The Importance of Properly Manufactured Helix Plates for Helical Pile Performance

Continued from front . . .

shapes including blunt (flat), sharpened, sea-shell cut, V-style cut, etc. to provide options for changing soil conditions. The trailing edge is generally either blunt or sharpened and has no effect on installation in varying soils.

A helix plate is formed by cold pressing the steel plate with matching machined dies. Both the shape of the die press and the amount of applied force during the press operations is important to ensure parallel leading and trailing edges and the required pitch tolerances. The amount of die press force must also be adjusted for changing plate thickness or steel grades.

The International Code Council (ICC) has approved the Acceptance Criteria for Helical Piles and Systems (AC358) which establishes design and manufacturing criteria for helical piles evaluated in accordance with the International Building Code. Specifically, AC358 has the following requirements for helix plates:

- Shall be true helix shaped plates that are normal with the shaft such that the leading and trailing edges are within 1/4 inch of parallel.
- Helix plate diameters may be between 8 and 14 inches with thickness between 3/8 inch and 1/2 inch.
- Helix plates and shafts are smooth and absent of irregularities that extend more than 1/16 inch from the surface excluding connecting hardware and fittings.
- Helix spacing along the shaft shall be between 2.4 to 3.6 times the helix diameter.
- The helix pitch is 3 inches ± 1/4 inches.
- All helix plates shall have the same pitch.
- Helical plates are arranged such that they theoretically track the same path as the leading helix.
- For shafts with multiple helices, the smallest diameter helix shall be mounted to the leading end of the shaft with progressively larger diameter helices above.
- Helical foundation shaft advancement shall equal or exceed 85% of the helix pitch per revolution at time of final torque measurement.
- Helix plates shall have generally circular edge geometry.

These ICC requirements are a good starting point for evaluation of helical pile design and manufacturing of helix plates. Please contact FSI if you have any questions about the above content or other topics regarding helical piles.

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For additional bio information, please visit the FSI website.
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FSI NEWSLETTER FOR DESIGN PROFESSIONALS

The Importance of Properly Manufactured Helix Plates for Helical Pile Performance

Don Deardorff, P.E. • *Senior Application Engineer*

The initial installation of a helical pile is performed by applying a downward force (crowd) and rotating the pile into the earth via the helix plates; a.k.a, helix blades or helix flights. Once the helix plates penetrate to a depth of about 2 to 3 feet, the piles generally require less crowd and installation is accomplished mostly by the downward force generated from the helix plates, similar to the effect of turning a screw into a block of wood. Therefore, the helix plate performs a vital role in providing the downward force or thrust needed to advance the pile to bearing depth. The helix plate geometry further affects the rate of penetration, soil disturbance and torque to capacity correlation. The consequences of a poorly-formed helix are twofold; (1) the helix flight severely disturbs the soil with an auguring effect which (2) directly results in more movement upon loading than a pile with well-formed helices. The differences between a well-formed helix and poorly-formed helix are visually obvious and are shown in Figure 1 below.

A true helix shape can be described as a three-dimensional curve that travels along and sweeps around an axis where any radial line remains perpendicular to that axis. Given the realities of manufacturing, a true helix shape is not quite possible for all regions of the helix plate. In general, a helical plate can be separated into three regions, designated as Regions I, II and III. The transitions between regions will vary among manufacturers but can be roughly estimated as follows:

