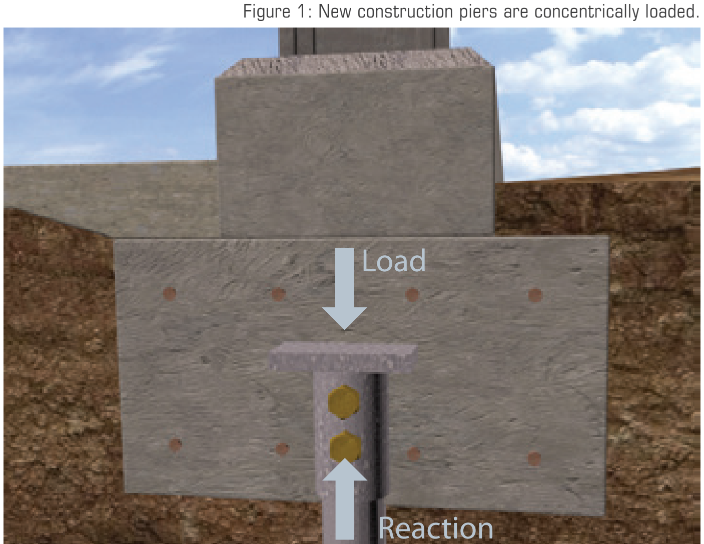
Design Considerations for Retrofit Helical Piers

Kyle Olson, P.E. Senior Structural Engineer

There are three ways to predict helical pier capacity with respect to the soil; i.e., individual bearing, cylindrical shear and torque correlation methods. These methods are appropriate for both new construction and retrofit applications. Although soil capacity typically governs the design for new construction helical piers, the allowable mechanical capacity of the retrofit pier "system," which includes the pier, bracket and the concrete foundation, may govern in higher-strength soil conditions. The spanning capability of the footing and foundation wall between proposed retrofit pier locations should also be checked as this often limits pier spacing beneath unreinforced or lightly-reinforced foundations.

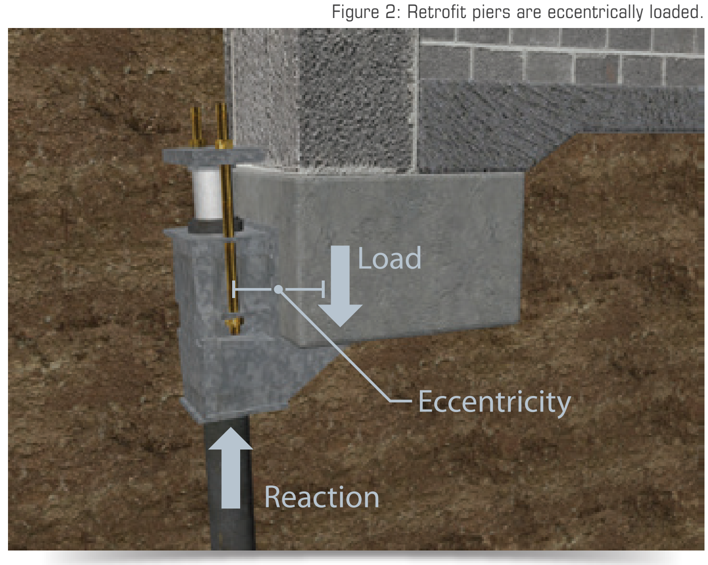
Figure 1: New construction piers are concentrically loaded.



New construction helical piers are generally designed to be concentrically loaded without inducing bending (Figure 1). New construction piers that are concentrically loaded will behave purely as columns and will be capable of supporting loads up to the maximum allowable mechanical capacity per AISC design methods. The maximum allowable mechanical capacity should consider the bracket capacity, the shaft and coupling capacity, and the helix plate capacity. The connection to the structure must also be designed appropriately with proper pier head embedment in the concrete, concrete strength, reinforcing steel, etc. Consideration of the maximum allowable mechanical capacity assumes that the soil is fully capable of supporting the load and that the shaft is laterally supported or braced along its entire length. In practice, the maximum allowable mechanical capacity of the pier is seldom achieved as the capacity is typically limited by soil strength.

Helical piers used in retrofit applications utilize side-load brackets directly adjacent to the structure (Figure 2). The pier shaft is not located directly under the footing or structural load. Therefore, retrofit piering systems are exposed to bending moments created by this eccentrically loaded condition and must be designed accordingly.

