Bridge Inspection Manual

PART 2 – INSPECTIONS

Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada
Canada

PART 2 – INSPECTIONS

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SECTION 1 – INSPECTIONS

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1.1 Structural Inspections

1.1.1 General

Components shall be assessed for material and performance defects. The type and extent of deterioration shall be recorded on the inspection forms in accordance with Appendix B – Inspection Report. Any unusual features or items shall be described in the space allotted for remarks. The components shall be given a condition rating and a priority code based on the material and performance condition of the component. The first time inspection shall act as the benchmarks for all further inspections and will permit an annual assessment of the rate of deterioration of components. Colour photographs shall be taken of significant defects.

1.1.2 Inspection Procedures

1.1.2.1 Comprehensive Detailed Inspections

Comprehensive detailed inspections of structures above water level shall consist of:

- A detailed inspection in accordance with Appendix A – Component Inspections and inspection forms completed in accordance with Appendix B – Inspection Reports;
- A detailed inspection of all components including those, which may require the use of, specialized access equipment (cherry picker, snorkel lift, below-deck inspection machine, scaffolding, swing stages, etc.) to view. All components shall be inspected at close range (hands on) except for massive concrete elements, which appear to be in good condition. Such elements may be inspected from their extremities (example, top and bottom of a tall pier);
- Components not visible or inaccessible at time of inspection shall be noted. The necessary provisions for inspection shall be identified and recommendations made for a proper inspection to be executed.
- Delamination and surface deterioration survey of concrete.
- Surface sounding for wood.
- Any or all of the following destructive or non-destructive tests on concrete, structural steel or wood as detailed in Appendix D – Material Condition Surveys and below may be recommended for future work based on field observations:

Concrete:

- Radar and Infrared Thermo graphic Survey;
- Impact – Echo Testing;
- Corrosion Potential survey;
- Concrete Cover Survey;
- Expansion Joint Survey;
- Concrete Coring and Testing Program;
- Asphalt Sawn Sample Program;
- Inspection of Catholic Protection Embedded Hardware and Catholically Protected Components;
- Conductive Asphalt Resistively Testing;
- Investigation of Fire Damaged Components.

Structural Steel:

- Liquid Penetration Testing;
- Magnetic Particle Testing;
- Ultrasonic Testing;
- Eddy Current Testing;
- Radiographic Testing.

Wood:

- Surface Testing by Probing, Pick Test or Paladin;
- Moisture Meter;
- Drilling and Coring;
- Shell-Depth Indicator Testing;
- Sonic Testing;
- Ultrasonic Testing;
- Radiation Testing.

1.1.2.2 Inspection of Underwater Components

An underwater inspection shall be performed on structure components in accordance with Appendix E, Section 4 and reported as required in Appendix B – Inspection Reports.

1.1.2.3 General Inspection

A general inspection shall be performed on structure components in accordance with Appendix A – Component Inspections. Components shall be visually assessed for material and performance defects. The extent of the deterioration shall be estimated but not measured. No physical testing is required except that accessible areas shall be sounded in areas where delaminations are suspected. Inaccessible components that are obstructed from view shall be noted as such during the General Annual Inspection. Colour photographs shall be taken of significant defects.

Where a structure has gone through a comprehensive detailed inspection according to the BIM, PWGSC shall supply the latest inspection reports. The type and extent of deterioration shall be visually assessed and compared with the condition and functional rating from the previous inspection. Additional deterioration or repairs that have been made since the last inspection shall be recorded. The condition rating and priority code shall be adjusted accordingly. For reporting, use the form in Appendix B – Inspection Reports.

1.1.2.4 Maintenance Inspections

Maintenance inspections comprise routine general visual observations by field maintenance personnel. The purpose of these inspections is maintenance-related only and reports must be kept at the local offices.

Daily or weekly inspections are visual general inspections performed from a vehicle, and are used to detect conditions which may adversely affect the comfort and safety of the travelling public. Examples of typical observations to be noted are as follows:

- Debris and litter on structures and approaches;
- Flooding and/or washouts (typically only with smaller structures and culverts);
- Regulatory and warning signs which are missing, damaged, turned, defaced or destroyed;
- Damaged guide rail on structures and approaches;
- Snow and ice accumulation on structures and approaches;
- Damaged or missing structures illumination; vehicular collisions on or with structures.

