2008-41TS
Published 10-3-08

RESEARCH
SERVICES SECTION

TECHNICAL SUMMARY

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TOTAL PROJECT COST:
$245,977

The new design is especially apt for short-span bridges common in rural areas where bridge closures result in long detours.

Validating Mn/DOT's Precast Composite Slab Span System

What Was the Need?

Precast elements have long been utilized in bridge construction because they speed construction times, and fabrication sites for these elements allow for a higher degree of quality control. However, older-style bridges incorporating precast hollow core panels have exhibited reflective cracking—cracking at the surface of the deck above the joints between the precast elements—which can necessitate significant maintenance or replacement costs.

Drawing on insights from an international scanning tour on accelerated bridge construction techniques as well as input from fabricators, contractors and academics, Mn/DOT engineers addressed the problem of reflective cracking with a Precast Composite Slab Span System, modeled after the Poutre Dalle system used in France. Mn/DOT's PCSSS removes the need for bridge deck formwork and is designed to simplify construction and reduce susceptibility to reflective cracking, using innovations such as "drop-in" reinforcement cages over the joint connections between the precast sections.

Mn/DOT's PCSSS can be applied to an important niche of bridges with relatively short spans (20 to 60 feet) that are currently served by cast-in-place slab-span bridges. Many of these bridges are nearing the end of their design life and are located in rural areas where bridge closures result in long detours and significant traffic disruption.

What Was Our Goal?

This project aimed to validate the performance of the new precast slab system through both field and laboratory work:

- In the field, the goals were to design and implement a detailed monitoring system for one of the new PCSSS bridges, followed by monitoring and analyzing the performance of the bridge for two years.
- The goal of the laboratory work was to perform a more controlled investigation of design characteristics and the effect of design variations (for example, in the amount of reinforcement, surface roughness or flange thickness) using a full-scale portion of a PCSSS bridge.

What Did We Do?

Researchers conducted a literature review of precast bridge systems, designed an overall instrumentation plan, selected the particular instruments needed, and installed the instrumentation in a three-span PCSSS bridge over the Center Lake Channel in Center City, Minnesota. They monitored the bridge for two years, analyzing the ongoing effects of the environment on the bridge structure.

A live-load test using trucks filled with sand was then performed, using seven single-truck and five paired-truck configurations. Among the characteristics investigated were the continuity of the bridge, whether live loads would likely lead to the development of cracks, and a comparison of the measured characteristics to those calculated during design.

Researchers identified modifications to the original Mn/DOT PCSSS design to improve system performance and economy, in particular reducing the thickness of the flange of the precast sections and increasing the spacing of some of the shear reinforcement. These modifications were applied to the construction of a two-span laboratory speci-

continued

"Mn/DOT uses lots of slab-span bridges, but the biggest potential use of these bridges is on county and State Aid highways, not trunk highways. There are hundreds of bridges on the State Aid highway side that could be replaced with this design."

–Keith Molnau,
Design Unit #2 Leader, Mn/DOT Office of Bridges and Structures

"The main goal of the bridge design was to control cracking, but there were no detailed design guidelines for this bridge. We needed to understand whether the design models were valid."

–Catherine E. French,
Professor, University of Minnesota Department of Civil Engineering

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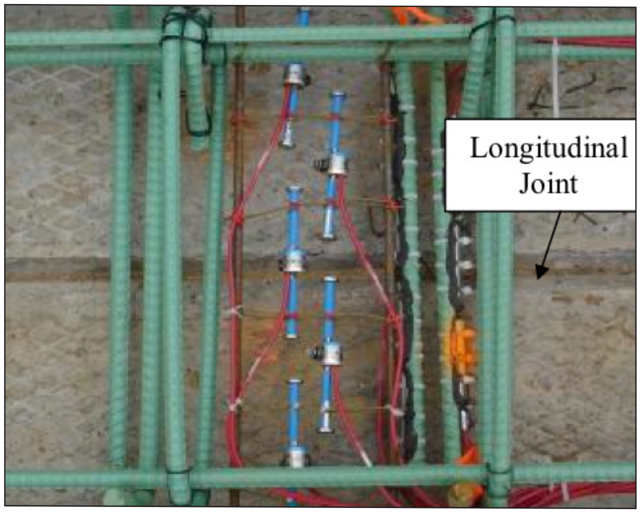

Strain gages were embedded in the concrete decking above the longitudinal joints of the bridge, providing researchers with data to study the development of cracks above the joints.

men, which was instrumented both within the cast-in-place concrete (as in the field test) and within the precast sections themselves, and tested with a variety of loads.

The data from the Center City bridge and the laboratory tests were extensively analyzed, particularly with respect to cracking, transverse load distribution, pier continuity and structural stresses.

What Did We Learn?

The results of the field and laboratory study confirmed the durability of the Mn/DOT PCSSS, showing it to be a practical and economical accelerated construction alternative to cast-in-place slab construction.

Data from monitoring indicated that cracking had begun in some parts of the decking. The analysis showed that the cracks resulted from environmental factors and shrinkage rather than from vehicle loads. The types of cracking observed were not reflective, however; they did not extend through the section to the top surface and will not affect the bridge's safety or load-carrying capacity.

From the live-load truck test, the transverse load distributions determined from the strain gage measurements agreed well with the models considered.

The reduced thickness of the flange section performed well in the laboratory and improved both the resistance to cracking and the transverse load distribution; this is recommended as a general design modification to the Mn/DOT PCSSS.

What's Next?

The new bridge design is considered a success. Five more of these bridges have been constructed in Minnesota, and 11 are planned for installation in the next two to three years. The project received the 2008 University of Minnesota Center for Transportation Studies Research Partnership Award.

An additional project, NCHRP 10-71, is under way to further investigate these bridges, covering issues such as bursting, fatigue, composite action, extending the system to longer span lengths, and materials durability.

This Technical Summary pertains to two reports: Report 2006-37, "Application of Precast Decks and Other Elements to Bridge Structures," published September 2006, and Report 2008-41, "Monitoring and Analysis of Mn/DOT Precast Composite Slab Span System (PCSSS)," published September 2008. The full reports can be accessed at http://www.lrrb.org/PDF/200637.pdf *and* http://www.lrrb.org/PDF/200841.pdf*, respectively.*