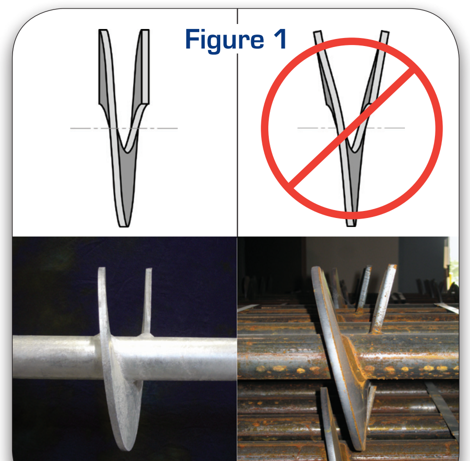


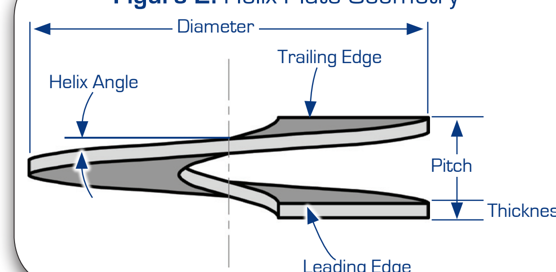
Figure 1

- Region I extends from the leading edge to Pi/2 radians (0 to 90 degrees)
- Region II extends from Pi/2 to 3Pi/2 radians (90 to 270 degrees)
- Region III extends from 3Pi/2 to the trailing edge (270 to 360 degrees)

As the helix angle trends toward zero at the leading and trailing edges, Regions I and III depart slightly from the definition of a true helix.

A helix plate is further defined by geometric parameters including diameter, thickness, pitch, helix angle and edge geometry (See figure 2). Helix plate diameters can vary from 6 to 16 inches for most commonly used shaft sizes. The majority of helix flights have thicknesses of either 3/8 or 1/2 inch, however thicker plates are used for large diameter piles. The pitch is the distance or separation between the leading and trailing edges and controls the depth of installation per revolution of the helix plate. The helix angle is the blade angle formed relative to the shaft (in Region II) and will vary within the blade for any given radius. The edge geometry refers both to the perimeter geometry of the helix and the shape of the leading and trailing edges. Most helix flights are manufactured with a perimeter geometry that is generally circular. The leading edge can have varying cuts and

Figure 2: Helix Plate Geometry



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FOUNDATION SUPPORTWORKS

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

Distribution Checklist

- ❏ ____________
- ❏ ____________
- ❏ ____________
- ❏ ____________
- ❏ ____________

CASE STUDIES

New Construction Helical Piles

Commercial

Project: Wastewater Treatment Plant Upgrades
Location: Saratoga County, New York
Foundation Supportworks™ Dealer/Installer: Adirondack Basement Systems, Inc.

Challenge: Proposed upgrades at the wastewater treatment plant included the construction of a new blower building with enclosed heavy equipment; i.e., two blowers and a generator. A geotechnical investigation at the site identified soft soils over hard shale bedrock at a depth of about 22 feet. The blower building was positioned on the site adjacent to recently constructed large aeration basins with floor elevations at or below the bedrock surface. With the expansive excavation needed for the aeration basins, the soils within the footprint of the blower building were also reportedly excavated down to bedrock and the entire area backfilled with clean, 1 ½-inch minus crushed stone. Even with this extensive excavation and backfilling operation, there was still concern about whether the crushed stone fill could support the heavy equipment without excessive settlement.

Solution: Helical piles were selected to support the equipment foundations due to the relatively low (mobilization) costs compared to other deep foundation alternatives. The foundation design included fourteen helical piles, six piles for the generator foundation and four piles for each of two blower foundations. The helical piles were designed for a service load of 10 tons. The helical pile configuration consisted of 2 7/8-inch OD by 0.276-inch wall hollow round shaft with 10-inch diameter single-helix leads. The 45-degree miter cut at the tip of the lead was cut off and the piles were advanced so the pile shaft would bear directly on the bedrock surface. The engineer's representative was on site to document and approve the pile installation. From start to finish, the pile installation and all related prep and finish work were completed in less than eight hours.


Advancing helical piles


Cutting pile to design elevation with portable band saw

Helical Tiebacks

Commercial


Tieback installation with handheld equipment


Tieback and waler installation complete

Project: I-80 Box Culvert Extension
Location: Greenwood, NE
Foundation Supportworks™ Dealer/Installer: Thrasher Basement Systems, Inc.

Challenge: West of Exit 426 (Mahoney State Park exit) there is a 120 feet long, 10 feet wide, and 10 feet high concrete box culvert that extends beneath the entire width of the eastbound and westbound lanes of the interstate. The box culvert was constructed in 1975. One end of the box culvert had to be extended 12 feet to allow for embankment construction to support the proposed road widening and reconstruction of an entrance ramp. A retaining wall was needed at the end of the existing culvert to allow removal of the culvert wing walls and to support the temporarily oversteepened slope of the interstate embankment.

