MODEL SPECIFICATION FOR HELICAL ANCHOR FOUNDATIONS TENSION APPLICATIONS

1. SCOPE

A. The work consists of designing, furnishing, installing, post-tensioning and testing helical anchors and any ancillary materials (e.g., sacrificial anodes, load transfer devices, etc.) used to support tension loads according to the project plans and these specifications. Unless otherwise noted, the installing contractor shall provide all labor, tools, equipment and materials necessary to accomplish the work.

B. 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 anchor performance unless specifically noted otherwise in the contract documents.

2. DEFINITIONS

A. The following terms apply to helical anchors used to support tension 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.

1. Allowable Load: See "Nominal Load" below

2. Anchorage: The capacity of the anchor and the soil into which it is installed that together resist tension loads applied to the anchor.

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

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

5. Design Load: See "Nominal Load" below.

6. Extension Section: Helical anchor component installed between the lead section and the load transfer device (bracket) to advance the helix plates to such depths as may be necessary to attain the required load capacity. Plain extensions (without helix plates) or helical extensions (with one or more helix plates) may be considered depending upon soil conditions. Helical extensions typically follow immediately behind the lead section. Extension shaft ends are designed to couple with helical lead sections, other extension sections and the load transfer device.

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

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

9. Helical Anchor (a.k.a. helical tieback or screw anchor): Consists of a central shaft with one or more helix-shaped bearing plates and a load transfer device (bracket) that allows attachment to structures. The anchor may include a surface coating or other means of corrosion protection. Helical anchors are installed into the ground by application of torque and down pressure ("crowd"), and thereafter resists tension loads through bearing of the helical plates in the soil they are embedded.

10. Helical (Helix) Plate: Generally round steel plate formed into a helical spiral and welded to the central steel shaft. When rotated in the ground, the helix shape provides thrust along the anchor's longitudinal axis thus aiding in anchor installation. The plate transfers axial load to the soil through bearing.

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

12. Limit State: A condition beyond which a helical anchor 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).

13. 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).

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

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

16. Mechanical Strength: The maximum tension load that can be resisted by the structural elements of a helical anchor.

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

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

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

20. Working Load: See "Nominal Load" above.

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

3. APPROVED HELICAL ANCHOR MANUFACTURERS

A. Foundation Supportworks™, Inc., 12330 Cary Circle, Omaha, NE 68128; Phone: (800) 281-8545; Fax: (402) 393-4002.

B. Due to the special requirements for design and manufacture of helical anchors, the anchors shall be obtained from Foundation Supportworks™, Inc., or other qualified manufacturer with an

approved equivalent product. A request to substitute any other manufactured helical product must be submitted to the Engineer for review not less than seven (7) calendar days prior to the bid date. The request must include:

1. Product drawings, details, and all necessary technical data sufficient to qualify the proposed product substitution.

2. Evidence of competence in the manufacture of helical anchors 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 anchors,
    b. The manufacturer's helical anchors have been used successfully in at least five engineered construction projects within the last three years,
    c. Product acceptance by the local building code official(s) having jurisdiction over the project, and/or
    d. Current ICC-ES product evaluation report or complete description of product testing and manufacturing quality assurance programs used to assess and maintain product quality.

4. ACCEPTABLE PRODUCTS

A. Solid Square Shaft or Hollow Round Shaft Helical Anchors

1. Hollow round shaft helical piles shall be used in applications of alternating compression and tension loads. Round shaft helical piles are generally more resistant to bending or buckling over solid square shaft counterparts due to superior sectional properties and coupling details.

2. Helical anchor capacity in tension is typically limited by the coupling detail; i.e., coupler weld or coupling hardware. Published anchor capacities shall therefore reflect the capacity of the limiting system component as determined in accordance with Section 5.B.

