

# FOUNDATION SUPPORTWORKS™

## MODEL 288 HELICAL PILE SYSTEM



STABILITY. SECURITY. INTEGRITY.

Foundation  
Supportworks™  
provides quality  
helical pile systems  
for both new  
construction and  
retrofit applications.

288 Helical  
Pile System

► Foundation Supportworks™ is a network of the most experienced and knowledgeable foundation repair and new construction piling contractors in North America. With dealers from coast to coast, Foundation Supportworks™ is focused on training, gathering, and sharing the best practices in the industry. Your authorized dealer is therefore operating with the resources of literally hundreds of years of combined experience. Each dealer is trained, authorized, and certified by Foundation Supportworks™.



Omaha, Nebraska



Seymour, Connecticut



## ENGINEERING

► Foundation Supportworks™ has both geotechnical and structural engineers on staff for product design, quality assurance of products, and dealer support. Our in-house engineers are available to assist with preliminary designs and provide technical support to engineers, architects, building departments, and general contractors local to the projects.

## HELICAL PILES

► Helical piles are a factory-manufactured steel foundation system consisting of a central shaft with one or more helix-shaped bearing plates, commonly referred to as blades or flights, welded to the lead section. Extension shafts, with or without additional helix blades, are used to extend the pile to competent load-bearing soils and to achieve design depth and capacity. Brackets are used at the tops of the piles for attachment to structures, either for new construction or retrofit applications. Helical piles are advanced (screwed) into the ground with the application of torque.

The terms helical piles, screw piles, helical piers, helical anchors, helix piers, and helix anchors are often used interchangeably by specifiers. However, the term 'pier' more often refers to a helical pile loaded in axial compression, while the term 'anchor' more often refers to a helical pile loaded in axial tension.



### ► DID YOU KNOW?

The use of helical piles in construction dates back nearly 200 years. In the 1830's, the earliest versions of today's helical piles were used in England for moorings and for the foundations of lighthouse structures. Today, helical piles are gaining worldwide acceptance throughout the construction industry and engineering community due to the versatility of both the product and the installation equipment. In 2007, the International Code Council Evaluation Service, Inc. (ICC-ES) approved AC358, Acceptance Criteria for Helical Foundation Systems and Devices. Helical piles are also now included in the 2009 International Building Code.

► **DESIGN CONSIDERATIONS**

Helical piles are designed such that most of the axial capacity of the pile is generated through bearing of the helix blades against the soil. The helix blades are typically spaced three diameters apart along the pile shaft to prevent one blade from contributing significant stress to the bearing soil of the adjacent blade. Significant stress influence is limited to a 'bulb' of soil within about two helix diameters from the bearing surface in the axial direction and one helix diameter from the center of the pile shaft in the lateral direction. Each helix blade therefore acts independently in bearing along the pile shaft.

Multiple piles shall have a center to center spacing at the helix depth of at least four (4) times the diameter of the largest helix blade (ICC-ES AC358). The tops of the piles may be closer at the ground surface but installed at a batter away from each other in order to meet the spacing criteria at the helix depth. For tension applications, the uppermost helix blade shall be installed to a depth of at least twelve (12) diameters below the ground surface (ICC-ES AC358).

► **DETERMINATION OF CAPACITY**

The ultimate capacity of a helical pile may be calculated using the traditional bearing capacity equation:

$$Q_u = \sum [A_h (cN_c + qN_q)]$$

- Where
- $Q_u$  = Ultimate Pile Capacity (lb)
  - $A_h$  = Area of Individual Helix Plate (ft<sup>2</sup>)
  - $c$  = Effective Soil Cohesion (lb/ft<sup>2</sup>)
  - $N_c$  = Dimensionless Bearing Capacity Factor = 9
  - $q$  = Effective Vertical Overburden Pressure (lb/ft<sup>2</sup>)
  - $N_q$  = Dimensionless Bearing Capacity Factor

Total stress parameters should be used for short-term and transient load applications and effective stress parameters should be used for long-term, permanent load applications. A factor of safety of 2 is typically used to determine the allowable soil bearing capacity, especially if torque is monitored during the helical pile installation.

