Preserving Historic Arches While Replacing the Superstructure

by Nick Nemec, Modjeski and Masters, Michael Hyzak, Texas Department of Transportation Bridge Division, Jorge Hinojosa, Bexar Concrete Works, and Bill Mayfield, Capital Excavation

Standing in the heart of New Braunfels, Tex., the San Antonio Street Bridge at the Comal River is a historic arch bridge originally constructed in 1923. The arch spans and girder spans supported a roadway with two lanes, each only 10 ft wide; lacked shoulders; and had narrow 4-ft-wide sidewalks that posed safety risks for pedestrians and drivers. In addition, with the posted weight limit on the bridge, it could not support heavy vehicles, including emergency response vehicles. Like many bridges of its age, the structure needed significant safety improvements to remain operational. With these existing conditions, the bridge was labeled substandard, which qualified it for the Texas Department of Transportation (TxDOT) Off-System Bridge Program. This enabled work to begin to rehabilitate the existing bridge.

The original arch bridge constructed in 1923 had two 10-ft-wide, shoulderless lanes and narrow sidewalks. With the posted weight limit, the bridge could not support heavy vehicles, including emergency response vehicles. Photo: Modjeski and Masters.

In addition to the need to preserve the bridge's historical architecture, another project challenge was that the structure stands in a popular recreational spot. Because the Comal River draws thousands of visitors who tube down the spring-fed body of water, it was important to keep river closure to a minimum.

Aesthetic Considerations

With community input showing a strong desire to maintain the historical architecture of the existing bridge, designers set out to develop a plan that met necessary safety requirements as well as aesthetic preferences. The existing historic structure was a series of five concrete spandrel arches, each with a span length of 70 ft, and a 30-ft-long approach span on each end. The proposed superstructure replacement design removed the existing deck and floor beams but kept the arches, piers, footings, and most of the spandrel columns to preserve the aesthetics of the original structure. This design called for a shallow superstructure to span between columns at the piers. A modified precast concrete box-beam superstructure with overhangs and finials was developed to resemble the architectural features of the original bridge. In addition, crashworthy railings with a historic appearance were provided, in combination with period light poles at pier locations. A three-dimensional rendering of the proposed scheme helped achieve community buy-in. This design maintained the original appearance by preserving the arches and shorter spandrel columns but removed them from the structural system.

Condition Assessment

Team members performed a site visit and condition assessment early in the design process. The key objectives of the assessment were to determine construction access, evaluate the structural integrity of the existing concrete, and investigate the bridge for signs of scour, along with the other typical assessment items.

Construction access was critical to the project because crane access was needed for both the superstructure removal operations and placement of the proposed box beams and other elements. Also, because the river is a popular recreation area, potential access restrictions and easements were evaluated to determine the best way to gain equipment access while maintaining public safety and reducing the project's economic impact on local businesses.

Structural integrity, particularly of the arches, was critical to the design. The

profile

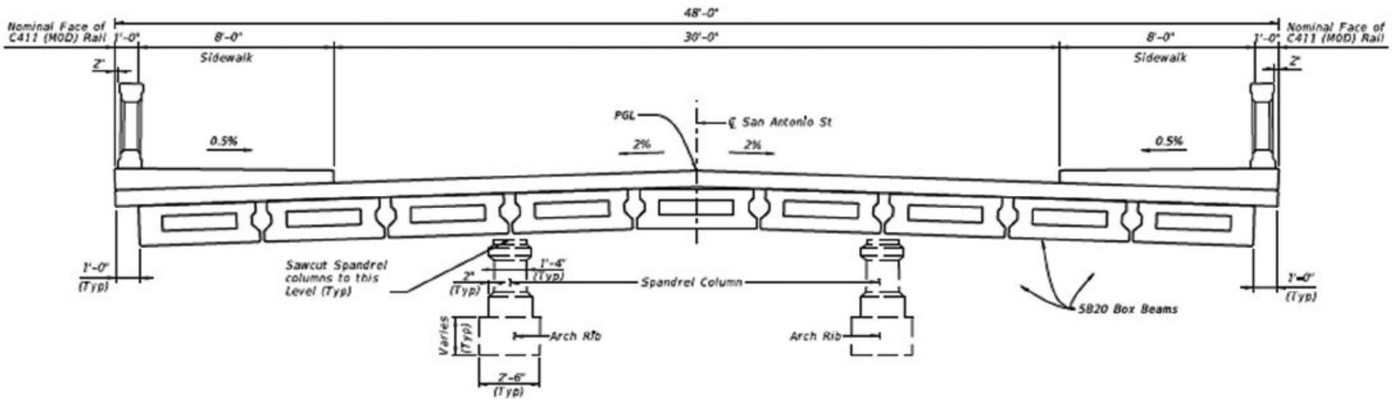
SAN ANTONIO STREET BRIDGE AT THE COMAL RIVER / NEW BRAUNFELS, TEXAS

BRIDGE DESIGN ENGINEER: Texas Department of Transportation, Bridge Division, Austin

PRIME CONTRACTOR: Capital Excavation, Buda, Tex.

