Understanding Bridge Component Condition Ratings

Based on material provided by: U.S. Army Corps of Engineers
Learning Objectives

• Correctly apply NBI condition ratings to bridge components
• Evaluate costs associated with inspection findings
Condition Rating

- A judgment of a bridge component condition in comparison to its original as-built condition
Three main components of a bridge

- Deck
- Superstructure
- Substructure
Sets the standards for rating components -
- Deck
- Superstructure
- Substructure
Bridge Inspection Reference Manual (BIRM)

- Provides inspection guidance with detailed guidelines on the application of condition ratings
Component-Level Descriptive Condition Ratings

- **Good** - component defects are limited to only minor problems.

- **Fair** - structural capacity of the component is not affected by minor deterioration, section loss, spalling, cracking, or other deficiency.

- **Poor / Critical** - structural capacity of the component is affected or jeopardized by significant deterioration, section loss, spalling, cracking, or other deficiencies.
### NBI Condition Ratings

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>NOT APPLICABLE</td>
</tr>
<tr>
<td>9</td>
<td>EXCELLENT CONDITION</td>
</tr>
<tr>
<td>8</td>
<td>VERY GOOD CONDITION - no problems noted.</td>
</tr>
<tr>
<td>7</td>
<td>GOOD CONDITION - some minor problems.</td>
</tr>
<tr>
<td>6</td>
<td>SATISFACTORY CONDITION - structural elements show some minor deterioration.</td>
</tr>
<tr>
<td>5</td>
<td>FAIR CONDITION - all primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.</td>
</tr>
<tr>
<td>4</td>
<td>POOR CONDITION - advanced section loss, deterioration, spalling, or scour.</td>
</tr>
<tr>
<td>3</td>
<td>SERIOUS CONDITION - loss of section, deterioration, spalling, or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.</td>
</tr>
<tr>
<td>2</td>
<td>CRITICAL CONDITION - advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.</td>
</tr>
<tr>
<td>1</td>
<td>“IMMINENT” FAILURE CONDITION - major deterioration or section loss present in critical structural components, or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put bridge back in light service.</td>
</tr>
<tr>
<td>0</td>
<td>FAILED CONDITION - out of service; beyond corrective action.</td>
</tr>
</tbody>
</table>
Condition Rating Guidelines

• Should characterize overall condition
• Consider severity and extent of deterioration
• Evaluate multiple spans
  » Quantitatively (how much)
  » Qualitatively (how bad)
Weak Link

- If a deficiency reduces the load carrying capacity or serviceability of the component, the element can be considered a "weak link" in the structure, and the rating of the component should be reduced accordingly.
Weak Link
• Bridge postings (weight limit signs)  
  » shall have no influence upon condition ratings

• Temporary members (temporary repairs)  
  » shall not be considered in the influence of condition ratings
Condition Descriptions

- Section loss - usually applies to steel members or reinforcing steel
- Fatigue crack - applies to steel members
- Cracking/spalling - usually used to describe concrete
- Shear crack - usually applies to concrete but may apply to timber
- Checks/splits - applies to timber members
- Scour - removal of a streambed material in the channel or waterway or of bank area by stream flow
Condition Rating Guidelines

- Problems
- Deterioration
- Severity
- Condition Rating
Assigning Condition Ratings

9  EXCELLENT CONDITION

8  VERY GOOD CONDITION – no problems noted

7  GOOD CONDITION – some minor problems

6  SATISFACTORY CONDITION – structural elements show some minor deterioration

5  FAIR CONDITION – all primary structural elements are sound but may have minor section loss, cracking, spalling, or scour (deterioration)

4  POOR CONDITION – advanced section loss, deterioration, spalling, or scour

3  SERIOUS CONDITION – loss of section, deterioration, spalling, or sour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
Assigning Condition Ratings

Condition Descriptions - Steel

Good

• No deterioration (8)
• Minor surface corrosion (7)
• Minor pitting (6)

Fair

• Minor section loss, ≤1/16” (5)
• Measurable section loss (4)

Poor

• Significant section loss (3)
• Fatigue cracks (3)
Problems vs. Deterioration
Assigning Condition Ratings

Condition Descriptions – Reinforced Concrete

- No deterioration (8)
- Minor cracking (7)
- Minor spalling/delamination, cracking (6)
- Spalling/delamination, exposed reinforcement, moderate cracking (5)
- Large spalls/delamination, section loss, advanced cracking (4)
- Shear cracks, advanced section loss (3)
## Assigning Condition Ratings

