STATE

Iowa

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The reconstruction of this portion of the Missouri River levee system was designed to increase the conveyance of the river overflow by replacing an existing constriction with dual bridges. The project had an aggressive schedule as a result of severe flooding in the previous season. All Photos: Iowa Department of Transportation.

While some states have a conservative bent, the Iowa Department of Transportation (DOT) has been a leader with new technology. As the first state to experiment with ultra-high-performance concrete (UHPC), Iowa has a rich history of cutting-edge bridge design and construction.

Drawing on the success of those early UHPC beams in 2010, Iowa is working with the Federal Highway Administration (FHWA) and PCI to develop structural design specifications for UHPC. The lack of codified design practices has slowed the widespread usage of UHPC, and adoption of design specifications by the American Association of State Highway and Transportation Officials (AASHTO) could stimulate the use of UHPC with more optimized precast concrete beam shapes across the country.

Technology Transfer

The Iowa DOT has readily shared information on its use of UHPC in overlays and bridge connections as well as its success with accelerated bridge construction (ABC) techniques. It looks to expand the use of these tools, but the new methodologies have not been without their challenges. Although management is comfortable with taking acceptable risks, Iowa also relies on a strong system of independent checks and balances. Ultimately, the Iowa DOT is not taking risks with safety; it is taking risks with innovation.

Consider, for example, the use of UHPC for bridge deck overlays. The first project required remediation to address problems encountered from constructability issues, the use of new experimental techniques, and extreme weather conditions. However, subsequent projects took those lessons learned into account, and the most recent applications of UHPC overlays have been successful.

Like other states, Iowa outsources a fair amount of design work, but ABC lateral bridge slide projects were initially kept in house. After the Iowa DOT mastered lateral slide projects, the framework was established for consultants to design such projects as well. That enabled the Iowa DOT to work on improving the ABC tools in its arsenal. Contractors have also mastered these ABC techniques, and every lateral slide bridge project in the state, as well as all but one modular-unit ABC project, has met the critical closure time allotted.

To accommodate overflow from the Missouri River, the project team used 63-in.-deep, 155-ft-long precast concrete bulb-tee beams in all seven spans for the two 1100-ft-long bridges. To simplify and accelerate construction, all supports were zero skew. Use of the standard girder shape fast-tracked design, fabrication, and installation.

The Iowa Department of Transportation chose accelerated bridge construction methods to replace the Iowa Route 1 bridge over Old Woman's Creek south of Iowa City because replacement using traditional construction methods would have required vehicles to detour 19 miles. The contractor constructed the single-span, 135-ft-long, 44-ft-wide precast, prestressed concrete beam bridge adjacent to its final location and then used the lateral slide technique to meet the 45-day closure period. The project incorporated lessons learned from earlier lateral slide projects and also used ultra-high-performance concrete to complete superstructure-to-substructure connections for the integral abutments.

Massena Lateral Bridge Slide

Iowa started constructing ABC projects consisting mainly of precast concrete elements and modular units in the early 2000s, but it was not until 2012 that the Iowa DOT began working with the FHWA to demonstrate the use of the lateral bridge slide technique coupled with prefabricated bridge element systems. The Massena lateral bridge slide constructed in 2013 was the first use of this technology in Iowa. The project to replace the existing bridge on Iowa Route 92 in southwestern Iowa minimized traffic impact with a nine-day critical closure and enhanced construction zone safety by building the new bridge superstructure away from traffic.

The Iowa DOT subsequently completed five lateral bridge slide projects and has additional projects included in its highway program. Iowa considers the lateral bridge slide technique to be cost-effective for projects that traditionally required a temporary bridge and for those with long detours.

Industry Partnerships

Industry associations are a powerful ally for owner agencies seeking to improve bridge design and construction practices. The Iowa DOT has a long-standing partnership with the state's chapter of the Associated General Contractors of America and meets with chapter members routinely to discuss pilot projects, new details, and other industry innovations. Both road and bridge bureaus have collaborated on the use of building information modeling (BIM) and three-dimensional (3-D) modeling for future project delivery. This engagement is critical to the implementation of research and development efforts.

The Iowa DOT recently made the switch to 3-D bridge design and Bentley Systems Connect. Going forward, a 3-D bridge model will be attached to each project, which makes the DOT's collaboration with industry groups critical. The end goal is a digital as-built model for use in asset management and the agency is working to define those deliverables.

Applying lessons learned from the Massena Bridge project, the second lateral slide bridge was performed for the Iowa Route 1 Bridge over Camp Creek. The project used accelerated bridge construction methods, as the new bridge was constructed just east of the existing bridge and then slid into place.

