conference preview

A BIG CONNECTION BETWEEN SMALL TOWNS

A new bridge between Iowa and Illinois signals another success for structural steel over the Mississippi River.

BY GREG HASBROUCK, PE

THE TINY TOWN OF SABULA, IOWA (population: circa 550) is located on a tiny island in the Mississippi River, roughly halfway between the larger Iowa river towns of Dubuque and Davenport.

While small in stature, it sits at one end of a significant crossing over the river, which has recently been replaced. The new US 52 Savanna-Sabula Bridge opened to traffic this past November, capping a monumental project for both Sabula and Savanna, Ill., on the other side of the Mississippi. At over 2,400 ft in length, the steel tied arch and plate girder bridge replaced a truss bridge, which was built in 1932. The crossing provides a crucial transportation link for the region, with the nearest alternate route over the Mississippi located 20 miles to the south in Clinton, Iowa. Over the years, a number of repairs had been made to the bridge, and it was rapidly approaching the end of its useful life and in need of replacement.

The new Savanna-Sabula Bridge consists of 12 spans totalling 2,454 ft: a 546-ft main span steel tied arch over the navigation channel flanked by steel girder approach spans. The structure, at a total cost of $80 million, extends from a causeway on the Iowa side in the middle of the Upper Mississippi River Wildlife and Fish Refuge to the high bluffs of the Mississippi Palisades in Illinois.

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Cross Section and Type Selection

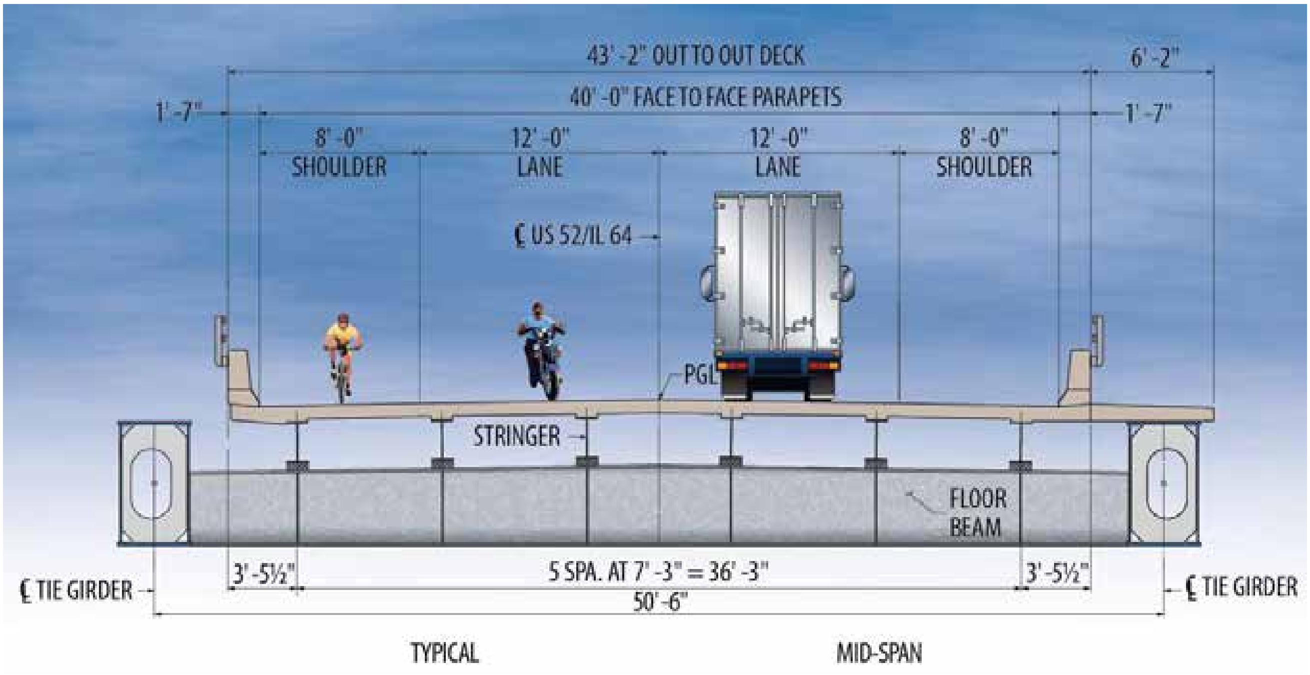
The existing structure consisted of two 10-ft lanes with no shoulders, and while projected traffic volumes for the area did not warrant more capacity, improving the cross section to meet policy standards was a priority for enhancing safety and mobility. The new cross section consists of two 12-ft lanes with 8-ft shoulders on each side to provide more clearance and accommodate bicyclists on the shoulders.

