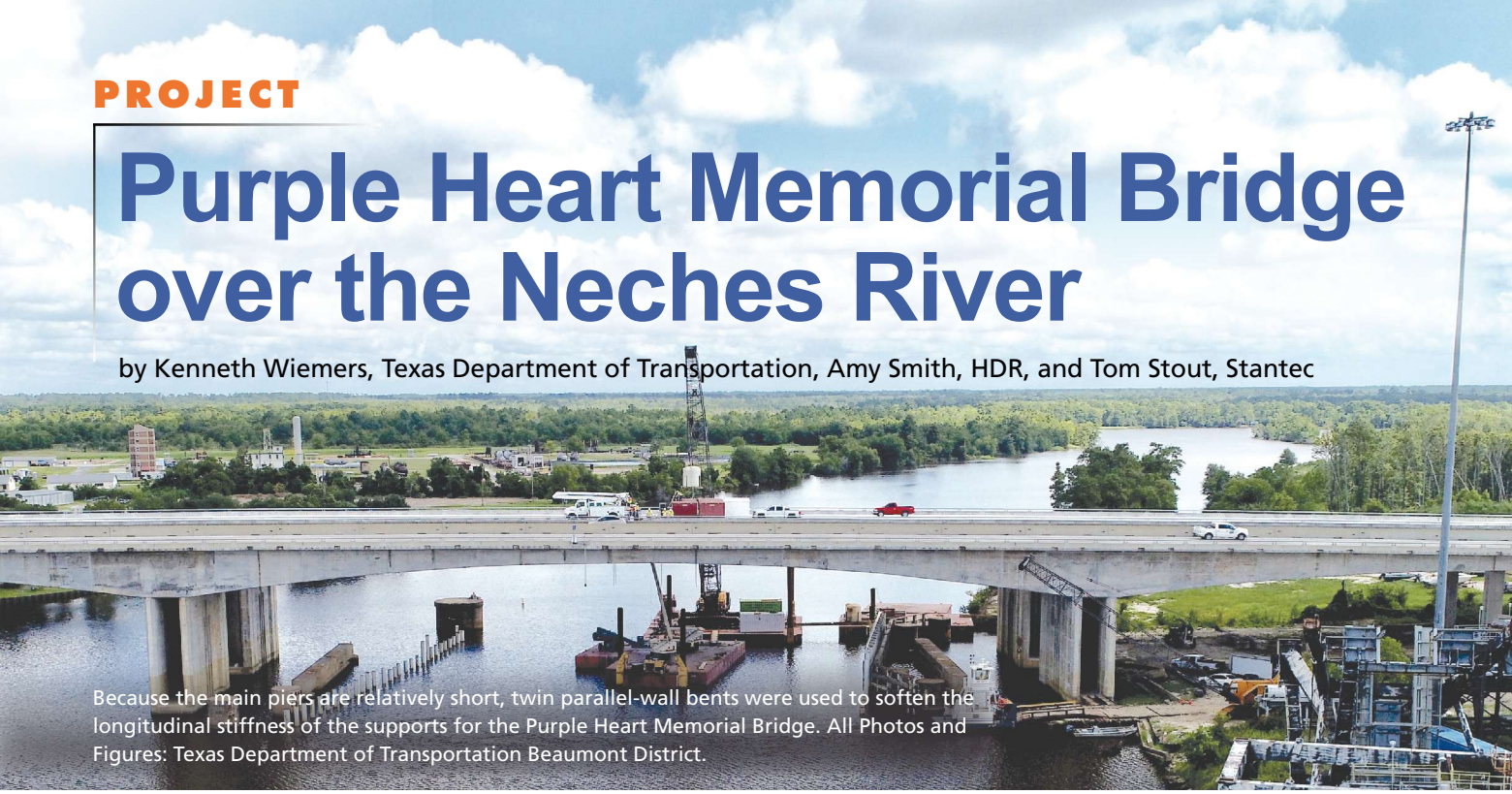
PROJECT

Purple Heart Memorial Bridge over the Neches River

by Kenneth Wiemers, Texas Department of Transportation, Amy Smith, HDR, and Tom Stout, Stantec



Because the main piers are relatively short, twin parallel-wall bents were used to soften the longitudinal stiffness of the supports for the Purple Heart Memorial Bridge. All Photos and Figures: Texas Department of Transportation Beaumont District.

