

MODEL SPECIFICATION

HELICAL SOIL NAILS FOR EARTH RETENTION

1 SCOPE

The work consists of designing, supplying, and installing helical soil nails and load transfer devices for helical soil nail walls according to the project Plans and these specifications. The parties and contract terms referred to in this specification are as follows:

- 1.1 The Owner is the person or entity that owns the structure or will own the structure once it is completed. The Owner may have contractual agreements with, and be represented by, other parties such as engineers, architects or contractors that perform services under the direction of the Owner. Where Owner is used in this specification, it refers to the Owner or the Owner's contracted representatives separate from the Installing Contractor.
- 1.2 The Installing Contractor installs and tests (if necessary) the helical soil nails and may perform other tasks associated with the project.
- 1.3 The Soil Nail Designer is the individual or firm hired by the Installing Contractor or Owner to design the helical soil nails.
- 1.4 The Plans refer to the contract documents, including but not limited to the drawings and specifications for the project.
- 1.5 The work may include helical soil nail load testing.
- 1.6 The Owner will be responsible for obtaining right-of-way or easement access permits necessary for the helical soil nail installation.
- 1.7 Unless otherwise noted, the Installing Contractor shall provide all labor, tools, equipment, and materials necessary to accomplish the work.
- 1.8 The Owner will provide suitable access to the construction site for the Installing Contractor's personnel and equipment.
- 1.9 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.
- 1.10 The Owner will be responsible for overall construction oversight to preclude the development of unsafe conditions.
- 1.11 The Owner will be responsible for a field survey of the wall excavation limits and helical soil nail locations prior to helical soil nail installation.
- 1.12 The work does not include any post-construction monitoring of soil nail performance unless specifically noted otherwise in the contract documents.

2 REFERENCES

- 2.1 American Institute of Steel Construction (AISC)
 - 2.1.1 AISC 360: Specification for Structural Steel Buildings
- 2.2 American Society for Testing and Materials (ASTM)
 - 2.2.1 ASTM A29: Steel Bars, Carbon and Alloy, Hot-Wrought
 - 2.2.2 ASTM A123: Zinc Coating (Hot-Dip) on Iron and Steel Products
 - 2.2.3 ASTM A572: High-Strength Low-Alloy Columbian-Vanadium Structural Steel
 - 2.2.4 ASTM A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - 2.2.5 ASTM B695: Coatings of Zinc Mechanically Deposited on Iron and Steel

- 2.3 Federal Highway Administration (FHWA)
 - 2.3.1 FHWA Geotechnical Engineering Circular No. 7, “Soil Nail Walls” (FHWA GEC7)
- 2.4 International Code Council Evaluation Services (ICC-ES)
 - 2.4.1 ICC-ES Acceptance Criteria 358 (AC358): Acceptance Criteria for Helical Pile Systems and Devices
- 2.5 Society of Automotive Engineers (SAE)
 - 2.5.1 SAE J429: Mechanical and Material Requirements for Externally Threaded Fasteners

3 DEFINITIONS

- 3.1 Allowable Strength Design (ASD): A structural and geotechnical design methodology which states that the summation of the actual estimated loads (nominal loads) must be less than or equal to the allowable strength. Allowable strength is obtained by dividing a nominal resistance (strength) by an appropriate factor of safety.
- 3.2 Bearing Stratum: The soil layer (or layers) that provides helical soil nail end bearing capacity through load transfer from the helical plates.
- 3.3 Crowd: Axial compressive force applied to the helical soil nail shaft as needed during installation to ensure the soil nail advances at a rate approximately equal to the helix pitch for each revolution.
- 3.4 Design Loads: The combined nominal loads using ASD methodology.
- 3.5 Design Strength: A term used in structural design which is defined as the product of the nominal strength and the applicable resistance factor. An equivalent term typically used in geotechnical design is sometimes referred to as factored resistance (Load and Resistance Factor Design).
- 3.6 Extension Section: Helical soil nail shaft sections connected to the lead section or other extension sections to advance the helix plates to the required bearing strata and nail length. Helical soil nail extensions have helix plates.
- 3.7 Factor of Safety: The ratio of the ultimate soil nail capacity or nominal resistance (strength) to the nominal or service load used in the design of any helical soil nail component or interface (Allowable Strength Design).
- 3.8 Factored Load: The product of a nominal load and an applicable load factor (Load and Resistance Factor Design).
- 3.9 Factored Resistance: The product of a nominal resistance and an applicable resistance factor (Load and Resistance and Factor Design).
- 3.10 Geotechnical Capacity: The maximum load or the load at a specified limit state, which can be resisted through the soil nails interaction with the bearing soils (see also Ultimate Soil Nail Capacity).
- 3.11 Helical Soil Nail: Consists of a central steel shaft with multiple helix-shaped bearing plates and a load transfer device that allows attachment to wall facing components. Helical soil nails are installed into the ground by application of torque and axial compressive force (“crowd”).
- 3.12 Helix (Helical) Plate: 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 soil nail’s longitudinal axis, thus aiding in soil nail installation. The helix plate transfers axial load to the soil through bearing.
- 3.13 Helix Pitch: The distance measured along the axis of the shaft between the leading and trailing edges of the helix plate.
- 3.14 Lead Section: The first helical soil nail shaft component installed into the soil. It consists of multiple helical plates welded to a central steel shaft.
- 3.15 Limit State: A condition beyond which a helical soil nail component or interface becomes unfit

