Item 59 – PPC I-Beams

Prestressed Concrete I-Beams

- Used since the 1950's
- “I” or “Bulb T” shape
- High Strength Concrete (5-10 ksi typically)
- New hybrid sections introduced by IDOT in March 2015
Item 59 – PPC I-Beams

Prestressed Concrete I-Beam

- The condition of the beam “PERIMETER” is used to determine the condition rating
- It is the bottom flange length enclosing the prestressing strands

Sounding

- Use hammer sounding to detect delaminated areas
- Delaminations have a distinctive “hollow or clacking” sound
- Sound concrete has a solid "pinging" sound
## Item 59 – PPC I-Beams

### Key Indicators
- **Cracks**
- **Delams & Spalls**
- **Exposed Reinf & Strands**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>VERY GOOD. No notable problems.</td>
</tr>
<tr>
<td>7</td>
<td>GOOD. No beams with prestressing strands, stirrup reinforcement bars or wire mesh exposed. Minor shrinkage or release cracks may be present. Minor map cracking at drains with sound concrete.</td>
</tr>
<tr>
<td>6</td>
<td>SATISFACTORY. Center half of span: No beams with prestressing strands, stirrup reinforcement exposed. End quarters of span: No more than 2 strands or 3” of stirrup reinforcement bars exposed in the bottom of any beam. Beam ends (up to 3’): Prestressed strands or stirrup reinforcement bars exposed up to ½ the perimeter of the bottom flange of any beam. Larger width of stirrups may be exposed due to inadequate concrete cover occurring during manufacturing (up to ½ cover). Webs may be spalled with exposed stirrups and only surface rust.</td>
</tr>
</tbody>
</table>

### Item 59 – PPC I-Beams

### Key Indicators
- **Cracks**
- **Delams & Spalls**
- **Exposed Reinf & Strands**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>FAIR. Center half of span: Prestressed strands or stirrup reinforcement bars exposed for no more than 1/4 the perimeter of the bottom flange of any beam. End quarters of span: Prestressed strands or stirrup reinforcement bars exposed for no more than 1/3 the perimeter of the bottom flange of any beam. Beam ends (up to 3’): Prestressed strands or stirrup reinforcement bars exposed from ½ to full perimeter of the bottom flange of any beam. Larger areas of stirrup may be exposed due to inadequate concrete cover that occurs during manufacturing (up to ½ cover). Webs may be spalled with exposed stirrups minor section loss.</td>
</tr>
</tbody>
</table>
### Item 59 – PPC I-Beams

#### Key Indicators

- **Cracks**
- **Delams & Spalls**
- **Exposed Reinf & Strands**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
</table>
| **4** | POOR. Center half of span: Prestressed strands or stirrup reinforcement bars exposed for no more than 2/3 the perimeter of the bottom flange of any beam.  
End quarters of span: Prestressed strands or stirrup reinforcement bars exposed up to full perimeter of the bottom flange of any beam. No strands are exposed inside the exterior perimeter of strands.  
Beam ends (up to 3'): Prestressed strands or stirrup reinforcement bars exposed full perimeter of the bottom flange of any beam with some strands exposed inside the exterior perimeter of strands.  
Webs are spalled with exposed stirrups with up to 30% section loss at ends of beams. |
## Item 59 – PPC I-Beams

### Key Indicators

- Cracks
- Delams & Spalls
- Exposed Reinf & Strands

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CRITICAL. Similar to but more serious and extensive than what is described for a condition rating of “3”. Structural elements that are judged to be in critical condition must receive special inspections in order for the structure to remain open to traffic. Measurable shear or transverse cracks. The Bureau of Bridges and Structures shall be notified immediately.</td>
</tr>
</tbody>
</table>

### New Construction

- No defects
- First inspection

New PPC I-Beam – Allowed first inspection only
Item 59 – PPC I-Beams

Very Good

- No deficiencies
- Second inspection

VERY GOOD. No notable problems.

Item 59 – PPC I-Beams

Good

Minor shrinkage cracks present in beams

GOOD. No beams with prestressing strands, stirrup reinforcement bars or wire mesh exposed. Minor shrinkage or release cracks may be present. Minor map cracking at drains with sound concrete.
Item 59 – PPC I-Beams

Satisfactory

Three strands exposed at the end of the beam

SATISFACTORY. Center half of span: No beams with prestressing strands, stirrup reinforcement exposed. End quarters of span: No more than 2 strands or 3” of stirrup reinforcement bars exposed in the bottom of any beam. Beam ends (up to 3’): Prestressed strands or stirrup reinforcement bars exposed up to ½ the perimeter of the bottom flange of any beam. Larger width of stirrups may be exposed due to inadequate concrete cover occurring during manufacturing (up to ½ cover). Webs may be spalled with exposed stirrups and only surface rust.

Two strands of reinforcement bars exposed in the bottom of beam

No beams with reinforcement exposed at center span
Item 59 – PPC I-Beams

**Fair**

Reinforcement bars exposed for 30% of perimeter of bottom flange in end quarter of span

Fair. Center half of span: Prestressed strands or stirrup reinforcement bars exposed for no more than 1/4 the perimeter of the bottom flange of any beam. End quarters of span: Prestressed strands or stirrup reinforcement bars exposed for no more than 1/3 the perimeter of the bottom flange of any beam. Beam ends (up to 3'): Prestressed strands or stirrup reinforcement bars exposed from 1/2 to full perimeter of the bottom flange of any beam. Larger areas of stirrup may be exposed due to inadequate concrete cover that occurs during manufacturing (up to 1/2 cover). Webs may be spalled with exposed stirrups minor section loss.

---

Item 59 – PPC I-Beams

**No beams with reinforcement exposed at center span**

**Spall with 4 exposed strands in the end quarter**

---
Item 59 – PPC I-Beams

Poor

Reinforcement bars exposed for more than 55% of perimeter of bottom flange in end quarter

POOR. Center half of span: Prestressed strands or stirrup reinforcement bars exposed for no more than 2/3 the perimeter of the bottom flange of any beam. End quarters of span: Prestressed strands or stirrup reinforcement bars exposed up to full perimeter of the bottom flange of any beam. No strands are exposed inside the exterior perimeter of strands. Beam ends (up to 3'): Prestressed strands or stirrup reinforcement bars exposed full perimeter of the bottom flange of any beam with some strands exposed inside the exterior perimeter of strands. Webs are spalled with exposed stirrups with up to 30% section loss at ends of beams.

Item 59 – PPC I-Beams

Serious

Strands exposed for full perimeter of bottom flange in center half of span

SERIOUS. Center half of span: Prestressed strands or stirrup reinforcement bars exposed up to full perimeter of the bottom flange of any beam. No strands are exposed inside the exterior perimeter of strands. End quarters of span: Prestressing strands, stirrup reinforcement bars exposed for the full perimeter of the bottom flange of any beam with some strands exposed inside the exterior perimeter of strands. Hairline transverse cracks in bottom of beams or hairline vertical/diagonal shear cracks in beam webs may be developing.
Item 59 – PPC I-Beams

**Critical**
- Prestressing strands exposed over full perimeter
- Open shear cracks
- Damage in middle half of beam

**Critical**. Similar to but more serious and extensive than what is described for a condition rating of “3”. Structural elements that are judged to be in critical condition must receive special inspections in order for the structure to remain open to traffic. Measurable shear or transverse cracks. The Bureau of Bridges and Structures shall be notified immediately.

