Steel Bridge NEWS
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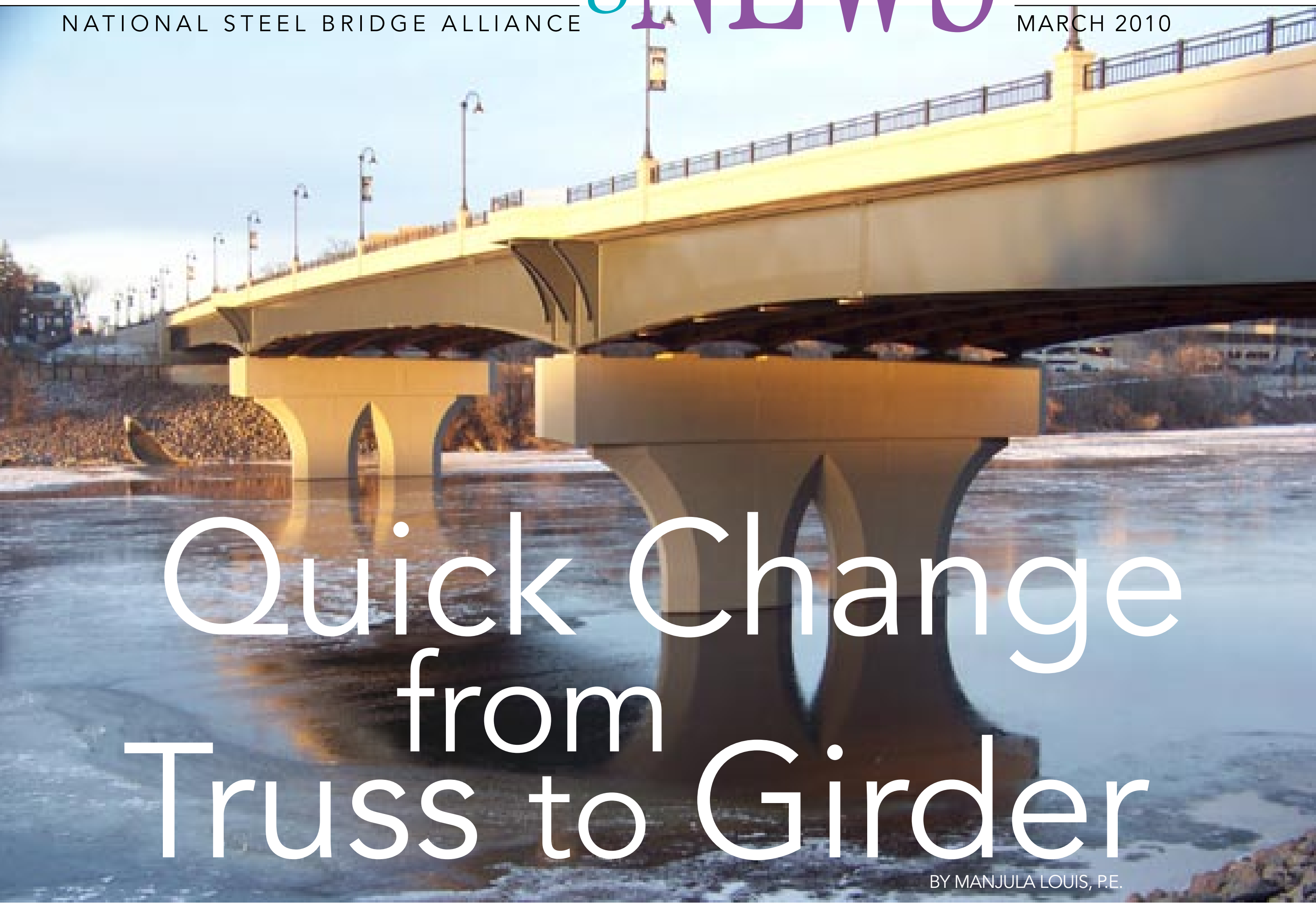

Quick Change from Truss to Girder

BY MANJULA LOUIS, P.E.

Extra effort and teamwork replaced the aging Desoto Bridge in surprisingly short order.

