PROJECT

Innovation in Central Florida: The Wekiva River Bridges

by Jerry Pfuntner and Jan Zitny, FINLEY Engineering Group Inc., and Garrett Jones, Superior Construction Company Southeast LLC

The 360-ft-long main span of the first cast-in-place segmental concrete box-girder bridge nears closure. Photo: Superior Construction Company Southeast.

In the heart of central Florida forests, the Wekiva River meanders within a fragile and unique setting, attracting many outdoor enthusiasts, many of whom appreciate this region's beauty from the water. The new Wekiva Parkway will span across this river with three new parallel cast-in-place, segmental concrete box-girder bridges with a main span length of 360 ft. The three-span bridges complement the surrounding environment and enhance the beauty of this pristine waterway.

The segmental bridges and the prestressed concrete Florida I-beam approach spans have been designed to minimize their impact on the local environment and wildlife. The height and length of the new structures will allow wildlife to follow their natural movement patterns without having to cross the widened Wekiva Parkway. Meeting transportation needs, promoting wildlife safety, and achieving aesthetic goals were among the challenges set forth by the Florida Department of Transportation (FDOT) for this design-build project.

Design-Build Procurement with a Twist

For this project, FDOT incorporated a new twist into the design-build procurement process. Traditionally, a technical proposal submission is the only document needed to communicate the design-build team's approach to the project. However, in this case, FDOT required teams to submit an initial bridge aesthetics and constructability package, which FDOT had to approve before a team could move forward with the final technical and cost proposal. FDOT placed particular value on the aesthetic and environmental concerns, and this early submission package ensured that the finalist teams would provide acceptable aesthetics, as well as a construction scheme that would maintain the existing site conditions, vegetation, and water access. This initial submittal was also required within three months of short listing, so the design-build teams had to immediately focus on the design and construction of the project's segmental portion.

For the initial submission, the bridge design engineer who ultimately led the project immediately began modeling the structure to develop the bridge design requirements and sizing the foundation and substructure elements. The bridge design firm directly coordinated the design modeling with its prime contractor to develop the construction sequence and temporary works concepts required to present the overall sequencing of the new bridge construction.

The conceptual demolition plan of the existing bridge also had to be included with the initial plans, and the team had to develop and commit to solutions to overcome the project's environmental impact, such as containment of saw cuttings and strategies to reduce turbidity during the removal of existing piles. The submission included an exceptionally detailed environmental impact strategy, including a tree survey

profile

WEKIVA RIVER BRIDGES FOR WEKIVA PARKWAY SECTION 6 / SORRENTO, FLORIDA

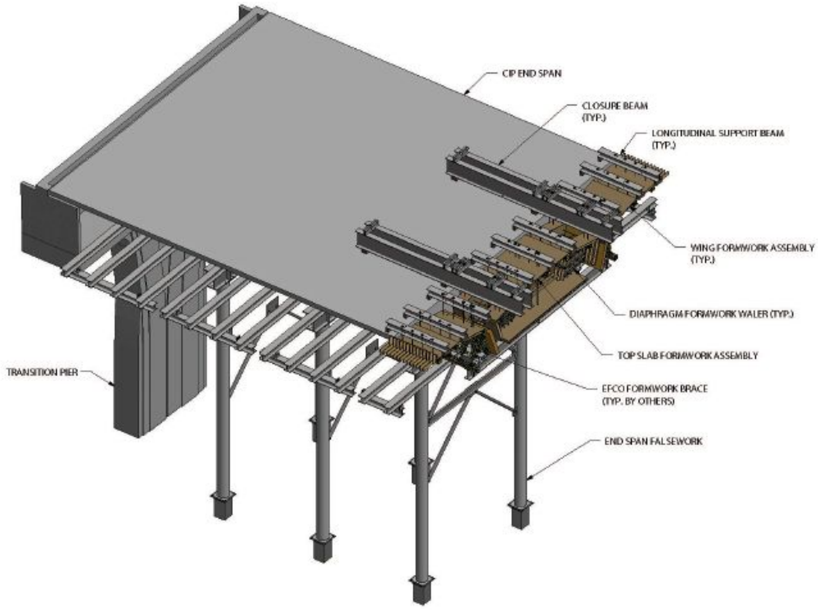
PRIME CONSULTANT: WGI, Orlando, Fla.

SEGMENTAL BRIDGE DESIGNER/CONSTRUCTION ENGINEER: FINLEY Engineering Group Inc., Tallahassee, Fla.

APPROACH SPAN DESIGNER: Arcadis, Jacksonville, Fla.

PRIME CONTRACTOR: Superior Construction Company Southeast LLC, Jacksonville, Fla.

GIRDER PRECASTER: Dura-Stress, Inc. Leesburg, Fla.—a PCI-certified producer



Three-dimensional model showing the end span falsework. Bridge information modeling technology allowed stakeholders to visualize constructability issues and possible conflicts, which could then be solved during the design process. Figure: FINLEY Engineering Group.

and a tree removal drawing to define the exact number of trees that would be removed, trimmed, or left intact.

Preparing this submittal was a uniquely detailed and exhaustive process. It gave the design-build team the opportunity to present a comprehensive plan that offered specific solutions to critical issues well before the technical proposal was written and the final prebid design, drawings, and quantities were produced. The design-build team's process ensured that its final submittal would meet project requirements and be acceptable to FDOT.

