Evaluation of the 24th Street Bridge

tech transfer summary

Accelerated construction methods using precast deck panels were implemented and evaluated on the 24th Street bridge in Council Bluffs, Iowa.

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RESEARCH PROJECT TITLE
Evaluation of the 24th Street Bridge

SPONSORS
Federal Highway Administration
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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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Introduction

Using accelerated construction methods, a prestressed, precast bridge was constructed by the Iowa Department of Transportation (DOT). The design concept involved the use of precast deck components that were grouted compositely with the steel girders.

The successful implementation of this approach has far reaching implications in Iowa, as well as nationwide, as proven rapid construction techniques could result in significant cost reductions in many instances. The application of precast deck panels represents a step forward from previous systems in Iowa and strives to further improve the design concept.

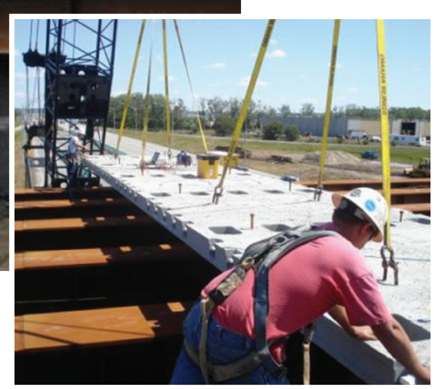
This evaluation documents the 24th Street bridge project, over Interstate 80 (I-80) in Council Bluffs, Iowa, including laboratory testing and field testing of the bridge.

Objectives and Scope

The overall objective was to perform laboratory and field tests to evaluate the bridge components and assess the bridge's overall performance.

To satisfy the objectives, the project scope included the following tasks:
- Investigate the installation and testing of the shear studs
- Evaluation of material consolidation in shear stud pocket
- Evaluation of the influence of surface treatment on transverse joint shear transfer
- Evaluation of duct splicing performance
- Monitoring for corrosion of prestress and post-tensioning strands
- Deck panel behavior during handling
- Post-tensioning strand behavior during stressing
- Diagnostic live load testing

Girders on west center pier during Phase I construction



Placing precast deck panel on girders

Bridge Description

The 24th Street bridge was constructed in two phases at an existing bridge site. The west lanes were constructed during Phase I and the east lanes were constructed during Phase II. The new bridge carries six lanes of 24th Street traffic (four through lanes and two turning lanes). The bridge is two spans, with a total length of 353 ft-6 in. from center-line of abutment bearings.

The superstructure of the bridge is comprised of prestressed, precast deck panels, supported and composite with steel plate girders. The completed bridge has 12 lines of girders, spaced at 9 ft-0 in. on center. The precast deck panels were designed to act compositely with the girders, requiring the deck be connected to the girders through the use of shear connectors.

The deck panels are 10 ft long x 52 ft-4 in. wide x 8 in. thick. Each panel has 28 1 in. x 3 in. embedded ducts to house four longitudinal post-tensioning strands, which run the full length of the bridge. Each panel is transversely prestressed with 10 1/2 in. diameter strands.

Laboratory Testing

Three laboratory tests were conducted prior to the fabrication and construction of the bridge. The tests involved a shear stud pocket investigation, to determine if the pocket size was large enough to fit the required number of studs and to conduct a quality control stud bend test. Additionally, the flow of grout from the stud pocket into the haunch area was investigated. The duct splice performance was investigated to determine if the couplings used at the joint would sufficiently seal out grout. Lastly, the transverse joint treatment between panels was investigated to determine the treatment that would provide the largest shear transfer.

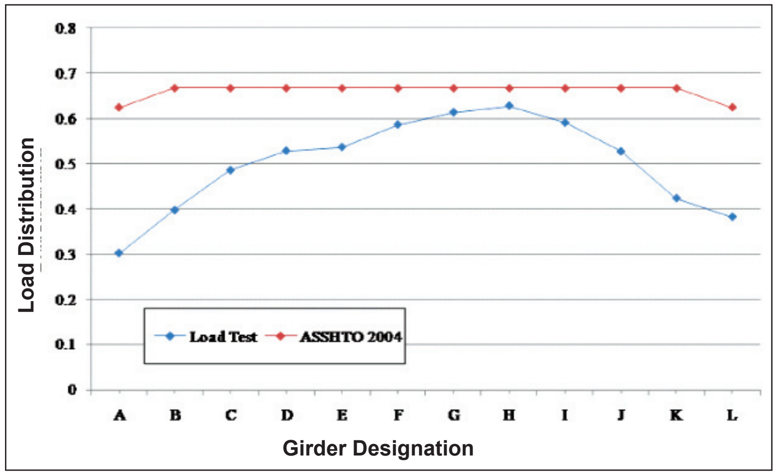
Field Testing

Four field tests were performed to better understand the performance of the bridge components and the completed bridge. The first test consisted of corrosion monitoring of both the prestress and post-tensioned strands within the precast deck panels. The monitoring took place during construction and shortly after construction was completed. To better understand the impact that handling and placement had on the deck panels, two panels were monitored for strain behavior during handling and placement. After the deck panels were placed and post-tensioning strands threaded, the joint stress between two adjacent panels were monitored during the tensioning and grouting of the strands. Lastly, a load test was performed, monitoring deflection and strain of critical members.

Range of strain at various locations on the bridge during load testing

Location	Strain ($\mu\varepsilon$)		
	Bottom Flange	Top Flange	Bottom of Slab
Abutment	-4 to +14	-5 to +6	NS
Pier	-16 to +3	-1 to +5	NS
Midspan	-22 to +66	-5 to +5	-2 to +6

NS - No strain gauge at location



Experimental and codified load distributions for 24th Street bridge

Findings

- No difficulty in installing the shear studs in the precast panel pockets were foreseen by the contractor or encountered by the research team. Conducting the bend test on the studs in the precast panel pockets was feasible for all six studs. Additionally, grout with the proposed slump can sufficiently flow through the stud pockets into the haunch areas.
- The duct splices can be sufficiently grout-proofed by the use of waterproof duct tape or butyl rubber methods.
- Sandblasting the surface of the concrete/grout joint was the most effective surface treatment for resistance to shear.
- Corrosion electrodes installed on both the post-tension and pre-tension strands indicate that no corrosion is taking place.
- During deck panel placement, the peak strain in the panel was 230 $\mu\varepsilon$ located near a pick point location.
- During load testing, the maximum north span deflection was observed to be -0.41 in., which corresponds to a span to deflection ration of L/5120. The maximum strain of +66 $\mu\varepsilon$ and the maximum strain range of 88 $\mu\varepsilon$ occurred at the same location and load case.
- The largest load distribution factor was 0.63. The load distribution factors obtained from field testing were within the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) load distribution requirements.
- The neutral axis location obtained from the field test was located between 58 in. and 61 in. from the bottom of the flange. The steel girder depth is 61 in. Therefore, the neutral axis lies near the top of the steel girder, but not in the haunch or deck slab.