MODEL SPECIFICATION FOR HELICAL PILE FOUNDATIONS
COMPRESSION APPLICATIONS

Note: changes to tension spec in blue

FOREWORD

Specifications for helical piles are typically one of the following types:

Prescriptive Specifications – The owner specifies the products and procedures to be used. The installing contractor is responsible for following the details of the specification; the owner is responsible for the resulting performance of the system.

1. Open Specifications – The installing contractor is permitted control over both the scope and the design of the installation, and is then responsible for ensuring adequate performance. This type specification is often used for temporary work, but is not recommended for permanent installations.
2. Performance Specifications – The installing contractor is permitted control over certain aspects of the design and/or construction process, but must demonstrate to the owner through certification and/or testing that the final product can be expected to meet the owner's defined needs. The owner retains responsibility for defining the needs in an objective and measurable or demonstrable manner.

The DFI Helical Foundations and Tiebacks Committee recommends performance specifications over either prescriptive or open specifications. This allows the owner's engineer to concentrate on defining what constitutes adequate performance in the context of the specific project and leaves the detailed design work to persons more familiar with helical pile design and application. The owner, pile designer and installing contractor will together be responsible for the tasks associated with the design, installation, acceptance and performance of the helical pile.

The installation of helical piles requires specialized equipment, techniques and appropriate workmanship. To specify every important detail of the work would be both burdensome for the specifier and oppressive for the installing contractor. The owner's needs can be more effectively served by specifying the needed performance, selecting competent helical pile designers and installing contractors to carry out the work, and auditing the work with an appropriate level of testing. The following Model Specification is written as a performance specification, but can be modified to an open or prescriptive specification if necessary.

As requirements for structures are more conservative and deflections more critical, the helical compressive piles will be divided into two categories, residential and commercial structures and industrial applications. Residential and commercial structures will be further subdivided into preloaded (underpinning) and non-preloaded (new construction).

MODEL SPECIFICATION

1. SCOPE

The work consists of designing, furnishing, installing, loading and testing helical piles used to support compressive loads, and any ancillary materials (e.g. sacrificial anodes, load transfer devices, etc.) according to the project plans provided and these specifications. Unless otherwise noted, the Installing Contractor shall provide all labor, tools, equipment and materials necessary to accomplish the work.

The owner will provide suitable access to the construction site for the Installing Contractor's personnel and equipment. Unless specifically noted otherwise in the contract documents, the Owner will remove and replace any structures, utilities, pavements, landscaping or other surficial improvements in the work area as necessary to facilitate the work. The owner will be responsible for overall construction oversight to preclude the development of unsafe conditions. The work does not include any post-construction monitoring of pile performance unless specifically noted otherwise in the contract documents.

2. DEFINITIONS

The following terms apply to helical piles used to support compressive loads. In determining the meaning of any term used herein, the definition contained in the following list shall take precedence, followed by the definition contained in the latest edition of "Glossary of Foundation Terms" published by the Deep Foundations Institute, then by customary usage.

Allowable Load: See "Nominal Load" below

Bearing Stratum: Any soil layer which provides a significant portion of the axial load capacity of an installed helical pile by providing resistance to one or more of the pile's helical plates.

Crowd: Axial compressive force or pressure applied to the helical pile as needed during installation to ensure the pile progresses into the ground a distance approximately equal to the helix pitch per revolution.

Design Load: See "Nominal Load" below.

Extension Section: Helical pile component installed between the lead section and the load transfer device allowing installation of the helix plates to such depth as may be necessary to attain the required load capacity. They may be plain (without helix plates) or (including one or more helix plates). Helical extensions typically follow immediately behind the lead section. Extension shaft ends are adapted to interconnect with helical lead sections, other extension sections and the load transfer device.

Effective Torsional Resistance: The average installation torque typically taken over a distance equal to the last three diameters of penetration of the largest helix plate.

Factored Load: Nominal load times the required load factor (Load Resistance Factor Design) or safety factor (Allowable Stress Design).

