Inspection Guidelines and Criteria for Load Rating Box Beams

Raju R. Iyer, PE
Load Rating Engineer, INDOT
Presentation Agenda

- Introduction: INDOT Emphasis
- FHWA Emphasis
- Focus on Box Beams, Box Beam Deterioration
- What is Load Rating?
- Load Rating Specifications & Guidelines
- Computer Software for Load Rating
- Load Rating Formulae & What Matters
- Load Rating & What Affects it
- Inspection for Load Rating
  - Load Rating Request Form
  - Load Rating Check List for Inspection
- Deterioration Inspection (Typical Sketch)
- Load Rating Criteria & Guidelines for Box Beams
- Box Beam Guidelines
- Significance of Corrosion
- Example: PS Box Beams, Rating Summary
- Conclusion/Questions?
Introduction and INDOT

- Commissioners Directive
  - On Time and On Budget (Deliver with focus on KPI and Performance and Quality Services)
  - Take Care of What We Have
    a) Plan to improve Bridge and Pavement Quality
    b) Ensure a Commitment to Safety
    c) Manage Talent to link strategy and operations to results
    d) Culture of Continuous Improvement
- Customer Satisfaction
FHWA Emphasis

- Box beams have a history of poor performance, premature distress, and failures. Box beams have failed in IL, PA, and IN.

- Box beams account for ~5,000 of 19,000 bridges in Indiana

- Purpose:
  - To ensure the safety of high risk box beam bridges
FHWA Emphasis

Scope:
- According to 2013 NBI submittal, IN has 24 box beam bridges with a Superstructure Rating of 3 or less
- Review team conducted field review of 13 of these bridges
- An additional 6 bridges had been replaced

Review Team
- FHWA - Keith Hoernschemeyer, Dan Brydl, Mohammad Hajeer, Micah Loesch, Jay DuMontelle
- INDOT - Merril Dougherty, Randy Strain, Bill Dittrich
- IL DOT - Steve Negangard
FINDINGS

- Many deficiencies were noted with the bridges reviewed
  - Longitudinal cracks, delaminations, and spalls with exposed/failed strands are common
  - 30%-50% failure rate of strands in an individual box is not uncommon
  - Large longitudinal structural cracks are not uncommon
  - Condition of individual beams is highly variable on the same structure
  - Leaking longitudinal joints are very common
  - Over the edge deck drainage with no curb is common
- Most had asphalt wearing surface with no membrane
- Many do not function as designed due to poor load distribution caused by deteriorated/non-functioning grout and transverse tensioning rods; limiting redundancy
FHWA Emphasis

FINDINGS

- Beams have minimal bottom concrete cover over strands and rebar
- Beams have "straps" (used in fabrication process) with minimal/no concrete cover
- Beams have only single row of strands
- Some beams have as few as 7 strands; thereby providing limited redundancy of the strands
FINDINGS

• Condition/deficiencies of the beams were generally not well documented in the inspection reports
• Review Team noted several critical findings that had not previously been identified – findings were addressed by owners during the review
• Assumptions for most load ratings were not well documented in the bridge file
• INDOT Inspection Manual has minimum guidance regarding condition rating and load rating of box beams
Focus on Box Beams

1. Joint in barrier wall passing through curb slab
2. View of corroded area
3. Close-up of corrosion
4. Corrosion on concrete surface
5. Overview of box beam damage
6. Diagram showing different levels of corrosion: New 7-Wire Stand, Corrosion w/o Pitting, Light Pitting, Heavy Pitting
Box Beam Deterioration

Typical asphalt overlay with longitudinal cracking, indicative of poor load distribution amongst adjacent beams and allowing water into joints/beams

Credit: FHWA-Indiana
Box Beam Deterioration

Non-functioning transverse tie rod, leading to poor load distribution amongst adjacent beams

Credit: FHWA-Indiana
Box Beam Deterioration

Leaking joints contributing to strand corrosion, longitudinal cracking, delaminations, and spalling – starting at edge of beams

Credit: FHWA-Indiana
Box Beam Deterioration

Deck drainage contributing to strand corrosion, longitudinal cracking, delaminations, and spalling – starting at edge of beams

Credit: FHWA-Indiana
Box Beam Deterioration

Corroded/failed strand

Credit: FHWA-Indiana
Box Beam Deterioration

- **Focus Areas**
  - Asphalt Overlay Cracks/Salt Water Ingress
  - Loss of Grout-Single Beam Action (Non Composite)
  - Fabrication Deficiencies (Component Thickness)
Box Beam Deterioration

- **Focus Areas**
  - Inadequate cover/Vent Hole Blocks/Longitudinal Cracks/Spalls
  - Lateral PT Rod Corrosion/Failure
  - Loss of Prestress – Strand Corrosion/Pitting/Exposed Strands
  - Edge Deck Drainage - Spalling/Corrosion
What is Load Rating?