Built from 1952 to 1953, the second Interstate 10 bridge crossing the Neches River in Beaumont, Tex., was a marvel of slide-rule engineering and built-up, riveted steel plate girder construction. Unfortunately, it had a subtle flaw. When the bridge was widened in 1976, the longitudinal slab construction joint was placed directly over the original outside girder. The original 6¼-in.-thick slab was placed in 20-ft segments with transverse construction joints between segments; however, no longitudinal reinforcement connected the segments. Although the 1976 plans showed that the existing transverse reinforcement would be cleaned and straightened into the new construction, results over time showed that this detail may not have been followed.

By 2000, the Texas Department of Transportation's (TxDOT's) maintenance forces were out on the deck almost monthly to patch the slab punchouts occurring at those corners between the longitudinal construction joint and the original deck segments. The time had come to evaluate other options. Redecking the bridge was considered; however, as the old deck was removed, suspected disintegration of the top flange of the original exterior girder under the leaking longitudinal construction joint was confirmed. TxDOT did not want to assess and then possibly repair 3450 ft of girder on this extremely busy and important corridor, so it decided to replace the old bridge with concrete girder approaches and segmental main spans.

Project Specifications

Whereas the old bridge was a single structure, the new crossing consists of eastbound and westbound twin structures, with just a 1-in.-wide gap at the roadway tie-ins and a 12-ft-wide separation at the segmental portion. The twin-structure design was selected for the Purple Heart Memorial Bridge for traffic control and inspection reasons. Each new structure is 70 ft wide and carries four lanes of traffic. There are 23 approach spans of prestressed concrete girders flanking the three-span balanced-cantilever segmental main unit over the Neches River.

Despite being more than 35 miles inland from the Gulf of Mexico, the Neches River is navigable under the bridge. Therefore, U.S. Coast Guard clearances had to be provided. The previous bridge had a main span of 240 ft and, because the alignment of the new Purple Heart Memorial Bridge was over the old bridge, the new main span had to extend beyond the existing piers. A balanced-cantilever segmental bridge proved to be the best choice for the main unit, ultimately providing 193 ft of horizontal navigation clearance.

profile

PURPLE HEART MEMORIAL BRIDGE / BEAUMONT, TEXAS

BRIDGE DESIGN ENGINEER: Texas Department of Transportation, Austin, Tex.

PRIME CONTRACTOR: Williams Brothers Construction Company, Houston, Tex.

PRECASTER: Valley Prestress Products, Eagle Lake, Tex.—a PCI-certified producer

POST-TENSIONING CONTRACTOR: Williams Brothers Construction Company, Houston, Tex.

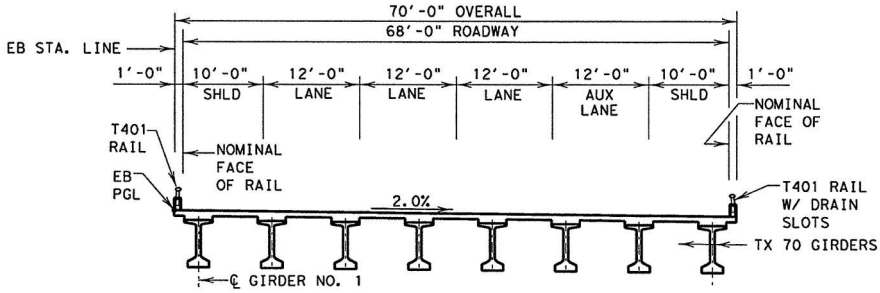
OTHER MATERIAL SUPPLIERS: Formwork, form travelers, and erection equipment: Williams Brothers Construction Company, Houston, Tex.; reinforcement fabricator: CMC Steel, Seguin, Tex.; bearings: Seismic Energy Products, Athens, Tex.; expansion joints: CMC Capital City Steel, Buda, Tex.; post-tensioning ducts and anchors: DYWIDAG-Systems International, Mansfield, Tex.; and post-tensioning steel: Insteel Wire Products, Gallatin, Tenn.

High-Performance Concrete

The Texas Department of Transportation's standard specification for producing high-performance concrete offers several options. However, in Texas, Class F fly ash is almost always included within the concrete. The result is a low-cost, highly durable, and low-permeability concrete.