Geotechnical Capacity (a.k.a. Ultimate Soil Capacity): The maximum load that can be resisted through the bearing of helix plates on the soil in which they are embedded.

Helical Pile: Consists of 1) One or more helical deformed plates ("helix plates") attached to a central shaft and 2) Load transfer device for attachment to a structure. It may also include surface coating or other corrosion protection means. It is installed by screwing into the soil with down pressure ("crowd"), and thereafter resists compressive loads through bearing of the helical plates on the soil in which they are embedded.

Helical Plate: Generally round steel plate formed into a helical spiral and welded to the central steel shaft. When rotated in the ground, the helical shape provides thrust along its longitudinal axis thus aiding in pile installation, plus the plate transfers axial load to the soil through bearing.

Lead Section: The first helical pile component installed into the soil. It consists of one or more helical plates welded to the central steel shaft.

Limit State: A condition beyond which a helical pile component or interface becomes unfit for service and is judged to be no longer useful for its intended function (serviceability limit state) or to be unsafe (strength limit state).

Loads: Forces or other actions that result from the weight of all building materials, occupants and their possessions, environmental effects, differential movement, and restrained dimensional changes. Permanent loads are those loads in which variations over time are rare or of small magnitude. All other loads are variable loads (see also Nominal Load below).

Load Factor: A factor that accounts for deviations of the actual load from the nominal load (Load Resistance Factor Design).

Mechanical Strength: The maximum compressive load that can be resisted by the structural elements of a helical pile.

Nominal Load: The magnitude of the loads determined by the Owner's engineer, which includes dead, live, soil wind, snow, rain, flood and earthquake.

Reveal: The distance from ground surface to the end of the last installed extension of a pile, measured along the pile's longitudinal axis.

Safety Factor: The ratio of the ultimate pullout resistance to the nominal load used for the design of any helical pile component or interface (Allowable Stress Design).

Load Test: A procedure to test the capacity and relation of load to movement by applying a compressive load on the helical pile.

Working Load: See "Nominal Load" above.

Ultimate Bearing Resistance: Limit state based on the lesser of mechanical strength or geotechnical capacity of the helical pile defined as the point at which no additional load can be justified.

3. DESIGN AND PERFORMANCE REQUIREMENTS

A. Helical piles shall be designed to support the nominal compressive load(s) as shown on the project plans. The overall length, helix configuration and minimum effective torsional resistance of a helical pile shall be such that the required geotechnical capacity is developed by the helix plate(s) in an appropriate bearing stratum(s).

B. Except where noted otherwise on the project plans, all residential and commercial structure pile components shall be selected to provide a minimum factor of safety against ultimate mechanical resistance of 2.5. All industrial pile components shall be selected to provide a minimum factor of safety against ultimate mechanical resistance of 2.1.

C. Except where noted otherwise on the project plans, all piles shall be installed to provide a minimum factor of safety against ultimate bearing resistance of 2, residential and commercial structure piles shall be installed to provide a maximum axial deflection at nominal compressive load of 0.5 inches, and must satisfy the deflection criteria as stated on the plans or drawings.

D. Except where noted otherwise on the project plans, each pile shall be designed to meet a corrosion service life of 50 years.

E. The pile design shall take into account such pile spacing, soil stratification, corrosion and strain compatibility issues as are present for the project.

F. The piles shall be designed such that the maximum test load for residential and commercial structure piles does not exceed 80% of the manufacturer's rated ultimate mechanical strength of any pile component or load transfer device. The maximum test load for industrial piles should not exceed 95% of the manufacturer's rated ultimate mechanical strength of any pile component or load transfer device.

4. PLACEMENT REQUIREMENTS

When helical pile placement is shown on the project plans, production piles shall be placed such that the pile head is within 3 inches, and the pile shaft alignment is within 2 degrees of the inclination angle, shown on the project plans. Cutoff elevation shall be within 2" of design. When pile placement is not shown on the project plans, the placements, alignments and their respective tolerances shall be included as part of the design submittal.