Once monthly, structures should be inspected on foot along both sides of the structures. Inspection of the underside should also be made, either by walking the length of the structure or from both embankments. Examples of typical observations to be noted are as follows:

- Accumulation of water, sand salt, debris or vegetation on the deck surface or in joints, deck drains, etc.;
- Debris or natural growth preventing free drainage of water away from the bridge, or free movement of watercourses;
- Brush preventing clear view of bridge or growing in contact with the bridge;
- Erosion of banks caused by water coming from deck drains, or around end of wing walls or by waterway;
- Damaged to structures which appears to be the result of accidents or vandalism;
- Settlement of slope paving and/or rip rap;
- Damaged, missing or misaligned barriers, guide rails, etc.;
- Settling or tilting at bridge approach slab;
- Changes in vertical alignment of bridge railing, curbs, deck, etc.;
- Noise emanating from structural components, such as expansion joints, bearings, or Bailey component;
- Frames and grates that are missing, damaged or not in place;
- Existence of surfaces defects, such as cracks, potholes, ravelling, shoving, etc.;
- Joint defects, such as: missing or deteriorating joint sealant material; steel finger-type joints, which show cracks, breaks in welds, loose anchorage, or hard objects wedged between the fingers;
- Existence of structural defects such as crack, buckles or kinks in steel members; splits or breaks in timber components; missing bolts or rivets. Evidence of punching in concrete decks; evidence of new cracks in concrete decks, piers, abutments, ballast walls or wing walls;
- Deterioration in the vicinity of the wave zone.

1.1.2.5 Special Inspections

These inspections, when deemed necessary, must be carried out by experienced maintenance personnel or qualified bridge inspectors, engineers and/or specialists during or immediately after the occurrence of the significant events listed below. These inspections may initially be undertaken by maintenance personnel to observe obvious defects or changes to the structure. Bridge engineers will be called in to ascertain the extent and implications of any damage to the structure and make a report.

Significant events requiring an unscheduled visual inspection include, but are not limited to:

- Vehicle/vessel collision with a structure;
- Component Distress/failure;
- Unusually high spring run-off;
- Heavy rainfall event in the catchments area;
- Prolonged periods of extreme temperatures;
- Significant earthquake (Richter 5 or greater) in general proximity;
- Concerns as a result of failure of a similar structure/component elsewhere;
- Unusual Permit Loads;
- Other special circumstances.

1.1.2.6 Monitoring Inspections

Monitoring inspections are intended to study and document a component deficiency/performance over an extended period of time, generally with a defined schedule. The inspection may include on-site observations and/or field measurements such as expansion joint gaps, settlements, translation or rotation of a bearing, crack widths and length in concrete or steel, scour, corrosion monitoring, etc.

Photographic records of on-site field observations should be maintained to allow comparison of change in condition over a period of time. Progressive records of any field measurements should also be maintained.

Trained and qualified personnel under the direction of a qualified bridge engineer must undertake monitoring Inspections

1.1.2.7 Condition Inspections

Condition Inspections are intended to assist in assessment of the state and performance of the individual components and the structure as a whole to determine the safe load carrying capacity of the structure. Additional information may be required in addition to that available from the Comprehensive Detailed Inspections. This may require additional destructive and non-destructive testing of materials as outlined in BIM.

The Bridge Engineer in charge of structural evaluation shall review the available plans, repair history and inspection data to assess and arrange to obtain the required additional information as may be necessary to assist in structural evaluation of the bridge.

1.2 Responsibilities of Inspectors

The Engineer performing, or directly supervising the inspection shall be responsible for the following:

- The thoroughness of the field inspection, the analysis and reporting of the findings, and the recommendations for corrective measures. All data recorded in the field shall be complete, legible, and unambiguous;
- Familiarizing themselves with the design and construction features of the structure in order to properly interpret what is observed and reported;
- Recognizing any structural deficiency, assessing its seriousness and probable cause;
- Recommending appropriate action necessary to maintain the bridge in a good and safe condition;
- Recognizing problems or potential problems which present a hazard to public safety so that appropriate preventive maintenance action can be taken promptly;
- Ensuring that proper safety practices are observed.
- Report immediately if an urgent action is required

1.3 Safety Regulations and Responsibilities

1.3.1 General

Structure inspections shall be carried out in such a manner to ensure the safety of the inspectors and public using the structure at all times. The safety practices implemented shall comply with the following:

- PWGSC Deputy Minister Directive 073: Occupational Health and Safety – Construction;
- Canada Labour Code, Part II;
- Canada Occupational Health and Safety Regulations;
- Provincial or territorial Labour and Occupational Health and Safety regulations, including all Worker's Compensation Board requirements;
- Manual of Uniform Traffic Control Devices or provincial equivalent.

