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This MANU-SPEC™ utilizes the Construction Specifications Institute (CSI) *Manual of Practice*, including *MasterFormat*™, *SectionFormat*™ and *PageFormat*™. A MANU-SPEC is a manufacturer-specific proprietary product specification using the proprietary method of specifying applicable to project specifications and master guide specifications. Optional text is indicated by brackets []; delete optional text in final copy of specification. Specifier Notes typically precede specification text; delete notes in final copy of specification. Trade/brand names with appropriate symbols typically are used in Specifier Notes; symbols are not used in specification text. Metric conversion, where used, is soft metric conversion.

This MANU-SPEC specifies power installed HELICAL PULLDOWN™ Micropiles. This product is manufactured by AB Chance. Revise MANU-SPEC section number and title below to suit project requirements, specification practices and section content. Refer to CSI *MasterFormat* for other section numbers and titles.

SECTION 02465
BORED PILES
(HELICAL PULLDOWN MICROPILES)

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: HELICAL PULLDOWN™ Micropiles.

Specifier Note: Revise paragraph below to suit project requirements. If a reader of this section could reasonably expect to find a product or component specified in this section, but it is actually specified elsewhere, then the related section number(s) should be listed in the paragraph below. Add section numbers and titles per CSI *MasterFormat* and specifier's practice. In the absence of related sections, delete paragraph below.

- B. Related Sections:

1. Division 2 Section: Foundation Walls.
2. Division 2 Section: Anchors.

Specifier Note: Article below may be omitted when specifying manufacturer's proprietary products and recommended installation. Retain References Article when specifying products and installation by an industry reference standard. If retained, list standard(s) referenced in this section. Indicate issuing authority name, acronym, standard designation and title. Establish policy for indicating edition date of standard referenced. Conditions of the Contract or Division 1 References Section may establish the edition date of standards. This article does not require compliance with standard. It is a listing of all references used in this section.

1.02 REFERENCES

- A. General: 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.
- B. ASTM International:
1. ASTM A29/A29M Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for.
 2. ASTM A36/A36M Standard Specification for Carbon Structural Steel.
 3. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

4. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. ASTM A193/A193M Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
7. ASTM A252 Standard Specification for Welded and Seamless Steel Pipe Piles.
8. ASTM A320/A320M Standard Specification for Alloy/Steel Bolting Materials for Low-Temperature Service.
9. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
10. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Steel.
11. ASTM A618 Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing.
12. ASTM A656 Standard Specification for Hot-Rolled Structural Steel, High-Strength Low-Alloy Plate with Improved Formability.
13. ASTM A1018 Standard Specification for 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.

Specifier Note: Retain or delete ASTM standards below to suit project requirements.

14. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field.
15. ASTM C33 Standard Specification for Concrete Aggregates.
16. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
17. ASTM C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
18. ASTM C150 Standard Specification for Portland Cement.
19. ASTM C494 Standard Specification for Chemical Admixtures for Concrete.
20. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
21. ASTM C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
22. ASTM C1240 Standard Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout.

Specifier Note: Retain or delete the ASTM standards below to suit project requirements.

23. ASTM D1143 Standard Test Methods for Piles Under Static Axial Compressive Load.
24. ASTM D1784 Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
25. ASTM D1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
26. ASTM D3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

Specifier Note: Retain or delete the two ASTM standards below to suit project requirements.

27. ASTM D3689 Standard Test Method for Individual Piles Under Static Axial Tensile Load.
28. ASTM D3966 Standard Test Method for Piles Under Lateral Loads.

C. Society of Automotive Engineers (SAE):

1. SAE J429 Mechanical and Material Requirements for Externally Threaded Fasteners.

1.03 DEFINITIONS

Specifier Note: Other definitions may be added to suit project requirements and special situations. Consult manufacturer's product literature or contact manufacturer for more information.

A Special definitions which apply to this section include:

Specifier Note: HELICAL PULLDOWN Micropiles (HPM) are primarily end-bearing foundation elements, but can develop significant secondary capacity by skin friction. Screw piers are not suited for solid, competent rock, but the helix plates can penetrate into dense bearing soils. It is recommended that HPM be installed to a specified minimum torque and depth to ensure the helix plates are terminated in bearing soils. Appropriate and repeatable installation techniques and pile termination criteria must be identified and verified in the field.