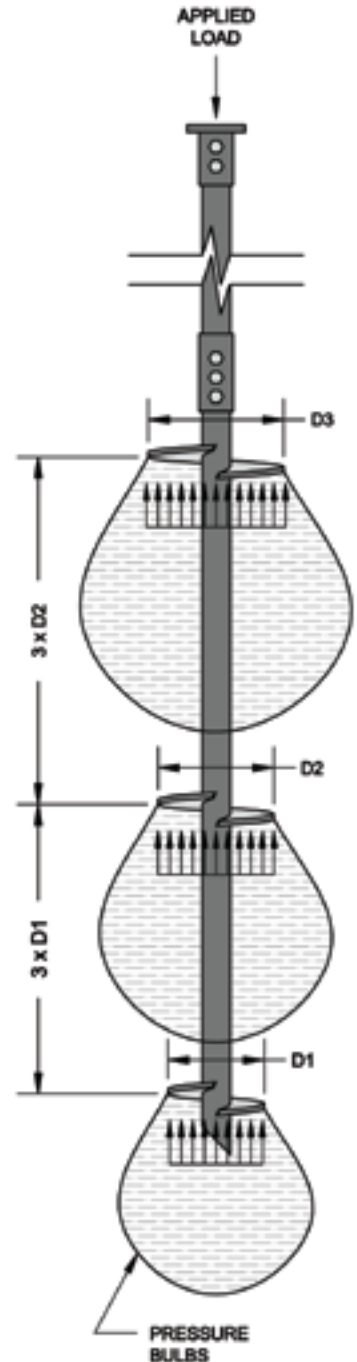
*\*Like other deep foundation alternatives, there are many factors to be considered in designing a helical pile foundation. Foundation Supportworks™ recommends that helical pile design be completed by an experienced geotechnical engineer or other qualified professional.*

Another well-documented and accepted method for estimating helical pile capacity is by correlation to installation torque. In simple terms, the torsional resistance generated during helical pile installation is a measure of soil shear strength and can be related to the bearing capacity of the pile.

$$Q_u = KT$$

- Where
- $Q_u$  = Ultimate Pile Capacity (lb)
  - $K$  = Capacity to Torque Ratio (ft<sup>-1</sup>)
  - $T$  = Installation Torque (ft-lb)

The capacity to torque ratio is not a constant and varies with soil conditions and the size of the pile shaft. Load testing using the proposed helical pile and helix blade configuration is the best way to determine project-specific K-values. However, ICC-ES AC358 provides default K-values for varying pile shaft diameters, which may be used conservatively for most soil conditions. The default value for the Model 288 Helical Pile System [2 7/8-inch diameter] is  $K = 9 \text{ ft}^{-1}$ .





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▶ The Model 288 Helical Pile System is an extremely versatile deep foundation alternative, and is used within grade beams and pile caps in residential, commercial and industrial load applications. The Model 288 Helical Pile can be installed with hand-held equipment, mini-excavators, skid steers, backhoes, or trackhoes, so the installation equipment can be sized for the project.

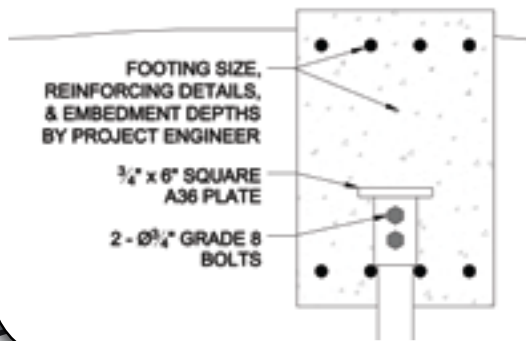
Model 288 Helical Pile System

# ADVANTAGES

- Helix blade configuration selected to achieve design depth and capacity
- Can be installed in areas of limited or tight access
- Installs quickly