In the case of a conflict between regulations, the most stringent of regulations shall govern.

Some bridge inspections involve working over, under and around water, working off of mobile equipment and swing stages, etc. In such cases, the specialized equipment required shall be operated by skilled personnel and in accordance with the latest issue of the following standards:

CSA Standard Z150	"Safety Code on Mobile Cranes"
CSA Standard Z271	"Safety Code for Suspended Platforms"
CSA Standard Z275.2	"Occupational Safety Code for Diving Operations"

All inspection and supervisory staff assigned to the inspection of structures must be trained in current safety practices and in the proper use of safety equipment. Courses in first aid and traffic control and protection are recommended and are actually now mandatory in some provinces.

1.3.2 Responsibility

1.3.2.1 Department

When the Department assumes the role of property owner, the designated departmental representative is responsible for ensuring that all federal and provincial/territorial regulations relating to construction occupational health and safety is adhered to in accordance with Deputy Minister's Directive 073: Occupational Health and Safety – Construction.

When the Department assumes the role of builder, the designated departmental representative is responsible for complying with the applicable federal and provincial/territorial statutes and regulations relating to the tasks to be undertaken in accordance with Deputy Minister's Directive 073: Occupational Health and Safety – Construction.

1.3.2.2 Inspection Supervisor

The engineer who supervises the inspection is responsible for ensuring that:

- inspection staff are aware of and follow policies and procedures affecting structure inspection safety;
- inspection staff are properly trained;
- inspection staff are adequately equipped with protective clothing, safety devices and equipment;
- safety devices and equipment are properly maintained and in good working condition.

1.3.2.3 Site Supervisor

The site supervisor is responsible for planning the inspection and ensuring that:

- adequate precautions are taken against hazardous situations;
- inspection staff follow the required safety policies and procedures;
- inspection staff wear required safety clothing and devices;
- safety equipment and devices are properly used;
- appropriate actions against any unsafe acts or situations are taken.

1.3.2.4 Inspectors and Auxiliary Personnel

Inspectors and auxiliary personnel are responsible for:

- following the established safety policies and procedures;
- wearing safety clothing and devices;
- using safety equipment properly;
- identifying and reporting any defective safety clothing, devices and equipment;
- identifying hazardous situations and taking appropriate measures;
- advising supervisor of any physical impairment that might affect his own ability to safely perform inspection duties.

1.3.3 Traffic Control

The purpose of traffic control devices is to warn motorists of work in progress, minimize risk of injury to the public and the inspection crew, and protect the inspection vehicles from collision damage.

All traffic control for bridge inspections shall be in accordance with the following:

- the Manual of Uniform Traffic Control Devices, Part D – Temporary Conditions (latest edition);
- federal, provincial or territorial health and safety, labour and traffic control regulations.

In the case of conflicting regulations, the most stringent regulation shall govern. A traffic control plan shall be submitted to the PWGSC Project Manager prior to the commencement of the field inspection.

At the start of the inspection, the site supervisor must have the necessary traffic control devices placed in accordance with the applicable standards and manuals.

Traffic control signs and cones, where applicable, must be placed so as to be clearly visible.

Where practicable, staff positioning or removing signs and cones should use the inspection vehicle with the roof light operating as a warning device.

Signs are to be covered or removed when the inspection crew is not working in the location where the signs are placed.

The site supervisor may adjust the number and/or placement of signs and traffic control devices to accommodate specific site situations. However, the minimum requirements must be met at all times.

For inspections requiring a lane closure, special vehicles and additional traffic control devices may be required.

1.4 Sample Safety Practices

The following sample safety practices are for information only. **They do not replace or supersede any of the regulations listed in Section 1.3.1.**

1.4.1 Staffing

1.4.1.1 General

For safety purposes, a structural inspection crew must be comprised of a minimum of two persons, one of whom will be designated as the site supervisor.

1.4.1.2 Water

Crews working in or around water of sufficient depth or current to pose a risk of drowning must be comprised of a minimum of three persons. At least two workers must be available for rescue operations, one of whom must be stationed away from the water but in continuous visual or voice contact with those in the water.

1.4.1.3 Ice

Crews working on ice must be comprised of a minimum of three persons. At least two workers must be available for rescue operations, one of whom must be stationed off the ice but in continuous visual or voice contact with those on the ice.

1.4.1.4 Confined Spaces

Crews working in confined spaces, such as steel box girders, must be comprised of a minimum of three persons. At least two workers must be available for rescue operations, one of whom must be stationed outside the confined space but in continuous visual or voice contact with those in the confined space.

