# BRIDGE CONDITION REPORT PROCEDURES & PRACTICES

Illinois Department of Transportation
Bureau of Bridges and Structures

# *Bridge Condition Report Procedures & Practices*

**Title Page**

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*Agency:*

*Illinois Department of Transportation*

*Place of Publication:*

*Springfield Illinois*

*2011*

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# Key to Acronyms:

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ASD | Allowable Stress Design |
| ASTM | American Society of Testing and Materials |
| BB&S | Bureau of Bridges & Structures (Illinois Department of Transportation) |
| BCR | Bridge Condition Report |
| BD&E | Bureau of Design and Environment |
| B-SMART | Bridge Surface Maintenance at the Right Time |
| CO | Concrete Overlay |
| FHWA | Federal Highway Administration |
| FWS | Future Wearing Surface |
| GGBFS | Ground Granulated Blast Furnace Slag |
| HRM | High Reactive Metakaolin |
| HMA | Hot Mix Asphalt |
| IDOT | Illinois Department of Transportation |
| ISIS | Illinois Structure Information System |
| LFD | Load Factor Design |
| LRFD | Load Resistance Factor Design |
| PONTIS | Computer based bridge management system |
| SPC | Seismic Performance Category |
| SPZ | Seismic Performance Zone |
| 3P | Pavement Preservation Policy |
| 3R | Resurfacing, Restoration & Rehabilitation |

# SECTION - I. INTRODUCTION

## GENERAL.

This document provides guidance for preparing Bridge Condition Reports for the improvement of roadway structures. It covers the wide range of information necessary to complete reports for various types of bridge projects. The guideline reviews background information, field inspection & testing (in brief), general analysis procedures and report preparation. Example bridge condition report formats have been provided in the appendices. This document was developed primarily with multi-girder supported bridges with cast in place concrete decks in mind. However, the general process provided can be applied to both simpler and more complicated structures.

The information provided in this revised "Bridge Condition Report Procedures & Practices" supersedes the guidance published in the previous document dated February, 2007.

## BRIDGE CONDITION REPORTS.

### Purpose.

Bridge Condition Reports provide a format for Districts to develop and document a proposed scope of work for a structure. The reports are submitted to the Bureau of Bridges & Structures (BB&S) for review and approval. Two main report formats have been developed; the Bridge Condition Report and Abbreviated Bridge Condition Report. A BCR is typically required for projects where significant work is planned for a structure. The Abbreviated BCR is intended for projects where only minor work is anticipated. The definition and purpose of each is provided below.

A Bridge Condition Report (BCR) is used to document the current physical condition and function of a structure and to develop a preliminary scope of work when significant work is anticipated. The scope of work selected should be a cost effective approach for the structure given its condition and the structural / geometric / hydraulic deficiencies and exterior constraints that affect it. This scope of work will set the general direction for the project; rehabilitation or replacement. It also establishes design features such as structure width and stage construction feasibility. The report addresses all known significant functional, structural and safety deficiencies associated with the structure. All corroborating information necessary to support the proposed scope of work is provided in the report.

An Abbreviated Bridge Condition Report is used to document the current physical condition of a structure where only minor work or no work is anticipated. It is similar to a BCR, but the documentation requirements are greatly reduced.

The scope of work and estimated cost developed in the BCR phase of project development are suitable for Departmental programming and preliminary design purposes but are subject to revision as the project progresses. While the decision to rehabilitate or replace the structure has been made, structure length, number of spans, structure type, etc are to be determined by the bridge planner during the TSL phase.

**Submittal Requirements.**

A Bridge Condition Report is required for every structure which is within a roadway section covered by a Phase-I report or which is the subject of a Phase-I report itself. Structures may fall into one of the following categories which would require a report.

- Allow structure to remain in place
- Gap structure temporarily
- Deck repair and resurface
- Rehabilitation or reconstruction of the structure
- Replace the structure

All existing structures > 20 ft. in length back-back abutment and cast in place multiple cell concrete box culverts meeting the above criteria require a Bridge Condition Report.

Coordination requirements for structures with the scope of work “Bridge to Remain in Place” that are located within a “3R” type highway project are found in Section – IV, “ABBREVIATED BRIDGE COORDINATION” of this document.

**Scope of work definitions for bridge projects are provided in Section-III of this document.**

For structures to be “Gapped Temporarily” within a 3R type highway project, a memorandum may be submitted briefly describing the District’s intent to complete work on these structures in a separate project. This approach should only be used in rare instances and the reason for gapping the structure provided in the memorandum. A Bridge Condition Report is still required in this case at a later date.

Structures located within SMART and 3P projects do not require the submittal of a Bridge Condition Report. However, if the structure is being resurfaced as part of the project, coordination will be made with the BB&S to approve the resurfacing method, bridge rating and general scope of work. See Section – IV, “ABBREVIATED BRIDGE COORDINATION” of this document for details.

Structures planned for “maintenance type work” do not require coordination with BB&S unless specifically requested by the District. However, if the structure is being resurfaced, coordination will be made with the BB&S to approve the resurfacing method and bridge rating. See Section – IV “ABBREVIATED BRIDGE COORDINATION” of this document for details.

**Bureau of Bridges & Structures (BB&S) Concurrence.**

The Bridge Condition Report allows the BB&S to review the proposed scope of work for a structure and provide concurrence based on its current condition, relevant design criteria and other applicable issues. Upon completion of their review, the BB&S will document concurrence or non-concurrence with the following geometric and structural factors as applicable:

- Replacement or reuse of components
- Proposed general configuration features
- Structural feasibility
- Proposed bridge clear width of the deck
- Stage construction feasibility of the existing structure

The BB&S concurrence relates to the structural and economic acceptability of the bridge improvement proposal. If appropriate, the economics of a proposal should be investigated as part of the report process and will be reviewed at this time. In some instances geometric, environmental or other design factors may preclude economic considerations. In these instances these factors should be well documented within the BCR.

Before design approval can be granted on a roadway project which includes structures or on a bridge by itself, the Bridge Condition Reports on all bridges must be approved by the Bureau of Bridges & Structures.

# SECTION - II. BRIDGE INSPECTION

## GENERAL.

A well planned and thorough inspection is critical to producing a high quality BCR. This section provides general guidance on the bridge inspection process required to collect the information necessary to produce bridge condition reports. It is not intended to be an all encompassing reference for bridge inspection. For detailed information on bridge inspection see the classes and publications listed below.

## BRIDGE INSPECTION REFERENCES.

The following classes and publications are recommended as references for conducting bridge inspections.

| | |
|---|---|
| FHWA Class: | 130055 “Safety Inspection of In Service Bridges” |
| FHWA Class: | 130053 “Bridge Inspection Refresher Training” |
| FHWA Class: | 130078 “Fracture Critical Inspection Techniques for Steel Bridges” |
| FHWA Pub.: | FHWA-NHI 03-001 “Bridge Inspector’s Reference Manual” |
| FHWA Pub.: | FHWA-IP-86-26 “Inspection of Fracture Critical Bridge Members” |
| FHWA Pub.: | FHWA-PD-96-001 “Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation’s Bridges” |
| IDOT Pub.: | “Structure Information and Procedure Manual” |
| AASHTO Pub.: | “Manual for Condition Evaluation of Bridges” |

## FIELD INSPECTION PROCESS.

The level of field inspection required for a structure is dependent on several factors. Structures being inspected to produce a report outlining the scope of work for a bridge in an upcoming project will generally require more effort than an inspection to meet the periodic mandated safety inspection requirements. Another factor affecting the effort is the current condition of the structure. A structure in poor condition will usually require more effort than one in good condition. Material testing and delamination surveys may also be used as part of the inspection process but are not always appropriate due to the high cost to prepare this data verses the benefit of having the additional information. This is often true for small structures, structures with little or no apparent deterioration, those that are functionally obsolete and must therefore be replaced anyway or are obviously beyond repair. On the other hand, for structures exhibiting a level of deterioration where it is unclear if the element in question is beyond economical repair, more extensive testing may be appropriate.

To accomplish the objectives of the Bridge Condition Report, the inspection must be as thorough as possible within engineering reason. It must also be documented in such a manner as to allow a proper scope of work to be determined and approved. An initial thorough detailed inspection will also reduce the potential need for return trips to the site to secure additional information during the report preparation and approval process.

**Preparation.**

Thorough preparation will improve the prospects of obtaining a good inspection. The following guidelines are provided as aids for planning a bridge inspection:

1. Review the structure plans of the bridge to be inspected for familiarity with the following details as appropriate:

- type of superstructure
- type and age of deck and of deck overlays
- joint types – longitudinal and transverse
- bearing types
- substructure types and borings
- details requiring special inspection
  - fatigue prone details
  - fracture critical details
  - pins and hangers in the main load carrying elements
- previous repair or maintenance work
- previous inspection reports

2. Prepare sketch plans of the top and bottom of the deck, abutments, piers and other structural elements as necessary to allow proper documentation of the location and description of significant distress features using the following guidelines:

- plans should be roughly to scale and of a convenient size for field use
- plans should include basic dimensions and a reference line from a point that can be easily located and measured from in the field and identified in the report
- areas of distress located on the sketches should have a linear or area dimension placed on it as appropriate
- areas of distress should be detailed in a distinctive manner and a key provided to distinguish between the different deterioration types

3. Prepare a list of equipment needed to complete the inspection. Include how you will access each element of the bridge to be inspected and if it will require coordination for special equipment and traffic control.

**Field Inspection.**

The inspection will generally include all elements of the bridge. The following list describes elements found on a typical bridge and issues to consider during their inspection. Photographs of distressed areas, areas of concern and areas depicting the general overall condition of the structure should be taken during the inspection. This list is not all inclusive and is only intended as a guide.

Deck / Slab:

Inspect the bottom of the deck first.  Some problem areas to look for and document are:

- wet or stained areas
- areas with heavy leaching and/or stalactites
- areas of cracking and leaching
- spalled and delaminated areas
- exposed reinforcement
- section loss in reinforcement
- previously repaired areas

Pay special attention to areas around joints, drains, along cracks and at construction joints.  These areas are often more susceptible to deterioration.

Inspect the top of the deck along with the parapet/railing.  Some problem areas to look for and document are:

- potholes
- spalled areas – particularly areas with exposed rebar
- broken and map-cracked areas in bituminous deck surfaces
- cracks that may relate to deteriorated areas observed on the bottom of the deck
- map cracking and other crack patterns
- record and locate deteriorated areas on curbs, medians or parapets
- record any bridge rail damage and/or deterioration, including deterioration of the overhang area which may indicate reduced capacity
- previously repaired areas

A delamination survey may be completed to aid in the repair or replacement decision if appropriate. A deck that is estimated to require deck repair should have a delamination survey completed.  The type and date of the delamination survey should be provided with the delamination plot.  An exception to this recommendation is deck repair projects that meet B-SMART criteria.

The visual top and bottom deck surveys, along with the results of the delamination survey and other tests if used, will be combined and correlated to determine the extent of estimated full-depth and partial-depth deck repairs needed.

