PROJECT

SC 802 over the Beaufort River and Intracoastal Waterway Bridge

Barge collision necessitates new bridge, more-resilient design

by Edward H. Stehmeyer III, Collins Engineers Inc.

In late April 2007, a barge carrying a crane with its boom partially raised struck the 4200-ft-long, two-lane McTeer Bridge over the Beaufort River and Intracoastal Waterway in Beaufort County, S.C. Two steel girders on the southern-most portion of the bridge spanning the navigable channel were destroyed, and a third girder was seriously damaged.

The damaged McTeer Bridge was one of only two bridges for more than 40,000 low-country drivers to travel from Lady's Island, and the other surrounding islands, to the mainland of Port Royal. The full and partial closures of the bridge for emergency repairs created substantial traffic problems for almost three months. The temporary inconvenience highlighted the inability of the existing transportation infrastructure to handle an increase in the amount of traffic should an evacuation from the islands occur prior to a hurricane.

Prior to the impact at the bridge, the residents of Beaufort County had voted to enact a local sales tax upon themselves to fund future infrastructure projects that would be effective in May 2007. Following the impact and subsequent repairs to the McTeer Bridge, the decision was made to widen the approaching roadway and build a new parallel "sister" bridge to the existing McTeer Bridge. The new bridge project, SC 802 over the Beaufort River and Intracoastal Waterway, was to be the recipient of $34.6 million of those local sales tax generated funds.

New Bridge Needed

The Beaufort County Engineering Division selected a bridge design engineer to provide project management and engineering design services for the construction of a new 4211-ft-long, two-lane, high-level bridge carrying SC 802 over the Intracoastal Waterway and adjacent protected marsh wetlands, and the widening of an additional 1.7 miles

Completed SC 802 over the Beaufort River and Intracoastal Waterway Bridge. Photo: Collins Engineers Inc.

profile

SC 802 OVER THE BEAUFORT RIVER AND INTRACOASTAL WATERWAY BRIDGE / PORT ROYAL AND LADY'S ISLAND, SOUTH CAROLINA

BRIDGE DESIGN ENGINEER: Collins Engineers Inc., Charleston, S.C.

PRIME CONTRACTOR: United Contractors LLC, Great Falls, S.C.

PRECASTER: Standard Concrete Products, Savannah, Ga., a PCI-certified producer

OTHER SUPPLIERS: S&ME Inc., Mt. Pleasant, S.C.; Tidewater Environmental, Johns Island, S.C.; Dennis Corporation, Columbia, S.C.; OLH Inc., Columbia, S.C.; Woolpert, Charleston, S.C.; and THC Right of Way Services Inc., Columbia, S.C.

of adjoining roadway. The bridge was designed on an accelerated 14-month schedule. Bid documents were ready in January 2009 and construction on the new bridge began in September 2009.

This Beaufort County-funded, South Carolina Department of Transportation (SCDOT)-owned and -operated project had several key tenets. Examples of those tenets were affordability to the county, maintainability for the SCDOT, and improvement of the hurricane evacuation route in the area. With the community putting up the funds for this critical infrastructure project, the construction budget was a key issue, as well as incorporating local residents' ideas expressed at numerous public information meetings.

A bridge type study was conducted to determine feasible and desirable alternatives and to incorporate improvements, such as bicycle and pedestrian access and aesthetics to complement the existing bridge. In addressing all of these points, the bridge design team focused on employing sustainable materials through an all-concrete design while satisfying the inherent hazards of the project location. The use of an all-concrete structure yielded construction cost savings and created future maintenance savings.

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Examples of these savings are eliminating the need to paint steel girders over long waterway spans and having fewer substructure units in the waterway. The resulting superstructure consists of 79- or 96-in.-deep, bulb-tee beams spaced at 9 ft 6 in. for the span lengths of 135, 140, and 170 ft. The girders support an 8-in.-thick, cast-in-place concrete deck. Reinforced concrete flat slabs are used for the thirty-five 30-ft-long spans over the low-level marsh wetland crossings.

Resiliency Required

A challenge posed by the bridge site was the need for a resilient bridge design with an end product capable of withstanding various extreme events including earthquakes (inertia loading and liquefaction), hurricane force winds and associated storm surge, flood and high currents (scour), and vessel impact. To tackle these issues, the design team employed a multi-hazard design approach using realistic combinations of extreme event loadings that were consistent with the latest Federal Highway Administration research.

