PROJECT

Connecting Interstate 4 and the Selmon Expressway

Major project in Tampa, Fla., uses a variety of segmental construction methods

by Thomas A. Andres and Richard W. Frank, Florida Department of Transportation, and John McShaffrey, AECOM

Rendering of the project that shows the completed Interstate 4/Selmon Expressway connector drawn into its location within an actual aerial photo. All photos: Florida Department of Transportation.

The Interstate 4 (I-4)/Selmon Expressway Connector project located in Tampa, Fla., connects two major east-west, limited-access corridors in a major Florida city. Though not originally part of the Tampa Interstate Study master plan that began in 1987, the connector was later added to the plan and ultimately advertised for construction on June 8, 2009. Construction began on March 1, 2010. Traffic is expected to begin using the facility by the end of 2013 and the project should conclude by the spring of 2014.

When it opens to traffic, the connector will provide a vital transportation link between the Selmon Expressway (a tolled facility) and I-4. It will also feature a direct I-4 connection to and from the Port of Tampa. Truck-only lanes are an important component of the project, which will remove through-truck traffic from local roadways in the Ybor City area—one of only two National Historic Landmark Districts in Florida—within the city of Tampa. This direct cargo link will be one of the first of its kind in the United States and will serve to route commercial traffic and hazardous cargo away from the Ybor historic district.

This project is primarily a viaduct connection between I-4 to the north and the Selmon Expressway to the south, including complex interchanges at both of these highways. It spans multiple local streets, State Road 60, and railroad tracks and spurs critical to commerce and the Port of Tampa. The connector includes a series of separate ramps created to improve the regional movement of traffic throughout the Tampa Bay area. The project completes an important regional link in the Tampa interstate system by providing an alternative route for commuters, improving the ability to evacuate in advance of hurricanes, and by aiding emergency response providers.

profile

I-4/SELMON EXPRESSWAY CONNECTOR / TAMPA, FLORIDA

BRIDGE DESIGN ENGINEER (NORTH INTERCHANGE): Parsons Brinkerhoff, Tampa, Fla.

BRIDGE DESIGN ENGINEER (SOUTH INTERCHANGE): Atkins North America, Tampa, Fla.

SUBCONSULTANT: FIGG Bridge Engineers Inc., Tallahassee, Fla.

PRIME CONTRACTOR: PCL/Archer Western, a Joint Venture, Tampa, Fla.

CONSTRUCTION ENGINEER: Corven Engineering, Tallahassee, Fla.

CIVIL ENGINEER: Cardno TBE, Clearwater, Fla.

CONCRETE SUPPLIER: CEMEX, Tampa, Fla.

PRECASTER: Standard Concrete Products, Tampa, Fla., a PCI-certified producer, and Mack Industries, Astatula, Fla.

POST-TENSIONING SUPPLIER: VSL, Ft. Lauderdale, Fla.

One of the project's many columns constructed using "bottom-up" concrete placement.

Segmental and bulb-tee bridges are seen in this photo looking south. It also shows mechanically stabilized earth wall construction, a concrete deck placement, and a look at the toll gantry across all lanes.

The project involves 35 bridge structures. Florida bulb-tees with a cast-in-place concrete decks are used for most of the tangent portions. Precast concrete segmental construction—utilizing both balanced cantilever and span-by-span construction methods—tie into the highways at either end. Other construction that is part of the project widens or rehabilitates existing bridges using Florida U-beams and Type IV AASHTO beams.

Innovation Is Key

This highly complex project has faced numerous challenges throughout design and construction. Innovation has been the key to financing, designing, and constructing the improvements. This article presents some of the details of procurement and financing methods, materials, equipment, and construction methods that have been critical in bringing this project to fruition.

Bidding and Financing

The project literally would not have gotten off the ground had outside-the-box bidding and financing methods not been developed. The procurement process combined the conventional design-bid-build process (A+B bidding) with an innovative build-finance procurement approach. This bid-finance approach was authorized under private-public partnership legislation passed by the Florida Legislature and signed into law by the governor in 2004. This unique contractor-financing component allowed the advancement of the project to construction at a time when the national and local economies were struggling and most of the needed cash was not readily available.

