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GroundED

FSI NEWSLETTER FOR DESIGN PROFESSIONALS

Don't "Push" Square Bar Helical Piles!

Solid square shaft helical piles were developed primarily as anchors in the utility industry for guying towers and poles. Later helical tieback and soil nail applications further proved the product's effectiveness to resist even moderate to high tension loads, while being installed efficiently with socket-like drive tools and smaller equipment. Unfortunately, about 30 to 40 years ago, a select few contractors and manufacturers began promoting the use of square bar products for applications where they are not as well suited; i.e., to resist compression loads on new construction and retrofit piering projects. With just a little understanding of these products and coupling details, most design professionals can quickly identify the inherent strengths and weaknesses of the square bar system, and then make the correct choice between solid square and hollow round shaft. A more in-depth discussion of round versus square can be found at *www.OnStableGround.com* within the online FSI Technical Manual.

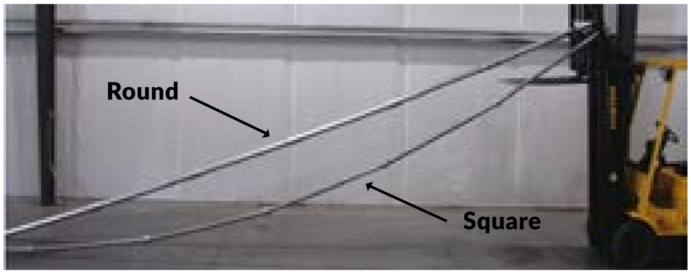


Figure 1

The forged and upset square bar couplers, although relatively economical to create, have large gaps, creating a "hinging" about the coupling bolt(s) (See Figure 1). Upsetting is also not a well-controlled manufacturing process to guarantee direct bearing between pile sections. However, the sloppy connections are only a detriment in compression applications. Any misalignment or eccentricity allowed by the connection detail is pulled straight when an axial tension load is applied. In short, solid square shaft helical piles are best suited for tension applications and hollow round shaft should be used to resist compression loads.

As part of an in-house testing program, FSI installed and tested two solid square shaft helical piles extending through 43 feet of soft to medium stiff clay for bearing within medium dense to very dense sand. The helix plate configurations were designed appropriately to achieve the maximum torque rating for each of the 1-1/2 inch and 1-3/4 inch square shafts, 6,500 ft-lb and 10,000 ft-lb, respectively. Five-foot long extension sections were used to advance each pile to bearing depths of about 53 feet.

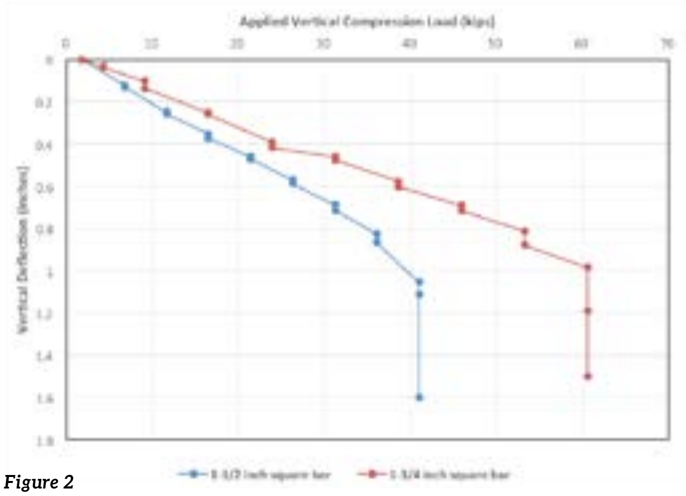


Figure 2

Torque-correlated ultimate pile capacities (Q_u) were estimated at 65 kips (1-1/2 square) and 100 kips (1-3/4 square) by multiplying the installation torque by the default torque correlation factor of 10 ft^{-1} for square shafts, as provided by the ICC-ES in Acceptance Criteria 358. However, the compression load versus deflection curves (See Figure 2) for the test piles indicate much lower ultimate capacities. With the piles end-bearing in dense sand, one could interpret the vertical deflections measured at the pile heads to be attributed to bowing or buckling of the pile shafts.

Hollow round shaft helical piles may also be susceptible to buckling in certain profiles, but experience has shown that it's really only a concern in the weakest (weight-of-hammer) soils. FSI offers both round and square shaft helical piles. Please contact FSI if you have any questions regarding products or applications.

JORDAN LARSEN, P.E., APPLICATION ENGINEER

Soils on property included dredged material from lake

Piles cut to design elevation and new construction brackets tack-welded in place

Piles advanced to refusal in deep gravelly sand

Advancing lead section of 3.5-inch O.D. pile

Completed piles and brackets

Project: Private Residence
Location: Pelican Lake, WI
Pile Installer: Foundation Supportworks of Wisconsin

Challenge: An existing cottage was removed to start construction of the proposed 4,200 square foot home. The soil profile in this area was known to include soils that were dredged from the lake adjacent to the property. Three soil borings were completed to depths of 10, 25 and 34 feet. The geotechnical investigation identified soft clayey silts with trace organics to depths of 21 to 27 feet over medium dense gravelly sand to the bottoms of the borings. Groundwater was encountered at depths of 2 to 3.5 feet. Settlement of the home was a concern given the soft clayey silts and organics in the upper part of the profile.

