PROJECT

Bridge 85851

Minnesota opens new bridge ahead of schedule and using construction manager/general contractor procurement methodology for the first time

by Terry Ward and Keith Molnau, Minnesota Department of Transportation

On August 27, 2016, Minnesota Department of Transportation and its project partners opened Bridge 85851 with a community celebration attended by over 700 people. Photo: Minnesota Department of Transportation.

On August 27, 2016, the Minnesota Department of Transportation (MnDOT) and its project partners opened the new Bridge 85851 with a community celebration that was attended by over 700 people. The bridge was built in only 2 years and opened ahead of schedule, with a cost below the original budget. This project performance required the use of a new procurement methodology, a strong team of engineers and project managers, a high-quality contractor, and a bit of luck.

Project History

Existing Bridge 5900, which spans the Mississippi River in Winona, Minn., was opened to traffic in 1942 and has provided an important regional crossing of the river. It has 24 spans, consisting of a through-truss, deck-trusses, steel beams, and concrete T-girders, and was redecked in 1985. It is fracture-critical and scour-critical and was closed for 2 weeks in 2008 for gusset plate repairs. Recent inspections had shown an acceleration in the rate of deterioration and the bridge was in need of repair.

Federal laws provide for the protection of historic bridges, and existing Bridge 5900 was eligible to be listed on the National Registry of Historic Places (NRHP). After several years of study of various alternatives that would comply with a no adverse effect finding and continued NRHP eligibility, planning efforts settled on an alternative that included rehabilitation of the cantilever through-truss (the main three spans), along with replacement of the approach spans. This alternate also included construction of a new girder type bridge on a parallel alignment. The total project cost estimate was $189 million.

Project Goals

Based on extensive outreach with our project partners, the overriding goals for the Bridge 85851 project became

- build the new bridge as quickly as possible,
- keep the river crossing open during construction, and
- preserve the historical importance of existing Bridge 5900 with both a no adverse effect and continued NRHP eligibility.

profile

BRIDGE 85851 / WINONA, MINNESOTA

BRIDGE DESIGN ENGINEER: FIGG Bridge Engineers, Denver, Colo., and Tallahassee, Fla.

DESIGN PEER REVIEW: Parsons Transportation Group, Minneapolis, Minn.

CONSTRUCTION MANAGER / GENERAL CONTRACTOR: AMES Construction, Burnsville, Minn.

INDEPENDENT COST ESTIMATE: Armeni Consulting Services, Suwanee, Ga.

PRECASTER: Cretex Concrete Products, Elk River, Minn.—a PCI-certified producer

POST-TENSIONING CONTRACTOR: Schwager Davis Inc., San Jose, Calif.

CONSTRUCTION INSPECTION: MnDOT District 6 Construction Unit, Rochester, Minn.; HDR Engineers, Minneapolis, Minn.; Stantec Engineers, St. Paul, Minn.; Mead & Hunt, LaCrosse, Wis.; and FIGG Bridge Inspection, Tallahassee, Fla. (Segmental)

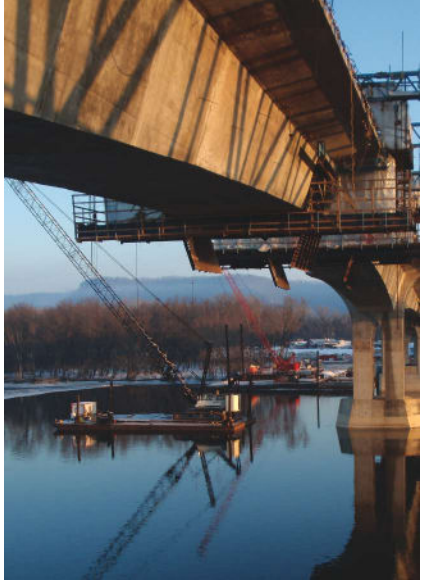
Project Challenges

In April 2013, the project was struggling with meeting the project goals within the traditional design-bid-build (DBB) methodology. The letting date was slated for March 2015 and was significantly behind schedule, based primarily on the delivery of 29 parcels of new right of way (ROW). These delays—along with the environmental assessment not being finalized and final design consultant contracts and environmental permits not having been initiated—were viewed as almost insurmountable obstacles with traditional DBB procurement.

The project team foresaw two major challenges. First, building the new bridge fast required breaking the project into multiple work packages and removing ROW from the critical path. Then, to ensure the rehabilitation and reconstruction of Bridge 5900 were able to move forward, MnDOT needed insight into the costs of the through-truss rehabilitation and a thorough understanding of the risks involved. Similar bridge rehabilitation projects had a history of coming in well over the estimated amounts. With the scale of this rehabilitation work, a different approach was clearly in order.

Final Design and CM/GC Procurement

With preliminary design studies nearing completion in May 2013, the MnDOT District team and Bridge Office team agreed to a very aggressive schedule using the construction manager/general contractor (CM/GC) project delivery method for the final design and construction of Bridge 85851 just upstream of the Bridge 5900.



The segmental box girder, which mirrored the historic cantilever through-truss, gained acceptance and was also the most cost-effective alternative. Photo: FIGG.