The original $389.5-million dollar price tag for construction of this project is funded with approximately $87 million of economic stimulus dollars, as well as other federal and state funds. About $298 million is being financed by the contracting team, with deferred state payments to the contractor extending into 2017.

To promote competition between the steel and concrete industries, the bid package included these four options:

a. All steel box-girder bridges
b. All segmental concrete bridges
c. Steel box-girder bridges for the interchange ramps and Florida bulb-tee bridges for the viaduct
d. Segmental concrete bridges for the interchange ramps and Florida bulb-tee bridges for the viaduct

FLORIDA DEPARTMENT OF TRANSPORTATION/FLORIDA'S TURNPIKE ENTERPRISE, OWNERS

OTHER SUBCONSULTANTS AND SUBCONTRACTORS: Ameristeel, Tampa, Fla.; Beijing Wowjoint Machinery Co., Beijing, China; DEAL, Italy; EFCO, Des Moines, Iowa; McNary Bergeron, Broomfield, Colo.; Old Castle Southern Group, Temple Terrace, Fla.; PCL Construction Services, Orlando, Fla.; and Watson-Bowman, Amherst, N.Y.

BRIDGE DESCRIPTION: 35 separate bridge structures utilizing segmental post-tensioned, box-girder construction, Florida bulb-tee beams, AASHTO Type IV beams, and Florida U-beams; the longest segmental box-girder structure is 5060 ft.

STRUCTURAL COMPONENTS: 1159 concrete drilled shafts ranging in diameter from 36 to 90 in. and varying in length from 49 to 183 ft, 246 footings with at least four shafts in each footing, 280 columns, 12 bridge structures used precast, post-tensioned, segmental concrete box girders utilizing both span-by-span overhead launching truss and balanced cantilever construction methods. Twenty-three bridge structures used Florida bulb-tees, Florida U-beams, and AASHTO Type IV girders with an 8-in.-thick, cast-in-place concrete deck

BRIDGE CONSTRUCTION COST: The present value of the total project is $411,696,543. The bridge square foot cost ranges from $229.98 to $72.39 with an average of $148.80.

The winning bidder selected option d, which includes 23 of the project's 35 bridges. Of the 23 bridges, 12 are segmental and 11 are Florida bulb-tee spans. The segmental bridges include both span-by-span and balanced cantilever construction.

To put the magnitude of the project in more perspective, it is helpful to consider the following:

- 1159 concrete drilled shafts, ranging from 36 to 90 in. in diameter, were installed in highly variable soil stratums.
- 246 footings were used with at least four shafts in each footing.
- 280 columns were needed to support the bridges.

Segment lifters work in tandem during balanced cantilever construction.

Columns were constructed using a bottom-up method for placing concrete. The bottom up process involved an injection point near the base, with additional injection points incrementally spaced along the height of the column. Once the concrete level had passed the next injection point, the pump hose was moved to the next location and the concrete injection continued. Occasional pulses of form vibration were used to consolidate the concrete. This method produced a high level of quality and required fewer workers. The tallest pier rises more than 87 ft above the ground and typical column dimensions for the rectangular piers are 6 by 5 ft, 8 by 5 ft, and 8 by 7 ft.

Segmental Construction

A total of 2929 segments were required to complete the segmental portion of this project. An off-site, short-line segment casting facility was constructed and used to manufacture 2765 individual precast concrete segments, using six typical-segment beds and two pier-segment beds. The remaining 164 segments were comprised of cast-in-place concrete elements to close and complete individual spans. Typical segments are 9.5 ft deep and vary in length from 9.2 to 10 ft. The segments range in width from 30 ft 1 in. to 47 ft 3½ in.

The manufactured precast concrete segments were trucked to the project site and hoisted into place by large cranes or two segment lifters that were employed for the balanced cantilever sections and a gantry used for the span-by-span sections.

The contractor chose to utilize these segment lifters for balanced cantilever construction at some pier locations. Project geometric constraints and traffic restrictions on the underlying roadways would have required very large ground-mounted crawler cranes because of the required lifting reach and the segments weights. The use of segment lifters increased production rates of the balanced cantilever construction, decreased traffic impacts, and eliminated mobilization times associated with large ground-mounted crawler cranes.