1. HELICAL PULLDOWN Micropile: A small diameter, soil displacement, cast-in-place screw pile, in which most of the applied load is resisted by the central steel shaft and steel reinforcement. Load transfer to soil is both end bearing and friction. Covered under United States Patent 5,707,180, Method and Apparatus for Forming Piles In-Situ. Referred to hereinafter using the abbreviation "HPM."

Specifier Note: Article below should be restricted to statements describing design or performance requirements and functional (not dimensional) tolerances of a complete system. Limit descriptions to composite and operational properties required to link components of a system together and to interface with other systems.

1.04 SYSTEM DESCRIPTION

A Design Requirements:

1. Design HPM to meet the specified loads and acceptance criteria as shown on the drawings.
2. Design power installed HPM application by [A designer employed by HPM manufacturer] [Professional Structural Engineer experienced in design of this work and licensed in {Specify state.}]. Comply with the following requirements:
 - a. Allowable Working Load in Compression (KIPS): [Specify allowable working load in compression (KIPS)].
 - b. Allowable Working Load in Tension (KIPS): [Specify allowable working load in tension (KIPS)].
 - c. Ultimate Structural Capacity in Compression (KIPS): [Specify ultimate structural capacity in compression (KIPS)].
 - d. Ultimate Structural Capacity in Tension (KIPS): [Specify ultimate structural capacity in tension (KIPS)].

B. Performance Requirements: Provide Power Installed HPM that have been manufactured, fabricated and installed to the following criteria:

Specifier Note: Manufacturer recommends that theoretical end-bearing capacity of the helix plates be determined using HeliCAP™ Engineering Software or comparable commercially available software. The required soil parameters (c, ϕ , γ or N-values) for use with HeliCAP™ or other software should be provided in the geotechnical reports.

1. Maximum Installing Torque (Foot Pounds): [Specify maximum installing torque (foot pounds)].
2. Overall Length: [Specify overall pile length (feet)].

Specifier Note: Article below includes submittal of relevant data to be furnished by Contractor before, during or after construction. Coordinate this article with Architect's and Contractor's duties and responsibilities in Conditions of the Contract and Division 1 Submittal Procedures Section.

1.05 SUBMITTALS

- A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
- B. Product Data: Submit manufacturer's product data and installation instructions.
- C. Shop Drawings: Provide drawings indicating profiles and product components and accessories and indicate the following:
 1. HPM number, location and pattern by assigned identification number.
 2. HPM design load.
 3. Type and size of central steel shaft.
 4. Helix configuration (number and diameter of helix plates).
 5. Minimum effective installation torque.
 6. Displacement plates/centralizers and their location.

7. Minimum overall length.
 8. Inclination of HPM.
 9. Grout column length.
 10. Minimum cased length, if applicable.
 11. Grout column diameter(s).
 12. Cutoff elevation.
 13. HPM attachment to structure relative to grade beam, column pad, etc.
- D. Quality Assurance/Control Submittals: Submit the following:
1. Design Data: Engineer's design data and calculations.
 2. Test Reports: Certified test reports showing compliance with specified characteristics and physical properties.
 3. Certificates: Submit the following:
 - a. Manufacturer's certificate that products meet or exceed specified requirements.
 - b. Manufacturer's Certificate of Registration for ISO 9001 compliance.
 - c. Mill test reports as requested.
- E. Closeout Submittals: Submit the following:
1. Installer's Field Reports: Accurately record the following: Type, size and actual locations of HPM, torque installation records on all HPM and torque monitoring calibration data.

Specifier Note: Article below should include statements of prerequisites, standards, limitations and criteria that establish an overall level of quality for products and workmanship for this section. Coordinate article below with Division 1 Quality Assurance Section.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Utilize an installer having demonstrated experience on projects of similar size and complexity and who is authorized and trained by the manufacturer to install its products.
- B. Manufacturer Qualifications: Utilize products from a manufacturer maintaining a quality system in compliance with ISO 9001 Requirements.

