



Steel Girders Support Bridge Construction Staging

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THE FIRST CONSTRUCTION PROJECT completed under the Council Bluffs's (Iowa) Interstate System (CBIS) improvement project was the 24th Street interchange, which crosses the overlapping segments of I-80 and I-29. As an important arterial serving major attractions and businesses such as casinos, a conference/event center, hotels and large shopping outlets, it was essential to maintain three lanes of traffic—one in each direction, plus a turning lane—throughout construction.

Projects of this scope typically are constructed over two consecutive construction seasons, but the critical location of this interchange required limiting traffic restrictions on 24th Street to a single season (April thru October). Maintaining traffic flow and the accelerated construction schedule became the driving forces in the structure's design.

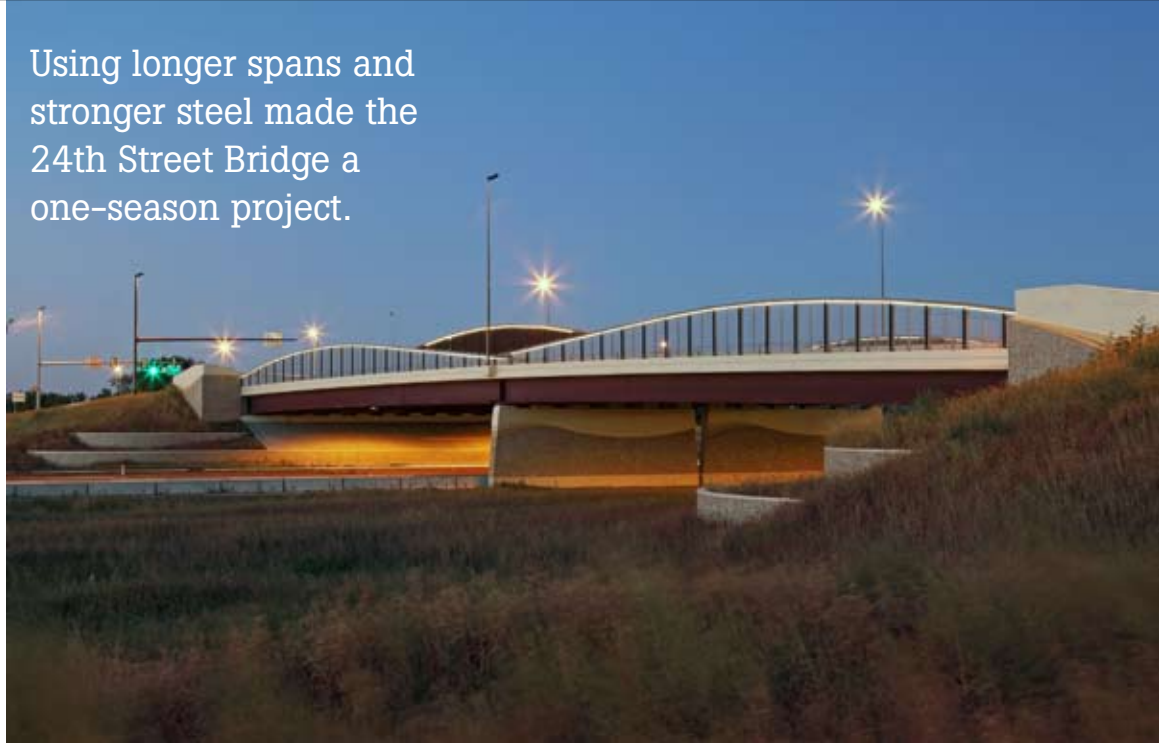
Fortunately, with the help of the Federal Highway Administration's Highway for Life (HfL) initiative and Innovative Bridge Research and Deployment (IBRD) program, Iowa Department of Transportation used innovations that are new to Iowa but already proven to meet the needs of the traveling public during and after construction. The HfL and IBRD programs accelerated construction while maintaining traffic access, reducing future maintenance and improving safety both during and after construction.

The Steel Solution

Several bridge types and construction phasing options were considered to best meet design and safety standards, facilitate traffic and minimize right-of-way impacts. The existing four-span, 216-ft-long by 64-ft-wide prestressed concrete beam bridge spanned five



Using longer spans and stronger steel made the 24th Street Bridge a one-season project.



Opposite page: The existing 24th Street Bridge spanned five interstate traffic lanes, but the new bridge will accommodate future interstate expansion to a 12-lane dual-divided roadway section and shift the centerline approximately 42 ft.

Above: Alignment and clearances dictated a shallower than optimum girder depth, prompting the use of higher strength material for the bottom flange as well as the top flange between the two field splices of the pier section.

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interstate traffic lanes, but the proposed bridge needed to accommodate future interstate expansion to a 12-lane dual-divided roadway section and a centerline shift of approximately 42 ft.

Shifting the I-29/I-80 centerline factored significantly into the design because it defined the location of the center pier. Interstate traffic beneath the bridge had to be maintained between existing piers and the proposed center pier during the first phase of construction. Adding more piers to reduce span lengths was not feasible when considering existing, staged and proposed roadway configurations.