Deck Joints – Transverse & Longitudinal:

Inspect the transverse & longitudinal joints.  Some problem areas to look for and document are:

- damaged, missing or loose joint sections
- evidence of leakage through the joint
- deteriorated concrete at the edges of the joint
- excessive opening/closure of the joint

Beams & Girders:

Inspect the beams and girders.  Some problem areas to look for and document as applicable are:

Steel Beams & Diaphragms:
- areas with heavy rusting or section loss
- damaged areas due to impact or other causes
- presence and condition of fatigue sensitive details (see section 2.4.2.4 in the "Bridge Manual")
- presence and condition of pin and link connections
- beam ends/sections under expansion & longitudinal joints
- condition of the paint

Concrete Beams & Diaphragms:
- areas with heavily deteriorated concrete such as cracking, staining, delaminations & spalling
- open cracks
- damaged areas due to impact or other causes
- exposed reinforcement
- section loss in reinforcement
- beam ends/sections under expansion & longitudinal joints (concrete sounding recommended in this area)

PPC Deck Beams:
- areas with heavily deteriorated concrete such as cracking, staining, delaminations & spalling
- large cracks (especially longitudinal cracks)
- damaged areas due to impact or other causes
- exposed stirrup reinforcement, wire mesh and prestressing strands
- section loss in stirrup reinforcement, wire mesh and prestressing strands
- beam ends/sections under expansion & longitudinal joints

Pay special attention to areas near and under joints and drains as structure elements are more susceptible to damage in these areas.

Bearings:

Inspect the bearings.  Some problem areas to look for and document are:
- areas with heavy rusting or section loss
- excessive movement, lack of movement or excessive tilting of the bearing
- damaged or missing bolts
- deterioration of the concrete at the base of the bearing
- bulging or tearing of elastomer

Abutments:

Inspect the abutments and wing walls. Some problem areas to look for and document are:

- areas of cracking and leaching
- spalled and delaminated areas
- exposed reinforcement (concrete sounding recommended in this area)
- section loss in reinforcement
- movement or rotation of the abutments
- scour or erosion around the abutments
- presence of excessive or unexplained moisture at or behind the abutments

Piers:

Inspect the piers. Some problem areas to look for and document are:

- areas of cracking and leaching
- spalled and delaminated areas
- exposed reinforcement (concrete sounding recommended in this area)
- section loss in reinforcement
- movement or rotation of the piers
- scour or erosion around the piers

Other Items:

Additional items that should be identified & documented as appropriate:

- presence and extent of scour or erosion at the site
- presence, types and condition of utilities on or near the structure
- condition of the slope protection system

**Documentation.**

Proper documentation of the inspection results is critical to producing a good BCR. Without proper documentation, it will be difficult to conduct a thorough analysis of the structure to determine the appropriate scope of work. It will also be difficult for the BB&S to quickly review the report once it is submitted for approval. Poor documentation often leads to wasted time for District, Consultant and BB&S personnel in retrieving information that should have been documented as part of the initial inspection and report preparation process. General guidance on providing adequate documentation of important aspects of the inspection is provided in the following paragraphs.

Photographs:

Adequate photographs of the structure need to be taken to convey its current condition and corroborate the recommended scope of work in the report. Photographs provided in the report must be color and of high quality to be useful. Photographs of distressed areas, areas of concern and areas depicting the general overall condition of elements of the structure should be taken during the inspection.

The example report formats located in Appendix A and B of this document provide a sample listing of photographs required.

<u>Top & Bottom of Deck Surveys</u>:

Provide detailed top and bottom of deck surveys from the results of the inspection sketches. These surveys are critical in estimating the condition of the deck and determining whether or not it is economical to repair. The top and bottom of deck survey plans allow proper documentation of the location and description of distress in the deck and should be detailed according to the following guidelines:

- plans should be drawn roughly to scale and made to fit in the report
- plans should include basic dimensions and reference points that can be easily identified in the report
- areas of distress should have a linear or area dimension placed on it as appropriate
- areas of distress should be detailed in a distinctive manner and a key provided to distinguish between different deterioration types

Plot estimated full and partial-depth patch areas on the bottom and top of deck surveys. Avoid being too conservative since the actual full-depth areas are generally larger than the distress areas visible during the inspection.

The bottom of deck survey is the more important of the two surveys as it allows the report preparer to estimate the amount of full depth patching required for the deck.

If a delamination survey is used, the areas of delamination found in the survey are plotted to scale on the top of deck survey sketch and squared off for easy measurement of delaminated areas. These areas will frequently overlap other distressed areas plotted and provide a more comprehensive assessment of the deck condition.

<u>Substructure Surveys</u>:

Provide detailed substructure surveys. These surveys are critical in estimating the condition of the substructure and whether or not it is economical to reuse. The survey plans provide documentation of the location and type of distress in the substructure and should be detailed similar to the top and bottom of deck surveys. The surveys will be used later to develop detailed repair plans, if applicable.

<u>Measurements at Areas of Concern</u>:

Section Loss. If significant section loss is detected on main load carrying elements the following measurements should be taken, if appropriate:

- thickness of the element in question (provide current and as designed thickness)
- length/area of section loss
- distance from known point to location of section loss
- photographs should be taken of the damage to include in the report

Concrete Crack. If significant concrete cracks are detected in structural members the following measurements should be taken:

- length of crack
- crack widths at identified points
- distance from known point to location of crack

Substructure Rotation or Movement. If it is suspected that substructure units (abutments or piers) have rotated or moved significantly since construction the following measurements should be taken, if appropriate:

- plumbness of the walls
- degree of rotation or movement of the bearings at the unit
- elevation of the bearing seats at each end of the unit
- length from adjacent substructure units to the unit in question taken at each end of the unit and measured from known points
- the opening width at each end of transverse expansion joints at the unit in question
- photographs should be taken of evidence supporting this conclusion to include in the report

## DELAMINATION SURVEYS.

The decision to use a delamination survey is dependent on several factors. Delamination surveys are not always appropriate due to the cost to prepare this data verses the potential benefit of having the additional information. This is often true for small deck areas, structures with little or no apparent deterioration, those that are functionally obsolete and must therefore be replaced regardless or are obviously beyond repair. On the other hand, for structures that exhibit a level of deterioration where it is unclear if the deck is beyond economical repair, completing a delamination survey is appropriate.

If it is estimated a deck will require deck repair, a delamination survey is recommended to verify the scope of work selected and aid in determining the estimated deck repair quantities.

The following methods are used to conduct delamination surveys:

Method 1-(ASTM D 4580) Measuring Delaminations in Concrete Bridge Decks by Sounding

Method 2 – (AASHTO TP36)* Evaluating Asphalt-Covered Concrete Bridge Decks Using Pulsed Radar
*This test method has been discontinued by AASHTO

Method 3-(ASTM D 4788) Detecting Delaminations in Bridge Decks Using Infrared Thermography

Method 1 may be used for exposed concrete bridge decks and bridge decks with a concrete overlay. However, for decks with a concrete overlay, this method will detect debonding of the overlay and delamination of the underlying concrete. This method cannot distinguish between debonding and delamination. Method 1 is very accurate for exposed concrete bridge decks, but the sounding process can be slow and traffic noises may restrict its use. The chain drag is the most commonly used procedure for conducting this test.

The results of a sounding survey (Delamtect, chain drag, or hammer) can be affected by cold temperatures and/or wet conditions. This type of survey should be performed when the air temperatures remain above $32^0$ F for a sufficient length of time to assure a dry and frost free deck.

The use of a delamination survey on precast-prestressed concrete box beam superstructures is not recommended.

Method 2 is primarily intended for concrete bridge decks with a hot mix asphalt overlay. This method may also be used for exposed concrete bridge decks and bridge decks with a concrete overlay. An advantage Method 2 has is it can distinguish between a debonded overlay and a delamination of the underlying concrete. However, abnormally shallow reinforcement concrete cover can produce distortions that interfere with the detection of a delamination. In addition, there is a high incidence of false concrete damage near steel abutment joints.

Method 3 may be used for exposed concrete bridge decks, and bridge decks with a concrete or hot mix asphalt overlay. However, this method cannot distinguish between a debonded overlay and delamination of the underlying concrete. Delamination surveys on decks with overlays present are likely to be of limited use because of this.

The following guidance is provided to determine which delamination survey method to use on a bridge deck:

- Use Method 1, 2 or 3 for exposed concrete decks and decks with a concrete overlay.
- Use Method 2 and/or 3 for decks with a hot mix asphalt overlay.

For more information concerning Methods 2 and 3, the publication "Evaluation of Bridge Deck Delamination Investigation Methods by Henrique L. M. dos Reis and Matthew D. Baright (Project IC-H1, 95/96 and Report No. ITRC FR 95/96-1)" is available from the Bureau of Materials and Physical Research. The report recommended that a combination of Methods 2 and 3 be used for the most accurate inspection of a bridge deck.

Since some delamination surveys may interpret the debonding of wearing surfaces as delaminations, the surveys must be closely coordinated with both the top and bottom of deck inspections to aid in estimating areas of deck delaminations.

If the deck condition remains unclear after the delamination survey and top and bottom of deck survey coordination, further tests such as spot overlay removal and deck cores can be taken. Additional diagnostic tests such as the half-cell survey and chloride content tests may also be made to aid in determining whether or not deck repair is appropriate.

## ADDITIONAL TESTING METHODS.

The following tests can be used to obtain additional information regarding concrete condition when necessary. A more detailed explanation of each test is provided in Appendix – C.

Test 1 – (No Test Reference) Measurement of Reinforcement Bar Concrete Cover

Test 2 – (AASHTO T 24) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

Test 3 – (ASTM C 805) Rebound Number of Hardened Concrete

Test 4 – (AASHTO T 22) Compressive Strength of Cylindrical Concrete Specimens

Test 5 – (ASTM C 876) Corrosion Potentials of Uncoated Reinforcing Steel in Concrete

Test 6 (Method A) – (AASHTO T 260) Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials

Test 6 (Method B) – (AASHTO T 332) Determining Chloride Ions in Concrete and Concrete Materials by Specific Ion Probe

Test 7 – (ASTM C 856) Petrographic Examination of Hardened Concrete

# SECTION - III. BRIDGE ANALYSIS & SCOPE OF WORK SELECTION

## GENERAL.

In this section the bridge analysis and scope of work selection process is reviewed. This process determines the appropriate scope of work for a structure within the framework of the project being considered. It considers information about the bridge and surrounding area such as the results of the inspection (current condition), geometric/hydraulic requirements, load capacity, construction feasibility, economics and exterior constraints when making this decision. This section provides general guidance on this process for typical structures.

## SCOPE OF WORK DEFINITIONS.

The scope of work for a structure covered in a bridge coordination report may be any of those provided below. These definitions have been modified from those provided in the BD&E Design Manual pg. 39-3.01(a).

Bridge Replacement. Replacement of the entire bridge.

Bridge Reconstruction. At a minimum complete replacement of the superstructure and may include work on the substructure and foundation.

Bridge Rehabilitation. Repair or replacement work on one or more of the major and/or minor components of a bridge (i.e., deck replacement, super/substructure widening, bridge rail retrofit/replacement, transverse or longitudinal joint work, beam repairs and substructure repairs).

Bridge Deck Repair. The existing bridge deck is structurally adequate, but deck repairs are required and an overlay may be necessary to improve the rideability and maintain the integrity of the deck. Additional repairs to the superstructure and/or substructure may be included with this work. This is considered a special type of “bridge rehabilitation”.

Bridge to Remain in Place. The bridge is structurally sound, has adequate load capacity and meets the minimum width/clearance/geometric criteria to remain in place without work.

## BRIDGE ANALYSIS PROCESS.

The bridge analysis process assists the engineer in determining the best scope of work for a given structure during the BCR preparation process. It applies thoroughness, sound judgment and professional knowledge to the decision process.

The analysis process requires the engineer to evaluate various aspects and components of the bridge to determine if they are suitable for reuse or repair. This begins with collecting the information necessary to make good evaluations and well informed decisions. Information gathered/determined by the engineer doing the analysis will include facts and well founded assumptions. Once the analysis process is complete the results are reviewed in whole and the appropriate scope of work selected.

