



PUTTING RESEARCH TO WORK

BRIEF

Bridge Construction Live Load Analysis Guide

The dramatic and disastrous collapse of the I-35W Mississippi River bridge in Minneapolis in 2007 drew attention to a number of issues in bridge construction and rehabilitation. Though a prime cause of the collapse were the gusset plates underdesigned for the loads they carried, the presence of heavy construction equipment on the bridge deck during rehabilitation work also compromised bridge performance.

What's the problem?

Rehabilitating bridges may require removing bridge components and installing new members, work often done with large cranes on the bridge that weigh several times the legal load limit for truck traffic across the bridge. WisDOT and many of its peer agencies in other states require contractors to analyze load-bearing capacity for bridges during construction and submit plans suited to load limitations. Significant research has been performed by AASHTO and others to determine load distribution for standard AASHTO design vehicles; however little data is available about how heavy construction loads, such as cranes and heavy haul dump trucks, distribute their loads across a bridge. WisDOT undertook this research to provide contractors with direction on how to conduct such assessments.

Research objectives

This study sought to provide construction engineers and designers with a new bridge construction live load analysis guide to assess construction loads and plan construction work accordingly. By determining appropriate load distribution factors and modifications to existing bridge design criteria for limiting certain construction loads, investigators provided methods to calculate and analyze construction loads, and to anticipate potential load effects.

Methodology

To begin, investigators observed rehabilitation work at bridge sites and surveyed state consultants and contractors for their perspective of construction load assessment. They also surveyed other transportation agencies about their approach to regulating construction loading on bridges. Then they prepared a finite-element modeling strategy for analyzing work on the three most common bridge types used in Wisconsin:

- Concrete slabs with reinforcing steel: Investigators studied a Kenosha County one-span concrete slab bridge over the Pike River (B30-0005).
- Concrete decks over steel girders: Investigators studied a two-span composite steel-plate girder bridge at County Road KE over WIS 16 (B67-173).
- Prestressed concrete girder bridges: Investigators studied a three-span composite prestressed girder bridge over the Holcombe Flowage (B09-273) on WIS 27.

Researchers modeled outrigger and track loads from 70-ton and 200-ton cranes, respectively, and wheel loads from a 156,000-pound heavy haul dump truck. Based on modeling results, investigators developed a live load analysis guide.

Results

SURVEY RESULTS Participants from 24 state transportation agencies and the transportation departments of Ontario, Canada, and U.S. Forest Service Region 4 responded to a seven-question survey. Results included the following:

- Twelve of 26 agencies have specifications for contractors to submit proof that the structure will not be overloaded by construction equipment. Three are developing specifications.

Investigator

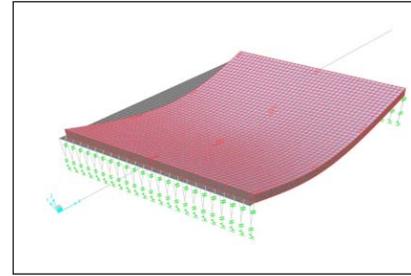


“Design distribution of loads is specified for bridges when they’re built. However, load distribution may not be the same when bridges are partially constructed or under rehabilitation.”

—Michael Garlich
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Researchers used CSiBridge, Version 15 to analyze construction loads on typical Wisconsin bridges.



Finite-element modeling of construction live loads guided researchers as they examined loading and developed a new guide for analyzing construction loading on bridges under construction or rehabilitation.

Project Manager



“The relative lack of guidance on live-load distribution for construction loads piqued our interest in this project. We thought it was important to provide our contractors with a document they can follow.”

—Travis McDaniel
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- Seven agencies provide guidance to contractors for analyzing construction loads.
- Two agencies have specific procedures outside of AASHTO’s requirements, and five require contractors to use the bridge’s original design specifications for load analysis.
- Fifteen agencies use their legal axle-load limits or permit-load requirements as the standard for construction vehicles.
- Seventeen agencies do not specifically issue guidance for construction load distribution.
- Fourteen agencies do not allow stockpiling of materials on the structure during construction.
- Twenty-one agencies determine what structures are analyzed for construction loads based on bridge condition, existing load rating capacity or other criteria.

MODELING RESULTS Models demonstrated that the cranes and trucks distribute loads similarly.

- For loads positioned between girders, cranes and trucks distribute about 70 percent of load directly beneath the equipment and 15 percent to each side. Outriggers distribute about 30 percent to each side.
- If an exterior girder is on one side of the equipment, about 50 percent from any piece of equipment is distributed to it.
- Loads at or near midspan and directly above a girder put about 30 percent to 40 percent of the load directly beneath.
- Loads placed near piers or abutments show an increase in the percentage of load distributed directly below the equipment.
- The use of timber mats has the beneficial effect of distributing loads over a greater area, but it does not significantly affect how much load is distributed to each girder.

BRIDGE CONSTRUCTION LIVE LOAD GUIDE Based on conservative use of the modeling data, investigators developed a guide with instructions for analyzing loads and using equipment. The guide details assessment information that should be submitted to WisDOT. It considers cranes with tracks, cranes with outriggers, excavators, loaders, pavers and other equipment. It also considers load distribution factors, equipment information, deck considerations and other factors.

Implementation

Contractors and consultants working with WisDOT will use the 24-page Bridge Construction Live Load Analysis Guide to plan distribution of loads during bridge deconstruction, construction and reconstruction. The guide will enable crews to carry out their work safely and efficiently while preserving the integrity of Wisconsin bridges.

This brief summarizes Project 0092-10-13, “Development of a Bridge Construction Live Load Analysis Guide,” produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research Program, 4802 Sheboygan Ave., Madison, WI 53707.

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