Proper Management Improves Process

The following describes the planning, design, and construction phases of a land development bridge, albeit not your typical land development bridge. Most land development bridges are "required" to carry traffic and pedestrians over some type of natural waterway. This bridge was built as the centerpiece of an up-scale golf community and was not required for a functional reason – it only spans a man-made lake. To an engineer like me, it is just a very impressive element of the "landscaping".

Planning Phase

The project planners with WCI Communities, Inc. (WCI), saw a similar looking bridge, on a fact finding tour in Italy, that set the precedent on what the Tuscany Reserve bridge would look like. The bridge is a five-span, filled spandrel, concrete arch structure supported by concrete footings on precast, prestressed concrete piles. The bridge is located in the Tuscany Reserve golf community in Naples, Florida and the developer was WCI Communities, Inc. of Bonita Springs, Florida. The overriding theme of this development is to provide the residents and its visitors with the feeling that they are in Tuscany, Italy. This theme is evident in every imaginable detail including this beautiful bridge in the heart of the community.

Design Phase

WCI contracted with Heidt Associates of Fort Myers, Florida to be the Civil Engineer of Record (CER) for the final design of the Tuscany Reserve community. Related to the bridge, Heidt Associates designed the over roadway profile and the bridge typical section. They also determined the length of the wingwalls and set the grades for the slopes adjacent to the bridge. Heidt's engineers, working together with WCI's in-house landscape architects, developed the span/rise relationship for each span of the bridge based on the available precast concrete BEBO arch elements distributed, at that time, by Oldcastle Precast.

Fast Track Construction Phase

Time was of the essence for the construction of the bridge, as is typical on most land development projects. WCI's project manager decided to fast track the construction process by pre-purchasing the precast concrete arch elements from the Oldcastle Precast plant in Fort Myers, Florida. Upon receipt of a contract for the supply of the arches, Oldcastle called in their consultant specialty structural engineer, Delta Engineers, to assist with the design and detailing of the precast components. Since WCI did not have a Structural Engineer of Record (SER) under contract at this time, they elected to supplement Oldcastle's contract to allow Delta Engineers to take on the responsibility as the SER. The additional engineering services requested of Delta included designing and detailing the cast-in-place concrete foundations, arch spandrel walls, wingwalls, and moment (anchor) slab to support the aesthetic bridge barriers. The services were later expanded to provide part time construction inspection and a letter of certification documenting that the bridge was constructed according to the plans.

To speed up the construction process, Delta Engineers prepared a set of preliminary bridge drawings (50% complete) and a complete design and set of details for the foundation. This approach allowed the contractors to provide WCI with pricing for the entire bridge and the ability to get started constructing the footings while Delta was finalizing the design and details for the rest of

the bridge and Oldcastle was fabricating the arches.

Delta's original design for the cast-in-place concrete spread footings was based on an allowable bearing pressure recommended by the project's geo-technical engineer, MACTEC. The selected contractor, Keesling Construction, was in the process of placing the reinforcing steel in the forms for the footings when MACTEC finalized a settlement analysis that concluded that we could expect approximately 1 inch of differential settlement between the abutment footings and the pier footings adjacent to the abutments. This settlement of the arches was not a structural concern, however, Delta expressed concerns regarding the potential for cracks to telegraph through to the proposed expensive aesthetic treatments.

The aesthetic treatments designed by WCI included a process that involved: 1) spraying the exposed surfaces of the bridge with shotcrete; 2) cutting grooves in the shotcrete before it cures giving it the appearance of a cut stone; and 3) staining the shotcrete to give it a natural terra cotta appearance. To mitigate the cracking of the aesthetic treatments, WCI considered 2 options that included: 1) utilize the spread footings and allow the bridge to settle prior to installing the aesthetic treatments, and 2) utilize a pile foundation.

The settlement was expected to take 3 to 6 months to stabilize, and WCI did not want to wait that long, so the decision was made to change the design to a pile foundation. Delta Engineers proceeded to design the pile footings using readily available precast, prestressed concrete pile sections from a local supplier. Keesling Construction had the reinforcing steel for the spread footings on site, so Delta designed the pile footings to allow the use of the same steel, wherever possible.