### Condition Descriptions – Pre-stressed Concrete

- **No deterioration** (8)
- **Nonstructural cracking** (7)
- **Minor spalling/delamination, cracking** (6)
- **Spalling/delamination, exposed mild reinforcement** (5)
- **Large spalls/delamination, section loss, structural cracking** (4)
- **Shear cracks, beam sag** (3)
Problems vs. Deterioration
Assigning Condition Ratings

Condition Descriptions – Timber

- **Good**
  - No deterioration (8)
  - Staining (7)
  - Presence of inherent defects (6)

- **Fair**
  - Minor decay, moderate cracking (5)
  - Advanced decay, splitting (4)

- **Poor**
  - Shear cracks, advanced decay (3)
Steel Beams
## Assigning Condition Ratings

### Condition Descriptions – Steel

<table>
<thead>
<tr>
<th>Deficiencies</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Corrosion/ Section Loss</td>
<td>• Minor (minor pitting, no section loss)</td>
</tr>
<tr>
<td>• Fatigue Cracks</td>
<td>• None noted</td>
</tr>
</tbody>
</table>
Assigning Condition Ratings

Condition Descriptions – Steel

Extents (Local/General): General

Weak Link? (Y/N): No

Rating (0-8): 6 – Minor deterioration (pitting)
Reinforced Concrete Columns
## Condition Descriptions – Reinforced Concrete

### Deficiencies
- Cracking
- Delamination
- Spalling
- Exposed Reinforcing

### Severity
- NA (due to and included in delamination)
- Minor (noted as minor)
- Moderate - Advanced (large surface area, localized deep spalls)
- Moderate - Advanced (localized section loss)
Assigning Condition Ratings

Condition Descriptions – Reinforced Concrete

Extents (Local/General): Localized (2 columns)

Weak Link? (Y/N): Yes (loss of a column is significant)

Rating (0-8): 3 – Local failures possible (due to depth of spalling and section loss in rebar)
Timber Deck
Rating Practice
<table>
<thead>
<tr>
<th><strong>Deficiencies</strong></th>
<th><strong>Severity</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Decay</td>
<td>Advanced decay with widespread failures.</td>
</tr>
</tbody>
</table>
Condition Descriptions – Timber

Extents (Local/General): General (widespread failures)

Weak Link? (Y/N): N/A (general condition)

Rating (0-8): 2 – Advance (due to amount of failures) deterioration of primary structural component. Closely monitor for advancement of decay or close and repair.
Topic Wrap-up
• Correctly apply NBI condition ratings to bridge components
• Evaluate costs associated with inspection findings
Recommendation Alternatives:
• Do Nothing
• Protect
• Repair
• Rehabilitate
• Replace
Inspection Findings

Good Condition
- Do Nothing
- Protect

Fair Condition
- Do Nothing
- Protect
- Repair
Inspection Findings

Poor Condition
• Protect
• Repair
• Rehab

Critical Condition
• Protect
• Repair
• Rehab
• Replace
Case Study

R-Viaduct Bridge NW Center
Bldg. 364
Property Number: J539
Structure No. (RUPID): 207332
Argonne National Laboratory
Deck Condition

- General delamination, cracking, spalling, and failed repairs.

The 6” thick deck with a 1-1/2” latex modified concrete overlay is in poor (4) condition. The deck spans 5’-6” over three beams with 2’-0” overhangs. Based on sounding and visual inspections, there are several areas of delamination, transverse and longitudinal cracks on both the top and bottom of the deck with efflorescence and several failed repairs.
Deck Condition

- General delamination, cracking, spalling, and failed repairs.

Large pieces of concrete from the underside of the deck have spalled and fallen either onto the roof of building 391 causing damage to the roof or to the ground below and should be considered a hazard. There is also extensive spalling at the concrete curbs and also the exterior edges of the deck with exposed and corroded reinforcing. There is a spalled area on the underside that is approximately 4’ x 4’ with corroded reinforcement.
Substructure Condition

• Localized areas of delamination, cracking, and spalling.

Overall the substructure is in **fair (5)** condition.

Abutments – The south abutment is in **good** condition.

Piers – The four piers are in **fair** condition.

Some of the repair from the 1995 rehabilitation have started to fail.
Substructure Condition

• Localized areas of delamination, cracking, and spalling.