3. Helix blades shall meet the following geometry and spacing criteria to minimize soil disturbance:

    a. True helix shaped blades that are normal with the shaft such that the leading and trailing edges are within ¼-inch of parallel.
    b. Helix pitch is 3 inches ± ¼-inch.
    c. All helix blades have the same pitch.
    d. Helix blades have circular edge geometry.
    e. Helix spacing along the shaft shall be between 2.4 and 3.6 times the helix diameter.
    f. Helix blades are arranged such that they theoretically track that same path as the leading helix.

5. DESIGN AND PERFORMANCE REQUIREMENTS

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

B. All steel structure anchor components shall be designed within the limits provided by the American Institute of Steel Construction (AISC). Either Allowable Stress Design (ASD) or Load & Resistance Factor Design (LRFD) are acceptable methods of analysis. Product testing in accordance with ICC-ES Acceptance Criteria 358 may also be considered as an acceptable means of establishing allowable system capacities.

C. Except where noted otherwise on the project plans, all anchors shall be installed to provide a minimum factor of safety against ultimate pullout resistance of ___, a maximum axial deflection at nominal tension load of ___ inches, and must satisfy the deflection criteria as stated on the plans or drawings. Pre-tensioning anchors is an acceptable and common means of reducing deflection at service loads.

D. Except where noted otherwise on the project plans, each anchor shall be designed to meet a corrosion service life of 50 years in accordance with ICC-ES Acceptance Criteria 358.

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

6. QUALIFICATIONS OF INSTALLING CONTRACTOR AND DESIGNER

A. The installing contractor and anchor 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.

B. Evidence of installing contractor's competence in the installation of helical anchors shall be provided to the owner's satisfaction and may include any or all of the following:

1. Anchor manufacturer's certificate of competency in installation of helical piles,

2. A list of at least three projects completed within the previous three years wherein the installing contractor installed helical anchors 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, and/or

3. A letter from the anchor manufacturer, distributor or manufacturer's representative expressing ability and intent to provide on-site supervision of the anchor installation.

C. 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.

D. Evidence of anchor designer's competence: evidence of competence in the design of helical anchors shall be provided to the owner's satisfaction and may include any or all of the following:

1. Registration as a Professional Engineer or recognition by the local jurisdictional authority,

2. A list of at least three projects completed within the previous three years wherein the anchor designer designed helical anchors 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, and/or

3. Recommendation from the anchor manufacturer, distributor or manufacturer's representative.

7. PRE-CONSTRUCTION SUBMITTALS

A. Within 2 weeks of receiving the contract award, the installing contractor and/or anchor designer shall submit the following helical anchor design documentation:

1. Certification from the anchor designer that the proposed anchors meet the requirements of Section 4

2. Qualifications of anchor installer per Sections 6.B and 6.C

3. Qualifications of anchor designer per Section 6.D

4. Product designations for helix and extension sections and all ancillary products to be supplied at each helical anchor location

5. Individual anchorage nominal loads

6. Individual anchorage pre-tensioning requirements (if any)

7. Manufacturer's published allowable system capacities for the anchor assemblies, including load transfer devices

8. Calculated theoretical geotechnical capacity of anchors

9. Minimum torsional resistance criteria

10. Maximum allowable installation torque of anchor

11. Minimum embedment lengths and such other site specific embedment depth requirements as may be appropriate for the site soil profiles

12. Inclination angle and location tolerance requirements

13. Copies of certified calibration reports for torque measuring equipment and load test measuring equipment to be used on the project. The calibrations shall have been performed within one year of the proposed starting date for helical anchor installation or as recommended by the equipment manufacturer based on the proposed starting date.

8. PLACEMENT REQUIREMENTS

A. When helical anchor placement is shown on the project plans, production anchors shall be placed such that the anchor head is within ___ inches laterally and ___ inches longitudinally, and the anchor shaft alignment is within ___ degrees of the inclination angle, shown on the project plans.

B. When anchor placement is not shown on the project plans, the placements, alignments and their respective tolerances shall be included as part of the design submittal.

9. ANCHOR 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 anchors per the project plans and approved anchorage design documentation. In the event of conflict between the project plans and the approved anchorage 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 anchors 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 anchor installation operations.

