PROJECT

I-85 Yadkin River Veterans Memorial Bridges

New dual highway bridges improve safety, accessibility

by Mark Robbins, STV / Ralph Whitehead Associates

To provide serviceability, the bridge utilizes continuous-for-live-load design and detailing for the prestressed concrete girder spans. Photo: Lane Construction Company.

On March 22, 2013, the North Carolina Department of Transportation (NCDOT) opened the southbound I-85 Yadkin River Veterans Memorial Bridge to traffic, completing the major dual highway bridge crossings located between Charlotte and Greensboro, N.C. These bridges and their improved horizontal alignment replaced one of the most dangerous bridge crossings in North Carolina.

The previous I-85 bridges were built in the 1950s and had become one of the most notorious bridge crossings in North Carolina. In addition to being narrow and unsafe, the condition of the existing bridges had become severely deteriorated. Designed to carry 10,000 vehicles per day, the bridges were subjected to 80,000 vehicles per day including heavy tractor-trailer traffic. The implementation of a cost-effective replacement solution was a dire need.

Historic, Challenging Site

The Yadkin River is one the largest rivers in North Carolina. The site of the I-85 Yadkin River Veterans Memorial Bridges is located where historical crossings have occurred and played key roles in the Revolutionary and Civil Wars. This location has been developed to include a Duke Energy power plant and related railroad access on the southern bank; and the Norfolk Southern Railroad mainline, with a railroad bridge crossing the Yadkin River, and the Spencer Rail Yard on the northern bank. This location is also in the tail water of the High Rock Lake Reservoir and includes extensive wetlands on each side of the river. The site includes approximately 1500 ft of wetland crossing, 700 ft of water crossing, and an upland area adjacent to the railroad tracks. These features combine to severely limit access to the bridge site from the north, west, and east, and impose minor restrictions from the south.

In addition to the owner, motorists, and local citizens, the proposed project involved stakeholders from the Army

profile

I-85 YADKIN RIVER VETERANS MEMORIAL BRIDGES / CHARLOTTE AND GREENSBORO, N.C.

BRIDGE DESIGN ENGINEER: STV / Ralph Whitehead Associates, Charlotte, N.C.

PRIME CONTRACTOR: Flatiron-Lane Joint Venture, Salisbury, N.C.

PRECASTER: Coastal Precast Systems, Chesapeake, Va., a PCI-certified producer

Corps of Engineers, Division of Water Quality; Duke Energy; Norfolk Southern Railroad; North Carolina Railroad; and Federal Energy Regulatory Commission.

The project solution needed to address safety and stakeholder requirements, limit environmental impacts, and be delivered quickly. The NCDOT selected the design-build best value method to provide that solution.

New Design Increases Safety

For increased highway capacity and safety, the new roadway utilizes a single, long, super-elevated, horizontal curve with a 17,000 ft radius to eliminate the series of tangents and horizontal curves that characterized the previous conditions. The number of lanes was increased from four to eight and the inside and outside shoulder widths widened to 12 ft. The inside shoulder is designed and constructed to be a future traffic lane.

The clear roadway of the dual bridges is 72 ft with a length of 2914 ft. The vertical grade of the bridge includes a gentle 0.5% grade for a majority of the bridge length and transition to just over 2% to achieve the 23 ft vertical clearance over the railroad tracks. This vertical profile results in pier heights ranging from 25 to 50 ft. The span over the railroad mainline accommodates the two existing tracks and three future tracks. The future tracks are expected to carry a combination of freight and high speed passenger service.

A study of the 245-ft-long railroad span included alternatives of prestressed concrete girders; cast-in-place, post-tensioned concrete boxes; and steel plate girders. This study also factored in the four bridges on the project, which included another single, 800-ft-long Yadkin River crossing on U.S. 29, in selecting the approach spans for the I-85 crossing of the Yadkin River. From this study, the design-build team selected 77-in.-deep, precast concrete for economical fabrication (PCEF) bulb-tee girders for all spans on the project, except the railroad span. The typical span length is 140 ft, which accommodates the horizontal curvature.

Design

The bridge superstructures for the I-85 Yadkin River Veterans Memorial Bridges consist of a cast-in-place concrete deck on 20 prestressed concrete girder spans and one steel plate girder span for each of the dual bridges. The skews of the intersecting features vary along the length of the bridge such that trapezoidal spans are incorporated in the concrete section to adjust the skew to meet the railroad alignment.