**Imminent Failure**
- Exterior beam has failed
- Strands exposed for full perimeter of bottom flange at center span

**Imminent Failure**. Condition requiring bridge closure or temporary measures to allow structure to remain open.
Discussion
CULVERTS

Item 62 - Culverts

- Types of Culverts
- Condition Ratings
### Item 62 - Culverts

#### Types of Culverts

- **Concrete Box Culverts**
  - Single or Multiple Cell
  - CIP or Precast Concrete

- **Precast Concrete Pipe Culverts**
  - Round
  - Elliptical

- **Corrugated Metal Pipe Culverts**
  - Round or Elliptical
  - Large Arches

#### Key Indicators

- Cracks
- Scaling
- Leaching
- Spalls/Delams
- Section Loss
- Scour

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>NOT APPLICABLE. Use when structure is not a culvert.</td>
</tr>
<tr>
<td>9</td>
<td>EXCELLENT. New with no deficiencies</td>
</tr>
<tr>
<td>8</td>
<td>VERY GOOD. No noticeable or noteworthy deficiencies which affect the condition of the culvert, insignificant scrape marks caused by drift.</td>
</tr>
<tr>
<td>7</td>
<td>GOOD. Isolated non-structural cracks up to 0.03&quot;, light scaling, and insignificant spalling which does not expose reinforcing steel, metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting, insignificant damage caused by drift with no misalignment and not requiring corrective action, some minor scour has occurred near curtain walls, wingwalls, or pipes.</td>
</tr>
</tbody>
</table>
Item 62 - Culverts

Key Indicators

- Cracks
- Scaling
- Leaching
- Spalls/Delams
- Section Loss
- Scour

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>SATISFACTORY. Extensive non-structural cracks up to .06&quot; with some leaching over the majority of the top slab, spalls and delaminations may be present on up to 10% in a 6' width of the concrete or masonry walls or slabs exposing primary reinforcement with surface rust only, up to 20% of the surface area of walls and slabs may be map cracked, spalled and delaminated. Metal culverts have a smooth curvature, non-symmetrical shape, minor corrosion or measurable pitting. Local minor scour at curtain walls, wingwalls, or pipes.</td>
</tr>
<tr>
<td>5</td>
<td>FAIR. Non-structural cracking with leaching at &lt; 5' intervals over the majority of the slab or wall surfaces, structural cracks &lt; 0.03&quot; in walls or slabs, section loss of primary reinforcement up to 10% in the top slab in a 6' width, up to 10% of compression surface area spalled or delaminated on top slabs in a 6' width (tension areas may be totally spalled), up to 10% section loss of concrete or rebar in a 10' width of wall, up to 10% section loss of concrete or reinforcement steel in a 10' width of bottom slab. Metal culverts have significant distortion and deflection in no more than one section, or significant corrosion or deep pitting with up to 10% average section loss in a 10' width, minor settlement or misalignment, noticeable scour or erosion at curtain walls, wingwalls, or pipes without undermining.</td>
</tr>
</tbody>
</table>

N-5

Item 62 - Culverts

Key Indicators

- Cracks
- Scaling
- Leaching
- Spalls/Delams
- Section Loss
- Scour

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>POOR. Structural cracks in top slab up to 0.06&quot;, structural cracks in walls up to 0.125&quot;, section loss of primary reinforcement up to 30% in the top slab in a 6' width, up to 30% of compression surface area spalled or delaminated on top slabs in a 6' width (tension areas may be totally spalled), up to 30% section loss of concrete or rebar in a 10' width of wall, up to 30% section loss of concrete or reinforcement steel in a 10' width of bottom slab. Metal culverts have significant distortion and deflection on more than one section, extensive corrosion or deep pitting throughout with up to 30% section loss in a 10' width, considerable settlement or misalignment, considerable scour or erosion at curtain walls, wingwalls or pipes with undermining.</td>
</tr>
<tr>
<td>3</td>
<td>SERIOUS. Any worse or combined condition described in condition rating &quot;4&quot;, up to 50% loss, metal culverts have extreme distortion and deflection in one section (collapse), extensive corrosion, or deep pitting with scattered perforations, severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe undermining of curtain walls, wingwalls or pipes.</td>
</tr>
</tbody>
</table>

N-6
## Item 62 - Culverts

### Key Indicators

- **Cracks**
- **Scaling**
- **Leaching**
- **Spalls/Delams**
- **Section Loss**
- **Scour**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CRITICAL. Large areas of slab or walls spalled full depth near traffic, large area of reinforcement losses greater than 50% near traffic, metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion, integral wingwalls collapsed, severe settlement of roadway due to loss of fill, section of culvert may have failed and can no longer support embankment, complete undermining of curtain walls and pipes, special feature inspection will be required to keep the structure open with possible load restrictions. The Bureau of Bridges and Structures shall be notified immediately.</td>
</tr>
<tr>
<td>1</td>
<td>IMMINENT FAILURE. Bridge closed. Corrective action may return bridge to light service.</td>
</tr>
<tr>
<td>0</td>
<td>FAILED. Bridge closed. Replacement necessary.</td>
</tr>
</tbody>
</table>

### New Construction

- **No Deficiencies**

EXCELLENT. No deficiencies – Allowed first inspection only
Item 62 - Culverts

**Very Good Condition**

No significant defects

VERY GOOD. No noticeable or noteworthy deficiencies which affect the condition of the culvert, insignificant scrape marks caused by drift.

---

**Item 62 - Culverts**

**Good Condition**

- Minor scaling
- Insignificant spalling
- No exposed reinforcement

GOOD. Isolated non-structural cracks up to 0.03", light scaling, and insignificant spalling which does not expose reinforcing steel, metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting, insignificant damage caused by drift with no misalignment and not requiring corrective action, some minor scour has occurred near curtain walls, wingwalls, or pipes.
**Item 62 - Culverts**

**Good Condition**
- Hairline vertical cracks in center wall
- Crack spacing greater than 10'
- Light scaling present

GOOD. Isolated non-structural cracks up to 0.03", light scaling, and insignificant spalling which does not expose reinforcing steel, metal culverts have a smooth symmetrical curvature with superficial corrosion and no pitting, insignificant damage caused by drift with no misalignment and not requiring corrective action, some minor scour has occurred near curtain walls, wingwalls, or pipes.

---

**Satisfactory Condition**
- Vertical cracks in the walls with leaching
- 10' crack spacing
- Minor spalls and delaminations present on 5% of surface

SATISFACTORY. Extensive non-structural cracks up to .06" with some leaching over the majority of the top slab, spalls and delaminations may be present on up to 10% in a 6’ width of the concrete or masonry walls or slabs exposing primary reinforcement with surface rust only, up to 20% of the surface area of walls and slabs may be map cracked, spalled and delaminated. Metal culverts have a smooth curvature, non-symmetrical shape, minor corrosion or measurable pitting. Local minor scour at curtain walls, wingwalls, or pipes.
Item 62 - Culverts

Satisfactory Condition

- Cracks with leaching at 10' spacing
- Minor spalls and delaminations present on 3% of surface

Satisfactory. Extensive non-structural cracks up to .06" with some leaching over the majority of the top slab, spalls and delaminations may be present on up to 10% in a 6' width of the concrete or masonry walls or slabs exposing primary reinforcement with surface rust only, up to 20% of the surface area of walls and slabs may be map cracked, spalled and delaminated. Metal culverts have a smooth curvature, non-symmetrical shape, minor corrosion or measurable pitting. Local minor scour at curtain walls, wingwalls, or pipes.

