A.H. Beck Tackles Tampa Expressway Connector
Tam pa’s I-4/Selmon Expressway Connector Project

The complexity of drilling 1,200 shafts for five elevated roadways and 23 bridges for Tam pa’s I-4/Selmon Expressway Connector
by R. Scott Carroll, Area Manager,
A.H. Beck Foundation Co., Inc.

The year 2012 marks the 80th anniversary of long time ADSC Contractor Member, A.H. Beck Foundation Co., San Antonio, Texas. A.H. Beck has been a leading figure in the advancement of foundation drilling technology since its own, and the industry’s earliest beginnings. In the 1920s, August Henry Beck, Sr. purchased two steam shovels and ventured into the excavation business using money he earned working at the San Antonio city quarry. In 1932, he modified one of his steam shovels to be capable of drilling round excavations. The improvements allowed the equipment to go deeper and faster than the other methods of “pier” installation and related types of excavation available at the time. Since then three additional generations of Beck heirs have been trying new things, continually modifying equipment and adapting processes based on the needs of a wide variety of project owners throughout the United States and in Central and South America. Over the decades, each innovation has contributed to the amazing technologies that are in use today. A.H. “Buddy” Beck, Jr. was a charter member of the Texas Drilled Shaft Contractors Association, later to become the ADSC. August H. “Gus” Beck III was a member of the ADSC’s Board of Directors in the 1980’s and 90’s. The following account of a current challenge faced by the company and some of the creative solutions its project managers and its client (PCL/Archer Western JV) devised, provided an example of the ingenuity and commitment of professionals in the drilled foundation industry. (Editor)

In September 2009, the Florida Department of Transportation (FDOT) received bids for the construction of a new series of bridges to connect two major thoroughfares running through Tampa, Florida. The resulting toll road, the I-4/Selmon Expressway Connector, will connect the mile-wide gap between the two heavily traveled parallel highways. It will also feature dedicated truck lanes to move cargo from the Port of Tampa to points beyond.

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FDOT issued the $389.5 million bid-build-finance contract jointly to PCL Civil Constructors (PCL) of Tampa and Archer Western Contractors of Atlanta, Georgia and construction began in March, 2010. A. H. Beck Foundation Company was selected to install the 1,200 drilled shafts required for the project and was one of the first teams onsite.

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Contraction challenges, including very complex bridges, a downtown urban environment, adjacent historical neighborhoods, contaminated ground conditions, highly variable subsurface conditions, multiple railroad crossings, and the need to maintain constant traffic flow.

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The Connector is located on the outskirts of downtown Tampa, bisecting the two major east-west thoroughfares that bring thousands of commuters into town daily. Additionally, Florida’s largest port, the highly industrialized Port of Tampa, is located to the south of the site bringing an estimated 11,000 tractor trailers per day through the area, and which are currently travelling surface streets. The completed project will move Port truck traffic to dedicated lanes on the elevated expressway, thus saving a multitude of truckers a good deal of hassle and time. It also will allow traffic on the Selmon Expressway to interconnect with traffic on Interstate 4 thus eliminating the need to drive on surface streets.

There are several neighborhoods impacted by the new Connector. At the north end of the project, the bridges cut through Ybor City, an arts district style neighborhood offering a pedestrian feel and is registered as a National Historic District. As previously mentioned, the far south end houses the Port of Tampa with its round-the-clock heavy truck traffic. Just north of the Port lies the Selmon (formerly Crosstown) Expressway, a main artery used by commuters and trucks traveling to and from the east county area and Interstate 75.

Due to this project’s close proximity to several neighborhoods and local businesses, care was taken to accommodate pedestrian traffic, and work hours were set to minimize impact on the community. Beck modified equipment, tooling and construction techniques in order to lessen the noise naturally created by foundation construction.

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Foundation Design and Soil Conditions

In this section of Tampa, the subsurface soils are predominantly sands and clays overlying a karst limestone formation, and interbeded voids, sand layers, and rock lenses. Other challenges included highly variable rock and solution zones.

The limestone rock itself is highly variable in this area with some solution zones filled with sands and clays that were classified as weight-of-hammer materials to extremely hard layers of Dolomite limestone. During the drilling process, another condition that required attention and provided a challenge occurred when occasional chert formations were encountered. This necessitated the use of core barrels and other hard rock tooling and excavation techniques.

