Iowa ABC Connections

tech transfer summary

While Iowa has become a national leader in accelerated bridge construction, the Iowa Department of Transportation continues to investigate critical design and construction details.

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RESEARCH PROJECT TITLE
Iowa ABC Connections

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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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Background and Problem Statement

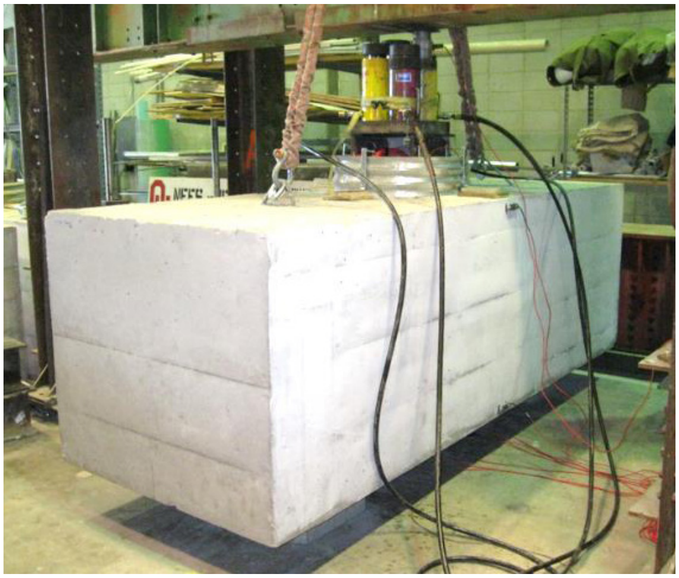
The Iowa Department of Transportation (DOT) and other organizations have been developing accelerated bridge construction (ABC) concepts, details, and processes, and Iowa has come to be viewed as a national leader in the area of ABC. However, the Office of Bridges and Structures does not have a complete set of working standards nor design examples to accompany the ABC portions of the Iowa DOT Load and Resistance Factor Design (LRFD) Bridge Design Manual.

In the fall of 2013, the Iowa DOT constructed a bridge on IA 92 near Massena, Iowa, using an ABC technique known as slide-in bridge construction. For this technique, the constructed superstructure is slid from a temporary position to the permanent position onto a newly constructed substructure. The method prescribed for the Massena Bridge used stainless steel sliding shoes on polytetrafluoroethylene (PTFE) topped neoprene bearing pads.

The type of pile-to-pile cap connection intended for this bridge is constructed by placing a precast pile cap, complete with pile pockets formed using corrugated metal pipe (CMP), over the top of driven steel H-piles at their final location. The connection is then completed by placing concrete into the pile pockets to create a positive connection with the CMP.

During the design of the Massena Bridge, questions arose about critical design and construction details: the pile-to-pile cap connection and the PTFE-topped bearing pads on which the bridge would slide. Investigating these questions offered an opportunity to provide significant value to the Iowa DOT Office of Bridges and Structures.

Slide-in bridge during accelerated bridge construction next to the original IA 92 Massena Bridge



Pile-to-pile cap connection specimen in reaction frame for load testing

Objectives

- Identify the push-through capacity of the pile and CMP assemblies and assess the performance differences among various shear transfer mechanisms between the pile and concrete-filled CMP
- Determine the coefficient of friction (CoF) between the sliding shoes and bearing pads

Research Description

To investigate the precast pile caps and shear transfer mechanisms, nine laboratory tests were conducted: three using headed stud shear connectors on the pile, three using threaded rods with heavy hex nuts passing through the pile web, and three using no shear connectors.

The nine specimens were constructed and tested upside down for simplicity. The specimens were elevated and supported at locations corresponding to the beam seats and loaded from above. Each specimen was instrumented with actuators and numerous strain and deflection gages, and the required strength of the connection was tested.

The CoF between the stainless steel sole plate and PTFE-topped neoprene bearing pads was determined by applying the anticipated service dead load to the testing assembly and pushing laterally until movement was obtained and sustained. Two variations of the test were completed: one without lubrication and one using Dawn dish soap as a lubricant.

The friction coefficients were calculated by measuring the loads required for movement. The bearing pad behaviors were also observed to determine whether excessive shear deformation occurred.

Key Findings and Conclusions

- The pile-to-pile cap connection greatly exceeds the strength required to withstand the anticipated service loads of the Massena Bridge.
- No appreciable difference was seen between the three different shear transfer mechanisms. The pile-to-pile cap connection does not require a shear connector between the pile and CMP infill.
- At anticipated service loading levels, the bearing pads performed well under lubricated and non-lubricated conditions and did not appear to be at risk for "rollover" during the slide.
- The CoF between the stainless steel slide shoe and PTFE-coated neoprene bearing pad is approximately 0.11 for non-lubricated conditions and 0.07 for lubricated conditions. The lubrication thus reduced the required jacking force by 36 percent.

Implementation Readiness and Benefits

The timing of this specific need and the initiation of this project offered a unique opportunity to provide significant short- and long-term value to the Office of Bridges and Structures.

Using the results from the laboratory testing, a design tool was developed that can enable engineers to quickly assess the connection strength of various combinations of piles, CMPs, pile cap sizes, concrete strengths, etc.

The tool also performs the checks to ensure that the prescribed geometric rules are followed. However, the tool does not check the geotechnical capacity of the pile nor design the pile cap.

Coefficient of friction test setup, showing stainless steel sole plate and PTFE-topped neoprene bearing pads