1.4.1.5 Additional Staff Requirements

The site supervisor shall determine any additional staffing requirements based upon specific site conditions.

1.4.2 Planning

Inspections should be scheduled to avoid peak traffic periods and should be discontinued if they create a hazard to the inspection crew or the public or interfere unduly with the flow of traffic.

At the start of each inspection, the site supervisor must:

- review the work to be done as part of the particular inspection;
- discuss with the inspection crew the hazards inherent in the work to be done and establish appropriate ways of dealing with those hazards.

During the inspection, the site supervisor must:

- monitor changes in traffic volume, sight distances, water levels, ice conditions and atmospheric and weather conditions and take appropriate action, such as placing additional signs or cones or removing the inspection crew from the site.

1.4.3 Equipment

1.4.3.1 Inspection Vehicle

The inspection vehicle shall be clearly identified and shall carry, as a minimum, the following:

- one flashing orange roof light;
- two (2) portable "Men at Work" signs complete with flag poles and flags;
- three (3) 450 mm blaze orange traffic cones;
- fully equipped emergency first aid kit adequate for a crew of at least 6 people including a current edition of St. John Ambulance First Aid Manual.

1.4.3.2 Protective Clothing and Personal Safety Equipment

Each member of the inspection crew shall wear the following minimum amount of personal protective clothing whenever working on the right-of-way:

- safety hard hat with chin strap;
- fluorescent blaze orange vest with yellow reflective stripes (note that vest is not to be worn when working on railway tracks);
- safety footwear with steel toe, or steel toe and sole.

The minimum additional requirements for protective clothing and personal safety equipment for various hazardous situations are given below. Additional protective clothing and/or safety equipment shall be worn and/or used as directed by the site supervisor.

FALLING

The following additional safety equipment shall be used when there is a risk of falling over 3 m:

- safety net; or
- safety belt/harness with lanyard fastened to a fixed support or lifeline.

This safety equipment is not required when working on a bridge deck that has adequate railing protection.

WATER

The additional safety equipment listed in Table 1.4.3.2 must be used when there is a risk of workers falling into water or drowning as a result of the current or the temperature of the water.

The risk of falling into water is deemed not to exist if:

- the worker stays at least 2 m away from the edge of water, or from the edge of a steep slope leading into the water;
- the worker wears a safety belt with lanyard fastened to a fixed support;
- there is a guardrail, between the worker and the water.

Depth of Water	Safety Equipment
0 – 0.3 m	• no special equipment required
0.3 – 1.0 m	• safety floatation line across waterway • life jackets
1.0 – 1.5 m	• safety floatation line across waterway, approximately 8 m downstream from worksite • life jackets • ring buoy with 15 m of 9.5 mm rope • whistle, horn or 2-way walkie-talkie
more than 1.5 m	• safety floatation line across waterway approximately 8 m downstream from worksite • life jackets • safety belt/harness with lanyard fastened to a fixed support • boat and equipment for rescue • whistle, horn or 2-way walkie-talkie

Table 1.4.3.2

Notes

- The safety floatation line, shown in Table 1.4.3.2, is not required where there is no current in the water. If it is not reasonable or practical to put a safety floatation line across the waterway then alternative precautions shall be considered.
- On navigable waters the waterway authority shall be contacted prior to installation of a safety floatation line across the waterway.

ICE

The following additional safety equipment must be used when there is risk of workers falling through the ice:

- auger or equivalent;
- thermal floatation suit;
- change of clothes or blanket;
- ring buoy with 15 m of 9.5 mm rope;
- whistle, horn or two-way electronic communications device.

If there is a combination of open water and ice, the safety measures for working near water identified above also apply.

Ice can support the following loads:

Loads	Thickness (mm) Clear Blue Ice	Thickness (mm) Snow Ice
Workers in single file	75	115

Bore a hole with an auger to measure the thickness of the ice and visually assess the quality of the ice. Holes should be bored no more than 15 m apart. If there is a strong current or there are sewer outlets in the vicinity, the test holes should be closer.

Check the thickness of the ice with a long pole that can also be used to rescue anyone who falls through.

If the same path is always used to get to and from the work site, the thickness of the ice along the path should be checked regularly.

Structural inspections carried out from ice must be discontinued if:

- the minimum safe thickness is not met;
- the ice turns grey, which occurs after a thaw and indicates the presence of water;
- there is water on the ice;
- radial cracks develop;
- continuous cracking is observed or heard;
- sagging is observed.