A design detail that required coordination between WCI and Delta were the arch spandrel walls. The standard details for the patented BEBO arch system utilizes precast concrete spandrel walls that derive their support from a "curb" that is integrally cast on the outside top surface of the fascia arch elements and layers of geo-grids embedded in the arch fill. WCI objected to the standard "curb" detail on the fascia of the bridge because it was not in accordance with their desired appearance for a flush alignment between the spandrel wall and the edge of the arch on the fascia. To provide the desired fascia detail, Delta Engineers designed a custom cast-in-place concrete spandrel wall to retain the arch fill. The spandrel wall was designed as a cantilever supported by the fascia arch element. The only complaints regard-

ing this design detail came from Keesling Construction. Building the concrete forms for the spandrel walls on the curved shape of the top of the arch (25 feet in the air!) was more of a challenge than Keesling bargained for when they bid the job. Although the construction took longer than expected and the desired profit margin was compromised, the contractor's workmanship was excellent.

The design for the lateral support of the bridge barrier was another detail that required coordination between Delta and WCI. WCI's desired appearance for the bridge barrier included installing a decorative set of balustrades between massive concrete columns. The precast concrete balustrades were not able to resist the 10,000-pound horizontal design force required by the design code in AASHTO. As an alternative, Delta designed a 1-foot wide by 2.25 feet high solid reinforced barrier wall that was supported by a 1 foot thick by 5 foot wide moment (anchor) slab that was designed to safely resist the design force. To provide stability for the fascia arch elements in the event of an impact, all of the individual arch elements were connected together using transverse reinforced concrete ties. The decorative balustrades and top rail were place on top of the structural barrier. This combination of systems provided a railing system that met WCI's aesthetic requirements and AASHTO's structural requirements.

After the application of a shotcrete layer on the face of a concrete pier of the bridge, workers cut grooves in the partially set material to give the surface the appearance of cut stone.

Conclusion

The planning, design and construction efforts by the project team produced one of the most beautiful land development bridges you may ever see. If you have a chance to visit Naples, Florida, consider taking the time to visit this bridge. Illuminated by the brilliant sunshine during the day or the exquisite subtle lighting at night, the view of this bridge is magnificent - truly a "signature" bridge. LDT

As an independent professional engineering firm, Delta Engineers provides specialized bridge design and coordination services as the Structural Engineer of Record for civil engineering and land development firms. Delta is focused on determining the most economical solution for land development bridge projects. Services include:

- *Bridge Type Studies*
- *Cost Analyses*
- *Aesthetic Recommendations*
- *Final Bridge Design*
- *Bidding Documents*
- *Construction Management*
- *Bridge Certifications*

Delta Engineers does not sell bridge products. The firm works with clients to sort through the numerous bridge options using its "Bridge Design Coordination Data" sheet. Learn more about Delta's process at www.deltaengineers.com.

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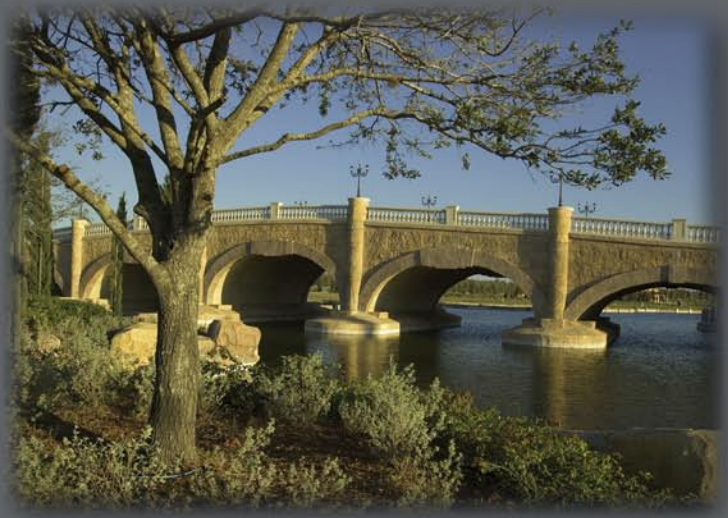

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