Specifier Note: Paragraph below should list obligations for compliance with specific code requirements particular to this section. General statements to comply with a particular code are typically addressed in Conditions of the Contract and Division 1 Regulatory Requirements Section. Repetitive statements should be avoided.

- C. Regulatory Requirements and Approvals: [Specify applicable requirements of regulatory agencies].
- D. Certifications: Certified mill test reports for the central steel shaft, as the material is delivered, for record purposes. Provide ultimate strength, yield strength, percent elongation and chemistry composition. [Specify requirement for certifications].

Specifier Note: Retain paragraph below if preinstallation meeting is required.

- E. Preinstallation Meetings: [Specify requirements for meeting].

Specifier Note: Article below should include specific protection and environmental conditions required during storage. Coordinate article below with Division 1 Product Requirements Section.

1.07 DELIVERY, STORAGE & HANDLING

- A. General: Comply with Division 1 Product Requirement Section.
- B. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- D. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

PART 2 PRODUCTS

Specifier Note: Retain article below for proprietary method specification. Add product attributes, performance characteristics, material standards and descriptions as applicable. Use of such phrases as “or equal” or “or approved equal” or similar phrases may cause ambiguity in specifications. Such phrases require verification (procedural, legal and regulatory) and assignment of responsibility for determining “or equal” products.

2.01 HELICAL PULLDOWN MICROPILES

Specifier Note: Paragraph below is an addition to CSI *SectionFormat* and a supplement to MANU-SPEC. Retain, edit or delete paragraph below to suit project requirements and specifier practice.

- A. Manufacturer: AB Chance Company.
 - 1. Contact: 210 North Allen Street, Centralia, MO 65240; Telephone: (573) 682-8414; Fax: (573) 682-8660; E-mail: hpscontact@hps.hubbell.com; Web site: www.abchance.com.
- B. Proprietary Products/Systems: Power Installed HELICAL PULLDOWN Micropiles, including the following:
 - 1. AB Chance HELICAL PULLDOWN Micropile:
 - a. Manufacturer Model Number Designation: Type SS5.
 - 2. AB Chance HELICAL PULLDOWN Micropile:
 - a. Manufacturer Model Number Designation: Type SS150.
 - 3. AB Chance HELICAL PULLDOWN Micropile:
 - a. Manufacturer Model Number Designation: Type SS175.
 - 4. AB Chance HELICAL PULLDOWN Micropile:
 - a. Manufacturer Model Number Designation: Type SS200.
 - 5. AB Chance HELICAL PULLDOWN Micropile:
 - a. Manufacturer Model Number Designation: Type SS225.
 - 6. AB Chance HELICAL PULLDOWN Micropile:
 - a. Manufacturer Model Number Designation: Type HS.

Specifier Note: Edit Article below to suit project requirements. If substitutions are permitted, edit text below. Add text to refer to Division 1 Project Requirements (Product Substitutions Procedures) Section.

2.02 PRODUCT SUBSTITUTIONS

- A. Substitutions: No substitutions permitted.

Specifier Note: Specify materials to be furnished. This article may be omitted and the materials can be included with the description of a manufactured unit, equipment, component or accessory. Retain, edit or delete language to suit project and specifier practice.

2.03 MATERIALS

- A. Central Steel Shaft:
 - 1. Consists of lead sections, helical extensions and plain extensions, Type [SS] [HS].
 - 2. SS5 1 1/2 inch Material: 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 with improved strength due to fine grain size. Torsional strength rating 5500 ft-lb (7457 N-m). Minimum yield strength 70 ksi (483 MPa).
 - 3. [SS150 1 1/2 inch] [SS175 1 3/4 inch] [SS200 2 inch] [SS225 2 1/4 inch] Material: 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. Torsional strength rating: [SS150 7000 ft-lb (9491 N-m)] [SS175 10,000 ft-lb (13,558 N-m)] [SS200 15,000 ft-lb (20,337 N-m)] [SS225 20,000 ft-lb (27,116 N-m)]. Minimum yield strength 90 ksi (621 MPa).
 - 4. HS 3 1/2 inch OD Material: Structural steel tube or pipe, seamless or straight-seam welded, in compliance with ASTM A53, ASTM A252, ASTM A500 or ASTM A618. Wall thickness is 0.300 inch (7.6 mm) (Schedule 80). Torsional strength rating 11,000 ft-lb (14,914 N-m). Minimum yield strength 50 ksi (345 MPa).