PRECASTER: Bexar Concrete Works, San Antonio, Tex.

CONSTRUCTION ENGINEERING: Modjeski and Masters, Round Rock, Tex.



Proposed typical section of new bridge deck system using precast, prestressed concrete adjacent box beams with a cast-in-place concrete deck. Existing spandrel columns and arch ribs remain as shown, with columns cut to clear the new structure. The existing 30 ft deck width was widened to 48 ft in the new structure. Figure: Texas Department of Transportation.

proposed solution would use the existing arch foundations to support new transverse frame bents that would be connected to the bases of the arches using epoxy adhesive with high-strength dowels. The concrete strength of the arch was assessed using a rebound hammer and found to be between 6000 and 8000 psi, much higher than what had been specified in the 1923 plans. The assessment did not identify any spalls, cracks, or other signs of distress in the arches that would have required repair.

Finally, a scour evaluation of the existing foundations was performed. The existing foundations were spread footings, and, upon investigation, no signs of scour were evident.

A precast concrete bent frame being erected on a new cast-in-place concrete seat. The six new frames were erected in two days. Photo: Modjeski and Masters.

Structural Design

The selected design used 20-in.-deep precast, prestressed concrete adjacent box beams with a 5-in.-thick cast-in-place (CIP) concrete deck. This superstructure is a standard system in Texas; however, at a 70-ft-span length, it approached the upper span limit for the beam type. The proposed design also included widening the bridge from 30 to 48 ft, making way for substantially wider and safer vehicle lanes and sidewalks on each side of the bridge. The overall structure length was increased from 410 to 450 ft by increasing the approach span length on each end of the bridge from 30 to 50 ft and retaining the five original 70 ft main arch spans. The approach spans were lengthened to avoid the footprint of the existing abutment foundations and to land the bridge where the grade of the ground was more level.

The new transverse bent frames located at the base of adjacent arches were designed as CIP elements. It was important to ensure the proposed dowel bars would not conflict with the existing reinforcement in the arches. Therefore, the design called for removing the surface concrete to expose the reinforcement before drilling the holes for the new dowels. After installation, the dowels would provide a full moment connection for the new frames to the arch bases.

Construction

Work for the project began in August 2019, and official closure followed at the beginning of September. The first major task was to demolish the existing deck and remove some of the spandrel columns. The crew completed demolition using a section-by-section method. Each original 70-ft-long arch span comprised seven individual 10-ft-long deck spans. The deck was removed by cutting each 10 ft span loose at the tops of the columns and then lifting the span with a crane. This method minimized the risk of damaging the remaining spandrel columns and arches below.

The contractor proposed several design modifications to accelerate the construction schedule and enhance worker safety. The goal was to allow the river to open for recreational activities earlier than the original December 2020 date. Two alternatives for accomplishing the task called for converting CIP elements into precast concrete.

The CIP transverse bent frame was replaced with a precast concrete frame with semi-pinned connections for the frame-to-arch connection. This alternative took advantage of the repetitive and consistent dimensions of the six frames. In addition, the precast concrete bent frame used a higher class of concrete than its CIP counterpart. The modification had several other

CITY OF NEW BRAUNFELS, OWNER

BRIDGE DESCRIPTION: Superstructure replacement of a spandrel arch bridge built in 1923 with a reconfigured load path using adjacent precast concrete box beams and precast concrete bent frames.

STRUCTURAL COMPONENTS: Five 70-ft-long spans and two 50-ft-long approach spans constructed using accelerated bridge construction methods with precast concrete bent frames and 20-in.-deep precast, prestressed concrete adjacent box beams with a 5-in.-thick cast-in-place concrete deck. The historic arch ribs and some columns of the original bridge were retained as nonstructural elements.

BRIDGE CONSTRUCTION COST: \$2.9 million (\$145/ft^2)

After each precast concrete frame was erected, cast-in-place concrete keys were used to to develop flexural capacity at the connection to the arch bases. This scheme reduced the risk of drilling and installing dowels into the existing arch. Photo: Modjeski and Masters.

advantages, the most notable of which was moving the forming and casting of the frames off the critical path. The six frames were constructed and ready for installation as soon as demolition was complete. Their erection took two days.

Lastly, the precast concrete bent frames provided an opportunity to alter the moment-resisting system in the frame-to-arch connection. The precast concrete alternative used CIP concrete keys to develop the flexural capacity, which was less invasive to the existing arch than drilling and installing multiple high-strength dowels. The post-installed keys also eliminated the risk of fit-up conflicts between the frames and the originally proposed embedded dowels.

To the project team's knowledge, this is the first time an entire spandrel column/floor beam (spandrel frame) has been replaced with a single precast concrete unit on any historic arch rehabilitation.
A second precast concrete alternative developed by the contractor was selecting to precast the deck and overhang on the exterior beams before erection. This option eliminated the need for forming the overhang, which greatly reduced the construction schedule for the deck and improved worker safety.