Figure 2: Retrofit piers are eccentrically loaded.

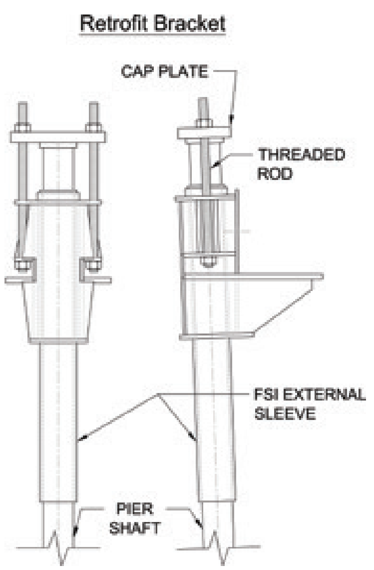


Most helical piers installed in retrofit applications have outer dimensions of 3.5 inches or less. These sections are therefore very sensitive to bending, thereby reducing the capacity of the pier to carry axial load. The retrofit pier does not act as a pure column as in a new construction application, but rather as a beam-column that must resist both axial load and bending. Herein lies the problem. The pier shaft has quantifiable axial and bending capacities, and independent of the other, may be significant. However, when both of these forces interact on the same element, both the allowable compressive capacity and allowable bending capacity are reduced. In fact, according to AISC design methods, the allowable compressive capacity may be reduced by more than two-thirds for many typical pile sections when applying a bending moment generated by an eccentricity of only two inches.

FOUNDATION SUPPORTWORKS®

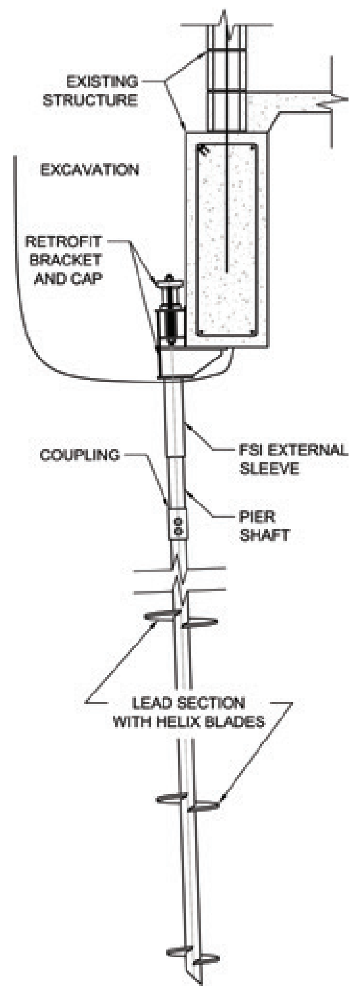
Foundation Supportworks addresses the issue of retrofit helical pier eccentricities in one of two ways. The first is to increase the stiffness of the pier system itself, allowing it to resist more of the eccentricity. This is accomplished by incorporating an external sleeve to resist the bending forces. The external sleeve extends through and below the foundation bracket to essentially create a bracket that is 30 inches tall (Figure 3). Since the external sleeve and the pier shaft are confined by the earth, the bending moment dissipates quickly into the surrounding soils and generally within the first few feet (Figure 4). The depth at which the bending moment dissipates is a function of the soil strength and is greater in soft soils and less in stiff soils. With the external sleeve present to resist only bending forces, the column capacity of the pier is preserved to resist the axial compressive forces.

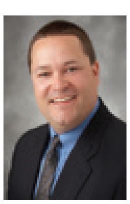
Figure 3: Retrofit Bracket Detail



The second way to address retrofit helical pier eccentricities is to increase rigidity of the bracket connection to the foundation, allowing it to function more like a cantilever from the structure. With an adequately designed rigid connection, much of the eccentricity is therefore transferred back to the foundation. This connection detail typically consists of several strategically-located, deeply embedded adhesive anchors. For example, the FSI HP350B helical bracket is attached to a foundation with six (6) 5/8-inch adhesive anchors embedded seven (7) inches.

Figure 4: Retrofit Helical Pier Installation





Kyle Olson, P.E. Senior Structural Engineer

Kyle focuses on the development and verification testing for many of FSI's products and equipment. He provides technical support to installing contractors and their consultants. Kyle is often involved in unique projects, especially those that include specialty connections, brackets or other custom products. Kyle also assists with the development of technical documents and presentations.