PROJECT

Five Replacement Structures for the Texas Department of Transportation's Amarillo District

by Zachary Mayer, Texas Department of Transportation

The Texas Department of Transportation's (TxDOT's) Amarillo District covers 17 of the northernmost counties of the Texas Panhandle, known as the high plains. The district spans 17,848 mi^2 and maintains 840 bridges, including upgrades. TxDOT and its contractor recently completed the replacement of five bridge structures on U.S. Route 83 and State Highway 15 across three Amarillo District counties with 77 miles between the outermost bridges as the bird flies.

Placement of a precast concrete abutment at U.S. Route 83 over West Fork Horse Creek (South). All Photos and Figures: Texas Department of Transportation.

All five bridges were originally constructed in the 1930s, supported on timber piles. They were later widened in the 1960s to carry two lanes of traffic with 10 ft shoulders. Two of the bridges on U.S. Route 83 carried an average of 3500 vehicles per day. A third of that traffic volume consisted of 18-wheelers, while the remainder were mostly commuter vehicles between the cities of Perryton and Canadian in the northeastern portion of the panhandle. All five bridges were nearing the end of their service life.

Site Constraints and Project Concept

Early in the design concept meetings, it was determined that traditional construction methods would not be the best option for this project. Given the rural locations of the structures, alternative routes were limited. Available detours would range from 10 to 92 miles. Furthermore, right-of-way widths and site conditions would not allow on-site detours to be constructed at every location.

Because of those limitations, TxDOT decided to use accelerated bridge construction (ABC) methods. The TxDOT in-house design team investigated the various ABC options available, with the goal of making the bridges as similar to each other as possible.

Formwork for the ultra-high-performance concrete (UHPC) closure pours between NEXT D beams. This was the second project in Texas to use UHPC.

The drilled shaft sizes and placements, bents, abutments, and beam cross sections were identical for all five structures. A standard bridge width

profile

U.S. ROUTE 83 AND STATE HIGHWAY 15 BRIDGE REPLACEMENT PROJECT / AMARILLO DISTRICT, TEXAS

BRIDGE DESIGN ENGINEERS: Initial design: Texas Department of Transportation, Austin, Tex.; alternate design: Thompson Engineering, Mobile, Ala.

OTHER CONSULTANTS: Plans, specifications, and estimates: Walter P Moore, McKinney, Tex.

PRIME CONTRACTOR: Webber LLC, The Woodlands, Tex.

PRECASTER: Texas Concrete Partners, Elm Mott, Tex.—a PCI-certified producer

OTHER MATERIAL SUPPLIERS: Ultra-high-performance concrete: Smart Up (material) and UHPC Solutions (installation)

New bridge before opening for traffic. Each structure went from start of demolition to being open to traffic in 10 to 12 days.

of 46 ft was used, and beam lengths were standardized to 60 or 70 ft. The bridges consisted of two to five spans and varied in total structure length from 140 to 300 ft.

Roadway vertical curves were adjusted such that grades along the decks were constant. This approach was designed to simplify construction, minimize the impact of the bridge replacement project on drivers, and decrease costs.

To limit the amount of work required on the approach pavement and decrease the effect of the project duration on the traveling public, vertical profiles were not adjusted more than 6 in. This allowed a hot-mix crew to complete the approaches for each bridge in a single day. The geometries of the existing roadways and their relations to the features being crossed meant that the structures did not require horizontal curves and could be built with no skew.

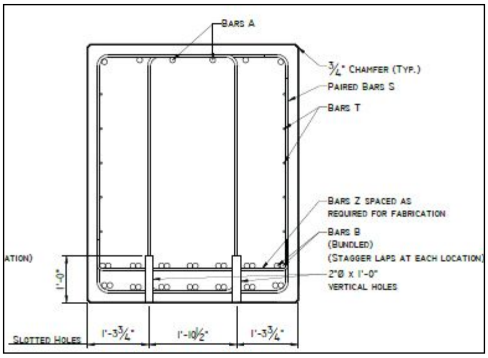
After putting together a preliminary set of plans, TxDOT met with several local bridge contractors. Construction processes, expectations, timelines, and alternative designs were all discussed. Concepts from these meetings were incorporated into the final design.

Placement of precast concrete bent cap. Two-column bents were used in combination with an oversized bent cap to allow construction of the drilled shafts before the bridge was demolished.

Substructure

The design of these structures required minimal removal of the existing structures to install the new drilled shafts. The abutments and bent caps were all precast concrete. Two-column bents were used in combination with an oversized bent cap so that drilled shafts and columns could be installed before each existing bridge was demolished. This strategy made it possible for much of the preliminary foundation work to be completed without disrupting traffic. It also allowed precast concrete bent caps to be placed on top of columns immediately after an existing structure was demolished. Each bent cap had slots where projecting

Section view of precast concrete bent cap. Each bent cap had holes where projecting reinforcing bars from the columns would connect into the caps.



