MASSENA BRIDGE
LATERAL SLIDE REPLACEMENT

by Ahmad Abu-Hawash and James Nelson, Iowa Department of Transportation

This photo shows the finished Massena Bridge after the lateral slide replacement. All photos: Iowa Department of Transportation.

Improving safety and reducing congestion in the construction zone were two primary factors that motivated the Iowa Department of Transportation (Iowa DOT) to develop a policy for accelerated bridge construction (ABC). Although several ABC projects had been completed in Iowa prior to the policy implementation in 2012, the ABC policy allowed for a systematic approach to selecting ABC projects.

As part of the ABC policy implementation, the Iowa DOT selected bridge sites across the state for the purpose of demonstrating various ABC methods and developing workforce expertise. The Massena Bridge site was identified for a lateral slide. One of the advantages of this method is the use of traditional construction methods.

Massena Design

Constructed in 1930, the original bridge over a small stream in Cass County near Massena, Iowa, had been designated as structurally deficient with a sufficiency rating of 38, load posted for one truck at a time, and was in need of major rehabilitation or replacement. A 120-ft-long by 44-ft-wide prestressed concrete, single-span structure was chosen to replace the existing 40-ft-long by 30-ft-wide steel beam bridge.

With a focus on building internal ABC design expertise, the preliminary and final designs were performed by Iowa DOT engineers. But because this was the first design for a lateral slide in Iowa, a design firm with significant experience in lateral slide was retained to conduct a design-constructability review.

The bridge superstructure consists of six 45-in.-deep, prestressed concrete bulb-tee beams with specified concrete compressive strength of 9.0 ksi at 28 days and an 8-in.-thick, cast-in-place concrete deck. While much of a lateral bridge slide design depends on the means and methods chosen by the contractor, the design team chose to show one feasible slide concept and associated details in the plans. Components for the slide that were anticipated to be permanently incorporated into the final structure included the slide shoe, jacking pockets, bearing pads, and solid end diaphragms.

The solid end diaphragm details were different than those in a traditional design. The end diaphragm had to accommodate jacking pockets, high-strength threaded rods, and anchorages used to push or pull the bridge superstructure.

Laboratory Confirmation

For design of the sliding shoe and bearing pads, the coefficient of friction was needed for the interaction between the pad and specified stainless steel. The Iowa DOT commissioned laboratory testing by Iowa State University (ISU) of a full-scale mock-up of the slide shoe and bearing pads. The tests were performed in both lubricated and non-lubricated conditions with the lubricant being common dish washing soap. Test results indicated that the suggested 10% coefficient of friction for design was reasonable.

Iowa DOT had previous ABC experience and research results with precast concrete abutment footings founded on driven HP10 piling. However, an HP14x117 was selected to meet the design and constructability requirements of this project. Extrapolating the original research data to a pile about twice as large was not felt to be appropriate and so ISU was commissioned to do laboratory testing of the new precast concrete abutment footing to pile pocket detail. The laboratory testing confirmed the design capacity of the new

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larger connection details.

Bidding and Contracting

With ABC in mind, the construction contract had three phases.

- Phase 1: construction of the replacement bridge superstructure on temporary supports. Constructing off alignment allowed the contractor to work with no working days being charged.
- Phase 2: the ABC period (called the critical closure). The contractor was allowed a maximum of nine days of road closure to remove the old structure, erect the new bridge in its final position, and restore traffic operations. A $10,000 per day incentive/disincentive clause was specified for this phase.
- Phase 3: miscellaneous work performed with no or minimal traffic restrictions. This work included seeding, revetment, and clean-up. A maximum of 15 working days was allowed for this phase.

Four local contractors participated in the April 16, 2013, letting with the bids ranging from $1.3 to $1.6 million. The calculated unit cost of $122/ft^2 of deck area—30% more than typical non-ABC projects for this bridge type in Iowa—is considered very reasonable based on past Iowa ABC projects. Furthermore, this direct construction cost premium is more than offset by the indirect user costs.