CONFINED SPACES

The following additional safety equipment shall be used when in a confined space:

- air testing equipment;
- flashlight or other suitable lighting;
- whistle, horn or two-way electronic communications device.

Structure inspections in confined spaces shall not be carried out unless the air quality has been tested and found to be adequate.

OTHER HAZARDS

Hazard	Equipment
a) Eye injury	Safety glasses
b) Hand injury	Safety gloves
c) Hearing damage	Hearing protection
d) Damage to personal clothing	Coveralls

1.5 Inspection Equipment

1.5.1 Standard Equipment Carried by Inspectors

All inspection personnel are required to use and be thoroughly familiar with the operation of the following equipment when conducting general annual inspections:

- Binoculars;
- Digital Camera and Colour Film(s);
- Chalk and Markers;
- Inspection Forms, and Clip Boards;
- Flashlight;
- Length of Chain (2 m);
- Crack Comparator;
- Light Chipping Hammer;
- Measuring Tape (3 m);
- Measuring Tape (30 m);
- Plumb Bob;
- Pocket Knife;
- Boots, Hat, Gloves, Vest;
- Safety Cones and Flashing Light;
- Straight Edge (1 m);

- Air, Concrete and Steel Thermometers;
- Mirror on a Swivel Head with an Extension Arm;
- Range Poles;
- Safety Belts, Flotation Vest;
- Scraper;
- Sounding Line (lead line);
- Wire Brush.

1.5.2 Specialized Equipment Required by Inspectors

Certain locations on a structure may not be accessible for inspection during comprehensive detailed inspections without special equipment. In addition to the equipment listed in Section 1.4.1 above, the following is a partial list of some of the specialized access inspection equipment which may be required:

- Boat or Barge;
- Extension Ladder (3.5 m);
- Scaffolding – mobile, cable supported or stationary;
- "Snooper" or "Cherry Picker" – truck mounted inspection bucket on a hydraulically operated boom off a truck.

Detailed Condition Surveys on concrete components also require specialized equipment. A partial list of the equipment required is as follows:

- gasoline powered saw for sawing asphalt;
- gasoline powered electric generator, gasoline, extension cords;
- electric core drill with 100 mm diameter bits, core retrievers, water tank and necessary supply hoses;
- wet/dry vacuum cleaner;
- quick set concrete repair material and plywood forms for filling core holes;
- waterproofing membrane and cold mix asphaltic patching material (cold patch) for cores on asphalt covered decks;
- electric chipping hammer, electric drill, sponges and rags, chisel, wire brush, screwdriver, visegrips, copper sulphate half cell, voltmeter, and lead wire for corrosion potential survey.

This specialized equipment would not normally be required for general annual inspections. If such equipment is needed, then arrangements should be made by the inspectors to obtain this equipment as required. In many cases, the sawing and coring is done by a subcontractor who specializes in this type of work.

1.6 Systematic Inspection Procedures

1.6.1 Preparation Prior to Field Inspection

The inspector shall:

- Review structure records prior to commencement of any field work including design and construction details, "as-built" drawings, previous inspection reports, correspondence and details of repairs.

- Prepare inspection forms, as in Appendix B, for each structure to be inspected. An individual inspection report can be built up, for any structure, by the collection and amalgamation of the appropriate component sheets, as required, to completely describe the structure under consideration. The inspection report is thus complied to suit each individual structure being inspected.
- Develop a time schedule for the inspection and review specialized equipment requirements including traffic protection devices.
- Make arrangements with the Project Manager/Engineer for specialized equipment and traffic control devices, if required.
- Obtain permission from the railway company if the bridge is over railway tracks and mobile platforms or other special equipment is going to be used in the track area.

1.6.2 Site Inspection

The inspector is required to:

- Complete a brief overview of the structure and identify obstacles that may either interfere with the inspection or indicate a need for additional special equipment;
- Discuss inspection procedures with the foreman of the traffic crew so that lane closings and traffic detours, etc., are timed to suit inspection needs;
- Ensure that all signs, temporary barriers, protective screens, safety devices, etc., are in place.

Once the site has been secured, the inspection can proceed in a systematic fashion.

- Draw up a list of the names of the people on site during the inspection;
- Note the date, weather and temperature;
- Note any unusual conditions;
- Note any restrictions affecting the inspection;
- Draw up a list of special equipment used;
- Complete the general information portion of the inspection form;
- Complete the inspection forms for each component of the structure;
- Carry out the inspection in a systematic manner;
- Note and record observations and make sketches as appropriate;
- Take photographs, including general views of the structure and damaged areas, noting the locations photographed.

