Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Refined Analysis of Slab Bridges for Load Rating

Research Objectives

1. Develop a finite element application that analyzes slab bridges to determine the response, specifically longitudinal bending moments.
2. Use the response to compute and report effective widths.
3. Validate the application with static checks and comparisons with LRFD and LFD equations.
4. Write output graphics and reports that aid the validation of computations and permit checking.
5. Document where the results may be entered into AASHTOWare BrR to create bridge/structure alternatives
6. Demonstrate using the bridge alternative for different operational use cases.
7. Create a short video on the use of the application
8. Provide a webinar to NDOT for engineers interested in using this application.

Research Benefits

This study will enrich the state-specific load rating strategies for slab bridges and help develop better load rating solutions. Comsol has a tool to develop the user interface. The finite element tool and application development are tightly integrated and are unique to the industry. The Comsol tool is then used to compile the interface and the interface to Comsol runtime modules. (Similar to almost all Windows applications that use Microsoft's runtime DLLs.) The runtime can be embedded into an executable application file (.exe), or the application can address a runtime downloaded separately. The end user does not have to purchase a Comsol license, and Comsol has no claim on these applications, royalties, etc. NDOT can share this application with their consultants, and others as they wish.

Principal Investigator

Marc Maguire (P.I.)
Jay Puckett (Co-P.I.)
University of Nebraska

NDOT Lead TAC Member

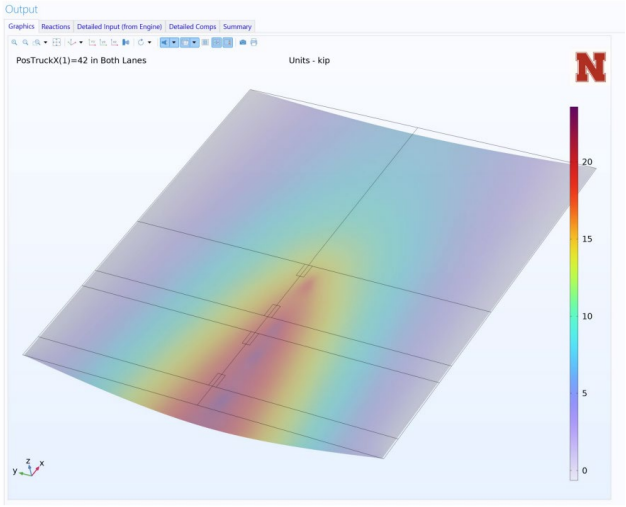
Emilie Hudon, **PE,** Bridge Engineer

Background

NDOT has approximately 100 slab bridges in its inventory that were originally built as early as the 1930's. Material strengths were relatively low, e.g., fy = 33 ksi, and f'c = 3000 psi or less. These structures often fail to pass load rating procedures and Superload (NDOT's) automated Routing and Rating System that uses LARS/Superload and LFR employing a beamline approach. Beamline analysis requires a distribution width E (the lane's width to support one or two lanes of trucks). The load demands are inversely proportional to E, i.e., a refined finite element analysis (FEA) might increase E by 20%, so the load demands a decrease by 20%. Better analysis can potentially economize bridge operations and allow vehicles to cross these structures safely. The process might allow increasing or removing the posting sign for any posted structures.

Conclusion

NDOT has approximately 500 slab bridges in its inventory. These bridges frequently fail load rating procedures and super-load routing, leading to posting and operational limitations. This project develops a refined finite element analysis application to compute effective distribution widths for live load distribution. The refined analysis reduces conservatism inherent in AASHTO equations, thereby providing more accurate ratings and potentially eliminating postings. Non-standard and standard axle gages are considered. The tool computes longitudinal bending moments and effective widths, validated against LRFD/LFD equations. Results can be imported directly into AASHTOWare Bridge Rating (BrR). A spreadsheet was developed to guide the engineer in linking the application and BrR. The tool improves NDOT's ability to rate slab bridges, allowing heavier vehicles to cross and minimizing unnecessary postings safely. The project tasks include application development, validation, implementation, training, and reporting. The long-term benefit is a modernized approach to bridge rating that better utilizes existing infrastructure.



One-span slab loaded with two lanes near the edge

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Interested in finding out more?
Final report is available:
HERE

NDOT Recommendations Based Off Research Project – 2026 – RRL5

This project delivers a targeted finite-element software tool that enables the Nebraska Department of Transportation (NDOT) to generate more accurate and less conservative distribution factors (DFs) for slab bridge load ratings. Traditional AASHTO equations yield conservative results, requiring either restrictive postings or resource-intensive full finite element analyses for improved accuracy. The developed software significantly streamlines this process by producing reliable DFs, which can be inputted in other load rating software, enhancing both precision and operational efficiency. This fits well within our current load rating and permitting processes without creating additional analysis burden.

This tool is used by NDOT's Bridge Load Rating Unit to identify additional structural capacity in slab bridges which perform well but appear deficient under the current conservative equation methods. Key benefits include substantial reduction in analysis time and cost savings through avoidance of unnecessary postings or replacements. Software distribution is managed by Dr. Puckett, available here. Interested parties should contact jaypuckett@puckettresearch.com to gain access. This tool is gaining growing interest from other State DOTs and National Bridge Committees, with 12 download requests having been made as of July 13th, 2026.

- *As provided by Emilie Hudon, Lead TAC Member*

Research Readiness Level (RRL) Assessment

RRL 5

Level 5: Standard Practice
Fully implemented.

Technology Transfer

Webinars/Presentations

- Puckett, J. and Hudon, E., *Load Rating of Slab Bridges with Rigorous Analysis*. Presented at the 2026 AASHTO Technical Committee Safety and Evaluation, Charlottle, NC. 2026.

This brief summarizes Project SPR-FY25(045)
"Refined Analysis of Slab Bridges for Load Rating"
Nebraska Department of Transportation Research Program