Item 62 - Culverts

Fair Condition

- Leaching map cracks throughout the top slab soffit
- Several small delaminations throughout

Fair. Non-structural cracking with leaching at ≤ 5’ intervals over the majority of the slab or wall surfaces, structural cracks ≤ 0.03” in walls or slabs, section loss of primary reinforcement up to 10% in the top slab in a 6’ width, up to 10% of compression surface area spalled or delaminated on top slabs in a 6’ width (tension areas may be totally spalled), up to 10% section loss of concrete or rebar in a 10’ width of wall, up to 10% section loss of concrete or reinforcement steel in a 10’ width of bottom slab. Metal culverts have significant distortion and deflection in no more than one section, or significant corrosion or deep pitting with up to 10% average section loss in a 10’ width, minor settlement or misalignment, noticeable scour or erosion at curtain walls, wingwalls, or pipes without undermining.
Item 62 - Culverts

Fair Condition

- Scour present on the downstream end
- Cutoff wall exposed, but not undermined
- Minor spalling of the headwall

FAIR. Non-structural cracking with leaching at < 5' intervals over the majority of the slab or wall surfaces, structural cracks < 0.03" in walls or slabs, section loss of primary reinforcement up to 10% in the top slab in a 6' width, up to 10% of compression surface area spalled or delaminated on top slabs in a 6' width (tension areas may be totally spalled), up to 10% section loss of concrete or rebar in a 10' width of wall, up to 10% section loss of concrete or reinforcement steel in a 10' width of bottom slab. Metal culverts have significant distortion and deflection in no more than one section, or significant corrosion or deep pitting with up to 10% average section loss in a 10' width, minor settlement or misalignment, noticeable scour or erosion at curtain walls, wingwalls, or pipes without undermining.

Item 62 - Culverts

Fair Condition

- 10% section loss along the bottom and near the water line
- Moderate distortion under the roadway

FAIR. Non-structural cracking with leaching at < 5' intervals over the majority of the slab or wall surfaces, structural cracks < 0.03" in walls or slabs, section loss of primary reinforcement up to 10% in the top slab in a 6' width, up to 10% of compression surface area spalled or delaminated on top slabs in a 6' width (tension areas may be totally spalled), up to 10% section loss of concrete or rebar in a 10' width of wall, up to 10% section loss of concrete or reinforcement steel in a 10' width of bottom slab. Metal culverts have significant distortion and deflection in no more than one section, or significant corrosion or deep pitting with up to 10% average section loss in a 10' width, minor settlement or misalignment, noticeable scour or erosion at curtain walls, wingwalls, or pipes without undermining.
**Item 62 - Culverts**

**Poor Condition**

- Leaching map cracks present in top slab
- Cracks up to 0.06" in top slab
- Leaching vertical cracks in walls up to 0.125"
- Concrete cores may be needed

**POOR.** Structural cracks in top slab up to 0.06", structural cracks in walls up to 0.125", section loss of primary reinforcement up to 30% in the top slab in a 6' width, up to 30% of compression surface area spalled or delaminated on top slabs in a 6' width (tension areas may be totally spalled), up to 35% section loss of concrete or rebar in a 10' width of wall, up to 30% section loss of concrete or reinforcement steel in a 10' width of bottom slab. Metal culverts have significant distortion and deflection on more than one section, extensive corrosion or deep pitting throughout with up to 30% section loss in a 10' width, considerable settlement or misalignment, considerable scour or erosion at curtain walls, wingwalls or pipes with undermining.

---

**Isolated structural cracks less than 0.03" in walls or slabs.**

**Spalls and delaminations on the bottom concrete slabs.**

**Structural cracks up to 0.06" in top slab.**

**Structural cracks up to 0.125" in walls.**
**Item 62 - Culverts**

**Serious Condition**
- Large spalls present with exposed primary reinforcement
- 35% section loss in primary reinforcement
- Top slab soffit is delaminated and slightly sagging

SERIOUS. Any worse or combined condition described in condition rating "4", up to 50% loss, metal culverts have extreme distortion and deflection in one section (collapse), extensive corrosion, or deep pitting with scattered perforations, severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe undermining of curtain walls, wingwalls or pipes.

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**Item 62 - Culverts**

**Serious Condition**
- Distortion in two sections
- Separation of sections has occurred
- Loss of fill has occurred at separation between sections

SERIOUS. Any worse or combined condition described in condition rating "4", up to 50% loss, metal culverts have extreme distortion and deflection in one section (collapse), extensive corrosion, or deep pitting with scattered perforations, severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe undermining of curtain walls, wingwalls or pipes.

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20
Item 62 - Culverts

Serious Condition

- 45% section loss along water line
- Several holes through the walls near ends of culvert

Critical Condition

- Large spall under traffic lane with two layers of reinforcement exposed
- There is movement in the remaining slab under live load
- Notify Bureau of Bridges and Structures immediately!

SERIOUS. Any worse or combined condition described in condition rating "4", up to 50% loss, metal culverts have extreme distortion and deflection in one section (collapse), extensive corrosion, or deep pitting with scattered perforations, severe movement or differential settlement of the segments, or loss of fill. Holes may exist in walls or slabs. Integral wingwalls nearly severed from culvert. Severe undermining of curtain walls, wingwalls or pipes.

CRITICAL. Large areas of slab or walls spalled full depth near traffic, large area of reinforcement losses greater than 50% near traffic, metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion, integral wingwalls collapsed, severe settlement of roadway due to loss of fill, section of culvert may have failed and can no longer support embankment, complete undermining of curtain walls and pipes, special feature inspection will be required to keep the structure open with possible load restrictions. The Bureau of Bridges and Structures shall be notified immediately.
Item 62 - Culverts

Critical Condition
- The bottom of the east pipe has failed
- Settlement of approximately 3’ has occurred
- Settlement has caused a dip in the roadway

Discussion

CRITICAL. Large areas of slab or walls spalled full depth near traffic, large area of reinforcement losses greater than 50% near traffic, metal culverts have extreme distortion and deflection throughout with extensive perforations due to corrosion, integral wingwalls collapsed, severe settlement of roadway due to loss of fill, section of culvert may have failed and can no longer support embankment, complete undermining of curtain walls and pipes, special feature inspection will be required to keep the structure open with possible load restrictions. The Bureau of Bridges and Structures shall be notified immediately.
LOCAL AGENCY ISSUES

Local Agency Issues to Highlight

- Scheduling Inspections
- Exposed Piling
- Timber Piles
- Record Retention on the Local System
- Load Rating Procedures
- Load Posting Requirements
Local Agency Issues to Highlight

**Scheduling Inspections**

- Local Agency Program Managers must track inspection schedules to ensure they are completed on time:
  - Routine, Fracture Critical, Special, etc.
  - Allow time for Consultant contract to be approved by IDOT if needed
- Be sure to schedule your inspections to be completed before their due dates
- Get inspections entered into BIS in a timely manner

**Scheduling Inspections – cont.**

- SIMS County - [http://www.dot.il.gov/sims/sims.html](http://www.dot.il.gov/sims/sims.html)
  - Access based program – Access 2010 or greater
  - Data files – Forms and Reports
  - SIMS Link – Queries, Personalized Reports
- Local Agencies are responsible for inspecting their bridges per State Policy
- Web-based data entry by locals for inspection ratings is currently being fielded. Goal is to try and field to all locals by end of 2021.
- Ramifications for delinquent inspections
  - LA pays for IDOT administered inspections (IDOT CL 2020-19)
  - Loss of funding
Local Agency Issues to Highlight – Exposed Piling
Local Agency Issues to Highlight

Exposed Steel Piling – Lessons Learned

- Difficult to inspect elements under water
- Pay extra attention to elements along the water line and/or ground line
- Schedule inspections during low water or revisit when access is possible
- Consider encasing piling in concrete if practical
- See Circular Letter 2014-15

Local Agency Issues to Highlight – Timber Piling
**Local Agency Issues to Highlight**

**Inspection Procedures for Timber Piling**
- Visual inspection only is not sufficient
- Sound with hammer over full height
- Key areas – ground line, cross-brace connections
- If hollow sounding, use drill or other means to determine extent of damage

