



# GUIDE TO MODEL SPECIFICATION – CHANCE® Civil Construction HELICAL PILES FOR STRUCTURAL SUPPORT

## TYPES OF SPECIFICATIONS

The three types of specifications that are used for Helical Pile projects are:

**Open Specifications:** The Contractor is given the responsibility for the scope and design of the Helical Pile installation. In addition, the construction, capacity, and performance of the Helical Pile are the sole responsibility of the Contractor. This specification assumes that the Owner or Designer has provided the required structural loads. This specification type is most common for securing bids on temporary projects, and is not recommended for permanent applications.

**Performance Specifications:** The Contractor is given the responsibility for certain design and/or construction procedures, but must demonstrate to the Owner through testing and/or mutually agreed upon acceptance criteria that the production Helical Piles meet or exceed the specified performance parameters. This specification assumes that the location and the required loads of the Helical Pile have been specified. The Contractor and Owner share the responsibility for the work.

**Prescriptive Specifications:** The Owner has the sole responsibility for the scope and design of the Helical Pile installation and specifies the procedures that must be followed. Prescriptive specifications mandate the Owner to be responsible for the proper performance of the Helical Piles. The Contractor is responsible for fulfilling the obligations/details as specified in the construction documents.

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Performance specifications are the most common and allow Contractors to use their unique installation methods and experience for any given site conditions. Owners receive the benefit of value engineering, which can result in lower costs.

The Owner, Designer, and Contractor will be jointly responsible for the design, installation, acceptance, and performance of Helical Piles. The installation of a Helical Pile requires specialized equipment, techniques, and trained work crews. Every detail of the work cannot be specified, and every potential problem cannot be

anticipated. Therefore, a contractor trained in the proper methods of design and installation of Helical Piles must be selected.

A list of the major tasks to be performed on a Helical Pile project is shown in Table-1 of the Model Specifications. The Owner or his representative should select the type of specification and procurement method. The responsible party for each task must be identified and mutually agreed upon at the earliest point in the contracting process. The completed Table-1 should be included in the construction documents. The process of continuous communication between all the parties involved is essential to achieve a satisfactory result. Clear communication and close cooperation are particularly important in the start-up phase and in testing. In addition, a timely preparation and review of all submittals is critical.

This model specification can be adapted to each of the three types of specifications. However, it is primarily written for the performance type. The identity of the “Contractor” and the “Owner” is always well defined, unlike that of the “Designer” or “Engineer”. For example, the “Engineer” may be an employee(s) of the Contractor, or a third-party consultant hired to secure a lower cost alternative during the bidding process. In contrast, the “Engineer” may be the Owner, an employee(s) of the Owner, or a representative hired by the Owner. It is recommended that the Engineer be a third-party agency employed by the Owner to serve in the owner’s best interests during the various stages of the contract.

For purposes of this Model Specification, the subject is a high capacity Helical Pile manufactured by CHANCE® Civil Construction. At present, maximum working or design loads range between 12.5 and 50 tons. The Helical Pile consists of one or more helical bearing plates attached at the tip of a high strength central steel shaft. The central steel shaft consists of either a solid square shaft of various sizes, or hollow pipe shaft of various diameters and wall thickness. The steel shafts are typically 1-1/2” to 8 inches in diameter and will accept load directly axially and/or laterally to provide structural support.

**It is suggested that the specification writer accurately and completely modify this model to suit his/her particular case.**

*Items in italics as such may be considered as “Commentary” and as such may be deleted or retained to suit the needs of the specification writer.*

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The following is list of general references that will provide additional background to Helical Pile technology:

Goen, J. Lee, *Compression Load on HELICAL PIER® Foundation Systems Anchors – Design and Construction*, Bulletin 01-9304, Copyright 1998 Hubbell/Chance, 210 North Allen St., Centralia, MO 65240

Hargrave, R. L. and Thorsten, R. E., 1992. Helical Piers in Expansive Soils of Dallas, Texas. *Proceedings 7<sup>th</sup> International Conference on Expansive Soils, Session 24*, Bulletin 01-9311, Copyright 1993 A. B. Chance, 210 North Allen St., Centralia, MO 65240

Hoyt, R.M. and Clemence, S.P., 1989. Uplift Capacity of Helical Anchors in Soil. *Proceedings of the 12th International Conference on Soil Mechanics and Foundation Engineering*, Vol. 2, pp. 1019-1022.

Hubbell Power Systems, Inc., Technical Design Manual – 4<sup>th</sup> Edition, Copyright 2018, Hubbell Inc., 210 North Allen St., Centralia, MO 65240

“ICC-ES ESR-2794”, Reissued April 2019, ICC Evaluation Service, Inc., Brea, CA 92821

Lutenegger, Alan J., Gary L. Seider, “Profiling Subsurface Stratigraphy Using Torque Measurements from Installation of a Helical Plate”, Proceedings, ISC’4, Fourth International Conference on Geotechnical and Geophysical Site Characterization, September 18 – 21, 2012 Porto de Galinhas, Pernambuco, Brazil.

Pack, J. S., 2000. Design of Helical Piles for Heavily Loaded Structures. *New Technological and Design Developments in Deep Foundations*, ASCE Geotechnical Special Publication, pp. 353- 367.

Seider, Gary L., “Versatile Steel Screw Anchors”, Structural Engineer Magazine, March 2000; Volume 1, Number 2, ppgs. 42-46.

Seider, Gary L. (2015), “Bearing and Friction Design Capacity Software for Helical Anchors and Piles”, Proceedings, The 2015 International Foundations Congress & Equipment Exposition (IFCEE), San Antonio, TX

Wesolek, Dana A., Schmednecht, Fred C., and Seider, Gary L. “Helical Piers/Anchors in the Chicago Building Code”, Proceedings of the DFI 30<sup>th</sup> Annual Conference on Deep Foundations, Chicago, IL pp. 193-204.

# CHANCE<sup>®</sup> Civil Construction HELICAL PILES

## MODEL SPECIFICATION

### 1. GENERAL

#### 1.1 Purpose of Specification

The purpose of this specification is to detail the furnishing of all designs, materials, tools, equipment, labor and supervision, and installation techniques necessary to install Helical Piles as detailed on the drawings, including connection details. This shall include provisions for load testing that may be part of the scope of work

*Specifier Note: This specification may require modification to account for unusual and/or unforeseen site and subsurface conditions and the particular circumstances of the project.*

#### 1.2 Scope of Work

This work consists of furnishing all necessary engineering and design services (if required), supervision, labor, tools, materials, and equipment to perform all work necessary to install the Helical Piles, at (location, City, State/Province) for (Company, State or Private Authority) per the specifications described herein, and as shown on the drawings. The Contractor shall install a Helical Pile that will develop the load capacities as detailed on the drawings. This may also include provisions for load testing to verify Helical Pile capacity and deflection, if part of the scope of work. The responsibilities and duties of the respective parties for this project are summarized in Table-1.

**Table-1.** Tasks and Responsibilities to be Allocated for Helical Pile Work

TASK		RESPONSIBLE PARTY*
1	Site Investigation, Geotechnical Investigation, Site Survey, and potential work restrictions	
2	Type of specification, requirement for a pre-contract testing program, and procurement method	
3	Obtaining easements	
4	Overall scope of work, design of the Helical Pile structure – including design loads (vertical, horizontal, etc.), pile locations, and pile spacing and orientation	
5	Definition and qualification of safety factors	
6	Calculation/estimation of allowable structural and/or Helical Pile movement in service (acceptance criteria)	
7	Definition of service life (temporary – months or permanent - years) and required degree of corrosion protection based on site conditions	
8	Type and number of tests (pre-contract, pre-production and production)	
9	Minimum total Helical Pile length, depth to bearing stratum	
10	Helical Pile components and details	
11	Details of corrosion protection, if required	
12	Details of pile connection to structure (e.g., for static and seismic conditions)	
13	Preparation of Drawings and test reports	
14	Evaluation of test results	
15	Construction methods, schedule, sequencing, and coordination of work	
16	Requirements of field production control, including logging of installation torque vs. installed depth	
17	Supervision of work	
18	Long-term monitoring	

\* To be filled in by specification writer.

