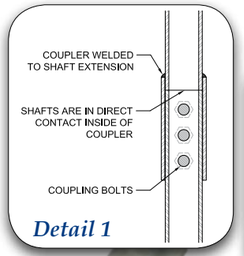
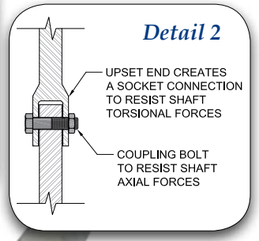
of soft clays or very loose sand.

FSI round shaft helical piles are manufactured with external welded or detached couplers. These systems are manufactured to strict tolerances to allow the pile shafts to be in direct contact inside the coupling, similar to Detail 1. *Why is this important?* The load path for piles under compression is then directly through the shafts of the extensions and lead section without having to pass through welds and bolts at each connection. The annular space between the pile shaft and coupler is also kept as tight as practical to maintain pile rigidity while also providing connections that are easily joined in the field *(See Photos 6 and 7)*.





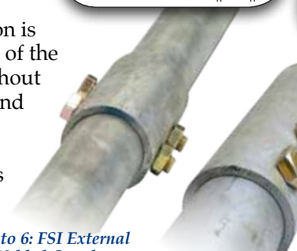


Photo 6: FSI External Welded Coupler

Photo 7: FSI External Detached Coupler

The most common coupler detail for solid square shaft utilizes a forged and upset end *(See Photo 8 and Detail 2)*. Cast detached couplers have also been used in lieu of the upsetting process. The upset end of square shaft is created in a similar manner as for the round shaft, except for forming a square socket connection. Photo 9 clearly shows a comparison of coupling rigidity between an FSI external welded coupler for round shaft and a typical upset coupler for square shaft. A similar draping effect is typical for round shaft helical piles with upset couplers.

Photo 8

Photo 9

As you now know, there are obvious, significant differences in coupling details that differentiate otherwise "like" products. FSI recommends that the design engineer request product drawings and review coupling details, tolerances and general fit-up prior to product selection. Please contact FSI with any of your product or application questions.

Jeff Kortan, P.E.
Director of Engineering

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

Your local dealer:

The *Difference* is in the *Details:* Coupler Details

Jeff Kortan, P.E. • *Director of Engineering*

In a previous issue of this newsletter, we discussed the importance of properly formed helix plates for helical pile performance. In another issue, we presented features and benefits of both hollow round shaft and solid square shaft helical piles. The coupler detail is yet another extremely important feature when considering helical piles and when selecting or specifying a product manufacturer. Manufacturers may advertise that they carry the same or equivalent helical shaft. However, shaft and coupler details are not consistent between manufacturers and these differences may not be readily apparent by simply reviewing product capacity tables. Some manufacturers rate their products based upon the capacities of the gross section of the shaft, thereby ignoring any limitations caused by the coupled connections. For these "equivalent" products, there can be dramatic differences in material properties, tolerances, spacing of bolt holes, oversize of bolt holes, general fit-up, weld quality, etc.

Some of the more common coupler details for round shaft include external welded, external detached, internal detached, and forged and upset. External couplers utilize tube or pipe sections with an internal diameter slightly larger than the outside diameter of the central shaft material *(See Photos 1 and 2)*. These couplers can be sized to provide tight connections that reduce angular deformation and variances from straightness. Such displacements at the couplers introduce eccentricities to the system which can significantly reduce the allowable compressive capacity of the pile, especially considering the slenderness of the more widely used shaft material (typically 3.5-inch outside diameter and smaller).

Photo 1: FSI External Welded Coupler

Photo 2: FSI External Detached Coupler

Internal detached couplers are made from solid round stock or tube or pipe material but with an outside diameter smaller than the inside diameter of the central shaft material. Internal coupler diameters may be significantly undersized to prevent interferences with internal weld beads of the central shaft or due to the variations that are typical in wall thicknesses and inside diameters of pipe sections. Larger gaps between the inside diameter of the shaft and the outside diameter of the coupler can result in a connection with more potential for angular displacements.