for service and is judged to no longer be useful for its intended function (serviceability limit state) or to be unsafe (ultimate limit state (strength)).

- 3.16 Load and Resistance Factor Design (LRFD): A structural and geotechnical design methodology that states that the Factored Resistance (Design Strength) must be greater than or equal to the summation of the applied factored loads.
- 3.17 Load Factor: A factor that accounts for the probability of deviation of the actual load from the predicted nominal load due to variability of material properties, workmanship, type of failure and uncertainty in the prediction of the load (Load and Resistance Factor Design).
- 3.18 Load Test: A process to test the ultimate soil nail capacity and relation of applied load to soil nail head movement by application of a known load on the helical soil nail head and monitoring movement over a specific time period.
- 3.19 Loads: Forces 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).
- 3.20 Mechanical Strength: The maximum load or the load at a specified limit state that can be resisted by the structural elements of a helical soil nail.
- 3.21 Net Deflection: The total movement at the helical soil nail head minus the theoretical elastic deformation of the soil nail shaft during a load test.
- 3.22 Nominal Loads: The magnitude of the loads specified, which include dead, live, soil, wind, snow, rain, flood, and earthquakes (also referred to as service loads).
- 3.23 Nominal Resistance: The soil nail capacity at a specified ultimate limit state (Load and Resistance Factor Design). See Ultimate Soil Nail Capacity.
- 3.24 Nominal Strength: A term used in structural design which is defined as the structure or member capacity at a specified strength limit state. See Ultimate Soil Nail Capacity.
- 3.25 Resistance Factor: A factor that accounts for the probability of deviation of the actual resistance (strength) from the predicted nominal resistance (strength) due to variability of material properties, workmanship, type of failure and uncertainties in the analysis (Load and Resistance Factor Design).
- 3.26 Service Loads: See “Nominal Loads” above.
- 3.27 Ultimate Soil Nail Capacity: The helical soil nail capacity based on the least capacity determined from applicable ultimate limit states for mechanical and geotechnical capacity.

4 APPROVED HELICAL SOIL NAIL MANUFACTURERS

- 4.1 Supportworks®, Inc., 11850 Valley Ridge Drive, Papillion, NE 68046; Phone: (800) 281-8545; Website: www.Supportworks.Commercial.com
- 4.2 Due to the specific requirements for design and manufacturing of helical soil nails, the soil nails shall be obtained from 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 Owner for review not less than seven (7) calendar days prior to the bid date. The request must include:
 - 4.2.1 Documentation of at least ten years of production experience manufacturing helical soil nails,
 - 4.2.2 Documentation that the manufacturer’s helical soil nails have been used successfully in at least three engineered construction projects within the last three years,
 - 4.2.3 Complete description of product testing and manufacturing quality assurance programs used to assess and maintain product quality and determine product mechanical strength and geotechnical capacity

5 **ACCEPTABLE PRODUCTS**

Solid Square Shaft Helical Soil Nail Models HS150 and HS175 manufactured in accordance with the requirements of Sections 5 and 6 of this specification.

