RESEARCH ADMINISTRATION
Bureau of Field Services
Michigan Department of Transportation

# Research Spotlight

## Developing representative truck configurations for bridge load ratings

**MDOT engineers calculate bridge load ratings using a list of representative vehicle configurations on Michigan roadways. Since the list was developed in the 1970s, bridge engineers were concerned it was outdated and they wanted to verify the accuracy of bridge load rating results. Using weigh-in-motion (WIM) data from sites across the state, researchers determined the characteristics of Michigan's current freight traffic. From this data, they calculated actual vehicle load effects and recommended rating procedures to account for modern vehicle configurations, which will allow bridges to be rated consistently and accurately.**

### Project Information

**REPORT NAME:** Developing Representative Michigan Truck Configurations for Bridge Load Rating

**START DATE:** March 2016

**REPORT DATE:** February 2018

**RESEARCH REPORT NUMBER:** SPR-1640

**TOTAL COST:** $167,036

**COST SHARING:** 20% MDOT, 80% FHWA through the SPR, Part II, Program

### MDOT Project Manager

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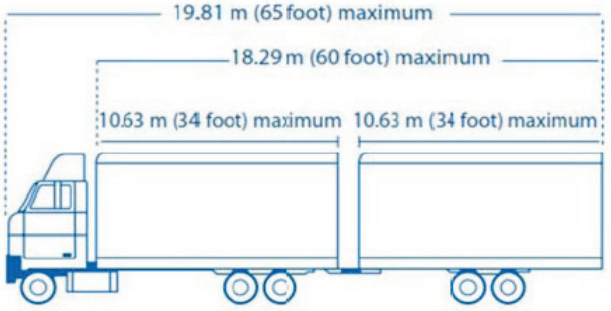
### Problem

The truck configurations that engineers use to determine bridge load ratings are meant to represent the load effects – such as bending or shear – caused by actual freight vehicles. However, the 28 configurations that MDOT uses were developed decades ago and may no longer correspond to modern freight configurations. In particular, MDOT engineers were concerned about the load effects caused by extended permit vehicles, which exceed the Michigan Vehicle Code maximum legal limits for length and load on roadways. Increased freight traffic also has led to more extended permit vehicles crossing Michigan bridges.




Researchers examined extensive WIM data from freight vehicles in the state. This maxi-cube vehicle is one of the many configurations considered in determining representative freight traffic on Michigan roads.

If the idealized set of vehicles used to determine bridge load ratings does not closely represent actual traffic loads, bridges may be rated inaccurately. Bridges could be rated too conservatively, resulting in unnecessary traffic restrictions. Conversely, they could be rated inaccurately and allow traffic loads that should

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> *"The research confirmed that the vehicle configurations currently used for bridge load ratings adequately represent the vehicles traveling on Michigan roads. The findings may allow us to reduce the number of vehicle configurations required for load rating analyses."*
>
> **Allie Nadjarian, P.E.**
> Project Manager

be restricted. MDOT's engineers wanted to update their bridge load rating model and confirm whether new representative freight vehicle configurations would be required.

## Research

The objective of this study was to recommend a rating process that represented the load effects for legal and extended permit vehicles in Michigan to ensure accurate bridge load ratings.

First, researchers gathered information from MDOT, the trucking industry, law enforcement, and state and federal sources to clarify the definition of legal and extended permit vehicles. The permitting process and methods for enforcing traffic restrictions also were investigated.

Next, researchers gathered high-fidelity WIM data from 20 representative sites throughout the state over 34 months between 2014 and 2017. After these data were analyzed to remove unreliable and noncritical, low-weight vehicle records, approximately 101 million truck records remained in the database. Using vehicle weight and configuration criteria developed for this study, researchers further refined the data to capture 89 million vehicles representing Michigan's legal and extended permit traffic. They used these data to determine the representative configurations of freight traffic operating on state roadways.

Researchers then calculated load effects for two-lane bridge spans from 20 to 200 feet. They considered single- and two-lane effects and other diverse load variations, computing results for two rating procedures: Load Factor Rating (LFR) for bridges designed to older specifications, and Load and Resistance Factor Rating (LRFR) for newer bridges designed to current standards. Bridge beam types considered for the analyses were steel, prestressed concrete, reinforced concrete, spread box and side-by-side box, with beam spacing from 4 to 12 feet.

## Results

Researchers determined the load effects that must be used in the rating process for bridges to meet required reliability levels when carrying legal and extended permit vehicle traffic. Analyses showed that with a few exceptions, the existing LFR procedure resulted in very conservative ratings. The current LRFR procedure was conservative in all cases that researchers considered.

Three rating procedures were developed to allow structures to meet required safety levels while minimizing excessively conservative results: a simplified approach, a more defined procedure using required load effect tables, and a precise assessment using structure-specific reliability analysis.

The simplified approach encompasses the existing MDOT system, which meets minimum reliability levels. It is the least precise, allowing bridges to be rated more conservatively than safety demands. However, it also requires the lowest investment of time and resources compared to the two other, more precise procedures. MDOT engineers may employ any of these procedures for safe rating assessment. Also, MDOT may reduce safely the number of representative vehicles it currently uses to rate bridges.

## Value

This project determined the configurations of current freight traffic on Michigan roadways, allowing for an up-to-date assessment of the rating process. It verified that current bridge ratings are safe generally, though they may be conservative in many cases. MDOT now has specific methods to refine load rating procedures that allow bridges to meet target reliability levels accurately.

## Research Administration

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