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**Local Agency Issues to Highlight**

**Record Retention Expectations for the Local System**
- Local Agencies must maintain bridge files for each of their structures – A separate file for each bridge
- Files should include all information found on IDOT BBS-BFC (Bridge File Checklist)
- Keep pictures from each inspection cycle
Local Agency Issues to Highlight

Load Rating Procedures

- The AASHTO Manual for Bridge Evaluation (MBE) defines procedures for calculating the load rating of structures
- Postings are typically based on the Operating Rating
- Posting is dependent on many factors to include: rating analysis method (ASD, LFD, LRFD), material type (concrete, steel, timber), and condition state
- By Illinois statutes, only IDOT can set the structure posting level
- Field posting must match required posting letter from IDOT

Load Posting Requirements

- Flaws in improper signage can be subtle
- If you can't see it, it's not posted!
Local Agency Issues to Highlight

Load Posting Requirements

- 2009 Manual on Uniform Traffic Control Devices (MUTCD)
- 2009 Illinois Supplement to the National Manual on Uniform Traffic Control Devices
- Load posting signs shall be located between 50 feet and 300 feet in advance of the structure to which it applies
- Advance signs should be erected at junctions which permit the driver of affected vehicles to choose an alternate route

Load Posting Requirements

- Regulatory Sign R12-5 is not a legal sign in Illinois, based on the 2009 IL Supplement to the National MUTCD
- The graphical representation of the third posting (5 or more axles) is shown with only 4 axles which is not an Illinois configuration. This is misleading to truckers and does not properly indicate the restrictions required by IDOT
- The modified sign (bottom) is a better graphical representation of the restriction, but it is not a legal sign in Illinois
Local Agency Issues to Highlight

Load Posting Requirements

- The R12-I100 or R12-101 signs shall be used when two or three separate weight restrictions are to be posted (IL Supplement)
- The R12-1 sign shall be used when a single weight limit is authorized
- 2009 IL Supplement to the National MUTCD for guidance

---

Local Agency Issues to Highlight

Load Posting Requirements

- The Legal Load Only sign (R12-I108) may be used at bridges not structurally adequate to carry loads in excess of the legal weight limit on such highways where permits have been issued allowing certain vehicles to exceed normal weight limits in accordance with Section 5/15-301 of the Illinois Vehicle Code
- Old LLO signs displaying 9 or 10 tons per axle, and 37 or 40 tons gross, now restrict trucks to less than legal loads. These signs shall not be replaced until an updated load rating has been performed and the higher weight limits have been approved by BB&S.
- Some structures will not be able to safely carry this new higher loading.

See IDOT CL2017-22
Discussion
Inventory Data

How often do you check Inventory Data?

1. Every Inspection
2. First Inspection
3. Never
4. What’s Inventory Data?
Inventory Data

Why bother, it doesn’t change, right?

- Some items DO CHANGE
  - Bridge Status
  - New overlays
  - Load postings
  - Rehabilitation or Maintenance work
  - Changes to approach roadways
- Also, MANY items in the system are incorrectly coded!!

Inventory Data

Typical Findings from QA Reviews

- Out-of-Date Information - undocumented rehabs
- Miscoded Items
  - Dimensions, Bridge Geometry & Approach rdwy geometry
  - Main Span & Sub Material, Type of Deck
- Missing Items – never input
- The degree of missing and incorrect information is a BIG PROBLEM when trying to analyze the IL bridge system
Inventory Data

We need your help to fix the bridge inventory data problem!

The Bridge Program Managers and Inspectors are the best hope of correcting this issue

What Can You Do?

- Review key inventory data during each routine inspection cycle to verify it is correct. Use these reports:
  - Inspectors Inventory Report (S-114)
  - Master Structure Report (S-107)
- Correct mistakes found by writing directly on these reports
- Forward the marked up/corrected reports to your District contact to update the information in the ISIS System
- Or email corrections to: DOT.BBS.BridgeMgmt@Illinois.gov
Inventory Data

COMMON MISCODED ITEMS:
- Item 19 - Bypass Length
- Item 27A - Construction Year
- Item 31 - Design Load
- Item 34 - Skew Direction
- Item 34A - Skew Angle
- Item 41 - Bridge Status
- Item 43A - Main Span Material
- Item 43B - Main Structure Type
- Item 45 - Number of Main Spans
- Item 46 - Number of Appr. Spans
- Item 48 - Length of Longest Span
- Item 49 - Structure Length
- Item 51 - Bridge Rdwy Width
- Item 52 - Deck Width
- Items 60A / 60B - Substr. Material
- Item 62A - Culvert Cells (Count)
- Item 62B - Culvert Cell Width (Ft.)
- Item 62C - Culvert Cell Height
- Item 62D - Culvert Opening Area
- Item 62E - Culvert Fill Depth
- Item 107 - Deck Structure Type
- Item 107A - Deck Structure Thickness
- Item 108D - Total Deck Thickness

Missing Inventory Data: Item 19 - Bypass Length

- This item considers the length of additional travel distance required if a structure is closed to traffic
- The additional travel distance required, following a designated detour over a road or bridge of equal or greater quality, is reported in Bypass Length

<table>
<thead>
<tr>
<th>Situation</th>
<th>Enter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary ground level bypass available</td>
<td>00</td>
</tr>
<tr>
<td>Structure bypassable utilizing interchange ramps</td>
<td>00</td>
</tr>
<tr>
<td>Structure over wide river, not bypassable, 21.4 miles additional travel</td>
<td>21</td>
</tr>
<tr>
<td>Structure (not an interchange) bypassable using parallel structure</td>
<td>01</td>
</tr>
<tr>
<td>Structure not bypassable, 100 miles or more additional travel required or a dead end road</td>
<td>99</td>
</tr>
</tbody>
</table>
Inventory Data

Item 27A – Construction Year

ORIGINAL CONSTRUCTION YEAR (coded - O)
- This is the year the bridge was originally built
- If the previous bridge was completely replaced this is the year the new bridge was built and the old date is replaced
- Often miscoded or listed as “1900”

RECONSTRUCTION YEAR (coded - R)
- This is the year the bridge was rebuilt

MAINTENANCE/REPAIRS YEAR (coded - M)
- This is the year of the last maintenance or repair work

Inventory Data

Item 31 – Design Load

- This is the Live Load the bridge was designed to carry
- It is typically found on the 1st or 2nd sheet of the bridge design plans
- The vast majority of our structures were designed using the following loads:
  - HL93 (1990's to present)
  - HS20 or HS20-44 (1944-2000's)
  - HS15 or HS15-44 (1944-1970's)
  - H15 and H20-rare (1931-1944)
- Use “Unknown” (when loading not found on plans)
- Item often not filled out or is miscoded
Inventory Data

**Item 34 - Skew Direction**
- Indicates the skew direction of the structure (left ahead shown in picture)
  - N = No Angle
  - R = Right Ahead
  - L = Left Ahead

**Item 34A - Skew Angle**
- This is the angle between the centerline of a pier or abutment and a line perpendicular to the roadway centerline
- Information incorrectly coded may be the complement of the skew angle. Often occurs with angles near 45° where error is not obvious.

