Assessment of Bridges with an Ohio Legal Rating Factor Greater than 1.35 to Meet Special Hauling Vehicle Requirements in Ohio

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4. Ohio Department of Transportation
OUTLINE OF PRESENTATION

• What is an SHV?
• SHV Loads vs AASHTO and Ohio Legal Loads
• FHWA Requirements
• Load Rating – Existing Bridges
• Statistical Approach
• AASHTOWare Bridge Rating Software (BrR)
• Load Rating Approach
• Automated Structural Analysis Checks
• Status
• Deliverables
• Conclusion
WHAT IS SHV?

- Specialized Hauling Vehicle
- Legal truck in Ohio
- Closely-spaced multi-axle Single Unit truck
- Recently introduced by trucking industry
- Examples: Dump Trucks, Construction Vehicles, Concrete Trucks, Solid Waste Trucks, Other Hauling Trucks
SHVs - Federal Bridge Formula

• SHVs in the MBE generally comply with federal weight laws including Bridge Formula B.
• Federal law also states:
  • Single axles limited to 20,000 pounds.
  • Axles closer than 96 inches apart (tandem axles) limited to 34,000 pounds.
  • Gross vehicle weight is limited to 80,000 pounds.

Bridge Formula B: \[ W = 500 \left( \frac{LN + 12N + 36}{N-1} \right) \]

- \( W \) = the overall gross weight on any group of two or more consecutive axles to the nearest 500 pounds
- \( L \) = the distance in feet between the outer axles of any group of two or more consecutive axles
- \( N \) = the number of axles in the group under consideration

MBE: AASHTO Manual of Bridge Evaluation
SHV LOADS VS AASHTO & OHIO LEGAL LOADS

• Shear and moment effects of these new Formula B SHVs are up to 50% over the same for the current family of AASHTO legal loads (NHCRP Report 575, 2007)

• Load rating and posting bridges for AASHTO legal loads or Ohio legal loads is insufficient to ensure safe operation for SHVs

• SHVs may be overstressing some non-posted bridges
EXAMPLE – OHIO LEGAL LOADS VS AASHTO SHVs

Ohio Legal Loads

27T; 18’ 4F1
10’ 12k 14k 14k 14k
27T; 18’
40T; 51’ 5C1
12’ 12k 17k 17k 17k

AASHTO SHV

27T; 18’
12k 12k
10’ 8k 8k 17k 17k
SU4

31T; 22’
12k 12k
10’ 8k 8k 17k 17k
SU5

October 25, 2016

OTECE 2016 SHV Load Rating
EXAMPLE - COMPARISON OF RFs

(Simple pre-stressed bridge with span of 28’10”. Bridge ID – 2000520)
FHWA Requirements

- FHWA SHV Memorandum (November 15, 2013) requires every state to post bridges for SHVs that do not pass a load rating analysis for these vehicles.

- Unless:
  - The State verifies that State laws preclude SHV use.
  - The State has its own rating vehicle models for legal loads that envelope the applicable AASHTO SHV loading models.

- ODOT has prepared a plan to load rate for SHVs.
LOAD RATING — EXISTING BRIDGES

ODOT bridge inventory divided into 3 Groups:

• Group A – Ohio Legal RF ≥ 1.35
• Group B – Ohio Legal RF ≥ 1.0 and RF < 1.35
• Group C – Ohio Legal RF < 1.0 (posted bridges)
ODOT’s Proposal to FHWA

• ODOT postulates that any bridge, with a current RF ≥ 1.35 based on Ohio legal loads (Group A), will not require load posting for SHVs.

• Proof requires rating a statistically valid sample of Group A bridges for SHV loads and showing the RF ≥ 1.0 at a reasonable confidence level.

• University Research Team (URT) assisting ODOT in load rating of bridges and statistical analysis.

• This study will save ODOT money compared to analyzing their complete inventory.
UNIVERSITY RESEARCH TEAM (URT)

• Ohio Department of Transportation

• Ohio University (OU)

• University of Cincinnati (UC)

• University of Toledo (UT)
LOAD RATING – FLOWCHART

Inventory and Operating Load Analysis

Is the bridge designed for HL93 load or, rated by LRFR?

