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Cover Article

Retrofit Helical Piers vs. Hydraulically-Driven Push Piers

"Helical pier advancement is independent of the structure and the retrofit bracket is set in place after the pier is installed."

Advancing Helical Piers Next to Footing

Featured Case Studies:

- LeClaire WWTF Blower Building - LeClaire, IA
- Royal Estates Apartment Complex - Jacksonville, FL
- Eastbay/Footlocker.com - Wausau, WI
- River Road Pump Station - Council Bluffs, IA

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of safety will likely not be achieved. Retrofit helical piers may therefore be the better option.

5. **Limited Access/Ease of Installation.** Push piers utilize smaller installation equipment and are ideal for interior work and limited access areas. Helical piers can be installed in tight access areas with hand-held equipment, but still with greater difficulty than push piers. Increasing the number of helix plates along the helical pier shaft also increases installation difficulty.

6. **Preference.** Even with all other factors considered, the engineer of record or the installing contractor may simply prefer one system over the other. Contractor preference is often reflected in comparative pricing.

There are certainly other factors that may be considered in the selection of push piers or helical piers, and many projects offer their own unique challenges. Contact FSI or an FSI installing contractor if you have questions about your next retrofit piering project.

FOUNDATION NATION™
FSI NEWSLETTER FOR DESIGN PROFESSIONALS
Quarterly Newsletter • Issue 19
Spring 2014

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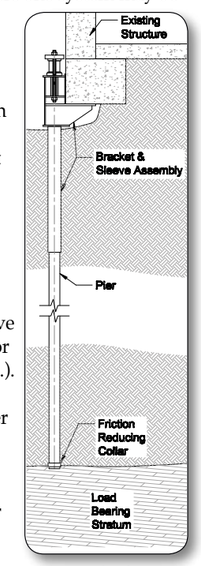
FOUNDATION NATION™
FSI NEWSLETTER FOR DESIGN PROFESSIONALS

Retrofit Helical Piers vs Hydraulically-Driven Push Piers

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

Both retrofit helical piers and hydraulically-driven push piers can be used to stabilize settled structures or support additional loads transferred to existing foundations. But are there conditions where one system may be a better fit over the other?



Push Pier Installation

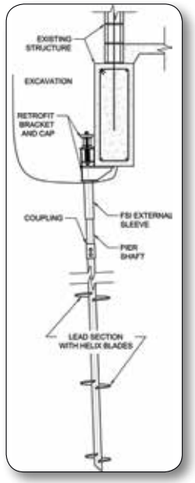
Let's start with a brief overview of the systems. Both utilize side load retrofit brackets positioned against and below the existing footings. With push piers, the bracket is first set against the footing, relatively small driving equipment is assembled at each location, and the pier sections are "pushed" through the bracket with a hydraulic cylinder to a suitable load bearing stratum. Push piers utilize the weight of the structure and the surrounding soil load as the reaction to drive the piers. Helical piers are rotated/screwed into the ground by the application of torque. Torque is provided by a drive head typically mounted to hand-held equipment or smaller machines (mini-excavators, skid steers, etc.). Helical pier advancement is independent of the structure and the retrofit bracket is set in place after the pier is installed.

FSI utilizes an external sleeve through the foundation brackets for most push and helical pier assemblies to resist the bending forces generated by the eccentric loading condition. The push pier external sleeve is typically 48 inches long as opposed to 30 inches for most retrofit helical piers. With the external sleeve resisting most of the bending, push pier sections are subjected to mainly axial loads during installation and while in service, and can therefore consist of thinner shaft material. Helical piers must resist torsional forces during installation, which generally requires a thicker pier shaft than would be required to simply resist axial loads.

Let's now review some of the factors that may be considered in the decision of selecting one system over the other.

1. **Cost.** Push piers are made with thinner pier sections than their helical counterparts and push pier couplers are simple slip-fit connections versus the helical pier external welded or detached couplers with nuts and bolts. Therefore, if both systems were advanced to similar depths, the push pier would be more economical.

2. **Soil Conditions.** Typically, standard penetration test (ASTM D1586) blow counts, N-values, of 35-40 blows per foot (bpf) for clay and 30-35 bpf for sand are required to provide end-bearing resistance for push piers. N-values of at least 15 bpf for clay and 10 bpf for sand are preferred for providing the end-bearing resistance for helical piers. Helical piers may then be considered the more versatile option for many soil profiles. Lead sections and extensions can be configured to develop capacity in a broader range of soil conditions.



Retrofit Helical Pier Installation

3. **Limited Soil Information.** Push piers are simply driven until competent soil is encountered. Push piers are driven to a target "ultimate" force and this force may be held for some pre-determined time to monitor for creep. Therefore, each push pier installation could be considered "load tested." For helical piers, a general knowledge of soil conditions is required to adequately determine the helix plate bearing area to support the design loads. You must also consider that a helical pier is more likely to develop its target (torsional) resistance within seemingly competent soil, like engineered fill, above deeper compressible layers. In such cases, retrofit piers provide no benefit and the structure would continue to settle.