- Load Rating is the task of evaluating the Safe Load Capacity of a Bridge for Live Loads using analytical and other methods to ensure Bridge Safety.
- Load Rating Factor should be preferably greater than 1.0 for the design live load.
- Load Rating Factor is the ratio of the net capacity of the superstructure to the live load demand.
- Load rating is different than condition rating.
- Load rating is usually derived analytically.
- Condition rating is usually derived from subjective judgment based on bridge inspection techniques.
Load Rating Specifications & Guidelines

Applicable Codes and guidance

  - Load Rating Guidelines
- AASHTO Standard Specifications for Highway Bridges (17\textsuperscript{th} Edition)
  - LFR or ASD Analysis
- AASHTO LRFD Bridge Design Specifications (6\textsuperscript{th} Edition)
  - LRFR Analysis
- Indiana Bridge Inspection Manual 2013 (being updated)
- FHWA Memorandums
- INDOT Central Office Memorandums
- INDOT Load Rating Practices are undergoing review (Multi-Year Process)
Computer Software for Load Rating

- Preferred software is AASHTOWARE BridgeRating 6.6.0 or BrR 6.6.0 (previously known as VIRTIS)
  - Can rate simple, continuous, steel or concrete, RC and prestressed, straight and curved beams, three sided culverts, RC slabs, plate girders, truss member ratings (not connections) and many others
  - Cannot rate post-tensioned box beams, arch spandrels, simple arches and fill structures, post tensioned slabs, gusset plates
- CANDE for arch and underfill structures
- SMARTCULVERT for arches and conspan type structures
- MIDAS/ABACUS/GT-STRUDL and BrR combo for FEM analysis including secondary effects for steel truss frame analysis as well as post tensioned curved concrete box structures
- Spread sheets and MathCAD sheets for custom development (example for Gusset Plate analysis)
- Conspan and Merlin-DASH also offer some load rating analysis but are not comprehensive.
Load Rating Formulae & What Matters

- **LRFR Load Rating Equation (MBE 6A.4.2)**
  - $C = \text{Capacity}$
  - $R_n = \text{Nominal Resistance}$
  - $g = \text{Load Factor}$
  - $j = \text{Resistance Factor}$
  - $j_c = \text{Condition Factor}$
  - $j_s = \text{System Factor}$
  - $g_{LL} = \text{Live Load Factor}$

Inventory Rating = 1.75*
Operating Rating = 1.35 *
* The above factors have been Modified to be less conservative
Per latest NCHRP study adopted By AASHTO to be published in The latest MBE.

\[
RF = \frac{\phi_0 \phi_1 \phi_2 R - \gamma_D DC - \gamma_w DW \pm \gamma_s P}{\gamma_s L(1 + IM)}
\]

Where:
- $RF = \text{Rating Factor}$
- $\gamma_D = \text{LRFD Load factor for structural components and attachments}$
- $\gamma_w = \text{LRFD Load factor for wearing surfaces and utilities}$
- $\gamma_s = \text{LRFD Load factor for permanent loads other than dead loads}$
- $\gamma = \text{Evaluation live load factor}$

- $A_c = \text{Condition factor}$
- $A_s = \text{System factor}$
- $R = \text{Nominal member resistance}$
- $DC = \text{Dead load effect due to structural components and attachments}$
- $DW = \text{Dead load effect due to wearing surface and utilities}$
- $P = \text{Permanent loads other than dead loads.}$
- $L = \text{Live Load effect}$
- $IM = \text{Dynamic Load Allowance}$
• LRFR Condition Factor, $j_c$
  Resistance reduction based on SI&A Condition Rating

Table 6A.4.2.3-1—Condition Factor: $\phi_c$

<table>
<thead>
<tr>
<th>Structural Condition of Member</th>
<th>$\phi_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good or Satisfactory</td>
<td>1.00</td>
</tr>
<tr>
<td>Fair</td>
<td>0.95</td>
</tr>
<tr>
<td>Poor</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Table C6A.4.2.3-1—Approximate Conversion in Selecting $\phi_c$