Yes

Perform Inventory and Operating Rating Analysis for HL93 loads by LRFR Method

No

Perform Inventory and Operating Rating Analysis for HS20 loads by LFR method

Legal & Posting Load Analysis

(Continued on next page)
Legal and Posting Load Analysis

Perform load rating for 2F1, 3F1, 4F1, 5C1, SU4, SU5, SU6 & SU7 Trucks*

*Use the same method of analysis as used for Inventory and Operating Rating Analysis

Are all RFs ≥ 1.0?

Prepare BR-100 for Bridge File

Determine the “Controlling” RF for 2, 3, 4, 5 & 6 axle trucks (select controlling one for each 4F1 vs SU4, 5C1 vs SU5 & SU6 vs SU7)

Prepare BR-100 and recommendation for reduced load posting

Prepare Load Posting Sign & Erect on Bridge

Stop
**PROGRESS**

- About 200 bridges with Ohio Legal RF ≥ 1.35 from Ohio’s National Bridge Inventory were selected for load rating.
- A variety of bridge types, spans, and skews were chosen to cover the common bridge types in Ohio.
- Less common bridge types, like cable stayed, suspension, and arch bridges were not selected for this research.
- Existing BARS (Bridge Analysis and Rating System) or BrR (AASHTOWare Bridge Rating Software) files and Bridge Load Rating Summary Reports are being provided to the Universities and ODOT.
AASHTOWare Bridge Rating Software (BrR)

- Bridges are being load rated using the AASHTOWare Bridge Rating Software (BrR version 6.8)
- BrR performs bridge load ratings for assuring public safety, scheduling retrofit or replacement elements, and for assessing overload permits
LOAD RATING APPROACH

• Girder-line analyses being used for the initial check
• Girder-line analysis – influence function is one dimensional
• Data for 3D system models is being input for all bridges
  – Allows BrR to calculate dead loads and distribution factors.
  – Allows easy transition to 3D system analysis if initial check is unfavourable
  – URT preparing System models, as opposed to the earlier Girder-line models in BARS
  – System models can be used in future for 3D Analysis
• URT performs a series of automated checks to confirm validity of the models
AUTOMATED STRUCTURAL CHECKS

• List of structural checks:
  • Comparing the DL and LL values in BrR and BARS
  • Comparing the shear/flexure RF of the bridges in BARS and BrR
  • Comparing the capacities
  • Confirming BARS operating RF $\geq 1.35$ (for legal loads)
  • Reviewing SFD, BMD, support reactions
  • Confirming BARS RF $\sim$ BrR RF
  • Manual calculation and comparison of these checks can take days/weeks
  • URT working to automate the checks
  • CSI Bridge will also be used to verify results for some of the bridges
RFs plotted from BRB output file
(Simple span pre-stressed bridge with span of 28’10”. Bridge ID – 2000520)

Ohio Legal

SHV

RF graph

October 25, 2016
OTECA 2016 SHV Load Rating
COMPARISON BETWEEN BARS AND BrR RF (GL ANALYSIS)
(Simple span pre-stressed bridge with span of 28’10” Bridge ID - 2000520)
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<th>Bridge Type</th>
<th>Structural Type Code</th>
<th>No. Obtained</th>
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<th>Checked</th>
<th>Passing</th>
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DELIVERABLES

Expectations from the Universities:

• As analyses proceed, statistical evaluation will be performed on the results to determine if additional bridges need to be evaluated in order to draw conclusions

• This may result in fewer than 200 total bridges being load rated

• Error-free xml data files will be provided to ODOT upon project completion

• ODOT Load Rating Summary Form BR100 to be completed and submitted to ODOT for all the bridges evaluated

• Results will be summarized in a report provided to ODOT which will include spreadsheet tables and charts of the rating results
CONCLUSION

• SHVs may give lower load rating than previous rating loads
• FHWA requires bridges be load rated for SHVs
• Hypothesis: Bridges with RF ≥ 1.35 for past Ohio Legal Loads will have RF ≥ 1.00 for SHVs
• URT working under ODOT direction to examine a sample of bridges
• All bridges analysed so far have satisfied the hypothesis
• Using URT allows students and faculty to gain an in-depth knowledge of load rating and develop ability to apply the software
Thank You

Questions?