All components (primary, secondary and auxiliary) of the structure shall be inspected and rated.

1.6.3 Post Inspection Procedures

The inspector is required to:

- ensure that all inspection equipment and temporary traffic control devices are removed from the inspection site and the site is left in workmanlike order;
- draft an initial report confirming that the inspection is complete and identifying any components that require immediate repair, and inform the project manager or engineer of the corrective measures to be taken;
- draft a final report containing observations, ratings, photographs and recommendations and indicating the priority of repairs.

SECTION 2 – RATING SYSTEM

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2.1 General

Section 2 describes the principles and general application of the condition rating system used to assess observed defects in the materials and performance of individual components of a structure, and the overall general condition rating for the structure as a whole. Also included are guidelines for the application of a priority code for recommended repairs.

The material and performance condition rating comprises a numerical system in which a number from 1 to 6 (1 = very severe defects, 6 = new condition) is assigned to each component of the structure based upon the severity of the observed material defects or the ability of a component to perform its function within the structure. Both material and performance defects shall be considered for all components. The numerical rating assigned to a particular component(s) shall reflect the most severe condition of material defects or reduction of performance observed. The component(s) condition rating shall be assigned without consideration of the importance of the component(s) within the structure.

Components not visible or inaccessible at the time of the inspection shall be noted. The provision necessary for inspection shall be identified, and arrangements made for proper inspection to be carried out.

In addition to the condition rating, each defect is given a summary priority code for remedial action and scheduling. The priority code comprises an alpha character indicative of the urgency and nature of the required repairs to a component or the need for more detailed inspection. Recognition of the importance of the component within the structure shall be reflected in the assigned priority rating.

The overall ratings of the bridge, as an indicator of the overall structural condition (Condition Rating) and functional elements based on currently accepted standards (Functional Rating) should be provided. These ratings shall be based on sound engineering judgement, taking into consideration the severity and extent of deficiencies observed for various components.

2.2 Rating System for Components of a Structure

Both material and performance defects shall be considered for all components. The numerical rating assigned to a particular component shall reflect the most severe condition of material defects or reduction of performance.

2.2.1 Material Condition Rating for Components of a Structure

The material condition rating for the components of a structure reflects the condition of the component based upon observed defects in the materials of the component. Commonly occurring defects in materials typically used in structures are described and categorized as to severity in Part 1 of this manual.

The application of the material condition rating system to components depends on the type, location and severity of the defects. General guidelines based upon the severity and extent of observed defects are given in Figure 2.2.

Additional guidelines for the material condition rating of components are given in Appendix A, Sections A1 to A9, for material defects that cannot be generalized, and for exceptions to the general guidelines.

The material condition rating should represent the worst observed material condition of the component and shall be based on any one or a combination of the guidelines given under that rating. The inspector shall record the observed material defects and the causes producing those defects wherever possible. The inspector shall take measurements to quantify the extent (perhaps expressed as a percentage) and general location of the defects for all components; however, extensive measurements will not normally be required.

2.2.2 Performance Condition Rating for Components of a Structure

The performance condition rating for components of a structure describes the condition of the component based upon its ability to perform its intended function in the structure. General guidelines based on the percentage reduction in the capacity of the component to perform its intended function are given in Figure 2.2. Additional guidelines for the performance condition rating of components are given in Appendix A, Sections A1 to A9, for performance defects that cannot be generalized, and for exceptions to the general guidelines.

In most cases, the performance defect of a component is closely related to, or attributable to, defects in the component materials as material defects often lead to performance defects. The severity of the performance defect is not necessarily the same as the severity of the material defect.

In some cases, performance defects exist due to defects in design or construction and may not be directly related to material defects. Also, performance defects in a component may be the result of unexpected behaviour of the structure or due to performance defects in other components of the structure. The inspector shall record the observed reduction in performance and the causes producing those effects wherever possible.