The evaluations required for a typical bridge during the analysis process generally include:

- Geometric & Hydraulic Capacity
- Deck
- Superstructure (other than deck)
- Substructure
- Miscellaneous Checks
- Stage Construction Feasibility
- Economic

General information on how to conduct each of these evaluations is provided in the following pages. The evaluations are presented in the general order they should be reviewed for a typical structure; however, the order may be revised if deemed appropriate by the engineer.

## GEOMETRIC & HYDRAULIC CAPACITY EVALUATION.

### General.

The Geometric and Hydraulic Capacity Evaluation consists of a review of the following aspects at the existing bridge if applicable:

- Roadway Geometry
- Bridge Clearances
- Hydraulic Capacity

### Roadway Geometry.

The geometry for the roadway through the bridge and for roadways under/over the structure should be evaluated for conformance to Department policy and needs. It must be determined if any changes will be made to the horizontal and vertical roadway alignments and widths within the scope of current or future projects that will affect the existing structure.

### Bridge Clearances.

The deck clear width between rails/curbs along with the horizontal and vertical clearance beneath the structure must be reviewed, as applicable, for conformance to Department policy. Minimum clearances for bridges to remain in place are found in the BD&E Manual in Chapters 49 and 50 (3R Guidelines) depending on the clearance type and roadway classification. Review the sections labeled “Criteria for Bridges to Remain in Place” to check existing structures. Clearances for improved bridges can be found in these same chapters along with Chapter 39 (Structure Planning/Geometrics).

### Hydraulic Capacity.

For bridges over streams, the hydraulic capacity should be reviewed when appropriate. A review of any hydraulic capacity analysis results and records of flooding should be made, if available. Changes since initial construction in the channel location or hydraulic opening through the structure should be noted. Changes in drainage conditions affecting the bridge should also be noted.

Where the existing vertical alignment is to be maintained and there is no history of serious hydraulic deficiencies at the location, then the existing bridge waterway opening may usually be retained.

For the following cases, development of a formal Hydraulic Report is required:

- bridge replacement.
- superstructure replacement.
- bridge widening requiring additional substructure to be added.
- reductions to the hydraulic opening through the structure.

Detailed guidance on Hydraulic Report production is available in the IDOT Drainage Manual.

### Geometric & Hydraulic Capacity Evaluation Assessment.

Once the information for the Geometric, Hydraulic and Capacity Evaluation has been collected it must be evaluated. If the structure meets the minimum clearance requirements, is hydraulically acceptable and no significant changes to the roadway geometry are anticipated, then it satisfies criteria for this evaluation to remain in place.

If the structure is found not to meet minimum clearance, hydraulic or geometric requirements then further investigation is required. The area not meeting policy must have a waiver of the policy granted if the structure is to remain in place. If a waiver of the policy is not granted by the approving authority, or desired by the District, then the element in question must be modified or replaced to meet policy. In cases where complete replacement of the structure is justified as necessary and economical after completion of the Geometric, Hydraulic and Capacity Evaluation then only a cursory review of the structure condition related evaluations need to be made if the existing structure is to be removed.

## DECK EVALUATION.

### General.

The deck evaluation consists of a review of the bridge elements that are related to the deck's condition. These elements are the deck joints, bridge railing, wearing surface (if applicable) and structural deck element condition.

### Deck Joints.

All transverse and longitudinal joints should be reviewed to determine their condition. If the joints are found to be significantly deteriorated, they should be considered for repair or replacement. Methods and details for replacement joint types are found in the BB&S "Structural Services Manual" for decks remaining in place and the BB&S "Bridge Manual" for decks being replaced.

When practical, deck joints should be considered for elimination. This reduces the potential for deck drainage passing through failed joints and causing deterioration of the structural elements located below. Guidance on deck joint elimination is as follows:

Transverse Joints. Transverse expansion joints may be eliminated if a structural check of the proposed loading/fixity condition is found to be acceptable on the existing superstructure, substructure & foundation.

Longitudinal Joints. All open longitudinal joints on girder supported decks with an out-to-out beam width of 120 feet or less may be considered for elimination. All open longitudinal joints on concrete slab structures 45 feet or less in width may also be considered for elimination. See the BB&S “Structural Services Manual” for typical joint closure details.

**Bridge Railings.**

The deck railing must be evaluated for conformance to Department policy to remain in place. All rails should be repaired, retrofitted or replaced that show evidence of significant accident damage, are in questionable condition, contain irregularities that could cause intolerable vehicular decelerations or do not meet current AASHTO strength standards. If replaced, rails and their connections to the deck shall be designed to meet current AASHTO strength and safety standards. All replacement rails should meet the criteria outlined in Section 2.3.6.1.7 “Bridge Rails” of the IDOT Bridge Manual.

Curb sections that project horizontally more than 9.0 in. but less than 3.0 ft. from the face of the rail will be retrofitted.

**Wearing Surface Condition.**

The condition of the wearing surface, if present, must be evaluated. The top of deck survey is the primary tool for this effort although the bottom of deck survey can also be useful. If the wearing surface shows significant deterioration such as cracking, debonding and spalling it should be considered for repair or replacement.

**Deck Condition.**

The top and bottom of deck surveys along with the results of any tests used are combined to evaluate the condition of the deck. The result of this evaluation should be separate estimates for the number of square feet and percentage of the total deck area that require full and partial depth deck slab repairs.

**Deck Repair/Replacement Assessment.**

Once the physical condition of the deck has been estimated, an assessment must be made to determine if it is more economical to repair or replace this element of the bridge. This process has been studied for various percentages of deck repair verse deck replacement using life cycle cost analysis. The results of the study were used to develop the table shown on the next page. ***The numbers listed represent the estimated total percentage of deck repair area for the deck (total repair % = partial depth repair % + full depth repair %)***. A maximum limit of 13% full depth deck repairs is recommended when repairing the deck for economic considerations and to ensure long term soundness (the % of full depth repairs includes deck removal at transverse joints).

| Deck Repair vs. Replacement Assessment Table | | |
|---|---|---|
| **Equal Width Decks[1]:** | **Decks Requiring Widening[1,2]:** | **Recommendation:** |
| ≤ 25% | ≤ 15% | Deck repair cost effective[3] |
| 26-35% | 16-25% | Deck repair cost effective only in well documented cases[4] |
| > 35% | > 25% | Deck replacement appropriate |

**Notes to Table:**
(1) – Deck area calculated using length x face-face parapet width.
(2) – This column pertains to deck widening which requires additional beam/s only.
(3) – For decks containing sidewalks and raised medians with significant amounts of repair/replacement work required, separate cost analysis estimates should be completed to justify deck repair versus deck replacement.
(4) – In this case deck repair may be considered appropriate when a detailed cost analysis and/or well documented exterior constraints indicate deck repair is more advantageous.

All deck repair projects must be evaluated with the length of time until construction being considered.

The maintenance history and age of the deck must also be considered when evaluating a deck for repair or replacement. Concrete decks in need of repair that contain large areas of patching from prior repair cycles are less desirable to retain. This is due to the tendency of the area around previously repaired areas to deteriorate more rapidly than the original deck.

Decks that have had thin concrete overlays previously placed on them will also need to be evaluated for repair. In order to be cost effective, a thin concrete overlay must last approximately 18 years, otherwise, deck replacement is often more economical. Decks that are in poor or questionable condition to last this length of time should not be considered for an additional overlay in most circumstances.

**Deck Repair Methods.**

There are multiple methods available to complete deck repairs on a bridge. Each method differs somewhat from the others in deck slab repairs, deck surface preparation and replacement wearing surface composition. The specific requirements for these methods are described in detail in the Departments Standard Specifications and Special Provisions.

Any deck repair method that results in the temporary elimination of bond between the concrete and the upper mat of negative moment reinforcing steel on continuous or rigid frame concrete structures (such as continuous T-beam and slab bridge superstructures) where this reinforcement acts as part of the primary superstructure support system must provide for the staging of repairs in those areas to maintain structural integrity. If the recommended repair method results in dead load in excess of the existing conditions, approval shall be obtained from the Bureau of Bridges and Structures.

**Deck Repair Overlay Selection.**

The table shown below was developed as a guide in the selection of deck overlay type. It uses desired overlay lifespan, ADT levels, stopping condition and construction duration as parameters to guide the selection of overlay type.

# Bridge Deck Overlay Selection Guide

| Issue: | Desired Overlay Lifespan < 12years[3] ADT < 10,000 | Desired Overlay Lifespan < 12years[3] ADT ≥ 10,000 | Desired Overlay Lifespan ≥ 12years ADT < 3,000 | Desired Overlay Lifespan ≥ 12years ADT ≥ 3,000 |
|---|---|---|---|---|
| **Overlay Type** | - HMA w/coal tar membrane<br>- HMA w/sheet membrane | - Fly Ash GGBFS CO<br>- Microsilica CO<br>- HRM CO<br>- Latex CO[1]<br>-Thin Polymer Over.[2] | - HMA w/coal tar membrane<br>- HMA w/sheet membrane | - Fly Ash GGBFS CO<br>- Microsilica CO<br>- HRM CO<br>- Latex CO[1]<br>-Thin Polymer Over.[2] |
| **Stopping Condition Within 300' of Deck** | - HMA w/coal tar membrane | - Fly Ash GGBFS CO<br>- Microsilica CO<br>- HRM CO<br>- Latex CO[1] | - Fly Ash GGBFS CO<br>- Microsilica CO<br>- HRM CO<br>- Latex CO[1] | - Fly Ash GGBFS CO<br>- Microsilica CO<br>- HRM CO<br>- Latex CO[1] |
| **Short Construction Duration Required** | - HMA w/sheet membrane<br>- HMA w/coal tar membrane | -Thin Polymer Over.[2] | - HMA w/sheet membrane<br>- HMA w/coal tar membrane | -Thin Polymer Over.[2] |

**Notes to Table:**
- The following acronyms were used in the table above:
  GGBFS = Ground Granulated Blast Furnace Slag
  HMA = Hot Mix Asphalt
  HRM = High Reactive Metakaolin
  CO = Concrete Overlay
(1) - For Latex CO projects the maximum slope allowed is 3% and the maximum thickness is 3.5".
(2) - Thin Polymer Overlays are generally recommended on decks with small areas and low patching quantities or when necessitated by the need to minimize additional dead load or the need to minimize height adjustments at the expansion devices.
(3) - For projects with an estimated lifespan ≤ 5 years, an HMA without a waterproofing membrane may be considered.

**The overlay types shown are recommendations for the criteria provided. Other overlay types may be used in these situations when justified by the engineer.**

**B-SMART Criteria.**

General. The B-SMART Program allows for the quick approval of low cost bridge deck preservation projects. It is intended to extend the life of the deck 12-20 years (dependant on overlay type and location) on structures with good superstructures and substructures.

Primary Improvement. The application of a thin concrete overlay (maximum 1 in. concrete deck scarification) or bituminous concrete overlay with waterproofing membrane system.

Additional Work Allowed. The following additional work is allowed on B-SMART deck overlay projects:

- Full and partial depth deck repair subject to the limits outlined in the Qualification Criteria paragraph.
- Expansion joint repair/replacement.
- Bearing reconditioning/replacement.
- Deck drain replacement, extension or plugging.
- Bridge rail repair/retrofit (replacement not allowed).
- Minor abutment backwall repairs (formed concrete repair ≤ 5 in.).

Other substructure repairs are excluded from this program unless approved by the Bureau of Bridges and Structures on an individual basis.