Solution: The design team recommended helical piles to penetrate the soft silts and organics to bear within the medium dense sand. Helical piles were an ideal deep foundation option for this site given the limited access and the ability to install the piles with smaller equipment, resulting in less anticipated disturbance of the surficial soils. Potential pile buckling was considered due to the presence of the soft soils. With buckling considered, the allowable capacities (to prevent buckling) of the Model 288 (2.875-inch OD by 0.276-inch wall) and Model 349 (3.5-inch OD by 0.300-inch wall) round shaft helical piles were limited to 18 kips and 32 kips, respectively, while maintaining a factor of safety of two. The foundation design included 14 Model 288 and 26 Model 349 helical piles to support the design working loads ranging from 6.7 kips to 32 kips. The Model 288 piles included 10"-12"-14" triple-helix lead sections and the Model 349 piles included 10"-12"-14" triple helix leads followed by a single 14" plate on the first extension. The 40 piles were advanced to depths of 27 to 40 feet below the pre-construction ground surface and to torque-correlated ultimate capacities greater than twice the design working loads. Due to the high groundwater levels, the tops of the piles were set one to two feet below pre-construction ground surface elevations. The 40 piles were installed in less than three days. After the foundation walls were poured, up to 2.5 feet of fill was placed around the footprint of the home to provide frost protection. The design of the home included a crawl space throughout, so no fill was placed inside the foundation walls.

Upcoming Webinar Opportunities

- **An Introduction to Helical Foundation Systems**

  1st Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)

- **An Introduction to Polyurethane Foam Injection**

  2nd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)

- **An Introduction to Hydraulically Driven Push Pier Systems**

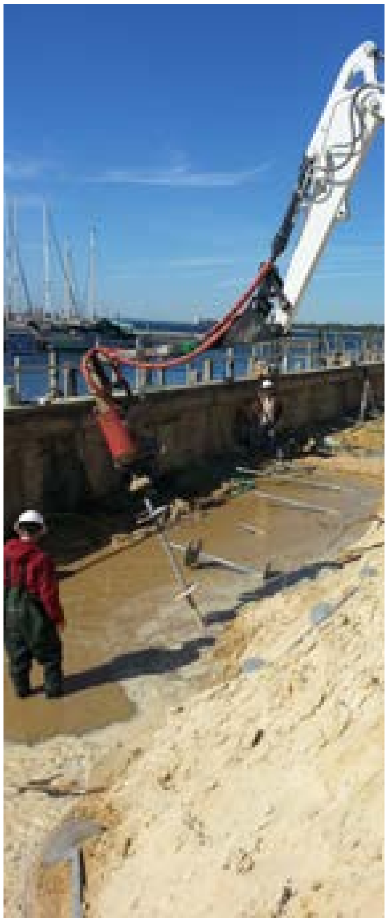
  3rd Wednesday of every month 11:30 am (CT) and 1:30 pm (CT)

Project: **Marina Seawall Stabilization**
Location: **Panama City, FL**
Pile Installer: **Alpha Foundation Specialists**

Challenge: The original tieback system for two intersecting, perpendicular 15-foot high (above mudline) bulkhead seawalls constructed in the 1950s had begun to fail. The plain steel 5/8-inch diameter cables and connections for the deadman anchors were severely corroded and, in some cases, corroded completely to disconnect the waler beams from the anchors. Proposed repairs included a new tieback and waler system installed behind 1,085 feet of failing seawall. A geotechnical investigation identified a soil profile consisting primarily of loose sands with isolated seams of medium dense sand. Given the marginal soil strengths observed, grouted soil anchors had estimated installation lengths on the order of 60 feet behind the walls. However, sections of the walls required that anchor lengths be limited to approximately 45 feet to avoid interfering with the installation of auger cast piles proposed to support a new lighthouse. Helical tiebacks were then considered in an attempt to shorten potential tieback lengths. Helical tiebacks could also be installed on land rather than from a barge, allowing for a considerable cost savings by avoiding barge rental and captain's fees.

Solution: The tieback system design included 182 helical tiebacks installed in a single row with a wall connection five feet down from the top of the wall. Soil directly behind the walls was excavated to allow installation of the tieback leads and extensions back beneath the excavator. One-hundred twenty-two (122) Model 150 (1.5-inch round corner square bar) and 60 Model 175 (1.75-inch round corner square bar) were installed to support design working tension loads of 22 kips and 30 kips, respectively. Helix plate configurations varied with the soil conditions, but included up to six plates (10"-12"-14"-16"-16"-16") for the HA150 shaft and eight plates (10"-12"-14"-16"-16"-16"-16"-16") for the HA175 shaft. The tiebacks were advanced to lengths from 35 to 45 feet and to torque-correlated ultimate capacities of at least twice the design working tension loads (FOS ≥ 2). Tieback installation angles generally varied from ten to 15 degrees. An 18-inch square precast concrete waler was mounted to the face of the seawall to distribute the tieback forces. All of the tiebacks were pre-tensioned to their respective design working loads with a calibrated hollow-core hydraulic cylinder. Six of the production tiebacks (three percent) were proof tested to 1.33 times the design working load. All of the tieback components were hot-dip galvanized for corrosion protection. The tieback components exposed beyond the waler beams were further coated with coal tar epoxy.

Excavation made behind seawall for tieback installation



Moving HA175 lead section to position for advancement

Helical tiebacks with threaded rod extending through seawall; prior to pre-tensioning

Waler system on stabilized seawall

To sign up, email us at training@foundationsupportworks.com with the following information:

- Name of the firm
- Location of firm
- Approximate number of engineers/architects/GCs that will be in attendance

FSI is an approved provider of continuing education credits through the AIA, RCEP and the Florida State Board of Engineers.

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For more information about Foundation Supportworks or to locate a Foundation Supportworks dealer in your area, please visit our website at foundationsupportworks.com or call 800.281.8545

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