The factored loads on each drilled shaft varied ranging from approximately 200 kips to as high as 1,200 kips. The vast majority of the drilled shafts were 36 inches in diameter, grouped together in pile caps of three to six shafts per foundation. In cases where pile caps were not feasible (usually due to space limitations), larger diameter single shaft foundations were installed. The overall design of the foundations dictated the use of multiple shafts to create redundancy in design. This redundancy is required by FDOT and has become the norm since the 2004 collapse of a pier on the Crosstown Expressway. The site of that collapse is located less than a mile away from the current project. A.H. Beck was the specialty foundation contractor hired in 2004 to perform remediation work on 67 of its piers.

In order to examine the localized soil conditions and help determine the final tip elevations for the drilled shafts, Standard Penetration Test (SPT) borings were conducted at each shaft location. In the end, the final design had to be altered, in some cases final shaft depths were adjusted to as deep as 176 feet, additional shafts were placed within the pile caps, larger shaft diameters were needed, and overall much deeper shafts were to be constructed. Although none of the bridges on this project spanned any significant body of water, the close proximity to Tampa Bay and the drainage canals that snake through the site required that many of the foundations be designed to accommodate extreme scour in the event of a major hurricane and flood event. The potential scour conditions caused the designers to place the pile caps deep below existing grade. This resulted in top of shaft cut-off depths up to 15 feet below the working grade.

Drilled Shaft Installation and Methodology

A.H. Beck has always prided itself on its flexibility and willingness to adapt foundation installation methods to the needs of its clients. For the I-4/Selmon Expressway Connector Project it was clear that one overall installation method would not be feasible for stabilizing each of the required 1,200 drilled shafts. Instead, it was essential to take a multi-faceted approach and be flexible in terms of work crews and equipment. Beck therefore undertook this project using sectional, temporary casing as the primary method for stabilizing the shaft excavations. Other methods that were successful included permanent casing, temporary conventional casing, and the use of mineral slurry.

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project site. To minimize moving costs and provide the greatest mobility, Beck chose to use European-style hydraulic drill rigs for most of the work. With as many as six drill rigs working simultaneously around the site, close coordination with PCL / Archer Western JV was needed to maintain an adequate supply of reinforcing cages and associated support. Frequently, a night shift was called for so that the drill rigs could achieve higher productivity levels.

In several cases where the work had to be completed under existing power lines and overpasses at the Selmon Expressway location, the drill rigs, which are well suited to this kind of application, were used in a short mast configuration. Due to the presence of overhead structures 22 feet above grade, low overhead operating procedures were employed.

Other challenges included very tight and restricted access to locations that were nestled in between the active railroad tracks, in between bridges, adjacent to canals, and many other areas alongside very busy roadways.

The majority of the shafts were 36 inches in diameter with typical depths of 60 to 80 feet which required installing 40 to 60 feet of temporary casing. For these shafts Beck used the same type of drilling rigs to twist sectional casing into the ground in three meter lengths. This sectional casing method provided a quick way to change the lengths of the temporary casing to meet the demands of highly variable soils and depths, and in order to reach competent material. Once the casings were set, the shaft could be drilled to its planned tip elevation. The shafts were initially processed with a clean-out bucket and then subjected to a final cleaning. This process carried the natural slurries to Beck-fabricated desanding systems. The desanding systems cleansed the silts and sands from the natural slurry allowing the water to be re-used and later pumped back into the shaft.

The largest diameter shafts constructed were 90 inches. The large diameter and concrete volume within these shafts meant they were categorized as a “mass concrete pour.” The mass concrete specification required that an elaborate manifold of tubing be incorporated into the drilled shaft reinforcing cage in order to allow circulation of water through the tubes. This began immediately after concrete placement. The goal of the cooling process was to lower the internal temperature of the shafts.

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The project had yet another extreme condition to deal with, this being deep shaft requirements that were brought into play by the localized poor subsurface conditions. One pier was changed on the final design from a pile cap of (4), 36 inch diameter shafts to a significantly larger pile cap incorporating (6), 54 inch drilled diameter shafts. These shafts were as deep as 168 feet plus a cut of 8 feet bringing the total drill depth to 176 feet. For this pile cap, Beck modified the bridge extension of a Bauer* B-36 crane-attached rotary drill unit and mounted it to Beck’s Liebherr* 883 lattice boom crane. The Bauer hydraulic crane attachment is powered by the 12V Mercedes diesel engine in the Liebherr crane producing 811 horsepower resulting in 280,000 ft. lbs. of rotary torque.