LOCATED 75 MILES NORTHWEST of Minnesota's capital, the Desoto Bridge in St. Cloud, Minn. for more than 50 years carried Highway 23 over the Mississippi River. The in-place truss bridge was built in 1957 and was named after Hernando Desoto, the first European to take credit for seeing the Mississippi River in 1541.

Following the I-35W bridge collapse in August 2007, one of the FHWA directives was to inspect all under-deck truss bridges. The Desoto Bridge was closed to traffic in March 2008 when minor distortion was found on a few of its gusset plates. Further analysis showed that the gusset plates had adequate strength but free edge stiffening would be required to remedy the minor distortions. The bridge was scheduled for replacement in 2010, but with these findings the district and the city decided to leave the bridge closed while accelerating design and construction so that a new bridge could be opened to traffic by November 2009. That required completing the preliminary and final design in a very short time—what typically would require 12 to 18 months had to be accomplished in less than two months.

Bridge Overview

Several options for spanning the river were considered, including prestressed concrete beams, post-tensioned concrete box girders, and continuous steel girders. In order to limit the number of piers in the river, which was a key issue in obtaining permitting, a continuous steel girder bridge was selected. An additional consideration for the selection was the Minnesota Department of Transportation (MnDOT) Bridge Office's experience with steel plate girder bridges of this length. Using this in-house expertise was helpful in limiting the time required to create construction documents.

The new bridge spans the Mississippi River with three continuous steel spans of approximately 222 ft, 345 ft, and 222 ft. For the river spans, the haunched plate girder web depth varies from 104 in. at mid-span to 168 in. over the supports. An additional 92-ft span crosses Riverside Drive on the north side of the river and uses 36-in. rolled beams.

Opposite: The new Granite City Crossing Bridge in St. Cloud, Minn., crosses the Mississippi River with three deep continuous steel spans. The girder depth is 104 in. at midspan and 168 in. at the piers.

Upper right: The truss that was the old Desoto Bridge's 145-ft center "drop-in" span was lowered intact onto a barge for removal.

Lower right: Even though the girders are made of weathering steel, a 5-ft section at the support end was painted with a zinc-rich epoxy paint system to provide additional protection against corrosion.

Construction Contracts

The bridge was let in two contracts. To ensure timely fabrication and delivery of the girders, an early steel contract was let on June 6, 2008, which provided additional time for steel procurement and fabrication. Upon award of the contract, the successful fabricator was to purchase the material, fabricate, and deliver the steel girders for the bridge to the project site by the date specified in the construction documents.

As completion of the project was tied to the on-time delivery of steel, a monetary deduction of $20,000 per calendar day was included in the contract for any material that did not meet the delivery schedule. The steel contract plans were sent to NSBA for distribution to interested fabricators. The steel contract was awarded to Chicago-based Industrial Steel Construction, Inc.

The final construction contract was let on July 25, 2008. To ensure opening of the bridge for traffic by November 1, 2009 a "Locked In Date" incentive of $1,000,000 was added. The final contract was awarded to Lunda Construction Company, Black River Falls, Wis. The total construction cost of the project was $19.5 million. The steel portion of the contract was $7,278,000.

Design Considerations

Final bridge plans and the specifications were completed in 55 days. This required close coordination with the city's visual quality task force, the geotechnical engineers for the river foundation coordination, and the local contractors for input on bridge demolition and conflicts between existing and new river pier foundations. The existing deck removal was done by saw cutting the deck and removing it in small sections. The pieces were dropped onto a barge to minimize damage to the riverbed. The in-place truss had a "drop-in" span about 145 ft long at the center of the bridge that was lowered intact onto the barge. Even though that was not the most efficient method for removing the truss, it had the least impact on the river channel. The 220-ft-long approach spans were supported on temporary falsework for stability and removed in sections by barge.