- 5.1 Helix plates shall meet the following geometry and spacing criteria to minimize soil disturbance:
 - 5.1.1 True helix-shaped plates that are normal to the shaft such that the leading and trailing edges are within ¼-inch of parallel.
 - 5.1.2 Helix pitch is 3-inches \pm ¼-inch.
 - 5.1.3 All helix plates have the same pitch.
 - 5.1.4 Helix plates have generally circular edge geometry.
 - 5.1.5 Helix spacing along the shaft shall be between 2.4 and 3.6 times the helix diameter.
 - 5.1.6 Helix plates are arranged along the shaft such that they all theoretically track the proceeding plate.

6 **MATERIALS**

- 6.1 Central Steel Shaft: 1.50-inch (HS150) or 1.75-inch (HS175) solid, round-corner square (RCS) hot-rolled steel bars conforming to ASTM A29 with a minimum yield strength of 90 ksi and a minimum tensile strength of 115 ksi. Shaft torsional rating of 6,500 ft-lb (HS150) or 10,000 ft-lb (HS175).
- 6.2 Helix Plate Material: Manufactured with 0.375-inch thick, ASTM A572 Grade 50 steel in accordance with ICC-ES AC358 conforming product specifications with outer diameters of 6 or 8 inches.
- 6.3 Shaft Coupling Hardware: HS150 and HS175 shaft sections are coupled with 0.750-inch standard hex bolts conforming to SAE J429 Grade 8 and jam nuts.
- 6.4 Thread Rod Adapter: Thread rod adaptors HA150TRA and HA175TRA are suitable for use with the HS150 and HS175 shafts, respectively.
- 6.5 Material Finish:
 - 6.5.1 Central Steel Shaft, Helix Plates and Thread Rod Adapters: Shall be either plain steel or hot-dip galvanized in accordance with ASTM A123.
 - 6.5.2 Coupling Hardware: Bolts and nuts shall be mechanically galvanized in accordance with ASTM B695.

7 **DESIGN AND PERFORMANCE REQUIREMENTS**

- 7.1 Helical soil nails shall be designed to support the specified load(s) as shown on the project Plans. The overall length, helix diameter and minimum torsional resistance of a helical soil nail shall be such that the required geotechnical capacity is developed by the helix plate(s) in an appropriate bearing stratum.
- 7.2 All structural steel soil nail components shall be designed within the limits provided by the American Institute of Steel Construction (AISC) Specification for Structural Steel Buildings (AISC-360). Either Allowable Strength Design (ASD) or Load and Resistance Factor Design (LRFD) are acceptable methods of analysis. Product testing in accordance with ICC-ES AC358 may also be considered as an acceptable means of establishing system capacities.
- 7.3 The design of helical soil nail walls shall be in accordance with the FHWA Geotechnical Engineering Circular No. 7 (FHWA GEC 7).
- 7.4 Except where noted otherwise on the project Plans, all helical soil nails shall be installed to provide a torque-correlated capacity based on an ASD or LRFD analysis. For ASD, a minimum factor of safety of 2 for internal stability of the wall at the elevation of the toe of the wall shall be used for temporary or permanent applications. Lower factors of safety may be considered if approved by the Owner. When an LRFD analysis is required, the Owner shall provide applicable

soil nail design information including but not limited to; factored loads, resistance factors, and/or the required ultimate soil nail capacity

- 7.5 The required ultimate torque-correlated capacity shall be verified at each soil nail location by monitoring and recording final installation torque and applying default torque correlations per ICC-ES AC358. Site specific torque correlation factors may be determined by field load testing as specified in Section 14.
- 7.6 Except where noted otherwise on the project Plans, each soil nail shall be designed to meet a corrosion service life of 50 years in accordance with ICC-ES AC358.
- 7.7 The soil nail design shall consider group efficiency from soil nail spacing.

8 QUALIFICATIONS OF INSTALLING CONTRACTOR AND DESIGNER

- 8.1 The Installing Contractor and/or Soil Nail Designer shall submit the documentation required in this Section to the Owner. Work shall not begin until all the submittals have been received and approved by the Owner.
- 8.2 Evidence of Installing Contractor's competence in the installation of helical soil nails shall be provided to the Owner's satisfaction and may include the following:
 - 8.2.1 A list of at least three projects completed within the previous three years wherein the Installing Contractor installed helical soil nails or helical tieback anchors. The list shall include names and phone numbers of those project representatives who can verify the Installing Contractor's participation in those projects.
 - 8.2.2 A letter from the helical soil nail manufacturer or manufacturer's representative expressing ability and intent to provide on-site supervision of the soil nail installation.
- 8.3 Evidence of Soil Nail Designer's competence shall be provided to the Owner's satisfaction and may include the following:
 - 8.3.1 Registration as a Professional Engineer or recognition by the local jurisdictional authority,
 - 8.3.2 A list of at least three helical soil nail or tieback projects completed within the previous three years by the Soil Nail Designer. The list shall include names and phone numbers of those project representatives who can verify the Soil Nail Designer's participation in those projects.