### 1.3 Qualifications of the Helical Pile Contractor

The Helical Pile Contractor shall be experienced in performing design and construction of Helical Piles and shall furnish all materials, labor, and supervision to perform the work. The Contractor shall be trained and authorized by Hubbell Power Systems, Inc. in the proper methods of design and installation of Helical Piles. The Contractor shall provide names of on-site personnel materially involved with the work, including those who carry documented certification from Hubbell Power Systems, Inc. At a minimum, these personnel shall include foreman, machine operator, and project engineer/manager.

The Helical Pile Contractor shall not sublet the whole or any part of the contract without the express written permission of the Owner.

#### 1.4 Related Project Specifications

*To be determined by the specification writer.*

#### 1.5 Definitions

A partial list follows. *The Owner may wish to add other specific, project-related items.*

**Contractor:** The person/firm responsible for performing the Helical Pile work.

**Coupling:** Central steel shaft connection means formed as integral part of the plain extension shaft material. For Type SS & RS Helical Piles, couplings are internal or external sleeves, or hot upset forged sockets.

**Coupling Bolt(s):** High strength, structural steel fasteners used to connect Helical Pile segments together. For Type SS segments, the coupling bolt transfers axial load. For Type RS segments, the coupling bolts transfer both axial and torsional forces.

**Helical Extension:** Helical Pile foundation component installed immediately following the lead or starter section, if required. This component consists of one or more helical plates welded to a central steel shaft of finite length. Function is to increase bearing area.

**Helix Plate:** Generally round steel plate formed into a ramped spiral. The helical shape provides the means to install the helical pile, plus the plate transfers load to soil in end bearing. Helix plates are available in various diameters and thickness.

**HELICAL PULLDOWN® Micropile:** A small diameter, soil displacement, cast-in-place Helical Pile, in which most of the applied load is resisted by the central steel shaft and steel reinforcement, if installed. Load transfer to soil is both end bearing and friction. United States Patent 5,707,180, Method and Apparatus for Forming Piles In-Situ. A.k.a. HPM.

**Helical Pile:** A bearing type foundation element consisting of a lead or starter section, helical extension (if so required by site conditions), plain extension section(s), and a pile cap. A.k.a. helical screw pile, screw pile, helical screw foundation.

**Installation Torque(T):** The resistance generated by a Helical Pile when installed into soil. The installation resistance is a function of the soil type, and size and shape of the various components of the Helical Pile.

**Lead Section:** The first Helical Pile foundation component installed into the soil, consisting of single or multiple helix plates welded to a central steel shaft. A.k.a. Starter Section.

**Pile Cap:** Connection means by which structural loads are transferred to the Helical Pile. The type of connection varies depending upon the requirements of the project and type of Helical Pile material used.

**Round Shaft (RS):** Round steel pipe central Shaft elements ranging in diameter from 2-7/8" to 10". A.k.a. Hollow Shaft (Type HS), Type T/C, Type PIF.

**Plain Extension:** Central steel shaft segment without helix plates. It is installed following the installation of the lead section or helical extension (if used). The segments are connected with integral couplings and bolts. Plain extensions are used to extend the helix plates beyond the specified minimum depth and into competent load bearing stratum.

**Safety Factor:** The ratio of the ultimate capacity to the working or design load used for the design of any structural element.

**Square Shaft (SS):** Solid steel, round-cornered-Square central Shaft elements ranging in size from 1-1/4" to 2-1/4". A.k.a. Type SQ.

**Torque Strength Rating:** The maximum torque energy that can be applied to the helical pile foundation during installation in soil, a.k.a. allowable, or safe torque.

## 1.6 Allowable Tolerances

The tolerances quoted in this section are suggested maximums. The actual values established for a particular project will depend on the structural application.

1.6.1 Centerline of Helical Piles shall not be more than 3 inches from indicated plan location.

1.6.2 Helical Pile plumbness shall be within 2° of design alignment.

1.6.3 Top elevation of Helical Pile shall be within +1 inch to -2 inches of the design vertical elevation.

## 1.7 Quality Assurance

1.7.1 Helical Piles shall be installed by authorized Hubbell Power Systems, Inc. Contractor. These Contractors shall have satisfied the requirements relative to the technical aspects of the product and installation procedures as therein specified. Authorization documents shall be provided upon request to the Owner or their representative.

1.7.2 The Contractor shall employ an adequate number of skilled workers who are experienced in the necessary crafts and who are familiar with the specified requirements and methods needed for proper performance of the work of this specification.

1.7.3 All Helical Piles shall be installed in the presence of a designated representative of the Owner unless said representative informs the Contractor otherwise. The designated representative shall have the right of access to any and all field installation records and test reports.

- 1.7.4 Helical Pile components as specified therein shall be manufactured by a facility whose quality systems comply with ISO (International Organization of Standards) 9001 requirements. Certificates of Registration denoting ISO Standards Number shall be presented upon request to the Owner or their representative.
- 1.7.5 Hubbell Power Systems, Inc. provides a 30-year Peace of Mind warranty on materials and workmanship of the product installed by a certified contractor. Any additional warranty provided by the Contractor shall be issued as an addendum to this specification.
- 1.7.6 Design of Helical Piles shall be performed by an entity as required in accordance with existing local code requirements or established local practices. This design work may be performed by a licensed professional Engineer, an authorized Hubbell Power Systems, Inc. Contractor, or Designer depending upon local requirements or practices.

1.8 Design Criteria

- 1.8.1 Helical Piles shall be designed to meet the specified loads and acceptance criteria as shown on the drawings. The calculations and drawings required from the Contractor or Engineer shall be submitted to the Owner for review and acceptance in accordance to Section 3.1 “Construction Submittals”.
- 1.8.2 The allowable working load on the Helical Piles shall not exceed the following mechanical strength values:
  - 1.8.2.1 For compression loads:

$$P_{allowc} = 0.6 * f_{yshaft} * A_{shaft}$$

Where:  $P_{allowc}$  = allowable working load in compression (kip)  
 $f_{yshaft}$  = minimum yield strength of central steel shaft (ksi)  
 $A_{shaft}$  = area of central steel shaft (with corrosion allowance if required) (in.<sup>2</sup>)

*The minimum yield strength of the central steel shaft is as follows: Type SS5: 70 ksi; Type SS125, SS150, SS175, SS200, SS225: 90 ksi; Type RS2875, RS3500, RS4500: 50 ksi.*

*The allowable working loads may be reduced by the allowable load capacity per helix plate(s) and the allowable load capacity based on soil type and pile-head end condition. It is recommended to use the allowable load capacities per helical pile type as published by Hubbell Power Systems, Inc. (shown in Section 7 of the Technical Design Manual – 4<sup>th</sup> Edition).*

- 1.8.2.2 For tension loads:

$$P_{allowt} = S_{ut} / FS$$



Where:  $P_{allowt}$  = allowable working load in tension (kip)  
 $S_{ut}$  = Min. ultimate tensile strength of central steel shaft segment (at coupling joint) (kip)  
FS = factor of safety suitable for application, i.e. temporary or permanent structures

*For permanent applications, it is recommended to use a factor of safety of two (2). For temporary applications, factor of safety typically ranges between 1.25 and 1.5.*

*The tension strength may be reduced by the ultimate strength per helix plate(s) – depending on the number of helix plates specified and type of shaft family used. The ultimate tension strength may also be reduced by the torque correlated capacity – depending on the type of shaft family used. It is recommended to use the tension strengths as published by Hubbell Power Systems, Inc. (shown in Section 7 of the Technical Design Manual – 4<sup>th</sup> Edition)*

- 1.8.3 Except where noted otherwise on the project plans, all helical piles shall be designed and installed to provide a minimum safety factor for ultimate applied load of \_\_\_\_\_ (2.0 typical), and a maximum axial displacement at working load of \_\_\_\_\_ (1 inch [25 mm] typical). The Owner shall determine the allowable response to axial loads based on serviceability requirements.
- 1.8.4 Helical Pile capacity in soil shall not be relied upon from the following soil layers as defined in the geotechnical reports:

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The overall length and installed torque of a Helical Pile shall be specified such that the required in-soil capacity is developed by end-bearing on the helix plate(s) in an appropriate strata(s).