For this project, the following compressive strength performance requirements were specified:

- 3.5 ksi prior to removing the forms
- 4.0 ksi before post-tensioning the top slab longitudinal and transverse tendons
- 5.5 ksi before post-tensioning the bottom longitudinal tendons
- 6.0 ksi at 28 days



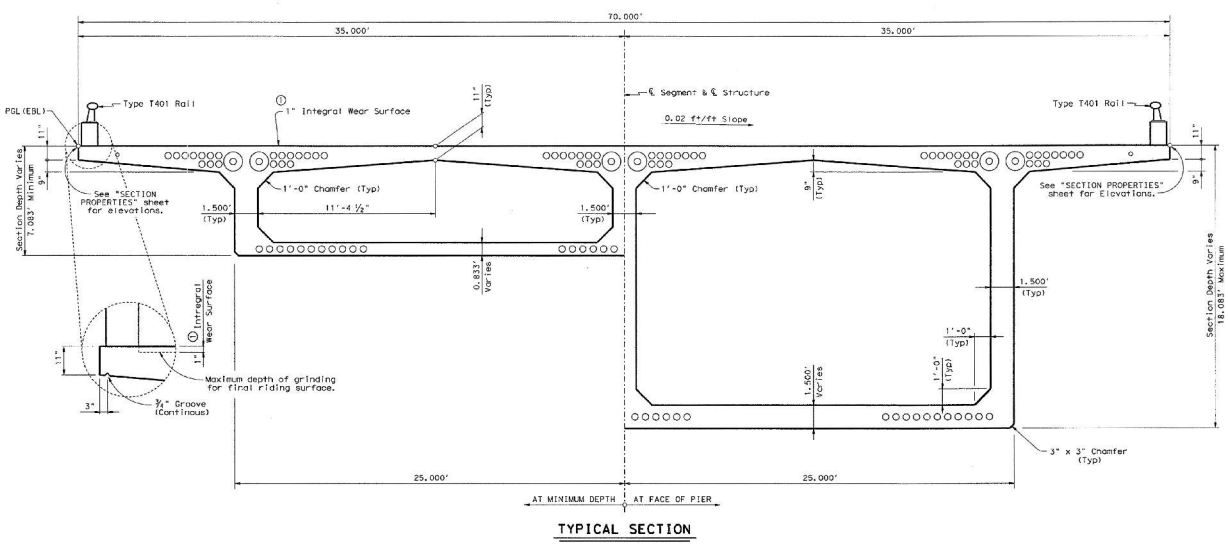
Typical cross sections for Tx70 girder approaches and segmental box-girder main spans of eastbound bridge (spans 13–16 and 20–26).

The design team selected cast-in-place construction using form travelers for the segmental units. Using cast-in-place concrete was preferable over precast concrete construction for a few reasons. Because the bridge is adjacent to downtown Beaumont, there would have been little available space to set up a staging and lifting yard for precast concrete segments. Also, the bridge crosses the Neches River at a location with numerous environmental challenges; therefore, launching precast concrete segments from a barge would have added a great deal of complexity and expense to the project. Furthermore, much of the cost savings associated with using precast concrete would not have been realized because the project has only six spans.

The segmental main units have spans of 180, 320, and 180 ft. The 70 ft deck width was achieved with a double-celled box. The parabolic soffit varies in depth from just over 7 ft at midspan to 18 ft at the piers. The webs are 18 in. thick, and the thickness of the bottom slab varies from 10 to 18 in. Tendons consist of eleven 0.6-in.-diameter strands in both the top and bottom slabs.

Forty-three segments were cast for each structure. To keep unbalanced moments to a minimum, the pier table was cast with one side half a segment longer than the other. Therefore, as each segment was constructed out from the pier on alternating sides, the

Typical section for concrete segmental box-girder main span unit. Left side shows minimum depth section (7 ft 1 in.); right side shows maximum depth section at face of pier (18 ft 1 in.).



TEXAS DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Twin bridges, each with a total length of 3895 ft, consisting of a three-span post-tensioned cast-in-place segmental concrete box-girder main unit (180, 320, and 180 ft) and 23 approach spans of prestressed concrete girders

STRUCTURAL COMPONENTS: 70-ft-wide cast-in-place balanced-cantilever constructed double-cell segmental box girder with depths varying from 7 ft to 18 ft; 8-in.-thick deck on 70-in.-deep bulb-tee prestressed concrete girders for approach spans (maximum 152 ft); 4-in.-thick precast, prestressed concrete deck panels; cast-in-place pier caps supported by columns and column walls; and 18-in.-square precast, prestressed concrete piles approximately 70 ft in length

BRIDGE CONSTRUCTION COST: $68 million ($124/ft^2)

Tx70 bulb-tee girders have been set for the eastbound approach spans on the Orange County side of the river.

system would never be more than a half segment out of balance. Five access doors are provided at each pier table for easy access to the various sections of the bridges for inspections. Future post-tensioning needs are addressed by the inclusion of empty ducts in the shear walls in both the pier table and end anchor segments.