Digital As-Builts

As an early adopter of new technology, the Iowa DOT is actively engaged with the AASHTO Technology and Software Committee, which is leading the effort for widespread use of BIM for bridges. Working with almost half of the state DOTs and the FHWA, the committee is charged with developing a national standard for open exchange of bridge and structure data using the Industry Foundation Classes schema. This model-based approach will encompass every phase from planning and design through fabrication, construction, and asset management.

The lack of national standards for BIM is holding the bridge industry back as compared with the building industry. Efforts to develop a unified framework for digital twin applications involve cooperation from concrete industry organizations such as the National Concrete Bridge Council, the American Segmental Bridge Institute, PCI, and others. (For more information on digital twins, see the Summer 2021 and Fall 2021 issues of *ASPIRE*®.)

To synchronize the digital model and the bridge, all stakeholders need to populate the model with data throughout its life cycle. The Iowa DOT foresees the long-term benefits of seamless integration, from avoiding conflicts in construction through asset management.

Safety and Mobility

Like many other states, Iowa frequently uses deicing salts to keep roads clear. The chlorides in these salts wreak havoc on the long-term durability of bridges. Maintaining the infrastructure system in a state of good repair requires a tremendous investment. There are many aging structures in Iowa's inventory, with

The precast, prestressed concrete beams for the Iowa Route 1 Bridge over Camp Creek are set on temporary falsework to construct the bridge superstructure off alignment. There are stainless steel slide shoes under the beams for the lateral slide of the new 120-ft-long, 44-ft-wide bridge.

bridges built in the 1960s and 1970s accounting for more than one-third of Iowa's primary system bridge inventory.

The Iowa DOT takes a three-pronged approach to maintaining the state's bridge assets. The first prong is an increased emphasis on bridge stewardship, balancing the need for bridge replacement with the need for capacity improvement. The second is to keep structures in good repair longer through active bridge preservation activities such as bridge deck overlays and bridge joint repairs. The third is a commitment to constructing robust bridges with excellent materials and smart, robust details. That investment in service-life design will pay off with modern, longer-lasting structures.

To support this approach, the agency is investigating service-life design concepts to minimize maintenance for 50 years. Currently, the average age of bridges at replacement is less than 65 years. The long-term goal is to consistently achieve a typical service life of 75 years for most bridges on the primary system and enhanced service life of 100 years for major structures, especially those over the Missouri and Mississippi Rivers.

Iowa Highway 2 Overflow Bridges

Historic flooding along the Missouri River in 2019 brought the need for flood relief, recovery, and mitigation to the forefront. The Iowa Highway 2 crossing at the Missouri River was identified as a pinch point constricting the flow of the Missouri River and the levee system. The Iowa DOT was challenged to deliver bridges that would accommodate the overflow of the river before the flood season of 2020. The agency needed to ensure that dual seven-span, 1100-ft-long precast concrete beam bridges would be designed and constructed in record time.

A drone-captured image of the ultra-high-performance concrete (UHPC) bridge deck overlay process in Jasper, Iowa. To extend the life of the existing bridge, a thin layer of UHPC was placed on the deck as a protective layer, sparing the expense of deck repair and full deck replacement. The Iowa Department of Transportation readily shares information on its use of UHPC in overlays.

The goal was to open the bridges to traffic by March 1, 2020. Notices to proceed on preliminary and final designs were awarded simultaneously on April 30, 2019, in an integrated contract approach that expedited the project. The bridges were designed in just nine weeks, which meant that most of the construction work could be completed before harsh winter weather arrived. The first bridge was open to traffic just six months after letting.

The decision to use standard Iowa bulb-tee beams was the key to fostering speed of design, fabrication, and construction. Because 63-in.-deep, 155-ft-long precast concrete bulb-tee beams (BTE 155) were used for all seven spans of each bridge, engineers could move quickly through beam design, the fabricator had the forms available, and the contractor was familiar with placement. For this accelerated project, standard precast concrete beams were the only viable option.

Using a standardized design may not seem innovative, but the creative decision to do so allowed the team to meet every critical deadline. This precast concrete project was completed in about half the time that a steel construction project would have required. ABC techniques frequently focus on the construction phase, but in this case, the Iowa DOT found a way to accelerate the entire delivery process.

Looking to the Future

Following the 10th anniversary of Iowa DOT using the first UHPC girders for a bridge in North America, Iowa is looking to the future AASHTO specifications for the structural design of UHPC members. Such new specifications are the key to innovative solutions, especially for increasing girder span-to-depth ratios. Significant savings may be achieved for replacement bridges over waterways where the hydraulic opening size must be increased. A longer, shallower beam could reduce costs for raising grades and acquiring rights-of-way, and potentially provide substructure savings as well.

The Iowa DOT's efforts with BIM and digital as-builts should enhance the efficiency of the design process and improve the quality of designs. The result will be the optimized design of materially efficient, high-performance, long-lasting concrete bridges.

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