4. **Light Structures.** Light structures with shallow footings (minimal soil load) may not be good candidates for push piers. The building may start to mobilize/lift before the target ultimate force is applied. When a minimum practical force, determined on a case by case basis, cannot be reached, an acceptable factor

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Distribution Checklist

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CASE STUDIES

Model 288 Push Piers

Project: LeClaire WWTF Blower Building ● **Location:** LeClaire, IA
Foundation Supportworks® Dealer/Installer: MidAmerica Basement Systems

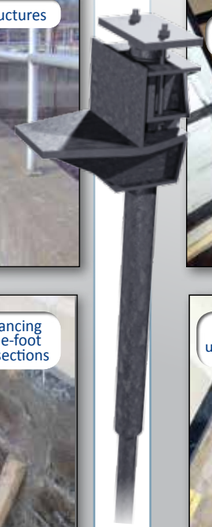
Challenge: Renovations at the wastewater treatment facility included the construction of a new generator pad east of an existing blower building. The blower building had reportedly experienced settlement since it was constructed in 1984. Consulting engineers determined the blower building had settled down to the north on the order of five inches and the settlement was likely due to poor compaction of fill soils. It was also believed that further consolidation of the soils could occur due to water infiltration, vibrations from the new equipment, and/or additional loading of the soils from the new equipment. Recommendations to stabilize the blower building included the installation of retrofit helical piers spaced at six feet center to center for design working loads of 21 kips each. The blower building was to be stabilized only, and not lifted, to prevent additional cracking in the foundations and floor slab. Lifting of the structure could also result in separation or damage of the utilities. One of the unique challenges for this project included limited working space (three feet) between the blower building and a storage basin. The closest soil boring to the footprint of the blower building identified loess soil consisting of medium stiff to stiff lean clay and medium dense silt to a depth of 33.5 feet underlain by stiff to very stiff clay to the maximum depth explored of 43 feet.

Solution: Both helical piers and push piers were considered for this project. Push piers were ultimately selected due to limited access for installation equipment, push piers being more economical since both systems would terminate at approximately the same depth, the difficulty of installing a helical pier lead section with three or more helix plates in a retrofit application, and the verification of each pier's ultimate capacity as determined through the installation process. The stabilization plan included sixteen (16) Model 288 (2.875-inch O.D. by 0.165-inch wall) hydraulically driven push piers spaced at six feet on center with design working loads of 21 kips each. The footing was notched for the placement of the underpinning bracket assemblies by removing small sections of concrete back to the face of the foundation wall. The sixteen piers were advanced to driving forces of at least 1.83 times the design working loads to an average depth of 40 feet below the bottom of the footing. After the piers were driven individually, hydraulic cylinders were attached to each pier, connected in series, and uniformly loaded to the design working load of 21 kips. Despite tight working conditions and utility obstacles, the building was successfully stabilized and the project was completed on time.

Commercial


Three feet of working space between structures


Advancing three-foot pier sections



Commercial


Advancing push piers to bedrock


Piers connected in series to uniformly stabilize the building

Model 288 Push Piers

Project: Eastybay/Footlocker.com ● **Location:** Wausau, WI
Foundation Supportworks® Dealer/Installer: Foundation Supportworks® of Wisconsin

Challenge: The Eastbay headquarters building in Wausau, Wisconsin had been experiencing differential settlement for many years. An area of particular concern was the northwest end of the building which had measured settlement on the order of 2-3/4 inches along an exterior wall and 3-1/2 inches at an interior column pad and grade beam. The interior grade beam supported an upper mezzanine level with a Spancrete precast concrete floor. With signs of distress becoming more and more evident, the owner had concerns that further settlement could potentially lead to collapse of the mezzanine. A geotechnical investigation included seven interior hand auger borings and three exterior borings completed with a truck-mounted drill rig. The borings identified seven to eight feet of uncontrolled fill over dense sand over weathered bedrock at 9.5 feet to 17 feet. Original building details from 1965 showed the tops of both the interior and exterior footings to be seven feet below the floor slab elevation. These footing depths correlated well with the depths of uncontrolled fill. Helical piers were initially considered to stabilize the settled foundations. However, due to the anticipated deep excavations and difficult equipment access, hydraulically-driven push piers were ultimately selected.

Solution: The piers were spaced no more than 4.5 feet apart to support a design working load of 23.4 kips per pier. Soil at the pier locations was removed by hydro-excavation to the top of the footing. Flush mount pier brackets were set against the foundation wall with adhesive anchors after a five-inch diameter core hole was made through the footing. The Model 288 (2.875-inch OD by 0.165-inch wall) piers were driven to an average depth of 17 feet below floor slab elevation. After the piers were driven individually, they were connected in series and uniformly reloaded to stabilize the building. The foundation supporting the mezzanine was lifted about ¾-inch to partially close cracks and separations in the walls. The excavations were backfilled and the soil compacted with a pneumatic hand tamper. With all phone orders from Footlocker.com and Eastbay catalogs taken at this facility, all work had to be performed after hours between 5 P.M. and 7 A.M. The 21 piers were installed in stages over a two week period. Hydraulically-driven slab piers and PolyLEVEL® polyurethane foam injection were also utilized in this and other areas of the building to support and relevel settled floor slabs.