- Installation does not generate spoils
- Vibration-free installation (unlike driven piles)
- Concrete can be poured immediately following pile installation
- Available with optional hot-dip galvanizing for added corrosion protection
- Cost-competitive compared to other deep foundation alternatives

**NEW CONSTRUCTION BRACKET**



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**PILE CAPACITY**

**Mechanical Axial Capacities (see note):**  
**Allowable Compression = 70.5 kips\***  
**Allowable Tension = 39.8 kips\***

\*Capacity based on black, uncoated steel with a loss in steel thickness due to corrosion over a period of 50 years. The design period and corrosion loss rates are in accordance with ICC-ES AC358. Mechanical compression limits are based on continuous lateral soil confinement. Piles with exposed unbraced lengths should be evaluated on a case by case basis by the project engineer.

**Torque Limited Axial Design Capacities based on Ultimate Torsional Resistance of Pile Shaft = 9,180 ft-lbs\*\*:**  
**Ultimate Soil Capacity = 82.6 kips\*\* (with  $K = 9 \text{ ft}^{-1}$ , see note)**  
**Allowable Soil Capacity = 41.3 kips\*\* (FOS = 2.0)**

\*\*This Ultimate Torsional Resistance and its corresponding Torque Limited Capacities are based on laboratory test results from an IAS accredited facility and may only be approached in idealized conditions. Plastic torsional deformations can begin in the pile shaft near 7,500 ft-lbs. This value may be reached and exceeded in the field by maintaining alignment between the pile and the drive head, limiting impact forces and torque reversal, and reducing the tendency to "crowd" (push down on) the pile. Installation through soils with obstructions or high variability may result in impact loading on the pile. In these cases, achieving high torque values becomes more difficult and a further reduction in the Design Torque Limit may be appropriate.

**TECHNICAL SPECIFICATIONS**

- ▶ • Outside Diameter (O.D.) = 2.875"
- Wall Thickness = 0.276"
- Pile Shaft Yield Strength = 60 ksi (min.)
- Coupling Hardware: (3) 3/4" Grade 8 Bolts with Nuts
- Available Helix Blade Diameters = 8", 10", 12", and 14"
- Helix Blade Thickness = 0.375"
- New Construction Bracket: 3/4" x 6" Square A36 Plate (for allowable compression capacities up to 60.0 kips)
- New Construction Bracket Hardware: (2) 3/4" Grade 8 Bolts with Nuts

**▶ NOTE:**

$K = 9 \text{ ft}^{-1}$  is a default value as published in ICC-ES AC358 which can, in many cases, be considered conservative. Higher capacities can often be achieved with site specific load testing. Allowable soil capacities based on site testing shall not exceed the Mechanical Axial Capacities.



▶ The Model 288 Helical Pile System can permanently stabilize sinking or settling foundations. The piles are mechanically advanced ('screwed') into the ground to appropriate depths and capacities and can be installed with small construction equipment or hand-held equipment in areas of tight or limited access. Heavy-duty, L-shaped steel foundation brackets are connected to the tops of the helical piles and installed against the footing. The weight of the existing structure is then carefully transferred from the unstable soils, through the piles, to competent soil or bedrock.



Model 288 Helical Pile System

**ADVANTAGES**

- Can be installed year-round
- Suitable for both light and heavy loads
- Round shaft has greater stiffness than comparable square shaft products
- Doesn't rely on the weight of the structure for installation
- Below-grade solution – won't be visible after installation
- Can often lift the foundation back to its original elevation
- Restores property value



**Model 288 Helical Pile System**  
**RETROFIT APPLICATIONS**

▶ Retrofit piles use side-load brackets, introducing eccentricity into the system. The Model 288 Helical Pile System incorporates an external sleeve at the top of the pile to aid in resisting the bending forces generated by this loading condition. This helps preserve the axial compressive capacity of the pile shaft. The external sleeve extends through and below the foundation bracket to essentially create a bracket that is 30 inches tall.

