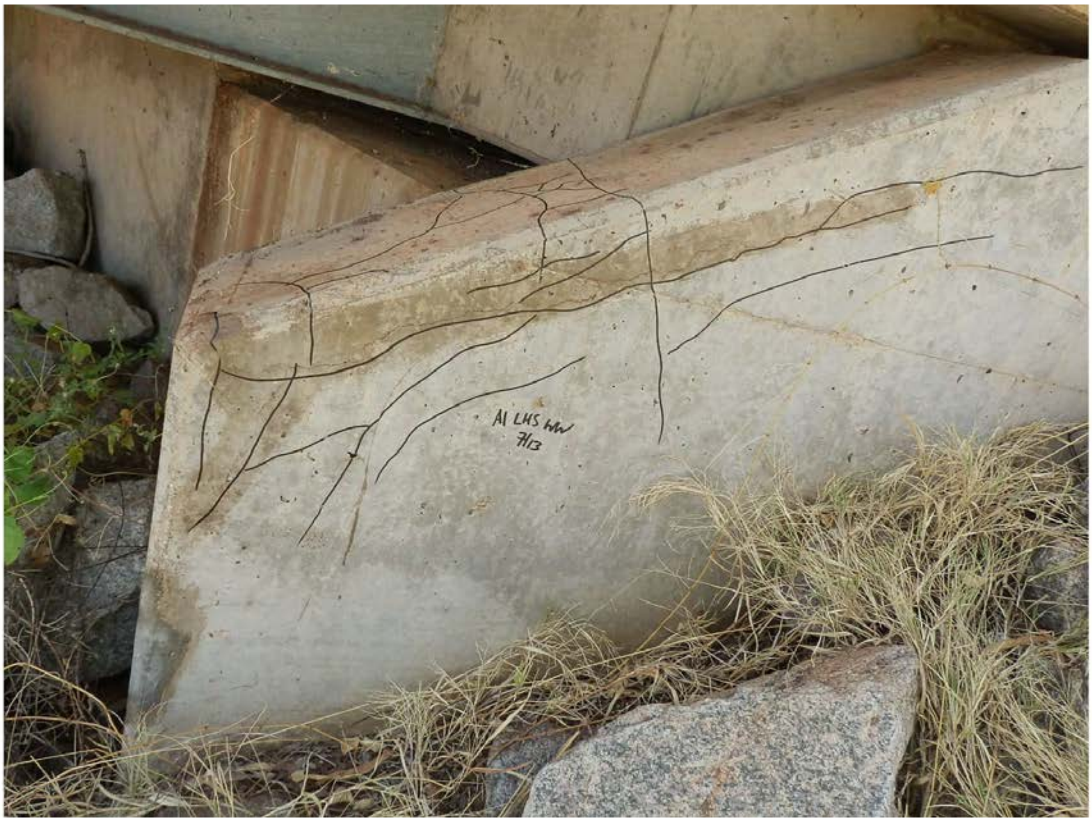



Photo No. 19: Abutment 1 left hand side wing wall. (Taken: 30-Jul-2013)

Photo No. 20: Abutment 1 capbeam. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 21: Abutment 1, bearing pad 2 of 5. (Taken: 30-Jul-2013)

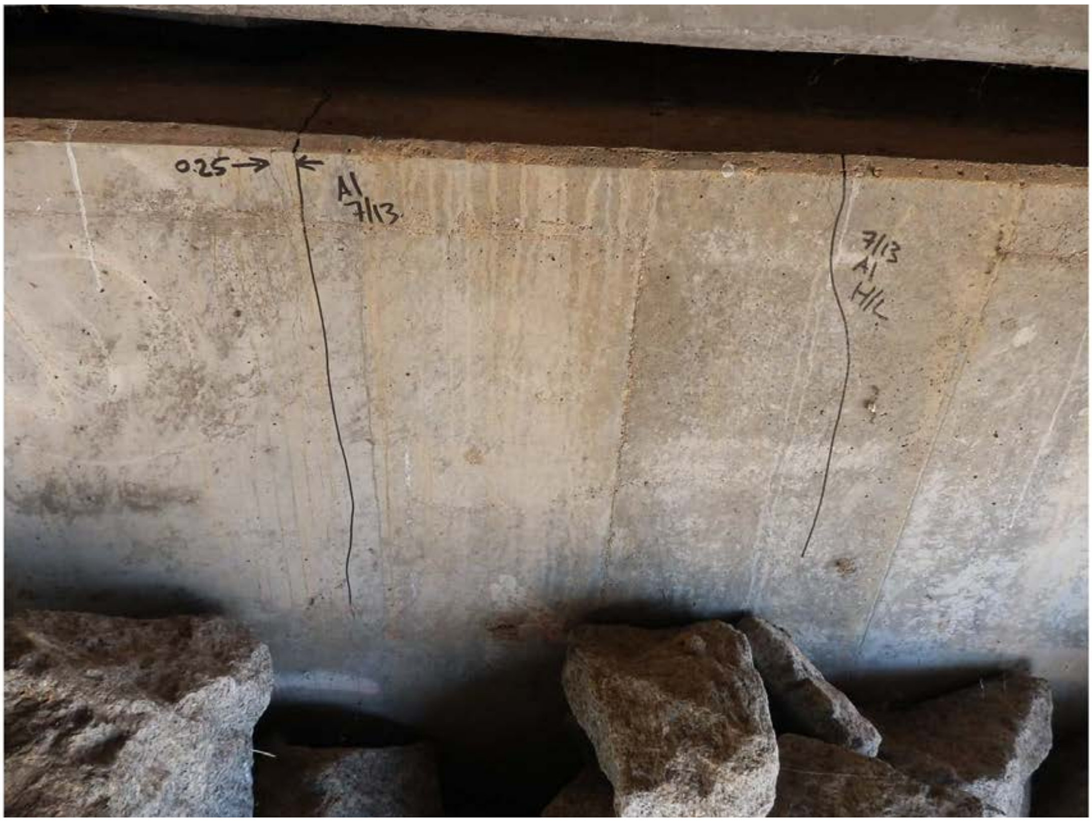



Photo No. 22: Abutment 1 capbeam between beams 2 and 3. Hairline to 0.25mm vertical cracking. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |


Photo No. 23: Abutment 1 diaphragm and capbeam.  0.25mm cracks as previously recorded. (Taken: 30-Jul-2013)

Photo No. 24: Abutment 1 right hand side wing wall.  0.15mm crack to top face of wall (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |


Photo No. 25: Abutment 1 general view of batter. (Taken: 30-Jul-2013)


Photo No. 26: Span 1 general view. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 27: Hairline cracking to left hand side cantilever of span 1. (Taken: 31-Jul-2013)

Photo No. 28: Hairline cracking to right hand side cantilever of span 1. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 29: Pier 1 general view. (Taken: 31-Jul-2013)

Photo No. 30: Flood debris up against previous fire damaged column. Unable to remove by hand but no obvious signs of deterioration to upper section that could be seen. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |


Photo No. 31: Pier 1 shear key/ diaphragm. Hairline cracks from internal corner up to shutter bolt hole. Abutment 1 face. (Taken: 31-Jul-2013)

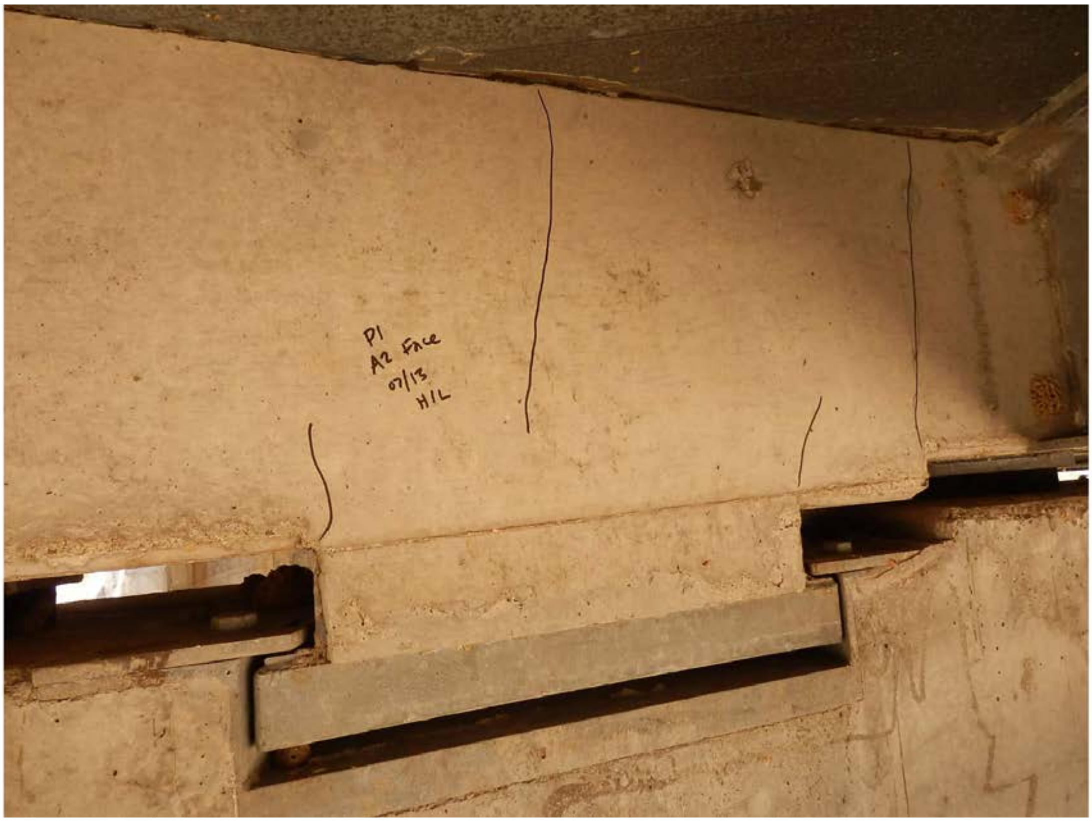



Photo No. 32: Pier 1 shear key/ diaphragm. Abutment 2 face. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 33: Pier 1 typical bearing pad in good condition. (Taken: 31-Jul-2013)

Photo No. 34: Span 2 general view. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 35: Span 2 left hand side cantilever.  Hairline cracks. (Taken: 31-Jul-2013)

Photo No. 36: Span 2 between beams 3 and 2. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 37: Span 2 right hand side cantilever. (Taken: 31-Jul-2013)

Photo No. 38: Pier 2 general view. (Taken: 31-Jul-2013)

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 39: Pier 2 abutment 1 face. Hairline cracking at shear key. (Taken: 31-Jul-2013)

Photo No. 40: Pier 2 abutment 2 face. Hairline cracking (up to 0.1mm) at shear key. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |


Photo No. 41: Pier 2 abutment 2 face.  Hairline cracks in diaphragm between beams 2 and 3. (Taken: 31-Jul-2013)

Photo No. 42: Span 3 general view. (Taken: 31-Jul-2013)

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 43: Span 3 left hand side cantilever.  Transverse hairline cracks. (Taken: 31-Jul-2013)

Photo No. 44: Span 3 left hand side cantilever.  Transverse hairline cracks. (Taken: 31-Jul-2013)

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 45: Span 3 right hand side cantilever. (Taken: 31-Jul-2013)

Photo No. 46: Pier 3 general view. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

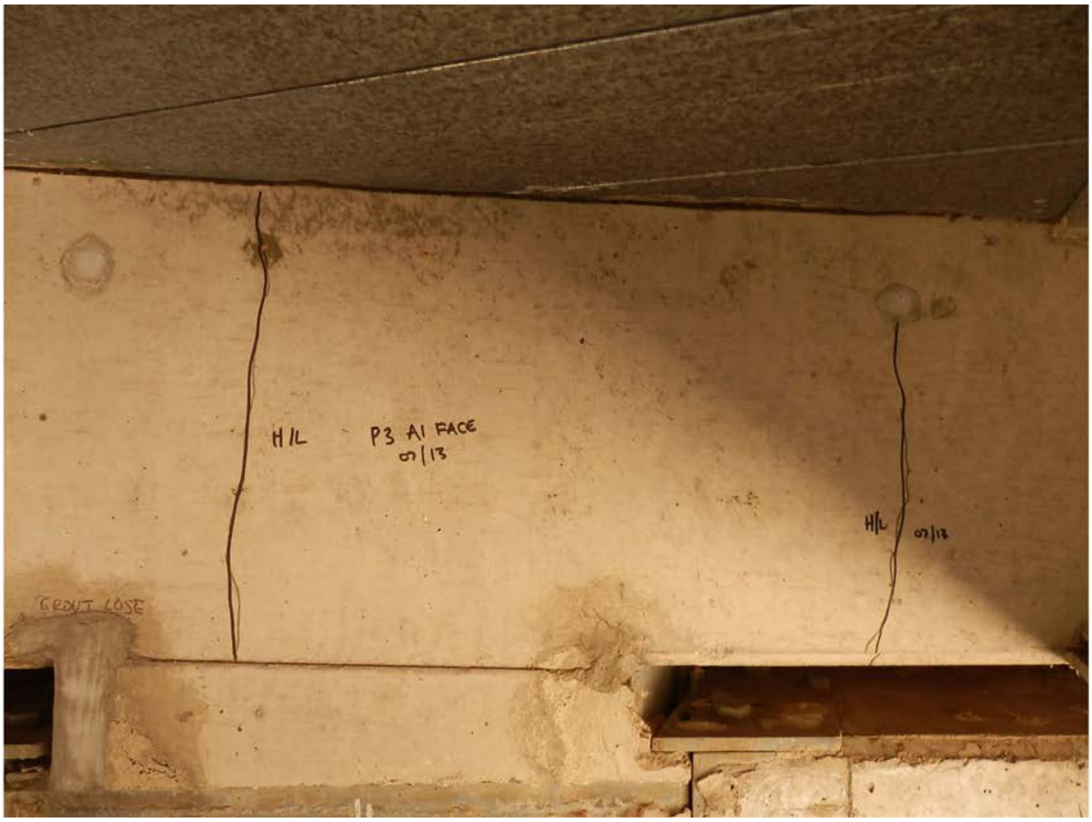



Photo No. 47: Pier 3 abutment 1 face. Hairline cracking. (Taken: 31-Jul-2013)


Photo No. 48: Pier 3 abutment 2 face. Minor hairline cracking. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 49: Pier 3 bearing pad 2 of 5. (Taken: 31-Jul-2013)

Photo No. 50: Span 4 general view. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 51: Span 4 between beams 2 and 3. (Taken: 31-Jul-2013)

Photo No. 52: Span 4, left hand side cantilever.  Hairline cracking at approximately 400mm centres. (Taken: 31-Jul-2013)

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 53: Pier 4 general view. (Taken: 31-Jul-2013)


Photo No. 54: Pier 4 abutment 1 face. Hairline cracking from internal corners of shear key up to plastic bolt hole forme for the formwork during construction. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