<table>
<thead>
<tr>
<th>Superstructure Condition Rating (SI &amp; A Item 59)</th>
<th>Equivalent Member Structural Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 or higher</td>
<td>Good or Satisfactory</td>
</tr>
<tr>
<td>5</td>
<td>Fair</td>
</tr>
<tr>
<td>4 or lower</td>
<td>Poor</td>
</tr>
</tbody>
</table>
Load Rating Formulae & What Matters

- **LRFR System Factor, \( \varphi_s \)**
  - Resistance reduction based on Redundancy and Fatigue Prone Details

Table 6A.4.2.4-1—System Factor: \( \varphi_s \) for Flexural and Axial Effects

<table>
<thead>
<tr>
<th>Superstructure Type</th>
<th>( \varphi_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welded Members in Two-Girder/Truss/Arch Bridges</td>
<td>0.85</td>
</tr>
<tr>
<td>Riveted Members in Two-Girder/Truss/Arch Bridges</td>
<td>0.90</td>
</tr>
<tr>
<td>Multiple Eyebar Members in Truss Bridges</td>
<td>0.90</td>
</tr>
<tr>
<td>Three-Girder Bridges with Girder Spacing 6 ft</td>
<td>0.85</td>
</tr>
<tr>
<td>Four-Girder Bridges with Girder Spacing ( \leq 4 ) ft</td>
<td>0.95</td>
</tr>
<tr>
<td>All Other Girder Bridges and Slab Bridges</td>
<td>1.00</td>
</tr>
<tr>
<td>Floorbeams with Spacing &gt;12 ft and Noncontinuous Stringers</td>
<td>0.85</td>
</tr>
<tr>
<td>Redundant Stringer Subsystems between Floorbeams</td>
<td>1.00</td>
</tr>
</tbody>
</table>
LFR Load Rating Equations

Manual For Bridge Evaluation 6B.4

\[ RF = \frac{C - A_1 D}{A_2 L (1 + I)} \]

- C = Capacity
- A1 = 1.3
- A2 = 2.17 for Inventory Rating and 1.3 for Operating Rating
- D = Dead Load Effect
- L = Live Load Effect
- I = Impact Factor (Dynamic)
Load Rating Formulae & What Matters

- Indiana uses LFR (H20/HS20) for older bridges and LRFR (HL 93) for newer bridges
- Bridges in Indiana Posted if H20 inventory rating is less than 16T
- Looking at LRFR and LFR formula above:
  - Desirable condition is Load Rating Factor is > 1.0
  - This is possible if Capacity is higher (C or Rn is higher) or the section of component is higher
  - This is combined with lighter dead loads and wearing surface loads
  - This is also combined with lower live loads actually travelling on the bridge (lower gross weights or axle loads)
  - Lower C or R or deterioration equals lower rating
Load Rating & What Affects It

FOR BOX BEAMS AND IN GENERAL

FACTORS AFFECTING OR LOWERING LOAD RATING ARE:

**LOWER C**
(DETERIORATION/SPALLING/LOSS OF PRESTRESS/NON COMPOSITE)

**HIGHER D**
(HIGHER DEAD LOADS-
OVERLAYS/BARRIER UPGRADES)

**HIGHER L**
(HIGHER LIVE LOADS WITH HIGHER IMPACT OR DYNAMIC LOAD ALLOWANCE)

WORST COMBO WOULD BE LOWEST C AND HIGHEST D AND L
LOAD RATING REQUEST FORM

Download from: http://www.in.gov/dot/div/contracts/design/dmforms/

Application No. 14

All requests for Load Rating must be made using this form. A copy of the form must additionally be attached to the email sent to coordinator 8 with a copy of the same to the INDOT Load Rating Engineer.
Inspection for Load Rating: Check List

- **Check List @**: [http://www.in.gov/dot/div/contracts/design/dmforms/](http://www.in.gov/dot/div/contracts/design/dmforms/)

- **Pre-Planning before inspection:**
  - Gather Plans, make field copies and sketches
  - Review Plans and familiarize with tension zones, critical areas, material types and design loads
  - BIAS Bridge File review for existing load ratings, critical locations and condition ratings, previous section loss areas
  - Prepare tools and see what may be required like callipers, verniers, tilt gage or D-meter