5. PRECONSTRUCTION SUBMITTALS

The Installing Contractor and/or pile designer shall submit to the Owner or Owner's representative a proposal including the following documentation. Work shall not begin until all the submittals have been received and approved by the owner. All costs associated with incomplete or unacceptable submittals shall be the responsibility of the Installing Contractor.

Documents to be submitted:

A. Evidence of Installing Contractor's competence and safety record:
   A.1 Evidence of Installing Contractor's competence in the installation of helical piles shall be provided to the owner's satisfaction and may include any or all of the following:

a. Pile manufacturer's certificate of competency in installation of helical piles, or
b. A list of at least three projects completed within the previous three years wherein the Installing Contractor installed helical piles similar to those shown in the project plans, such list to include names and phone numbers of those project owner's representatives who can verify the Installing Contractor's participation in those projects, or
c. A letter from the pile manufacturer, pile distributor or manufacturer's representative expressing ability and intent to provide on-site supervision of the pile installation.

A.2 A listing of all safety violations lodged against the Installing Contractor within the previous three years and the current status or final resolutions thereof. Descriptions of safety improvements instituted within the previous three years may also be submitted, at the Installing Contractor's discretion.

B. Evidence of pile designer's competence:

B.1 Evidence of competence in the design of helical pile shall be provided to the Owner's satisfaction and may include any or all of the following:
a. Recommendation from the pile manufacturer, pile distributor or manufacturer's representative
b. Registration as a Professional Engineer or recognition by the local jurisdictional authority
c. A list of at least three projects completed within the previous three years wherein the pile designer designed helical piles similar to those shown in the project plans, such list to include names and phone numbers of those project owner's representatives who can verify the engineer's participation in those projects.

C. Evidence of pile manufacturer's competence and capability:

C.1 Evidence of competence in the manufacture of helical piles shall be provided to the owner's satisfaction and may include any or all of the following:
a. At least three years of production experience making helical piles.
b. The manufacturer's helical piles have been used successfully in at least three engineered construction projects within the last three years, or
c. Product listing by an applicable building code authority (ICC, BOCA, ICBO, SBCCI, NES, IBC, etc), or
d. Product acceptance by the local building code official(s) having jurisdiction over the project.

6. DESIGN DOCUMENTATION SUBMITTALS

Within 2 weeks of receiving the contract award, the Installing Contractor and/or pile designer shall submit the following helical pile design documentation:

A. A pile hardware schedule showing, for each category of pile:

A.1 Product designations for helix and extension sections and all ancillary products to be supplied at each helical pile location.
A.2 Individual pile nominal loads.
A.3 Individual pile loading requirements (if any).
A.4 Manufacturer's published mechanical strengths for the pile assemblies, including load transfer devices.

A.5 Calculated theoretical geotechnical capacity of piles.
A.6 Minimum effective torsional resistance criteria.
A.7 Maximum allowable installation torque of pile.
A.8 Minimum embedment lengths and such other site specific embedment depth requirements as may be appropriate for the site soil profiles.
A.9 Inclination angle and location tolerance requirements.

B. If pile placements are not shown on the project plans, drawings showing the proposed pile placements and placement tolerances. Known Rights of Way and obstructions (provided by the Owner) shall be shown to demonstrate how the piles will be installed to miss these items.
C. Proposed production quality control plan, including method and equipment to be used to measure torsional resistance during installation.
D. Procedures and acceptance criteria for any proposed performance and/or proof testing.
E. Certification by the pile designer that the selected piles can be installed with ordinary skill to achieve the requirements of the project plans and this specification.
F. Certification by a registered professional engineer that the proposed loading and test equipment (if any) can be safely used to apply and hold the proposed loads.
G. Copies of certified calibration reports for torque measuring equipment and load measuring equipment to be used on the project. The calibrations shall have been performed within one year of the proposed starting date for helical pile installation or as recommended by the equipment manufacturer based on the proposed starting date.

7. PILE INSTALLATION

A. Before entering the construction site to begin work, the Installing Contractor shall provide proof of insurance coverage as stated in the general specifications and/or contract.