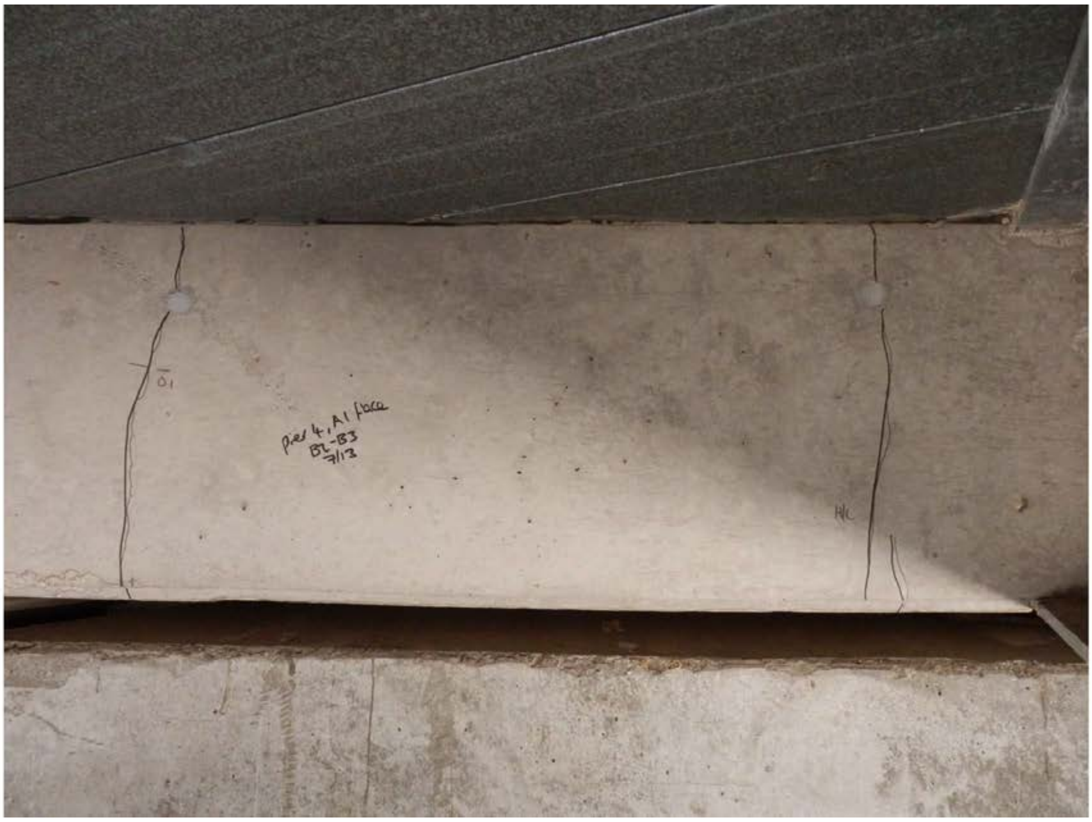



Photo No. 55: Pier 4 abutment 1 face diaphragm between beams 2 and 3. Vertical 0.1mm cracks from bolt hole formers for the original shuttering. (Taken: 31-Jul-2013)


Photo No. 56: Span 5 general view. (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
|---|---|---|
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 57: Span 5 beams 2 to 5. (Taken: 31-Jul-2013)


Photo No. 58: Abutment 2 general view including batter (Taken: 31-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 59: Abutment 2 capbeam.  Various cracking, hairline, 0.2mm and 0.3mm. (Taken: 30-Jul-2013)

Photo No. 60: Abutment 2.  Cracking to capbeam and diaphragm at shear key. (Taken: 30-Jul-2013)

# Structure No: 1355 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Great Northern Hwy | LGA: Wyndham - East Kimberley | Inspection Date: 30-Jul-2013 |
| Crossing: Camel Creek | SLK: 3036.76 | Inspector: David Watts |

Photo No. 61: Abutment 2 left hand side wing wall. (Taken: 30-Jul-2013)

Photo No. 62: Abutment 2 right hand side wing wall.  0.15mm crack to top face of wall. (Taken: 30-Jul-2013)

# APPENDIX G(ii)

## EXAMPLE OF

## DETAILED VISUAL BRIDGE INSPECTION REPORT FOR PRECAST BOX UNIT BRIDGES (Level 2)

# DETAILED CONCRETE AND STEEL BRIDGE INSPECTION SUMMARY

| | | | |
|---|---|---|---|
| **Bridge No.:** | 4382A | **Region:** | Metropolitan Region |
| **Crossing Name:** | Oaklands Main Drain | **SLK:** | 0.69 |
| **Road:** | King Rd | **Road No.:** | 1080026 |
| **LGA:** | Serpentine - Jarrahdale | | |

## 1.0 GENERAL

The bridge was built in 1988 and is generally in good condition.

## 2.0 STRUCTURE

### 2.1 Walls & Aprons

No obvious defects or signs of deterioration.

### 2.2 Barrels

All barrels and units are in good condition with no obvious faults. Gaps between units appear to have been from incorrect placement during construction and have been waterproofed. No works are required as the units appear stable.

## 3.0 RECOMMENDATIONS

1. Remove the tree from Abutment 1 LHS.
2. Sweep the shoulders to improve drainage.
3. Advise Water Corporation of required flood gate maintenance.

V. Montaldo
BRIDGE CONDITION OFFICER
MAIN ROADS WESTERN AUSTRLIA

14 March 2010

## WORK ITEMS - SUMMARY
## CONCRETE & STEEL BRIDGES

**BRIDGE No.: 4382A**

### (A) GENERAL SUPPORTING ACTIVITIES

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| G010 | Bridge - Monitor Defect | | | |

### (B) PREVENTATIVE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| | | | | |

### (C) ROUTINE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| | Bridge - Remove Graffiti | | | |
| | Bridge - Repair Scour (Minor) | | | |
| | Bridge - Clear Debris and Vegetation | Y | 1 | Abut. 1 LHS tree removal |
| | Deck Surface - Maintain | | | |
| | Drainage - Maintain | Y | 1 | Sweep shoulders |
| | Fence - Remove | | | |
| | Guardrail - Maintain / Repair | | | |
| | Kerb - Repair (Minor) - Non Structural | | | |
| | Lighting - Maintain | | | |
| | Sign - Maintain | | | |

### (D) SPECIFIC WORKS

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| | Approach Slab - Repair | | | |
| | Apron - Repair | | | |
| | Barrel - Repair | | | |
| | Bridge - Repair Embankment | | | |
| | Bridge - Repair Scour (Major) | | | |
| | Bridge - Widen Embankment | | | |
| | Drainage - Repair | | | |
| | Footpath - Repair | | | |
| | Footpath Railing - Repair | | | |
| | Guardrail - Install | | | |
| | Headwall - Repair | | | |
| | Kerb - Repair | | | |
| | Wing Wall - Extend | | | |
| | Wing Wall - Repair | | | |

| **PRIORITY CODE** | **INDICATIVE TIMEFRAME** |
|---|---|
| 0 - Critical: EMERGENCY action required | Immediate within 6 months |
| 1 - High Priority | Within 3 years |
| 2 - Medium Priority | Within 4-6 years |
| 3 - Low Priority (monitor) | Assess again at next Detailed (Level 2) Inspection (7 years for non-timber bridges) |

*Note: Add additional standard work items to the above lists as required.*
*Refer to Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges for full listing.*

## DETAILED VISUAL (LEVEL 2) BRIDGE INSPECTION REPORT

### (PRECAST BOX UNIT BRIDGE)

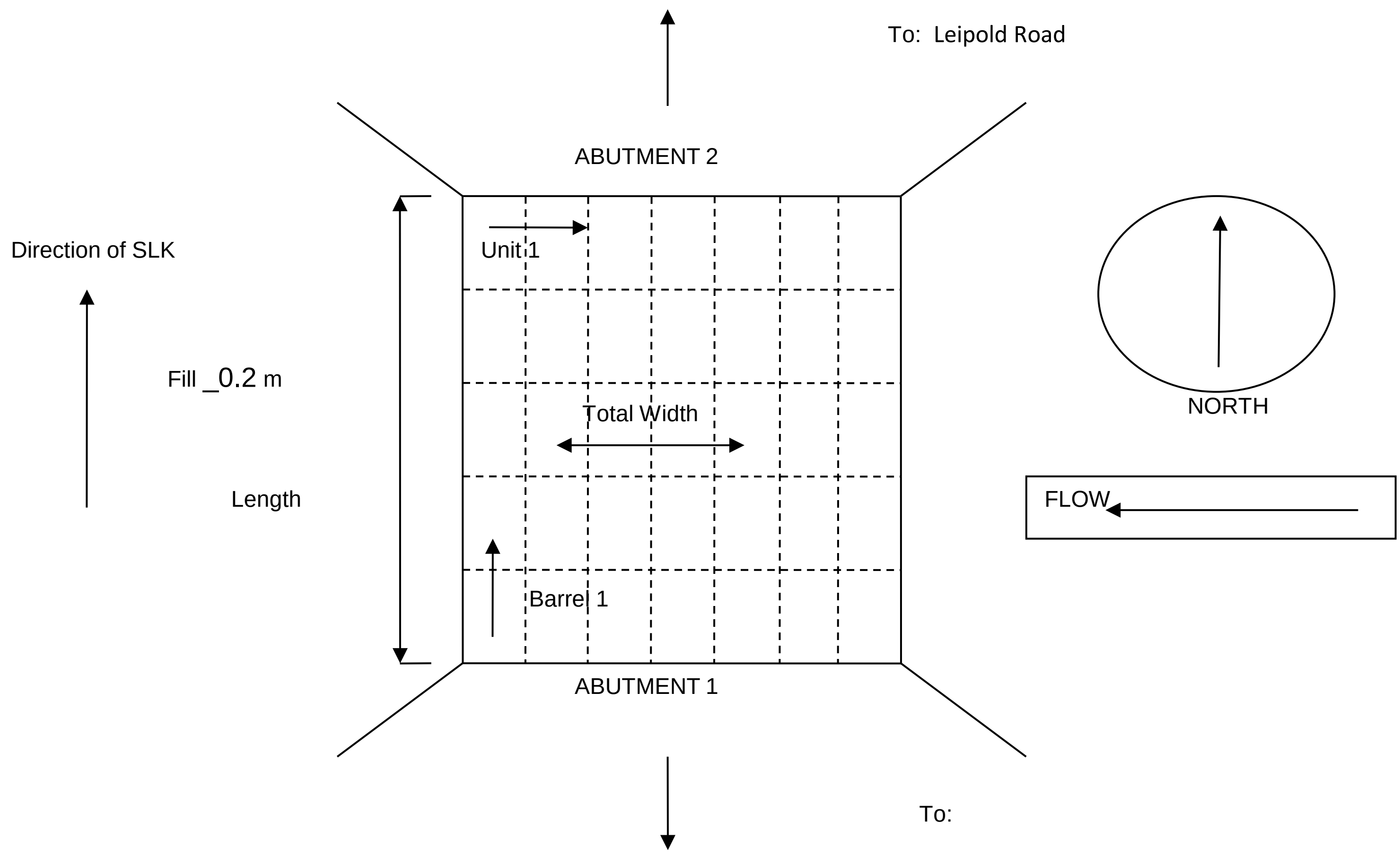
| | | | |
|---|---|---|---|
| **Bridge Number:** | 4382A | | |
| **Road Name** | King Rd | **Road Number:** | 1080026 |
| **Crossing Name:** | Oaklands Main Drain | **Local Govt.:** | Serpentine - Jarrahdale |
| **SLK** | 0.69 | **Owner** | Water Corporation |
| **Responsibility Area:** | Metropolitan Region | **Latitude:** | -32.28728 |
| | | **Longitude:** | 115.90717 |

### Geometry

| | | | | |
|---|---|---|---|---|
| **No. Barrels** | 3 | **Opening Size (m)** | **Span** | 3.60 |
| **Length (m)** | 11.50 | | **Height** | 3.00 |
| **Total Width (m)** | 9.76 | **Width between kerbs (m)** ~~**or Formation Width**~~ | (indicate which one) | 9.40 |
| **Skew (deg)** | 0 | | | |

Notes:

1. Abutments are numbered in the direction of increasing SLK.
2. Arch numbers are numbered along the structure in ascending order from Abutment 1 to Abutment 2.
3. Unit numbers are numbered across the structure in ascending order from left to right when facing the direction of increasing SLK.
4. Height of Fill above the arch (i.e. depth of soil from the top of the arch to the road surface) is measured at the structure's LHS in metres to one decimal place.
5. Mark in widening and footpath location, where applicable.




This bridge has been inspected in accordance with the requirements of the Main Roads Western Australia Bridge Guidelines for Level 2 inspections of concrete and steel bridges.

| | | | |
|---|---|---|---|
| Inspected by: | V. Montaldo | Checked by: | |
| Date: | 14-March-2010 | Date: | |

| | | | | |
|---|---|---|---|---|
| **DRIVE THROUGH** | **Visible Line of Sight from Abut. 1:** | | | Both approaches straight and flat with good visibility in both directions |
| | **Visible Line of Sight from Abut. 2:** | | | Both approaches straight and flat with good visibility in both directions |
| **TRAFFIC CONTROL** | **Abut. 1 end:** | | | |
| (Describe if different to the generic TMP) | **Abut. 2 end:** | | | |
| **PARKING POSITION** | > 3 m | ☒ | **Position:** | Driveways nearby to park totally off the road |
| | 1.2 to 3 m | ☐ | **Position:** | |
| | 0 to 1.2 m | ☐ | **Position:** | |
| **ACCESS TO ABUTMENTS** | **Abutment 1:** | | | |
| | LHS: | | | Walk down slope from road, not steep and good footing |
| (Describe access conditions at each wing) | RHS: | | | Walk down slope from road, not steep and good footing |
| | **Abutment 2:** | | | |
| | LHS: | | | Walk down slope from road, not steep and good footing |
| | RHS: | | | Walk down slope from road, not steep and good footing |
| | **Vegetation:** | | | All clear |
| **ACCESS TO PIERS** | **LHS:** | | | All clear |
| (Describe access conditions along each side of the structure) | **RHS:** | | | All clear |
| | **Vegetation:** | | | None |
| **PIER HEADROOM** | **Minimum (m):** | | | 3.00 m |
| | **Maximum (m):** | | | 3.20 m |
| **POTENTIAL HAZARDS** | **Railing/Posts:** | | | |
| | **Bolts:** | | | |
| | **Services:** | | | |
| | **Other:** | | | Water Corporation 'flood gates' across barrels |
| **FENCES** | **Timber:** | ☐ | **Location:** | |
| | **Wire/Mesh:** | ☐ | **Location:** | Fences tie into wing walls but are not restrictive to bridge opening/channel |
| | **Electrified:** | ☐ | **Location:** | |
| | **Barbed Wire:** | ☐ | **Location:** | |
| | **Other (Specify):** | | | **Location:** |
| **WATER** | **Depth (m):** | | | Dry at time of inspection |
| | **Flow Rate:** | | | |
| | **Algae:** | | | |
| | {Access may be restricted by toxic algae} | | | |
| | **Tide:** | | | |
| | **Location:** | | | |
| **POWERLINES** | **Side of bridge:** | | | |
| | **Horizontal distance from edge of deck (m):** | | | |
| | **Estimated vertical height above deck (m):** | | | |

V. Montaldo
Signature

14 March 2010
Date

**Bridge No.: 4382A**

## Barrier Type

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| None | | | | | | | | | |
| RHS Rails No. of Rails (on bridge): _____ | | | | | | | | | |
| Thriebeam | | | | | | | | | |
| W Beam | X | | X | X | | X | X | | X |
| Tric-Bloc Concrete Barrier | | | | | | | | | |
| Reinforced Concrete Barrier (Type F) | | | | | | | | | |
| Constant Slope Concrete Barrier | | | | | | | | | |
| Other Concrete Profiles | | | | | | | | | |

## Post Type

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | |
| Concrete | | | | | | | | | |
| Steel Type: _Ch_ | X | | X | | | | X | | X |
| Steel Type: _RHS_ | | | | X | | X | | | |

[Types: C Section (C), I Section (I), RHS (R), Square Hollow Section SHS (S), Tubular (T), Steel PFC (PFC), Steel Channel (Ch)]

*Off bridge:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of Posts off Bridge | 4 | | 3 | | | | 3 | | 4 |
| Length of Barrier off Bridge (m) | 7.8 | | 5.8 | | | | 5.8 | | 7.8 |

## Top Rails

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Steel Pipe | | | | | | | | | |
| Steel RHS/Channel | | | | | | | | | |
| Steel C Section | | | | | | | | | |
| Timber | | | | | | | | | |

## Visibility Barrier

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| Timber No. of Rails (on bridge): _____ | | | | | | | | | |
| Steel Pipe(s) No. of Pipes (on bridge): _____ | | | | | | | | | |
| Guide Posts | | | | | | | | | |
| Balustrade | | | | | | | | | |

## End Terminals

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| *Approved End Terminal Types:* | | | | | | | | | |
| WAMELT | | | | | | | | | |
| SKT-350 | | | | | | | | | |
| ET-2000 | | | | | | | | | |
| X Tension | | | | | | | | | |
| TAU II Crash Cushion | | | | | | | | | |
| Other: ____________________ | | | | | | | | | |
| *Other End Terminal Types:* | | | | | | | | | |
| None | | | | | | | | | |
| Turn-down | | | | | | | | | |
| Bullnose | X | | | | | | | | X |
| Fishtail | | | X | | | | X | | |
| Other: ____________________ | | | | | | | | | |