9 PRECONSTRUCTION SUBMITTALS

Within 2 weeks of receiving the contract award, the Installing Contractor and/or Soil Nail Designer shall submit the following helical soil nail design documentation to the Owner:

- 9.1 Certification from the Soil Nail Designer that the proposed soil nails meet the requirements of this specification.
- 9.2 Qualifications of the Installing Contractor and Soil Nail Designer per Section 8.
- 9.3 Product designations for helical soil nail lead and extension sections and all ancillary products to be supplied at each helical soil nail location.
- 9.4 Individual soil nail nominal loads, ASD factors of safety or LRFD load and resistance factors.
- 9.5 Individual soil nail loading or post-tensioning requirements (if any).
- 9.6 Manufacturer's published allowable system capacities for the proposed soil nail assemblies, including load transfer devices, if any.
- 9.7 Calculated mechanical and theoretical geotechnical capacities including unit bond stress of the proposed soil nails.
- 9.8 Minimum helical soil nail termination torque requirements.
- 9.9 Maximum estimated installation torque and allowable installation torque rating of soil nail.

- 9.10 Minimum and/or maximum embedment lengths or other site specific embedment length or depth requirements as may be appropriate for the site soil profiles.
- 9.11 Inclination angle and location tolerance requirements.
- 9.12 Load test procedures and failure criteria, if applicable.
- 9.13 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 helical soil nail installation starting date.
- 9.14 Provide proof of insurance coverage as stated in the project Plans and/or contract.

10 PLACEMENT REQUIREMENTS

- 10.1 Helical soil nails shall be installed within 3-inches of the indicated plan location.
- 10.2 Helical soil nail shaft alignment shall be within 2-degrees of the inclination angle shown on the Plans.

11 SOIL NAIL INSTALLATION

- 11.1 Installing Contractor shall furnish and install all helical soil nails per the project Plans and approved soil nail design documentation. In the event of conflict between the project Plans and the approved soil nail design documentation, the Installing Contractor shall not begin construction on any affected items until such conflict has been resolved.
- 11.2 The Installing Contractor shall conduct their construction operations in a manner to ensure 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.
- 11.3 The Owner shall request marking of underground utilities by an underground utility location service as required by law, and the Installing Contractor shall avoid contact with all marked underground facilities.
- 11.4 The portion of the construction site occupied by the Installing Contractor's equipment and material stockpiles shall be kept reasonably clean and orderly.
- 11.1 Installation of helical soil nails may be observed by representatives of the Owner for quality assurance purposes. The Installing Contractor shall give the Owner at least 24 hours' notice prior to the soil nail installation operations.
- 11.2 The lead section shall be positioned at the location and batter angle as determined from the plan drawings and site survey.
- 11.3 The helical soil nail sections shall be advanced into the soil in a continuous manner at a rate of rotation less than 25 revolutions per minute (rpm). Sufficient crowd shall be applied to advance the helical soil nail sections at a rate approximately equal to the pitch of the helix plate per revolution. The rate of rotation and magnitude of crowd pressure shall be adjusted for different soil conditions and depths. The soil nails shall be installed to meet the termination criteria in Section 12.

12 TERMINATION CRITERIA

The minimum final torsional resistance and/or any required soil nail length or embedment depth criteria must be satisfied prior to terminating the soil nail installation. In the event any helical soil nail fails to meet the production quality control termination criteria, the following remedies may be suitable if authorized by the Owner:

- 12.1 When the final installation torque readings at the planned helical soil nail lengths do not achieve the minimum final torque requirements per the design or Plans, the Owner shall be notified to make recommendations for adding soil nails or extending the non-conforming soil nail to greater lengths.
- 12.2 Helical soil nail installation shall be terminated when the planned length is achieved as long as the final installation torque requirements per the design are met. When the maximum torque

rating of the helical soil nail shaft is achieved prior to reaching the design length, the Soil Nail Designer shall be notified to make design recommendations to the Owner.