B. Helix Bearing Plate:

1. 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:
2. SS5 Material: Per ASTM A572, or ASTM A1018 or ASTM A656 with minimum yield strength of 50 ksi (345 MPa). Plate thickness 3/8 inch (9.5 mm).
3. [SS150] [And] [SS175] Material: Per ASTM A656 or ASTM A1018 with minimum yield strength of 80 ksi (552 MPa). Plate thickness 3/8 inch (9.5 mm).
4. [SS200] [And] [SS225] Material: Per ASTM A656 or ASTM A1018 with minimum yield strength of 80 ksi (552 MPa). Plate thickness 1/2 inch (12.7 mm).
5. HS Material: Per ASTM A36, or ASTM A572, or ASTM A1018 or ASTM A656 depending on helix diameter, per the minimum yield strength requirements cited above. Plate thickness 3/8 inch (9.5 mm).

C. Bolts:

1. The size and type of bolts used to connect the central steel shaft sections together shall conform to the following ASTM specifications: [SS5 and SS150 1 1/2 inch Material: 3/4 inch diameter bolt per ASTM A320 Grade L7] [SS175 1 3/4 inch Material: 7/8 inch diameter bolt per ASTM A193 Grade B7] [SS200 2 inch Material: 1 1/8 inch diameter bolt per ASTM A193 Grade B7] [SS225 2 1/4 inch Material: 1 1/4 inch diameter bolt per ASTM A193 Grade B7] [HS 3 1/2 inch OD Material: 3/4 inch diameter bolts (3 per coupling) per SAE J429 Grade 5].

D. Couplings:

1. Formed as integral part of the plain and helical extension material.
2. [For Type SS material, the couplings shall be hot upset forged sockets.] [For Type HS material, the couplings shall be hot forged expanded sockets.].

E. Displacement Plates/Centralizers: Fabricate displacement plates (lead or extension plates) from steel or other material that will not affect the structural integrity of the central steel shaft or grout column. Do not use wood for this purpose.

F. Plates, Shapes or Pier Caps: For structural steel plates and shapes for HPM top attachments, conform to ASTM A36 or ASTM A572, Grade 50 (Grade 345).

G. Pipe/Casing:

1. For steel casing relied upon to carry compression or lateral loads, or to stiffen the HPM, the casing/pipe shall conform to requirements of ASTM A53 Type E or S Grade B, ASTM A252 Grade 2, ASTM A500 Grade B or ASTM A618.
2. For PVC casing relied upon for grout containment, fissured or void-filled soils, or as a bond breaker, the casing/pipe shall conform to ASTM D1784, ASTM D1785 and ASTM D3034.

Specifier Note: Corrosion protection is a function of structure type, service life, loading condition and the overall aggressiveness of the project soils. The need for corrosion protection of HPMs subjected to tension loads must be carefully determined and specified as necessary. Corrosion resistant coatings (i.e., epoxy, plastic sheath) on the lead 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. Casing is typically not provided with corrosion resistant coatings for the same reasons. Extension sections are typically hot dip galvanized, but other coatings can be specified. Retain, edit or delete language below to suit project requirements and specifier practice.

H. Corrosion Protection:

1. Epoxy Coating: Electrostatically apply coating to the central steel shaft to a thickness of 7 - 12 mil (0.178 - 0.305 mm) in accordance with ASTM A775. Bend test requirements are not required. Coupling bolts, nuts and displacement plates are not required to be epoxy coated.
2. Galvanization: All [Type SS material shall be hot dipped galvanized in accordance with ASTM A153] [Type HS material shall be hot dipped galvanized in accordance with ASTM A123] after fabrication.