Case Study

Pier#2 was sounded by hammer along the accessible face. The areas repaired in 1995 sounded solid, but there are small temperature and shrinkage cracks developing in the repair concrete.
Recommendations include:

Option A - Full Replacement

Option B - Bridge Deck replacement with Substructure Repairs
  • Replace deck, including joints and railings
  • Repair substructure deficiencies including spall and crack repairs
## List of Deficiencies from the Inspection Report

### Repair Recommendations

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNIT</th>
<th>QTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Railing Type TP-1</td>
<td>LF</td>
<td>600</td>
</tr>
<tr>
<td>Removal of existing concrete deck</td>
<td>EA</td>
<td>1</td>
</tr>
<tr>
<td>Deck Concrete</td>
<td>CY</td>
<td>123</td>
</tr>
<tr>
<td>Reinforcing bars, epoxy coated</td>
<td>LB</td>
<td>19,000</td>
</tr>
<tr>
<td>Preformed strip seal</td>
<td>LF</td>
<td>100</td>
</tr>
<tr>
<td>Substructure concrete repair</td>
<td>SF</td>
<td>250</td>
</tr>
</tbody>
</table>
### Case Study

**Estimating Repair Needs Cost in CAIS**

<table>
<thead>
<tr>
<th>IU Number</th>
<th>Quantity</th>
<th>RSM Line Number</th>
<th>Line Number Description</th>
<th>RSM Unit Cost</th>
<th>Unit of Measure</th>
<th>Repair Needs Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>55506</td>
<td>600.00</td>
<td>347113260100</td>
<td>Vehicle guide rails, corrugated steel, galvanized steel posts, install metal guide/guard rail, double face, wood posts 6'-3&quot; O.C., 6&quot; x 8&quot; posts</td>
<td>$45.50</td>
<td>L.F.</td>
<td>$27,165</td>
</tr>
<tr>
<td>55507</td>
<td>1,500.00</td>
<td>030130725058</td>
<td>Concrete spall repairs, of horizontal concrete surfaces (ACI RAP-7), remove additional conc to 3/4&quot; under double layer of corroded #6 bar</td>
<td>$40.50</td>
<td>S.F.</td>
<td>$64,352</td>
</tr>
<tr>
<td>55508</td>
<td>123.00</td>
<td>033053400300</td>
<td>forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), placing and finishing</td>
<td>$1,500.00</td>
<td>C.Y.</td>
<td>$191,896</td>
</tr>
<tr>
<td>55509</td>
<td>10.00</td>
<td>032116100100</td>
<td>Epoxy coating, for reinforcing steel, add to plain steel rebar pricing for epoxy-coated rebar</td>
<td>$925.00</td>
<td>Ton</td>
<td>$9,141</td>
</tr>
<tr>
<td>55510</td>
<td>100.00</td>
<td>323410103440</td>
<td>Fabricated highway bridges, expansion dams, steel, for double slotted extrusions with seal strip, add</td>
<td>$345.00</td>
<td>L.F.</td>
<td>$34,091</td>
</tr>
<tr>
<td>55511</td>
<td>300.00</td>
<td>030130711450</td>
<td>for horizontal, vertical and overhead repairs, up to 1/8&quot; (0.125&quot;) wide x 12&quot; deep, manual injection with 2-part epoxy cartridge, excludes prep</td>
<td>$8.60</td>
<td>L.F.</td>
<td>$2,692</td>
</tr>
<tr>
<td>55512</td>
<td>250.00</td>
<td>030130725059</td>
<td>Concrete spall repairs, of horizontal concrete surfaces (ACI RAP-7), remove additional conc to 3/4&quot; under double layer of corroded #7 bar</td>
<td>$44.00</td>
<td>S.F.</td>
<td>$11,662</td>
</tr>
</tbody>
</table>

**Total** $340,999
Learning Objectives

• Correctly apply NBI condition ratings to bridge components
• Evaluate costs associated with inspection findings
Topic Wrap-up
Program Points of Contact

Find more information on PowerPedia - Bridge Management Program:

- Program Requirements
- Industry Standards for Inspection
- Quality Management
- Annual Inspection Plan
- Inventory and Record Keeping

- Reporting
- Program Management Review and Plan of Corrective Actions
- Data Uses
- Training Opportunities
- References

Cindy Hunt, PE
Facilities Engineer
U.S. Department of Energy
Office of Asset Management (MA-50)
1000 Independence Ave, SW Washington
DC 20585
202.586.4539
Cindy.Hunt@hq.doe.gov

Gordie Clark, PE
Facilities Engineer
U.S. Department of Energy
Office of Asset Management (MA-50)
1000 Independence Ave, SW Washington
DC 20585
202.287.1304
Gordon.Clark@hq.doe.gov