- 12.3 Helical soil nails that encounter unanticipated obstructions during installation may be relocated with the Owner's approval.

13 INSTALLATION RECORD SUBMITTALS

The Installing Contractor shall provide the Owner, or his authorized representative, copies of individual helical soil nail installation records within 24 hours after each soil nail installation is completed. Formal copies shall be submitted within 30 days following the completion of the helical soil nail installation. These installation records shall include but are not limited to the following information.

- 13.1 Date and time of installation
- 13.2 Gear motor make and model
- 13.3 Location of helical soil nail and soil nail identification number
- 13.4 Helical soil nail model and helix plate diameter
- 13.5 Quantity and length of lead and extension sections installed
- 13.6 Installation torque log taken in minimum 5-foot increments of the total soil nail length and the final installation torque
- 13.7 Installation angle from horizontal of each soil nail
- 13.8 Comments pertaining to interruptions, obstructions, or other relevant information

14 HELICAL SOIL NAIL TESTING

Helical soil nail testing may consist of verification and/or proof testing in conformance with these specifications and the requirements of FHWA GEC 7. The Verification Test Load (VTL) and Proof Test Load (PTL) shall be determined by the Owner, taking into consideration the combined nominal loads using ASD methodology unless stated otherwise in the Plan documents. The Owner shall specify the quantity, type, and location of the soil nail testing. The Installing Contractor shall furnish all labor, equipment, and material necessary to perform soil nail testing as shown on the Plans. The Installing Contractor shall submit a test plan to the Owner for review and approval prior to testing. No deviations from the approved test plan will be allowed without explicit approval in writing from the Owner.

- 14.1 The test plan shall include, but not be limited to, the following information:
 - 14.1.1 The quantity of tests for each type of testing (verification and/or proof) and the proposed locations for testing.
 - 14.1.2 The soil nail test procedures and loading requirements in conformance with these specifications.
 - 14.1.3 The quantity, type, and accuracy of equipment used to apply the test load and monitor soil nail deflection.
 - 14.1.4 Calibration reports for any load application and monitoring equipment used in the load test such as dial or digital gauges, load cells, hydraulic cylinders, and pressure gauges.
- 14.2 The load test equipment shall consist of:
 - 14.2.1 Calibrated dial or digital gauge(s) capable of measuring to 0.001-inch shall be mounted to an independent reference frame to measure soil nail movement.
 - 14.2.2 A hydraulic cylinder and pressure gauge calibrated as a unit shall be used to apply the test loads. The pressure gauge shall be graduated in 100 psi increments or less. The hydraulic cylinder shall have a nominal load capacity exceeding the maximum anticipated jack load by at least 20%. The cylinder maximum stroke shall have an additional 15% stroke length as anticipated for the test.
 - 14.2.3 A reaction frame shall be used to provide reaction for the test loads. The reaction frame shall be designed to minimize movement of the hydraulic cylinder during load

application and to have the load application co-linear to the test soil nail. Proof testing may use a reaction frame against the wall face as a reaction for the test load. The structural capacity of the wall must be sufficient to allow the reaction frame to distribute the proof test load without damage to the wall face.

- 14.3 Verification testing of sacrificial helical soil nails shall be performed prior to installation of production helical nails to verify the Installing Contractor's installation methods and nail pullout resistance. The verification testing shall consist of:
- 14.3.1 Install sacrificial test helical nails in accordance with Section 11 of this specification.
 - 14.3.2 Sacrificial helical test nails shall have lengths of shaft without helix plates (smooth shaft) in addition to the test nail with helix plates in accordance with FHWA GEC 7.
 - 14.3.3 Isolate the test nail from the reaction frame used during testing.
 - 14.3.4 Submit the proposed location and length of shaft sections with and without helix plates prior to testing to the Owner for review and approval in accordance with the Pre-construction Submittals Section 9.
 - 14.3.5 The maximum test load (VTL) shall be determined by the Owner, taking into consideration the required ultimate soil nail capacity and bond stress.
 - 14.3.6 Verification test nails shall be incrementally loaded to a maximum test load of 1.00 VTL in accordance with the following loading schedule. The helical soil nail head movements shall be recorded at the specified times and at the beginning and end of each load increment.