It is recommended that the theoretical end-bearing capacity of the helix plates be determined using HeliCAP<sup>®</sup> Engineering Software or equal commercially available software. The required soil parameters ( $c$ ,  $\phi$ ,  $\gamma$ , or N-values) for use with HeliCAP<sup>®</sup> or equal shall be provided in the geotechnical reports.

*Helical Piles are not suited for solid, competent rock, but the helix plates can penetrate into dense bearing soils. It is recommended that Helical Piles be installed to a specified minimum torque and depth to ensure the helical plates are terminated in bearing soils. Appropriate and repeatable installation techniques and Helical Pile termination criteria must be identified and verified in the field.*

- 1.8.5 Lateral Load and Bending: Where Helical Piles are subjected to lateral or base shear loads as indicated on the plans, the bending moment from said loads shall be determined using lateral load analysis program such as LPILE or equal commercially available software. The required soil parameters ( $c$ ,  $\phi$ ,  $\gamma$ , and  $k_s$ ) for use with LPILE or equal shall be provided in the geotechnical reports. The Owner shall determine the allowable response to lateral loads based on serviceability

requirements. The combined bending and axial load factor of safety of the Helical Pile shall be as determined by the Owner.

*CHANCE® Helical Piles are slender foundation elements, i.e. the shafts range from 1-1/4” to 4-1/2” in diameter. As such, vertically installed Helical Piles generally require enlarged shaft sections or pile caps to adequately resist lateral load. The lateral load analysis as detailed in Section 1.8.5 of the specification can be used to determine the required diameter and length of the enlarged shaft section or pile cap.*

*It is recommended to list below each load combination and required factor of safety for this specific project.*

- 1.8.6 Critical Buckling Load: Where Helical Piles are installed into low strength soil, the critical buckling load shall be determined using lateral load analysis program such as LPILE or equal commercially available software, or various other methods. The required soil parameters ( $c$ ,  $\phi$ ,  $\gamma$ , and  $k_s$ ) for use with LPILE or equal shall be provided in the geotechnical reports.

*Research shows that buckling, either elastic or nonelastic, is of practical concern only for long Helical Pile shafts in the softest soils. This is in agreement with past findings regarding conventional pile foundations.*

- 1.8.7 Down-Drag/Negative Skin Friction: Type SS and Type RS Helical Piles are slender shaft foundation elements and are not practically affected by down-drag/negative skin friction. If Helical Piles with central steel shafts  $>4$ ” in diameter are used in areas where compressible or decomposing soils overlie bearing stratum, or where expansive or frozen soils can cause pile jacking, Helical Pile shafts should be provided with a no-bond zone along a specified length to prevent load transfer that may adversely affect pile capacity. Alternately, Helical Piles can be provided with sufficient axial load capacity to resist down drag/negative skin friction forces.

- 1.8.8 The Helical Pile attachment (pile cap) shall distribute the design load (DL) to the concrete foundation such that the concrete bearing stress does not exceed those in the ACI Building Code and the stresses in the steel plates/welds does not exceed AISC allowable stresses for steel members.

- 1.8.9 Corrosion Protection

***This section is optional (see below). Provisions of this section and Section 4.7 below may not be required in the Specification. If this section is not used, then Section 4.7 should likewise be deleted. The degree and extent of corrosion protection must be specified by the Owner (Table-1).***

*Corrosion protection is a function of structure type, service life, and the overall aggressiveness of the project soils. The need for corrosion protection of Helical Piles must be carefully determined and specified as necessary.*

*Corrosion resistant coatings (i.e. epoxy, plastic sheath or tape coatings) on the lead/starter section are impractical due to abrasive action wearing off the coating as the soil flows over the helix plates and around the central steel shaft. Hot dip galvanization is the only practical means to provide a corrosion resistant coating capable of withstanding the rigors of installation. Extension sections are typically hot-dip galvanized, but other coatings can be specified.*

*The following requirements are typical. The specifier should review and edit as appropriate for the project.*

**Structure Type:** \_\_\_\_\_ (e.g. temporary, permanent) *with a temporary structure being defined within a specified time frame (i.e. months rather than years). In general, permanent structures have a service life greater than 24 months.*

Temporary structures do not require corrosion protection.

**Service Life:** \_\_\_\_\_ (years) *a typical service life of 50 years should be used unless otherwise specified. If the service life of a temporary Helical Pile is likely to be extended due to construction delays, it should be considered permanent.*

For a service life of less than 20 years in non-aggressive soil, corrosion protection is not recommended.

Corrosion protection requirements for the various Helical Pile elements shall be provided meeting the requirements of Table-1 in the Appendix for:

**Soil:** \_\_\_\_\_ Aggressive or Non-Aggressive *with optional location and elevation limits defined by the Specifier.*

*For guidance on aggressiveness classification, see Table-1 in the Appendix. It is recommended to retain the services of a corrosion design professional for very aggressive soils.*

**TABLE-2**

<b>CORROSION PROTECTION</b>				
<b>LOADING</b>	<b>TENSION</b>		<b>COMPRESSION</b>	
<b>SOIL</b>	<b>AGGRESSIVE<sup>1</sup></b>	<b>NON-AGGRESSIVE</b>	<b>AGGRESSIVE<sup>1</sup></b>	<b>NON-AGGRESSIVE</b>
<b>CENTRAL STEEL SHAFT (Lead Section)</b>	a. Galvanization OR b. Minimum 1/8” corrosion loss on outside	a. Bare steel OR b. Galvanization OR c. Minimum 1/8” corrosion loss on outside	a. Galvanization OR b. Minimum 1/8” corrosion loss on outside	a. Bare steel OR b. Galvanization OR c. Minimum 1/8” corrosion loss on outside

<b>CENTRAL STEEL SHAFT (Extension Section)</b>	a. Galvanization OR b. Epoxy coating OR c. Tapecoat® d. a., b. or c. + Grout cover <sup>2</sup>  The Specifier may elect to use a grout case.	a. Bare steel OR b. Galvanization OR c. Epoxy coating d. Tapecoat®	a. Galvanization OR b. Epoxy coating OR c. Tapecoat® d. a., b. or c. + Grout cover <sup>2</sup>  The Specifier may elect to use a grout case.	a. Bare steel OR b. Galvanization OR c. Epoxy coating d. Tapecoat®
<b>STEEL PILE CAP</b>	a. Galvanization OR b. Epoxy coating	e. Bare steel OR f. Galvanization OR g. Epoxy coating	c. Galvanization OR d. Epoxy coating	h. Bare steel OR i. Galvanization OR j. Epoxy coating

**NOTES:**

Lettered items are options.

For guidance on aggressiveness classification, see Table-2 of the Appendix.

