

Calibrating National Bridge Standards for Michigan's Unique Truck Loading

The live load factors in the national Load and Resistance Factor Design (LRFD) code and the Load and Resistance Factor Rating (LRFR) code are based on load data thought to be representative of heavy truck traffic nationwide. However, the code allows for recalibrating live load factors for a jurisdiction if weigh-in-motion data are available. Michigan DOT's extensive weigh-in-motion data collection program allowed researchers to adjust standard LRFD/LRFR requirements to accommodate Michigan's higher legal loads for heavy trucks.



Extreme loading of bridges by heavy trucks in Michigan is much less common than loading by lighter vehicles, which allows for Michigan DOT's modifications to default LRFD/LRFR values.

Problem

The 1967 collapse of the Silver Bridge on the Ohio River prompted establishment of the Federal Highway Administration's (FHWA) National Bridge Inspection Standards. In the decades since the formation of this program, FHWA and the American Association of State Highway and Transportation Officials (AASHTO) have worked toward establishing more uniform standards for designing and inspecting bridges. Current practice calls for using the LRFD/LRFR methodology, which takes into consideration such factors as a bridge's structural capacity, the current condition of the structure and the anticipated weight of the vehicles traveling the bridge (known as "live load"). LRFD/LRFR is intended to enhance and make more consistent the level of public safety on bridges across the United States.

In Michigan, however, more than 30,000 oversize or overweight permits are issued annually to transport everything from livestock to power plant components and

provide a vital service to the state's economy. Previous studies have shown that heavy trucks in Michigan cross bridges less frequently in extreme configurations—such as side-by-side and in series—compared with LRFR defaults. The latest LRFD/LRFR design and rating system, if left unmodified, could prevent these oversize/overweight vehicles from driving across a new structure. Engineering new bridges to meet the default LRFR standards would result in a 9.5 percent increase in bridge construction costs. (For further discussion of these issues, see reports RC-1413, *Investigation of the Adequacy of Current Bridge Design Loads in the State of Michigan*, and RC-1466, *LRFD Load Calibration for State of Michigan Trunkline Bridges*.)

Approach

Investigators first needed to assess the range of load rating systems used by Michigan DOT engineers:

- Federal ratings
- State legal loads
- State overload classification

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Project Information

Report Name: *Recommendations for Michigan Specific Load and Resistance Factor Design Loads and Load and Resistance Factor Rating Procedures*

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Total Cost: The costs of this research were incidental to the daily activities of the Michigan DOT investigators.
Cost Sharing: None.

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The federal ratings are for informational purposes only and provide FHWA with a common reference point for comparing structures within a state and across the country. They do not directly measure the operational capacity of structures in Michigan.

On the other hand, the Michigan legal loads and overload classification have a direct impact on state motorists and truckers. With this in mind, researchers chose to analyze these two rating systems and their relationship to actual data collected through Michigan's extensive weigh-in-motion system.

Research

Weigh-in-motion equipment collects traffic data by vehicle classification and weight. The collected data also includes date, time, vehicle length by axle spacing, speed and axle weight. Michigan DOT is considered a national leader in weigh-in-motion data collection, and researchers analyzed this data to compare the loading conditions in Michigan to those used to develop the LRFR code.

Using information gathered from weigh-in-motion sites in the Detroit metropolitan area, the load effects of the actual trucks that drive in Michigan were calculated for 20 bridges representative of recently constructed structures. Investigators characterized heavy vehicle travel on these Michigan roadways and calculated the expected forces on the state's bridges.

Results

This research confirmed that trucks cross Michigan bridges less frequently in extreme configurations than assumed by default LRFD/LRFR code. Given this information, combined with the heavier legal loads allowed in the state, researchers were able to provide recommendations for modifications to the LRFD/LRFR code based on data specific to Michigan traffic patterns and loads. Use of state-calibrated LRFD/LRFR specifications is expected to lead to new construction cost savings as high as five percent.

“As a result of this research, bridges in Michigan will meet LRFD reliability standards while maintaining truck capacity.”

*Rebecca Curtis, P.E.
Load Rating Engineer*

Value

This research exemplifies how Michigan DOT strives to apply new standards in ways that are most appropriate for the state. Implementing the results of this investigation will allow the agency to support continued economic growth by efficiently designing structures that will maintain both truck capacity and structural reliability. ■

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The final report is available online at: <https://mdotjboss.state.mi.us/SpecProv/getDocumentById.htm?docGuid=74484bb5-9b88-45ff-8c29-7b9e14315661>.

The Michigan DOT report RC-1466, *LRFD Load Calibration for State of Michigan Trunkline Bridges*, referenced in this *Research Spotlight*, is available at <https://mdotjboss.state.mi.us/SpecProv/getDocumentById.htm?docGuid=a76c4d7b-a2eb-4ade-adaa-188fd0c80125>. For information on the Michigan DOT report RC-1413, *Investigation of the Adequacy of Current Bridge Design Loads in the State of Michigan*, contact 517-636-0305.