

ITEM 211.0210—25 – SOIL NAILED SLOPE WITH ROPE NET OVER WIRE MESH

1. DESCRIPTION:

- 1.01 The work under this item shall consist of furnishing, installing and testing a steel wire mesh stone retention system made of TECCO® System and/or Spider high-tensile wire rope, soil nails, and associated cables, clips, plates and other fastening hardware as described herein, at the location shown on the Contract Plans or as ordered by the Engineer.
- 1.02 This system shall be installed over a layer of stone filling and geotextile placed under separate items.
- 1.03 The Contractor performing this work shall have prior experience installing soil-nailed structures, as described in this specification.

2. MATERIALS:

- 2.01 All materials used in the construction of this system, with the exception of soil nails, centralizers and nail grout, shall be supplied by Geobrugg North America, LLC, 551 West Cordova Rd., PMB 730, Santa Fe NM, 87505, Tel. () .
- 2.02 TECCO® Steel Wire Mesh G65 shall meet the following requirements:
 - A. The wire shall be alloyed high strength carbon steel wire with a tensile strength of to . The minimum diameter of the wire shall be .
 - B. The mesh shall be woven construction and diamond shaped. The ends of each wire shall be formed in a loop and twisted. The loops of the wire mesh shall be fastened together to prevent unraveling of the mesh. The size of the mesh opening shall be by (+/- 2%) and the depth of the mesh shall be (+ / -). The mesh shall have going across the mesh and going down the mesh.
 - C. The wire shall be galvanized with a / with a minimum weight of .
 - D. TECCO® Compression Claws shall be carbon steel bar with a minimum diameter of . The claws shall be with a minimum layer thickness of .
- 2.03 Spider High-Tensile Spiral Rope Net S4-230 shall meet the following requirements:
 - A. The wire shall be alloyed high strength carbon steel wire with a minimum tensile strength of . The minimum diameter of the wire shall be .
 - B. The rope net shall be woven construction and rhomboid shaped. The ends of each wire shall be formed in a loop and twisted. The loops of the wire mesh shall be fastened together to prevent unraveling of the mesh. The size of the mesh opening shall be by (+/- 5%) and the depth of the mesh shall be (+ / -).

The rope net shall have going across the mesh and going down the mesh.

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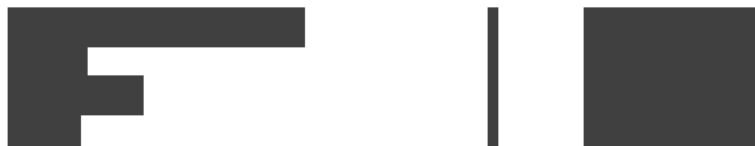
2. MATERIALS: (cont'd)

- C. The wire shall be galvanized with a 95% Zinc / 5% Aluminum coating with a minimum weight of .0256 lbs/ft².
- D. Shackles shall be [REDACTED] h screw pin anchor shackles, have a minimum breaking strength of [REDACTED], shall be galvanized with a minimum layer thickness of [REDACTED], and shall meet Federal Specification [REDACTED] including [REDACTED].
- E. Spider P33/405 Spike Plates shall be diamond-shaped [REDACTED] thick steel plates with a width of [REDACTED] and a length of [REDACTED]. The plates shall be hot-dipped galvanized with a minimum layer thickness of [REDACTED].
- F. Support ropes shall have [REDACTED], a minimum diameter of [REDACTED] and a have minimum breaking strength of [REDACTED]. The rope shall meet the requirements of Federal Specification [REDACTED].

2.04 Soil nails shall meet the following requirements:

- A. Main Nails shall be Dywidag GEWI bolts (or approved equal) with ball nuts with a diameter of [REDACTED] or [REDACTED] as required by the contract drawings. The nails shall have a corrosion allowance of [REDACTED] of [REDACTED] included in their diameter.
- B. Short Nails shall be Dywidag GEWI bolts (or approved equal) with ball nuts with a diameter of [REDACTED], as required by the contract drawings. The nails shall have a corrosion allowance of [REDACTED] included in their diameter.
- C. Nail Centralizers shall be manufactured from [REDACTED] or [REDACTED] or any material not detrimental to the [REDACTED] (except that [REDACTED] shall not be used).

2.05 Nail grout materials shall conform to the following requirements for grout manufacture:



Admixtures which control bleed, improve flowability, reduce water content and retard set may be used in the grout subject to review and acceptance by the Engineer. Acceptance will be based on the manufacturer's name appearing on the NYSDOT Materials Bureau's Approved List. Accelerators and expansive admixtures are not permitted. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations.

2.06 All miscellaneous materials such as wire rope clips, thimbles, etc. shall be [REDACTED] and supplied by the TECCO® and/or Spider System manufacturer.