**Structural problem found? (Y/N)** [ ] If Yes, comment below.

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
## (PRECAST BOX UNIT BRIDGE)

***Bridge Number:*** *4382A* ***Group:*** *Bridge* ***Road Name:*** *King Rd*

| *General Items* | *Comments** <br><br> *Full description including details of:* <br> ** Location of defect/condition/item* <br> ** Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|
| **1. Delineation** <br> Missing, damaged, obscured | Approach 1 - All in reasonable condition. | | | N | | | |
| | Approach 2 - All in reasonable condition – Abutment 2 LHS has minor graffiti but is still adequate. | | | N | | | |
| **2. Road Surface** <br> Approaches and Road Surface: Material defects, surface defects, settlement, depressions, joint transitions, kerbing, shoulders, line marking, services | Road surface is in good condition, no sign of settlement or material loss. | | | N | | | |
| **3. Guardrails/Barriers** <br> Accident damage, connections, alignment, material defects | W beam railing with bullnose and fishtail terminals. No traffic damage. | | | N | | | |
| **4. Road Drainage** <br> Spoon drains, drains, gully traps, erosion | Scuppers partly blocked through build-up on shoulders | | | Y | R208 | Drainage - Maintain | 1 |
| **5. Footpaths** <br> Drainage, evenness, surface conditions, railing | N/A | | | | | | |
| **6. Lights** <br> Visibility, damage, connections, stability, material defects | N/A | | | | | | |
| **7. Services** <br> Damage, connections, fittings, material defects. | N/A | | | | | | |

***Bridge Number:*** ***4382A*** ***Group:*** ***Bridge*** ***Road Name:*** ***King Rd***

| *General Items* | *Comments** <br> *Full description including details of:* <br> * *Location of defect/condition/item* <br> * *Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|
| **8. Walkway** <br> Drainage, eveness, surface condition | N/A | | | | | | |
| **9. Waterways, Vegetation and Debris** <br> Vegetation and debris in waterways and clearance envelope <br> Embankment erosion, scour, silt build-up, blockages, damaged guide-banks, revetment mattresses, rock protection | No obvious issues. Banks and batters seem stable. Waterway area open and clear, minor bed erosion at each end, some silting in the culvert, up to 0.1 m. The Water Corporation 'flood gates' are in need of repair and maintenance and Water Corporation should be advised. Minor debris build-up in the gates. Tree close to Wing Wall A1 LHS needs removing so it does not destabilise the wall in the future. | | 4 <br> 5 <br> 8 <br> 9 | Y | R205 | Bridge - Clear Debris and Vegetation | 1 |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
## (PRECAST BOX UNIT BRIDGE)

**Bridge Number:** *4382A* **Group:** *Structure - Walls & Aprons* **Road Name:** *King Rd*

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State | | | | Not Inspected (%) | Comments* (include location and extends) | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | | | | | | | | |
| **10. Structure - Walls & Aprons** Describe: Material types, condition and defects (impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining, settlement/movement) ** | | | | | | | | | | | | | | | | |
| 10.1 a) Headwall | LHS | Concrete | Original | $m^2$ | 100 | | | | | No obvious defects or signs of deterioration. | | | N | | | |
| 10.1 b) Headwall | RHS | Concrete | Original | $m^2$ | 100 | | | | | No obvious defects or signs of deterioration. | | | N | | | |
| 10.2 a) Wing Wall A1 | LHS | Concrete | Original | $m^2$ | 100 | | | | | No obvious defects or signs of deterioration. | | | N | | | |
| 10.2 b) Wing Wall A1 | RHS | Concrete | Original | $m^2$ | 100 | | | | | No obvious defects or signs of deterioration. | | | N | | | |
| 10.2 c) Wing Wall A2 | LHS | Concrete | Original | $m^2$ | 100 | | | | | No obvious defects or signs of deterioration. | | | N | | | |
| 10.2 d) Wing Wall A2 | RHS | Concrete | Original | $m^2$ | 100 | | | | | No obvious defects or signs of deterioration. | | | N | | | |
| 10.3 Apron | 1 | Concrete | Original | $m^2$ | | | | | | N/A | | | | | | |
| 10.4 Other - _________ | | | | | | | | | | N/A | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

** Headwalls, wing walls and aprons shall be only assigned Condition States when they are considered structural components. Other non-structural walls and aprons shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.

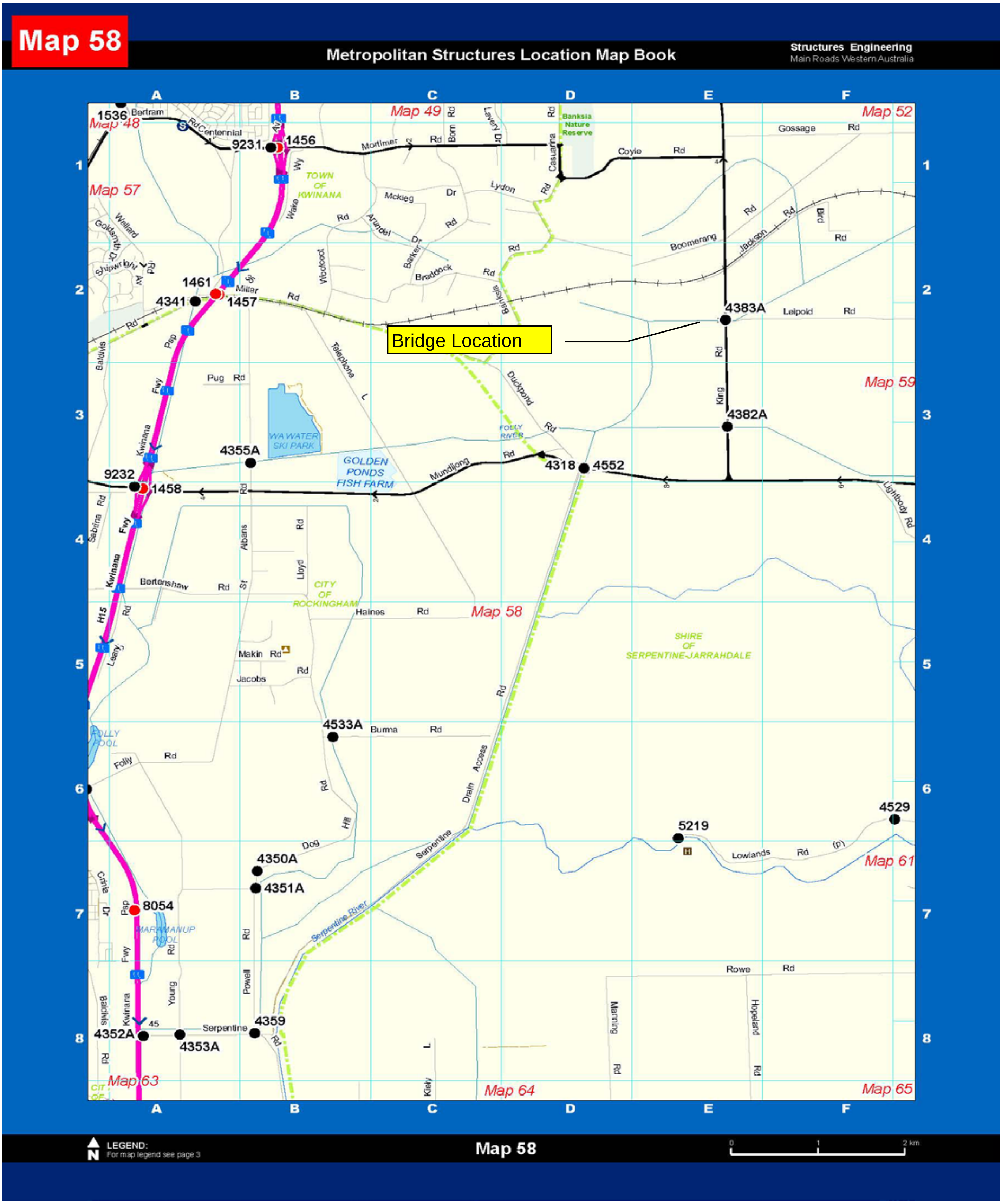
**Bridge Number:** *4382A* **Group:** *Structure - Barrels* **Road Name:** *King Rd*

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments* (include location and extends) | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **11. Structure - Barrel** Each row in the table is for an individual barrel (box unit, link slab or base slab). Each barrel will be made up of a series of connecting units. All units within each barrel need to be inspected providing detail of what unit number the comments refer to. Describe: Material defects (impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining, settlement/movement) | | | | | | | | | | | | | | | | |
| Barrel | 1 | Concrete | Original | $m^2$ | 100 | | | | | Precast Box. 8 Units and base slab.<br><br>All units are in good condition with no obvious faults.<br><br>There are gaps between units 6, 7 and 8 (typical in all barrels) which appear to have been waterproofed by packing with a foam material. The gaps were checked but no evidence of differential movement or settlement was found. The base slab and locating key were excavated locally and appeared to be without fault. It is likely the precast box units were incorrectly placed during construction. | | 6<br>7 | N | | | |
| Barrel | 2 | Concrete | Original | $m^2$ | 100 | | | | | Link Slab. 8 Units and base slab.<br>All units are in good condition with no obvious faults. | | | N | | | |
| Barrel | 3 | Concrete | Original | $m^2$ | 100 | | | | | Precast Box. 8 Units and base slab.<br>All units are in good condition with no obvious faults.<br>Similar gaps evident as identified for Barrel No. 1. | | | N | | | |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

| ***Additional Comments*** |
|---|
| None |

| | | | |
|---|---|---|---|
| ***Bridge Number:*** | **4382A** | ***Crossing:*** | **Oaklands Main Drain** |
| ***LGA:*** | **Serpentine - Jarrahdale** | ***Road Name:*** | **King Rd** |
| ***Inspector:*** | **V. Montaldo** | ***SLK:*** | **0.69** |




**Bridge Location Sheet**

# Structure No: 4382A - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: King Rd | LGA: Serpentine - Jarrahdale | Inspection Date: 14-Mar-2010 |
| Crossing: Oaklands Main Drain | SLK: 0.69 | Inspector: V. Montaldo |

Photo No. 1: Abutment 1 end, looking north (Taken: 14-Mar-2010)

Photo No. 2: Abutment 2 end, looking south (Taken: 14-Mar-2010)

# Structure No: 4382A - PHOTO SHEET

| Road Name: King Rd | LGA: Serpentine - Jarrahdale | Inspection Date: 14-Mar-2010 |
|---|---|---|
| Crossing: Oaklands Main Drain | SLK: 0.69 | Inspector: V. Montaldo |

Photo No. 3: Right hand side view, from upstream (Taken: 14-Mar-2010)

Photo No. 4: Left hand side view, looking upstream (Taken: 14-Mar-2010)

# Structure No: 4382A - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: King Rd | LGA: Serpentine - Jarrahdale | Inspection Date: 14-Mar-2010 |
| Crossing: Oaklands Main Drain | SLK: 0.69 | Inspector: V. Montaldo |

Photo No. 5: Wing Wall, Abutment 1 LHS – minor scour and tree close to wing wall (Taken: 14-Mar-2010)

Photo No. 6: Barrel No.1 – typical gaps between units (Taken: 14-Mar-2010)

# Structure No: 4382A - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: King Rd | LGA: Serpentine - Jarrahdale | Inspection Date: 14-Mar-2010 |
| Crossing: Oaklands Main Drain | SLK: 0.69 | Inspector: V. Montaldo |

Photo No. 7: Close up of gap between units 7 and 8, Barrel No.2 (Taken: 14-Mar-2010)

Photo No. 8: Barrel No.1, looking upstream (Taken: 14-Mar-2010)

# Structure No: 4382A - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: King Rd | LGA: Serpentine - Jarrahdale | Inspection Date: 14-Mar-2010 |
| Crossing: Oaklands Main Drain | SLK: 0.69 | Inspector: V. Montaldo |

Photo No. 9: Upstream side of Barrel No.2 (Taken: 14-Mar-2010)

Photo No. 10: Barrel No.3, upstream (Taken: 14-Mar-2010)

# Structure No: 4382A - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: King Rd | LGA: Serpentine - Jarrahdale | Inspection Date: 14-Mar-2010 |
| Crossing: Oaklands Main Drain | SLK: 0.69 | Inspector: V. Montaldo |

Photo No. 11: Abutment 2 approach RHS (Taken: 14-Mar-2010)

Photo No. 12: Abutment 2 approach LHS (Taken: 14-Mar-2010)

# APPENDIX G(iii)

## EXAMPLE OF

## DETAILED VISUAL BRIDGE INSPECTION REPORT FOR ARCH BRIDGES (Level 2)

# DETAILED CONCRETE AND STEEL BRIDGE INSPECTION SUMMARY

| | | | |
|---|---|---|---|
| **Bridge No.:** | 9066 | **Region:** | Metropolitan Region |
| **Crossing Name:** | Ennis Avenue Underpass - Right | **SLK:** | 28.20 |
| **Road:** | Melville Mandurah Hwy | **Road No.:** | H002 |
| **LGA:** | Rockingham (C) | | |

## 1.0 GENERAL

Bridge 9066 is single span steel multiplate arch structure and was constructed in 1979. The bridge carries the northbound carriageway of the Melville Mandurah Highway over a pedestrian underpass. The southbound carriageway of the Melville Mandurah Highway is supported by adjacent bridge 9067 which is of similar construction.
Bridge 9066 is generally in good condition with only some minor routine works required.

## 2.0 STRUCTURE

### 2.1 Walls & Footings

The concrete head and wing walls have graffiti present which requires removal, and some infrequent fine cracking but are otherwise in good condition. The small visible portion of the arch footings are in good condition.

### 2.2 Arches

The steel arch is in good condition. Previous corrosion treatment to the base of the arch has prevented further deterioration.

## 3.0 RECOMMENDATIONS

1. Clear debris from gully pits adjacent to left and right hand side underpass entries.
2. Remove graffiti from wing walls.