Model 288 Retrofit Helical Piles

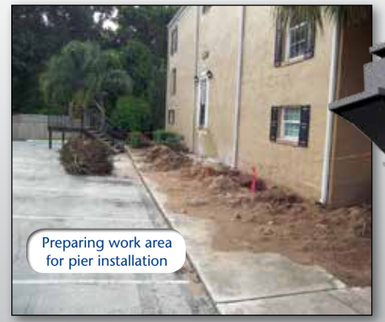
Project: Royal Estates Apartment Complex ● **Location:** Jacksonville, FL
Foundation Supportworks® Dealer/Installer: Alpha Foundation Specialists, Inc.

Challenge: Six apartment buildings within the Royal Estates Apartment Complex were experiencing differential settlement, with measured movements as much as four to seven inches. The considerable movement was evident by cracking and damage in the interior and exterior walls as well as many doors and windows within the units being inoperable. Twelve individual units could not be rented due to the magnitude of differential settlement and the associated distress.

A geotechnical investigation was completed at the site to determine the cause of settlement. Test borings encountered highly compressible organic laden soils, classified as peat, from approximately 14 to 24 feet below the ground surface. Settlement was likely caused by consolidation of the identified peat layer. The subsurface investigation also identified dense sand below the peat.

Solution: The owner wished to stabilize the buildings only, rather than attempt to lift back toward original elevations. Some repair work had been done in previous years and lifting the structures could potentially reopen cracks or cause additional damage. Retrofit helical piers were chosen to underpin the buildings due to their ability to be installed in areas of limited access. Design working loads up to 18 kips per pier were estimated for a pier spacing up to 5 feet. One-hundred seventy-seven (177) Model 288 (2.875-inch O.D. by 0.276-inch wall) round shaft helical piers with a 12"-14" double-helix lead section were installed along the exterior foundation walls and the footings of the interior load bearing walls. The helical piers were advanced to depths of 28 to 35 feet to bear within the dense sand. Installation torque was at least 4,000 ft-lb to correlate to ultimate pier capacities of at least 36 kips (FOS ≥ 2). A mini-excavator was used to install the exterior piers, but for the interior piers where working space was limited, hand-held equipment had to be utilized. Following installation, each pier was fitted with a retrofit bracket and a 30-inch long external pier sleeve and then loaded to the design working load. The pier components were hot-dipped galvanized to provide additional corrosion resistance.

Commercial


Preparing work area for pier installation


Advancing lead section

Commercial


Fractured concrete


Completed pier with retrofit bracket, excavations filled with cement grout

Model 288 Retrofit Helical Piers

Project: River Road Pump Station ● **Location:** Council Bluffs, IA
Foundation Supportworks® Dealer/Installer: Foundation Supportworks® by Thrasher

Challenge: The River Road Pump Station, constructed in 2001, consists of a 2,700 square-foot, two-story building that pumps collected storm water into the Missouri River. Cracks in the poured concrete north foundation wall indicated that the structure was settling differentially. Initial underpinning recommendations to stabilize the building included either helical piers or hydraulically-driven push piers with a design working compression load of 35 kips per pier.

One soil boring was advanced for the original construction of the building. The boring identified 12 feet of clay fill underlain by loose to medium dense sandy silt to a depth of 17 feet. Beneath the silt, medium stiff clay was observed to a depth of 23 feet underlain by loose to medium dense sand to the maximum depth explored of 50 feet. Groundwater was observed at a depth of 15 feet at the time of the exploration.

Solution: Helical piers, determined to be the better fit for the soil conditions, were ultimately selected to stabilize the north wall of the building. The underpinning design included nine retrofit helical piers, spaced 5.5 feet on center, with a design working load of 35 kips each. The helical pier configuration consisted of Model 288 (2.875-inch O.D. by 0.276-inch wall) hollow round shaft with a 10"-12"-14" triple-helix lead section followed by two 14-inch helix plates on the first extension. Prior to advancing the lead sections, 16-inch diameter holes were augered at each pier location to a depth of eight feet below the bottom of the footing to allow all five helix plates to pass the footing while maintaining the proper pier angle of two to three degrees. The piers were installed with a skid steer to depths of 40 to 55 feet and to torque-correlated ultimate capacities of at least 70 kips (FOS ≥ 2). Non-shrink grout was placed between the retrofit brackets and the footing to fill any voids and to eliminate possible point loading on the bearing plate of the bracket. Hydraulic cylinders were used to uniformly load the piers to the design working load. After the piers were loaded, the augered holes were backfilled with grout and the brackets were epoxy-anchored to the footing as specified by the project engineer. Despite longer than normal footing preparation due to the footing being much larger than anticipated and containing No. 8 rebar, the entire project was completed in just three days.