1. Corrosion protection shall extend 15'-0" below corrosive material.
2. Minimum 1" in soil. If protective coatings (galvanization, epoxy) are provided in compression, minimum cover may be 0.25" in soil. Grout column can be installed using the patented HELICAL PULLDOWN® Micropile method.

*The most critical area to protect from corrosion is at or near the ground line – if the surficial soils have been disturbed. Undisturbed soils are deficient in oxygen a few feet below ground line or below the water table zone. Undisturbed soils typically result in steel piling not being appreciably affected by corrosion.*

**1.9. Ground Conditions**

The Geotechnical Report, including logs of soil borings as shown on the boring location plan, shall be considered to be representative of the in-situ subsurface conditions likely to be encountered on the project site. Said Geotechnical Report shall be the used as the basis for Helical Pile design using generally accepted engineering judgement and methods.

*If soil borings are not available, it is suggested to install a Helical Pile at various locations on the project site. Using the well-known installed torque vs. capacity attribute of helical piles, a presumptive soil profile can be generated.*

The Geotechnical Report shall be provided for purposes of bidding. If during Helical Pile installation, subsurface conditions of a type and location are encountered of a frequency that were not reported, inferred and/or expected at the time of preparation of the bid, the additional costs required to overcome such conditions shall be considered as extras to be paid for.

*All available information related to subsurface and general site conditions should be made available to all bidders at the time of bid preparation. It is not reasonable to expect bidders to conduct supplemental site investigations at their own risk and cost prior to bidding, unless the specific contract requirements call for it (Table-1) and provide for appropriate compensation. A mandatory site visit and pre-bid meeting should be held so that the details of the project and the specifications can be thoroughly discussed. These steps will help avoid technical and contractual problems developing during the execution of the work, and will help all parties manage their respective risk.*

## **2 REFERENCED CODES AND STANDARDS**

Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title, or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation. In case of conflict, the particular requirements of this specification shall prevail. The latest publication as of the issue of this specification shall govern, unless indicated otherwise.

### **2.1 American Society for Testing and Materials (ASTM):**

- 2.1.1 ASTM A29/A29M Steel Bars, Carbon and Alloy, Hot-Wrought and Cold Finished.
- 2.1.2 ASTM A36/A36M Structural Steel.
- 2.1.3 ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- 2.1.4 ASTM A153 Zinc Coating (Hot Dip) on Iron and Steel Hardware.
- 2.1.5 ASTM A252 Welded and Seamless Steel Pipe Piles.
- 2.1.6 ASTM A775 Electrostatic Epoxy Coating
- 2.1.7 ASTM A193/A193M Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
- 2.1.8 ASTM A320/A320M Alloy-Steel Bolting Materials for Low Temperature Service.
- 2.1.9 ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- 2.1.10 ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- 2.1.11 ASTM A513 Standard Specification for Electric Resistance Welded Carbon and Alloy Steel Mechanical Tubing.
- 2.1.12 ASTM A536 Standard Specifications for Ductile Iron Castings
- 2.1.13 ASTM A572 HSLA Columbium-Vanadium Steels of Structural Quality.
- 2.1.14 ASTM A618 Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing.
- 2.1.15 ASTM A656 Hot-Rolled Structural Steel, High-Strength Low-Alloy Plate with Improved Formability.
- 2.1.16 ASTM A958 Standard Specification for Steel Castings, Carbon, and Alloy, with Tensile Requirements, Chemical Requirements Similar to Wrought Grades.
- 2.1.17 ASTM A1018 Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability.

- 2.1.18 ASTM D1143 Method of Testing Piles Under Static Axial Compressive Load.
- 2.1.19 ASTM D3689 Method of Testing Individual Piles Under Static Axial Tensile Load.

**2.2 American Welding Society (AWS):**

- 2.2.1 AWS D1.1 Structural Welding Code – Steel.
- 2.2.2 AWS D1.2 Structural Welding Code – Reinforcing Steel.

**2.3 American Society of Civil Engineers (ASCE):**

- 2.3.1 ASCE 20-96 Standard Guidelines for the Design and Installation of Pile Foundations.

**2.4 Deep Foundations Institute (DFI):**

- 2.4.1 *Guide to Drafting a Specification for High Capacity Drilled and Grouted Micropiles for Structural Support*, 1<sup>st</sup> Edition, Copyright 2001 by the Deep Foundation Institute (DFI).
- 2.4.2 *Model Specification – Helical Anchor Foundations- Tension Applications*, 1<sup>st</sup> Edition, Copyright 2014 by the Deep Foundations Institute(DFI).

**2.5 Society of Automotive Engineers (SAE):**

- 2.5.1 SAE J429 Mechanical and Material Requirements for Externally Threaded Fasteners.

**3 SUBMITTALS**

**3.1 Construction Submittals**

- 3.1.1 The Contractor or Engineer shall prepare and submit to the Owner, for review and approval, working drawings and design calculations for the Helical Piles intended for use at least 14 calendar days prior to planned start of construction (but note also Paragraph 3.1.8). All submittals shall be signed and sealed by a Registered Professional Engineer currently licensed in the State/Province of \_\_\_\_\_.

- 3.1.2 The Contractor shall submit a detailed description of the construction procedures proposed for use to the Owner for review. This shall include a list of major equipment to be used.

- 3.1.3 The Working Drawings shall include the following:

- 3.1.3.a Helical Pile number, location and pattern by assigned identification number
- 3.1.3.b Helical Pile design load and required safety factor
- 3.1.3.c Type and minimum size of central steel shaft

*Type SS125 1-1/4” RCS, SS5/SS150 – 1-1/2” RCS, Type SS175 – 1-3/4” RCS, Type SS200 – 2” RCS, Type SS225 – 2-1/4” RCS, Type RS2875 – 2-7/8” OD, Type RS3500 – 3-1/2” OD Pipe, Type RS4500 – 4-1/2” OD Pipe.*

- 3.1.3.d Minimum number of helix plates
- 3.1.3.e Minimum effective installation torque (optional)

*It is recommended to specify either the design load and required safety factor (3.1.3.b) or the minimum effective installation torque (3.1.3.e)*

- 3.1.3.f Minimum overall depth
- 3.1.3.g Inclination angle of Helical Pile
- 3.1.3.h Cut-off elevation
- 3.1.3.i Helical Pile attachment to structure relative to grade beam, column pad, pile cap, etc.

*If the minimum number of helix plates and minimum overall depth for the Helical Piles is not shown on the Working Drawings, the Contractor shall have the option of performing subsurface tests using methods subject to the review and acceptance of the Owner. The data collected along with other information pertinent to the project site shall be used to determine the required helix configuration and overall depth.*

- 3.1.4 The Contractor shall submit shop drawings for all Helical Pile components, including corrosion protection and pile top attachment to the Owner for review and approval. This includes Helical Pile lead/starter and extension section identification (manufacturer's catalog numbers).

*Shop drawings for Helical Pile components, including pile top attachments, can be obtained from CHANCE Civil Construction, their certified Distributors and Installing Contractors, or directly from <https://www.hubbell.com/chancefoundationsolutions/en>.*

- 3.1.5 If required, the Contractor shall submit certified mill test reports for the central steel shaft, as the material is delivered, to the Owner for record purposes. The ultimate strength, yield strength, % elongation, and chemistry composition shall be provided.
- 3.1.6 The Contractor shall submit plans for pre-production (optional) and production testing for the Helical Piles to the Owner for review and acceptance prior to beginning load tests. The purpose of the test is to determine the load versus displacement response of the Helical Pile and provide an estimation of ultimate capacity.