---

**Inventory Data**

**Item 41 – Bridge Status**
- 1 - Open, no restrictions
- 2 - Open, load posted (may include other restrictions)
- 3 - Open, posted OTAT or speed limit posted, but no posted load limit restrictions
- 4 - Open, posting recommended but not legally implemented
- 5 - Open, temporary measures in place to allow traffic and having no load or speed restrictions
- 6 - Open, temporary measures in place to allow traffic, but has load or speed restrictions
- **7** - Open, staged construction
- 8 - Open, new structure, not yet inspected
- 9 - New or planned structure, not yet open
- **A** - Closed, replacement/repairs under contract
- B - Closed, replacement/repair anticipated within next 5 years
- C - Road Closed, closure not related to condition of the structure
- E - Closed, permanent closure due to bridge condition, repair/replacement not anticipated within next 5 years.
### Inventory Data

#### Item 43A - Main Span Material
- 1 Concrete
- 2 Concrete *continuous*
- 3 Steel
- 4 Steel *continuous*
- 5 Prestressed concrete
- 6 Prestressed concrete *continuous*
- 7 Timber
- 8 Masonry
- 9 Aluminum, Wrought Iron or Cast Iron
- 0 Other or Varied
- A Precast concrete - Not prestressed
- B Post Tension Concrete *Segmental* (revised 2018)
- C Fiber Reinforced Polymer (new item 2018)

#### Coding Structures of Multiple Material Types
- Code based on which material constitutes the majority of sq. ft.
**Item 43B - Main Structure Type**

- Identifies the predominant type of structure used in the main structure
- Includes all spans of most bridges (but the major unit only of large bridges)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Slab</td>
<td>11</td>
<td>Arch - Deck, Filled Spandrel</td>
<td>24</td>
<td>Thru Girder</td>
</tr>
<tr>
<td>02</td>
<td>Multi-Beam</td>
<td>12</td>
<td>Arch – Thru</td>
<td>25</td>
<td>Arch-Deck, Open Spandrel</td>
</tr>
<tr>
<td>03</td>
<td>Deck Girder (non-redundant)</td>
<td>13</td>
<td>Suspension</td>
<td>26</td>
<td>Low Water Crossing</td>
</tr>
<tr>
<td>04</td>
<td>Tee Beam</td>
<td>14</td>
<td>Cable Stayed</td>
<td>27</td>
<td>Retaining Wall</td>
</tr>
<tr>
<td>05</td>
<td>Box Beam - Multiple Adjacent</td>
<td>15</td>
<td>Movable – Lift</td>
<td>28</td>
<td>Segmental Box Girder</td>
</tr>
<tr>
<td>06</td>
<td>Box Beam - Single or Spread</td>
<td>16</td>
<td>Movable – Bascule</td>
<td>29</td>
<td>Channel Beam</td>
</tr>
<tr>
<td>07</td>
<td>Rigid Frame &amp; 3-Sided Struct</td>
<td>17</td>
<td>Movable – Swing</td>
<td>30-70</td>
<td>Truss Types – Specific</td>
</tr>
<tr>
<td>08</td>
<td>Orthotropic</td>
<td>18</td>
<td>Tunnel</td>
<td>91</td>
<td>Culvert Rigid Frame</td>
</tr>
<tr>
<td>09*</td>
<td>Truss - Deck (non specific)</td>
<td>19</td>
<td>Culvert</td>
<td>00</td>
<td>Other</td>
</tr>
<tr>
<td>10*</td>
<td>Truss-Thru &amp; Pony (non specific)</td>
<td>20</td>
<td>Pipeline</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Use codes 30-70 in place of 09 & 10 (they are shown for historical reference only).

**Inventory Data**

- Precast Channel Beams (29) often miscoded as Slab (01)
- Culvert – Rigid Frame (91) versus Culvert (19). **Rigid Frame Culverts** have the vertical bars in the Outer Sidewalls located in the outside face and these bars extend into and lap with the bars in the Top Slab. **Code 91 was added in July 2016** due to the different rating requirements for the two.
- You need to verify if your culverts fit code 19 or 91
Inventory Data

**Item 45 – Number of Main Spans**
- The total number of spans in the main structure
- Typically consists of all spans of most structures
- Used to differentiate between “main unit” and “approach unit” spans when the approaches are of a different design/material or to identify the main unit of sizable structures

**Item 46 – Number of Approach Spans**
- The total number of spans in the approaches to the main structure
- Connects main spans to the roadway or other approach spans

---

Inventory Data

**Items 45 & 46 – Number of Main & Approach Spans**

- Has approach spans
- Doesn’t have approach spans
Inventory Data

Item 48 – Length of Longest Span

- Indicates the longest span center – center bearing in the structure.
- The length is measured along the centerline of the structure roadway.
- Skewed culverts are frequently miscoded with the right-angle dimension.
- PPC Deck Beams and PC Channel Beams are frequently miscoded with center to center length between substructure units rather than center to center of the beam dowel rods (bearing points) as required.

Inventory Data

Item 49 - Structure Length

- The overall length of roadway supported by the structure, measured along the centerline of the structure roadway.
- The length should be measured back to back of backwalls of abutments or from paving notch to paving notch.
- Skewed culverts are frequently miscoded with the right-angle dimension.
Item 51 – Total Bridge Roadway Width

- This measures the minimum distance between curbs and rails on the structure roadway
- Raised or non-mountable medians, open medians and barrier widths are to be excluded from the summation along with barrier-protected bicycle and equestrian lanes
- The measurement is exclusive of flared areas for ramps

Item 52 – Total Deck Width

- This measures the out – out width of the deck at right angles to the structures centerline
- The measurement is exclusive of flared areas for ramps
### Inventory Data

#### Items 60A / 60B: Substructure Material

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Timber with repairs made</td>
</tr>
<tr>
<td>2</td>
<td>Timber</td>
</tr>
<tr>
<td>3</td>
<td>Steel</td>
</tr>
<tr>
<td>4</td>
<td>Masonry</td>
</tr>
<tr>
<td>5</td>
<td>Concrete</td>
</tr>
<tr>
<td>6</td>
<td>Exposed Steel (not encased)</td>
</tr>
<tr>
<td>7</td>
<td>Metal Shell</td>
</tr>
<tr>
<td>8</td>
<td>Precast Concrete (not piles)</td>
</tr>
<tr>
<td>N</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

- Item 60A = Abutment Material Type
- Item 60B = Pier Material Type
- See the SIP manual and the examples
- Field verify information

#### Culvert Related Items

- **Item 62A** – Culvert Cells (total number)
- **Item 62B** – Culvert Cell Width (Ft.)
  - Horizontal width, measured at right angle to culvert, of individual cells or openings in the culvert
- **Item 62C** – Culvert Cell Height
  - Vertical height of individual cells or openings in the culvert
  - If more than one height exist, record the predominate height
- **Item 62D** – Culvert Opening Area
  - Total cross section area of all cells of the culvert
  - Areas of dissimilar individual cells, report the true calculated square footage of opening.
  - Measurement does not have to agree with the calculation made from values reported in Items 62B and 62C
  - Variable opening dimensions should be recorded in Item 5A1 – Bridge Remarks (General)
- **Item 62E** – Culvert Fill Depth
  - The depth of fill (earth and pavement thickness) measured from the top of the culvert structure to the top of the pavement surface
Item 107 – Deck Structure Type

- Identifies the type of deck system on the structure
- If more than one type exists, identify the predominant type

Inventory Data

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>CIP Concrete normally formed</td>
</tr>
<tr>
<td>B</td>
<td>CIP Concrete PPC Deck Plank formed</td>
</tr>
<tr>
<td>C</td>
<td>CIP Concrete Steel Stay in place forms</td>
</tr>
<tr>
<td>D</td>
<td>Precast Reinforced Concrete Deck Beams</td>
</tr>
<tr>
<td>E</td>
<td>Precast Prestressed Concrete Deck Beams</td>
</tr>
<tr>
<td>F</td>
<td>Precast Concrete transverse deck panels</td>
</tr>
<tr>
<td>G</td>
<td>Open Steel Grating</td>
</tr>
<tr>
<td>H</td>
<td>Concrete filled Steel Grating</td>
</tr>
<tr>
<td>I</td>
<td>Steel Plate (orthotropic)</td>
</tr>
<tr>
<td>J</td>
<td>Corrugated steel form and asphalt</td>
</tr>
<tr>
<td>K</td>
<td>Aluminum</td>
</tr>
<tr>
<td>L</td>
<td>Timber</td>
</tr>
<tr>
<td>M</td>
<td>Other</td>
</tr>
<tr>
<td>N</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

Measurements for Item 107A and Item 108D

- Item 107A - Deck Structure Thickness
  Item 107A reports the structural portion of the deck thickness as originally built and does not include built up wearing surface thickness.