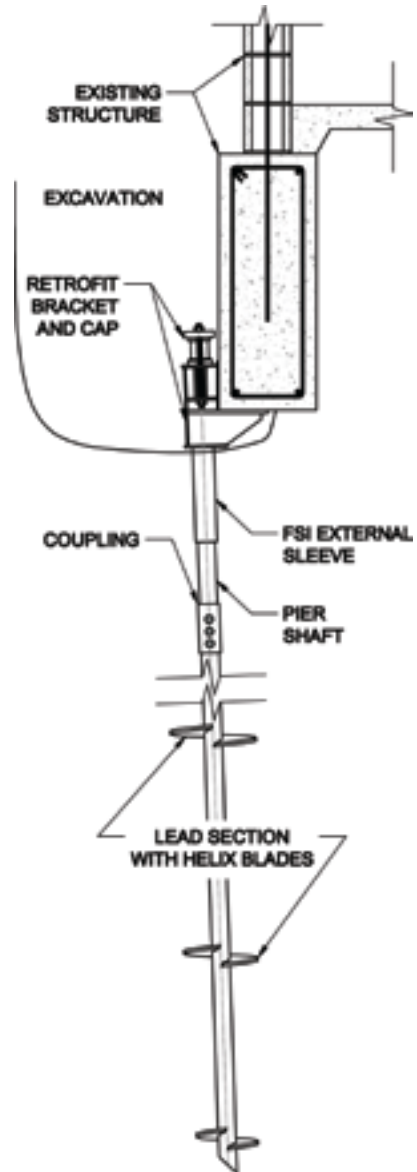
The depth or length of sleeve and pile over which the bending force dissipates is a function of the soil stiffness. This depth is greater in soft clay and loose sand, thereby increasing the amount of bending in the pile shaft and decreasing the system capacity.

Soil Type	Consistency/ Relative Density	Soil Strength Parameters			Allowable System Capacity* (kips)**
		SPT, N-value (blows/ft)	Cohesion (psf)	Friction Angle (degrees)	
Clay	Very Soft	< 2	< 250	-	25.3
Clay	Soft	2 - 3	250 - 500	-	27.8
Clay	Medium Stiff	4 - 7	501 - 1,000	-	30.9
Clay	Stiff	8 - 15	1,001 - 2,000	-	34.3
Clay	Very Stiff	16 - 32	2,001 - 4,000	-	36.8
Sand	Very Loose	< 3	-	26 - 30	32.6
Sand	Loose	4 - 9	-	28 - 34	33.0
Sand	Medium	10 - 29	-	30 - 36	34.4
Sand	Dense	30 - 49	-	34 - 40	34.8

\* Capacity based upon a concrete compressive strength of 2,500 psi for the foundation.

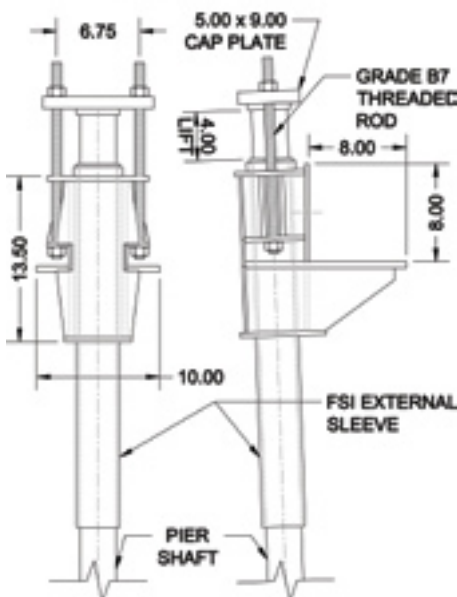
\*\* Capacity considers a loss in black, uncoated steel thickness due to corrosion over a period of 50 years. The design period and corrosion loss rates are in accordance with ICC-ES AC308.

\*\* 1 kip = 1,000 pounds (lb.)