*It is the responsibility of the structural engineer of record to establish acceptance criteria for Helical Pile verification tests, which can be incorporated into the project specific specification. Load testing also provides the means to verify the empirical ratio between the ultimate capacity and the average installing torque of the Helical Pile for a specific project site.*

- 3.1.7 The Contractor shall submit to the Owner copies of calibration reports for each torque indicator or torque motor, and all load test equipment to be used on the project. The calibration tests shall have been performed within 6 months of the date submitted. Helical Pile installation and testing shall not proceed until the Owner has received the calibration reports. These calibration reports shall include, but are not limited to, the following information:

- 3.1.7.a Name of project and Contractor
- 3.1.7.b Name of testing agency
- 3.1.7.c Identification (serial number) of device calibrated

- 3.1.7.d Description of calibrated testing equipment
- 3.1.7.e Date of calibration
- 3.1.7.f Calibration data

*Load test equipment includes load cylinders, pressure gauges, and load transducers. Chance Digital Torque Indicator (SKU C3031836) is calibrated at the factory prior to shipment.*

- 3.1.8 Work shall not begin until all the submittals have been received and approved by the Owner. The Contractor shall allow the Owner a reasonable time to review, comment, and return the submittal package after a complete set has been received. All costs associated with incomplete or unacceptable submittals shall be the responsibility of the Contractor.

### **3.2 Installation Records**

The Contractor shall provide the Owner copies of Helical Pile installation records within 24 hours after each installation is completed. Records shall be prepared in accordance with the specified division of responsibilities as noted in Table-1. Formal copies shall be submitted on a weekly basis. These installation records shall include, but are not limited to, the following information.

- 3.2.1 Name of project and Contractor
- 3.2.2 Name of Contractor's supervisor during installation
- 3.2.3 Date and time of installation
- 3.2.4 Name and model of installation equipment
- 3.2.5 Type of torque indicator used
- 3.2.6 Location of Helical Pile by assigned identification number
- 3.2.7 Actual Helical Pile type and configuration – including lead section (number and size of helix plates), number and type of extension sections (manufacturer's SKU numbers)
- 3.2.8 Helical Pile installation duration and observations
- 3.2.9 Total length of installed Helical Pile
- 3.2.10 Cut-off elevation
- 3.2.11 Inclination of Helical Pile
- 3.2.12 Installation torque at one-foot intervals for the final 10 feet
- 3.2.13 Comments pertaining to interruptions, obstructions, or other relevant information
- 3.2.14 Rated load capacities

### **3.3 Test Reports**

The Contractor shall provide the Owner copies of field test reports within 24 hours after completion of the load tests. Records shall be prepared in accordance with the specified division of responsibilities as noted in Table-1. Formal copies shall be submitted within a reasonable amount of time following test completion. These test reports shall include, but are not limited to, the following information (note Section 6 – Helical Pile Load Tests).

- 3.3.1 Name of project and Contractor



- 3.3.2 Name of Contractor’s supervisor during installation
- 3.3.3 Name of third party test agency, if required
- 3.3.4 Date, time, and duration of test
- 3.3.5 Location of Helical Pile by assigned identification number
- 3.3.6 Type of test (i.e. tension or compression)
- 3.3.7 Description of calibrated testing equipment and test set-up
- 3.3.8 Actual Helical Pile type and configuration – including lead section, number and type of extension sections (manufacturer’s SKU numbers)
- 3.3.9 Steps and duration of each load increment
- 3.3.10 Cumulative pile-head movement at each load step
- 3.3.11 Comments pertaining to test procedure, equipment adjustments, or other relevant information
- 3.3.12 Signed by third party test agency rep., registered professional engineer, or as required by local jurisdiction

### 3.4 Closeout Submittals

- 3.4.1 Warranty: Warranty documents specified herein
  - 3.4.1.a Project Warranty: Refer to Conditions of the Contract for project warranty provisions

*Coordinate the warranty period stated herein with the project warranty as stated in the Contract documents.*

Warranty Period: (*Specify Term*) years commencing on date of Substantial Completion

- 3.4.1.b Manufacturer’s Warranty: Submit, for Owner’s Acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to, and not a limitation of, other rights the Owner may have under Contract Document.

## 4 PRODUCTS AND MATERIALS

### 4.1 Central Steel Shaft:

The central steel shaft, consisting of lead sections, helical extensions, and plain extensions, shall be Type SS (Square Shaft) or RS (Round Shaft) or a combination of the two (SS to RS Combo Pile) as manufactured by Hubbell Power Systems, Inc.(Centralia, MO).

- 4.1.1 *SS5 1-1/2” Material:* Shall be hot rolled Round-Cornered-Square (RCS) solid steel bars meeting dimensional and workmanship requirements of ASTM A29. The bar shall be modified medium carbon steel grade (similar to AISI 1044) with improved strength due to fine grain size.
  - 4.1.1.a Torque strength rating = 5,700 ft-lb
  - 4.1.1.b Minimum yield strength = 70 ksi

- 4.1.2 *SS125 1-1/4"*; *SS150 1-1/2"*; *SS175 1-3/4"*; *SS200 2"*; *SS225 2-1/4"* *Material*: Shall be hot rolled Round-Cornered-Square (RCS) solid steel bars meeting the dimensional and workmanship requirements of ASTM A29. The bar shall be High Strength Low Alloy (HSLA), low to medium carbon steel grade with improved strength due to fine grain size.
- 4.1.2.a Torque strength rating: SS125 = 4,000 ft-lb; SS150 = 7,000 ft-lb; SS175 = 10,500 ft-lb; SS200 = 16,000 ft-lb; SS225 = 21,000 ft-lb
- 4.1.2.b Minimum yield strength = 90 ksi
- 4.1.3 *Type RS2875 2-7/8" OD Material*: Structural steel tube or pipe, welded or seamless, in compliance with ASTM A500 or A513. Wall thickness is 0.203" or 0.276".
- 4.1.3.a Torque strength rating: RS2875.203 = 7,000 ft-lb, or 6,710 ft-lb for building code compliant products listed in ICC-ES ESR-794; RS2875.276 = 8,000 ft-lb, or 8,900 ft-lb for building code compliant products listed in ICC-ES ESR-794.
- 4.1.3.b Minimum yield strength = 50 ksi
- 4.1.4 *Type RS3500 3-1/2" OD Material*: Shall be structural steel tube or pipe, seamless or straight-seam welded, per ASTM A53, A252, ASTM A500, or ASTM A618. Wall thickness is 0.300" (schedule 80).
- 4.1.4.a Torque strength rating = 13,000 ft-lb; or 12,500 ft-lb for building code compliant products listed in ICC-ES ESR-794.
- 4.1.4.b Minimum yield strength = 50 ksi
- 4.1.5 *Type RS4500 4-1/2" OD Material*: Shall be structural steel tube or pipe, seamless or straight-seam welded, per ASTM A500 or A513. Wall thickness is 0.337" (schedule 80).
- 4.1.5.a Torque strength rating = 25,000 ft-lb or 24,320 ft-lb for building code compliant products listed in ICC-ES ESR-794.
- 4.1.5.b Minimum yield strength = 50 ksi
- 4.1.6 *SS5/150 to RS2875 Combo Pile Material*: Shall be Type SS5/150 and RS2875 material as described above with a cast ductile iron adapter per ASTM A536 for the transition from SS5/150 to RS2875.
- 4.1.7 *SS175 to RS2875 Combo Pile Material*: Shall be Type SS175 and RS2875 material as described above with a cast ductile iron adapter per ASTM A536 for the transition from SS175 to RS2875.
- 4.1.8 *SS175 to RS3500 Combo Pile Material*: Shall be Type SS175 and RS3500 material as described above with a cast ductile iron adapter per ASTM A536 for the transition from SS175 to RS3500.
- 4.1.9 *SS200/225 to RS4500 Combo Pile Material*: Shall be Type SS200/225 and RS4500 material as described above with a cast ductile iron adapter per ASTM A536 for the transition from SS200/225 to RS4500.

