



Field Demonstration of an Innovative Box Beam Connection

tech transfer summary

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RESEARCH PROJECT TITLE

Field Demonstration of an Innovative Box Beam Connection

SPONSORS

Iowa Highway Research Board
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The Bridge Engineering Center (BEC) is part of the Institute for Transportation (InTrans) at Iowa State University. The mission of the BEC is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

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An innovative longitudinal joint design for box girder bridges that features a unique rebar configuration and Type K cement can help mitigate early age cracking.

Objective

The objective of this project was to demonstrate the field implementation of an innovative longitudinal joint design for box girder bridges that features a unique rebar configuration and the use of Type K cement to limit volumetric changes during concrete curing. The joint was implemented in a new box girder bridge construction project in Washington County, Iowa.

Background

Cracking in box girder bridges tends to be most prominent at the interfaces between the box girders and the joint concrete and initiates during the early age of the joint concrete. This cracking is suspected to be caused by low bond strength between the joint material and box girders, significant shrinkage of the joint material, and temperature changes.

In a previous research phase, an innovative joint detail was designed that incorporates Type K cement to achieve shrinkage-compensating concrete, form retarder to increase shear and bond capacity between the joint material and box girders, and steel reinforcing bars across the interface between the joint and box girders.

Problem Statement

In laboratory tests for temperature loading, vertical cyclic loading, and horizontal loading, the innovative joint design performed well in resisting early-age joint cracking. However, the joint design had yet to be incorporated into girders manufactured at a precast concrete plant, implemented in an in-service bridge, or evaluated for its performance in the field.



Completed box girder bridge in Washington County, Iowa

Research Description

The research team observed and documented the fabrication of specially designed box girders in a precast concrete plant and the field construction of the bridge, including installation of the girders and placement of the joint concrete. The bridge was constructed in early October 2020 and opened to traffic in November.

During construction, two joints were selected for early-age monitoring, and 24 strain gauges with thermistors were embedded in the joints and adjacent girders. A seven-day

field monitoring period focusing on those joints began immediately after construction, with temperature and strain data collected every 10 minutes.

After the bridge was opened to traffic, long-term monitoring commenced. The bridge was instrumented with eight strain gauges and six displacement transducers, and three live load tests were conducted in November 2020, October 2021, and August 2022 to evaluate load distribution and performance changes over time. Additionally, the bridge deck was visually inspected in October 2020, May 2021, October 2021, and August 2022 to monitor cracking.



Box girder form with reinforcement in precast concrete plant



Embedded strain gauge at the top of a box girder before concrete pouring



Placement of joint concrete in the field



Embedded strain gauge at the bottom of a joint before concrete placement



Live load testing

Key Findings

- The innovative joint sufficiently resisted early-age longitudinal joint cracking.
- The innovative joint adequately distributed live loads in the transverse direction. The live load performance remained relatively unchanged from the joint's initial construction.
- The live load tests indicated that the concrete box girder and joint assembly acted nearly monolithically between the individual components.
- The structure was found to have a high stiffness, with deflection values much lower than the maximum recommended limit per the American Association of State Highway and Transportation Officials *Load and Resistance Factor Design Bridge Design Specification*.

- The bridge's integral abutment, which encapsulates the girder ends, positively affects the strain distribution in the innovative joint near the joint ends. The abutment provides restraint in the transverse direction, thereby aiding the resistance to joint cracking.
- After two years in service, the innovative joint remained in very good condition with no observable cracking.

Implementation Readiness and Benefits

The innovative joint design, which includes a unique rebar configuration and Type K cement, resulted in a durable and well-performing joint that resists the early-age cracking often observed in box girder bridges with traditionally constructed joints.

The observations of the box girder prefabrication and bridge construction processes indicated that the bridge was constructed with relative ease.

The procedures and operations documented in the report can serve as a “how-to” for counties interested in constructing box girder bridges that feature the innovative joint design.