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3. CONSTRUCTION DETAILS:

3.01 Submissions:

- A. Prior Experience - The following proof of prior contractor experience shall be submitted with the required Shop Drawings to the Chief Engineer of the NYSTA: 1) written documentation listing at least three projects on which the Contractor has successfully installed soil nails and ground anchors including cased anchor installations within the past five years and 2) the foreman and drill rig operators for this work having at least three years experience, on at least three projects, in the installation of soil nails and ground anchors.
- B. Shop Drawings –The methods of construction shall be submitted to the Chief Engineer of the NYSTA for approval. The Chief Engineer of the NYSTA will require 20 working days to approve the submission after receipt of all pertinent information. No work shall begin prior to approval.

The size and type of shop drawings shall conform to the requirements of Subsection [REDACTED] s”.

Include the following information:

- 1. Proposed start date, completion date and detailed system construction sequence.
 - 2. Plan describing how surface water will be diverted, controlled and disposed of.
 - 3. Proposed nail drilling methods and equipment including hole diameter, method of keeping hole open and hole clean-out procedures.
 - 4. Proposed nail grout placement procedures and equipment.
 - 5. Nail grout mix design including: proportions of mix by weight and water-cement ratio, proposed admixtures (manufacturer, dosage, technical literature, etc.), compressive strength test results supplied by a qualified independent testing laboratory verifying a minimum 3-day compressive strength of [REDACTED] and a minimum 28-day compressive strength of [REDACTED].
 - 6. Proposed nail testing (for both verification testing and proof testing) methods and equipment setup including details of the jacking frame and appurtenant bracing and methods of grouting the unbonded length of proof test anchors after testing.
 - 7. Type of equipment, and a description of how this equipment is calibrated, used to tighten nuts and tension mesh to the value specified in the design.
- C. Certifications - Submit the following documentation to the Engineer at least 15 days prior to the planned start of the soil nailed slope system construction:
 - 1. Identification number and certified calibration records for each test jack and pressure gage and load cell to be used. Jack and pressure gauge shall be calibrated as a unit. Calibration records shall include the date tested, device identification number and calibration test results and shall be certified for accuracy of at least 2 percent of the applied certification loads by a qualified independent testing laboratory within 90 days prior to submittal.
 - 2. Manufacturer Certificates of Compliance for the soil nail centralizers.
 - 3. Certified mill test results for nail bars and ball nuts from each heat specifying the ultimate strength, yield strength, elongation and composition.

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3. CONSTRUCTION DETAILS: (cont'd)

- 3.02 Geobrugg North America shall provide a qualified system representative on the site at the start of construction of the Spider and TECCO® Systems to ensure that the Contractor installs the system in accordance with the plans, specifications and approved shop drawings. The representative shall continue to provide technical assistance at the discretion of the Engineer. The representative shall provide the Contractor and the Engineer a copy of the installation guidelines for reference.
- 3.03 The slope area to be stabilized shall be prepared as shown on the plans or as directed by the Engineer and shall be cleared of all trees, brush, debris and loose rock. This work shall be paid under their respective items as indicated on the plans.
- 3.04 Positive control and discharge of all surface water that will affect the installation of the wire rope mesh retention systems shall be provided throughout construction. All ditches, pipes or conduits used to control surface water shall be maintained during construction. Damage caused by surface water shall be repaired at no additional cost. Upon substantial completion of the soil nailed slope system, as determined by the Engineer, surface water control pipes or conduits shall be removed from the site.
- 3.05 Nails shall be installed at the locations and to the inclination and length shown on the drawings. The nail holes shall be progressed by core drilling, rotary drilling, percussion drilling or auger drilling. Install temporary casings as required to keep the hole clean and open. The drill bit diameter shall not be smaller than the specified hole diameter minus [REDACTED]. The hole shall extend [REDACTED] beyond the designed nail length shown on the contract drawings. The holes shall be drilled to the inclination shown on the contract drawings within a three-degree tolerance.
- 3.06 The nails shall be equipped with centralizers at a maximum center to center spacing of [REDACTED] throughout the length of the nail. A centralizer shall also be placed within [REDACTED] of the top and the bottom of the nail. The centralizers shall be fabricated to provide a minimum grout cover over the nail bar of either [REDACTED] or the amount specified on the contract drawings, whichever is greater. The sag of the nail shall be taken into account when selecting centralizer diameter and spacing. The centralizers shall be sized to allow the insertion of a tremie tube to the bottom of the drill hole and allow the grout to freely flow up the drill hole.
- 3.07 The nail shall be inserted in the casing or hole after the hole is drilled to the final depth. The nail shall be located within a [REDACTED], in any direction, of the position shown on the contract drawings. Location tolerances are applicable to only one nail and not accumulative over large slope areas.
- 3.08 Grouting equipment shall be capable of continuous mixing and producing grout free of lumps. The grouting equipment shall be sized to enable the entire nail to be grouted in one continuous operation. The grout shall be placed within 60 minutes after mixing or within the time recommended by the admixture manufacturer, if admixtures are used. Grout not placed in the allowed time limit will be rejected.
- 3.09 The grouting operation shall be performed after the nail is inserted. Each drill hole shall be grouted within 2 hours of completion of drilling, unless otherwise approved by the Engineer. To prevent air voids, the hole shall be filled with grout progressively from the bottom to the top. The drill hole shall be completely filled in one continuous operation.

