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A Bridge Building Machine

Top Down Bridge Construction


Figure 1


Figure 2

A Bridge Building Machine

True Top Down Construction

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When the North Carolina Department of Transportation (NCDOT) began constructing a 6.8-mile bypass on US 17 around the city of Washington, NC, they had to contend with a major crossing of the Tar River as well as adjoining environmentally sensitive wetlands. The project, located on North Carolina's coastal plain in Beaufort County, features a 2.8-mile, 4-lane structure over the Tar River and wetlands.

NCDOT hired the Flatiron-United JV Design-Build team (Flatiron-United) to develop the design and construction of this challenging project, and a team from Earth Tech's North Carolina operations as the team's engineer of record.

To minimize the construction footprint in these environmentally sensitive areas, the Flatiron-United team developed a new and innovative top down construction approach using a unique overhead gantry. This approach results in minimal impact to the wetlands and accelerated construction schedule when compared to conventional construction techniques. This design-build project, the Department's largest design-build contract to date, was awarded to Flatiron-United in February 2006 for $192 million and is scheduled for completion in November 2010.

A pair of 592-ft. long, 750-ton gantries are now in operation, one at each end of the bridge and working towards the middle of the structure. The gantries were designed and fabricated by DEAL, an Italian firm, and Berminghammer of Ontario, Canada, with direction from Flatiron's Vice President of Engineering, Elie Homsi.

The self-launching truss system performs the complete sequence of construction activities – from driving the 30-in. square prestressed concrete piling, to setting the pre-cast post-tensioned bent caps and 72-in. modified Bulb-T girders, to handing materials for construction of the cast-in-place concrete deck. The world's first application of the pile driving operation from an erection gantry is the most unique feature of the system and is the essential element that truly eliminates the need for equipment and temporary access trestles and ground work in the fragile wetlands.

Construction activities are on-going simultaneously across three spans (typically 120-ft in length) in an assembly line progression. As a span is completed and deck cured, the gantry is launched ahead to begin the pile driving on the next span. The dramatic reduction in wetland disturbance offered by this "true top down" construction operation was well received by the US Army Corps of Engineers, North Carolina Division of Water Quality, North Carolina Department of Natural Resources, US Coast Guard, and other environmental agencies during the permitting process.

Over 80% of the bridge (2.3 miles) is on tangent horizontal alignment with a continuous 70-ft. deck width (carrying 4 lanes of traffic), thus providing ideal repetitive conditions for this construction gantry operation (Fig. 1). However, the remaining 0.5 miles on the north end of the structure is complicated by the separation into independent north and southbound spans in a horizontal curve. As shown in Figure 2, the north gantry features a wider transverse support beam straddling both northbound and southbound spans, and is thus capable of performing simultaneously all of the construction operations of both superelevated deck sections of the split structure. A vertical clearance of 45 ft. is provided over the Tar River navigational channel.

The structure design is largely controlled by the construction equipment and operational loadings, as opposed to normal service load conditions. Since this area is often in the path of hurricanes making landfall on the North Carolina coast, the bridge and gantry were designed to withstand 100 mph wind loads during the construction period. Normal construction activities may proceed until wind speeds reach 45 mph, at which time the gantry is secured in place in a short-term out of service condition. Once wind speeds exceed 64 mph, the gantry is retracted to a position over a completed span and securely anchored in place. This section of the Tar River is also subject to tidal action and the potential scour from storm surge intensifies the loading to the substructure elements. Earth Tech performed a sophisticated 2D Flow Model scour evaluation to predict this scour potential.

Flatiron/United's innovative, patent-pending, gantry operation, with its pile driving capabilities, is truly state of the art in bridge construction. ■