G. The helical anchor 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 anchor design drawings. Inclined helical anchors 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 anchor 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 anchor 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 torsional resistance as shown on the project plans.

10. TERMINATION CRITERIA

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

1. If the installation fails to meet the minimum torsional resistance criterion at the minimum embedment length:

    a. 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
    b. Demonstrate acceptable anchor performance through proof testing, or
    c. Replace the anchor with one having a different helix configuration. The replacement anchor 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 anchor and meet the minimum torsional resistance criterion, or (B) pass proof testing.

2. If the torsional resistance during installation reaches the helical anchor's allowable torque rating prior to satisfaction of the minimum embedment length criterion:

    a. Terminate the installation at the depth obtained if allowed by the owner's representative, or
    b. Replace the anchor with one having a shaft with a higher torsional strength rating. This replacement anchor 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 anchor

without exceeding any applicable maximum embedment length requirements, and it must meet the minimum torsional resistance criterion, or

c. Replace the anchor with one having a different helix configuration. This replacement anchor 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 anchor without exceeding any applicable maximum embedment length requirements, and it must meet the minimum torsional resistance criterion, or
d. If allowed by the anchor location tolerance or approved by the owner's representative, remove and reinstall the anchor 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 anchor repositioning may require the installation of additional helical anchors with nominal loads adjusted for these spacing changes.

3. If the installation reaches a specified maximum embedment length without achieving the minimum torsional resistance criterion:

   a. If allowed by the anchor location tolerance or approved by the owner's representative, remove and reinstall the anchor 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 anchor repositioning may require the installation of additional helical anchors with nominal loads adjusted for these spacing changes, or
   b. Demonstrate acceptable anchor performance through proof testing, or
   c. De-rate the load capacity of the helical anchor and install additional anchors as necessary. The de-rated capacity and additional anchor location shall be subject to the approval of the Owner's representative, or
   d. Replace the anchor with one having a different helix configuration. This replacement anchor must be installed to satisfy the minimum embedment length criterion and it must meet the minimum torsional resistance criterion.

4. If a helical anchor fails to meet acceptance criteria in a performance or proof test:

   a. Install the anchor to a greater depth and 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
   b. Replace the anchor 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
   c. If approved by the owner's representative, de-rate the load capacity of the helical anchor and install additional anchors. Additional anchors must be installed at positions that are at least three times the diameter of the largest helix away from any other anchor locations and are approved by the Owner's representative. Anchors installed in cohesive soils shall not be spaced closer than four helix diameters.

5. Proof testing to qualify an anchor 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 anchor 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.

11. INSTALLATION RECORD SUBMITTALS

A. The installing contractor shall provide the owner, or his authorized representative, copies of individual helical anchor 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:

1. Date and time of installation
2. Location of helical anchor
3. Actual helical anchor type and configuration
4. Anchor reveal
5. Total length of installed anchor
6. Actual inclination of the anchor
7. Actual torsional resistance
8. Calculated geotechnical capacity based on actual torsional resistance
9. Comments pertaining to interruptions, obstructions, or other relevant information

12. ANCHOR TESTING

A. If anchor testing is required, the installing contractor shall furnish all labor, equipment and pre-production helical anchors necessary to accomplish the testing as shown in the approved anchor design documentation. Installing contractor shall apply the specified loads for the specified durations and record the specified data, for the specified number of anchors. No deviations from the test plan(s) will be allowed without explicit approval in writing from the owner's representative. Anchor testing shall be in general accordance with ASTM D3689.

B. 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 (insert amount of time) following test completion. Formal test reports shall include, but are not limited to, the following information:

1. Name of project and installing contractor
2. Name of Installing Contractor's supervisor during installation
3. Name of third party test agency, if any
4. Pre-production or production test
5. Date, time, and duration of test
6. Unique identifier and location of helical anchor tested
7. Type of test (performance or proof)
8. Description of calibrated testing equipment and test set-up
9. Actual helical anchor type and configuration
10. Steps and duration of each load increment
11. Cumulative anchor-head movement at each load step

13. CLEANUP

A. Within (insert time period) 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.