User costs for the traditional construction methodology, which would have detoured traffic for the duration of the construction, were estimated at over $400,000. Indirect user costs—such as the value of people's time, safety, and lost local business due to inconvenience—were not included. If the simple user costs are factored into the cost of the project, the lateral bridge slide ABC methodology provided a net savings of about $100,000 versus the traditional construction methodology.

Contractor Modifications

In lieu of the precast concrete abutment footings that were specified in the contract documents, the contractor requested to construct the abutment footings using the traditional cast-in-place concrete method. With the understanding that the contractor is still limited to the same nine-day ABC period, Iowa DOT did not object to the request for change. The contractor utilized a concrete mixture that achieved high early strength with typical insulation. The maturity method was used to verify the concrete strength.

The new bridge superstructure nears completion. A jacking frame has been installed for a test roll.

Preparing the high-strength threaded rods to pull the prefabricated bridge superstructure into position.

The jacking frame for pulling the prefabricated bridge superstructure into position.

The switch to cast-in-place for the abutment footing eliminated the risk of the precast concrete footing pile pockets not fitting over the driven H-pile deep foundation. Pile driving tolerances were 3 in. in any direction from the intended center. Past ABC projects had shown this tolerance to be achievable with the use of a rigid template and contractor care. The contractor also felt that curing of the entire footing was preferable over the curing of just the pile pocket concrete. The larger mass of concrete generates more heat of hydration for faster strength gain versus the smaller mass of concrete of just the pile pockets alone.

The contractor also proposed to change the sliding system from the stainless steel sliding shoe and bearing pads to heavy duty rollers. The contractor had previously rolled a railroad bridge and already owned several rollers. This alternative was anticipated and allowable by the specifications. It required minor plan changes to delete the stainless steel from the sliding shoe and delete the pads from the bearings. A few weeks prior to the bridge slide, a test move was conducted successfully by rolling the bridge in the opposite direction of the actual move to verify the system operation.

Constructing and Opening

The contractor began the critical closure on Friday, September 27, by implementing the roadway detour and beginning demolition of the existing bridge. By the evening of Monday, September 30, the contractor was ready to move the prefabricated bridge superstructure commencing the move at about 7:30 p.m. The move was completed by 2:00 a.m. the next morning, taking about 6½ hours to complete. Gage pressure readings on the jacks were monitored along with the relative distance of travel of both ends of the bridge. The equivalent coefficient of friction typically varied from 2.5 to 5% with a brief period when the gage pressures correlated to an equivalent coefficient of friction of 13% due to binding or racking of the system.

Following the prefabricated concrete bridge superstructure move, there were many additional work items on the critical path including precast concrete wingwall installation, subdrain installation, backfilling, approach pavement placement, longitudinal grooving, painting, and guardrail installation. The contractor completed these activities expeditiously and reopened the roadway to traffic on Sunday, October 6.

This project was considered to be a successful demonstration of a lateral bridge slide. Both the contactor and Iowa DOT achieved the desired critical closure schedule with quality construction. Even in a successful project, there can be lessons to be learned and room for improvement on future projects.

As a standard practice on ABC projects, the Iowa DOT held a post-construction review meeting to gather feedback from both the DOT staff who worked on the project, the contractor, and the contractor's engineer. Notes from the post-construction review can be found on the project website (http://www.iowadot.gov/MassenaBridge/index.html).

Based on the success of the Massena Lateral Slide Bridge Replacement project, the Iowa DOT would not hesitate to use this ABC methodology again where appropriate. Currently, ABC design concepts for several bridge replacement projects in Iowa are being developed with serious considerations given to the lateral slide method.

Lifting the bridge superstructure with pancake jacks to remove the rollers.

Roller in guide channel for rolling the prefabricated bridge superstructure.

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Team members for the Massena Bridge included Iowa Department of Transportation, bridge design engineer, Ames, Iowa; Herberger Construction Co., prime contractor, Indianola, Iowa; and Cretex Concrete Products, a PCI-certified precaster, Iowa Falls, Iowa.