Because the main piers are relatively short (approximately 38 ft off the water), twin parallel-wall bents were used to soften the longitudinal stiffness of the supports, thus keeping temperature-induced moments from driving the segmental design. The walls rest on a twin-cell hollow column from the waterline down to the 51 × 38 × 8 ft pile cap. Each main pier is supported on ninety approximately 70-ft-long, 18-in-square precast, prestressed concrete piles.

Like all segmental bridges constructed in Texas, the Purple Heart Memorial Bridge includes concrete pavement ride requirements. For this bridge, the plans required 3 in. of concrete clear cover, which provided sufficient thickness for the contractor to diamond grind the pavement to satisfy the ride specification while also maintaining sufficient cover for the deck reinforcement.

The approach spans consist of Tx70 bulb-tee prestressed concrete girders (70 in. deep); this project was the first to use this particular shape. This type of girder has proven to be extremely stable, and it, as well as the other bulb-tee girder shapes developed by TxDOT, are now used frequently throughout the state. The lengths of the Purple Heart Memorial Bridge approach spans vary, reaching a maximum of 152 ft. No continuity other than the deck slab was provided, and the girders were designed as simple spans. Precast, prestressed concrete subdeck form panels were used throughout the approach spans, as is the usual practice in Texas.

These side-by-side, 3896-ft-long structures used prodigious amounts of concrete:

- 478,000 ft^2 of approach bridge deck
- 57,000 linear ft of prestressed concrete girders
- 16,000 linear ft of bridge rail
- 13,000 yd^3 of approach bent high-performance concrete (HPC)—see the sidebar for more information on the HPC
- 2500 yd^3 of main pier HPC
- 10,500 yd^3 of concrete in the segmental bridge

Completed pier table on twin parallel-wall columns for segmental box-girder main span unit.

Location-Related Challenges

Because very little right-of-way was acquired, the old bridge had to be deconstructed in phases to allow the new eastbound bridge to be built while maintaining traffic. The deconstruction plan represented its own complex project, with 54 plan sheets dedicated to propping up the old structure long enough to build the new one. Because the old slab was in such poor condition, 440,000 pounds of rolled girders were needed to shore the slab edge.

Equally as challenging as the actual design were the ancillary issues addressed in the design process. A bathymetric survey done to gauge the condition of the river bottom uncovered a sunken World War I–era wooden steamship lying up against the pivot pier of the original swing bridge at this crossing. According to contemporaneous newspaper reports, the 286-ft-long vessel had caught fire at its moorings in 1924 and drifted downstream to bump into the newly completed swing bridge, where the ship eventually sank. After coordinating with the Texas Historical Commission, a no-disturbance zone was delineated in the plans along with a monitoring system as a means of preventing damage to the wreckage during construction of the new bridge.

Brakes Bayou, on the west side of the river system, was home to an Environmental Protection Agency Superfund site. Remediation to clean up a former creosote plant was ongoing, and disturbance of the sediment at the bottom of the bayou had to be kept to a minimum. Turbidity barriers were installed during the driving of the concrete piles to capture silt. Pile caps that would have normally been placed below the mudline were instead left at the normal water elevation.

Another environmental concern was that the existing steel girders in all spans were known to have lead in their paint coating. Therefore, to ensure that the contractor could safely make cuts in the beams, a separate contract was arranged for the removal of the paint at specific locations before the beginning of construction.

The old bridge conveyed numerous utilities across the river. Because of phasing constraints, the owner decided to not include space for them on the new bridges. Instead, the utilities were relocated to a common bore under the river at a location away from the bridge.

Conclusion

Bridges over time become part of the historical landscape of the community they serve. The new Purple Heart Memorial Bridge is the third generation of structures to inhabit this site. The previous bridges are woven into the fabric of Beaumont, Tex., even if all that is now visible are a few abandoned piers, shorn to the waterline. We hope the new bridges add to that legacy of silent service, transporting generations of families toward their futures.

Kenneth Wiemers is the Texas Department of Transportation area engineer in Beaumont, Tex. Amy Smith is a senior bridge engineer for HDR Inc, in St. Louis, Mo. Tom Stout is a bridge designer for Stantec in Austin, Tex. Both Smith and Stout were formerly with TxDOT.

Cantilever truss being set up to make the segmental closure pour on the eastbound side of the Purple Heart Memorial Bridge at its connection to the precast concrete girder approach portion. Bearing seat buildups are on the right, and metal overhang and bottom forms are in the center. Post-tensioning ducts and grouting ports can be seen as well as the cavities of the double-celled box segments.