- **During Inspection:**
  - Sketches:
    - Use Pre-prepared sketches or quick line drawings to log deterioration (Lx Wx D or t)
    - All sheets should have structure number, date, name of inspector and indicate span or location
  - Photos:
    - Take at least two clear photos of deterioration, one close up and one long shot (Can print, annotate and scan or use i-pad with some apps for dimensioning)
Inspection for Load Rating: Check List

- **Check List @**: [http://www.in.gov/dot/div/contracts/design/dmforms/](http://www.in.gov/dot/div/contracts/design/dmforms/)
- **What to look for ?:**
  - Prestressed concrete box beam bridges
  - Identify if Deck is present
  - Identify Asphalt wearing surface and overlays- Look for longitudinal and transverse cracks (Document in detail sketches)
    - Check for longitudinal cracks at bottom and sides of beam (L x W, location, condition)
    - Check for vertical cracks at ends of beam (L x W, location, condition)
    - Check for cracks/spalls/rust stains/water seepage or stains, efflorescence (L x W x D)
    - Check for repeat condition (Are cracks appearing on all beams or focused at ends?)
    - Check for Beam Sag, Check for Rust Stains and Rusted PT Rods and Blocked Vent holes
    - Check for broken rusted strands, vehicle impact and unsound concrete
    - Check for edge spalling
    - Document in notes and sketches
Typical Sketch

Pier 1

Span 1, Beam 6

Pier 2

Spall with 8 exposed strands
Load Rating Criteria for Box Beams

- Current Bridge Inspection Manual
  Load Rating Chapters being Revised

- Three sources for reference:
  - Illinois DOT Structural Services Manual
  - Pennsylvania Pub. 238, Box Beams
  - ODOT Research Report
Box Beam Guidelines

- Use Engineering Judgment with Inspection data and condition rating. Remove Unsound concrete
- Spall: Remove one strand for no exposure/sound concrete
- Spall with exposed strands unsound concrete: Remove at least two layers including adjacent strands
- Longitudinal Cracks: Remove strand above crack and each adjacent strand
- Longitudinal Crack with Rust stains or efflorescence: Remove adjacent strands at least two layers
Significance of Corrosion

- Corrosion rate @ 1 mil/year, 50% section loss in strands occurs five times quicker than rebar
- Lehigh University team research: Forensic Examination of a Non-composite Adjacent Precast Prestressed Concrete Box Beam Bridge (see JOURNAL OF BRIDGE ENGINEERING © ASCE / JULY/AUGUST 2010)
- Presence of Hairline crack on the bottom flange could indicate significant corrosion and pitting of the strand above it
- Corrosion can spread across adjacent strands without any surface indication of distress. Pitting to strands could reduce tensile strength by over 30%
- Corrosion typically occurs on the bottom face of the strand. Since the strand consists of six wires wound around the central wire, all six strands are vulnerable to corrosion
Example: Prestressed Concrete Box Beams

Inspection Sketch Provided by INDOT

Sketch 7/10/2014
by Nicole Pfeiffer

Note:
- "long" is in direction of beam.
- "wide" is across beams.

- Tip: beam and pitched.
- Not to scale.
- 6" x 6" @ pier 2
- 15" long x 2" wide, adjacent to screen.
- Spill of 6" exposed strands.
- Corner spill of 1" exposed strand.
- Corner spill of 1" exposed strand.
- Corner spill of 1" exposed strand.
- West face of pier 2 cap has widespread delamination.

Span A
box beams
Prestressed Concrete Box Beam

[Diagram of Prestressed Concrete Box Beam]

- "long" is in direction of beams
- "wide" is across beams
- Top of beam and pocket
- Corner spill of 3 exposed strands
- Spell of 3 exposed strands
- 8" wide
- 12" up side of beam x 6" long
- Pier 2
- Beam 6
- Beam 5
- Span B box beam
- 12" up side of beam x 6" long
- Sketch 7/10/2014 by Mark Pfieffer
- Not to scale
- 12" up side of beam x 6" long
- 24" long x 16" wide
- 24" long x 16" wide
- 4" long 16" wide
- Corner spill of 1 exposed strand
- Corner spill of 1 exposed strand
- Spell of 7 exposed strands
- Spell of 1 exposed strand
- Spell of 1 exposed strand
Prestressed Concrete Box Beam