- Item 108D - Total Deck Thickness
  This item describes the total thickness of the structure's deck and includes the structural deck and the wearing surface above the top of deck support.

- Measurements for Item 107A (Deck Structure Thickness) and Item 108D (Total Deck Thickness) must be obtained from the same location on the structure.
- May be recorded backwards
- May be measured incorrectly
Discussion
STEEL SUPERSTRUCTURES

Item 59 - Steel Superstructures

- Types of Steel Structures and Unique Details
- Common Missed Deficiencies
- Section Remaining vs. Section Loss
- Condition Ratings
Item 59 - Steel Superstructures

Rolled I-Beams

- Various standard sizes:
  - 18” – 36” depths common in bridges (3” increments)
  - 40” & 44” also available
- May have bearing stiffeners
- Common in short to mid-span steel bridges

Welded Girders (I-shape)

- Made of plates welded together
- Width and thickness of flanges and webs can be varied
- Usually have bearing stiffeners
- Depth of web typically greater than 36”
Item 59 - Steel Superstructures

Types of Steel Superstructures

Riveted Girder (I-shape)
- Made up of plates and angles riveted together
- Width and thickness of flanges and webs can be varied
- Usually have bearing stiffeners
- Often have intermediate stiffeners

Steel Box Girders
- Rectangular or trapezoidal cross section
- Commonly used for curved bridges
- Fracture Critical Inspection should include both inside and outside of box
- Confined Space Procedures?
Item 59 - Steel Superstructures

Types of Steel Superstructures

Steel Two-Girder System

- May be riveted or welded
- Floor system may consist of floorbeams and stringers
- Through Girders fall in this category
- They are Fracture Critical Members

Steel Trusses

- Used since the early 1800’s
- Structure made of triangles
- Two parallel trusses
- Trusses are the main load-carrying members

Three Main Types

- Through
- Pony
- Deck
Item 59 - Steel Superstructures

Types of Steel Superstructures

Steel Arches

- Constructed since the late 1800’s
- 3 Types
  - Deck
  - Through
  - Tied
- Tension chord, hangers & floor beams – typ. Fracture Critical

Unusual Details

Pin and Hanger

- Used on Multi-span bridges prior to 1970
- Moves expansion joints away from abutments and piers
- Simplified analysis
- No longer used in design
Item 59 - Steel Superstructures

Unusual Details

Pin Connection

Single pin used without hanger bars to allow rotation only

Item 59 - Steel Superstructures

Unusual Details

Steel Eyebars

- Eyebars are tension only members that require pins for end connections.
- Found on older truss bridges or suspension chain bridges
Item 59 - Steel Superstructures

Common Missed Deficiencies

- Section loss at beam ends below transverse deck joints
- Look for heavy section loss in webs and in the bearing area
- For ratings $\leq 3$ due to web section loss at the bearing area, PM's are responsible for installing/recommending wood blocking between flanges to resist web crushing (July 2017)

Item 59 - Steel Superstructures

Common Missed Deficiencies

- Section loss along the bottom of the web and
- Section loss along the top of the bottom flange
- Section loss around diaphragm connections
Item 59 - Steel Superstructures

Common Missed Deficiencies

Defects Hidden by Pack Rust

- Superstructure rating had just been lowered from a 5 to a 4
- The condition of the floor stringers was not considered in the rating
- Actual super rating was a 1!!

Common Missed Deficiencies

Cracks at Coped or Dapped Ends

- Connection may have been designed as a pinned
- The web may be carrying moment due to stiffness resulting from the depth of the connection
- Section loss can increase potential for cracks
Item 59 - Steel Superstructures

**Common Missed Deficiencies**

**Cracks at Connections**

Cracks can occur at rigid connections of transverse members to thin webs due to out-of-plane bending.

**Common Missed Deficiencies**

Section loss in truss members and gusset plates at connections.
Item 59 - Steel Superstructures

Section Loss Measurements

- Steel Section Loss is measured as a % loss in the area of the original undamaged cross section of the **critical portion of a member**
- IDOT looks at Section Loss in 3 separate zones for a typical flexural steel member:
  - Flexure zone
  - Shear zone
  - Bearing zone
- Pure Tension or Compression members are typically evaluated over the full section area
- See the IDOT BB&S Website for a webinar on Calculating Steel SL

FLEXURE ZONE:

- Section Loss is typically measured as the % loss in the area of either **one** of the flange cross sections
- A hole in a member is not necessarily 100% section loss
**Item 59 - Steel Superstructures**

**Section Loss Measurements**

**SHEAR ZONE:**
- Section Loss is typically measured as the % loss in the area of the total web cross section.
- A hole in a member is not necessarily 100% section loss.

**BEARING ZONE:**
- Section Loss is typically measured as the % loss in the area of the web cross section located directly above the bearing.
- A hole in a member is not necessarily 100% section loss.
Item 59 - Steel Superstructures

Section Loss Measurements

TENSION & COMPRESSION MEMBERS:

- Section Loss is typically measured as the % loss in the total area of the member cross section
- A hole in a member is not necessarily 100% section loss

Key Indicators

- Section Loss
- Cracks

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Culvert.</td>
</tr>
<tr>
<td>9</td>
<td>New superstructure.</td>
</tr>
<tr>
<td>8</td>
<td>VERY GOOD. No visible rust.</td>
</tr>
<tr>
<td>7</td>
<td>GOOD. Some rust may be present but without any section loss.</td>
</tr>
<tr>
<td>6</td>
<td>SATISFACTORY. Initial section loss (minor pitting, scaling, or flaking) up to 2% section loss.</td>
</tr>
<tr>
<td>5</td>
<td>FAIR. Initial section loss up to 10% in critical areas, fatigue or out-of-plane bending cracks may be present in secondary members, arrested fatigue cracks may be present in primary members, hinges may be showing minor corrosion problems, anchor bolt(s) may be missing.</td>
</tr>
</tbody>
</table>
### Item 59 - Steel Superstructures

#### Key Indicators

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>POOR. Section loss up to 30% in critical area, fatigue or out-of-plane bending cracks may be present in primary members, previously arrested fatigue cracks propagating beyond arresting holes in primary members, fatigue cracks in secondary members throughout the bridge, anchor bolts or pintles broken on rocker bearings with an offset of ½” or more between the rocker and the bearing or sole plates.</td>
</tr>
<tr>
<td>3</td>
<td>SERIOUS. Advanced section loss up to 50%, extensive perpendicular to stress fatigue or out of plane bending cracks in primary members.</td>
</tr>
<tr>
<td>2</td>
<td>CRITICAL. Severe section loss over 50% requires special inspections, temporary supports or repairs may be required to remain open to traffic. The Bureau of Bridges and Structures shall be notified immediately.</td>
</tr>
<tr>
<td>1</td>
<td>Superstructure in “imminent failure” condition requiring bridge closure or temporary measures to allow structure to remain open.</td>
</tr>
<tr>
<td>0</td>
<td>Superstructure that has failed and is beyond repair, requiring bridge closure.</td>
</tr>
</tbody>
</table>

#### New Construction

**No deficiencies**

New superstructure – Allowed first inspection only
Item 59 - Steel Superstructures

Very Good Condition

- No deficiencies
- Not new construction
- Note: Weathering Steel

VERY GOOD. No “excessive” rust.