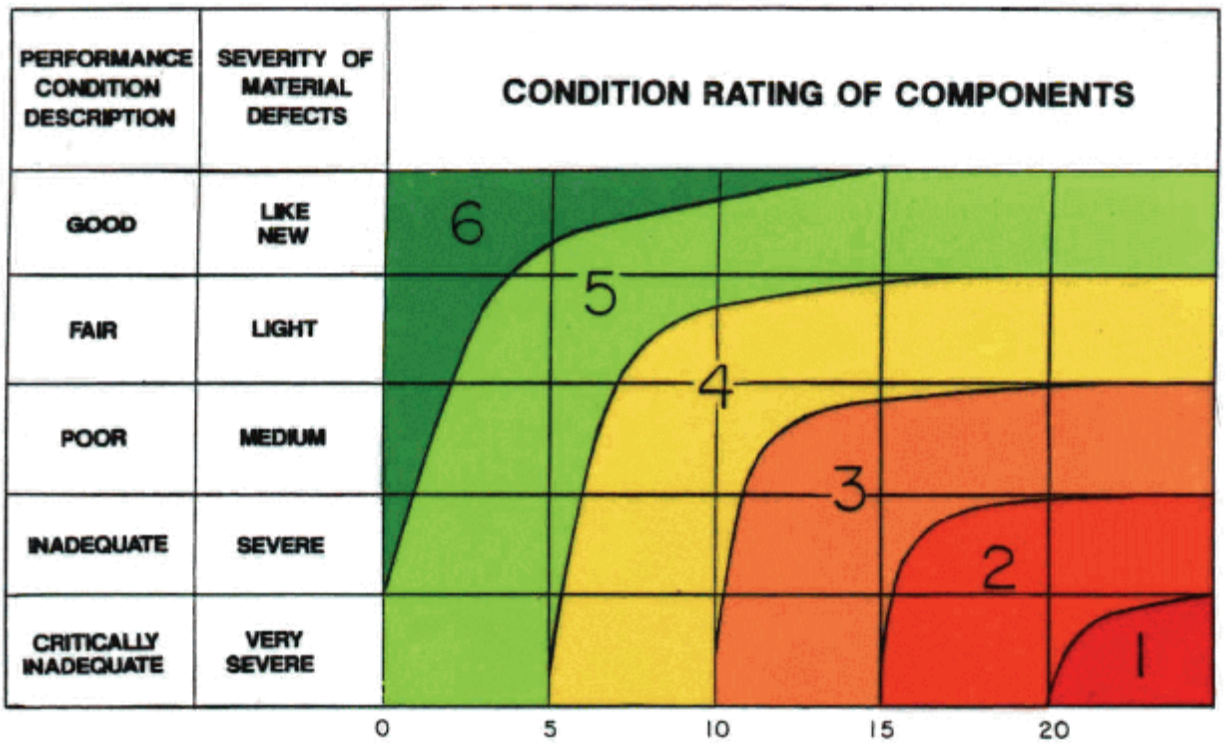

Figure 2.2 Condition Rating of Components

2.3 Priority Code for Component Repairs of a Structure

The priority code assigned to each component shall be one of the following:

U Urgent requires immediate attention and remedial measures to ensure public safety.

M Required work to be done as part of routine annual maintenance.

S Further study/investigations/surveys required prior to initiating repair programme.

A Repair and/or replacement to be done in less than 1 year.

B Repair and/or replacement to be done in less than 3 years.

C Repairs and/or replacement to be done in less than 5 years.

D Condition to be re-assessed at the next inspection.

All components shall be assigned a priority code indicative of the urgency and nature of recommended repairs, or need for further inspection. Performance related deficiencies should be considered to be of higher priority than material related defects. Nevertheless, the objectives of the recommended rehabilitation programme should be to address, where possible, all material and performance related defects.

Recognition of the importance of the component within the structure shall also be reflected in the priority rating assigned. Recognition of the importance of the component will be achieved by the classification of all components as either primary, secondary or auxiliary as given in Table 2.3. The classification is generally along traditional structural behaviour except for non-structural components, which should be classified as shown in Table 2.3.

In the event that the component condition rating indicates a significant level of deterioration or loss of performance, yet the recommended repairs are assigned a low priority, a brief written explanation shall note the component classification and nature of the deficiency.

Section of B.I.M. APPENDIX A	Primary Components	Secondary Components	Auxiliary Components
A1	• Streams		
A2	• Embankments supporting foundations	• Embankments supporting foundations	• Slope Protection
A3	• Foundations • Abutment Walls • Piers	• Ballast Walls • Wingwalls • Retaining Walls • Bearing Seats	
A4	• Pin and Hanger Bearings	• Other Bearings	
A5		• Joints	
A6	• Beams, Girders • Stringers • Floor Beams • Thick Slabs • Trusses • Arches • Culverts • Soil-steel structures • Load Bearing Diaphragms • Connections of primary components	• Non-load Bearing Diaphragms • Bracings • Connections of secondary components	
A7	• Decks • Wearing Surface • Sidewalks accessible to traffic	• Curbs • Sidewalks not accessible to traffic • Approaches • Approach Slabs	• Deck Drains and Drainage Systems
A8		• Barrier Walls • Railings	
A9	• Structural Steel Coatings on primary components	• Structural Steel Coatings on secondary components	
A10			• Signs
A11			• Utilities

Table 2.3 – Classification of Components

2.4 Overall Bridge Ratings

The Comprehensive Detailed Inspection Reports and the General Inspection Reports shall include:

- **Structural Condition Rating** – to provide an overall rating of the structure, taking immaterial and performance ratings of the individual components into consideration.
- **Functional Rating** – to provide an overall rating of the structure based on functional needs.