Forged and upset couplers are formed by heating one end of the shaft, placing this end in a form and then enlarging the end with a hammer-like tool or press *(See Photo 3)*. With this method of manufacturing, it is difficult to create tight connections to strict tolerances. It is not uncommon to have 1/8-inch or more difference between the outside diameter of the shaft and the inside diameter of the upset coupler of the round shaft *(See Photo 4)*. Again, the greater the freedom allowed in the connection, the greater the potential variance from straightness and the higher the potential for bending or buckling of the pile under high compressive loads *(See Photo 5)*. The risk of pile buckling further increases with unsupported lengths above the ground surface, or if the pile extends through soil strata consisting

Photo 3: Upset Coupler With Over-Sized, Closely-Spaced Bolt Holes

Photo 4: Coupler Tolerances; (A) Competitor Upset Coupler, (B) FSI External Welded Coupler

Photo 5: Competitor Upset Coupler Variance from Straightness

Continued on back . . .

FOUNDATION SUPPORTWORKS

- **New Construction and Retrofit Helical Piles**
- **Helical Tiebacks**
- **Hydraulically Driven "Push" Piers**
- **GeoLock™ Wall Anchors**
- **SmartJacks™**
- **Slab Piers**
- **PowerBrace™**

Distribution Checklist

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

CASE STUDIES

Helical Tiebacks

Commercial

Project: Pi Beta Phi Sorority House Retaining Wall
Location: Tallahassee, FL
Foundation Supportworks™ Dealer/Installer: Alpha Foundation Specialists

Challenge: The Pi Beta Phi Sorority House property includes masonry block retaining walls along the south and east property lines to provide grade transition from the higher elevation of the lot to the lower elevations of the public right-of-way and streets. The south retaining wall, which retained as much as 10 to 11 feet of soil, showed excessive movement and cracking, making the parking lot in this area unsafe and unusable. The failed wall was also located about 20 feet south of the sorority house, causing some concern that the shallow footings of the building may be affected if wall movement continued. On the lower elevation side of the wall, the wall face was as close as 15 feet from a major street. The existing retaining wall needed to be removed and replaced. The lack of reliable soil information and the limited access were particular challenges for the design and constructability of several potential wall options.

Solution: A new cast-in-place concrete retaining wall was designed with helical tiebacks to resist the lateral forces. The design included two rows of tiebacks; eleven (11) near the top of the wall with an 8-foot spacing and an installation angle of 30 degrees downward from horizontal, and eighteen (18) near the bottom of the wall with 4, 5, and 6-foot spacings and a horizontal orientation. Design working loads for the angled and horizontal tiebacks were 40 kips and 37.5 kips, respectively. The helical tieback configuration consisted of 3 1/2-inch OD round shaft with 10"-12"-14" triple-helix lead sections. The angled and horizontal tiebacks were installed to torque values of at least 8,600 ft-lb and 8,000 ft-lb, respectively, to provide torque-correlated ultimate capacities of at least 1.5 times the design working loads. Due to the soil variability, the tiebacks were advanced to lengths ranging from 17 to 46 feet in order to achieve the target torque values. The correlation between installation torque and ultimate capacity was verified with two load tests. One retrofit helical pier was also installed to vertically support the footing of an existing block wall against undermining and settlement at the connection to the new wall. The pier configuration consisted of a 2 7/8-inch OD round shaft with a 10"-12" lead section. The pier was installed to a depth of 14 feet and to a torque-correlated ultimate capacity of 30 kips for a factor of safety of 2.


Installation of helical tieback.


Helical tiebacks completed and ready to be cast into new concrete retaining wall.

Helical Piles, Slab Piers & Push Piers

Commercial


Voids encountered upon removal of floor slab


New construction brackets/piles cast into structural slab.

Project: Little Theatre of Norfolk
Location: Norfolk, VA
Foundation Supportworks™ Dealer/Installer: JES Construction, Inc.

Challenge: The Little Theatre of Norfolk (LTN) was built in the early 1920's and is the oldest continually operating community theatre in the nation, preparing to begin its 84th season. The structure is supported on deep pile foundations, but the interior floor slabs and non-load-bearing walls are supported on grade. A generalized soil profile identified with on-site test borings consists of fill soils over very loose to medium dense sand over very soft to medium stiff sandy clay over medium dense to dense sand. The medium dense to dense sand was encountered at depths ranging from 32 to 40 feet. Over the years, the interior floor slab settled from 1 inch to 13 inches, creating trip hazards and atypically-sloped floor conditions. The fixed auditorium seats leaned in the direction of the floor settlement. The floor movement was attributed to settlement of the upper fill layers and consolidation of the weak native soil beneath the weight of the fill soils and floor slab. Even with these unsafe conditions, the LTN was granted a special waiver to remain in operation so that profits could be used for the repair work and renovation.