Sketch 7/10/2014 by Nate Pfeiffer

2/24/14

Mark up Copy

N

not to scale

long is in direction of beams

wide is across beams

corner (size?) in 24" long x 12" wide

spall of rebar exposed

24" up side of beam

span C

box beams
### Prestressed Concrete Box Beams

<table>
<thead>
<tr>
<th>Description:</th>
<th>3 Simple Span Prestressed Concrete Box Beams - Side-by-Side</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9 Girder System</td>
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<table>
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<tr>
<th>By:</th>
<th>TLW</th>
<th>Date:</th>
<th>9/17/2014</th>
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<tr>
<td>Checked:</td>
<td>DZ</td>
<td>Date:</td>
<td>9/17/2014</td>
</tr>
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</table>

| Load Rating Method: | LFR           |
| Load Rating Program: | Virtis 6.5.0  |

| Year Built:   | 1966          |
| Year Reconstructed: | N/A          |
| Design Loading: | HS-20         |
| Units:        | US Customary  |

<table>
<thead>
<tr>
<th>Bridge Geometry</th>
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<tbody>
<tr>
<td>Spans:</td>
</tr>
<tr>
<td>Girder Spacing:</td>
</tr>
<tr>
<td>O-To-O Coping:</td>
</tr>
<tr>
<td>Clear Roadway:</td>
</tr>
<tr>
<td>Left Overhang:</td>
</tr>
<tr>
<td>Skew:</td>
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<table>
<thead>
<tr>
<th>Location Information</th>
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<tbody>
<tr>
<td>County:</td>
</tr>
<tr>
<td>District:</td>
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<tr>
<td>Reference Post:</td>
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<table>
<thead>
<tr>
<th>Bridge Geometry</th>
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<tbody>
<tr>
<td>Slab</td>
</tr>
<tr>
<td>Total Depth:</td>
</tr>
<tr>
<td>Structural Depth:</td>
</tr>
<tr>
<td>Wearing Surface:</td>
</tr>
<tr>
<td>SIP:</td>
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<table>
<thead>
<tr>
<th>Materials</th>
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<tbody>
<tr>
<td>Resteel:</td>
</tr>
<tr>
<td>Deck Concrete:</td>
</tr>
<tr>
<td>Beam:</td>
</tr>
<tr>
<td>Beam Concrete:</td>
</tr>
<tr>
<td>Strands:</td>
</tr>
</tbody>
</table>

Rehab Summary:
Prestressed Concrete Box Beams

Indicates strand observed in the field as being exposed. This strand was removed from the load rating model.
Prestressed Concrete Box Beams

Span: A Beam: 7
Row 1 Row 2
Original Strand: 29 7
Removed: 6 0
Remaining: 23 7

Span: A Beam: 8
Row 1 Row 2
Original Strand: 29 7
Removed: 2 0
Remaining: 27 7

Span: A Beam: 9
Row 1 Row 2
Original Strand: 29 7
Removed: 1 0
Remaining: 28 7

Indicates strand observed in the field as being exposed. This strand was removed from the load rating model.

Span: B Beam: 1
Row 1
Original Strand: 27
Removed: 1
Remaining: 26

Span: B Beam: 2
Row 1
Original Strand: 27
Removed: 6
Remaining: 21

Span: B Beam: 3
Row 1
Original Strand: 27
Removed: 7
Remaining: 20

Indicates strand observed in the field as being exposed. This strand was removed from the load rating model.
Prestressed Concrete Box Beams

Span: B Beam: 4

- Original Strand: 27
- Removed: 6
- Remaining: 21

% Removed = 48%

Span: B Beam: 5

- Original Strand: 27
- Removed: 13
- Remaining: 14

Indicates strand observed in the field as being exposed. This strand was removed from the load rating model.

Span: B Beam: 6

- Original Strand: 27
- Removed: 8
- Remaining: 19

Span: B Beam: 7

- Original Strand: 27
- Removed: 11
- Remaining: 16

Span: B Beam: 8

- Original Strand: 27
- Removed: 0
- Remaining: 27

Span: B Beam: 9

- Original Strand: 27
- Removed: 7
- Remaining: 20

Indicates strand observed in the field as being exposed. This strand was removed from the load rating model.
### Box Beam Rating Summary