Whereas the following tables are intended to provide some guidelines, these should not be interpreted literally. Engineering judgement should be exercised based on severity and extent of deficiencies observed during field inspections and ratings assigned to individual components.

A brief explanation of the Overall Ratings should be provided in the Report.

Rating	Condition	Observations
6	Excellent	• New condition, minor imperfections – no repairs warranted; • Structure meets current CHBDC live loading and seismic requirements.
5	Good	• Structure meets current CHBDC live loading and seismic requirements; • Minor repairs required to secondary or auxiliary components; • Known problems relating to primary components but no repairs required; • Minor touch up coating required.
4	Fair	• Structure meets current CHBDC live loading; • Minor repairs required to primary components; • Significant repairs may be required to secondary or auxiliary components; • Minor scour problems; • Significant touch up coating required – no rust holes.
3	Poor	• Structure does not meet current CHBDC live loading; • Posted to within 15% of CHBDC live loading; • Repairs required to primary components and/or load carrying capacity is not compromised; • Medium scour problems; • Rust holes limited to secondary or auxiliary members.
2	Inadequate	• Structure does not meet current CHBDC loading; • Load posted more than 15% below CHBDC loading; • Significant scour problems; • Significant repairs and strengthening required to primary components to reinstate load capacity.
1	Critically Inadequate	• Inadequate to support vehicular loads; • Possibility of imminent failure; • Structure has failed or is closed to traffic; • Public safety is of concern.

Table 2.4(a) – Overall Bridge Rating: Structural Condition

Rating	Condition	Observations
6	Excellent	• New condition, minor imperfections – no repairs warranted; • Structure meets current CHBDC live loading and seismic requirements; • Structure meets TAC width and vertical clearance requirements; • Crash tested barriers at bridge and approaches – meet current requirements; • Traffic Capacity Level of Service: C; • Riding quality – excellent; • Approach geometric conditions meet current standards.
5	Good	• Structure meets current CHBDC live loading requirements; • Structure meets TAC width and vertical clearance requirements; • Crash tested barriers at bridge and approaches – meet current requirements, minor repairs required; • Traffic Capacity Level of Service: C; • Riding quality – Good; • Approach geometric conditions: Minor variations from current standards but generally acceptable.
4	Fair	• Structure meets current CHBDC live loading requirements; • Deficiency in terms of bridge width and/or vertical clearance per TAC requirements is less than 10%; • Approach or Bridge barriers do not meet current standards; • Repairs required at multiple locations (<20 percent); • Traffic Capacity Level of Service: D; • Riding quality – Fair; • Bridge or approaches posted at 10 km/hr below the normal highway speed; • Approach geometric conditions deficient in terms of horizontal or vertical alignment.
3	Poor	• Structure does not meet current CHBDC live loading; • Load posted to within 15**%** of CHBDC live loading; • Deficiency in terms of bridge width and/or vertical clearance per TAC requirements is more than 10%; • Approach and Bridge barriers do not meet current standards; • Repairs required at multiple locations (>20 percent but <50%); • Traffic Capacity Level of Service: E; • Riding quality – poor; • Approach geometric conditions deficient in terms of horizontal and vertical alignment; • Bridge and approaches posted at 20 km/h below normal highway speed.
2	Inadequate	• Structure does not meet current CHBDC loading; • Load posted to more than **15%** below CHBDC loading; • Deficiency in terms of width and/or vertical clearance per TAC requirements is more than 20%; • Non crash tested barriers, deficient in terms of original design strength requirements and/or more than 10% in terms of height requirements Repairs required at multiple locations (>50 percent); • Riding quality – very poor; • Traffic Capacity Level of Service: F; • Approach conditions deficient in terms of horizontal and vertical alignment; • Speed restrictions – posted at more than 30 km/h below normal highway speed.
1	Critically Inadequate	• Inadequate to support vehicular loads; • Possibility of imminent failure; • Structure has failed or is closed to traffic; • Public safety is of concern.

Table 2.4 (b) – Overall Bridge Rating: Functional