Inspector Name
BRIDGE ENGINEER
MAIN ROADS WESTERN AUSTRALIA

16 November 2016

# WORK ITEMS - SUMMARY
# CONCRETE & STEEL BRIDGES

**BRIDGE No.: 9066**

## (A) GENERAL SUPPORTING ACTIVITIES

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| G010 | Bridge - Monitor Defect | | | |

## (B) PREVENTATIVE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| | | | | |

## (C) ROUTINE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| R202 | Bridge - Remove Graffiti | Y | 2 | Remove graffiti from wing walls. |
| R203 | Bridge - Repair Scour (Minor) | | | |
| R205 | Bridge - Clear Debris and Vegetation | | | |
| R207 | Deck Surface - Maintain | | | |
| R208 | Drainage - Maintain | Y | 1 | Clear debris from gully pit on left and right hand side of underpass entries. |
| R210 | Fence - Remove | | | |
| R212 | Guardrail - Maintain / Repair | | | |
| R213 | Kerb - Repair (Minor) - Non Structural | | | |
| R214 | Lighting - Maintain | | | |
| R215 | Sign - Maintain | | | |

## (D) SPECIFIC WORKS

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| S407 | Approach Slab - Repair | | | |
| S411 | Arch - Reapir | | | |
| S716 | Barrel - Repair | | | |
| S301 | Bridge - Repair Embankment | | | |
| S350 | Bridge - Repair Scour (Major) | | | |
| S308 | Bridge - Widen Embankment | | | |
| S449 | Drainage - Repair | | | |
| S461 | Footpath - Repair | | | |
| S537 | Footpath Railing - Repair | | | |
| S467 | Guardrail - Install | | | |
| S731 | Headwall - Repair | | | |
| S473 | Kerb - Repair | | | |
| S585 | Wing Wall - Extend | | | |
| S588 | Wing Wall - Repair | | | |

| PRIORITY CODE | INDICATIVE TIMEFRAME |
|---|---|
| 0 - Critical: EMERGENCY action required | Immediate within 6 months |
| 1 - High Priority | Within 3 years |
| 2 - Medium Priority | Within 4-6 years |
| 3 - Low Priority (monitor) | Assess again at next Detailed (Level 2) Inspection (7 years for non-timber bridges) |

*Note: Add additional standard work items to the above lists as required.*
*Refer to Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges for full listing.*

| | | | | |
|---|---|---|---|---|
| **DRIVE THROUGH** | **Visible Line of Sight from Abut. 1:** | | | 150 m to left hand bend. |
| | **Visible Line of Sight from Abut. 2:** | | | 100 m to left hand bend. |
| **TRAFFIC CONTROL** | **Abut. 1 end:** | | | 1m |
| (Describe if different to the generic TMP) | **Abut. 2 end:** | | | 1m |
| **PARKING POSITION** | > 3 m | ☒ | **Position:** | Approach 2 left hand side verge. |
| | 1.2 to 3 m | ☐ | **Position:** | |
| | 0 to 1.2 m | ☐ | **Position:** | |
| **ACCESS TO ABUTMENTS** | **Abutment 1:** | | | |
| (Describe access conditions at each wing) | LHS: | | | Down sandy slope. |
| | RHS: | | | Follow paths. |
| | **Abutment 2:** | | | |
| | LHS: | | | Down sandy slope. |
| | RHS: | | | Follow paths. |
| | **Vegetation:** | | | Long grasses. |
| **ACCESS TO PIERS** | **LHS:** | | | N/A |
| (Describe access conditions along each side of the structure) | **RHS:** | | | |
| | **Vegetation:** | | | |
| **PIER HEADROOM** | **Minimum (m):** | | | N/A |
| | **Maximum (m):** | | | |
| **POTENTIAL HAZARDS** | **Railing/Posts:** | | | None. |
| | **Bolts:** | | | None. |
| | **Services:** | | | None. |
| | **Other:** | | | None. |
| **FENCES** | **Timber:** | ☐ | **Location:** | None. |
| | **Wire/Mesh:** | ☐ | **Location:** | |
| | **Electrified:** | ☐ | **Location:** | |
| | **Barbed Wire:** | ☐ | **Location:** | |
| | **Other (Specify):** | | | **Location:** |
| **WATER** | **Depth (m):** | | | N/A |
| | **Flow Rate:** | | | |
| | **Algae:** | | | |
| | {Access may be restricted by toxic algae} | | | |
| | **Tide:** | | | |
| | **Location:** | | | |
| **POWERLINES** | **Side of bridge:** | | | None. |
| | **Horizontal distance from edge of deck (m):** | | | |
| | **Estimated vertical height above deck (m):** | | | |

Inspector Name
Signature

2 November 2016
Date

**Bridge No.:** 9066

## Barrier Type

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| None | | | | | | | | | |
| RHS Rails No. of Rails (on bridge): _____ | | | | | | | | | |
| Thriebeam | | | | | | | | | |
| W Beam | x | | x | x | | x | x | | x |
| Tric-Bloc Concrete Barrier | | | | | | | | | |
| Reinforced Concrete Barrier (Type F) | | | | | | | | | |
| Constant Slope Concrete Barrier | | | | | | | | | |
| Other Concrete Profiles | | | | | | | | | |

## Post Type

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | |
| Steel Type: C | | | x | | | x | | | x |
| Steel Type: Ch | x | | | x | | | x | | |
| Steel Type: I | | | | | | | | | x |

[Types: C Section (C), I Section (I), RHS (R), Square Hollow Section SHS (S), Tubular (T), Steel PFC (PFC), Steel Channel (Ch)]

*Off bridge:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of Posts off Bridge | 4 | | - | | | | 4 | | - |
| Length of Barrier off Bridge (m) | 15.5 | | >40 | | | | 15.5 | | >40 |

## Top Rails

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Steel Pipe | | | | | | | | | |
| Steel RHS/Channel | | | | | | | | | |
| Steel C Section | | | | | | | | | |
| Timber | | | | | | | | | |

## Visibility Barrier

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| Timber No. of Rails (on bridge): _____ | | | | | | | | | |
| Steel Pipe(s) No. of Pipes (on bridge): _____ | | | | | | | | | |
| Guide Posts | | | | | | | | | |
| Balustrade | | | | | | | | | |

## End Terminals

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| *Approved End Terminal Types:* | | | | | | | | | |
| WAMELT | | | | | | | | | |
| SKT-350 | | | | | | | | | |
| ET-2000 | | | | | | | | | x |
| X Tension | | | | | | | | | |
| TAU II Crash Cushion | | | | | | | | | |
| Other: ________________________ | | | | | | | | | |
| *Other End Terminal Types:* | | | | | | | | | |
| None | | | | | | | | | |
| Turn-down | | | | | | | | | |
| Bullnose | | | x | | | | x | | |
| Fishtail | x | | | | | | | | |
| Other: ________________________ | | | | | | | | | |

**Structural problem found? (Y/N)** [ ] If Yes, comment below.

**DETAILED VISUAL (LEVEL 2)**
**BRIDGE INSPECTION REPORT**
**(ARCH BRIDGE)**

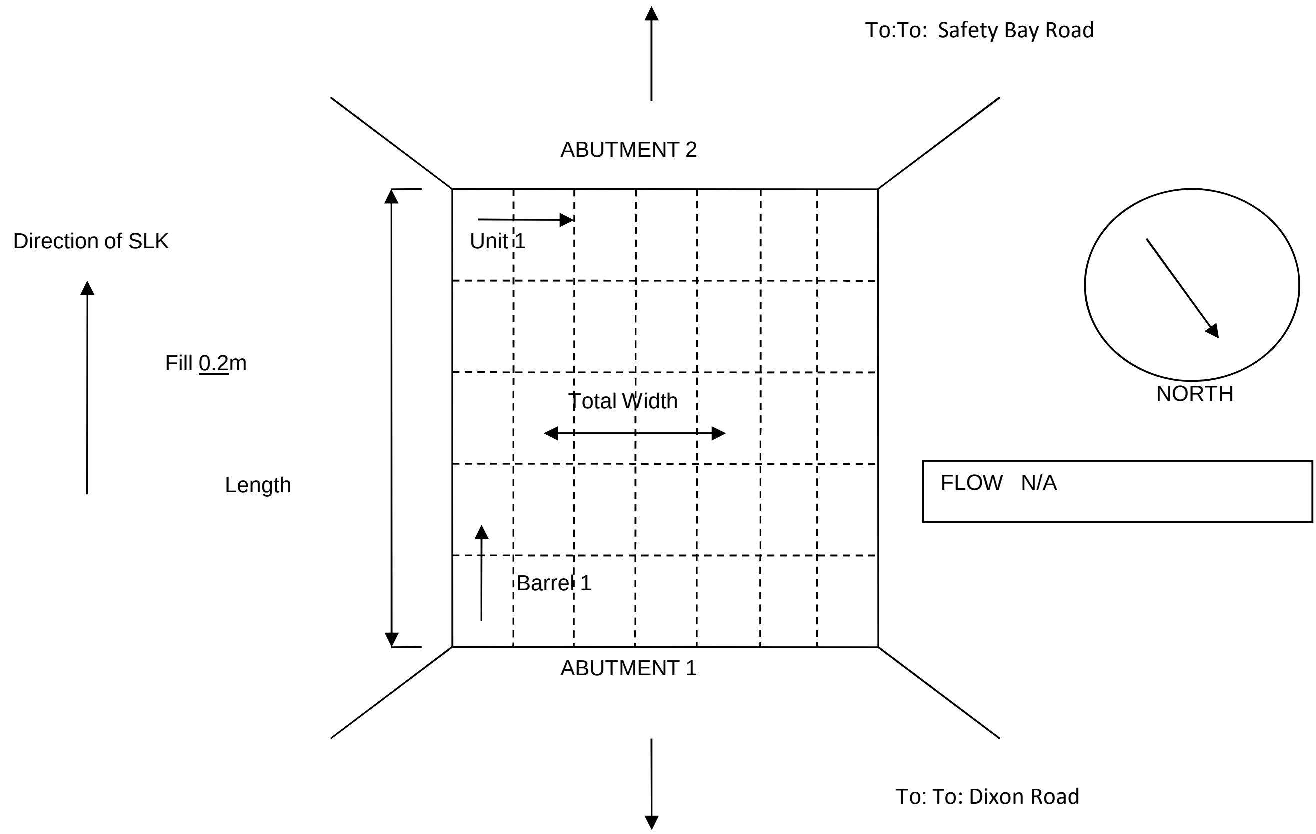
| | | | |
|---|---|---|---|
| ***Bridge Number:*** | 9066 | | |
| ***Road Name*** | Melville Mandurah Hwy | ***Road Number:*** | H002 |
| ***Crossing Name:*** | Ennis Avenue Underpass - Right | ***Local Govt.:*** | Rockingham (C) |
| ***SLK*** | 28.20 | ***Owner*** | Main Roads |
| ***Responsibility Area:*** | Metropolitan Region | ***Latitude:*** | -32.28312 |
| | | ***Longitude:*** | 115.75854 |

## *Geometry*

| | | | | |
|---|---|---|---|---|
| ***No. Arches*** | 1 | ***Opening Size (m)*** | ***Span*** | 4.56 |
| ***Length (m)*** | 15.20 | | ***Height*** | 2.75 |
| ***Total Width (m)*** | 14.99 | ***Width between kerbs (m) or Formation Width*** | (indicate which one) | 12.19 |
| ***Skew (deg)*** | 0 | ***Arch Material:*** | Steel | |

Notes:

1. Abutments are numbered in the direction of increasing SLK.
2. Arch numbers are numbered along the structure in ascending order from Abutment 1 to Abutment 2.
3. Unit numbers are numbered across the structure in ascending order from left to right when facing the direction of increasing SLK.
4. Height of Fill above the arch (i.e. depth of soil from the top of the arch to the road surface) is measured at the structure's LHS in metres to one decimal plac
5. Mark in widening and footpath location, where applicable.




This bridge has been inspected in accordance with the requirements of the Main Roads Western Australia Bridge Guidelines for Level 2 inspections of concrete and steel bridges.

| | | | |
|---|---|---|---|
| Inspected by: | Inspector Name | Checked by: | |
| Date: | 02-November-2016 | Date: | |

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
**(ARCH BRIDGE)**

***Bridge Number:*** ***9066*** ***Group:*** ***BRIDGE*** ***Road Name:*** ***Melville Mandurah Hwy***

| *General Items* | *Comments** <br> *Full description including details of:* <br> ** Location of defect/condition/item* <br> ** Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|
| **1. Delineation** <br> Missing, damaged, obscured | Approach 1 - The left and right hand side headwalls are delineated by road safety barrier. | | 2 | N | | | |
| | Approach 2 - The left and right hand side headwalls are delineated by road safety barrier. A width marker is incorporated into the ET2000 terminal on the right hand side. | | 3,7 | N | | | |
| **2. Road Surface** <br> Approaches and Road Surface: Material defects, surface defects, settlement, depressions, joint transitions, kerbing, shoulders, line marking, services | The bitumen road surface and concrete kerbing is in good condition. | | 8 | N | | | |
| **3. Guardrails/Barriers** <br> Accident damage, connections, alignment, material defects | Good condition. | | 4,5, 6,7, | N | | | |
| **4. Road Drainage** <br> Spoon drains, drains, gully traps, erosion | Road drains to approaches and un-kerbed median on left hand side. | | 2 | N | | | |
| **5. Footpaths** <br> Drainage, evenness, surface conditions, railing | None above underpass. | | | N | | | |
| **6. Lights** <br> Visibility, damage, connections, stability, material defects | Streetlights in right hand side verge were off at time of inspection but appear in good condition. | | 3 | N | | | |

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
**(ARCH BRIDGE)**

***Bridge Number:*** ***9066*** ***Group:*** ***BRIDGE*** ***Road Name:*** ***Melville Mandurah Hwy***

| ***General Items*** | ***Comments****<br><br>***Full description including details of:***<br>*** * Location of defect/condition/item***<br>*** * Description of defects including type, magnitude and extent*** | ***Sketch Number*** | ***Photograph Number*** | ***Work Required*** | ***Work Item Number*** | ***Work Description*** | ***Priority*** |
|---|---|---|---|---|---|---|---|
| **7. Services**<br>Damage, connections, fittings, material defects. | None evident. | | | N | | | |
| **8. Walkway**<br>Drainage, eveness, surface condition | Concrete pavers through underpass are cracked in several locations but otherwise are level and in fair condition.<br>Gully pits located at both the right and left hand side underpass entries are full of debris | | 9,12, 15 | Y | R208 | Drainage - Maintain | 1 |
| **9. Waterways, Vegetation and Debris**<br>Vegetation and debris in waterways and clearance envelope<br>Embankment erosion, scour, silt build-up, blockages, damaged guide-banks, revetment mattresses, rock protection | N/A | | | | | | |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
### (ARCH BRIDGE)

***Bridge Number:*** ***9066*** ***Group:*** ***Structure - Walls & Footings*** ***Road Name:*** ***Melville Mandurah Hwy***

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments* (include location and extends) | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10. Structure - Walls & Aprons** Describe: Material types, condition and defects (impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining, settlement/movement) ** | | | | | | | | | | | | | | | | |
| 10.1 a) Headwall | LHS | Concrete | Original | $m^2$ | 100 | | | | | Up to 0.1 mm wide vertical cracks to headwall capping, otherwise in good condition. | | 9,19 | N | | | |
| 10.1 b) Headwall | RHS | Concrete | Original | $m^2$ | 100 | | | | | Good condition. | | 12 | N | | | |
| 10.2 a) Wing Wall A1 | LHS | Concrete | Original | $m^2$ | 100 | | | | | Good condition. Graffiti to wall. | | 10 | Y | R202 | Bridge - Remove Graffiti | |
| 10.2 b) Wing Wall A1 | RHS | Concrete | Original | $m^2$ | 100 | | | | | Good condition. | | 13 | N | | | |
| 10.2 c) Wing Wall A2 | LHS | Concrete | Original | $m^2$ | 100 | | | | | Up to 0.1 mm wide vertical cracks otherwise in good condition. Graffiti to wall. | | 11 | Y | R202 | Bridge - Remove Graffiti | |
| 10.2 d) Wing Wall A2 | RHS | Concrete | Original | $m^2$ | 100 | | | | | Good condition. Graffiti to wall. | | 14 | Y | R202 | Bridge - Remove Graffiti | |
| 10.3 Footing A1 | 1 | Concrete | Original | $m^2$ | 100 | | | | 90 | Top 400 mm of arch footing is visible and in good condition. Past repairs are evident and in good condition. Remainder of footing is buried and behind arch. | | 17 | N | | | |
| 10.4 Footing A2 | 1 | Concrete | Original | $m^2$ | 100 | | | | 90 | Top 400 mm of arch footing is visible and in good condition. Past repairs are evident and in good condition. Remainder of footing is buried and behind arch. | | 18 | N | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

** Headwalls, wing walls and aprons shall be only assigned Condition States when they are considered structural components. Other non-structural walls and aprons shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
**(ARCH BRIDGE)**