Innovations

Each project brings a unique set of challenges, which can bear the fruit of innovation. These new Wekiva Parkway bridges exemplify innovation in the design and construction of concrete segmental bridges, as several unique features have been incorporated into the three-span segmental structures.

Specifically, FDOT has developed a new approach to enhancing the durability of its post-tensioned structures and now requires the use of flexible fillers for continuity post-tensioning (PT) (see the article in the Winter 2017 issue of *ASPIRE*®). With this approach, the tendons may be removed and replaced at any time in the future. Additionally, the continuity tendons must be a combination of internal tendons and draped external tendons. For this project, the internal tendons contained twenty-two 0.6-in.-diameter strands and the external tendons used nineteen 0.6-in.-diameter strands. Combining unbonded PT strand and bonded mild reinforcement increases the complexities of strain compatibility and geometric analyses to determine the correct stresses in the strand at ultimate loading. These analyses go well beyond typical bridge design and analysis software design capabilities.

This project also built on the successful implementation of diabolos that the bridge design engineer had developed for the FDOT District 6 Palmetto Section 5 project, which was the first use of diabolos in Florida. The external PT tendons for the Wekiva River Bridge project all use diabolos for the deviation of the external tendons, allowing standardized deviation segment formwork and diabolo details (see related article in the Fall 2015 issue of *ASPIRE*).

For this project, the designers incorporated an innovative bridge information modeling (BIM) approach, where bridge information databases were introduced into the planning, design, and construction processes using advanced engineering software.

Side view of cantilever construction of the main span with form travelers. Span closure is ready for concrete placement at the form traveler on the right. Photo: Superior Construction Company Southeast.

FLORIDA DEPARTMENT OF TRANSPORTATION AND NATIONAL PARK SERVICE, OWNERS

OTHER MATERIAL SUPPLIERS: Formwork: EFCO, Orlando, Fla.; form travelers: NRS, Oslo, Norway; reinforcement fabricator: CMC Rebar, Kissimmee, Fla.; bearings: RJ Watson Inc., Alden, N.Y.; expansion joints: mageba LLC, New York, N.Y.; post-tensioning: Structural Technologies, Pompano Beach, Fla.

BRIDGE DESCRIPTION: Design-build project including three cast-in-place segmental concrete box-girder bridges built in balanced cantilever with span lengths of 260, 360, and 260 ft. Approach spans were constructed using prestressed concrete Florida I-beams.

STRUCTURAL COMPONENTS: Cast-in-place segmental bridges built in balanced cantilever with form travelers, prestressed concrete I-beams, prestressed concrete piles

BRIDGE CONSTRUCTION COST: Approximately \$60 million (\$160/ft^2)

Aerial view of segmental bridge construction in several stages: The completed first bridge (on the right) is open to traffic; construction on the outer bridge (on the left) is progressing from two main piers; and foundation construction has begun on the center bridge after demolition of previous bridge. Photo: Superior Construction Company Southeast.

The designers used general aspects of BIM for bridges and advanced software to develop the project workflow for integrating analysis models in SOFiSTiK with computer-aided design and drafting production models in Autodesk.

This integration enabled the design team to work more efficiently and reduced the efforts by project engineers as each member was able to work simultaneously on multiple facets of the project, including bridge design, construction analysis, geometry control, the construction manual, and superstructure shop drawings. This increased consistency and reduced the time spent on repeated efforts between analysis models and drawing production; in addition, this smooth workflow significantly increased the overall quality of the final project.

For the Wekiva River Bridges, it was critical that the design and construction engineering activities were nearly concurrent. With BIM, as changes were made in the analysis model, the construction model was also updated. Similar efficiencies were achieved in the integrated three-dimensional (3-D) bridge model that was used for the construction manual, as the falsework towers in the integrated bridge model would update with any changes and follow through in every drawing sheet of the construction manual, significantly reducing errors and drawing production effort. Using the construction models with the bridge visualization simplified the fabrication of the temporary falsework towers, resulting in 3-D isometric views and falsework drawings that were very similar to the physical product.

In general, 3-D BIM allows for greater understanding of constructability issues and possible conflicts, which can be solved with relative ease during the design process, helping to avoid delays at the construction site or in the casting yard. Sometimes, it is a true challenge to clearly show intricate details of the reinforcing bar cage in two-dimensional drawings. Using the BIM method, designers could share the integrated 3-D segmental model with the prime contractor's staff, thereby preventing confusion and preempting questions during construction. (For more details on BIM, see the Concrete Bridge Technology article in the Winter 2019 issue of *ASPIRE*.)

Conclusion

The requirements for the new Wekiva River Bridges dictated that the design-build team go above and beyond the conventional proposal submittal process for a new FDOT project because of the project's location in a fragile and diverse ecosystem. The design-build team focused on innovative and definitive planning to give FDOT the confidence to move forward with the team's proposal, which included design modeling concepts through the use of BIM technology, environmental impact strategies, and well-conceived construction sequences. Implementation of these plans ensured the eventual success of the project.

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A dual-shaft pier was used to stabilize the pier segment. Photo: Superior Construction Company Southeast.

External post-tensioning tendons passing through diabolos in a deviator segment. Because flexible filler is used, the tendons may be removed and replaced in the future. Photo: Superior Construction Company Southeast.