The proposed schedule was to begin construction of the river piers in July 2014 and put traffic on the new bridge by the end of 2016, both viewed as almost impossible challenges. This would then allow two-way traffic on the new bridge, after which the needed rehabilitation of the historic truss could begin.

The CM/GC procurement method allowed the project team to break the project into smaller work packages. With no ROW needed for construction of the main river spans and north approach, Bridge 85851 could be designed and constructed on an accelerated schedule focusing on materials procurement, river access, and foundations. Subsequent work packages included the remainder of the new bridge and grading plans, followed by the rehabilitation of the historic bridge.

With schedule goals formalized, MnDOT procured final design consultant contracts and selected separate firms for engineer of record and peer reviewer for new Bridge 85851. MnDOT also procured its first CM/GC, along with a separate independent cost estimate for pricing verification of the contractor's estimate at various phases of the project.

Structure Type Selection

The concrete box-girder structure type was selected for the new bridge based on criteria that included assessment of the visual impact to the historic bridge. Since 1941, the graceful historic cantilever through-truss had become an iconic structure in Winona. Preliminary

The main river spans utilized the cast-in-place balanced cantilever construction method. Photo: Minnesota Department of Transportation.

MINNESOTA DEPARTMENT OF TRANSPORTATION, OWNER

OTHER MATERIAL SUPPLIERS: Form Travelers: VSL, Fort Worth, Tex.; Formwork: EFCO, Des Moines, Iowa; Reinforcement Fabricator: CMC Rebar, Kankakee, Ill.; Bearings and Expansion Joints: DS Brown, North Baltimore, Ohio; and Ornamental Metal Railing: Utility Sales and Supply Inc., Loretto, Minn.

BRIDGE DESCRIPTION: A 2295-ft-long structure composed of a four-span, cast-in-place, post-tensioned concrete slab and five spans of 63-in.-deep precast, pretensioned concrete girders on the south approach, transitioning to a three-span, single-cell, segmental box-girder unit built using the balanced cantilever method with form travelers, followed by four spans of 63-in.-deep precast, pretensioned concrete beams on the north approach

STRUCTURAL COMPONENTS: Segmental spans are 242, 450, and 242 ft. A thin, variable depth (1 ft 9 in. minimum, 3 ft 3 in. maximum) post-tensioned slab with spans of 15, 50, 57, and 60 ft was used to obtain vertical clearance over local streets for the south approach in Winona, Minn. The remainder of the approaches were 130-ft-long, 63-in.-deep precast, pretensioned concrete spans aligned with the spans of the adjacent historic bridge

BRIDGE CONSTRUCTION COST: $77 million for Bridge 85851 and associated roadway work

AWARDS: *Roads and Bridges* Top 10 Bridge Awards, 2015 (#7)

engineering studies set maximum approach grades of 5% (for ADA compliance of the 12 ft wide shared use pedestrian path) with a variable structure depth of 21 ft maximum at the haunches and a 242-450-242 ft span arrangement to align the piers with the adjacent historic bridge. The bottom slab of the box girder tapered from 4 ft thick at the face of the pier diaphragms to a minimum of 9 in. thick at about 140 ft from the centerline of the pier.

Thinner structure type alternatives were also reviewed, including tied arch and cable-stayed superstructure types, but overhead arches or towers would visually compete with the cantilever through-truss. Thus, the haunches of the segmental concrete box girder, which mirrored the historic cantilever through-truss, gained acceptance and was also the most cost-effective alternative.

The balanced cantilever method of construction was initially selected by MnDOT over cast-in-place (CIP) concrete back-spans on falsework due to concerns with tall falsework within the levee and river. The CM/GC concurred that the proposed structure type was the best fit for this location and the method was finalized.

Project Management

Upon selection of the structure type for the new bridge, much work was needed prior to initiating final design. Multiple critical path schedules were juggled by MnDOT project managers, working with consultants to keep the project on the aggressive schedule that had been set. The MnDOT Bridge Office took the lead on concurrently obtaining the Coast Guard Permit and procuring final design consultant contracts. The MnDOT District 6 Office worked on a parallel path with consultants to obtain other permits, ROW acquisition, and municipal consent from the city of Winona, and to develop the environmental assessment.

A volunteer-based visual quality review committee was formed with local Winona representatives to develop the aesthetics and architectural details for the new bridge. The process required separate review by historians to ensure compliance with a no adverse effect finding. The preliminary design was completed leading up to a January 2014 final design kick-off meeting with the final design consultants and CM/GC.

Foundation Design and Durability Considerations

For the foundations, 42-in.-diameter open ended piles had been successfully used on past projects in Minnesota, and appeared to be the viable alternative for resisting vessel collision loads. The CM/GC had the appropriate pile-driving hammer available from construction of the nearby Dresbach Bridge (see Summer 2016 issue of *ASPIRE*™), and provided input that the same foundation type was preferred and more economical than drilled shafts or other alternatives.