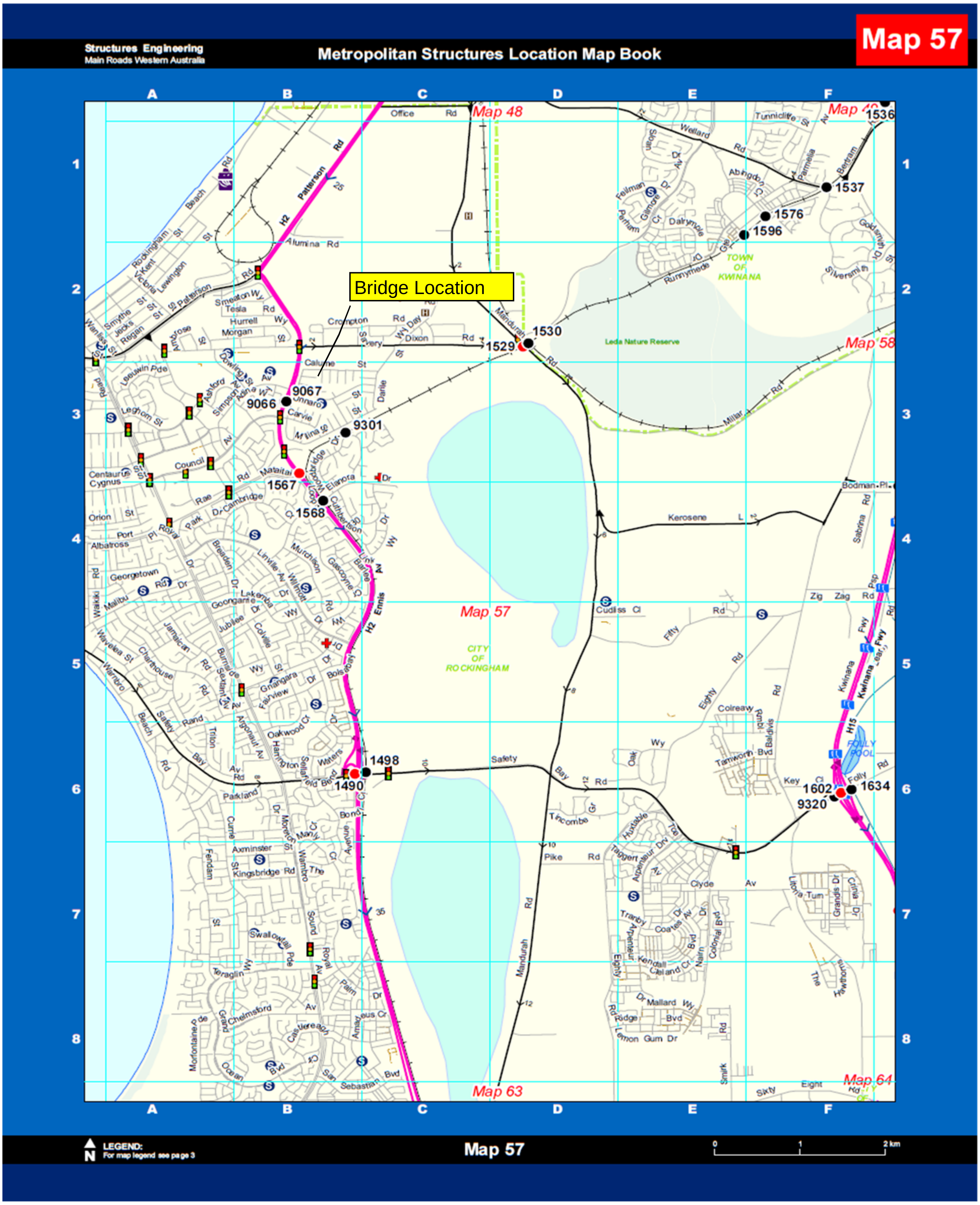
***Bridge Number:*** ***9066*** ***Group:*** ***Structure - Arches*** ***Road Name:*** ***Melville Mandurah Hwy***

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State | | | | Not Inspected (%) | Comments* (include location and extends) | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | | | | | | | | |
| **11. Structure - Arch**<br>Each row in the table is for an individual barrel (box unit, link slab or base slab). Each barrel will be made up of a series of connecting units. All units within each barrel need to be inspected providing detail of what unit number the comments refer to.<br>Describe: Material defects (impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining, settlement/movement) | | | | | | | | | | | | | | | | |
| Arch | 1 | Steel | Original | $m^2$ | 100 | | | | | The Armco multiplate arch is in good condition. Previous corrosion treatment to the arch base have prevented further corrosion. | | 16, 17, 18, | | | | |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

| ***Additional Comments*** |
|---|
| None |

| | | | |
|---|---|---|---|
| ***Bridge Number:*** | **9066** | ***Crossing:*** | **Ennis Avenue Underpass - Right** |
| ***LGA:*** | **Rockingham (C)** | ***Road Name:*** | **Melville Mandurah Hwy** |
| ***Inspector:*** | **Nicholas Zaknic** | ***SLK:*** | **28.20** |




**Bridge Location Sheet**

# Structure No: 9066 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |


Photo No. 1: Bridge number (Taken: 02-Nov-2016)

Photo No. 2: View from approach 1 (Taken: 02-Nov-2016)

# Structure No: 9066 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |

Photo No. 3: View from approach 2 (Taken: 02-Nov-2016)

Photo No. 4: Left hand side barrier (Taken: 02-Nov-2016)

# Structure No: 9066 - PHOTO SHEET

| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
|---|---|---|
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |

Photo No. 5: Approach 1 right hand side barrier (Taken: 02-Nov-2016)

Photo No. 6: Approach 2 right hand side barrier (Taken: 02-Nov-2016)

# Structure No: 9066 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |

Photo No. 7: Approach 2 right hand side terminal (Taken: 02-Nov-2016)

Photo No. 8: Road surface (Typ.) (Taken: 02-Nov-2016)

# Structure No: 9066 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |

Photo No. 9: Left hand side view (Taken: 02-Nov-2016)

Photo No. 10: Abutment 1 left hand side wing wall (Taken: 02-Nov-2016)

# Structure No: 9066 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |

Photo No. 11: Abutment 2 left hand side wing wall (Taken: 02-Nov-2016)

Photo No. 12: Right hand side view (Taken: 02-Nov-2016)

| | | |
|---|---|---|
| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |

Photo No. 13: Abutment 1 right hand side wing wall and batter (Taken: 02-Nov-2016)

Photo No. 14: Abutment 2 right hand side wing wall and batter (Taken: 02-Nov-2016)

# Structure No: 9066 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |

Photo No. 15: Drainage gully at right hand side entry (Taken: 02-Nov-2016)

Photo No. 16: Underside of arch (Taken: 02-Nov-2016)

# Structure No: 9066 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |

Photo No. 17: Abutment 1 side of arch (Taken: 02-Nov-2016)

Photo No. 18: Abutment 2 side of arch (Taken: 02-Nov-2016)

# Structure No: 9066 - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: Melville Mandurah Hwy | LGA: Rockingham (C) | Inspection Date: 02-Nov-2016 |
| Crossing: Ennis Avenue Underpass - Right | SLK: 28.20 | Inspector: Inspectors Name |

Photo No. 19: Cracks to abutment 2 left hand side head wall cap (Taken: 02-Nov-2016)

# APPENDIX H(i)

## TEMPLATE FOR

## DETAILED VISUAL BRIDGE INSPECTION REPORT FOR CONCRETE & STEEL BRIDGES (Level 2)

# DETAILED CONCRETE AND STEEL BRIDGE INSPECTION SUMMARY

**Bridge No.:** **Region:**
**Crossing Name:** **SLK:**
**Road:** **Road No.:**
**LGA:**

## 1.0 GENERAL

The bridge was built in XXX and is generally in YYY condition.

## 2.0 SUBSTRUCTURE

2.1 Abutments

2.2 Piers

## 3.0 SUPERSTRUCTURE

## 4.0 RECOMMENDATIONS

1.
2.
etc.



name
TITLE
COMPANY

Date

## WORK ITEMS - SUMMARY
## CONCRETE & STEEL BRIDGES

**BRIDGE No.**

### (A) GENERAL SUPPORTING ACTIVITIES

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| G005 | Bridge - Durability Survey (L3) | | | |
| G009 | Bridge - Load Rating | | | |
| G010 | Bridge - Monitor Defect | | | |

### (B) PREVENTATIVE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| P102 | Bridge - Maintain Fastener | | | |

### (C) ROUTINE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| R201 | Bearing - Maintain | | | |
| R202 | Bridge - Remove Graffiti | | | |
| R203 | Bridge - Repair Scour (Minor) | | | |
| R205 | Bridge - Clear Debris and Vegetation | | | |
| R207 | Deck Surface - Maintain | | | |
| R208 | Drainage - Maintain | | | |
| R209 | Expansion Joint - Maintain | | | |
| R210 | Fence - Remove | | | |
| R212 | Guardrail - Maintain / Repair | | | |
| R213 | Kerb - Repair (Minor) - Non Structural | | | |
| R214 | Lighting - Maintain | | | |
| R215 | Sign - Maintain | | | |

### (D) SPECIFIC WORKS

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| S504 | Abutment - Repair (Non-Timber) | | | |
| S401 | Approach Slab - Install | | | |
| S407 | Approach Slab - Repair | | | |
| S601 | Beam - Repair | | | |
| S619 | Bearing - Repair | | | |
| S513 | Bracing - Replace | | | |
| S350 | Bridge - Repair Scour (Major) | | | |
| S308 | Bridge - Widen Embankment | | | |
| S516 | Capbeam - Repair | | | |
| S519 | Column - Repair | | | |
| S413 | Deck - Repair | | | |
| S431 | Deck Joint - Repair | | | |
| S531 | Diaphragm - Repair | | | |
| S455 | Expansion Joint - Repair | | | |
| S534 | Footing - Repair | | | |
| S461 | Footpath - Repair | | | |
| S537 | Footpath Railing - Repair | | | |
| S467 | Guardrail - Install | | | |
| S473 | Kerb - Repair | | | |
| S555 | Mechanically Stabilised Earth Wall - Repair | | | |
| S558 | Pier - Repair | | | |
| S564 | Pile - Repair | | | |
| S567 | Pile Cap - Repair | | | |
| S385 | Services - Repair | | | |
| S573 | Sill Beam - Repair | | | |
| S479 | Slab - Repair | | | |
| S585 | Wing Wall - Extend | | | |
| S588 | Wing Wall - Repair | | | |

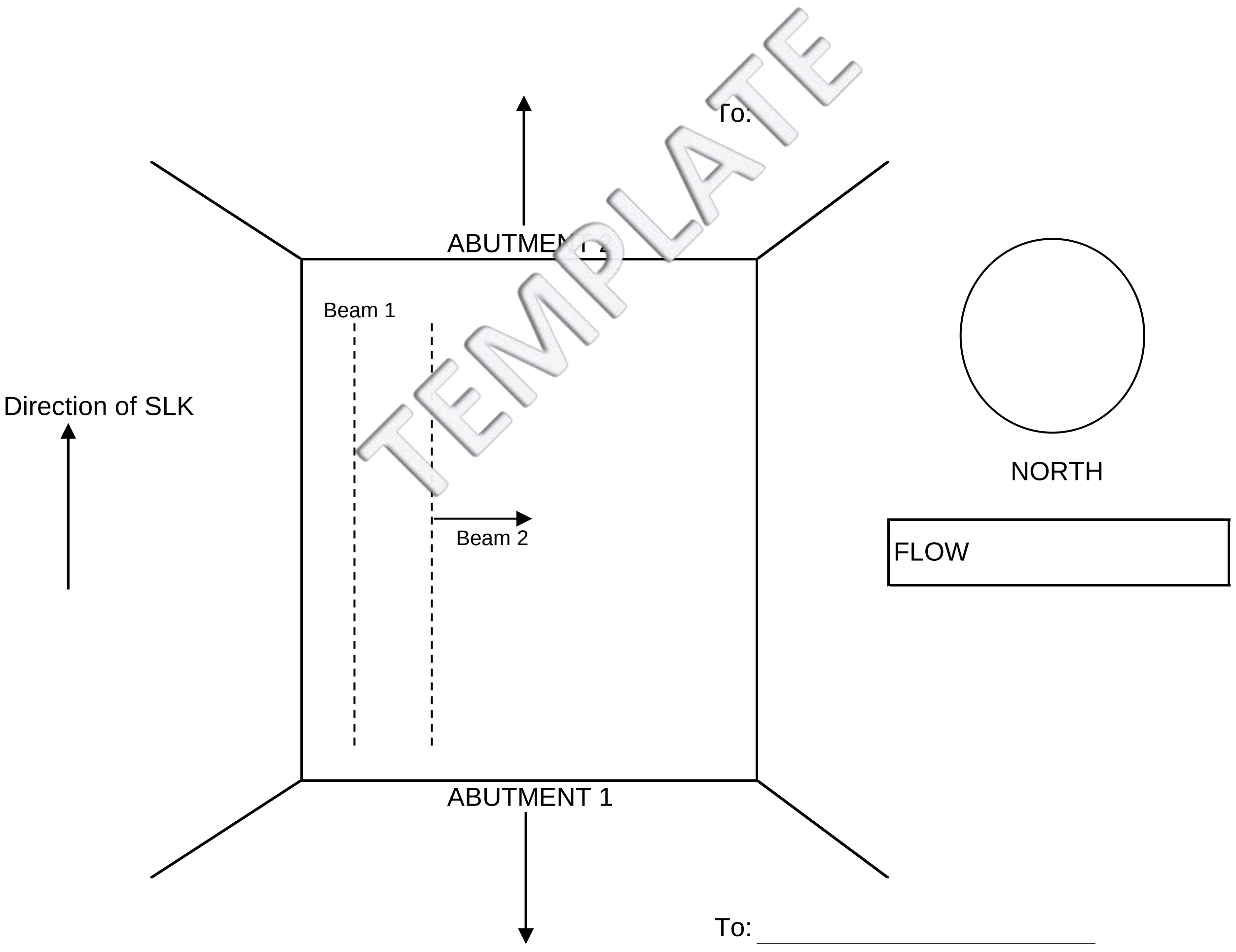
| PRIORITY CODE | INDICATIVE TIMEFRAME |
|---|---|
| 0 - Critical: EMERGENCY action required | Immediate within 6 months |
| 1 - High Priority | Within 3 years |
| 2 - Medium Priority | Within 4-6 years |
| 3 - Low Priority (monitor) | Assess again at next Detailed (Level 2) Inspection (7 years for non-timber bridges) |

*Note: Add additional standard work items to the above lists as required.*
*Refer to Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges for full listing.*

**DETAILED VISUAL (LEVEL 2)**
**BRIDGE INSPECTION REPORT**

| | | | | | |
|---|---|---|---|---|---|
| ***Bridge Number:*** | | | | ***Date:*** | |
| ***Structure Type:*** | | ***GPS Location*** | | ***Lat.:*** | |
| ***Superstructure:*** | | | | ***Long.:*** | |
| ***Responsibility Area:*** | | | | ***Road Number:*** | |
| ***Road Name:*** | | | | ***Owner:*** | |
| ***Local Govt.:*** | | | | ***SLK:*** | |
| ***Crossing Name:*** | | | | ***Skew:*** | |
| ***Total Width (m):*** | | ***Max. H/Room (m):*** | | ***Min. H/Room (m):*** | |
| ***No. Spans:*** | | ***Width Between Kerbs (m):*** | | ***Length (m):*** | |

Abutments are numbered in the direction of increasing SLK.
Piers are numbered along the bridge in ascending order from Abutment 1 to Abutment 2.
Piles and Columns are numbered across the bridge in ascending order from left to right when facing the direction of increasing SLK.
Beams are numbered across the bridge in ascending order from left to right when facing the direction of increasing SLK.






Mark in widening and footpath locations.

This bridge has been inspected in accordance with the requirements of the Main Roads Western Australia Bridge Guidelines for Level 2 inspections of concrete and steel bridges.