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**Retrofit Bracket**



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**Model 288 Helical Pile System**  
**BRACKET SPECIFICATIONS**

▶ **Bracket:** Weldment manufactured from 0.25", 0.375", and 0.50" thick steel plate. Yield strength = 36 ksi (min.), tensile strength = 58 ksi (min.).

**External Sleeve:** 3.50" OD x 0.216" wall x 30" long with sleeve collar welded to one end. Yield strength = 50 ksi (min.), tensile strength = 62 ksi (min.).

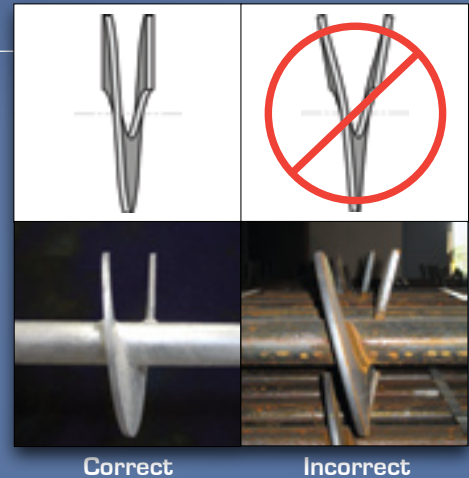
**Bracket Cap:** 5.0" wide x 9.0" long x 1" thick plate with confining ring welded to one side. Yield strength = 50 ksi (min.), tensile strength = 65 ksi (min.).

**All-Thread Rod:** 0.75" diameter x 16" long, zinc plated. Grade B7, tensile strength = 125 ksi (min.).

## HELIX BLADE GEOMETRY

▶ Foundation Supportworks™ helical piles feature blades manufactured with a true helix shape conforming to the geometry criteria of ICC-ES AC358. The leading and trailing edges of true helix blades are within one-quarter inch of parallel to each other and any radial measurement across the blade is perpendicular to the pile shaft. A true helix shape along with proper alignment and spacing of the blades is critical to minimize soil disturbance during installation.

Conversely, blades that are not a true helix shape are often formed to a 'duckbill' appearance. These plates create a great deal of soil disturbance and do not conform to the helix geometry requirements of ICC-ES AC358 since their torque to capacity relationships are not well documented.



Correct

Incorrect

## ROUND VS. SQUARE

▶ Solid square shaft helical piles have been used successfully for decades in tension applications; i.e., as anchors, tiebacks, and soil nails, and have proven to be a suitable and reliable support alternative for such projects. Not surprisingly, some manufacturers have then adapted the use of square shaft helical piles to include support of compression loads.

FSI recommends that round shaft, rather than square shaft helical piles, be used in compression applications for the following reasons:

- Square shaft helical piles typically have a socket and pin coupling which increases variances from straightness, introduces additional eccentricity to the system, and increases buckling potential.
- Shaft to shaft contact is difficult to achieve within upset couplings of square shaft – load is then transferred through double shear of the single coupling bolt.

For comparable round versus square sections:

- The area of steel for a round shaft is located outward from the neutral axis, thereby providing a higher moment of inertia [resistance to bending]. This is even more critical in eccentric loading conditions.
- Round shaft typically has higher installation torque rating.
- Round shaft offers higher lateral resistance due to larger surface area exposed to the surrounding soil.

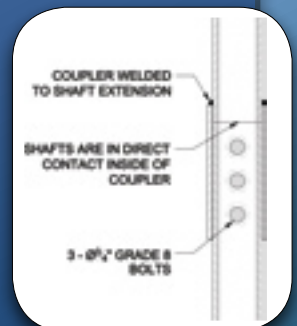
FSI offers both round and square shaft helical piles. Please contact FSI if you have any questions regarding product applications.



Round vs. Square Helical Piles

## COUPLING DETAIL

▶ The Model 288 Helical Pile System is manufactured to strict tolerances to allow the pile shafts to be in direct contact inside the coupling connections. 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 coupling.



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