Another advantage of using segment lifters is the ability to lift the segments from any point along the cantilever. For the cantilevers constructed in this project, the lifters moved in sequence so that balance was maintained at all times. Concrete counterweight blocks—weighing as much as 450,000 lb—were placed on the outside radius of the pier segments to stabilize the curved cantilevers. More than two-thirds of the project uses balanced-cantilever construction, accounting for 104 spans. The longest cantilevers consist of 28 segments and have a span length in excess of 250 ft.

The span-by-span overhead gantry truss was chosen by the engineering designer to better accommodate the variable span lengths and the horizontal curvature within the project, as well as to better address ground-level constraints. The span-by-span precast concrete segments were lifted by the gantry from below with hangers and then aligned. When the complete span of segments was in place, groups of segments within the span were coated with epoxy at the joints and then stressed together with temporary post-tensioning bars. This process was repeated until all segments within the span were stressed. Closure concrete was placed and permanent post-tensioning installed and stressed. The span was then lowered onto bearings and the truss launched to the next span.

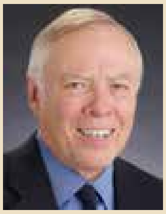
Of the 12 segmental, post-tensioned concrete box girders, two of the longest are ramp S (truck only lanes)—which consists of 31 individual spans totaling 5060 ft in length—and ramp B (eastbound I-4 to eastbound Selmon Expressway), which consists of 27 spans totaling 4785 ft.

Tolling and Partners

The project will also include a state-of-the-art toll facility with an all-electronic toll collection system that will allow for traffic to maintain highway speeds and for maintenance of toll equipment without disrupting traffic. The electronic open road tolling will be done through SunPass and toll-by-plate tolling at one location—the massive toll gantry between I-4 and State Road 60. Florida's Turnpike Enterprise will manage the tolling system and will maintain the

AESTHETICS COMMENTARY

by Frederick Gottemoeller



Directional ramps at major freeway interchanges are often called "flyovers," a recognition of the curved aerial paths that high-speed vehicles take as they make their way from one freeway to the other. Concrete box girders are uniquely suited to this type of bridge.

In a large interchange, if the ramp widths are sufficiently standardized, there is often enough length of bridge to support the costs of specialized segmental forming. The longer spans and narrow pier shafts of segmental construction allow more options for pier placement and minimize the need for straddle bents. Segmental ramp bridges also have great aesthetic potential. If the pier shafts are kept thin and the pier caps are no wider than the soffit of the box girder, all the dominant lines of the structure—the deck edges, the overhang/web intersections, and the soffit edges—are parallel to the curvature of the ramp. Indeed, they reflect the trajectories of the vehicles above.

Their appearance from below also is pleasing to drivers passing through. Major interchanges are inherently confusing places, with drivers having to weigh multiple path choices while competing for road space with other drivers that are occupied likewise. Wide openings between the ramp piers maximize sight opportunities for drivers passing below, while the simple, clean lines of the structure are quickly grasped and easily understood, so that the bridges do not distract drivers.

The I-4/ Selmon flyover ramp bridges take advantage of all of this potential. The spans are long and the number of pier shafts are relatively few. The webs are sloped and the box widths are minimized, which means that the pier cap width and the pier shaft width are also minimized. Drivers can easily see between the thin and widely spaced piers to the signs and ramp choices beyond. The minimal box width, sloped webs, and resulting long overhangs also allow more daylight to penetrate the spaces below the bridges. Because of this, drivers have an easier time recognizing traffic patterns and potential hazards. Relatively thin and widely spaced as they may be, there are still a lot of piers and a lot of pier caps in the I-4/Selmon interchange. Because they are simple geometric shapes with a minimum amount of detail, their potential for visual distraction is minimized and the overall appearance remains consistent. The height and prominence of the bearings is a welcome touch. At each pier, the box girders rest on two relatively small, raised pads.

From many angles a bit of sky is visible between the pier caps and the girder soffits. The girders appear to be very light in weight. They look like they are floating in the air, actually "flying over." For drivers, traversing major interchanges will always be somewhat stressful. The I-4/Selmon Interchange's open views, seemingly lightweight girders, simple shapes, and, most of all, congruence of the lines of the bridges with its traffic patterns, make this interchange less so.

roadway. Project partners are the Florida Department of Transportation (District Seven), Florida's Turnpike Enterprise, the Tampa-Hillsborough County Expressway Authority, and the Federal Highway Administration.

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