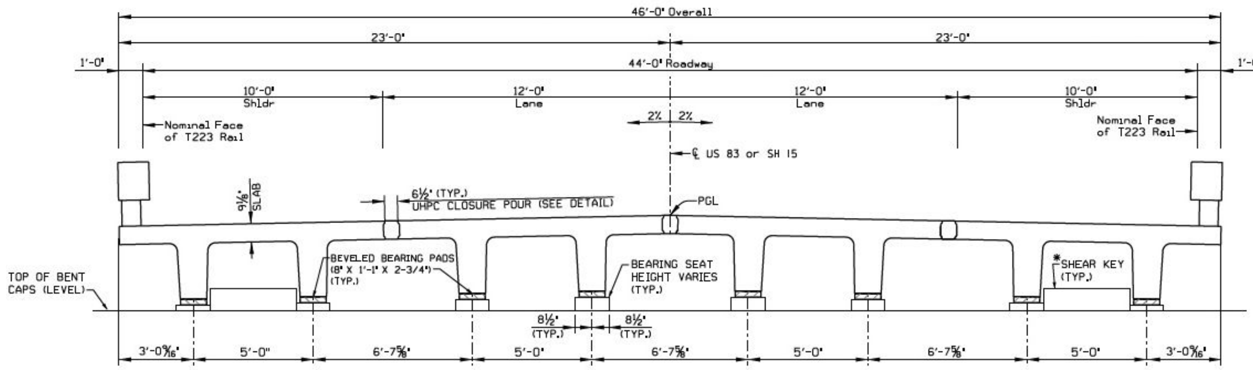
TEXAS DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTIONS:

- U.S. Route 83 at West Fork of Horse Creek (South), 210 ft long, three 70 ft spans
- U.S. Route 83 at West Fork of Horse Creek (North), 200 ft long, two 70 ft spans and one 60 ft span
- State Highway 15 at Farwell Creek, 140 ft long, two 70 ft spans
- State Highway 15 at Palo Duro Creek, 300 ft long, five 60 ft spans
- State Highway 15 at Ivanhoe Creek, 240 ft long, four 60 ft spans

STRUCTURAL COMPONENTS: 68 precast, prestressed concrete NEXT 36 D beams, 12 precast concrete bent caps, 10 precast concrete abutments with wingwalls, forty-four 48-in.-diameter drilled shafts

BRIDGE CONSTRUCTION COST: $168.95/ft^2



The bridge typical section shows the four NEXT 36 D beams, ultra-high-performance concrete closure joints, and the standard bridge width of 46 ft, which was used for all five bridges. The goal was to make the bridges as similar to each other as possible to optimize efficiency.

reinforcing bars from the columns would connect into the caps.

Superstructure

The project let with a proposed superstructure that consisted of four precast concrete deck units with an 11-ft 1⅛-in. wide deck with two precast concrete Tx28 I-girders per unit, with the precast concrete deck to be cast on site for camber considerations. Four of these units would be set side by side to create each span of the bridge, which provided the width for two lanes of traffic with 10 ft shoulders for each structure. The proposed bridge deck thickness was increased to 9 in. from TxDOT's standard bridge deck thickness of 8.5 in. The additional 0.5 in. was intended to be sacrificial to allow the completed bridge to be diamond-ground across the entire deck to ensure a good ride quality.

TxDOT specified that ultra-high-performance concrete (UHPC) be used between units to join the superstructure together. TxDOT's UHPC specification requires 14,000-psi compressive strength within 4 days and 21,000 psi within 28 days. This would be the second use of UHPC in Texas.

After the contract was let and awarded, the contractor approached TxDOT with several alternative designs. TxDOT allows post-let alternative designs for selected concrete elements to provide avenues for innovation with atypical precast concrete components. On this project, TxDOT partnered with the contractor and allowed the use of Northeast Extreme Tee (NEXT) beams, which are a type of double-tee beam (see the Creative Concrete Construction article on page 40 of this issue of *ASPIRE*®). Conceptually, the NEXT 36 D beam with 1 in. added to the top flange and TxDOT's proposed superstructure were very similar and used many of the same construction methods. Being able to construct the units at a precast concrete plant was a definite advantage. UHPC was still specified for the closure pours.

Conclusion

TxDOT's openness to using alternative designs fosters ingenuity and the development of new construction methods. In this case, it helped the contractor successfully navigate the site constraints and transportation challenges of this project. As a result, each structure went from start of demolition to being open to traffic in 10 to 12 days.

Zachary Mayer is the Pampa Area engineer for the Texas Department of Transportation.

Placement of NEXT 36 D beams.

The concrete for the T223 rail was placed on site using slip forming equipment.

An abutment is placed on the drilled shafts, which were installed before the road was closed to traffic.

Comments from TxDOT's Pampa Area Engineer, Zachary Mayer

In the design phase, I worked in the Transportation, Planning & Design (TP&D) department at the Amarillo District, Tex., headquarters. As the design project manager, I was tasked with developing a plan set package for these five bridges. While it is not unusual to bundle five bridges into one design project, it was still a juggling act—first, among the Texas Department of Transportation's Bridge Division, TP&D, and consultants, and again when the contractor made alternative recommendations.

At that time of design, I had no idea that I would be promoted to Pampa Area engineer and eventually oversee the construction aspect of this project as well. Moving from how I thought the project would unfold from the design aspect to how it actually came together in the construction process offered a unique opportunity to learn lessons that would have otherwise been missed. For instance, I have become more mindful of camber. Because there were so many aspects and entities involved, it was an opportunity to be reminded of areas where communication can be improved. These are lessons I look forward to carrying forward into future projects.