Central Florida Opens Four-level Interchange to Ensure Smoother Ride to Orlando International Airport

Aerial view of the completed interchange

Over two million pounds of steel was required for the temporary shoring
A ribbon cutting February 12 marked the opening of a new four-level interchange between the Central Florida Greenway (SR 417) and Orlando International Airport’s (OIA) South Access Road at the location of the existing Boggy Creek Road Interchange. Officials from the Central Florida Expressway Authority (CFX), Greater Orlando Aviation Authority and Lake, Orange and Osceola Counties were in attendance, signifying the regional importance of this interchange.

The construction of a direct connection between SR 417 and OIA, which currently is the fourth busiest airport in the United States with over 35 million passengers annually, was needed to accommodate current traffic and future demands related to the expansion of OIA, including a new south terminal and multi-modal center. CFX took the lead on this multi-agency project that has been planned since 1990, when SR 417 was originally constructed with a diamond interchange at Boggy Creek Road.

A unique aspect of the project was the use of horizontally curved, precast concrete U-girders for three of the ramp bridges (a fourth was designed with curved steel trapezoidal box girders). All of the ramp bridges were originally designed with steel plate trapezoidal box girders; however, the CFX believed that a cost savings could be realized with the use of the concrete U-girders. Bids for the interchange, with precast concrete curved U-girders, were accepted in October 2013, with the low bid of $71 million, estimated to be a savings of $7 to $9 million over an all-steel girder design.

The SR 417 interchange is the first standard delivery project in the United States to incorporate curved precast concrete U-girders as the primary design. Previous projects constructed in Colorado have all been a result of value engineering redesigns or an alternate design allowed by the contract documents and completed by the contractor.

**Girder Design**

The bridge cross sections consist of two 84-inch-deep concrete U-girders supporting a cast-in-place concrete deck. One of the challenges of a precast concrete U-girder structure is the heavy self-weight of the segments. To keep the segments to a manageable length and weight for lifting and transport to the site, the spliced and post-tensioned method of construction was used. The bridges were broken up into segments, with one segment over each pier and a segment in between. The length of the girder segments was limited to a maximum of 110 feet so that each segment could be transported. The basic sequence included precasting the curved U-shaped segments, supporting each segment on temporary shoring towers and splicing the sections together by using post-tensioning. Gaps for the closure placements between each of the curved segment sections, which consist of cast-in-place concrete, were typically two feet wide. Post-tensioning tendons run through internal ducts from the beginning to the end of each unit, connecting all of the U-girder segments in the unit when stressed. Due to the complex geometry, numerous phases of construction and changes in support/loading conditions of the segments, a three-dimensional computer model was developed that included a detailed, time-dependent, staged construction analysis with both girder lines and deck slab. This analysis ensured that the segments met all design requirements during each phase of construction and also allowed for accurate calculation of camber.

**Girder Construction**

Since it was the first precast concrete curved U-girder bridge constructed in Florida, new forms had to be purchased by the precaster for the project. The curvature was obtained by using short, straight sections with small angle breaks between the sections, for both external and internal forms. Reinforcing bar cages, utilizing welded wire mesh, were built outside the forms and the completed assemblies lifted in one piece and placed in the forms. Additional
Longitudinal reinforcing bars were used in the webs and bottom slabs of the girders to address lifting and handling operations. To allow quicker girder removal from the forms, stresses were checked considering only the reinforcing steel, allowing the bottom flange tendons to be stressed in the yard later once the required concrete strength was achieved.

Shipping of the girders (maximum weight of 340 kips) was by multi-axle trucks to the construction site—about 40 miles from the fabrication yard. Girders were shipped at night to arrive early in the morning so that placement could occur during lane closure windows. Girder segments were supported at each end by temporary steel shoring towers (over two million pounds of steel was used for the towers) and, at the ends of the units, by the abutment or pier. Post-tensioned diaphragms were cast at the piers to tie the two-girder system together and transmit loads to the bearings. One of the continuous post-tensioning tendons was stressed in each web prior to casting a lid slab, which closed the top of the boxes for torsional rigidity. Thereafter, the remaining three post-tensioning tendons were stressed. After post-tensioning and grouting were completed, shoring was removed, and the girders were ready for placing the deck slab as with any other composite continuous girder system.

**Summary**

The design and construction of the SR 417 and Boggy Creek Road interchange introduced a new girder type to the state of Florida. Where curved structures are required and aesthetics are important, the concrete U-girder provides an alternative to the steel trapezoidal box girder, increasing competition and allowing for more competitive pricing. This new system brings the advantages of standard precast concrete construction, including durability, quality, and speed of construction, to curved concrete U-girders.

Donald W. Budnovich, Resident Engineer for CFX, said, “The Central Florida Expressway Authority is excited to provide our customers and the central Florida region with a more efficient means to enter the Orlando International Airport, through the construction of this interchange. The innovative design employing the post-tensioned curved concrete U-girders provides a durable and cost-effective project that we expect will serve central Florida for decades to come.”

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*Concrete U-girder form*