Specifier Note: Specify subordinate or secondary items that aid and assist primary products specified above or are necessary for preparation or installation of those items.

2.04 ACCESSORIES
A. Provide the following accessory components:

1. Water: Water for mixing grout shall be potable, clean and free from impurities, which may be detrimental to grout or steel. Potable water shall be available in quantities sufficient to mix grout and for equipment cleanup.
2. Cement: Cement for HELICAL PULLDOWN Micropile grout shall be Portland cement conforming to ASTM C150 Type I or Type II. Prepackaged, non-shrink cement grouts shall be subject to the review and acceptance of the Owner and shall conform to the requirements of ASTM C1107.

Specifier Note: Admixtures are generally not required for PULLDOWN Micropile grouts. However, project-specific soil conditions and loads may require high performance grout properties attainable with admixtures. For example, silica fume resists segregation and washout by improving bond between the cement particles. Its small particle size and shape improves flowability and reduces porosity, which leads to durable, high-strength grout with increased chemical and electrical resistance. Fly ash improves pumpability, improves compressive strength and reduces grout cost. Retain, edit or delete to suit project requirements and specifier practice.

3. Admixtures and Chemical Admixtures:
 - a. Conform to the requirements of ASTM C494. Do not use accelerators.
 - b. Chemical admixtures, if used, shall be compatible with the central steel shaft and mixed in accordance with the grout manufacturer's recommendations.
 - c. Chemical admixtures which control bleed water, improve consistency, reduce water/cement ratio and retard set may be used in the grout subject to the review and acceptance of the Owner.
 - d. Expansive admixtures may be used to fill confined areas of the central steel shaft coupling joints or to compensate for drying shrinkage.
 - e. [Specify admixture requirements].
4. Mineral Admixtures:
 - a. Conform to the requirements of ASTM C618 (coal fly ash) or C1240 (silica fume).
 - b. Mineral admixtures, which provide thixotropic consistency, reduce porosity, increase compressive strength and resist segregation, may be used in the grout subject to the review and acceptance of the Owner.
 - c. Mineral admixtures, if used, shall be compatible with the central steel shaft and mixed in accordance with the grout manufacturer's recommendations.
5. Aggregate:
 - a. Sand fillers may be used in the grout mix as an extender with large diameter grout columns, subject to the approval of the Owner. Do not include aggregate in small diameter grout columns.
 - b. Use fine sand only. Do not use medium or coarse sand.

Specifier Note: Specify proportions and procedures for site mixing materials. Mixing is the preparation of materials for use and is considered to be part of the manufacturing process.

Specifier Note: Grout specimen testing is generally not required for production piles, but is required for pre-production tests to evaluate the quality and strength of the grout mix. If required, a strength test shall be the average of the strength of 2 specimens made from the same sample of grout as used for production HPMs and tested at 28 days or at the test age designated for determination of compressive strength. The specimens should be made and cured under field conditions in accordance with ASTM C31 and tested in accordance with ASTM C39.

2.05 MIXES

- A. [Specify grout mix requirements].

PART 3 EXECUTION

Specifier Note: Article below is an addition to the CSI *SectionFormat* and a supplement to MANU-SPEC. Revise article below to suit project requirements and specifier's practice.

3.01 MANUFACTURER'S INSTRUCTIONS

- A. Comply with the instructions and recommendations of the power installed HPM manufacturer.

Specifier Note: Specify requirements where an unusually high quality of workmanship is required. Retain, edit or delete to suit project

requirements.

3.02 ACCEPTABLE INSTALLERS

- A. [Specify acceptable installers and contact information.].

Specifier Note: Specify actions to physically determine that conditions are acceptable to receive primary products of the section.

3.03 EXAMINATION

- A. Site Verification of Conditions:

1. Verify that site conditions are acceptable for installation of power installed HELICAL PULLDOWN Micropiles.
 - a. Verify that all work of other trades is completed to the point where HPMs may commence without restriction.
 - b. Verify that all HPMs may be installed in accordance with all pertinent codes and regulations regarding such items as underground obstructions, right-of-way limitations, utilities, etc.
2. Do not proceed with installation of power installed HELICAL PULLDOWN Micropiles until unacceptable conditions are corrected.