To provide serviceability, the bridge utilizes continuous-for-live-load design and detailing for the prestressed concrete girder spans.

To provide serviceability, the bridge utilizes continuous-for-live-load design and detailing for the prestressed concrete girder spans. The continuous units were limited to two spans to minimize the size of the bridge joints and their initial cost, and to simplify their future maintenance. The top reinforcing mat in the deck is epoxy coated.

Seven girder lines are used for each span resulting in a maximum girder spacing of 11 ft 11 in. Concrete compressive strengths up to 8 ksi were used for the prestressed concrete girders. Galvanized steel intermediate cross frames were used as diaphragms between the concrete girders.

The 2500-ft-long work trestle. Photo: STV.

Elastomeric bearings are used for the prestressed concrete spans.

Another significant superstructure element is the structure drainage system, which directs deck drainage to a treatment basin prior to discharge into the river. Given the 72-ft-wide bridge deck and the prohibition of discharging into the river or wetland, the deck drainage system extends 2300 ft along the side of each bridge.

Girder delivery at the southern end of the bridges. Photo: Flatiron.

A fiberglass-reinforced plastic pipe was evaluated for the project because its thermal expansion properties are approximately 1/6th that of polyvinyl chloride (PVC) pipe and is very close to the thermal coefficient of concrete. This minimized issues with differential thermal movements. The pipe, while slightly more expensive than PVC, was used because of its thermal characteristics, flexibility of installation, and lighter weight.

The substructure of the bridge consists of cast-in-place concrete, post and

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION, OWNER

OTHER CONSULTANTS: HDR of the Carolinas, Raleigh, N.C. and Froeling & Robertson, Charlotte, N.C.

BRIDGE DESCRIPTION: Dual, 2900-ft-long, 21-span structures utilizing 77-in.-deep, precast concrete for economical fabrication (PCEF), bulb-tee prestressed concrete girders up to 140 ft long made continuous for live-load

STRUCTURAL COMPONENTS: 280 PCEF-77 bulb-tee girders; 9-in.-thick, cast-in-place concrete deck; and cast-in-place concrete pier caps, columns, and drilled shafts

Erection of the southbound bridge, which is closely located next to the northbound bridge with the trestle between them. Photo: STV.

North end of the work trestle. Photo: STV.

Northbound bridge opened early to improve safety. Photo: STV.

beam style interior piers. The typical pier caps are 5 ft 6 in. deep and 5 ft 0 in. wide and the columns are 48 or 54 in. in diameter. The foundation is a combination of drilled shafts for the 17 piers in the wetland/water regions and pile footings for the three piers in the upland areas. The bridges include 140 drilled shafts with diameters of 54 and 60 in. and depths up to 80 ft.

Construction Logistics

The size of the bridges, restricted access, desire for early opening to improve safety in the corridor, and numerous stakeholders presented significant challenges to delivery. Extensive coordination and cooperation with the owner was used to work through the various stakeholder requirements to facilitate design and construction.

The solution for the access to construction was to widen the proposed median such that a construction trestle could be constructed between the dual structures. This approach is generally considered counter-intuitive as typically the approach to minimizing environmental impacts is to reduce the footprint of the project. However, based on a review, it was determined that environmental impacts could be minimized by using a single trestle rather than two work trestles outside each bridge as originally anticipated.

Since the railroad mainline tracks and close proximity to the Spencer Yard and other site conditions prevented access from the west, north, and east, the temporary trestle was installed from the southern end of the dual bridges. This meant that construction occurred across the wetlands, the river, and to the upland area south of the mainline tracks. This required almost 2500 linear feet of work trestle and created a single access point for all construction south of the railroad track. The contractor implemented and scheduled operations utilizing multiple working shifts as necessary to complete the construction with this limited access.

The first priority of the project was to complete the northbound bridge such that both directions of the existing I-85 traffic could be shifted to the new northbound bridge. This provided significant early safety enhancement to the public as it facilitated early use of the improved horizontal alignment, increased shoulder offsets, and eliminated the reoccurrence of structural maintenance issues on the almost 60-year-old existing I-85 steel beam bridges. Traffic was shifted to the new northbound bridge in May 2012, which was less than two years from the start of construction. Construction of the I-85 southbound bridge and all I-85 widening was completed by May 2013.

Mark Robbins is a vice-president with STV / Ralph Whitehead Associates in Charlotte, N.C.