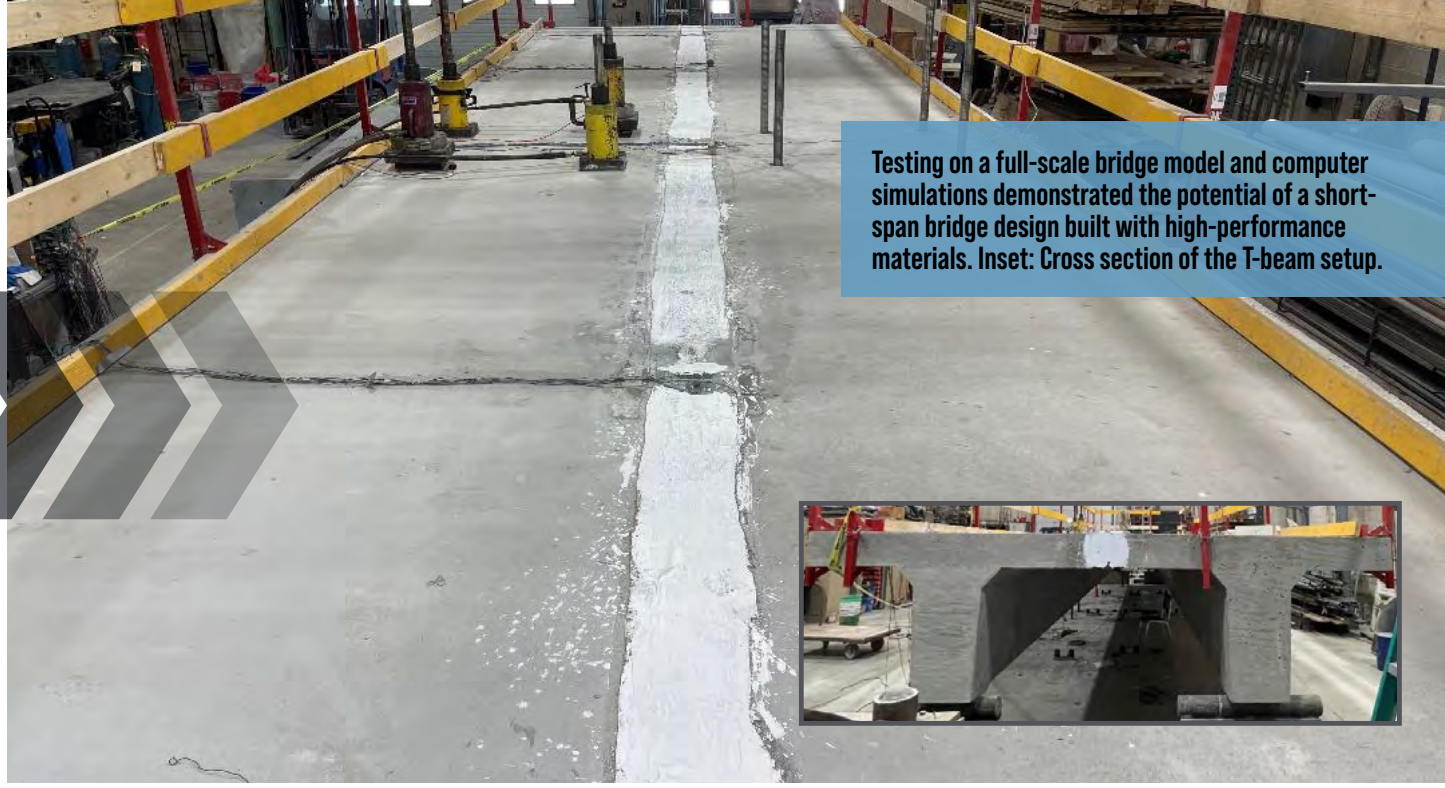

Testing on a full-scale bridge model and computer simulations demonstrated the potential of a short-span bridge design built with high-performance materials. Inset: Cross section of the T-beam setup.

RESEARCH SOLUTIONS

Research explores new materials and designs for stronger, longer-lasting short-span bridges

In bridges built with T-shaped concrete beams, longitudinal joints are used to connect each T-beam to the beams next to it. These joints often experience strength and durability issues that require frequent maintenance and repair. Newer, technologically advanced materials show promise at not only improving the performance of these joints but also increasing the service life of the entire bridge. Researchers developed and tested a short-span bridge design that incorporates two such materials: ultra-high-performance concrete (UHPC) and reinforcing bars made of corrosion-resistant, high-strength steel.

THE NEED

Maintaining the approximately 20,000 bridges on Iowa's secondary road system is a significant undertaking for county engineers. One typical short-span bridge design involves placing T-beams side by side to form the bridge superstructure. Conventionally, the beams are connected along longitudinal joints made of concrete and overlapping steel bars. However, cracking in joint filler materials can allow water and deicing chemicals to seep through the superstructure, potentially corroding the reinforcing steel bars within the concrete and leading to structural deterioration.

Newer construction materials have shown promise at addressing these issues. In particular, UHPC has emerged as a new class of cementitious materials, offering high strength and low permeability. Iowa DOT has been a leader in exploring the use of UHPC in various structural applications, but its use in longitudinal joints of T-beam bridges had remained largely unexplored.

(continued)

"Iowa is a leader in using UHPC for bridges. Joints are key areas in a bridge, and using this material, combined with corrosion-resistant reinforcing steel, is a promising alternative for county engineers."

— **BRIAN KEIERLEBER,**
Buchanan County Engineer

Meanwhile, corrosion-resistant, high-strength reinforcing bars made with newer steel alloys have performed especially well at mitigating corrosion-related issues. Iowa DOT and county engineers in the state were interested in how these unique materials could contribute to stronger and more durable bridges.

RESEARCH APPROACH

This project's goal was to evaluate an alternative short-span bridge design using technologically advanced materials. Researchers employed both full-scale laboratory experiments and computer simulations to develop, test, and refine the new design.

Researchers built a full-scale test setup, 46 feet long and 12 feet wide, consisting of two T-beams connected with a longitudinal joint made of UHPC. Corrosion-resistant, high-strength steel bars were used to reinforce the T-beams and the longitudinal joint.

They tested the configuration under service limit loads in four configurations:

- On the outer edges of each beam.
- On the inner edges of each beam near the joint.
- On one beam while the other was restrained to maximize loading demand on the joint.
- On each beam individually after cutting them apart through the joint.

Using a variety of gauges to monitor the T-beams and the longitudinal joint, researchers recorded key structural response measures, including deformations, strains, and stresses. They then created computer models of the new design, validated them with results from the laboratory tests, and used them to further investigate the performance of the entire bridge system. In these analyses, researchers simulated various loading scenarios and showed how the developed joint details would be expected to perform in future field implementations.

WHAT IOWA LEARNED

Results from the combined laboratory tests and modeling analyses were encouraging. The joints performed well in tests for both flexure and shear, with no observable cracking or separation under loads. Testing on the individual T-beams also showed excellent performance under expected loading demands.

PUTTING IT TO WORK

Strength, durability, and simplicity make this design—a T-beam bridge system incorporating UHPC in the longitudinal joint and corrosion-resistant, high-strength reinforcing bars—a promising alternative for short-span bridges in Iowa. Although high-performance construction materials typically cost more up front, they have the potential to save agency resources over the long term by reducing needed maintenance and repair.

As a next step, a pilot project could be undertaken to demonstrate the handling of these newer materials during construction and to evaluate the performance of this new bridge system in real life.

ABOUT THIS PROJECT

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