Qualification Criteria. The following criteria must be met to qualify for the B-SMART Program:

- Superstructure and Substructure Condition Ratings must be greater than or equal to “6”.
- Deck Condition Rating must be greater than or equal to “5”.
- Partial Depth Patching is restricted to a maximum of 15% of the total deck area based on the visual top and bottom deck survey results included in the element level inspection.
- Full Depth Patching is restricted to a maximum of 5% of the total deck area not including the removal areas for joint repair and deck drain replacement.

A delamination survey of the deck is not required. A visual top and bottom of deck survey is adequate for documentation. This survey will be satisfied by a PONTIS inspection.

There are no restrictions on these projects regarding roadway type, age of structure or ADT. They also need not be used in conjunction with Pavement SMART projects.

B-SMART projects will not be approved for funding beyond the first three years in the Department’s Multiyear Program due to the potential for structural condition state changes. The deck survey must be taken within one year of the proposed letting date. Structures that fail the above restrictions will not be approved and will revert to standard procedures for deck repair.

Projects that qualify for the B-SMART Program should be submitted for review and approval using the Abbreviated Bridge Condition Report Format in this document.

## SUPERSTRUCTURE EVALUATION (other than deck)

### General.

The superstructure evaluation usually consists of a review of the superstructure condition, load capacity, bearings and any special considerations defined below.

### Condition.

The main and secondary load carrying elements of the superstructure are evaluated to determine if they are structurally sound and in sufficient condition to remain in place or require repair or replacement. These main load carrying elements often consist of girders and the secondary load carrying elements often consist of diaphragms or cross bracing. Some areas of importance to consider during this review are:

- significant section loss of a member/reinforcement that will affect the load capacity.
- general deteriorated condition of an element that indicates possible reduced capacity.
- damaged areas due to impacts or other causes that may affect the load capacity.

If elements of the superstructure are thought to have sufficient damage to significantly affect the load capacity, a capacity check must be made. The design loading requirements are described in the next sub-section.

### Load Capacity.

The load capacity of the superstructure must be evaluated for conformance to Department policy. Review the superstructure elements live load capacity based on the design specifications used to design the structure:

ASD and LFD Designs (HS-20 live load). Evaluate these structures based on the proposed scope of work as described below.

Bridge Rehabilitation, Bridge Deck Repair & Bridge to Remain in Place Projects: If the superstructure has a live load inventory rating equal to or greater than HS-20 for the proposed loading condition, no further investigation is required. If this live load rating is less than HS-20, the main load carrying elements of the superstructure must be investigated to determine if they are capable of carrying the live load specified in the BDE Manuals 3R Guidelines (Chapters 49 & 50) for the type of roadway classification being considered. These loads are found under the 3R sections labeled "Criteria for Bridges to Remain in Place". If the member does not meet these criteria in its current condition it must be strengthened or replaced to meet the required capacity.

Bridge Reconstruction Projects: All superstructure replacement projects will be designed using HL-93 live load and the LRFD Bridge Design Specifications.

LRFD Designs (HL-93 live load): If the superstructure has a live load inventory rating factor for the proposed loading condition equal to or greater than 1.0 using LRFR, no further investigation is required. If the live load rating factor is less than 1.0, the main load carrying elements of the superstructure must be investigated to determine if they are capable of carrying the design loading without exceeding 65% of the strength of any member. If the member does not meet these criteria in its current condition it must be strengthened or replaced to meet the required capacity.

Note: LRFR rating factors may be obtained from the BB&S if necessary.

If additional dead load is to be added to the superstructure, the capacity of the main load carrying elements must be reviewed for compliance with the live load criteria discussed in the previous paragraphs for either case described.

In some cases the use of a reduced FWS allowance may be considered to permit reuse of existing structure elements. Contact the BB&S for approval when considering this approach.

**Coring of Reinforced Concrete Superstructures.**

Projects involving the staged removal of reinforced concrete slab bridges and box culverts will have top slab concrete cores taken to verify the condition of the concrete for use under stage traffic. Use the following guidance in taking cores:

- Take a minimum of one 4-inch diameter core per span.
- Take cores near mid-span, preferably along the centerline of a wheel-path.
- Take cores from the section of the slab anticipated to carry staged traffic.
- Determine the compressive strength of the structural concrete component of the core.

A Bridge Core Data Form (IDOT BB&S Form: BBS 2720) will be used to record the results and provide a detailed description and photograph of the core. If the cores indicate the concrete is in an advanced state of deterioration (i.e. heavily fragmented or returned to an aggregate like material) immediately notify the Bureau of Bridges and Structures for evaluation and possible load posting.

The coring results will be used in the analysis and scope of work selection process as well as included in Attachment M of the Bridge Condition Report.

**Bearings.**

The general condition and type of bearings present on the structure must be reviewed. All bearings should be repaired/reset or replaced that show evidence of excessive deterioration, damage or tilting. Additional guidance on bearings is as follows:

<u>At Transverse Expansion Joint Locations</u>.
On Bridge Reconstruction and Bridge Rehabilitation (deck replacement and super/substructure widening) projects all steel high profile rocker and roller bearings will be replaced with elastomeric bearings, if practical.

On Bridge Rehabilitation (other than deck replacement and super/substructure widening) or Bridge Deck Repair projects these bearings should be replaced with elastomeric bearings if in poor condition or if desired by the District and funding is available.

<u>At Non-Transverse Joint Locations</u>. If the bearings are in good overall condition they may be reused, if practical.

<u>In Structure Widening Cases Where Additional Beam Lines Are Required</u>. If additional beam lines are added to a structure the expansion bearings must be matched in type transversely across the structure.

**Special Considerations.**

The superstructure should be reviewed and analyzed for the following details if applicable.

Steel Beams & Girders: Existing steel beams or girders scheduled for a new deck shall be made composite their full length when practical regardless if composite action is necessary for strength.

Fatigue Evaluation of Existing Welded Cover-plates: On Bridge Reconstruction and Bridge Rehabilitation (deck replacement and super/substructure widening) projects the remaining fatigue life of all structural steel girders with Category E or E' details must be evaluated in accordance with Section 2.4.2.4 "Retrofit of Existing Welded Coverplates" of the IDOT BB&S "Bridge Manual". The results of this analysis will be documented in the BCR. Reports produced by Consultant firms will provide this analysis as part of the report preparation process. Reports produced by District personnel will have this analysis completed by the BB&S Staff upon request.

Pin & Hanger Connections: On Bridge Reconstruction and Bridge Rehabilitation (deck replacement and super/substructure widening) projects steel girders with pin and hanger connections should be evaluated for elimination of this detail by making them continuous whenever practical and economical. Bridge condition reports produced by Consultant firms will provide this analysis as part of the report preparation process. Reports produced by District personnel will have this analysis completed by the BB&S Staff upon request.

Paint System: The condition of the paint system should be assessed and the cost to repaint the structure calculated if applicable. See the All Bridge Designers Memorandum 02.1 for details.

**Superstructure Widening.**

On superstructures being considered for widening, the following guidelines should be reviewed when determining the scope of work:

- The widened section should have similar structural characteristics to the existing section.
- Evaluate the condition of the existing deck if it is being considered for reuse in the widening. It is desirable for the existing and new sections of the deck to have the potential for similar maintenance and life expectancies. The higher the percentage the new deck is of the total deck area the more important this correlation becomes. Existing decks with significantly different maintenance or life expectancies than the proposed addition should be considered for replacement. If the existing deck is reused the joint between the new and existing deck sections should be placed within the center half of the slab span when practical.
- Evaluate any effects the widening will have on vertical clearances beneath the structure.

**Superstructure Evaluation Assessment.**

Once the information for the Superstructure Evaluation (other than deck) has been collected it must be evaluated. If the structure meets the minimum load capacity requirements for the proposed loading in its current condition then it satisfies criteria for this evaluation to remain in place. Bearing and special consideration factors must also be considered.

If the superstructure is found not to meet minimum requirements discussed in this section then further investigation is required. Girders not meeting minimum strength requirements should be strengthened or replaced. Items in the “special considerations” category should be assessed and any work required identified. Changes to the bearings required to meet policy should also be noted.

## SUBSTRUCTURE EVALUATION

**General.**

This evaluation usually consists of a review of the substructure condition, load capacity and a scour assessment as applicable.

**Condition.**

The main load carrying elements of the substructure are evaluated to determine if they are structurally sound and in sufficient condition to remain in place or require repair or replacement. Areas that require repair are identified and an estimated length or area requiring repair is made. These main load carrying elements often consist of substructure caps, columns, stems, footings and piling. Some areas of importance to consider during this review are:

- significant section loss or damage to a member that affects the load capacity.
- general deteriorated condition of an element that indicates possible reduced capacity.

If elements of the substructure are thought to be have sufficient damage to significantly affect the load capacity then a capacity check must be made.

**Load Capacity.**

Changes to substructure and foundation loading condition will be evaluated as follows:

**Abbreviated Analysis:**

The load capacity of existing substructure and foundation elements may be assumed to be adequate for reuse without a detailed structural analysis when:

- The substructure elements are in good condition (NBIS Condition Rating of 6 or greater) and show no significant structural distress under existing live load.
- The proposed service dead load is not greater than 115% of the original design service dead load at the top of the substructure element (top of bearing seat).
- There is no significant reconfiguration of loads (i.e. changes to bearing locations or substructure fixities).

**Detailed Analysis:**

If the structure does not satisfy the criteria outlined above for an Abbreviated Analysis, a detailed capacity check of the existing substructure elements (caps, columns, stems, footings, etc) and foundation elements (piling and spread footing) shall be completed as follows:

<u>Substructure Elements</u>:

For Caps, Columns, Stems, Footings, etc. originally designed using the AASHTO ASD or LFD design codes: A detailed capacity check of the existing substructure elements shall be completed using an Illinois Modified Group-1 load combination per the AASHTO LFD Bridge Design Specifications. The analysis shall consider all applicable dead loads and the effects of the HS-20 live load configuration. As a minimum, the substructure elements shall be investigated for the Standard Specifications, Division 1A, 500 year seismic hazard. The Illinois Modified Group-1 load combination is:

1.15 x DL + 1.3 x (1.67 x LL)

If a substructure element is found to be deficient following detailed analysis with this load combination, consider:

1. Reducing the proposed dead loads (i.e. reduce or eliminate FWS, change parapet type, etc.)
2. Investigate individual substructure element replacement, strengthening, or retrofit based on an economic analysis. All replacement elements shall be designed LRFD.
3. Total replacement

All of the above approaches are subject to the approval of the BB&S.

Existing substructures originally designed using the LRFD design code which are in adequate condition to consider being reused with a new LRFD designed superstructure may be evaluated as described above under Load Capacity with the exception that when completing a Detailed Analysis of a substructure the AASHTO LRFD Bridge Design Specifications with HL-93 Live Loading will be used to complete the analysis.

<u>Foundation Elements</u>:

**Pile Foundations**: When existing production pile driving data is available, the "as driven" pile resistance may be used rather than the plan design capacity. Existing piles often have greater geotechnical resistance than specified on the original plans due to various factors. ***The following table and the example calculation provide a method to calculate the potential increased pile capacity for existing structures constructed prior to January 2007. The increased pile capacity calculated using this table does not apply to structures constructed after this date***.