The original navigation channel span closer to the Illinois riverbank provided a 508-ft horizontal clearance and a 64.6-ft vertical clearance above the normal pool elevation. As part of the studies to improve the geometric configuration of the new bridge and roadway, the desire was to minimize the vertical profile grades on the bridge. To help achieve this goal, the design team approached the U.S. Coast Guard and facilitated the coordination of a 150-ft shift of the navigation channel toward the center of the river to bring down the grade and allow for a 7.5-ft superstructure depth over the channel.

Deep girder spans were eliminated from consideration due to the minimal structure depth, leaving tied arch and cable-stayed structure type options for the main span. After a type evaluation, a steel tied arch was selected for the main span due to its slightly lower overall cost, perceived advantages in constructability and DOT familiarity with maintenance and potential future deck replacement options.

New Tied Arch

The new bridge structure consists of an eight-span 1,420-ft steel girder approach structure on the Iowa side, a 546-ft main span steel tied arch over the navigation channel and a three-span 488-ft steel girder approach structure on the Illinois side, including a span over the BNSF rail road. The cross section consists of a 6-girder layout with girders spaced at 7 ft, 3 in. Using six girders allowed for the bridge deck to be replaced one half at a time while maintaining bidirectional controlled traffic on one lane, and three girders to maintain a redundant



▲ A cross-section view at the arch.

➤ The $80 million bridge consists of 12 spans totalling 2,454 ft: a 546-ft main span steel tied arch over the navigation channel flanked by steel girder approach spans.

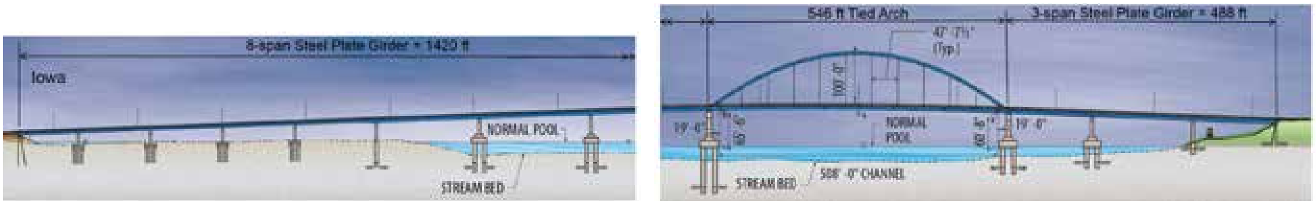
structure and eliminate the need for total closure for future maintenance and repairs.

A welded steel box section arch rib and bolted built-up box tie girder were selected to provide both an efficient section for the arch in compression and redundancy for the tie girder in tension, with continuity of the force flow through the web plates in the knuckle to simplify connection details. High-performance Grade HPS50W steel was specified for the tie girder and knuckle plates for improved toughness, and the tie girder is designed for the loss of any single plate (web or flange) and the resulting eccentric loading on the remaining section.

Two vertical structural strand hangers support the tie and floor system and are offset from the floor beam and upper lateral bracing connections to simplify load paths, detailing and fabrication at these critical connections. The dual-strand system also provides redundancy at the hanger connection in the event of hanger loss.

A floating deck system, with deck supported by six lines of continuous stringers spanning over top the floor beams, was selected to accommodate future deck replacement. The stringers are fixed at the center two floor beams and rest on elastomeric bearings over the remainder of the floor beams to allow for any differential movements of the arch and floor system during service. Relative movements during erection were taken through slotted holes in the connections, with the bolts tightened after pouring the deck.

▼ Erection of the cantilever arch.



▲ The apan layout of the new bridge.

▼ The bridge's location on the Mississippi River between Iowa and Illinois.

At midspan of the arch, the deck is extended and connected to the tie girders to transfer longitudinal loads from the deck directly to the arch system through diaphragm action of the deck. The floor beams, stringers and lower lateral bracing were all detailed with lengths under 60 ft to permit hot-dipping in local galvanizing tanks for additional corrosion protection of the floor system.

Upper lateral X-bracing was chosen to provide a modern, light and efficient bracing system using simpler pin-connected tension and compression truss elements made from square box sections. These sections are galvanized to provide a protective coating on both the inside and outside surfaces of the members.

Contractor and steel erector Kraemer North America elected to construct the arch through cantilever erection, with stay towers erected on top of the main river piers and tied back to the approach superstructure steel girders two piers away. The tension in the back stays was resisted by compression in the approach girders back to the main piers, creating a balanced system with the compression occurring in the arch during erection. ■

This article is a preview of Session B3 "Major Spans–Part 1" at NASCC: The Steel Conference, taking place April 11-13 in Baltimore. Learn more about the conference at www.aisc.org/nascc. In addition to featuring the US 52 Savanna-Sabula Bridge project mentioned above, the session will also focus on Little Rock's Broadway Bridge replacement project, which was featured in "Making a Signature Connection" in the July 2017 issue, available at www.modernsteel.com.

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