More than 20 engineers and drafters from MnDOT's Bridge Office were involved in completing the bridge design and construction documents. Daily meetings were held to coordinate the work done by team members in different functional groups. To meet the schedule, final design was started at the same time as the preliminary plan group was finalizing the roadway alignment and profile. Visual quality and environmental assessment are normally critical path items as they require input from outside agencies and citizens. The Bridge Office already was working with a citizen advisory committee on the visual quality aspects of another bridge of significance in the area. Due to the proximity of Desoto Bridge to that bridge, the committee decided to use the same aesthetic details. A categorical Exclusion Document was put together in place of an Environmental Assessment document due to minimal environmental impact in the river.

Substructure Design

A geotechnical consultant contract for subsurface investigation and completion of the foundation report was let in April 2008. Design and drafting of the substructures was started ahead of foun-

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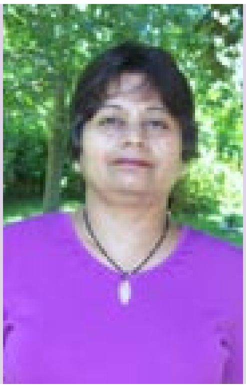

left, top: The haunched section of this interior girder shows the longitudinal stiffeners that were required at the river piers.

left, middle: Lateral bracing was included to resist wind loads during construction.

left, bottom: The 92-ft span over Riverside Drive, on the north side of the river, uses 36-in. rolled beams. The deeper girder ends are visible to the left of the support.

dation recommendation. The foundations were designed based on existing soil borings and pile records and had to be revised as new borings were completed. To minimize revisions and rework, the normal process of drafting substructures foundations on up, a top down process was utilized.

Foundation recommendations were completed in June. The borings indicated dense granular soils in the top layers followed by dense loamy soil at all substructure locations except Pier 2. At Pier 2 granite rock was encountered at depths varying from 15 ft to 30 ft from the bottom of the footing. The west abutment, Pier 3 and east abutment are supported on spread footings, Pier 1 is on H-piling, and Pier 2 is on rotary drilled cast-in-place concrete piles.

Due to the proximity of the rock layer at Pier 2, the cofferdam design was challenging. Lowering the water level in the river by using the dam downstream was considered to meet the factors of safety required by MnDOT. But ice build-up in the river made this an unreliable option. The seal thickness varied from 10 ft to 16 ft and the seal design was revised using average thickness.

Superstructure Design

Special deck design considerations were required due to a deck span of 15 ft, 6 in. and the addition of overlook areas. The pier overlooks were supported using steel plate brackets fanning from the girder stiffeners.

The delivery schedule for steel plates and the availability of high-strength steel were discussed with NSBA, which suggested not using high-performance steel due to uncertainty in steel delivery schedule.

The plate girder used two different web thicknesses—¾ in. for outer spans and over the river piers and 13⁄16 in. for the middle span between the river piers. Longitudinal stiffeners were required over the river piers. The thickness of the flanges varied from 1¼ in. to 3¾ in. Lateral bracing was required to resist wind loads during construction.

The bridge also carries a 24-in. water main hung underneath the deck that required special diaphragm details. Haunch girders and the presence of the water main resulted in seven different types of diaphragms. Weathering steel was used for the girders, which is MnDOT's standard practice. The end 5 ft of the beams are painted with a zinc-rich epoxy paint system to provide protection against corrosion. Also, the exposed face of fascia girders was painted to meet visual quality requirements.

Conclusions

A project this size typically requires 12 to 18 months for completion and the final design is normally handled by a group consisting of a principal engineer, two senior engineers and four drafters. Thanks to very good coordination between various agencies and district offices, using more than 20 engineers and drafters made the delivery of this project possible in less than two months. Also, by letting the project in two contracts, the early steel contract provided additional time for steel procurement and fabrication.

Steel proved to be cost competitive for this project, and the cost of replacing the Desoto Bridge was well below MnDOT estimates. The bridge opened to traffic on October 29, 2009, renamed the Granite City Crossing Bridge to pay tribute to the many granite quarries found in the vicinity. **MSC**

Owner
Minnesota Department of Transportation

Structural Engineer
Minnesota Department of Transportation – Bridge Office

Steel Fabricator
Industrial Steel Construction, Inc., Chicago (AISC Member)

General Contractor
Lunda Construction Company, Black River Falls, Wis. (IMPACT Member)