<table>
<thead>
<tr>
<th>Code: LFR</th>
<th>Member: BB5, Span B</th>
<th>Length: 33.83’</th>
<th>LLD Factor: 1.000</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>INV. (Location)</td>
<td>OPER. (Location)</td>
<td></td>
</tr>
<tr>
<td>H20-44</td>
<td>0.559 (16.92’)</td>
<td>1.231 (16.92’)</td>
<td></td>
</tr>
<tr>
<td>HS20-44</td>
<td>0.479 (16.92’)</td>
<td>1.046 (20.30’)</td>
<td></td>
</tr>
<tr>
<td>HL 93</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Fatigue Truck</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>HS 25</td>
<td>0.383 (16.92’)</td>
<td>0.837 (20.30’)</td>
<td></td>
</tr>
<tr>
<td>Michigan Train #5</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Michigan Train #8</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
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<tr>
<td>Military Loading</td>
<td>N/A</td>
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### Additional Table

<table>
<thead>
<tr>
<th></th>
<th>INV. (Location)</th>
<th>OPER. (Location)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SuperLoad - 11 Axles</td>
<td>0.307 (16.92’)</td>
<td>0.677 (16.92’)</td>
</tr>
<tr>
<td>SuperLoad - 13 Axles</td>
<td>0.360 (16.92’)</td>
<td>0.792 (16.92’)</td>
</tr>
<tr>
<td>SuperLoad - 14 Axles</td>
<td>0.233 (16.92’)</td>
<td>0.513 (16.92’)</td>
</tr>
<tr>
<td>SuperLoad - 19 Axles (305k)</td>
<td>0.330 (16.92’)</td>
<td>0.727 (16.92’)</td>
</tr>
<tr>
<td>SuperLoad - 19 Axles (480k)</td>
<td>0.255 (16.92’)</td>
<td>0.562 (16.92’)</td>
</tr>
<tr>
<td>Toll Road Truck 126k</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Toll Road Truck 99.6k</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Toll Road Truck 90k</td>
<td>N/A</td>
<td>N/A</td>
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</table>
Box Beam Rating Summary

236-32-02412-Det
WB=029660 (PCDB) - 9 Beam System (Span B)
02/09/15

36'-6"
35'-3"
33'-0"
7'-1/2"
7'-1/2"
2'-2"

Deck Thickness 5 1/4"

Travelway 1

1.574 (33T) 1.635 (32T) 32 T 32 T 32 T 32 T 32 T 32 T 33T

8@4'-1/4" = 32'-2"
Box Beam Rating Summary

Recommendation:
1. Post weight limit of 11 tons.
2. Increase inspection frequency, e.g., 6 to 12 months.
3. Replace beams with load rating factors below 0.80.

Remaining Roadway Width = 11'-5"
Allow 3'-0" for temporary barrier off beam to be replaced
Deck Thickness 5 1/4"

<table>
<thead>
<tr>
<th>Beam Code</th>
<th>Rating Factor</th>
<th>Load (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSC BB1 (det)</td>
<td>1.025</td>
<td>20.5 tons</td>
</tr>
<tr>
<td>PSC BB2</td>
<td>1.223</td>
<td>24.4 tons</td>
</tr>
<tr>
<td>PSC BB3 (det)</td>
<td>0.885</td>
<td>17.6 tons</td>
</tr>
<tr>
<td>PSC BB4 (det)</td>
<td>0.936</td>
<td>18.7 tons</td>
</tr>
<tr>
<td>PSC BB5 (det) (Critical)</td>
<td>0.559</td>
<td>11.1 tons</td>
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<tr>
<td>PSC BB6 (det)</td>
<td>0.833</td>
<td>16.6 tons</td>
</tr>
<tr>
<td>PSC BB7 (det)</td>
<td>0.671</td>
<td>13.4 tons</td>
</tr>
<tr>
<td>PSC BB8</td>
<td>1.223</td>
<td>24.4 tons</td>
</tr>
<tr>
<td>PSC BB9 (det)</td>
<td>0.729</td>
<td>14.5 tons</td>
</tr>
</tbody>
</table>
Conclusions

BETTER INSPECTION LEADS TO BETTER DATA

BETTER DATA LEADS TO MORE ACCURATE LOAD RATINGS

ACCURATE LOAD RATINGS LEAD TO ENSURING SAFETY PREVENTING LOSS OF LIFE AND MONEY
Questions?

- **Contact Information**
  - Bridge Inspection Manager: Merril Dougherty (mdougherty@indot.in.gov)
  - Load Rating: Raju R. Iyer (riyer@indot.in.gov)