Bridge 5900 was originally constructed on timber piles and foundation retrofitting was necessary to strengthen the historic bridge for current design load requirements for vessel collision forces. To strengthen the lateral capacity of the old piers adjacent to the navigation channel, a CIP strut was evaluated that would brace the 75-year-old piers off the newly constructed piers of Bridge 85851. The CM/GC recommended the use of a precast concrete strut instead of the CIP strut, which would have required de-watering. Ultimately, a receiver bracket was cast into the footings of the new Bridge 85851 to support a concrete-filled 42-in.-diameter pipe from leftover pile cut-offs that would bear against the side of the old footing.

To address long-term durability, MnDOT included several provisions for a 100-year design life. The segmental box girder was designed with 50 psi residual compression in the top of the deck and with stainless steel reinforcing bars in the closure segments and in the top slab of typical segments. High-performance concrete with contractor-provided mixture proportions was specified with a compressive strength of 7 ksi; ranges on cement, fly ash, and slag; a requirement for low absorption aggregates; and limitations on shrinkage and scaling.

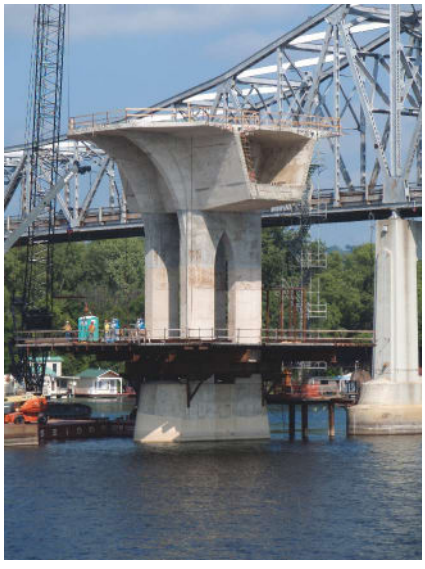
New Bridge Construction

Construction on the new bridge began in July 2014, and the construction team worked through the winter of

An early foundations contract was used to accelerate construction of the river pier foundations. Photo: Minnesota Department of Transportation.

2014-2015 to get the new river piers up and out of harms' way of potential Mississippi River flooding. To meet the aggressive schedule, no flooding delays could be allowed. A unique idle marine fleet provision was implemented and cofferdam elevations were set lower than typical. This reduced the construction cost of the cofferdams and better shared the risk between the contractor and owner. Thus, the goal of getting up and out of the way of flooding was accomplished and MnDOT saved approximately $490,000.

Work continued in 2015 with the start of the CIP main river spans. Fifty segments were cast, many during the



The pier table was constructed one-half segment out of balance with 28 ft projecting into the main span and 20 ft into the back span. Photo: FIGG.

harsh Minnesota winter months, with the resulting structure being ahead of schedule in the spring of 2016.

CM/GC Advantages

The four work packages for the new bridge and associated roadway work cost $77 million, which is around $2.5 million below the letting amounts. In addition, the project team documented over $10 million in cost savings directly attributed to the use of the CM/GC procurement methodology and the partnership efforts of the entire team.

MnDOT used a CM/GC collaborative process with a first-time construction engineering innovation that included the engineer of record (EOR), peer reviewer, CM/GC, and the post-tensioning subcontractor. Models developed by the EOR for the design and peer review were updated with information provided by the contractor's suppliers, leading to a seamless effort to produce integrated segmental girder shop drawings by the EOR. Collaboration before letting allowed for early production of complex pier table segments, and other segments that were on the critical path, rather than the contractor beginning development of shop drawings after letting. This process also allowed for early collaboration with the form traveler supplier to review form traveler details and make adjustments. This took an entire year off the construction schedule.

Form travelers with suspended heated enclosures enabled concrete for the segments to be placed throughout the winter. Photo: FIGG.

Keith Molnau is the bridge design project manager with the Minnesota Department of Transportation in Oakdale, Minn., and Terry Ward is the Winona project manager with the Minnesota Department of Transportation in Rochester, Minn.

Main river piers are 3 ft by 9 ft 6 in. and extend 45 ft above the top of the ice breaker to the pier table. Photo: FIGG.

AESTHETICS COMMENTARY

by Frederick Gottemoeller

Building a new bridge parallel to an existing bridge is always a difficult aesthetic problem, especially where, as in this case, the old bridge is recognized for its historic nature and aesthetic quality. One can always just duplicate the old bridge, unless its materials and technology are so outdated as to make that strategy hopelessly expensive. That was the case in Winona. So, that establishes the aesthetic challenge: to create some visual relationship with the old bridge while using completely different materials and construction methods, and to do it in such a way as to not create an adverse effect on the old bridge or compromise its continued eligibility for the National Register of Historic Places.

The designers decided to base the visual relationship on the graceful downward curve of the top chord of the cantilever truss. They answered that with an equally graceful upward curve of the soffit of the haunched girder. The result is almost a mirror image, a yin-yang relationship that turns the two bridges into an ensemble, in spite of the fact that they are completely different materials, technologies, and colors. The most powerful visual aspect of any bridge is its overall shape, and here the designers have made that shape work for them very well.

Frederick Gottemoeller is an engineer and architect, who specializes in the aesthetic aspects of bridges and highways.