**<u>Existing Pile Capacity Determination Table</u>:**

<table>
<tr><td>$C_s$</td><td>Existing Pile Capacity Source</td><td colspan="4">Existing Driving Records<br>(0% capacity increase)</td><td colspan="4">Existing Plans Pile Data<br>(10% capacity increase)</td></tr>
<tr><td>$C_b$</td><td>Low Capacity Formula Bias</td><td colspan="4">Pile Capacity > 40 tons<br>(0% capacity increase)</td><td colspan="4">Pile Capacity < 40 tons<br>(6% capacity increase)</td></tr>
<tr><td>$H_e$</td><td>Hammer Efficiency Correction</td><td colspan="3">Closed End Diesel, Drop or Unknown Hammer<br>(0% capacity increase)</td><td colspan="3">Open End Diesel Hammer<br>(4% capacity increase)</td><td colspan="2">Air-Steam Hammer<br>(8% capacity increase)</td></tr>
<tr><td>$P_e$</td><td>Pile Effect on Hammer Efficiency</td><td colspan="4">Precast Concrete or Timber Pile<br>(0% capacity increase)</td><td colspan="4">Metal Shell or Steel H-Pile<br>(4% capacity increase)</td></tr>
<tr><td>$P_l$</td><td>Pile Length Formula Conservatism</td><td colspan="2">Driven or Estimated Length < 60 ft.<br>(0% capacity increase)</td><td colspan="3">Estimated Plan Pile Length > 60 ft.<br>(2% capacity increase)</td><td colspan="3">Driving Records Driven Length > 60 ft.<br>(4% capacity increase)</td></tr>
<tr><td>$S_m$</td><td>Borings Indicate Main Mode of Support</td><td>No Records Available<br>(0% cap. increase)</td><td>End Bearing in Soil or Shale<br>(0% cap. increase)</td><td colspan="2">Friction in Granular Soils<br>(8% cap. increase)</td><td>Friction in Cohesive Soils<br>(16% cap. increase)</td><td colspan="2">End Bearing in Sandstone<br>(16% cap. increase)</td><td>End Bearing in Limestone or Dolomite<br>(20% cap. increase)</td></tr>
</table>

**Example**: Existing plans pile data indicate timber piles, estimated to be 62 ft. long, with a design capacity of 24 tons. The pile driving records indicate that a MKT 11B3, a Closed End Air-Steam hammer, was used and on average the piles were driven 57 ft. with a final bearing of 30 tons.

The allowable resistance available $R_a$, can be determined by the following formula: $R_a$ = **Existing Capacity** x ($1+C_s+C_b+H_e+P_e+P_l+S_m$). The Exist Cap = 30 tons from driving records, $C_s$ = 0.0 since we have driving records, $C_b$ = 0.06 since the Exist Cap is below 40 tons, $H_e$ = 0.08 due to the use of an Air-Steam Hammer, $P_e$ = 0.0 because timber piles were used, $P_l$ = 0.0 based on a driven length < 60 ft., and $S_m$ = 0.0 since no borings are available. The factored resistance available $R_F$ is determined by multiplying by the factor of safety which is assumed to be 3.0 and the resistance factor which is taken as 0.5.

$R_a$ = 30 tons x (1+0+0.06+0.08+0+0+0) = 30 tons x 1.14 = 34.2 tons, 14% < 50% so OK.
$R_F$ = $R_a$ x (Safety Factor) x (Resistance Factor) = 34.2 x 3 x 0.5 x 2 kips/ton = 102.6 kips

*<u>The new factored strength group pile loading must not exceed the factored resistance available of 102.6 kips</u>*.

**Spread Footing Foundations**: Existing spread footings often have greater geotechnical capacity than indicated on the original plans when various factors are present. The table shown below and the example provide a method to calculate the potential increased capacity for existing structures. Settlement need not be checked when using this table.

**Existing Spread Footing Capacity Determination Table:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **$R_a$** | No Borings Available (**2 ksf**) | Mixed soils with N >15 (**4 ksf**) | Clay soils with $Q_u$ > 3.0 (**6 ksf)** | Very Dense Granular with N > 50 (**8 ksf**) | Hard Clay Till with $Q_u$ > 4.5 (**10 ksf**) | Sandstone or Shale (**15 ksf**) | Limestone or Dolomite (**30 ksf**) |

Example: Obtain the footing plan dimensions and base elevation from the existing plans. Calculate the existing and proposed footing loading to obtain the maximum applied service bearing pressure (**$Q_{max}$**) and resultant eccentricity. If the proposed $Q_{max}$ is more than 50% above the existing loading, the footing cannot be reused. If founded on soil, calculate the proposed equivalent uniform bearing pressure (**$Q_{EUBP}$**). Using new or existing boring data, locate the footing base elevation and evaluate the soils/rock within a depth of 1.5 times the footing width to determine the allowable **service bearing capacity $R_a$** from the above table.

*The proposed applied bearing pressure ($Q_{max}$ for rock or $Q_{EUBP}$ for soil) must be less than the allowable service bearing capacity $R_a$ and the proposed resultant eccentricity must be within the middle third (for soil) or middle half (for rock) of the footing for the existing foundation to be considered adequate*.

For both piles and spread footings lateral loads to piles or sliding need not be checked unless the structure is in seismic categories C or D (AASHTO LFD) or seismic zones 3 or 4 (AASHTO LRFD). The allowable resistance available may be converted to factored resistance by multiplying by 1.5 (3.0 Factor of Safety times 0.5 resistance factor). The foundation element may be reused providing the following conditions exist:

1. The Illinois Modified Group-1 load combination is below the actual calculated resistance available from the existing foundation as described above.
2. The hydraulic analysis and soil conditions indicate no substantial scour.
3. Deterioration has not compromised the structural integrity of the piles or footing.
4. Inspections indicate no past foundation settlement.
5. There is sufficient redundancy (more than 4 piles per foundation element).
6. The increase in pile capacity or service bearing loading does not exceed 50%.

In-kind substructure widening with additional foundation capacity being added typically does not require a detailed analysis at this time except as described above. However, when the original structural design concept is changed, such as replacing a series of simple spans with a continuous span structure, changing superstructure to substructure fixity or significant changes in bearing location and elevation are made the capacity of the substructure unit must be evaluated. In these cases the Abbreviated Analysis does not apply and a Detailed Analysis will be required.

In some cases the use of a reduced FWS allowance may be considered to permit reuse of existing structure elements. Contact the BB&S for approval when considering this approach.

**Semi-Integral Abutments.**

Existing structures with transverse expansion joints at the abutments that are being considered for Bridge Reconstruction or Bridge Rehabilitation (deck replacement and super/substructure widening) should be considered for modification to semi-integral abutments if applicable. The limitations for use of this type of abutment are found in Section 2.3.6.2.1 of the IDOT Bridge Manual. The capacity of the abutments should also be reviewed to ensure they are adequate to carry the additional loading often required in the conversion to this abutment type.

**Scour Review.**

A review of the substructure for scour related problems should be made on structures over streams. Areas of particular concern to identify are exposed footings and piling. The potential for future damage due to this problem should also be assessed.

If scour damage is identified or thought to be likely then repairs/countermeasures should be identified for bridges not being replaced.

**Substructure Widening.**

On substructures being considered for widening the following general guidelines should be reviewed when determining the scope of work:

For bridge widening projects, the pier cap may be widened and cantilevered off the existing stem where structurally practical and sufficient foundation capacity exists.

Piers with an "expansion" fixity condition to the superstructure that require additional foundation capacity may often be widened with a single row of piles in a pile bent. Situations that may preclude this treatment are locations were the loads to be carried are large and require multiple rows of piles to support them or grade separation structures were this approach may not be aesthetically desirable. In these situations widening the pier "in kind" may be necessary.

Piers with a "fixed" fixity condition to the superstructure that require additional foundation capacity may potentially be widened by either of the two methods mentioned above. However, a check of the pier capacity for the revised longitudinal and transverse forces applied must also be made in addition to vertical load capacity review. If insufficient longitudinal or transverse capacity is found then widening in kind may be necessary.

When selecting a method of substructure widening consideration must be given to maintaining the structural integrity of those elements to be reused especially in regard to the method of attachment of the new section of substructure to the existing sections.

**Substructure Evaluation Assessment.**

Once the information for the Substructure Evaluation has been collected, it must be evaluated. If the substructure meets the capacity requirements for the proposed loading in its current or modified condition then it satisfies criteria for this evaluation to remain in place.

If the structure is found not to meet requirements discussed in this section then further investigation may be required. Substructures not meeting minimum strength requirements should be strengthened, have capacity added, or be replaced.

## SEISMIC EVALUATION.

### General:

This sub-section provides guidance on completing seismic evaluations. A large number of factors may contribute to how a bridge responds during seismic loading. These factors can vary greatly with the structure type and location. Given the large number of variables that exist, a simple cook-book type approach which can be applied to all structures is not practical. The following guidance outlines the level of evaluation required. Some basic seismic retrofit measures are also identified.

Each bridge will initially be assessed to determine the level of seismic evaluation required based on its importance category, structure type, location, estimated remaining service life and scope of work. Three levels of evaluation have been developed. The levels are: Seismic Evaluation Not Required, Abbreviated Seismic Evaluation and Detailed Seismic Evaluation. Each is described in the following paragraphs and detailed in the flow chart on page 28 of this document.

For additional guidance use the IDOT Bridge Manual and the FHWA-RD-94-052 "Seismic Retrofit Manual for Highway Bridges" (May 1995). The general analysis and design philosophy of the May 1995 FHWA publication is preferred by the Department. The more recent publication FHWA-HRT-06-03T "Seismic Retrofitting Manual for Highway Structures" (January 2006) should also be consulted when selecting specific retrofit measures for the various elements of the bridge. This document provides more extensive guidance on retrofit measures.

The two importance categories for highway structures used in this guidance are Essential and Standard Bridges. They are defined as follows:

Essential Bridge: A bridge located on or crossing over an IDOT Earthquake Emergency Route (EER). Consult with the District to determine if a bridge falls within this category.

Standard Bridge: All structures not meeting the criteria outlined for Essential Bridges.

### Seismic Evaluation Not Required:

A Seismic Evaluation is Not Required for bridges meeting one of the following criteria:

- Structures with ≤ 15 years of estimated remaining service life (unless otherwise determined by the BB&S).
- Structures falling in AASHTO LFD SPC-A.
- Box culverts and buried structures.
- Simple & continuous span bridges with integral abutments and pile bent piers.
- All bridges with a Scope of Work consisting of maintenance type work not requiring a BCR.

### Abbreviated Seismic Evaluation:

An Abbreviated Seismic Evaluation is required for bridges not meeting the criteria for "Seismic Evaluation Not Required" and meeting the following criteria:

- Structures falling in AASHTO LFD SPC-B or C.
- Bridges in the following Scope of Work categories:
  - Essential and Standard bridges requiring Bridge Deck Repair
  - Standard Bridges requiring Bridge Rehabilitation (other than Substructure Widening)
- Essential and Standard single span bridges in AASHTO LFD SPC-B & SPC-C.

An abbreviated seismic evaluation will be completed for these structures consisting of the following:

1. Substructure Seat Widths will be reviewed and modified if necessary to meet current policy as outlined in the IDOT Bridge Manual (BM), T3.15.4.2-1.

2. Liquefaction potential will be reviewed using the existing borings. If existing borings are not available or inadequate contact the BB&S for guidance.

3. Bearings will be reviewed and:
   - High profile rocker or roller expansion bearings will be replaced with elastomeric bearings if practical.
   - High profile fixed bearings will be modified ,if necessary, for a applied lateral force of 20 percent of total dead load as stated in Appendix A-2 (FHWA), and allowable capacity as stated in the BM, T.3.7.3-1 & 2. Contact the BB&S for fixed bearing retrofit options.