The precast concrete alternatives introduced their own challenges. The concrete mixture proportions and formwork design had to be carefully considered to mitigate and avoid shrinkage cracking. Considerable attention was also paid to addressing stresses from lifting the bent frames from their casting positions and rotating them vertically. Finally, shipping large and heavy components to the site took extensive coordination among all parties.

Conclusion

This unique superstructure replacement and bridge rehabilitation project used creative precast concrete solutions and maintained the historical character of the existing bridge by preserving the pier foundations, arch ribs, and some spandrel columns. The rest of the spandrel columns and the entire superstructure above the arches—the railing, deck, and floor beams—were replaced, and a new load path was created with precast concrete box beams carrying the deck loading to new precast concrete bents at the piers.

The proposed schedule had the bridge opening to traffic by the end of 2020. With the alternatives proposed by the contractor, the schedule was significantly accelerated, allowing the bridge to be officially opened to traffic

The contractor precast the deck and overhang on exterior beams before erection, which shortened the schedule and improved worker safety. Photo: Texas Department of Transportation.

on July 15, 2020. Public access to the river for recreational activities was opened on Memorial Day 2020, just 10 months after the project began.

The collaboration of the engineer of record, the contractor, City of New Braunfels, and TxDOT ensured the project was completed successfully, on budget, and ahead of schedule. The widened roadway and sidewalks provide a safer experience for travelers and pedestrians, and with the load posting removed, emergency vehicles can now cross the bridge. The project is a testament to collaboration, innovation, and dedication to the safety and infrastructure of the New Braunfels community.

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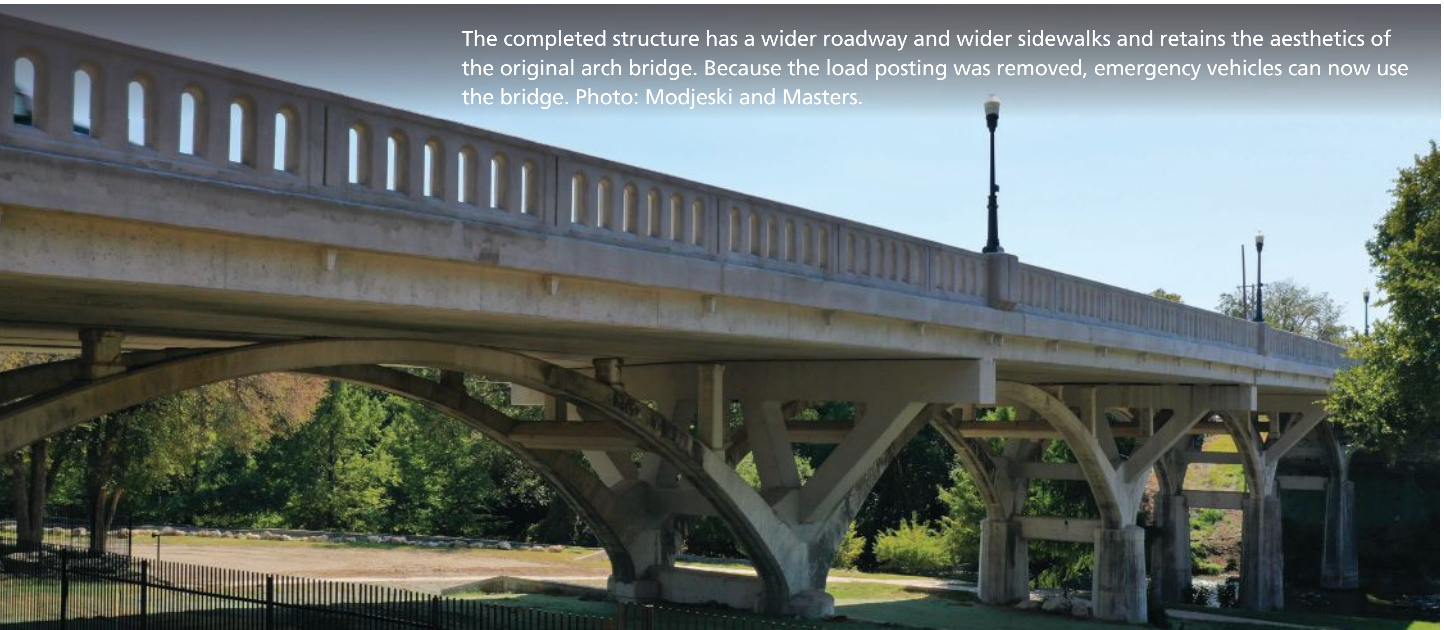

The completed structure has a wider roadway and wider sidewalks and retains the aesthetics of the original arch bridge. Because the load posting was removed, emergency vehicles can now use the bridge. Photo: Modjeski and Masters.