The steel casings at this pier were designed to be permanent to a depth of 130 feet, thus casing-off and isolating the fluid concrete during placement. This kept the concrete from flowing uncontrollably into the zero blow count zones indicated on the borings. The steel casings were driven in 55-foot lengths using an APE* 300 Vibratory Hammer. Due to the layers of rock interbeded with sand pockets, the casings had to be installed in sections and drilled out before subsequent sections could be welded together and then driven. The reach of the B-36 drill mounted to the large crane allowed the drill to excavate the soils from within the casing and beyond. Ultimately the casings could be driven through the hard layers and therefore could seat the bottom of the casing in competent materials. This provided a method of dealing with the issue of installation in very poor soils.

PCL/Archer Western JV assisted and worked closely with Beck to provide the coordination and support required to facilitate the many changes and the “dynamic nature” of this difficult Connector project. The contractors worked well together arriving at the best solutions for construction and reinforcing installation. This was an important aspect of the project so that the combination of low overhead construction and the length of the deepest shafts could be addressed. Many of the reinforcing cages were fabricated in central locations and had to be trucked to the shafts. Since they were installed in sections the procedure often required that the reinforcing cages were spliced together over the shaft. In that Crosshole Sonic Logging (CSL) tubes were included on every cage extra care and diligence was required so that the splices could be made correctly, as well as to protect the tubes for the testing procedure that took place after the concrete pour.

**Quality Control / Quality Assurance**

Ever since the drilled shaft-supported pier collapsed on the Crosstown project in 2004, the PCI/Lincoln JV assisted and worked closely with Beck to provide the coordination and support required to facilitate the many changes and the “dynamic nature” of this difficult Connector project. The contractors worked well together arriving at the

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*Images:*
- Permanent casings installed on a work trestle.
- Beck's patented concrete pump working on the trestle.
authorities have been more demanding in their oversight of drilled shaft construction. The I-4/Selmon Connector project called for an SPT boring at each shaft location. Depending on the loads and an analysis of the soils the occasional re-boring of shaft locations to deeper depths for further investigation was required.

Every drilled shaft on this project called for CSL tubes to be added to the reinforcing cage in order to accommodate the testing program. Many of the shafts were also selected for the new Thermal Integrity Test. The test method is based on measuring the heat generation of hydrating cement by lowering a thermal probe into CSL access tubes and measuring the tube wall temperature. The analysis of measured temperature profiles requires knowledge of the concrete mix used and soil profile for the purposes of determining heat generation and soil insulation parameters.

Some shafts were designated as “non-redundant” elements and were subjected to additional inspection in locations where single shaft foundations were used to support the columns. A down-hole Shaft Inspection Device (SID) was used to verify shaft cleanliness and bottom conditions.

Summary

A year from now, when the I-4/Selmon Expressway Connector is completed and fully functioning, motorists will enjoy a smoother and more efficient ride through the Tampa Bay area courtesy of this high profile FDOT project. The average driver will never know or care about the multitude of challenges contractors faced when building the complicated structure of bridges and multiple elevated lanes. A.H. Beck is proud of its involvement with the project, the end result of which will be to ease congestion for millions of people for years to come (including Beck’s own Tampa-based staff!)

A H. Beck would also like to specifically thank and express its gratitude to its client, PCL/Archer Western JV, for their continued support and diligent guidance on the I-4/Selmon Expressway Connector project. It has been quite a challenge navigating through the many obstacles that were overcome throughout the course of installing drilled shafts in congested and variable site conditions. The complex scheduling and execution of the work was only made possible due to PCL/Archer Western JV’s unwavering dedication to progress regardless of the conditions or obstacles encountered.

A H. Beck Foundation Company performs all types of specialty foundation construction, ground improvement, and deep foundations. Its markets include commercial, industrial, transportation, marine, and electrical generation and distribution. A family owned company in business since 1932, Beck is based in San Antonio, Texas, with offices in Houston and Dallas, Texas, Tampa, Florida, Asheboro, North Carolina, and Puerto Rico. A.H. Beck works throughout the United States, the Caribbean, and Central and South America.

*Indicates ADSC members.

Project Team

Owners: Florida Department of Transportation
          Tampa-Hillsborough Expressway Authority
          Florida’s Turnpike Enterprise

Structural Engineer: PB Americas, Inc. (Northern portion)
                      PBS&J (Southern portion)

Geotechnical Engineer: Professional Service Industries
                       (Northern portion)
                      Tierra Inc. (Southern portion)

CEI: I-4/Selmon Expressway Connector CEI Team

General Contractor: PCL / Archer Western, A Joint Venture

Drilled Shaft Contractor: A. H. Beck Foundation Co., Inc.
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