## 4.2 Helix Bearing Plate:

Shall be hot rolled carbon steel sheet, strip, or plate formed on matching metal dies to true helical shape and uniform pitch. Bearing plate material shall conform to the following ASTM specifications.

- 4.2.1 *SS5 Material:* Per ASTM A572, or A1018, or A656 with minimum yield strength of 50 ksi. Plate thickness is 3/8”.
- 4.2.2 *SS125 and SS1375 Material:* Per ASTM A572 with minimum yield strength of 50 ksi. Plate thickness is 3/8” or 1/2”.
- 4.2.3 *SS150 and SS175 Material:* Per ASTM A656 or A1018 with minimum yield strength of 80 ksi. Plate thickness is 3/8” or 1/2”.
- 4.2.4 *SS200 and SS225 Material:* Per ASTM A656 or A1018 with minimum yield strength of 80 ksi. Plate thickness is 1/2”.
- 4.2.5 *RS2875 Material:* Per ASTM A36, or A572, with minimum yield strength of 36 ksi. Plate thickness is 3/8” or 1/2”.
- 4.2.6 *RS3500 Material:* Per ASTM A36, or A572, or A1018, or A656 depending on helix diameter, per the minimum yield strength requirements cited above. Plate thickness is 3/8” or 1/2”.
- 4.2.7 *RS4500 Material:* Per ASTM A572 with minimum yield strength of 50 ksi. Plate thickness is 1/2”.

## 4.3 Bolts:

The size and type of bolts used to connect the central steel shaft sections together shall conform to the following ASTM specifications.

- 4.3.1 *SS125 1-1/4” Material:* 5/8” diameter bolt per ASTM A325.
- 4.3.2 *SS5 and SS150 1-1/2” Material:* 3/4” diameter bolt per ASTM A193 Grade B7 w/ cold weather prop.
- 4.3.3 *SS175 1-3/4” Material:* 7/8” diameter bolt per ASTM A193 Grade B7 w/ cold weather prop.
- 4.3.4 *SS200 2” Material:* 1-1/8” diameter bolt per ASTM A193 Grade B7.
- 4.3.5 *SS225 2-1/4” Material:* 1-1/4” diameter bolt per ASTM A193 Grade B7.
- 4.3.6 *RS2875 2-7/8” OD Material:* 3/4” diameter bolts (2 per coupling) per SAE J429 Grade 5.
- 4.3.7 *RS3500 3-1/2” OD Material:* 3/4” diameter bolts (3 per coupling) per SAE J429 Grade 5.
- 4.3.8 *RS4500 4-1/2” OD Material:* 3/4” diameter bolts (4 per coupling) per SAE J429 Grade 8.

4.4 **Carbide Tip:** Proprietary carbide “tooth” welded on pilot point of CHANCE Type Square Shaft (SS) central steel shaft lead sections. The tip shall extend beyond and below the surface on the lower extremity of the pilot point.

## 4.5 Couplings:

For type SS125, SS5, SS150, SS175, SS200, and SS225 material, the coupling shall be formed as an integral part of the plain and helical extension material as hot upset forged sockets.

For Type RS2875, RS3500, and RS4500 material, the couplings shall be formed as an integral part of the plain and helical extension material as cold upset expanded sockets, or as pipe sleeves welded to the

extension shaft. The welded steel sleeves can be either DOM tubing or ERW pipe shaft with holes for connecting shaft sections together.

#### **4.6 Plates, Shapes, or Pile Caps:**

Depending on the application, the pile cap shall be a welded assembly consisting of structural steel plates and shapes designed to fit the pile and transfer the applied load. Structural steel plates and shapes for HELICAL PILE top attachments shall conform to ASTM A36 or ASTM A572 Grade 50.

#### **4.7 Corrosion Protection (Optional)**

*The corrosion protection requirements, if any, are identified in Section 1.8.9. The Specifier may elect to delete this section entirely if no corrosion protection materials are required such as for compression Helical Piles in non-aggressive ground.*

4.7.1 Epoxy Coating: If used, the thickness of coating applied electrostatically to the central steel shaft shall be 7-12 mils. Epoxy coating shall be in accordance with ASTM A775. Bend test requirements are not required. Coupling bolts and nuts are not required to be epoxy coated.

4.7.2 Galvanization: If used, all Hubbell Power Systems, Inc./A. B. Chance Type SS material shall be hot-dipped galvanized in accordance with ASTM A153 after fabrication. All Hubbell Power Systems, Inc./A. B. Chance Type RS material shall be hot-dipped galvanized in accordance with ASTM A153 or A123 as specified after fabrication.

### **5 EXECUTION**

#### **5.1 Site Conditions**

5.1.1 Prior to commencing Helical Pile installation, the Contractor shall inspect the work of all other trades and verify that all said work is completed to the point where Helical Piles may commence without restriction.

5.1.2 The Contractor shall verify that all Helical Piles may be installed in accordance with all pertinent codes and regulations regarding such items as underground obstructions, right-of-way limitations, utilities, etc.

5.1.3 In the event of a discrepancy, the Contractor shall notify the Owner. The Contractor shall not proceed with Helical Pile installation in areas of discrepancies until said discrepancies have been resolved. All costs associated with unresolved discrepancies shall be the responsibility of the Owner.

#### **5.2 Installation Equipment**

5.2.1 Shall be rotary type, hydraulic power driven torque motor with clockwise and counter-clockwise rotation capabilities. The torque motor shall be capable of continuous adjustment to revolutions per minute (RPM's) during installation. Percussion drilling equipment shall not be permitted. The

torque motor shall have torque capacity 15% greater than the torsional strength rating of the central steel shaft to be installed.

*Helical Piles should be installed with high torque, low RPM torque motors, which allow the helical screw plates to advance with minimal soil disturbance.*

- 5.2.2 Equipment shall be capable of applying adequate down pressure (crowd) and torque simultaneously to suit project soil conditions and load requirements. The equipment shall be capable of continuous position adjustment to maintain proper Helical Pile alignment.

### **5.3 Installation Tooling**

- 5.3.1 Shall consist of a Kelly Bar Adapter (KBA) and Type SS or RS drive tools as manufactured by Hubbell Power Systems, Inc. and used in accordance with the manufacturers written installation instructions.

*Installation tooling should be maintained in good working order and safe to operate at all times. Flange bolts and nuts should be regularly inspected for proper tightening torque. Bolts, connecting pins, and retainers should be periodically inspected for wear and/or damage and replaced with identical items provided by the manufacturer. Heed all warning labels. Worn or damaged tooling should be replaced.*

- 5.3.2 A torque indicator shall be used during Helical Pile installation. The torque indicator can be an integral part of the installation equipment or externally mounted in-line with the installation tooling. Torque indicators are available from Hubbell Power Systems, Inc.
- 5.3.2.a Shall be capable of providing continuous measurement of applied torque throughout the installation.
- 5.3.2.b Shall be capable of torque measurements in increments of at least 500 ft-lb
- 5.3.2.c Shall be calibrated prior to pre-production testing or start of work. Torque indicators which are an integral part of the installation equipment, shall be calibrated on-site. Torque indicators which are mounted in-line with the installation tooling, shall be calibrated either on-site or at an appropriately equipped test facility. Indicators that measure torque as a function of hydraulic pressure shall be calibrated at normal operating temperatures.
- 5.3.2.d Shall be re-calibrated, if in the opinion of the Owner and/or Contractor reasonable doubt exists as to the accuracy of the torque measurements.