Specifier Note: Coordinate article below with manufacturer's recommended installation requirements.

3.04 INSTALLATION

- A. General:

1. The HPM installation technique shall be consistent with the geotechnical, logistical, environmental and load carrying conditions of the project.

Specifier Note: Helical screw piers are designed to be installed with high torque, low RPM torque motors, which allow the helical screw plates to advance with minimal soil disturbance.

2. Installation equipment shall be rotary type, hydraulic power driven torque motor with clockwise and counterclockwise rotation capabilities.
 - a. Utilize a torque motor capable of continuous adjustment to number of revolutions per minute (RPM) during installation and with a torque capacity 15% greater than the torsional strength rating of the central steel shaft to be installed. Do not use percussion drilling equipment.
 - b. Utilize equipment capable of applying adequate downward pressure and torque simultaneously to suit project soil conditions and load requirements, and capable of continuous position adjustment to maintain proper HPM alignment.
3. Installation tooling shall consist of a Kelly Bar Adapter (KBA) and Type SS or HS drive tool as manufactured by AB Chance Company.
4. A calibrated torque indicator shall be used during HPM installation. The torque indicator may be an integral part of the installation equipment or externally mounted in-line with the installation tooling.

- B. Central Steel Shaft Installation Procedure:

1. Engage and advance HPM into soil in a smooth, continuous manner at a rate of rotation of 5 - 20 RPM. Provide extension sections to obtain the required minimum overall length and installation torque as shown on the working drawings. Connect sections together using coupling bolt and nut tightened to torque of 40 ft-lb (54 N-m).
2. Apply sufficient down pressure to uniformly advance the HPM sections approximately 3 inches (76 mm) per revolution. Adjust rate of rotation and magnitude of down pressure for different soil conditions and depths.
3. Position a lead displacement plate (LDP) of appropriate diameter on the central steel shaft at the location necessary to install the grout column as shown on the working drawings. Do not position the LDP closer than 12 inches (305 mm) above the top helix plate. Position additional LDPs or extension displacement plates (EDP) on the central steel shaft at regular intervals, typically at every coupling joint. Do not place displacement plates more than 7 feet (2.1 m) apart. Displacement plates shall permit the free flow of grout without misalignment of the central steel shaft.

- C. Grout Installation Procedure:

Specifier Note: Typical water-cement ratio for premixed microsils is 0.2 - 0.3. Overwatering of grout will result in reduced

compressive strengths, increased shrinkage and reduced physical properties. Best results are obtained when the grout is mixed with colloidal or high shear mixers, which provide complete wetting of the cement particles.

1. Mix grout with equipment capable of providing a steady supply at the required level of production at a water-cement ratio for neat cement grouts between 0.4 and 0.5. When using prepackaged grout, comply with manufacturer's recommended water-cement ratios shown in mixing instructions on package.
2. Place grout using a gravity-fed reservoir located at the surface. Place grout in reservoir immediately prior to advancement of first LDP into soil. Maintain volume of grout contained in the reservoir at a level sufficient to maintain positive hydrostatic pressure on the grout column.
3. Continue grout placement until the minimum grout column length has been achieved as shown on the working drawings. Take volume measurements throughout the installation in order to determine the actual grout column diameter.
4. Allow grout to attain the minimum design strength prior to being loaded.

Specifier Note: Vertically installed HELICAL PULLDOWN Micropiles subjected to lateral loads require steel casing reinforcement. The lateral load analysis, as detailed in manufacturer's installation recommendations, can be used to determine the required diameter and length of the steel case reinforcement.

D. Casing Installation Procedure:

1. If required, install casing in segments corresponding to the sections of the central steel shaft.
2. Advance casing into the soil by direct connection with lead and extension displacement plates.
3. Fill each casing segment with grout immediately after placement.