B. Installing Contractor shall furnish and install all helical piles per the project plans and approved pile design documentation. In the event of conflict between the project plans and the approved pile design documentation, the Installing Contractor shall not begin construction on any affected items until such conflict has been resolved.

C. The Installing Contractor shall conduct his construction operations in a manner to insure the safety of persons and property in the vicinity of the work. The Installing Contractor's personnel shall comply with safety procedures in accordance with OSHA standards and any established project safety plan.

D. The Installing Contractor shall request marking of underground utilities by an underground utility location service as required by law, and shall avoid contact with all marked underground facilities.

E. The portion of the construction site occupied by the Installing Contractor, his equipment and his material stockpiles shall be kept reasonably clean and orderly.

F. Installation of helical piles may be observed by representatives of the Owner for quality assurance purposes. The Installing Contactor shall give the Owner's representative at least 24 hours prior notice of pile installation operations. All helical pile sections and ancillary products shall be marked as necessary to allow correlation with the pile design documentation before shipment from the manufacturer.

G. The helical pile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the project. The lead section shall be positioned at the location as shown on the pile design drawings. Inclined helical piles can be positioned perpendicular to the ground to assist in initial advancement into the soil before the required batter angle shall be established. After initial penetration, the required inclination angle shall be established. The helical pile sections shall be engaged and advanced into the soil in a smooth, continuous manner at a rate of rotation of 5 to 25 RPM's. Sufficient down pressure (crowd) shall be applied to uniformly advance the helical pile sections a distance approximately equal to the pitch of the helix plate (typically 3 inches) per revolution. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths. Extension sections shall be provided to obtain the required minimum overall length and minimum effective torsional resistance as shown on the project plans.

8. TERMINATION CRITERIA

The minimum overall length criteria and the minimum effective torsional resistance criteria as specified in the Design Documentation Submittals must be satisfied prior to terminating the pile installation. In the event any helical pile fails to meet these production quality control criteria, the following pre-qualified remedies are authorized:

A. If the installation fails to meet the minimum effective torsional resistance criterion at the minimum embedment length:
   - A.1. Continue the installation to greater depths until the torsional resistance criterion is met, provided that, if a maximum length constraint is applicable, continued installation does not exceed said maximum length constraint, Or
   - A.2. Demonstrate acceptable pile performance through proof testing. Or,
   - A.3. Replace the pile with one having a different helix configuration. The replacement pile must not exceed any applicable maximum embedment length and either (A) be embedded to a length that places its last helix at least three times its own diameter beyond the position of the first helix of the replaced pile and meet the minimum effective torsional resistance criterion, or (B) pass proof testing.

B. If the torsional resistance during installation reaches the helical pile's allowable torque rating prior to satisfaction of the minimum embedment length criterion:
   - B.1. Terminate the installation at the depth obtained if allowed by the owner's representative. Or,
   - B.2. Replace the pile with one having a shaft with a higher torsional strength rating. This replacement pile must be installed to satisfy the minimum embedment length criterion. It must also be embedded to a length that places its last helix at least three times its own diameter beyond the position of the first helix of the replaced pile without exceeding any applicable maximum embedment length requirements and it must meet the minimum effective torsional resistance criterion. Or, Replace the pile with one having a different helix configuration. This replacement pile must be installed to satisfy the minimum embedment length criterion. It must also be embedded to a length that places its last helix at least three times its own diameter beyond the position of the first helix of the replaced pile without exceeding any applicable maximum embedment length requirements, and it must meet the minimum effective torsional resistance criterion.

B.3. If allowed by the pile location tolerance or approved by the Owner's representative, remove and reinstall the pile at a position at least three times the diameter of the largest helix away from the initial location. Original embedment length and torsional resistance criteria must be met. This pile repositioning may require the installation of additional helical piles with nominal loads adjusted for these spacing changes.