Inspected by: ______________________ Checked by: ______________________

Date: ______________________ Date: ______________________

**Bridge No.:**

| | | | |
|---|---|---|---|
| **DRIVE THROUGH** | **Visible Line of Sight from Abut. 1:** | | |
| | **Visible Line of Sight from Abut. 2:** | | |
| **TRAFFIC CONTROL** | **Abut. 1 end:** | | |
| (Describe if different to the generic TMP) | **Abut. 2 end:** | | |
| **PARKING POSITION** | > 3 m | ☐ | **Position:** |
| | 1.2 to 3 m | ☐ | **Position:** |
| | 0 to 1.2 m | ☐ | **Position:** |
| **ACCESS TO ABUTMENTS** | **Abutment 1:** | | |
| (Describe access conditions at each wing) | LHS: | | |
| | RHS: | | |
| | **Abutment 2:** | | |
| | LHS: | | |
| | RHS: | | |
| | **Vegetation:** | | |
| **ACCESS TO PIERS** | **LHS:** | | |
| (Describe access conditions along each side of the structure) | **RHS:** | | |
| | **Vegetation:** | | |
| **PIER HEADROOM** | **Minimum (m):** | | |
| | **Maximum (m):** | | |
| **POTENTIAL HAZARDS** | **Railing/Posts:** | | |
| | **Bolts:** | | |
| | **Services:** | | |
| | **Other:** | | |
| **FENCES** | **Timber:** | ☐ | **Location:** |
| | **Wire/Mesh:** | ☐ | **Location:** |
| | **Electrified:** | ☐ | **Location:** |
| | **Barbed Wire:** | ☐ | **Location:** |
| | **Other (Specify):** | | **Location:** |
| **WATER** | **Depth (m):** | | |
| | **Flow Rate:** | | |
| | **Algae:** {Access may be restricted by toxic algae} | | |
| | **Tide:** | | |
| | **Location:** | | |
| **POWERLINES** | **Side of bridge:** | | |
| | **Horizontal distance from edge of deck (m):** | | |
| | **Estimated vertical height above deck (m):** | | |



Signature

Date

**Bridge No.:**

## Barrier Type

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| None | | | | | | | | | |
| RHS Rails No. of Rails (on bridge): _____ | | | | | | | | | |
| Thriebeam | | | | | | | | | |
| W Beam | | | | | | | | | |
| Tric-Bloc Concrete Barrier | | | | | | | | | |
| Reinforced Concrete Barrier (Type F) | | | | | | | | | |
| Constant Slope Concrete Barrier | | | | | | | | | |
| Other Concrete Profiles | | | | | | | | | |

## Post Type

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | |
| Concrete | | | | | | | | | |
| Timber | | | | | | | | | |
| Steel Type: _____ | | | | | | | | | |

[Types: C Section (C), I Section (I), RHS (R), Square Hollow Section SHS (S), Tubular (T), Steel PFC (PFC), Steel Channel (Ch)]

*Off bridge:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of Posts off Bridge | | | | | | | | | |
| Length of Barrier off Bridge (m) | | | | | | | | | |

## Top Rails

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Steel Pipe | | | | | | | | | |
| Steel RHS/Channel | | | | | | | | | |
| Steel C Section | | | | | | | | | |
| Timber | | | | | | | | | |



## Visibility Barrier

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| Timber No. of Rails (on bridge): _____ | | | | | | | | | |
| Steel Pipe(s) No. of Pipes (on bridge): _____ | | | | | | | | | |
| Guide Posts | | | | | | | | | |
| Balustrade | | | | | | | | | |

## End Terminals

| | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| *Approved End Terminal Types:* | | | | | | | | | |
| WAMELT | | | | | | | | | |
| SKT-350 | | | | | | | | | |
| ET-2000 | | | | | | | | | |
| X Tension | | | | | | | | | |
| TAU II Crash Cushion | | | | | | | | | |
| Other: ______________________ | | | | | | | | | |

*Other End Terminal Types:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | |
| Turn-down | | | | | | | | | |
| Bullnose | | | | | | | | | |
| Fishtail | | | | | | | | | |
| Other: ______________________ | | | | | | | | | |

**Structural problem found? (Y/N)** ☐ If Yes, comment below.

**DETAILED VISUAL (LEVEL 2)**
**BRIDGE INSPECTION REPORT**

***Bridge Number:*** ________ ***Group:*** ***BRIDGE*** ***Group Number:*** ***N/A***

| *General Items* | *Comments*<br><br>*Full description including details of:*<br>* *Location of defect/condition/item*<br>* *Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Item Description* | *Priority* |
|---|---|---|---|---|---|---|---|
| Vegetation | | | | | | | |
| Drainage | | | | | | | |
| Waterway Area | | | | | | | |
| Scour | | | | | | | |
| Signs and Lights | | | | | | | |
| Fences | | | | | | | |
| Services on Bridge (types, size, location) | | | | | | | |
| Substructure Protection | | | | | | | |

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

***Bridge Number:*** ___________________ ***Group:*** ***APPROACH*** ***Group Number:*** ***1 or 2***

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Comments* <br> *Full description including details of:* <br> ** Location of defect/condition/item* <br> ** Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Item Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Approach Kerb | LHS | | | Linear m | | | | | | | |
| Approach Kerb | RHS | | | Linear m | | | | | | | |
| Approach Guardrailing | LHS | | | Linear m | | | | | | | |
| Approach Guardrailing | RHS | | | Linear m | | | | | | | |
| Footpath Approach Kerb | LHS | | | Linear m | | | | | | | |
| Footpath Approach Kerb | RHS | | | Linear m | | | | | | | |
| Footpath Approach Railing | LHS | | | Linear m | | | | | | | |
| Footpath Approach Railing | RHS | | | Linear m | | | | | | | |
| Approach Slab | 1 | | | Item | | | | | | | |
| Road Surface on Approach | 1 | | | $m^2$ | | | | | | | |
| Cladding | LHS | | | $m^2$ | | | | | | | |
| Cladding | RHS | | | $m^2$ | | | | | | | |
| | | | | | | | | | | | |
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**DETAILED VISUAL (LEVEL 2)**
**BRIDGE INSPECTION REPORT**

***Bridge Number:*** __________  ***Group:*** ***DECK***  ***Group Number:*** ***N/A***

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Percentage of Inspected Component in Each Condition State* 1 | 2 | 3 | 4 | *Not Inspected (%)* | *Comments* Full description including details of: * Location of defect/condition/item * Description of defects including type, magnitude and extent | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Item Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kerb | LHS | | | Linear m | | | | | | | | | | | | |
| Kerb | RHS | | | Linear m | | | | | | | | | | | | |
| Bridge Guardrailing | LHS | | | Linear m | | | | | | | | | | | | |
| Bridge Guardrailing | RHS | | | Linear m | | | | | | | | | | | | |
| Footpath Kerb | LHS | | | Linear m | | | | | | | | | | | | |
| Footpath Kerb | RHS | | | Linear m | | | | | | | | | | | | |
| Footpath Railing | LHS | | | Linear m | | | | | | | | | | | | |
| Footpath Railing | RHS | | | Linear m | | | | | | | | | | | | |
| Barrier | LHS | | | Linear m | | | | | | | | | | | | |
| Barrier | RHS | | | Linear m | | | | | | | | | | | | |
| Overlay | 1 | | | $m^2$ | | | | | | | | | | | | |
| Footpath | LHS | | | $m^2$ | | | | | | | | | | | | |
| Footpath | RHS | | | $m^2$ | | | | | | | | | | | | |
| Expansion Joint | 1 | | | Each | | | | | | | | | | | | |
| Deck Joint | 1 | | | Linear m | | | | | | | | | | | | |
| Road Surface on Bridge | 1 | | | $m^2$ | | | | | | | | | | | | |
| Median | 1 | | | Linear m | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | |

**DETAILED VISUAL (LEVEL 2)**
**BRIDGE INSPECTION REPORT**

***Bridge Number:*** ___________ ***Group:*** ***ABUTMENT*** ***Group Number:*** ***1 or 2***

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Percentage of Inspected Component in Each Condition State* | | | | *Not Inspected (%)* | *Comments* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Item Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *1* | *2* | *3* | *4* | | *Full description including details of:*<br>* *Location of defect/condition/item*<br>* *Description of defects including type, magnitude and extent* | | | | | | |
| Pile | 1 | | | Each | | | | | | | | | | | | |
| Column | 1 | | | Each | | | | | | | | | | | | |
| Wall | 1 | | | $m^2$ | | | | | | | | | | | | |
| Mechanically Stabilised Earth Wall *1 | 1 | | | $m^2$ | | | | | | | | | | | | |
| Wing Wall | LHS | | | $m^2$ | | | | | | | | | | | | |
| Wing Wall | RHS | | | $m^2$ | | | | | | | | | | | | |
| Turndown Wall | 1 | | | $m^2$ | | | | | | | | | | | | |
| Tie Back | 1 | | | Each | | | | | | | | | | | | |
| Capbeam | 1 | | | $m^2$ | | | | | | | | | | | | |
| Sill Beam | 1 | | | $m^2$ | | | | | | | | | | | | |
| Diaphragm | 1 | | | $m^2$ | | | | | | | | | | | | |
| Pile Cap | 1 | | | $m^2$ | | | | | | | | | | | | |
| Footing | 1 | | | $m^2$ | | | | | | | | | | | | |
| Bearing Unit *2 | 1 | | | Each | | | | | | | | | | | | |
| Permanent Formwork | 1 | | | $m^2$ | | | | | | | | | | | | |
| External Strengthening | 1 | | | Each | | | | | | | | | | | | |
| Batter Protection | 1 | | | $m^2$ | | | | | | | | | | | | |
| Access Door | 1 | | | Each | | | | | | | | | | | | |
| Walkway | 1 | | | $m^2$ | | | | | | | | | | | | |
| Tie Beam | 1 | | | Each | | | | | | | | | | | | |
| Bracing | 1 | | | Each | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

**2 - {Bearing Units shall only be assigned Condition States when structural. In this instance, ‘structural’ means that the bearing is a rocker, elastomeric or pot bearing. Mortar pad, thin rubber or bituminous paper bearings shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.}*

**1 - {Each Mechanically Stabilised Wall shall be considered as a whole. Individual panels shall only be detailed in comments to describe faults if necessary}*

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

***Bridge Number:*** ___________ ***Group:*** ______***PIER***______ ***Group Number:*** _______

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Percentage of Inspected Component in Each Condition State* | | | | *Not Inspected (%)* | *Comments*<br>*Full description including details of:*<br>* *Location of defect/condition/item*<br>* *Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Item Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *1* | *2* | *3* | *4* | | | | | | | | |
| Pile | 1 | | | Each | | | | | | | | | | | | |
| Column | 1 | | | Each | | | | | | | | | | | | |
| Wall | 1 | | | $m^2$ | | | | | | | | | | | | |
| Capbeam | 1 | | | $m^2$ | | | | | | | | | | | | |
| Sill Beam | 1 | | | $m^2$ | | | | | | | | | | | | |
| Diaphragm [*2] | 1 | | | $m^2$ | | | | | | | | | | | | |
| Bracing | 1 | | | Each | | | | | | | | | | | | |
| Tie Beam | 1 | | | Each | | | | | | | | | | | | |
| Pile Cap | 1 | | | $m^2$ | | | | | | | | | | | | |
| Footing | 1 | | | $m^2$ | | | | | | | | | | | | |
| Bearing Unit [*1] | 1 | | | Each | | | | | | | | | | | | |
| Mast | 1 | | | Linear m | | | | | | | | | | | | |
| Cable Connector | 1 | | | Each | | | | | | | | | | | | |
| Permanent Formwork | 1 | | | $m^2$ | | | | | | | | | | | | |
| External Strengthening | 1 | | | Each | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

**1 - {Bearing Units shall only be assigned Condition States when structural. In this instance, 'structural' means that the bearing is a rocker, elastomeric or pot bearing. Mortar pad, thin rubber or bituminous paper bearings shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.}*

**2 - {A Cast Insitu concrete diaphragm that ties a number of beam together is considered as one component}*

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

***Bridge Number:*** __________ ***Group:*** ***SPAN*** ***Group Number:*** ______

***Span Length (m):*** ________________ *(CL to CL)* ***Span Length (m):*** ___________ *(Clear Span)*

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State | | | | Not Inspected (%) | Comments<br>Full description including details of:<br>* Location of defect/condition/item<br>* Description of defects including type, magnitude and extent | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Item Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | | | | | | | | |
| Beam | 1 | | | Each | | | | | | | | | | | | |
| Slab | 1 | | | $m^2$ | | | | | | | | | | | | |
| Box Girder *2 | 1 | | | Each | | | | | | | | | | | | |
| Arch | 1 | | | $m^2$ | | | | | | | | | | | | |
| Truss | 1 | | | Each | | | | | | | | | | | | |
| Diaphragm | 1 | | | $m^2$ | | | | | | | | | | | | |
| Bracing | 1 | | | Each | | | | | | | | | | | | |
| Tie Beam | 1 | | | Linear m | | | | | | | | | | | | |
| Tie Rod/Bolt *3 | 1 | | | Each | | | | | | | | | | | | |
| Prestressing Anchorage | 1 | | | Each | | | | | | | | | | | | |
| Cable/Hanger | 1 | | | Each | | | | | | | | | | | | |
| Cable Connector | 1 | | | Each | | | | | | | | | | | | |
| Permanent Formwork *1 | 1 | | | $m^2$ | | | | | | | | | | | | |
| External Strengthening | 1 | | | Each | | | | | | | | | | | | |
| Cladding | LHS | | | $m^2$ | | | | | | | | | | | | |
| Cladding | RHS | | | $m^2$ | | | | | | | | | | | | |
| Static Sign | 1 | | | Each | | | | | | | | | | | | |
| Static Sign Mounting Brackets | LHS | | | Each | | | | | | | | | | | | |
| Static Sign Mounting Brackets | RHS | | | Each | | | | | | | | | | | | |
| Variable Message Sign (VMS) | 1 | | | Each | | | | | | | | | | | | |
| VMS Mounting Brackets | LHS | | | Each | | | | | | | | | | | | |
| VMS Mounting Brackets | RHS | | | Each | | | | | | | | | | | | |
| Electrification Screen | 1 | | | Each | | | | | | | | | | | | |
| Electrification Screen Mounting Brackets | LHS | | | Each | | | | | | | | | | | | |
| Electrification Screen Mounting Brackets | RHS | | | Each | | | | | | | | | | | | |



**1 - {Numbered consectively across Bridge from left to right, i.e. per bay}*

**2 - {Where a deck wth cells has been cast as one unit the deck is deemed to only have one Box. Individually cast boxes are counted separately]*

**3 - {Tiebolts shall be indidually counted. In cases where there is more than 40 tiebolts the number can be estimated}*

## DETAILED VISUAL (LEVEL 2) BRIDGE INSPECTION REPORT

| | |
|---|---|
| ***Bridge Number:*** | ***Crossing:*** |
| ***LGA:*** | ***Road Name:*** |
| ***Inspector:*** | ***SLK:*** |



Bridge location

**Bridge Location Sheet**

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

**Bridge Number:** ____________ **Inspection Date:** ________________

Sketch No. 1:



Sketch No. 2:

# Structure No: - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: | LGA: | Inspection Date: |
| Crossing: | SLK: | Inspector: |

Photo No. 1: *description*. (Taken: *DD-MMM-YYYY*)



Photo No. 2: *description*. (Taken: *DD-MMM-YYYY*)

# APPENDIX H(ii)

## TEMPLATE FOR

## DETAILED VISUAL BRIDGE INSPECTION REPORT FOR PRECAST BOX UNIT BRIDGES (Level 2)

# DETAILED CONCRETE AND STEEL BRIDGE INSPECTION SUMMARY

**Bridge No.:**
**Crossing Name:**
**Road:**
**LGA:**

**Region:**
**SLK:**
**Road No.:**

## 1.0 GENERAL

## 2.0 STRUCTURE

2.1 Walls & Aprons

2.2 Barrels



## 3.0 RECOMMENDATIONS

1.
2.
etc.