4. Projects in this category require no detailed analysis of the substructure or foundation for seismic loads unless specifically requested by the BB&S.

**Detailed Seismic Evaluation:**

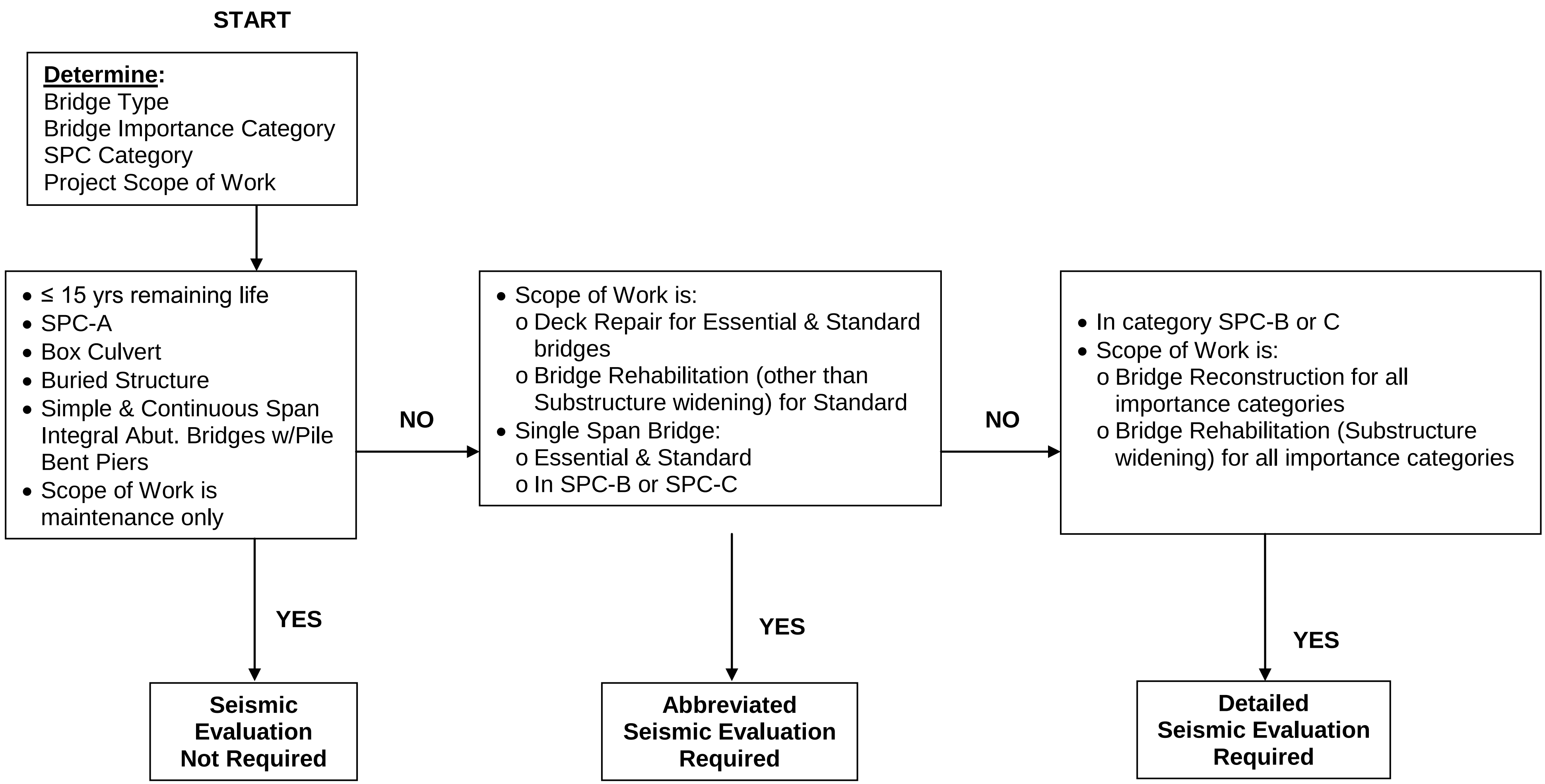
A Detailed Seismic Evaluation is required for bridges not meeting the criteria for Seismic Evaluation Not Required or Abbreviated Seismic Evaluation and meeting the following criteria:

- Structures falling in AASHTO LFD SPC-B or C.
- Bridges in the following Scope of Work categories: Bridges of all importance categories requiring Bridge Reconstruction or Bridge Rehabilitation (Substructure Widening).

If seismic rehabilitation measures are determined to be warranted, the objective of the measures should be:

- Hazard to life is minimized.
- Bridges may suffer damage but should have a low probability of collapse.
- Damage should be confined to easily accessible locations if practical and economical.
- The function of Essential-EER bridges will be maintained with little or no repair required.

Bridges determined to require seismic retrofit will have an estimated scope of work provided in the BCR for review and approval by the BB&S. The extent of the rehabilitation measures used will be influenced by factors such as the bridges importance, ADT, estimated service life and the availability of funding.




**Seismic Evaluation Requirements:**

## MISCELLANEOUS CHECKS

### Deck Drains.

On bridges were the existing deck is proposed to remain in place, a review of the deck drains should be made if applicable. Many older decks have drains that do not meet current policy and cause damage to the bridge. The following general criteria should be used when reviewing free fall deck drains to remain in place:

- Drains located within 10' of substructure units should be plugged if practical.
- Decks that contain large numbers of small drains spaced at less than 8' centers should have every other drain of this type plugged if practical.
- Drains to remain in place that do not extend below the low beam elevation of the nearest beam a minimum of 3" should be extended to a point at least 6" below the low beam.

Existing closed drainage systems should be inspected for clogging and damage. Repairs or modifications to these systems should be planned as needed.

### Waterborne Debris.

Debris buildup at structures over streams can cause a reduction in flow through the structure and an increased likelihood of scour. Any current or past debris collection problems at the structure should be noted and a description provided.

### Slopewall & Stream Protection.

The slope and stream protection systems on structures and embankments proposed to remain in place should be reviewed for adequacy. The following general criteria should be used when reviewing slopewalls & stream protection systems to remain in place:

- Slopewall and stream protection systems should be reviewed for damage, deterioration or undermining. If they are found to have significant damage they should be repaired or replaced.
- When it is determined the slope protection system needs replaced it is preferred to use riprap at stream crossings and concrete slopewalls at grade separation structures. If the stream velocity or site conditions preclude the use of riprap then rock blankets, slope mattress or other protective system may be considered.
- The slope protection system should be checked for conformance to the width dimension policies past the edge of deck located in the Bridge Manual Section 2.3.6.3.3.

### Reuse of Bridge Components Without Original Plans Available.

The following general criteria should be used when considering the reuse of bridge components for which the original plans are not available:

- Structures falling in the scope of work categories of Bridge to Remain in Place, Bridge Deck Repair and Bridge Rehabilitation (other than deck replacement and super/substructure widening) may be considered for reuse if found to be in good condition with only the need for minor repairs and after a structural evaluation has been made.

- Structures requiring additions in load, Bridge Reconstruction or Bridge Rehabilitation (deck replacement and super/substructure widening) should in general not be considered for reuse.

## STAGE CONSTRUCTION FEASIBILITY EVALUATION

If stage construction is being considered as an option to complete the proposed scope of work then a review of the structure should be made to determine if this is practical. The categories listed below provide some general guidance that should be reviewed as applicable.

**Lane Widths.**

The lane widths listed below should be considered when reviewing stage construction practicality:

- Lane widths of 14' or greater are optimal as they do not require a wide load detour.
- Lane widths of 12' or greater are desirable from a safety aspect.
- A lane width of 10' is generally considered the minimum allowable.

**Superstructure Considerations.**

The following superstructure considerations should be reviewed for stage construction projects:

- On multi-girder supported bridges, each stage section should be supported by a minimum of 3-longitudinal girders. The use of any other stage construction configuration requires approval from the BB&S.
- Superstructures that consist of a truss, arch, or 2-girder system are often not compatible with stage construction on major Rehabilitation, Reconstruction or Replacement projects. A structural evaluation will have to be made to determine staging feasibility on a case by case basis for these bridges.
- On girder supported bridges the cantilevered deck section at the stage line must be reviewed for structural acceptability.
- On culverts with high skews to the roadway and the primary reinforcement placed perpendicular to the axis of the barrels, temporary support of the slab may be necessary at the stage line for reinforcement cut on the skew.
- When practical, select the section of the structure in the best structural condition to carry stage construction traffic.
- Existing PPC deck beams being proposed to carry stage construction traffic may require evaluation for sufficient capacity and life to last the duration of the construction project.

**Substructure Considerations.**

The following substructure considerations should be reviewed for stage construction projects:

- Overall stability of the remaining section of a substructure unit supporting traffic must be reviewed if a significant structural element of the unit is removed.
- One or two column piers may not be compatible with stage construction on replacement projects. A structural evaluation will have to be made to determine staging feasibility on a case by case basis.

**Profile Changes.**

The considerations listed below should be reviewed for stage construction projects involving significant profile changes. Projects with large profile changes should not be stage constructed whenever practical.

- The feasibility/cost of retaining the soil due to the proposed cut/fill situation must be reviewed.
- The stability of substructure units near proposed cut/fill situations must be investigated.

## ECONOMIC EVALUATION

**General.**

Once the evaluations of the various geometric, hydraulic, physical and structural aspects of the structure are finished, an economic evaluation should be completed. The economic evaluation will estimate the initial construction cost for the various scope of work alternatives being considered for the project. The estimates will reflect the findings of the other evaluations completed regarding need for repair, rehabilitation and reconstruction of any structure elements being considered for reuse. To be considered for reuse an element must be in good or economically repairable condition with adequate structural capacity. The element must also have sufficient remaining service life after the project is complete to last as long as the other major elements of the structure without requiring an unreasonable amount of maintenance. Aesthetic appearance may also be considered when warranted.

In the absence of other overriding factors, a rule of thumb to determine when existing structure elements are economical for reuse is as shown below:

<u>Cast in Place Concrete Decks</u>: See the "Deck Repair verse Replacement Assessment Table" located in this section for guidance on repair verse replacement.

<u>Individual Bridge Elements</u>: If the cost to modify, repair and/or strengthen it is < 50% of the replacement cost, it may be considered for reuse.

<u>Major Components</u>: If the cost to modify, repair and/or strengthen it is < 60% of the replacement cost, it may be considered for reuse.

NOTE: the above categories are defined as follows:
Cast in Place Concrete Decks – self explanatory
Individual Bridge Elements – pier cap, column, individual beam line, etc.
Major Components – superstructure, substructure or entire structure

In some instances an economic analysis regarding reuse of existing structure components may not be necessary. Examples of these cases are structures whose physical condition is obviously beyond economical repair, a major roadway geometry change causing the structure to be relocated or unacceptable hydraulic or structural capacity factors. In these instances the reason for not completing an economic analysis must be well documented in the Bridge Condition Report.

**Cost Estimate Preparation.**

The economic evaluation is usually completed as one or more cost estimates. A cost estimate must be completed for each scope of work deemed appropriate for the given project parameters and structure condition/capacity. Unless otherwise directed, cost estimates will be prepared based on initial construction cost to complete the work using itemized costs.