### **5.4 Installation Procedures**

#### **5.4.1 Central Steel Shaft: (Lead and Extension Sections)**

- 5.4.1.a The Helical Pile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the project.
- 5.4.1.b The lead section shall be positioned at the location as shown on the working drawings. Battered 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. 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 20 RPM's. Extension sections shall be provided to obtain the required minimum overall length and installation torque as shown on the working drawings. Connect sections together using coupling bolt(s) and nut torqued to 40 ft-lb.

- 5.4.1.c Sufficient down pressure shall be applied to uniformly advance the Helical Pile sections approximately 3 inches per revolution. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths.

## 5.5 Termination Criteria

- 5.5.1 The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.
- 5.5.2 The minimum installation torque and minimum overall depth criteria as shown on the working drawings shall be satisfied prior to terminating the Helical Pile installation.
- 5.5.3 If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to achieving the minimum overall length required, the Contractor shall have the following options:
- 5.5.3.a Terminate the installation at the depth obtained subject to the review and acceptance of the Owner, or:
  - 5.5.3.b Remove the existing Helical Pile and install a new one with fewer and/or smaller diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner. If re-installing in the same location, the top-most helix of the new Helical Pile shall be terminated at least (3) three feet beyond the terminating depth of the original Helical Pile.

*It is generally not recommended to re-use Type SS Helical Pile shaft material after it has been permanently twisted during a previous installation. Likewise, it is generally not recommended to re-use Type RS Helical Pile shaft material after the coupling bolt holes have been noticeably elongated during a previous installation.*

- 5.5.4 If the minimum installation torque as shown on the working drawings is not achieved at the minimum overall length, and there is no maximum length constraint, the Contractor shall have the following options:
- 5.5.4.a Install the Helical Pile deeper using additional extension sections, or:
  - 5.5.4.b Remove the existing Helical Pile and install a new one with additional and/or larger diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner. If re-installing in the same location, the top-most helix of the new Helical Pile shall be terminated at least (3) three feet beyond the terminating depth of the original Helical Pile.

- 5.5.4.c De-rate the load capacity of the Helical Pile and install additional Helical Pile(s). The de-rated capacity and additional Helical Pile location shall be subject to the review and acceptance of the Owner.
- 5.5.5 If the Helical Pile is refused or deflected by a subsurface obstruction, the installation shall be terminated and the pile removed. The obstruction shall be removed, if feasible, and the Helical Pile re-installed. If the obstruction can't be removed, the Helical Pile shall be installed at an adjacent location, subject to review and acceptance of the Owner.
- 5.5.6 If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to proper positioning of the last plain extension section relative to the final elevation, the Contractor may remove the last plain extension and replace it with a shorter length extension. If it is not feasible to remove the last plain extension, the Contractor may cut said extension shaft to the correct elevation. The Contractor shall not reverse (back-out) the Helical Pile to facilitate extension removal.
- 5.5.7 The average torque for the last two feet (0.6 meter) of penetration shall be used as the basis of comparison with the minimum installation torque as shown on the working drawings. The average torque shall be defined as the average of the last three readings recorded at one-foot intervals.

*The average torque can be empirically related to the Helical Pile's ultimate capacity in end-bearing. This well-known attribute of helical piles can be used as a production control method to indicate the Helical Pile's end-bearing capacity.*

## **6 HELICAL PILE LOAD TESTS**

### **6.1 Pre-Production Tests (Optional)**

Load tests shall be performed to verify the suitability and capacity of the proposed Helical Pile, and the proposed installation procedures prior to installation of production helical piles. \_\_\_\_\_ sacrificial test helical piles shall be constructed immediately prior to the start of work on the production piles. The Owner shall determine the number of pre-production tests, their location, acceptable load and movement criteria, and the type(s) of load direction (i.e., tension, compression, or both). Additional purpose of pre-production tests is to empirically verify the ultimate capacity to the average installing torque of the Helical Pile for the project site.

Pre-production Helical Pile installation methods, procedures, equipment, and overall length shall be identical to the production Helical Piles to the extent practical except where approved otherwise by the Owner.

The Contractor shall submit for review and acceptance the proposed Helical Pile load testing procedure. The pre-production test proposal shall be in general conformance with ASTM D1143 and/or D-3689, and shall provide the minimum following information:

- ◆ Type and accuracy of load equipment
- ◆ Type and accuracy of load measuring equipment

- ◆ Type and accuracy of pile-head deflection equipment
- ◆ General description of load reaction system, including description of reaction anchors
- ◆ Calibration report for complete load equipment, including hydraulic jack, pump, pressure gauge, hoses, and fittings.

*The following test procedure shall be considered to meet the minimum requirements. It is not intended to preclude local building codes, which may mandate other requirements, such as full 24-hour load tests.*

If the pre-production test fails to meet the design requirements, the Contractor shall modify the Helical Pile design and/or installation methods and retest the modified anchor, as directed by the Owner. *For prescriptive specifications, the Engineer will define the appropriate modifications.*

## **6.2 Load Test Equipment**

- 6.2.1 The load test equipment shall be capable of increasing or decreasing the applied load incrementally. The incremental control shall allow for small adjustments, which may be necessary to maintain the applied load for a sustained, hold period.
- 6.2.2 The reaction system shall be designed so as to have sufficient strength and capacity to distribute the test loads to the ground. It should also be designed to minimize its movement under load and to prevent applying an eccentric load to the pile head. Test loads are normally higher than the design loads on the structure. The direction of the applied load shall be collinear with the Helical Pile at all times.
- 6.2.3 Dial gauge(s) shall be used to measure Helical Pile movement. The dial gauge shall have an accuracy of at least  $\pm 0.001$ -in. and a minimum travel sufficient to measure all Helical Pile movements without requiring resetting the gauge. The dial gauge shall be positioned so its stem is parallel with the axis of the Helical Pile. The stem may rest on a smooth plate located at the pile head. Said plate shall be positioned perpendicular to the axis of the Helical Pile. The dial gauge shall be supported by a reference apparatus to provide an independent fixed reference point. Said reference apparatus shall be independent of the reaction system and shall not be affected by any movement of the reaction system.
- 6.2.4 The load test equipment shall be re-calibrated, if in the opinion of the Owner and/or Contractor reasonable doubt exists as to the accuracy of the load or deflection measurements.

## **6.3 Testing Program**

- 6.3.1 The hydraulic jack shall be positioned at the beginning of the test such that the unloading and repositioning of the jack during the test shall not be required. The jack shall also be positioned coaxial with respect to the pile-head so as to minimize eccentric loading. The hydraulic jack shall be capable of applying a load not less than two times the proposed design load (DL). The pressure gauge shall be graduated in 100 psi increments or less. The stroke of the jack shall not be less than the theoretical elastic shortening of the total Helical Pile length at the maximum test load.



- 6.3.2 An alignment load (AL) shall be applied to the Helical Pile prior to setting the deflection measuring equipment to zero or a reference position. The AL shall be no more than 10% of the design load (i.e., 0.1 DL). After AL is applied, the test set-up shall be inspected carefully to ensure it is safe to proceed.
- 6.3.3 Axial compression or tension load tests shall be conducted by loading the Helical Pile in step-wise fashion as shown in Table-3 to the extent practical. Pile-head deflection shall be recorded at the beginning of each step and after the end of the hold time. The beginning of the hold time shall be defined as the moment when the load equipment achieves the required load step.
- 6.3.4 Test loads shall be applied until continuous jacking is required to maintain the load step or until the test load increment equals 200% of the design load (DL) (i.e., 2.0 DL), whichever occurs first. The observation period for this last load increment shall be 4 minutes. Displacement readings shall be recorded at 0 and 4 minutes (load increment maxima only).
- 6.3.5 The applied test load shall be removed in four approximately equal decrements per the schedule in Table-3. The hold time for these load decrements shall be 1 minute, except for the last decrement, which shall be held for 5 minutes.