Name
Title
Company

Date

# WORK ITEMS - SUMMARY
# CONCRETE & STEEL BRIDGES

**BRIDGE No.:**

## (A) GENERAL SUPPORTING ACTIVITIES

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| G010 | Bridge - Monitor Defect | | | |

## (B) PREVENTATIVE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| | | | | |

## (C) ROUTINE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| R202 | Bridge - Remove Graffiti | | | |
| R203 | Bridge - Repair Scour (Minor) | | | |
| R205 | Bridge - Clear Debris and Vegetation | | | |
| R207 | Deck Surface - Maintain | | | |
| R208 | Drainage - Maintain | | | |
| R210 | Fence - Remove | | | |
| R212 | Guardrail - Maintain / Repair | | | |
| R213 | Kerb - Repair (Minor) - Non Structural | | | |
| R214 | Lighting - Maintain | | | |
| R215 | Sign - Maintain | | | |



## (D) SPECIFIC WORKS

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| S407 | Approach Slab - Repair | | | |
| S411 | Apron - Repair | | | |
| S716 | Barrel - Repair | | | |
| S301 | Bridge - Repair Embankment | | | |
| S350 | Bridge - Repair Scour (Major) | | | |
| S308 | Bridge - Widen Embankment | | | |
| S449 | Drainage - Repair | | | |
| S461 | Footpath - Repair | | | |
| S537 | Footpath Railing - Repair | | | |
| S467 | Guardrail - Install | | | |
| S731 | Headwall - Repair | | | |
| S473 | Kerb - Repair | | | |
| S585 | Wing Wall - Extend | | | |
| S588 | Wing Wall - Repair | | | |

| PRIORITY CODE | INDICATIVE TIMEFRAME |
|---|---|
| 0 - Critical: EMERGENCY action required | Immediate within 6 months |
| 1 - High Priority | Within 3 years |
| 2 - Medium Priority | Within 4-6 years |
| 3 - Low Priority (monitor) | Assess again at next Detailed (Level 2) Inspection (7 years for non-timber bridges) |

*Note: Add additional standard work items to the above lists as required.*
*Refer to Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges for full listing.*

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
## (PRECAST BOX UNIT BRIDGE)

***Bridge Number:*** ______________________

| | | | |
|---|---|---|---|
| ***Road Name*** | | ***Road Number:*** | |
| ***Crossing Name:*** | | ***Local Govt.:*** | |
| ***SLK*** | | ***Owner*** | |
| ***Responsibility Area:*** | | ***Latitude:*** | |
| | | ***Longitude:*** | |

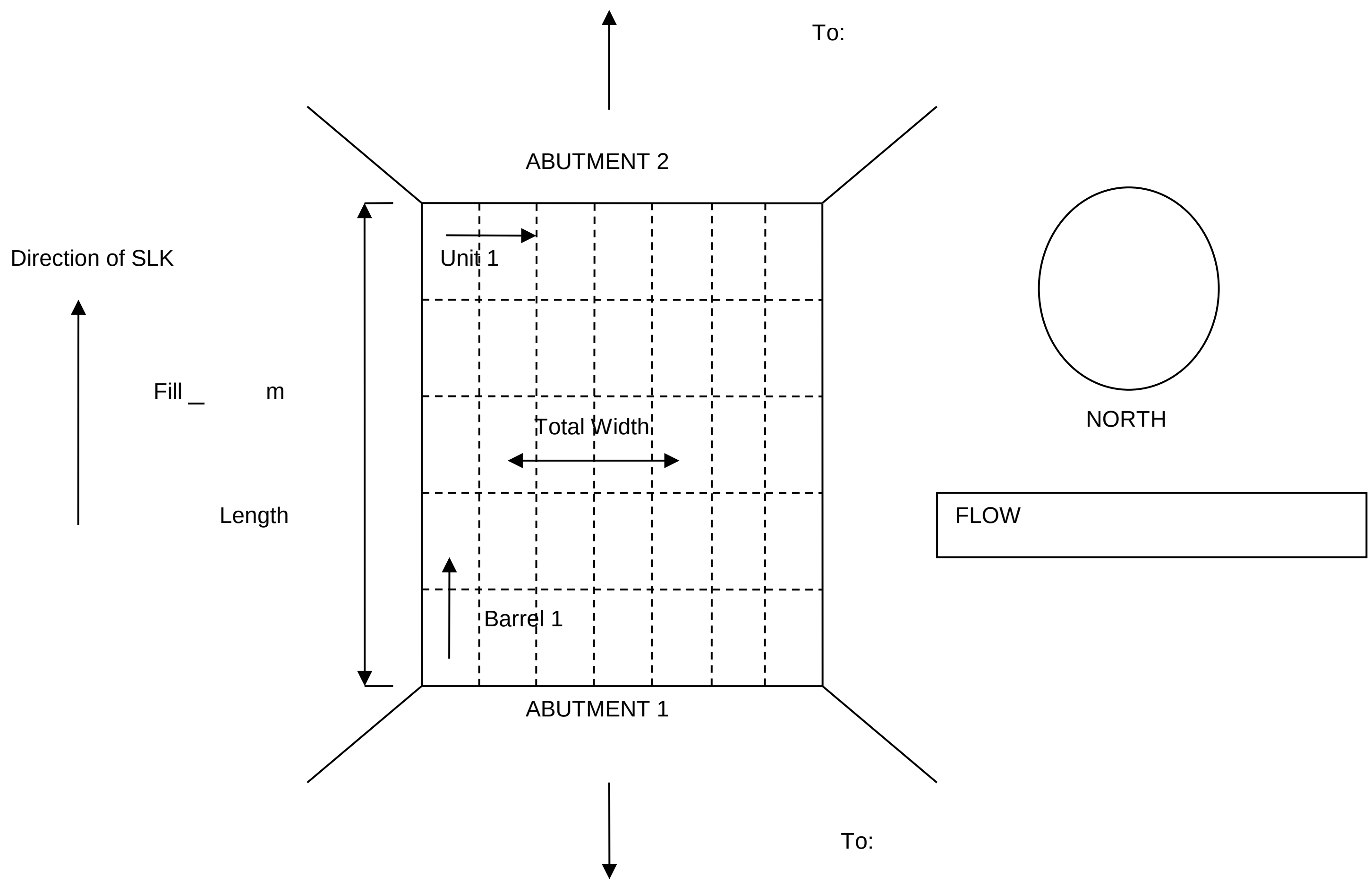


### *Geometry*

| | | | | |
|---|---|---|---|---|
| ***No. Barrels*** | | ***Opening Size (m)*** | ***Span*** | |
| ***Length (m)*** | | | ***Height*** | |
| ***Total Width (m)*** | | ***Width between kerbs (m)*** ~~***or Formation Width***~~ | (indicate which one) | |
| ***Skew (deg)*** | | | | |

Notes:

1. Abutments are numbered in the direction of increasing SLK.
2. Arch numbers are numbered along the structure in ascending order from Abutment 1 to Abutment 2.
3. Unit numbers are numbered across the structure in ascending order from left to right when facing the direction of increasing SLK.
4. Height of Fill above the arch (i.e. depth of soil from the top of the arch to the road surface) is measured at the structure's LHS in metres to one decimal pl
5. Mark in widening and footpath location, where applicable.




This bridge has been inspected in accordance with the requirements of the Main Roads Western Australia Bridge Guidelines for Level 2 inspections of concrete and steel bridges.

Inspected by: ______________________ Checked by: ______________________

Date: ______________________ Date: ______________________

| | | | |
|---|---|---|---|
| **DRIVE THROUGH** | **Visible Line of Sight from Abut. 1:** | | |
| | **Visible Line of Sight from Abut. 2:** | | |
| **TRAFFIC CONTROL** (Describe if different to the generic TMP) | **Abut. 1 end:** | | |
| | **Abut. 2 end:** | | |
| **PARKING POSITION** | > 3 m | ☒ | **Position:** |
| | 1.2 to 3 m | ☐ | **Position:** |
| | 0 to 1.2 m | ☐ | **Position:** |
| **ACCESS TO ABUTMENTS** (Describe access conditions at each wing) | **Abutment 1:** | | |
| | LHS: | | |
| | RHS: | | |
| | **Abutment 2:** | | |
| | LHS: | | |
| | RHS: | | |
| | **Vegetation:** | | |
| **ACCESS TO PIERS** (Describe access conditions along each side of the structure) | **LHS:** | | |
| | **RHS:** | | |
| | **Vegetation:** | | |
| **PIER HEADROOM** | **Minimum (m):** | | |
| | **Maximum (m):** | | |
| **POTENTIAL HAZARDS** | **Railing/Posts:** | | |
| | **Bolts:** | | |
| | **Services:** | | |
| | **Other:** | | |
| **FENCES** | **Timber:** | ☐ | **Location:** |
| | **Wire/Mesh:** | ☐ | **Location:** |
| | **Electrified:** | ☐ | **Location:** |
| | **Barbed Wire:** | ☐ | **Location:** |
| | **Other (Specify):** | | **Location:** |
| **WATER** | **Depth (m):** | | |
| | **Flow Rate:** | | |
| | **Algae:** {Access may be restricted by toxic algae} | | |
| | **Tide:** | | |
| | **Location:** | | |
| **POWERLINES** | **Side of bridge:** | | |
| | **Horizontal distance from edge of deck (m):** | | |
| | **Estimated vertical height above deck (m):** | | |



Signature

Date

**Bridge No.:**

| Barrier Type | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| None | | | | | | | | | |
| RHS Rails No. of Rails (on bridge): _____ | | | | | | | | | |
| Thriebeam | | | | | | | | | |
| W Beam | | | | | | | | | |
| Tric-Bloc Concrete Barrier | | | | | | | | | |
| Reinforced Concrete Barrier (Type F) | | | | | | | | | |
| Constant Slope Concrete Barrier | | | | | | | | | |
| Other Concrete Profiles | | | | | | | | | |

| Post Type | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | |
| Concrete | | | | | | | | | |
| Timber | | | | | | | | | |
| Steel Type: _____ | | | | | | | | | |

[Types: C Section (C), I Section (I), RHS (R), Square Hollow Section SHS (S), Tubular (T), Steel PFC (PFC), Steel Channel (Ch)]

| *Off bridge:* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of Posts off Bridge | | | | | | | | | |
| Length of Barrier off Bridge (m) | | | | | | | | | |

| Top Rails | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Steel Pipe | | | | | | | | | |
| Steel RHS/Channel | | | | | | | | | |
| Steel C Section | | | | | | | | | |
| Timber | | | | | | | | | |



| Visibility Barrier | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| Timber No. of Rails (on bridge): _____ | | | | | | | | | |
| Steel Pipe(s) No. of Pipes (on bridge): _____ | | | | | | | | | |
| Guide Posts | | | | | | | | | |
| Balustrade | | | | | | | | | |

| End Terminals | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| *Approved End Terminal Types:* | | | | | | | | | |
| WAMELT | | | | | | | | | |
| SKT-350 | | | | | | | | | |
| ET-2000 | | | | | | | | | |
| X Tension | | | | | | | | | |
| TAU II Crash Cushion | | | | | | | | | |
| Other: ____________________ | | | | | | | | | |
| *Other End Terminal Types:* | | | | | | | | | |
| None | | | | | | | | | |
| Turn-down | | | | | | | | | |
| Bullnose | | | | | | | | | |
| Fishtail | | | | | | | | | |
| Other: ____________________ | | | | | | | | | |

**Structural problem found? (Y/N)** ☐ If Yes, comment below.

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
## (PRECAST BOX UNIT BRIDGE)

***Bridge Number:*** ________ ***Group:*** ***Bridge*** ***Road Name:*** ________________________________

| *General Items* | *Comments** <br> *Full description including details of:* <br> * *Location of defect/condition/item* <br> * *Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|
| **1. Delineation** <br> Missing, damaged, obscured | Approach 1 - | | | | | | |
| | Approach 2 - | | | | | | |
| **2. Road Surface** <br> Approaches and Road Surface: Material defects, surface defects, settlement, depressions, joint transitions, kerbing, shoulders, line marking, services | | | | | | | |
| **3. Guardrails/Barriers** <br> Accident damage, connections, alignment, material defects | | | | | | | |
| **4. Road Drainage** <br> Spoon drains, drains, gully traps, erosion | | | | | | | |
| **5. Footpaths** <br> Drainage, evenness, surface conditions, railing | | | | | | | |
| **6. Lights** <br> Visibility, damage, connections, stability, material defects | | | | | | | |

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
## (PRECAST BOX UNIT BRIDGE)

***Bridge Number:*** ________ ***Group:*** ***Bridge*** ***Road Name:*** ________________________________

| *General Items* | *Comments** <br><br> ***Full description including details of:*** <br> **** Location of defect/condition/item*** <br> **** Description of defects including type, magnitude and extent*** | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|
| **7. Services**<br>Damage, connections, fittings, material defects. | | | | | | | |
| **8. Walkway**<br>Drainage, eveness, surface condition | | | | | | | |
| **9. Waterways, Vegetation and Debris**<br>Vegetation and debris in waterways and clearance envelope<br>Embankment erosion, scour, silt build-up, blockages, damaged guide-banks, revetment mattresses, rock protection | | | | | | | |



* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
## (PRECAST BOX UNIT BRIDGE)

***Bridge Number:*** ___________ ***Group:*** ***Structure - Walls & Aprons*** ***Road Name:*** ____________________

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Percentage of Inspected Component in Each Condition State* 1 | 2 | 3 | 4 | *Not Inspected (%)* | ***Comments**** *(include location and extends)* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10. Structure - Walls & Aprons** Describe: Material types, condition and defects (impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining, settlement/movement) ** | | | | | | | | | | | | | | | | |
| 10.1 a) Headwall | LHS | | | $m^2$ | | | | | | | | | | | | |
| 10.1 b) Headwall | RHS | | | $m^2$ | | | | | | | | | | | | |
| 10.2 a) Wing Wall A1 | LHS | | | $m^2$ | | | | | | | | | | | | |
| 10.2 b) Wing Wall A1 | RHS | | | $m^2$ | | | | | | | | | | | | |
| 10.2 c) Wing Wall A2 | LHS | | | $m^2$ | | | | | | | | | | | | |
| 10.2 d) Wing Wall A2 | RHS | | | $m^2$ | | | | | | | | | | | | |
| 10.3 Apron | 1 | | | $m^2$ | | | | | | | | | | | | |
| 10.4 Other - _________ | | | | | | | | | | N/A | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

** Headwalls, wing walls and aprons shall be only assigned Condition States when they are considered structural components. Other non-structural walls and aprons shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT
## (PRECAST BOX UNIT BRIDGE)

***Bridge Number:*** ___________ ***Group:*** ***Structure - Barrels*** ***Road Name:*** ___________

| Component Type | Component Number | Component Material | Modification Status | Unit | Percentage of Inspected Component in Each Condition State 1 | 2 | 3 | 4 | Not Inspected (%) | Comments* (include location and extends) | Sketch Number | Photograph Number | Work Required | Work Item Number | Work Description | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **11. Structure - Barrel**<br>Each row in the table is for an individual barrel (box unit, link slab or base slab). Each barrel will be made up of a series of connecting units. All units within each barrel need to be inspected providing detail of what unit number the comments refer to.<br>Describe: Material defects (impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining, settlement/movement) | | | | | | | | | | | | | | | | |
| Barrel | 1 | | | $m^2$ | | | | | | | | | | | | |
| Barrel | 2 | | | $m^2$ | | | | | | | | | | | | |
| Barrel | 3 | | | $m^2$ | | | | | | | | | | | | |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

| ***Additional Comments*** |
|---|
| None |

# DETAILED VISUAL (LEVEL 2)
# BRIDGE INSPECTION REPORT

**Bridge Number:**

**Crossing:**

**LGA:**

**Road Name:**

**Inspector:**

**SLK:**

Bridge Location



**Bridge Location Sheet**

# Structure No: - PHOTO SHEET

| | | |
|---|---|---|
| Road Name: | LGA: | Inspection Date: |
| Crossing: | SLK: | Inspector: |

Photo No. 1: *description*. (Taken: *DD-MMM-YYYY*)



Photo No. 2: *description*. (Taken: *DD-MMM-YYYY*)

# APPENDIX H(iii)

## TEMPLATE FOR

## DETAILED VISUAL BRIDGE INSPECTION REPORT FOR ARCH BRIDGES (Level 2)

# DETAILED CONCRETE AND STEEL BRIDGE INSPECTION SUMMARY

**Bridge No.:**
**Crossing Name:**
**Road:**
**LGA:**

**Region:**
**SLK:**
**Road No.:**

## 1.0 GENERAL

## 2.0 STRUCTURE

2.1 Walls & Aprons

2.2 Arch



## 3.0 RECOMMENDATIONS

1.
2.
etc.

