RESEARCH ADMINISTRATION
Bureau of Field Services
Michigan Department of Transportation

Research Spotlight

Project Information

REPORT NAME: High Skew Link Slab Bridge System with Deck Sliding over Backwall or Backwall Sliding over Abutments

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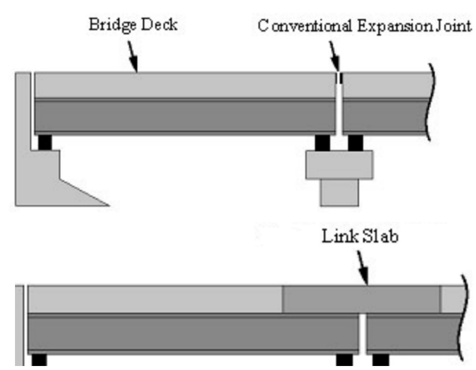
Improving the design of high-skew jointless bridges

National bridge specifications encourage the removal or avoidance of expansion joints to improve bridge deck durability and rideability. One approach to removing joints is to make the bridge deck continuous over the piers by means of a link slab. This research addressed many of the challenges associated with designing jointless bridges, focusing on highly skewed structures, which are more complicated to design. The recommended designs will lead to longer service life and lower maintenance costs for Michigan's new and retrofitted high-skew jointless bridges.

Problem

To avoid structural damage, bridges must be rigid enough to carry traffic loads, but flexible enough to accommodate movement caused by temperature changes and other factors. One method for accommodating movement is to provide expansion joints on bridge decks. The expansion joint is typically a flexible steel assembly that connects the bridge span segments while allowing for movement. For continuous bridge spans, underneath each joint is a support—a pier or abutment on which the girders on either side of the joint are supported. Bearings at the supports allow the beam ends to move as envisioned in design.

The use of expansion joints decreases bridge durability by allowing surface water laced with deicing chemicals to reach and corrode the underlying structure supporting the bridge. National bridge specifications promote the use of designs that avoid using expansion joints between piers and eliminate existing expansion joints over piers when possible. Generally, during bridge rehabilitation activities, the deck is made continuous over supports using a link slab, a section of reinforced concrete



(Deck thickness exaggerated for emphasis.)

Link slabs create a continuous bridge deck covering the gap between girders over supports, preventing water and deicing chemicals from infiltrating, corroding and weakening the underlying supporting structure.

(continued)

> *"This project will allow us to improve the durability of high-skew jointless bridges, which in Michigan have had durability issues identified with link slab cracking."*
>
> **Steven Kahl, P.E.**
> Project Manager

that is placed over the underlying gap at the support between girders. Movement of the deck is then accommodated using abutment configurations that allow sliding.

However, jointless bridge designs can be challenging for bridges that are highly skewed. Skewed bridges have spans that are not at a right angle to their abutments, and high-skew bridges deviate from a right angle by more than 30 degrees. High-skew bridges experience greater torsional stresses than other bridges, and other stresses can differ in location and magnitude. Movement of the bridge will no longer be uniform along the axis of the bridge, and high-skew bridges require special guide systems to keep them in alignment during movement. Consequently, the performance of these bridges in Michigan has been below expectations, with link slabs often suffering from cracking.

Approach

The objective of this project was to develop recommendations for the design of high-skew bridges with link slabs by integrating the findings from the literature review, field load testing and finite element computer modeling and analysis.

Research

Researchers undertook the following tasks:

- Conducted a literature review of research on the behavior and performance of skewed and jointless bridges to identify design configurations with better performance records.
- Monitored a high-skew bridge under truck loads and thermal loads to evaluate the performance of sliding bearings and the behavior of the bridge under various load types.
- Used finite element computer modeling to conduct a detailed analysis of skewed link slabs, evaluating how the force at the link slab section directly over a pier changes with bridge skew angle and various bearing configurations.
- Conducted a finite element analysis for various skew angles of two skewed abutment configurations.

Results

Using the results of the literature review, load testing and finite element analysis, researchers developed three design recommendations that account for the effects of bridge skew. The first recommendation deals with high-skew link slab design, and recommends increased reinforcement for the zones of transition between the link slab and the deck, where stresses are higher in high-skew bridges. The design also includes saw cuts that relieve stresses and associated cracking on other parts of the deck and localize them at the cuts, allowing simple crack sealing maintenance.

The remaining two design recommendations address the bridges' transverse restraint systems, bearing details and abutment configurations. The restraint systems are designed to keep a high-skew bridge aligned along its vertical axis despite expansion that tends to displace the bridge transversely. The abutment configurations allow the movement of a jointless bridge in the absence of expansion joints by either a) allowing the entire deck to slide over the backwall, the part of the abutment that acts as a retaining wall where the deck meets the embankment, or b) allowing a combined deck-backwall system to slide over the remaining part of the abutment. Researchers provided detailed design examples for proposed inclusion in the MDOT *Bridge Design Guide*.

Value

This project provides new designs that will allow engineers to better account for the effects of skew, which means Michigan can expect reduced link slab cracking, longer service life and lower maintenance costs from new and retrofitted high-skew bridges. Researchers recommend evaluating and refining the new design procedures by incorporating them into pilot implementation projects and monitoring their performance.

Research Administration

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