Solution: JES Construction, Inc. (JES) was awarded the design-build project with the general scope of work to include; partial demolition of the existing concrete slab, installation of helical piles and a new structurally-reinforced concrete slab, construction of a new wheelchair seating area, and incidental carpentry repairs. Fifty-eight (58) helical piles were installed within the 45-foot by 60-foot auditorium. The pile configuration consisted of 2 7/8-inch OD by 0.203-inch wall round shaft with 8"-10" double-helix leads. The helical piles were installed to an average depth of 45 feet to support the design working load of 15 kips. The structural slab was detailed at 5 inches thick (3,000 psi) with No. 4 rebar at 12 inches on center each way and a maximum pile grid spacing of 8 feet.

During the demolition phase of the contract, JES encountered unforeseen conditions in the lobby area and near the main stage. A 10-inch void was encountered beneath the lobby area floor slab and the foundation wall at the stage had settled approximately 1 inch. To resolve these unforeseen conditions, a contract modification was executed to install eighteen (18) hydraulically-driven slab piers in the lobby area and three (3) hydraulically-driven foundation piers at the main stage. The void beneath the pier-supported lobby slab was then filled with cement grout.

New Construction Helical Piles

Commercial

Project: Culver's Restaurant
Location: Orland Park, IL
Foundation Supportworks™ Dealer/Installer: Foundation Supportworks of Wisconsin

Challenge: Construction details for the new Culver's restaurant included an 8-inch-thick poured concrete foundation wall, steel framing and anchored masonry veneer. Based upon the geotechnical investigation, project engineers recommended helical piles be used to support the structure. Four test borings extended to depths of 25 feet and encountered stiff silty clay at the bottoms of each of the borings. In fact, all four test borings identified consistent soil types, strengths, layer thicknesses and strata depths. Existing fill soil was encountered from the surface to a depth of 11 feet, over soft peat from 11 to 15 feet, over loose organic silt from 15 to 19 feet. Therefore, the helical piles were designed to extend beyond the 19-foot depth for bearing in stiff silty clay.

Solution: Due to scheduling issues and forecasted cold weather conditions, pouring concrete at the site needed to be completed within 13 days from the start of construction. Helical piles became an even more logical solution since foundation concrete can be poured immediately after installation of the piles. Forty-seven (47) Foundation Supportworks Model 288 Helical Piles were specified on the project with allowable capacities of 5, 10, 15, 20 and 25 kips. Three different helical lead configurations were installed to torque values that correlated to the respective capacities, or higher, including a factor of safety of two. Isolated obstructions were encountered within the fill at depths between 10 and 12 feet, but the piles were able to advance through or around this material. Large boulders were also encountered within the first few feet at several locations, requiring removal in order to complete the pile installation. Despite the challenges, the installation of the 47 helical piles was completed in less than three days and the project remained on schedule.


Lead sections are advanced.


Pile caps installed.

New Construction & Retrofit Helical Piles

Commercial


Attaching helical pile extension.


Retrofit helical pile installation.

Project: Heatherwood Elementary School
Location: Boulder, CO
Foundation Supportworks™ Dealer/Installer: Complete Basement Systems

Challenge: The renovation project for the Heatherwood Elementary School in Boulder, Colorado included repair work in an existing area of the building as well as the construction of two additions. Apparent settlement in an area of the existing structure caused widening of expansion joints and cracking within the brick and mortar exterior veneer. Differential settlement and cracking of interior slabs was also observed. A geotechnical investigation at the site identified up to 10 feet of variable and low-density fill material (silty sand and sandy clay) over residual sandy clay over interbedded sandstone and claystone bedrock. The bedrock was encountered at depths of 16 to 17 feet below grade.

Solution: Helical piles were selected to penetrate the upper fill and residual soils for end-bearing within the bedrock. Helical piles proved to be the most cost-effective approach, partly due to the relatively low mobilization costs compared to other deep foundation alternatives. The smaller installation equipment could also access and maneuver more easily within the congested construction site. The foundation design for the new additions included twenty-one new construction helical piles. Twelve retro-fit helical piles were also proposed to support and stabilize the existing structure against further settlement. The helical piles were designed for a working load of 15 tons (30 kips). The helical pile configuration consisted of 2 7/8-inch OD by 0.276-inch wide round shaft with an 8-inch diameter, single-helix lead section. Standard extensions were used to advance the piles to depths ranging from 18 to 23 feet. The pile installation and all related prep and finish work were completed in 4 days and ahead of schedule, even with exterior temperatures reaching negative twelve (-12) degrees Fahrenheit.