Item 59 - Steel Superstructures

Good Condition

- Minor rust on the bottom flanges
- No section loss

GOOD. Some rust may be present but without any section loss.
Item 59 - Steel Superstructures

Good Condition
- Minor rust on bottom flange
- No section loss

GOOD. Some rust may be present but without any section loss.

Item 59 - Steel Superstructures

Satisfactory Condition
- Initial section loss in non-critical area of bottom flange
- Rust stains on web resulting from rust on secondary member

SATISFACTORY. Initial section loss (minor pitting, scaling, or flaking) up to 2% section loss.
Item 59 - Steel Superstructures

Satisfactory Condition

- Section loss on flanges of diaphragm (secondary member)
- No section loss on girder web

Satisfactory Initial section loss (minor pitting, scaling, or flaking) up to 2% section loss.

Fair Condition

- Minor cracks
- Arrester holes have been drilled in web to prevent further progression of cracks

Fair Initial section loss up to 10% in critical areas, fatigue or out-of-plane bending cracks may be present in secondary members, arrested fatigue cracks may be present in primary members, hinges may be showing minor corrosion problems, anchor bolt(s) may be missing.
Item 59 - Steel Superstructures

Fair Condition

8% section loss at bottom flange and on web of girder

FAIR. Initial section loss up to 10% in critical areas, fatigue or out-of-plane bending cracks may be present in secondary members, arrested fatigue cracks may be present in primary members, hinges may be showing minor corrosion problems, anchor bolt(s) may be missing.

Item 59 - Steel Superstructures

Fair Condition

7% Section loss along the lateral edge bracing

FAIR. Initial section loss up to 10% in critical areas, fatigue or out-of-plane bending cracks may be present in secondary members, arrested fatigue cracks may be present in primary members, hinges may be showing minor corrosion problems, anchor bolt(s) may be missing.
Item 59 - Steel Superstructures

Poor Condition

- 25% section loss in the web of the girder

POOR. Section loss up to 30% in critical area, fatigue or out-of-plane bending cracks may be present in primary members, previously arrested fatigue cracks propagating beyond arresting holes in primary members, fatigue cracks in secondary members throughout the bridge, anchor bolts or pintles broken on rocker bearings with an offset of \( \frac{1}{2} \)" or more between the rocker and the bearing or sole plates.

Item 59 - Steel Superstructures

Poor Condition

- 25% section loss in web
- Hole at cope

POOR. Section loss up to 30% in critical area, fatigue or out-of-plane bending cracks may be present in primary members, previously arrested fatigue cracks propagating beyond arresting holes in primary members, fatigue cracks in secondary members throughout the bridge, anchor bolts or pintles broken on rocker bearings with an offset of \( \frac{1}{2} \)" or more between the rocker and the bearing or sole plates.
**Item 59 - Steel Superstructures**

**Poor Condition**
- Cracked intermittent welds along edge of cover plate
- (cover plate area = 28% of bottom flange)

**Serious Condition**
- Cracks in web along bottom flange
- Arrested crack perpendicular to stress in web
- 15% section loss in lower portion of web

**Section loss**
- up to 30% in critical area, fatigue or out-of-plane bending cracks may be present in primary members, previously arrested fatigue cracks propagating beyond arresting holes in primary members, fatigue cracks in secondary members throughout the bridge, anchor bolts or pintles broken on rocker bearings with an offset of 1/8" or more between the rocker and the bearing or sole plates.

**Section loss**
- Advanced up to 50%, extensive perpendicular to stress fatigue or out of plane bending cracks in primary members.
Item 59 - Steel Superstructures

Critical Condition

- 80% section loss above bearing
- Critical section for bearing at beam end is cut horizontally
- Critical section for shear near beam end is cut vertically

CRITICAL. Severe section loss over 50% requires special inspections, temporary supports or repairs may be required to remain open to traffic. The Bureau of Bridges and Structures shall be notified immediately. (install wood blocking)

Item 59 - Steel Superstructures

Critical Condition

- 50% section loss of web at mid-span
- 100% section loss of bottom flange at mid-span (completely disconnected from web)

CRITICAL. Severe section loss over 50% requires special inspections, temporary supports or repairs may be required to remain open to traffic. The Bureau of Bridges and Structures shall be notified immediately.
Item 59 - Steel Superstructures

Critical Condition

- Bottom flange cracked at bearing

CRITICAL. Severe section loss over 50% requires special inspections, temporary supports or repairs may be required to remain open to traffic. The Bureau of Bridges and Structures shall be notified immediately.

Item 59 - Steel Superstructures

Critical Condition

- Severe section loss throughout
- 100% section loss above bearing
- Beam supported by bottom flange in flexure

CRITICAL. Severe section loss over 50% requires special inspections, temporary supports or repairs may be required to remain open to traffic. The Bureau of Bridges and Structures shall be notified immediately. (install wood blocking)
Discussion
Fatigue, Fracture & Gusset Plates

Fatigue:
The tendency of a member to fail at a stress level below yield stress when subjected to cyclical loading.

Fracture:
The separation of a member into two parts.

Fractured Girder
Fatigue, Fracture & Gusset Plates

AASHTO Fatigue Categories:

- For in-plane bending only
- Details are prioritized in categories from A – E'
- Inspectors: look carefully at details in categories D, E and E'

Fracture Critical Member:

1. Must be steel
2. Must be in tension or have a tension component
3. Failure would likely cause partial or complete collapse of the structure
Fatigue, Fracture & Gusset Plates

Redundancy:

- The structural condition where the number of supporting elements is greater than necessary for stability (alternate load paths exist)

- 3-Types of Structural Redundancy
  - Internal
  - Structural
  - Load Path

Fatigue, Fracture & Gusset Plates

**Internal Redundancy** – a member configuration containing 3 or more elements mechanically fastened together (by rivets or bolts) to form multiple independent load paths

- **Riveted Girder**
  - Has internal redundancy

- **Welded Girder**
  - No internal redundancy
Fatigue, Fracture & Gusset Plates

Internal Redundancy

Riveted/Bolted Girder
Has internal redundancy

Welded Girder
No internal redundancy

Fatigue, Fracture & Gusset Plates

Structural Redundancy – provides continuity of load path from span to span on interior spans of continuous structures

None

None

Spans 2 & 3
Fatigue, Fracture & Gusset Plates

Load Path Redundancy – having 3 or more main load carrying members between substructure units

Non-Redundant Structures:

- Do not have load path redundancy
- Internal redundancy is disregarded
- Structural redundancy is disregarded
Fatigue, Fracture & Gusset Plates

FC INSPECTION PROCEDURES

- FC inspector background
- Equipment needs
- Where to look
- What to look for
- Nondestructive testing

Fatigue, Fracture & Gusset Plates

FC INSPECTOR BACKGROUND:

(preferred qualifications)

- Experienced steel inspector
- Has taken the NHI course on Fracture Critical Inspection Techniques for Steel Bridges (required starting in 2022)
- Has an understanding of structural behavior and fatigue prone details
- Attention to detail
- Willingness to access hard to reach locations
Fatigue, Fracture & Gusset Plates

Equipment Needs (Access Equip. – Arms Length Reach):

- Tape measure
- Crack gauge
- UT thickness meter
- Hammer
- Wire brush
- Grinding wheel bit
Fatigue, Fracture & Gusset Plates

Where to Look: (we will discuss each in detail)

- Areas vulnerable to corrosion
- Field, intersecting, plug (weld filled holes) & tack welds
- Sudden changes in cross section
- Stress risers (included in many of these)
- Locations with high displacement induced stress’s
- Web stiffeners
- Coped sections
- Eyebars
- Pin and hanger assemblies