The itemized cost estimates will generally include all significant pay items necessary to complete the proposed work to include the following:

- Structure pay items to include structure repairs
- Staging & Traffic Control related to the structure
- Profile revisions necessary for structure related issues such as clearances

## SCOPE OF WORK SELECTION

The scope of work selection is the final step in the bridge analysis process. It requires a review of the critical factors surrounding the structure and project. These factors can be separated into the following categories:

1. Structure Condition and Load Capacity
2. Geometric and Hydraulic Acceptability
3. Economic Evaluation
4. Exterior Constraints

The first three items on this list have already been covered in this section during the discussion of the following evaluations:

- Geometric & Hydraulic Capacity
- Deck
- Superstructure (other than deck)
- Substructure
- Miscellaneous Checks
- Stage Construction Feasibility
- Economic

The remaining factor, Exterior Constraints, consists of issues which impact a project but are not directly related to the physical condition, geometrics/hydraulics and repair/replacement cost relationships. Typical exterior constraints are:

- Adverse affects on traffic control
- Unacceptable user delay
- Emergency need of repair
- Availability of funding

When Exterior Constraints influence the scope of work decision on a structure they must be thoroughly analyzed and well documented in the Bridge Condition Report.

Once all the categories of evaluation have been completed, the results are reviewed in whole and the most appropriate scope of work is selected for the structure.

# SECTION - IV. ABBREVIATED BRIDGE COORDINATION

## GENERAL.

The Abbreviated Bridge Coordination formats are used to document the necessary information for a structure to allow the proposed scope of work to be approved. These formats are intended for projects were minor or no work is planned for a structure. They are intended to minimize the effort required by District and Central Bridge Office personnel to complete, process and approve these types of projects while ensuring adequate documentation and analysis of the proposed work.

Abbreviated bridge condition reports for deck repair projects should not be submitted for approval with scheduled construction dates greater than two calendar years from the date submitted.

The paragraphs listed below describe the required abbreviated formats for the various scopes of work covered by this section. Scope of work definitions are provided in Section-III of this document.

## BRIDGES TO REMAIN IN PLACE COORDINATION.

Structures whose scope of work is determined to be "Bridge to Remain in Place" fall into this category. A memorandum may be submitted in lieu of a formal BCR or Abbreviated BCR in this case. The memorandum must briefly describe the good condition of the structure and the District's intent to do no work on the bridge as part of the proposed improvement. Along with the memorandum a copy of the Illinois Structure Information System (ISIS) – Master Report (107) and of the most recent NBIS report should be attached.

## B-SMART, BRIDGE REPAIR & MAINTENANCE REPORTS.

Structures with the scope of work indicated below and meeting the criteria shown fall into this category. An Abbreviated BCR is required for these structures.

| SCOPE OF WORK: | CRITERIA: |
|---|---|
| Bridge Deck Repair | Bridge deck overlays to be completed as B-SMART projects (1). |
| Bridge Rehabilitation | (Other than deck replacement and super/substructure widening) Minor repairs such as bridge rail retrofit, transverse or longitudinal joint work, minor beam repairs and minor substructure repairs (2). |

Notes:

(1) All deck overlay projects not meeting this criterion except Day Labor Force and Contract Maintenance Projects require the submittal of a full BCR. See Section V of this document for the appropriate format. Day Labor Force and Contract Maintenance deck overlay projects do not require the submittal of a BCR or Abbreviated BCR. However, a memorandum describing the proposed work type, surface removal thickness, overlay type and overlay thickness must be sent to the BB&S for approval prior to completing the work.

(2) When the minor repairs listed above as part of "Bridge Rehabilitation" are to be completed by Day Labor forces, District Maintenance forces or as part of Contract Maintenance projects this work does not require submittal of a BCR or Abbreviated BCR to approve the work.

## REPORT FORMAT.

The information required in the Abbreviated BCR has been provided in an example report format. Each report prepared should follow the format provided. Incomplete reports will be returned to the District for correction and resubmittal.

**See Appendix – A, of this document for the Abbreviated Bridge Condition Report Format.**

# SECTION - V. BRIDGE CONDITION REPORT PREPARATION

## GENERAL.

The Bridge Condition Report is used to document the necessary information on a structure to allow the proposed scope of work to be approved. This report is intended for projects where significant work is planned for a structure. It is required for the scopes of work Bridge Replacement, Bridge Reconstruction and Bridge Rehabilitation (deck replacement and super/substructure widening). Those structures classified as Bridge Rehabilitation (other than deck replacement and super/substructure widening) and Bridge Deck Repair which do not meet the requirements for an Abbreviated Bridge Condition Report described in Section-IV must also have a Bridge Condition Report completed for approval.

## REPORT PREPARATION.

Bridge Condition Reports must be detailed and thorough. Many scope of work decisions require some structural analysis. If the report is being prepared by a Consultant Firm, then the Consultant is responsible for completing this analysis. If the report is being prepared by the District then the BB&S should be contacted to complete the required structural analysis. All cost estimates, surveys and attachments must be completed by those responsible for preparing the report.

Bridge condition reports for deck repair projects should not be submitted for approval with scheduled construction dates greater than two calendar years from the date submitted.

## REPORT FORMAT.

The information required in the Bridge Condition Report has been provided in an example report format. The format describes in detail the information required to complete high quality reports that can be quickly processed and approved. Each report prepared should follow the format provided. Incomplete reports will be returned to the District for correction and resubmittal.

**See Appendix – B, of this document for the Bridge Condition Report Format.**

**APPENDIX – A. Example Abbreviated Bridge Condition Report Format (B-SMART, Minor Repair and Maintenance Projects)**

# ABBREVIATED BRIDGE CONDITION REPORT

## I. Administrative Data.

**REGION:**
**DISTRICT:**
**COUNTY:**
**ROUTE:**
**SECTION:** *(Provide the information indicated.)*
**JOB NUMBER:**
**PROPOSED LETTING DATE:**
**STRUCTURE NUMBER:**

**LOCATION:** *(Provide route carried over feature crossed.)*

## II. Roadway/Structure Data.

**Roadway Classification:**
**ADT (current):**
**ADTT (current):** *(Provide the information indicated.)*
**Inventory Rating (HS or HL):**
**Operating Rating (HS or HL):**
**Sufficiency Rating:**

**Construction / Reconstruction / Repair History:**

- *Provide the year, route and section the original structure was built under.*
- *Also provide the year/s and a brief description of any reconstruction, rehabilitation or repairs done to the structure since it was built.*

## III. Structure Condition Data.

**Inspection History (NBIS Ratings).**
**Year: Deck: Super: Sub:**
*Provide the latest NBIS ratings available for the structure.*

**Deck:** *Provide a description of the condition of the deck, railing and wearing surface. For concrete decks and slabs include separate square foot areas and percentages of the deck that are estimated to currently require partial and full depth patching.*

**Joints:** *Provide a description of the joint type and their condition.*

**Bearings:** *Provide a description of the condition of the bearings. Include any observations such as excessive tilting (give direction and angle), significant deterioration and broken/missing anchor bolts.*

**Beams:** *Provide a brief description of the condition of the beams. Include the locations and extent of any significant deterioration/damage which may affect the structural capacity of the bridge.*

**Substructure:** *Provide a brief description of the condition of the substructure. Include the area/length that is estimated currently requires repairs such as formed concrete repair or crack sealing. Describe any scour problems identified.*

**(Other):** *Provide a description of the condition of any other area being proposed for work. Include the locations and extent of any significant deterioration/damage.*

## IV. Discussion and Recommended Scope of Work:

*In this section the proposed scope of work is discussed. A detailed list of the work to be completed on the structure is provided. Included in this list should be all proposed deck repair work, overlay type, milling and overlay thickness, joint work, rail work, bearing work, substructure/beam repairs, plug/extend drains, slope protection repairs, etc.*

*The method of construction (road closure, temporary runaround or staging) must also be listed.*

## ATTACHMENTS:

### Attachment A. IDOT Master Structure Report
*Provide a copy of the Master Structure Report.*

### Attachment B. Bridge Inspection Report
Provide a copy of the most recent NBIS and Pontis bridge inspection reports.

### Attachment C. Cost Estimate
*Provide a copy of the cost estimate for the proposed work.*

### Attachment D. Structure Photos
*The following list can be used as a guideline to the type of photographs desired. All photos must be color and of high quality.*

1. *Picture taken looking up or down-station through the structure from approximately 30 feet off the bridge.*
2. *Picture(s) taken depicting the general condition of the top and bottom surfaces of the deck.*
3. *Picture(s) taken depicting the general condition of the joints and bearings.*
4. *Picture(s) of other areas of concern on the structure that are being proposed for work.*

### Attachment E. Abbreviated Existing Plans
*Provide an 11"x17" copy of the General Plan & Elevation and Superstructure Cross Section sheets only.*

**APPENDIX – B. Example BCR Format (Deck Repair, Major Rehabilitation & Replacement Projects)**

# BRIDGE CONDITION REPORT

**REGION:**

**DISTRICT:**

**ROUTE:**

**COUNTY:**

**JOB NUMBER:**

**STRUCTURE NUMBER:**

**LOCATION:** *(Provide route carried over feature crossed.)*

*(Comment: This cover sheet provides general information necessary to process the report. Provide the information indicated.)*

PREPERED BY: (provide name of preparer and District Office/Consultant name)

DATE INSPECTED:

PROPOSED LETTING DATE:

## Table of Contents



*(Comment: Provide a table of contents as shown above.)*

# I. Geographical & Administrative Data:

**Structure Number:** *(Provide the information listed in the column on the left.)*
**County:**
**Route Carried:**
**Feature Crossed:**
**Section:**
**Station:**

**Roadway Classification:**
**Design/Posted Speed:**
**ADT (current/design):** (Provide the ADT/ADTT for routes crossed also if applicable.)
**ADTT (current/design):**
**DHV:**
**Inventory Rating (HS or HL):**
**Operating Rating (HS or HL):**
**Sufficiency Rating:**

**Construction / Reconstruction / Repair History:**

- *Provide the year, route and section the original structure was built under.*
- *Also provide the year/s and a brief description of any reconstruction, rehabilitation or repairs done to the structure since it was built.*

# II. Physical Description of Structure:

*Provide a brief description of the structure with the following information:*

- *superstructure and substructure type*
- *length & width*
- *span arrangement and lengths*
- *skew*
- *existing wearing surface type and thickness*
- *existing horizontal & vertical alignment*
- *any utilities or attachments present*

# III. Field Inspection & Physical Evaluation:

**Provide a description of the physical condition of the different aspects of the structure. Some of the possible areas requiring comment are listed below. The reported conditions should be supported by the top & bottom of deck and substructure condition surveys along with the structure color photos provided in the attachments. The items listed below may not cover all areas requiring description for every structure. The engineer will have to use their judgment to determine if additional areas should be covered or if some areas listed are not required for a given report.**

## <u>Superstructure</u>:

**Deck:** *Provide a description of the condition of the deck, railing and wearing surface. For concrete decks and slabs include <u>separate square foot areas and percentages</u> of the deck that are estimated to currently require partial and full depth patching.*

**Beams:** *Provide a description of the condition of the beams. Include the locations and extent of any significant deterioration/damage which may affect the structural capacity of the bridge. The condition of the paint on steel beams should also be addressed if applicable. Some areas that may require special comment and/or analysis include fatigue sensitive details such as welded cover plates and pin & link systems.*

**Joints:** *Provide a description of the condition of the joints along with the joint type. A measurement of the joint opening and the temperature the measurement was taken at should also be provided if possible.*

**Bearings:** *Provide a description of the condition of the bearings. Include any observations such as excessive tilting (give direction and angle), significant deterioration and broken/missing anchor bolts.*