Name
Title
Company

Date

## WORK ITEMS - SUMMARY
## CONCRETE & STEEL BRIDGES

**BRIDGE No.:**

### (A) GENERAL SUPPORTING ACTIVITIES

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| G010 | Bridge - Monitor Defect | | | |

### (B) PREVENTATIVE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| | | | | |

### (C) ROUTINE MAINTENANCE

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| R202 | Bridge - Remove Graffiti | | | |
| R203 | Bridge - Repair Scour (Minor) | | | |
| R205 | Bridge - Clear Debris and Vegetation | | | |
| R207 | Deck Surface - Maintain | | | |
| R208 | Drainage - Maintain | | | |
| R210 | Fence - Remove | | | |
| R212 | Guardrail - Maintain / Repair | | | |
| R213 | Kerb - Repair (Minor) - Non Structural | | | |
| R214 | Lighting - Maintain | | | |
| R215 | Sign - Maintain | | | |



### (D) SPECIFIC WORKS

| BMS Item No. | ITEM DESCRIPTION | WORK REQD | PRIORITY CODE | COMMENTS |
|---|---|---|---|---|
| S407 | Approach Slab - Repair | | | |
| S411 | Arch - Reapir | | | |
| S716 | Barrel - Repair | | | |
| S301 | Bridge - Repair Embankment | | | |
| S350 | Bridge - Repair Scour (Major) | | | |
| S308 | Bridge - Widen Embankment | | | |
| S449 | Drainage - Repair | | | |
| S461 | Footpath - Repair | | | |
| S537 | Footpath Railing - Repair | | | |
| S467 | Guardrail - Install | | | |
| S731 | Headwall - Repair | | | |
| S473 | Kerb - Repair | | | |
| S585 | Wing Wall - Extend | | | |
| S588 | Wing Wall - Repair | | | |

| PRIORITY CODE | INDICATIVE TIMEFRAME |
|---|---|
| 0 - Critical: EMERGENCY action required | Immediate within 6 months |
| 1 - High Priority | Within 3 years |
| 2 - Medium Priority | Within 4-6 years |
| 3 - Low Priority (monitor) | Assess again at next Detailed (Level 2) Inspection (7 years for non-timber bridges) |

*Note: Add additional standard work items to the above lists as required.*
*Refer to Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges for full listing.*

| | | | |
|---|---|---|---|
| **DRIVE THROUGH** | **Visible Line of Sight from Abut. 1:** | | |
| | **Visible Line of Sight from Abut. 2:** | | |
| **TRAFFIC CONTROL** | **Abut. 1 end:** | | |
| (Describe if different to the generic TMP) | **Abut. 2 end:** | | |
| **PARKING POSITION** | > 3 m | ☒ | **Position:** |
| | 1.2 to 3 m | ☐ | **Position:** |
| | 0 to 1.2 m | ☐ | **Position:** |
| **ACCESS TO ABUTMENTS** | **Abutment 1:** | | |
| (Describe access conditions at each wing) | LHS: | | |
| | RHS: | | |
| | **Abutment 2:** | | |
| | LHS: | | |
| | RHS: | | |
| | **Vegetation:** | | |
| **ACCESS TO PIERS** | **LHS:** | | |
| (Describe access conditions along each side of the structure) | **RHS:** | | |
| | **Vegetation:** | | |
| **PIER HEADROOM** | **Minimum (m):** | | |
| | **Maximum (m):** | | |
| **POTENTIAL HAZARDS** | **Railing/Posts:** | | |
| | **Bolts:** | | |
| | **Services:** | | |
| | **Other:** | | |
| **FENCES** | **Timber:** | ☐ | **Location:** |
| | **Wire/Mesh:** | ☐ | **Location:** |
| | **Electrified:** | ☐ | **Location:** |
| | **Barbed Wire:** | ☐ | **Location:** |
| | **Other (Specify):** | | **Location:** |
| **WATER** | **Depth (m):** | | |
| | **Flow Rate:** | | |
| | **Algae:** {Access may be restricted by toxic algae} | | |
| | **Tide:** | | |
| | **Location:** | | |
| **POWERLINES** | **Side of bridge:** | | |
| | **Horizontal distance from edge of deck (m):** | | |
| | **Estimated vertical height above deck (m):** | | |



Signature

Date

**Bridge No.:**

| Barrier Type | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| None | | | | | | | | | |
| RHS Rails No. of Rails (on bridge): _____ | | | | | | | | | |
| Thriebeam | | | | | | | | | |
| W Beam | | | | | | | | | |
| Tric-Bloc Concrete Barrier | | | | | | | | | |
| Reinforced Concrete Barrier (Type F) | | | | | | | | | |
| Constant Slope Concrete Barrier | | | | | | | | | |
| Other Concrete Profiles | | | | | | | | | |

## Post Type

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | |
| Concrete | | | | | | | | | |
| Timber | | | | | | | | | |
| Steel Type: _____ | | | | | | | | | |

[Types: C Section (C), I Section (I), RHS (R), Square Hollow Section SHS (S), Tubular (T), Steel PFC (PFC), Steel Channel (Ch)]

*Off bridge:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of Posts off Bridge | | | | | | | | | |
| Length of Barrier off Bridge (m) | | | | | | | | | |

## Top Rails

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Steel Pipe | | | | | | | | | |
| Steel RHS/Channel | | | | | | | | | |
| Steel C Section | | | | | | | | | |
| Timber | | | | | | | | | |



| Visibility Barrier | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |
| Timber No. of Rails (on bridge): _____ | | | | | | | | | |
| Steel Pipe(s) No. of Pipes (on bridge): _____ | | | | | | | | | |
| Guide Posts | | | | | | | | | |
| Balustrade | | | | | | | | | |

| End Terminals | Approach 1 | | | On Bridge | | | Approach 2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | LHS | Median | RHS | LHS | Median | RHS | LHS | Median | RHS |

*Approved End Terminal Types:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| WAMELT | | | | | | | | | |
| SKT-350 | | | | | | | | | |
| ET-2000 | | | | | | | | | |
| X Tension | | | | | | | | | |
| TAU II Crash Cushion | | | | | | | | | |
| Other: ________________________ | | | | | | | | | |

*Other End Terminal Types:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | |
| Turn-down | | | | | | | | | |
| Bullnose | | | | | | | | | |
| Fishtail | | | | | | | | | |
| Other: ________________________ | | | | | | | | | |

**Structural problem found? (Y/N)** ☐ If Yes, comment below.

# DETAILED VISUAL (LEVEL 2) BRIDGE INSPECTION REPORT

**(ARCH BRIDGE)**

***Bridge Number:*** ____________________

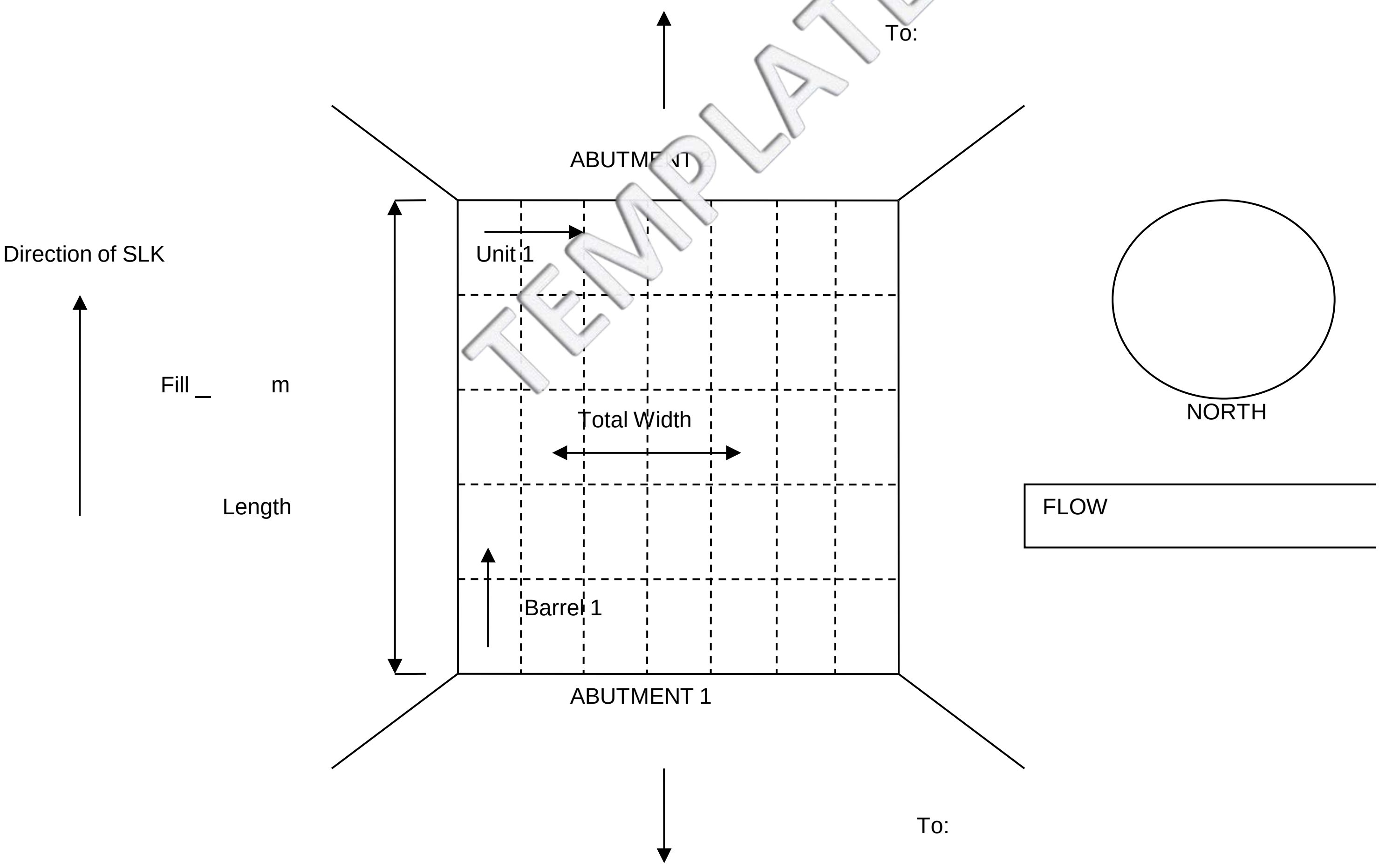
| | | | |
|---|---|---|---|
| ***Road Name*** | | ***Road Number:*** | |
| ***Crossing Name:*** | | ***Local Govt.:*** | |
| ***SLK*** | | ***Owner*** | |
| ***Responsibility Area:*** | | ***Latitude:*** | |
| | | ***Longitude:*** | |

## *Geometry*

| | | | | |
|---|---|---|---|---|
| ***No. Arches*** | | ***Opening Size (m)*** | ***Span*** | |
| ***Length (m)*** | | | ***Height*** | |
| ***Total Width (m)*** | | ***Width between kerbs (m) or Formation Width*** | (indicate which one) | |
| ***Skew (deg)*** | | ***Arch Material:*** | | |

Notes:

1. Abutments are numbered in the direction of increasing SLK.
2. Arch numbers are numbered along the structure in ascending order from Abutment 1 to Abutment 2.
3. Unit numbers are numbered across the structure in ascending order from left to right when facing the direction of increasing SLK.
4. Height of Fill above the arch (i.e. depth of soil from the top of the arch to the road surface) is measured at the structure's LHS in metres to one decimal place
5. Mark in widening and footpath location, where applicable.






This bridge has been inspected in accordance with the requirements of the Main Roads Western Australia Bridge Guidelines for Level 2 inspections of concrete and steel bridges.

Inspected by: ____________________ Checked by: ____________________

Date: ____________________ Date: ____________________

***Bridge Number:*** ________ ***Group:*** ***Bridge*** ***Road Name:*** ________________________________

| *General Items* | *Comments** <br> *Full description including details of:* <br> ** Location of defect/condition/item* <br> ** Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|
| **1. Delineation** <br> Missing, damaged, obscured | Approach 1 - | | | | | | |
| | Approach 2 - | | | | | | |
| **2. Road Surface** <br> Approaches and Road Surface: Material defects, surface defects, settlement, depressions, joint transitions, kerbing, shoulders, line marking, services | | | | | | | |
| **3. Guardrails/Barriers** <br> Accident damage, connections, alignment, material defects | | | | | | | |
| **4. Road Drainage** <br> Spoon drains, drains, gully traps, erosion | | | | | | | |
| **5. Footpaths** <br> Drainage, evenness, surface conditions, railing | | | | | | | |
| **6. Lights** <br> Visibility, damage, connections, stability, material defects | | | | | | | |

## DETAILED VISUAL (LEVEL 2)
## BRIDGE INSPECTION REPORT
### (ARCH BRIDGE)

***Bridge Number:*** ________ ***Group:*** ***Bridge*** ***Road Name:*** ______________________________

| *General Items* | *Comments** <br><br> *Full description including details of:* <br> ** Location of defect/condition/item* <br> ** Description of defects including type, magnitude and extent* | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|
| **7. Services** <br> Damage, connections, fittings, material defects. | | | | | | | |
| **8. Walkway** <br> Drainage, eveness, surface condition | | | | | | | |
| **9. Waterways, Vegetation and Debris** <br> Vegetation and debris in waterways and clearance envelope <br> Embankment erosion, scour, silt build-up, blockages, damaged guide-banks, revetment mattresses, rock protection | | | | | | | |



* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

***Bridge Number:*** ___________ ***Group:*** ***Structure - Walls & Aprons*** ***Road Name:*** ___________

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Percentage of Inspected Component in Each Condition State* 1 | 2 | 3 | 4 | *Not Inspected (%)* | *Comments** (include location and extends) | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10. Structure - Walls & Aprons** | | | | | | | | | | | | | | | | |
| Describe: Material types, condition and defects (impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining, settlement/movement) ** | | | | | | | | | | | | | | | | |
| 10.1 a) Headwall | LHS | | | $m^2$ | | | | | | | | | | | | |
| 10.1 b) Headwall | RHS | | | $m^2$ | | | | | | | | | | | | |
| 10.2 a) Wing Wall A1 | LHS | | | $m^2$ | | | | | | | | | | | | |
| 10.2 b) Wing Wall A1 | RHS | | | $m^2$ | | | | | | | | | | | | |
| 10.2 c) Wing Wall A2 | LHS | | | $m^2$ | | | | | | | | | | | | |
| 10.2 d) Wing Wall A2 | RHS | | | $m^2$ | | | | | | | | | | | | |
| 10.3 Apron | 1 | | | $m^2$ | | | | | | | | | | | | |
| 10.4 Other - _________ | | | | | | | | | | N/A | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

** Headwalls, wing walls and aprons shall be only assigned Condition States when they are considered structural components. Other non-structural walls and aprons shall be inspected with comments but the Condition State columns shall be greyed out in the inspection report template.

**Bridge Number:** ________ **Group:** ***Structure - Barrels*** **Road Name:** ________

| *Component Type* | *Component Number* | *Component Material* | *Modification Status* | *Unit* | *Percentage of Inspected Component in Each Condition State* 1 | 2 | 3 | 4 | *Not Inspected (%)* | *Comments** (include location and extends) | *Sketch Number* | *Photograph Number* | *Work Required* | *Work Item Number* | *Work Description* | *Priority* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **11. Structure - Arch**<br>Each row in the table is for an individual barrel (box unit, link slab or base slab). Each barrel will be made up of a series of connecting units. All units within each barrel need to be inspected providing detail of what unit number the comments refer to.<br>Describe: Material defects (impact damage, cracking, spalling, honeycombing, corrosion, coating defects, undermining, settlement/movement) | | | | | | | | | | | | | | | | |
| Arch | 1 | | | $m^2$ | | | | | | | | | | | | |
| Arch | 2 | | | $m^2$ | | | | | | | | | | | | |
| Arch | 3 | | | $m^2$ | | | | | | | | | | | | |

* Refer to the MRWA document *Detailed Visual Bridge Inspection Guidelines for Concrete & Steel Bridges* (Doc: No. 6706-02-2233) for guidance on aspects to consider when inspecting each component.

| ***Additional Comments*** |
|---|
| None |

***Bridge Number:***

***Crossing:***

***LGA:***

***Road Name:***

***Inspector:***

***SLK:***

Bridge Location



**Bridge Location Sheet**

# Structure No: - PHOTO SHEET

| Road Name: | LGA: | Inspection Date: |
| --- | --- | --- |
| Crossing: | SLK: | Inspector: |

Photo No. 1: *description*. (Taken: *DD-MMM-YYYY*)



Photo No. 2: *description*. (Taken: *DD-MMM-YYYY*)