Solution: The design team recommended a driven sheet pile wall with helical tiebacks and walers. The wall system included a total of ten tiebacks, five on each side of the culvert in rows of three (top) and two (bottom), with a typical spacing of six feet. The tiebacks were designed for a service load of 15 kips and a factor of safety of at least 1.5. The tieback configuration consisted of 1.5-inch round corner square bar with 8″-10″-12″ triple helix lead sections. Standard extensions were used to advance the tiebacks to lengths of 37 to 47 feet. Installation torque ranged from 2,700 to 6,100 ft-lb. The tiebacks were installed with portable handheld equipment due to the limited access and working space. Following installation, the tiebacks were proof-tested to 1.3 times the design load, unloaded, and then pre-tensioned to the design load.

Push Piers and Helical Piers

Commercial

Project: Camelot Apartment Complex
Location: Colorado Springs, CO
Foundation Supportworks™ Dealer/Installer: Peak Structural

Challenge: The Camelot Apartment Complex was constructed in 1977 and consists of 13 multi-unit buildings, each building with approximate plan dimensions of 220 feet by 35 feet. Construction details also included dirt floor crawl spaces with heights of about 24 inches from the soil to the bottom of the floor joists. Over the years, three of the buildings settled as much as 18 inches over the 220-foot length. Because there was no soil information available, two push piers were driven to estimate depth to the local claystone bedrock. Two helical piers were also advanced to estimate the depth where at least 4,000 ft-lb of installation torque would be achieved.

Solution: A total of 101 Foundation Supportworks™ Model 288 Push Piers were installed to depths ranging from 35 to 42 feet. The push piers were installed along the exterior walls, but from within the crawl spaces of the three buildings in order to avoid removing and replacing sidewalks surrounding each building. Due to the tight, low-headroom working conditions, portions of the subfloor were removed at each pier location to accommodate the hydraulic equipment used to drive the piers. The piers were spaced at eight to nine feet and installed to an average driving force of more than 48,000 pounds, exceeding the 15,000 to 20,000 pound design loads by factors of safety greater than two. Sixteen Foundation Supportworks™ Model 288 Helical Piers were advanced to depths ranging from 14 to 17 feet to support interior columns. The helical pier lead section consisted of a 10-inch single helix. The ultimate capacities of the helical piers, as estimated by correlation to installation torque, exceed the design loads by factors of safety of 2 or more. The 117 piers were installed in ten days.


Removal of subfloor for pier installation


Pier installations completed in tight conditions

Retrofit Helical Piers

Commercial


Interior helical pile installed with hand equipment


Brackets attached to the column footings

Project: Florida Association of Court Clerks
Location: Tallahassee, FL
Foundation Supportworks™ Dealer/Installer: Alpha Foundation Specialists, Inc.

Challenge: The Florida Association of Court Clerks building underwent a renovation project that included repair of drywall cracks and other distress-related issues caused by structural settlement. Each of the nine interior columns had settled within the range of 1/2-inch to 2 1/4 inches. An evaluation of the structural details and existing soil conditions determined the probable cause of settlement to be insufficient footing design given the soils present on the site. The depth of problematic soils ranged from 6 to 14 feet, so a shallow fix was not practical. Due to the extent of information which the Association of Court Clerks processes and stores, shutting down the facility even temporarily for the repairs was not an option.

Solution: Helical piles were selected for their ability to achieve the design capacities of 20 kips with smaller, less intrusive installation equipment. The helical pile configuration consisted of 2 7/8-inch OD by 0.276-inch wall hollow round shaft with 8″-10″ double-helix lead sections. The piles were installed with portable handheld equipment to at least 5,000 ft-lb of torque and to depths of approximately 20 feet. Four piles were installed at each of the nine column locations. Ultimate capacities of the piles, estimated by correlation to installation torque, were at least twice the design load. The piles were attached to the column footings with heavy duty retrofit/side-load brackets. All work on the project was completed within 8-hour shifts at night to prevent interruption to daily operations within the building. The prep work, installation of 36 helical piles, backfilling, and clean up took less than five days to complete and the renovation project continued on schedule.