*This cyclic loading method will permit the analyses of the total, elastic, and net movements, since they can be separated and studied. For special test piles not to be used later in service, further load cycles may be conducted to provide an estimation of the ultimate capacity.*

**Table-3.** Steps for Pre-Production Load Testing

<b>LOAD STEP</b>	<b>HOLD TIME (MINUTES)</b>
AL	1.0 Min.
0.20 DL	4.0 Min.
0.40 DL	4.0 Min.
0.60 DL	4.0 Min.
0.80 DL	4.0 Min.
1.0DL	4.0 Min.
0.75 DL	1.0 Min.
0.50 DL	1.0 Min.
0.25 DL	1.0 Min.
AL	1.0 Min.
0.5 DL	1.0 Min.
1.0 DL	1.0 Min.
1.2 DL	4.0 Min.
1.4 DL	4.0 Min.
1.6 DL	4.0 Min.
1.8 DL	4.0 Min.

2.0 DL	4.0 Min.
1.5 DL	1.0 Min.
1.0 DL	1.0 Min.
0.5 DL	1.0 Min.
AL	5.0 Min.

AL = Alignment Load; DL = Design Load

#### 6.4 Acceptance Criteria for HELICAL PILE Verification Load Tests

Both of the following criteria must be met for approval:

1. The Helical Pile shall sustain the compression and tension design capacities (1.0 DL) with no more than \_\_\_\_ in. (mm) total vertical movement of the pile-head as measured relative to the top of the Helical Pile prior to the start of testing.
2. Failure does not occur at the 2.0 DL maximum compression and tension test loads. The failure load shall be defined by one of the following definitions – whichever results in the lesser load:
  - The point at which the movement of the Helical Pile tip exceeds the elastic compression/tension of the pile shaft by 0.1B, where B is defined as the average helix diameter. *(Note that tension loads are limited to the minimum ultimate tensile strength of the coupling joint(s) of the central steel shaft. It is recommended to use the minimum ultimate tensile strengths as published by Hubbell Power Systems, Inc. (shown in Section 7 of the Technical Design Manual – 4<sup>th</sup> Edition).*
  - The point at which the slope of the load versus deflection (at end of increment) curve exceeds 0.05 inches/kip.

The Contractor shall provide the Owner copies of field test reports confirming Helical Pile configuration and construction details within 24 hours after completion of the load tests. Formal copies shall be submitted as per Section 3.3. This written documentation will either confirm the load capacity as required on the working drawings or propose changes based upon the results of the pre-production tests.

When a Helical Pile fails to meet the acceptance criteria, modifications shall be made to the design, the construction procedures, or both. These modifications include, but are not limited to, de-rating the Helical Pile load capacity, modifying the installation methods and equipment, increasing the minimum effective installation torque, changing the helix configuration, or changing the Helical Pile material (i.e., central steel shaft). Modifications that require changes to the structure shall have prior review and acceptance of the Owner. The cause for any modifications of design or construction procedures shall be decided in order to determine any additional cost implications.

#### 6.5 Production Helical Pile Testing (This may be the only type of load test conducted, depending on project conditions.)

The Contractor shall perform proof tests on a minimum of \_\_\_\_% of the total production Helical Piles. The Helical Piles to be tested will be selected by the Owner. At the Contractor’s suggestion, but with the Owner’s permission, tension tests may be performed in lieu of compression tests up to 1.00 DL for Helical Piles with sufficient structural tension capacity. *The requirements of Table-4 may be regarded as a*

minimum, however, it is not recommended to test production Helical Piles to values of up to 2.0 DL unless the Helical Pile’s failure load is significantly higher than 2.0 DL. The maximum production Helical Pile test load shall be determined by the Owner. For example, ASTM D1143 stipulates testing to 2.0 DL.

The test sequence shall be as shown in Table-4 to the extent practical.

**Table-4.** Steps for Production Load Testing

LOAD STEP	HOLD TIME (MINUTES)
AL	0 Min.
0.20 DL	4.0 Min.
0.40 DL	4.0 Min.
0.60 DL	4.0 Min.
0.80 DL	4.0 Min.
1.00 DL	4.0 Min.
0.60 DL	1 Min.
0.40 DL	1 Min.
0.20 DL	1 Min.
AL	5 Min.

AL = Alignment Load; DL = Design Load

The acceptance criteria for production Helical Piles shall be per Section 6.4 Item 1.

If a production Helical Pile that is tested fails to meet the acceptance criteria, the Contractor shall be directed to proof test another Helical Pile in the vicinity. For failed Helical Piles and further construction of other foundations, the Contractor shall modify the design, the construction procedure, or both. These modifications include, but are not limited to, installing replacement Helical Piles, modifying the installation methods and equipment, increasing the minimum effective installation torque, changing the helix configuration, or changing the Helical Pile material (i.e., central steel shaft). Modifications that require changes to the structure shall have prior review and acceptance of the Owner. Any modifications of design or construction procedures shall be at the Contractor’s expense.

## 6.6 Lateral Testing

*If required, lateral load tests shall be conducted in accordance with ASTM D3966. If a production Helical Pile is to be lateral load tested, care must be taken not to cause permanent damage – which can reduce its axial load capacity. The acceptance criteria as selected by the Owner, typically expressed as a maximum total movement at a specific load, must be realistic in its magnitude so as not to potentially damage the structure. It is suggested that lateral loads be resisted through some other means, such as soil anchors, battered piles, or enlarged concrete pile caps/grade beams.*

## 7 MEASUREMENT AND PAYMENT

Helical Pile work can be paid for in different ways, reflecting the relative risk to be accepted by the Owner and the Contractor. However, the following items are common and standard.

QUANTITY	DESCRIPTION	UNIT
1	Mobilization/Demobilization	Lump sum
As required	Conduct pre-production test program of declared scope	Lump sum
As required	Test Production Helical Piles	Per foundation
-	Obstructions	Per hour or Force Account
As required	Helical Pile Installation	As below

- ◆ Per Unit Length: Helical Piles meeting the design capacity shall be paid for per lineal foot below grade.
- ◆ Per Helical Pile: Helical Piles meeting the design capacity shall be paid for on a “per foundation” basis (no allowance for changes in length relative to that originally bid).
- ◆ Per Helical Pile with Add/Deduct: Helical Piles meeting the design capacity shall be paid for on a “per foundation” basis, with a predetermined length, and an add/deduct amount per lineal foot to accommodate field changes.
- ◆ Lump Sum: The whole Helical Pile project shall be paid for on a “lump sum” basis (no allowance for changes due to additional Helical Pile length relative to that originally bid).

END OF SPECIFICATION

# APPENDIX

## TABLE-1

### GUIDANCE OF GROUND AGGRESSIVENESS CLASSIFICATION

Soil tests may be performed to measure the aggressiveness of the soil environment, especially if field observations indicate corrosion of existing structures. The most common and simplest tests are for electrical resistivity, pH, chloride, and sulfates. The designation for these tests and the critical values defining whether an aggressive soil environment exists, are as shown below. Per FHWA-RD-89-198, the ground is considered aggressive if any one of these indicators shows critical values.

<b>Property</b>	<b>Test Designation</b>	<b>Critical Values</b>
Resistivity	ASTM G 57 AASHTO T-288	below 2,000 ohm-cm
pH	ASTM G 51 AASHTO T-289	below 5
Sulfate	ASTM D 516M ASTM D 4327	above 200 ppm
Chloride	ASTM D 512 ASTM D 4327 AASHTO T-291	above 100 ppm
Organic Content	AASHTO T-267	1% max