New construction system protects environmentally sensitive areas

TECHNOLOGY DRIVEN

by Craig A. Shutt

Constructing the new Washington Bypass, an upgraded alternative route for U.S. Route 17 in Beaufort County, N.C., created unique challenges beyond traditional bypass construction. The $192-million project, encompassing 6.8 miles of roads, includes two major interchanges and bridges that span environmentally sensitive lands. To meet the variety of needs, especially the goal of minimizing impact to wetlands, the construction team created an innovative gantry system that drives piles, sets precast bents, and erects beams. After the deck is cast, the gantry progresses to the next span.

The bridge construction represents the second part of a three-part project, explains Maria Rogerson, assistant resident engineer with the North Carolina Department of Transportation (NCDOT). The first part, begun in February 2008, focused on widening

profile

U.S. ROUTE 17 WASHINGTON BYPASS / BEAUFORT COUNTY, N.C

DESIGN-BUILDER: Flatiron/United, a joint-venture company comprising Flatiron Construction Corp., Longmont, Colo., and United Contractors Inc., Chester, S.C.

ENGINEER OF RECORD: Earth Tech Inc., Long Beach, Calif.

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

GANTRY: Deal, Italy

The innovative gantry system used on the U.S. Route 17 Washington Bypass Bridge in Beaufort County, N.C., drives piles, sets precast concrete bents, and erects beams. After the deck is cast, it progresses to the next span. All photos: Flatiron.

the southern 4 miles of two-lane roadway to four lanes. Construction of the new 2.8-mile-long bridge, spanning wetlands along the 6.8-mile-long section of roadway, is now underway. It will be followed by widening 4 miles of highway north of the bridge under a contract to be let toward the end of 2009. The goal is to create an accessible 70-mph corridor from Virginia down to Wilmington, N.C., she explains.

Design-Build Opens Opportunity

"What gave us the ability to be a little bit creative on this project was the design-build process," says Rogerson. The state has created several smaller design-build projects prior to this one, she notes, but the delivery method has not been used extensively. Bidders were scored both on their creativity in meeting the variety of needs, as well as the cost to deliver the bridge. Three companies were short-listed based on their bids and technical proposals. Initially, all three bids came in too high, so adaptations were made to make the design more cost efficient. It is the largest design-build project in the state.

"The design-build process cuts the timeframe on construction before the NCDOT acquires the bridge, because the contractor is responsible for final design, right-of-way access, and construction in their contract," Rogerson explains.

The Flatiron competitively priced proposal was accepted because, among other features, it did not require the use of a temporary work bridge to erect the structure, which would have had more impact on the wetlands, she notes. "Their design required less clearance in the wetland areas, only 30 ft from the edge of the bridge, with minimal impact below." Executing this concept then became the design-build team's responsibility.

Innovative Gantry System

The bridge is being constructed using two 592-ft-long, patent-pending gantry systems starting from each end of the bridge. Each gantry consists of two parallel and connected trusses that are long enough to reach over four spans of the bridge. The gantry system begins at one end of the bridge and drives the piles for each bent. Approximately 1227 30-in.-square. precast, prestressed concrete hollow piles will be driven to support 140 spans including both portions of the Y-shaped split at the end. Each span is about 121 ft long. Earlier, test piles had been driven near the bridge's alignment to confirm the length of the piles and tip elevations.

The precast concrete piles and girders were fabricated off site while the pile caps were cast on site at a precasting yard set up at the south end of the bridge. The components are inspected and approved at both sites prior to delivery to the gantry.

Gantry Operation

The precast piles and beams are delivered to staging areas at the north and south abutments and then loaded onto a special carrier that comprises two trucks, one driving forwards and one driving backwards, explains Elie H. Homsi, vice president of engineering services at Flatiron Constructors Inc. and developer of this top-down concept.

The pile is loaded into the lead with an attachment for the hammer clamped to its top. The lead then rotates the pile into a vertical position for driving.

PRECAST, PRESTRESSED CONCRETE BRIDGE / NORTH CAROLINA DEPARTMENT OF TRANSPORTATION, OWNER

BRIDGE DESCRIPTION: Precast concrete bridge consisting of 140 spans (116 spans plus two parallel structures of 12 spans) each about 121 ft long, with 1227 precast, prestressed concrete hollow piles, 922 precast beams, 140 precast post-tensioned pile cap bents and cast-in-place concrete deck

PILE DRIVING EQUIPMENT: Birminghammer, Hamilton, Ont., Canada

BRIDGE CONSTRUCTION COST: $192 million

The gantry system is used to attach pile caps in three pieces to the precast concrete piles.

On typical spans, the gantry drives nine piles, then sets the precast concrete caps in three pieces on the piles. The caps are then post-tensioned and infill concrete placed.

The trucks position the pile under the tail of the gantry, where two separate trolleys lift each end. The pile is threaded into the lead and an attachment for the hammer is clamped to the top of the pile. The trolleys move to the end of the gantry, and the lead rotates the pile into a vertical position for driving.

The entire gantry is mounted on front and rear supports. Each support can move independently forwards, backwards, and sideways. The front support can be moved to the right while the back can be moved to the left, to skew the positioning, or they can be moved in the same direction to keep components parallel, Homsi explains. The sideways movement allows the gantry to be positioned to reach the locations of the piles and the beams.

On typical spans, the gantry drives nine piles and then sets the precast concrete caps in three pieces on the piles. The caps are post-tensioned and infill concrete is placed. The concrete infill is loaded into buckets and transported to the leading end of the truss using the gantry trolley. The trolley maneuvers the bucket into the position required for concrete placement.

Next, seven beams are placed by the gantry and the concrete deck is cast. Once the 3500-psi concrete compressive strength is achieved, the gantry moves forward, and the cycle is repeated for the next span.

"This new method allowed the Flatiron/United team to break the record for top-down construction for this type of precast beam bridge by constructing 120-ft-long spans without relying on ground-based support equipment," says Homsi. The truss eliminated the need to erect a temporary bridge and significantly reduced the environmental impact. Fewer trees has to be cut down using this method.

Environmental Challenge

The challenges were significant for the design team. The key element was building the 2.8-mile-long bridge over sensitive wetlands that could not be disturbed and opening it to traffic by November 2010, bringing it in line with the widening projects planned to the north and south. Complicating this process was a moratorium by the state Wildlife Resource Commission for no "in water" pile-driving work from February 15 to June 15 to allow for fishery hatching of three species.

The innovative top-down construction method results in minimal disturbance to the wetlands during the construction operation. The only permanent impact is the actual pile footprint.

Mark Mallett, project manager for the Flatiron/United joint venture, explains, "The gantries are essentially a bridge-building assembly line. There are three spans of bridge under construction in the launching cycle at all times. It is one challenge to get the gantry to perform each of its tasks and another to synchronize these tasks so that all three spans can be built simultaneously."

The gantry progresses in a "caterpillar" mode of movement, Homsi says, stretching out the front support to its new location and retracting the rear support as construction progresses. The gantry is driving piles for the leading or first span as the deck is cast on the second span and the deck concrete is curing in the third span.

Achieving the needed concrete strength at the rear of each segment was the key to being able to progress, Rogerson notes. About four spans could be set each month. "It moved along pretty well."

All of the construction is moving smoothly, she adds. There are penalties of $10,000 per day for late completion, but no one is worried at this point. "So far, we're remaining on schedule," she says. Meeting that schedule with such an innovative approach to the construction will no doubt gain the attention of other departments of transportation, as more states look for ways to complete projects quickly while minimizing the impact to their sensitive environmental areas.

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