The solution was a two-span, 354-ft-long by 105-ft-wide bridge with welded plate high performance steel (HPS) girders supporting full-depth post-tensioned deck panels. Steel girders were the most feasible option considering the required span lengths of 178.5 ft and 175 ft exceeded Iowa DOT's prestressed concrete

beam standards. Longer spans accommodated the interstate final lane configurations and allowed the flexibility to stage interstate traffic without reducing the number of lanes. Furthermore, the contractor could choose whether to install the shear connectors after deck placement, which afforded the opportunity to make any needed adjustments. The final design featured 12 lines of steel girders spaced 9 ft on-center with a maximum length between field splices of 121.75 ft.

Constraints on vertical profiles required a shallower than optimum girder depth, which also favored the choice of HPS girders. The designer determined the use of higher strength material for the bottom flange and the top flange between the two field splices of the pier section to be the most economical. HPS 70W steel was selected for these areas based on its higher strength

Eliminating Congestion in Stages

The 75,000 vehicles that travel Interstate 80 through Council Bluffs, Iowa, on a typical day represent more than double the estimated traffic flow when the roadway was designed and constructed in the 1960s. With its capacity already stretched, the highway is expected to see daily totals climb to more than 120,000 in the next 20 years. Similarly, the 20,000 drivers using I-29, which interchanges and overlaps I-80 in Council Bluffs, is projected to double over the next two decades.

In response to the safety, congestion and capacity concerns created by the I-80/I-29 corridor's popularity, the Iowa Department of Transportation (DOT) initiated the Council Bluffs Interstate System (CBIS) improvements project. The project encompasses 18 miles of interstate highway in Council Bluffs and the eastern portion of Omaha, Neb., and affects 11 interstate-to-local road interchanges as well as three interstate-to-interstate interchanges. To help manage the magnitude of work, the overall project is organized into five adjacent segments. More information is available at www.iowadot.gov/cbinterstate/.



Allowing the contractor to install the shear studs in the field rather than having them installed in the shop as is traditionally done with cast-in-place decks provided greater tolerance for the erection of the deck panels and facilitated their placement.

coupled with improved toughness and durability. All other steel, including the web, was specified to be A709, Grade 50. The web thickness of 0.5 in. required no intermediate stiffeners in the positive moment regions and a minimal number in the negative moment zones. Cross-frame diaphragms consisted of two angle cross braces between two WT-shaped top and bottom struts generally spaced at 22 ft. A plate diaphragm was specified between the two phases of construction with one set of girder holes for Phase 1 to be drilled and connected after the Phase 2 superstructure was completed and most of the dead load applied.

Working Together

Because the steel girders were designed to act compositely with the deck, the girders and deck were joined together using shear connectors. Shear studs grouped together maximized the economy of deck panel fabrication and provided the necessary composite action. In addition, the plans allowed the contractor to install the shear studs in the field rather than having them installed in the shop as is traditionally done with cast-in-place decks. Again, incorporating an on-site installation method into the design provided greater tolerance for the erection of the deck panels and facilitated placing them more quickly.

The cross-section included two lanes in each direction, two turn lanes, a raised median, a raised sidewalk and a raised multi-use trail. Each of the 70 deck panels was fabricated to be 10 ft long by 52 ft 4 in. wide and 8 in. thick, comprising roughly

half of the new bridge width. The design made it possible to construct each half in one phase, then join the two halves of the completed deck using a longitudinal closure pour. To improve rideability and provide an additional level of protection for the post-tensioned deck system, the panels were topped with a high-density overlay.

Each panel was pretensioned in the transverse direction with ten, 0.5-in.-diameter, 270-ksi low relaxation strands at the top and ten, 0.5-in.-diameter, low-relaxation strands at the bottom of the panels. A total of 28 flat ducts embedded in each panel housed the longitudinal post-tensioning. Four 0.6-in.-diameter, low relaxation, 270-ksi strands were installed in each of the embedded ducts. Pockets in the panels accommodated the headed shear studs. Designing Phase 1 panels to be geometrically similar to Phase 2 panels provided economy of fabrication.

The deck panels were installed after the steel framing was erected and the slab buildup below the deck panels was formed. Slab build-up forming methods and leveling the panels to the correct elevation were left up to the contractor; however, the plans included optional leveling bolts embedded in the deck panels that could be used by the contractor to aid in setting the panels to the correct elevations. After all the deck panels for a phase were erected, the transverse joints were filled with high-strength, non-shrinking grout.

The 24th Street Bridge used female-to-female transverse joints between panels, eliminating the need for match casting and reducing the risk of damaging panel edges

during erection and post-tensioning. Experience with other projects showed that this type of joint tended to perform better than alternative joints, especially where longitudinal post-tensioning was utilized. The transverse joint configuration in the panels was a very important aspect to the design and successful service life of the structure. A poor detail of the transverse joint could result in leakage of the joint material and spalling adjacent to the joint.

Coordination among the designer, the owner, local contractors and fabricators were key to developing an economical design for this project while also reducing future maintenance. Using accelerated construction techniques and innovative construction methods made it possible to maintain traffic access and improve safety during and after construction, and incorporating high-performance steel girders into the design made it possible to complete the project within a single construction season. MSC

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