Where to Look - Areas Vulnerable to Corrosion:

*Locations that trap and hold moisture & debris*

- Beneath deck joints
- Near drains
- On flat surfaces
- Exposed surfaces of fascia beams
- Steel in contact with concrete
- At overlapping steel plates
- Corners on steel members

*Loss of section due to corrosion causes a stress riser that may be susceptible to fatigue*
Fatigue, Fracture & Gusset Plates

Where to Look – Field, Intersecting, plug(weld filled holes) & Tack Welds

- Field & intersecting welds are more susceptible to flaws
- Flawed welds cause increased strain
- Fatigue cracks can initiate more easily at these locations
- Field, intersecting, tack and plug welds
- Any weld in a tension zone on a FCM that is not part of the original design should be documented and brought to the attention of a structural engineer for evaluation

Fatigue, Fracture & Gusset Plates

Where to Look – Sudden Change in Cross Section:

- Sudden changes in cross section cause stress increases
  - Cover plate terminations
  - Changes in plate size
- These are susceptible locations for fatigue cracks to initiate
Fatigue, Fracture & Gusset Plates

Where to Look – Transverse Web Stiffeners:

Schematic of a Crack in the Girder Web at Floor Beam Connection Plates

Fatigue, Fracture & Gusset Plates

Where to Look – Longitudinal Web Stiffeners:
Where to Look – **Eyebars:**

**Fatigue, Fracture & Gusset Plates**

- Intersecting welds at stiffeners and connection plates without corner clips
- Transverse members rigidly connected to girder webs without attachment to flanges

**Highly-Restrained Connections**

- "Hoan" like details
- Intersecting welds at stiffeners and connection plates without corner clips
- Transverse members rigidly connected to girder webs without attachment to flanges
Fatigue, Fracture & Gusset Plates

Recent Case: I-40 over Mississippi R. at Memphis

- May 2021, fracture of lower truss cord discovered during inspection
- Interstate closed due to severity
- Crack may have been present for a few years
- Inspector from previous inspection cycles fired. Claimed it was a difficult to reach location.

What to Look For:
- Section Loss
- Poor Weld Details
- Crack Identification
- Evaluating the Crack
Fatigue, Fracture & Gusset Plates

Nondestructive Testing Methods:

- **Ultrasonic Testing** – Method uses high frequency sound waves to measure material thickness. Surface must be relatively smooth and clean. Effective in finding surface & subsurface defects.

- **Magnetic Particle Test** – Method uses a magnetic field with iron particles to locate defects. Can be difficult to use in the field. Effective in finding surface & subsurface defects.

- **Dye Penetrant Test** – Method involves applying an oil based liquid penetrant & a developer around a suspected crack. Surface must be very clean. Effective in finding cracks open to the surface.

GUSSET PLATE INSPECTION:

- Background
- Inspection Procedures
- General Findings
Fatigue, Fracture & Gusset Plates

BACKGROUND: I-35W over Mississippi R. Collapse
- August 1, 2007 failure of 14 span deck truss
- Loss of 13 motorists lives
- February 2009, FHWA Pub. No. FHWA-IF-09-014: Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges
- May 11, 2010, IDOT ABD Memo 10.2: Load Rating Guidance for Bolted and Riveted Gusset Plate in Steel Truss Bridges
- 2010 – IDOT Local Roads CL 2010-09 recommends Gusset Plate inspections & ratings for all qualifying bridges
- October 2015, IDOT ABD Memo 15.5: Revised Load Rating Guidance for Gusset Plates

Fatigue, Fracture & Gusset Plates

BACKGROUND: GP Locations & Numbers
- 596 Gusset Plates
- 840 Gusset Plates
Fatigue, Fracture & Gusset Plates

GP INSPECTION PROCEDURES

- Arms length access to FC-GP
- Equipment needs:
  - Appropriate access equipment
  - Measurement tools
- Key Indicators:
  - Section Loss
  - Cracks
  - Plate Distortions
  - Damaged Fasteners

GENERAL FINDINGS: Gusset Plate Condition

- Condition varies depending on location
- Age & maintenance history important factors
- Locations above “splash line” generally good
- Locations below the splash line more susceptible
- Areas at PL or member connections more susceptible
Fatigue, Fracture & Gusset Plates

Field Photos: GP in good condition

Fatigue, Fracture & Gusset Plates

Field Photos:
Fatigue, Fracture & Gusset Plates

Field Photos:

[Images of field photos related to fatigue, fracture, and gusset plates.]

Fatigue, Fracture & Gusset Plates

Field Photos:

[Images of field photos related to fatigue, fracture, and gusset plates.]

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Fatigue, Fracture & Gusset Plates

Field Photos: Poor repairs

Discussion
Bearings

Bridge Bearing Types

- Fixed Bearings
  - Transmits loads from superstructure to substructure
  - Allows rotation caused by loads

- Expansion Bearings
  - Transmits loads from superstructure to substructure
  - Allows rotation caused by loads
  - Permit longitudinal movement
**Bearings**

**Basic Bearing Elements**

- **Sole Plate** – distributes forces from the superstructure to the bearing
- **Bearing Device** – transmits forces to the masonry plate, allows for superstructure rotation and longitudinal movement (if expansion bearing)
- **Masonry Plate** – distributes forces to the substructure
- **Anchorage** – connects masonry plate/bearing to substructure unit

**Low Profile Fixed Bearing**
Bearing

General Inspection Procedures

Check For:

- Excessive section loss or wear
- Freedom of movement and clear of foreign material
- Full contact with supporting bearing surfaces
- Properly positioned for location and temperature
- Anchor bolt condition

Common Fixed Bearing Types

- High Profile Fixed Bearing
- Low Profile Fixed Bearing
Bearing Types

- Elastomeric
- Rocker
- Roller
- Sliding Plate
- Pot

Elastomeric Bearing

Inspect For:

- Bearing location in relation to support pads
- Abnormal flattening or bulging of elastomer
- Cracking or splitting
- Complete contact with substructure or masonry PL
- Excessive shear deformation
Bearing Sections

**Elastomeric Bearing**

- Cracking & splitting
- Excessive bulging
- Excessive shear deformation / location

**Rocker Bearing**

Remote For:
- Alignment & tilt angle
- Freedom of movement
- Full bearing surface contact
- Excessive section loss
- Anchor bolt condition
Bearing

Rocker Bearing

- Poor alignment w/ masonry PL
- Heavy section loss
- Excessive tilt

Bearings

Roller Bearing

Inspect For:
- Alignment
- Freedom of movement
- Full bearing surface contact
- Section loss
- Anchor bolt condition
Bearings

Roller Bearing

Section loss on plates, rotated out of position & loss of bearing area

Bearings

Sliding Plate

Inspect For:
- Alignment
- Freedom of movement
- Full bearing surface contact
- Section loss
- Anchor bolt condition
Bearsings

Pot

Inspect For:
- Excessive leakage of rubber
- Full bearing surface contact
- Guide bar damage
- Cracked welds
- Vertical movement under traffic
- Anchor bolt condition

Bearsings

Pot

Excessive leakage of rubber

Bearing at extension limit

Damaged guide & rubber loss
Bearsings

Common Modern IDOT Bearings

ELEVATION AT 90°

SECTION A-A

ELEVATION AT 90°

SECTION A-A
Bearings

NBI Rating Guidelines for Item 59 Superstructure

- The condition of bearings is not often included in the superstructure rating except in extreme situation (Steel Super Item 59 Codes 5 & 4)
- However, deficiencies identified in bearings should be noted on the inspection form so they may be addressed when necessary
- Unexplained excessive movement of bearings can be a clue to other significant problems