E. Termination Criteria:

1. Satisfy the minimum installation torque and minimum overall length criteria as shown on the working drawings prior to terminating the HELICAL PULLDOWN Micropile.
2. The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.
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 installer shall have the following options:
 - a. Terminate the installation at the depth obtained subject to the review and acceptance of the Owner, or:
 - b. Remove the existing HPM 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 reinstalling in the same location, the topmost helix of the new HPM shall be terminated at least 3 feet (1 m) beyond the terminating depth of the original HPM.
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:
 - a. Install the HPM deeper using additional extension sections, displacement plates, casing if required, and grout, or:
 - b. Remove the existing HPM 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 reinstalling in the same location, the topmost helix of the new HPM shall be terminated at least 3 feet (1 m) beyond the terminating depth of the original HPM.
 - c. De-rate the load capacity of the HPM and install additional pile(s). The de-rated capacity and additional pile location shall be subject to the review and acceptance by the Owner.
5. If the HPM is refused or deflected by a subsurface obstruction, terminate the installation and remove the pile. Remove the obstruction, if feasible, and reinstall the HPM. If not feasible to remove the obstruction, install the HPM at an adjacent location, subject to review and acceptance by the Owner.
6. The average torque for the last 3 feet (1 m) 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 3 readings recorded at 1 foot (304.8 mm) intervals.

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

- F. Site Tolerances: Install HPM to the following allowable variation:
1. Centerline of piling shall not be more than 3 inches (76 mm) from indicated plan location.
 2. Pile plumbness shall be within 2 degrees of design alignment.
 3. Top elevation of pile shall be within +1 inch (25 mm) to -2 inches (-50 mm) of the design vertical elevation.
 4. Centerline of central steel shaft shall not be more than 3/4 inch (19 mm) from the centerline of the pile.

Specifier Note: Specify the tests and inspections required for installed or completed work. Retain, edit or delete to suit project requirements.

3.05 FIELD QUALITY CONTROL

Specifier Note: The manufacturer provides extensive information on load test procedures and acceptance criteria. Specific procedures and criteria will vary depending on project requirements. Consult manufacturer for more information. Specify to suit project requirements and specifier practice.

- A. Site Tests:
1. Load Test Procedures: [Specify load test procedures and applicable standards here and above under References article.].
 2. Acceptance Criteria: [Specify acceptance criteria and applicable standards here and above under References article.].
- B. Site Test Records: Provide the Owner copies of field test reports within 24 hours after completion of the load tests. Include, at a minimum, the following information:
1. Name of project and Contractor.
 2. Name of Contractor's supervisor during installation.
 3. Name of third party test agency, if required.
 4. Date, time and duration of test.
 5. Location of HPM by assigned identification number.
 6. Type of test (i.e., tension or compression).
 7. Description of calibrated testing equipment and test setup.
 8. Actual HPM type and configuration - including lead section, number and type of extension sections (manufacturer's SKU numbers).
 9. Steps and duration of each load increment.
 10. Cumulative pile-head movement at each load step.
 11. Comments pertaining to test procedure, equipment adjustments or other relevant information.
 12. Signed by third party test agency representative, registered professional engineer or as required by local jurisdiction.
- C. Installation Records: Provide the Owner copies of HPM installation records within 24 hours after each installation is completed. Include, at a minimum, the following information.
1. Name of project and Contractor.
 2. Name of Contractor's supervisor during installation.
 3. Date and time of installation.
 4. Name and model of installation equipment.
 5. Type of torque indicator used.
 6. Location of HPM by assigned identification number.
 7. Actual HPM type and configuration - including lead section (number and size of helix plates), number and type of extension sections (manufacturer's SKU numbers).
 8. HPM installation duration and observations.
 9. Total length of installed HPM.

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10. Cutoff elevation.
 11. Inclination of HPM.
 12. Installation torque at 1 foot (304.8 mm) intervals for the final 10 feet (3 m).
 13. Grout quantities pulled down on a per section basis.
 14. Actual grout column diameter and length.
 15. Comments pertaining to interruptions, obstructions or other relevant information.
 16. Rated load capacities.

Specifier Note: Specify provisions for protecting work after installation but prior to acceptance by the owner. Coordinate article below with Division 1 Execution Requirements Section.

3.06 PROTECTION

- A. Protect installed work from damage due to subsequent construction activity on the site.

END OF SECTION