## <u>Substructure</u>:

**Abutments:** *Provide a description of the condition of the abutments, wingwalls and backwalls. Include the area/length that is estimated currently requires repairs such as formed concrete repair or crack sealing. If the abutments are thought to have moved or rotated this should be described and the distance from the face of the backwall to the top and bottom of the two fascia beam ends should be measured and provided. Describe any scour problems identified.*

**Piers:** *Provide a description of the condition of the piers. Include the area/length that is estimated currently requires repairs such as formed concrete repair or crack sealing. If the piers are thought to have moved or rotated this should be described. Describe any scour problems identified.*

**Scour/Slope Protection:** *Provide a description of the type and condition of the scour/slope protection. Include any estimated areas and locations that require repair.*

## Inspection History (NBIS Ratings):

**Year Deck Super Sub**

*Provide the NBIS ratings for the structure over the last 3 reporting periods if available.*

## <u>Geometric, Horizontal & Vertical Clearance / Hydraulic Data</u>:

*Provide information on the vertical & horizontal clearances through and beneath the structure as applicable. The hydraulic adequacy of the structure should be addressed if applicable. If scour or debris collection is a problem it should be described. Comment on whether the clearances, geometrics and/or hydraulics meet current requirements.*

## IV. <u>Potential Scope of Work Determination & Analysis</u>:

In this section potential courses of action are determined and analyzed for the structure. The number of courses of action that should be considered depends on the condition of the structure and its ability to meet current and proposed design criteria set by the Department. Some courses of action typically considered include the following:

1. <u>Rehabilitation - Repairs</u>:

2. <u>Rehabilitation - Deck Repair</u>:

3. <u>Rehabilitation - Deck Replacement</u>:

4. <u>Rehabilitation - Structure Widening</u>:

5. <u>Reconstruction - Superstructure Replacement</u>:

6. <u>Complete Replacement</u>:

An additional criterion that must be considered with the various courses of action is the method of construction – road closure, temporary runaround or staging.

The courses of action that are determined to be appropriate for analysis should be summarized individually listing a detailed description of the scope of work and have a cost estimate completed and included in the attachments if appropriate. Each course of action must consider how all desired design criteria will be addressed.

Typical example design criteria for structures are:
1. Geometrics / horizontal and vertical clearance through and beneath the bridge
2. Structure live load capacity
3. Bridge rail type
4. Structure condition/service life
5. Overall economics
6. Hydraulic capacity

## V. <u>Discussion and Recommended Scope of Work</u>:

*In this section the positive and negative merits of the potential scopes of work evaluated are summarized. The best scope of work is then selected after weighing these results. The reasons for selecting a particular scope of work must be identified. Any Exterior Constraints that affected the selection of the scope of work must be identified and discussed.*

On Rehabilitation and Reconstruction projects provide a sufficiently detailed scope of work. Some examples of what may be necessary to address are: bearings, joints, backwalls, approach pavements, bridge rails, drain extensions, beam/slope protection/substructure repairs and painting.

*The proposed structure clear width must be provided for Replacement, Reconstruction and Rehabilitation (deck replacement and super/substructure widening) projects.*

The method of construction (road closure, temporary runaround or staging) must also be identified.

**ATTACHMENTS:**

**Attachment A**. Location Map

*Provide a map identifying the location of the structure.*

**Attachment B. IDOT Master Structure Report**

*Provide a copy of the Master Structure Report.*

**Attachment C. Bridge Inspection Report**

*Provide a copy of the most recent NBIS and Pontis bridge inspection reports.*

**Attachment D. Top and Bottom of Deck Condition Surveys**

*Provide separate sketches of the top and bottom of deck detailing the location, area and type of deterioration present.*

**Attachment E. Substructure Condition Surveys**

*Provide sketches of each substructure unit detailing the location, area and type of deterioration present.*

**Attachment F. Cost Estimates**

*Provide copies of the cost estimates used in the Scope of Work Selection section. Each analysis should identify the proposed scope of work it pertains to along with pay item, quantity, unit cost and total cost of the items considered in the estimate.*

**Attachment G. Proposed Structure**

*Provide the proposed structure elevation view, plan view and cross section drawings. Provide a cross section for the route over if applicable. See the Bridge Manual, Section 2.2.3.4.4 for details.*

**Attachment H. Structure Photos**
*Provide high quality color photographs detailing the general condition of the structure. Photos of damaged areas or deterioration must also be provided.*

*The following list can be used as a guideline to the type of photographs desired:*

1. *Picture taken looking up-station through the structure from approximately 30 feet down-station of bridge.*

2. *Picture taken looking down-station through the structure from approximately 30 feet up-station of bridge.*
3. *Picture taken from the structure looking upstream (route) showing the existing ground features.*
4. *Picture taken from the structure looking downstream (route) showing the existing ground features.*
5. *Picture taken through the structure looking upstream (route) showing the bridge.*
6. *Picture taken through the structure looking downstream (route) showing the bridge.*
7. *Picture(s) of the corners of the structure showing the condition of the wingwalls and embankment.*
8. *Picture(s) of the expansion joints in the superstructure.*
9. *Picture(s) of the type and condition of the bridge rail.*
10. *Picture(s) depicting the general condition of the underside of each span of the superstructure.*
11. *Picture(s) depicting areas of deterioration/damage on the underside of the superstructure.*
12. *Pictures of each abutment depicting its type and condition to include the bearings and backwall.*
13. *Pictures of each pier depicting its type and condition.*
14. *Picture(s) showing any evidence of scour or streambed movement if* applicable.

**Attachment I. Hydraulic Analysis Summary (if applicable/available)**

*Provide a summary of the hydraulic analysis listing any concerns/issues and a copy of the approved waterway information table if available along with the streambed elevation at the structure.*

**Attachment J. Proposed Plan & Profile (if available)**

*Provide a copy of the proposed plan and profile sheet if available.*

**Attachment K. Existing and Proposed Roadway Cross Sections (if available)**

*Provide a copy of the existing and proposed (if available) roadway cross section adjacent to the structure.*

**Attachment L. Abbreviated Existing Plans**

Provide an 11”x17” copy of the General Plan & Elevation and Superstructure Cross Section Sheets only (provide any “as built” plan sheets if applicable).

Attachment M. Additional Test Results (if applicable)

*Provide a copy of any additional testing results taken (if applicable), i.e. Slab Coring Reports and structure borings.*

## APPENDIX – C. Concrete Deck Testing Procedures

Test 1 – (No Test Reference) Measurement of Reinforcement Bar Concrete Cover

This test uses a cover meter (pachometer) to detect reinforcing steel within concrete. For a meaningful evaluation, the greater of 40 locations per bridge deck or 40 locations per 465 m2 (5,000 sq. ft.) is recommended. The accuracy of the cover meter decreases as the depth of concrete cover increases. Thus, a correction factor should be obtained by exposing the reinforcement at one location to determine the actual depth. The test is used to verify an abnormally shallow reinforcement cover.

Test 2 – (AASHTO T 24) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

The primary use of deck coring is to determine the depth of delaminations, and to differentiate between delaminations and debonding when an overlay is present. This information is helpful when conducting delamination surveys according to Methods 1 and 3. The deck core also provides a visual inspection of the quality of the deck. The number of cores is based on engineering judgment.

Test 3 – (ASTM C 805) Rebound Number of Hardened Concrete

The operation of the rebound hammer (also called the Schmidt Hammer or Swiss Hammer) provides a quick method to determine the uniformity of concrete at the surface, which may be useful information if surface removal by hydro-demolition is anticipated. The test has also been used to estimate concrete strength, but accuracy is limited. Therefore, concrete strength estimation with this test method is not recommended. The number of test locations is based on engineering judgment, with 10 tests per test location area.

Test 4 – (AASHTO T 22) Compressive Strength of Cylindrical Concrete Specimens

This test is the best method for determining concrete strength of bridge deck cores obtained according to Test 2. The test information may help with determining areas of the bridge deck which need full depth repairs. Areas of the bridge deck which appear to be sound should also be tested for comparison. The number of tests is based on engineering judgment. However, at least three deck cores should be tested when determining strength.

Test 5 – (ASTM C 876) Corrosion Potentials of Uncoated Reinforcing Steel in Concrete

This test is used for detecting the corrosion activity of the reinforcing steel in the bridge deck, but does not provide information on the corrosion rate. For a meaningful evaluation, refer to ASTM C 876 for an appropriate testing program. The test should not be performed on bridge decks which contain epoxy-coated or galvanized reinforcement. Data presentation of the test measurements is performed by an equipotential contour map or by a cumulative frequency diagram. The equipotential contour map provides a graphical presentation of where corrosion activity may be occurring in the bridge deck. The frequency diagram provides an indication of the magnitude of the affected bridge deck area. The usefulness of this test comes from the comparison to tests performed on other bridge decks. The test results and the subsequent performance of bridge deck repairs can provide some guidance on the most effective rehabilitation method. Rehabilitation methods may include overlays, sealers, corrosion inhibitors, and cathodic protection. In addition, the test results obtained from several bridge decks may provide information for estimating repair quantities on future bridge deck projects.

Test 6 (Method A) – (AASHTO T 260) Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials

This test determines total chloride content of concrete. This includes chloride content that is soluble and will contribute to corrosion, plus chloride content that is chemically bound to the concrete and may not contribute to corrosion. Chemically bound chlorides are found in the aggregate, and this is called “benign” chloride content. If benign chlorides exist in the aggregate, the corrosion threshold is 0.8 kg/cu m (1.4 lb./cu yd) plus the amount of benign chloride content in the aggregate. In Illinois, chloride content in bridge decks will generally exceed the corrosion threshold limit. For a meaningful evaluation, the greater of 10 locations per bridge deck or 10 locations per 465 m2 (5,000 sq. ft.) is recommended. The usefulness of this test comes from the comparison to tests performed on other bridge decks. The test results and the subsequent performance of bridge deck repairs can provide some guidance on the most effective rehabilitation method. Rehabilitation methods may include overlays, sealers, corrosion inhibitors, and cathodic protection. In addition, the chloride test results obtained from several bridge decks will provide information for estimating repair quantities on future bridge deck projects. The disadvantage of the test is the fewer number of test results which can be obtained in a day, as compared to Test 5. However, the presence of epoxy-coated or galvanized reinforcement does not restrict the use of the test as compared to Test 5.

Test 6 (Method B) – (AASHTO T 332) Determining Chloride Ions in Concrete and Concrete Materials by Specific Ion Probe

AASHTO T 332 is another test for determining total chloride content of concrete. The test results correlate well with the AASHTO T 260 test method. The advantage of the AASHTO T 332 test over AASHTO T 260 is that more tests can be performed in a day. In addition, the AASHTO T 332 testing can be conducted in the field.

Test 7 – (ASTM C 856) Petrographic Examination of Hardened Concrete

This test is conducted on bridge deck cores obtained according to Test 2, and should be done only after consultation with the Bureau of Materials and Physical Research. Bridge decks which are experiencing excessive and unusual concrete deterioration, as compared to other decks at the same age, may warrant this test. The test is used to determine possible freeze/thaw damage due to inadequate air entrainment of the concrete, possible freeze/thaw damage due to susceptible aggregate materials, possible alkali-silica reactivity of certain aggregate materials, and possible alkali carbonate reactivity of certain aggregate materials. The number of tests is based on engineering judgment.

The following references were used to provide information on Tests 1 – 7.

Guide for Evaluation of Concrete Structures Prior to Rehabilitation (ACI 364.1R)
In-Place Methods for Determination of Strength of Concrete (ACI 228.1R)
Workshop of SHRP Research Products related to Methodology for Concrete Removal, Protection and Rehabilitation (Publication No. FHWA-SA-97-003)