C. If the installation reaches a specified maximum embedment length without achieving the minimum effective torsional resistance criterion:
   C.1. If allowed by the pile location tolerance or approved by the Owner's representative, remove and reinstall the pile at a position at least three times the diameter of the largest helix away from the initial location. Original embedment length and torsional resistance criteria must be met. This pile repositioning may require the installation of additional helical piles with nominal loads adjusted for these spacing changes. Or,
   C.2. Demonstrate acceptable pile performance through proof testing, Or
   C.3. De-rate the load capacity of the helical pile and install additional piles as necessary. The de-rated capacity and additional pile location shall be subject to the approval of the Owner's representative. Or,
   C.4. Replace the pile with one having a different helix configuration. This replacement pile must be installed to satisfy the minimum embedment length criterion and it must meet the minimum effective torsional resistance criterion.

D. If a helical pile fails to meet acceptance criteria in a performance or proof test:
   D.1. Install the pile to a greater depth & installation torque and re-test provided that, if a maximum embedment length constraint is applicable, continued installation will not exceed said maximum length constraint, Or
   D.2. Replace the pile with one having more and/or larger helix plates. It must be embedded to a length that places its last helix at least three times its own diameter beyond the position of the first helix of the replaced pile without exceeding any applicable maximum embedment length requirements. This replacement pile must be re-tested. Or,
   If approved by the Owner's representative, de-rate the load capacity of the helical pile and install additional piles. Additional piles must be installed at positions that are at least three times the diameter of the largest helix away from any other pile locations and are approved by the Owner's representative. Piles installed in cohesive soils shall not be spaced closer than four helix diameters.

   D.3.

   Proof testing to qualify a pile under any of the foregoing remedial actions shall not be used to satisfy proof testing frequency requirements shown in the project plans or the design documentation.

   If a helical pile fails a production quality control criterion for any other reason, any proposed remedy must be approved by the Owner's representative prior to initiating its implementation at the project site.

9. INSTALLATION RECORD SUBMITTALS

The Installing Contractor shall provide the Owner, or his authorized representative, copies of individual helical pile installation records within 24 hours after each installation is completed. Formal copies shall be submitted (insert time frequency). These installation records shall include, but are not limited to, the following information:

A. Date and time of installation
B. Location of helical pile
C. Pile Reveal
D. Actual helical pile type and configuration
E. Total length of installed pile
F. Actual inclination of pile
G. Actual effective torsional resistance
H. Calculated geotechnical capacity based on actual torsional resistance and soil parameters appropriate for subsurface conditions within 3 helix diameters above below the helix depth.
I. Comments pertaining to interruptions, obstructions, or other relevant information
J. For commercial structures pile installation shall be observed by a Professional Engineer competent in the specific task area or graduate of accredited engineering technology program under the direct supervision of a PE or a NICET Certified Engineering Technologist (CT) observe the pile installation.

10. PILE TESTING

If pile testing is required, the Installing Contractor shall furnish all labor, equipment and pre-production helical piles necessary to accomplish the testing as shown in the approved pile design documentation. Installing Contractor shall apply the specified loads for the specified durations and record the specified data, for the specified number of piles. No deviations from the test plan(s) will be allowed without explicit approval in writing from the Owner's representative. Pile testing shall be in accordance with ASTM D1143.
Installing Contractor shall provide the owner, or owner's representative, copies of raw field test data or reports within 24 hours after completion of each load test. Formal test reports shall be submitted within 30 days following test completion. Formal test reports shall include, but are not limited to, the following information:

A. Name of project and Installing Contractor
B. Name of Installing Contractor's supervisor during installation
C. Name of third party test agency, if any
D. Pre-production or production test
E. Date, time, and duration of test
F. Unique identifier and location of helical pile tested
G. Type of test (performance or proof)
H. Description of calibrated testing equipment and test set-up
I. Actual helical pile type and configuration
J. Steps and duration of each load increment
K. Cumulative pile-head movement at each load step
L. Signatures as required by local jurisdiction

11. CLEANUP

Within one week of completion of the work, the Installing Contractor shall remove any and all material, equipment, tools, building materials, concrete forms, debris, or other items belonging to the Installing Contractor or used under the Installing Contractor's direction.