Verification Test Loading Schedule

<u>Load</u>	<u>Hold Time (minutes)</u>
AL (0.025 VTL max.)	1
0.13 VTL	10 (recorded at 1, 2, 4, 5 and 10)
0.25 VTL	10 (recorded at 1, 2, 4, 5 and 10)
0.38 VTL	10 (recorded at 1, 2, 4, 5 and 10)
0.50 VTL	10 (recorded at 1, 2, 4, 5 and 10)
0.63 VTL	10 (recorded at 1, 2, 4, 5 and 10)
0.75 VTL (Creep Test)	60 (recorded at 1, 2, 4, 5, 6, 10, 20, 30, 50, 60)
0.88 VTL	10
1.00 VTL	10
AL	1

The alignment load (AL) should be the minimum load required to align the testing apparatus and should not exceed 2.5% of the VTL. Dial gages should be set to "zero" after the alignment load has been applied. Each load increment shall be held for at least 10 minutes. The verification test helical soil nail shall be monitored for creep at 0.75 VTL. Nail movements during the creep portion of the test shall be measured and recorded at 1 minute, 2, 4, 5, 6, 10, 20, 30, 50, and 60 minutes.

- 14.4 Proof tests shall be performed on production helical soil nails selected by the Owner to verify that there are no significant variations in soil nail performance throughout the wall. The proof testing shall consist of:
- 14.4.1 Isolate the test nail from the shotcrete facing and/or reaction frame used during testing.
 - 14.4.2 The maximum test load (PTL) shall be determined by the Owner, taking into consideration the required ultimate soil nail capacity and bond stress.
 - 14.4.3 Proof test nails shall be incrementally loaded to a maximum test load of 1.00 PTL in accordance with the following loading schedule. The helical soil nail head movements shall be recorded at the specified times and at the beginning and end of each load increment. At load increments other than the maximum test load, the load shall be held long enough to obtain a stable reading

Proof Test Loading Schedule

<u>Load</u>	<u>Hold Time (minutes)</u>
AL (0.025 PTL max.)	1
0.17 PTL	Until Stable
0.33 PTL	Until Stable
0.50 PTL	Until Stable
0.67 PTL	Until Stable
0.83 PTL	Until Stable
1.00 PTL (Creep Test)	10 (recorded at 1, 2, 4, 5, 6 and 10)
AL	

The alignment load (AL) should be the minimum load required to align the testing apparatus and should not exceed 2.5% of the PTL. Dial gages should be set to “zero” after the alignment load has been applied. The proof test helical soil nail shall be monitored for creep at 1.00 PTL. Nail movements during the creep portion of the test shall be measured and recorded at 1 minute, 2, 4, 5, 6, and 10 minutes.

14.5 A helical soil nail test shall be considered acceptable when the following criteria are met:

14.5.1 For verification tests, a total creep movement of less than 0.08 inches per log cycle of time between the 6 and 60 minute readings, and the creep rate is linear or decreasing throughout the creep test load hold period.

14.5.2 For proof tests, a total creep movement of less than 0.04 inches is measured between the 1 and 10 minute readings, or a total creep movement of less than 0.08 inches is measured between the subsequent log cycles, and the creep rate is linear or decreasing throughout the creep test load hold period.

14.5.3 For verification and proof tests, a pullout failure does not occur at the maximum test load. Pullout failure is defined as the load which results in continued pullout (creep) movement of the test helical soil nail.

15 REPORTING REQUIREMENTS:

Installing Contractor shall provide the Owner copies of raw field test data within 24 hours after the completion of each load test. Formal test reports shall be submitted within 30 days following test completion. Formal test reports shall include the following information:

15.1 Name of project and Installing Contractor’s representative(s) present during load testing.

15.2 Name of manufacturer’s representative(s) present during load testing, if any.

15.3 Name of third-party test agency and personnel present during load testing, if any.

15.4 Date, time, duration, and type of the load test.

15.5 Unique test identifier and map showing the test soil nail location.

15.6 Soil nail model and installation information including shaft type, helix diameter, lead and extension section quantities and lengths, angle of installation, final soil nail tip depth, installation date, total test nail length, and final termination torque.

15.7 Calibration records for applicable soil nail installation and test equipment.

15.8 Tabulated test results including cumulative soil nail head movement, loading increments and hold times.

15.9 Plots showing load versus soil nail head movement for each loading/unloading interval.

16 CLEANUP

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