The balancing act presented when considering the strength and ductility to withstand a seismic event in conjunction with a scoured and un-scoured channel bottom condition was examined. In particular, the displacement demands were determined through elastic dynamic (modal) analyses and the substructure displacement capacity was determined through the use of non-linear static (pushover) analyses. And, while vessel impact due to barge trains and small cruise ships was considered separately through a probabilistic hazard design, the strength and ductility implemented to withstand earthquake loading lent itself to the bridge's resistance to vessel impact and other environmental lateral loadings.

Record-setting, 96-in.-deep main-span; bulb-tee beams being set. Photo: United Contractors.

Substructure

The resulting substructure design incorporated prestressed concrete pile bents for the low level marsh wetland crossings, and isolated reinforced concrete drilled shaft bents and drilled shaft groups supporting reinforced concrete waterline footings and hammerhead piers for the high-level spans over the main waterway. Another unique design challenge for the project was the 7- to 8-ft daily tide swing. Through the use of permanent precast concrete soffit elements to construct the waterline footings, construction time savings were realized.

Aesthetics

The design process included aesthetic considerations in conjunction with traditional structural demands, since the new bridge parallels the existing McTeer Bridge. While longer spans for the new bridge would have been possible with the use of newer technology like spliced bulb-tee concrete girders, the public desire to have the new bridge resemble the existing bridge remained strong. Span arrangements were therefore kept similar to the existing bridge, with some pier locations eliminated to minimize substructure elements in the waterway and streamline the bridge profile to stay fairly symmetrical with the existing bridge, creating a "twin" or "sister" bridge appearance.

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: A 4211-ft-long, high-level bridge with two lanes for vehicular traffic, a pedestrian walkway, and shared bicycle lanes. The bridge's main spans of 170 ft are the longest single-piece, precast concrete beam spans in the state using 96-in.-deep, prestressed concrete bulb-tee girders.

STRUCTURAL COMPONENTS: Permanent precast concrete soffits; 15 cast-in-place concrete waterline footings; 11,810 ft of 79-in.-deep, modified, prestressed concrete, bulb-tee beams; 3875 ft of 96-in.-deep, prestressed concrete, bulb-tee beams; and a cast-in-place deck

BRIDGE CONSTRUCTION COST: $34.6 million ($176.70/ft^2)

AWARDS: 2013 PCI Design Award: Best Bridge with Spans over 150 ft and ACEC-SC Engineering Excellence Awards: 2012 Finalist

Flat slab bridge section piles and deck slab beginning to take shape from the shore at Lady's Island. Photo: Aaron Goldberg, S&ME Inc.

Superstructure

The superstructure design included the use of 96-in.-deep, prestressed concrete bulb-tee girders for the three 170-ft-long main spans over the Intracoastal Waterway. The bridge design team selected prestressed concrete girders to meet the overall project tenets of maintainability for the SCDOT. Reinforced concrete hammerhead piers were used to mimic the overall profile of the existing piers. Whereas pile group foundations were present on the existing structure, drilled shaft construction was used on the new bridge to resist the high lateral demands from seismic, wind, and vessel collision hazards. The hammer head pier stems were also treated with a fluted form liner to improve aesthetics over a plain solid concrete face.

Placing deck concrete for the new structure. Photo: United Contractors.

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Sustainability

The design team's focus on sustainability also led to investigating sources of bridge components and designed structural elements that could be locally produced, shipped, and constructed cost effectively. While the 170-ft-long girders set a record becoming the longest single-piece, prestressed concrete girder spans in South Carolina, they are a conventional and readily available construction method that did not require specialty subcontractors to erect the beams.

The beams were specified for an initial and 28-day concrete compressive strength of 7 and 10 ksi, respectively.

The large precast concrete girders were produced in Savannah, Ga., less than 50 miles from the project site and also located on the Intracoastal Waterway. This location facilitated shipping beams directly from the plant to the site on barges, which saved on transport costs and eliminated the need for special overland heavy load permits.

The new SC 802 over the Beaufort River and Intracoastal Waterway Bridge consists of two, 12-ft-wide travel lanes; one, 4-ft-wide shoulder; one, 10-ft-wide shoulder that also incorporates a bicycle lane; and a 5-ft-wide pedestrian walkway. The existing McTeer Bridge was re-striped for one way traffic and dedicated bicycle lanes. The completed bridge, which officially opened in November 2011, provides improved multi-modal access along the SC 802 corridor with protected pedestrian sidewalks and bicycle lanes across the bridge for the enjoyment of the citizens and visitors of Beaufort County, S.C.

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