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3. CONSTRUCTION DETAILS: (cont'd)

- 3.10 For drill holes advanced by either cased or auger methods, a sufficient grout level shall be maintained within the casing during casing removal, to offset the external groundwater/soil pressure and prevent hole caving. A sufficient grout head or grout pressure shall be maintained to ensure that the drill hole will be completely filled with grout and to prevent unstable soil or groundwater from contaminating or diluting the grout.
- 3.11 The grout and nail shall be removed and replaced with fresh grout and undamaged nail bar at no additional cost if grouting is suspended for more than 30 minutes or does not satisfy the requirements of this specification or the approved shop drawings.
- 3.12 **Nail Testing (General)** - Designated nails shall be verification and proof tested. Verification tests shall be performed on sacrificial test nails as described herein. Proof tests shall be performed on production test nails at locations selected by the Engineer and as described herein. Nail testing shall not be performed until the nail grout has cured for at least 72 hours and attained at least its specified 3-day compressive strength. Testing in less than 72 hours will only be allowed if the Contractor submits compressive strength test results, for tests performed by a qualified independent testing laboratory, verifying that the nail grout being used will provide the specified 3-day compressive strength in the lesser time.

Test nails shall be constructed using the same equipment, method and hole diameter as planned for the production nails. Changes in the drilling or installation method may require additional testing as determined by the Engineer.

Each test nail shall have a minimum temporary unbonded length of [REDACTED]. The bonded length of the test nail shall be grouted prior to testing. The test nail shall be isolated from the reaction frame during testing.

The alignment load (AL) necessary to maintain position of the stressing and testing equipment shall not exceed 0.05 times the design load (P). Set dial gauges to “zero” after the alignment load has been applied.

The maximum test load shall not exceed 80 percent of the guaranteed ultimate tensile strength of the nail. Monitor the jack load with a load cell. Provide the Engineer with the calibration curve before start of testing.

Submit two copies of all test data to the Engineer.

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3. CONSTRUCTION DETAILS: (cont'd)

- 3.13 **Verification Tests** – A minimum of two verification tests shall be performed in each different soil/rock unit and for each different drilling/grouting method proposed to be used. Verification test nails will be sacrificial and not incorporated as production nails. Bare bars can be used for the sacrificial verification test nails.

Incrementally load the verification test nails to a maximum test load of 2 times the design load (P) in accordance with the following schedule. Record soil nail movements (to the nearest 0.025 mm) at each load increment.

<u>Load</u>	<u>Hold Time</u>
AL	1 minute
0.25 P	10 minutes
0.50 P	10 minutes
0.75 P	10 minutes
1.00 P	10 minutes
1.25 P	10 minutes
1.50 P (Creep Test)	60 minutes
1.75 P	10 minutes
2.00 P	10 minutes

Monitor the verification test nail for creep at the 1.50 P load increment. Measure nail movements during creep portion of the test and record at 1 minute, 2, 3, 5, 6, 10, 20, 30, 50 and 60 minutes. Maintain load during the creep test within 2 percent of the intended load by use of the load cell. The Engineer will review all verification tests to determine if the nail is acceptable. A nail will be accepted if the following three criteria are met:

1. A total creep movement of less than [REDACTED] per log cycle of time between the 6 and 60 minute readings is measured during creep testing and the creep rate is linear or decreasing throughout the creep test load hold period.
 2. The total measured movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the test nail unbonded length.
 3. A pullout failure does not occur at the maximum test load. Pullout failure is defined as the load at which attempts to further increase the test load simply result in continued pullout movement of the test nail. The pullout failure load shall be recorded as part of the test data.
- 3.14 **Proof Testing** - Perform proof testing on 5 percent (1 in 20) of the production nails in each row or a minimum of 1 per row. The Engineer shall designate the locations. Incrementally load the proof test nail to a maximum test load of 1.5 times the Design Load (P) in accordance with the following schedule. Record the soil nail movements (to the nearest 0.001 inch) at each load increment.

<u>Load</u>	<u>Hold Time</u>
AL	Minimum of 1 minute
0.25 P	Minimum of 1 minute
0.50 P	Minimum of 1 minute
0.75 P	Minimum of 1 minute
1.00 P	Minimum of 1 minute
1.25 P	Minimum of 1 minute
1.50 P (Max. Test Load)	See Below

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3. CONSTRUCTION DETAILS: (cont'd)

3.14 Proof Testing (cont'd)

Hold each load increment, except for the 1.50 (P) load, until the deflection stabilizes.

All load increments shall be maintained within 5 percent of the intended load. Depending on the performance, either 10 minute or 60 minute creep tests shall be performed at the maximum test load (1.50 P). The creep period shall start as soon as the maximum test load is applied and the nail movement shall be measured and recorded at 1 minute, 2, 3, 5, 6 and 10 minutes. Where the nail movement between 1 minute and 10 minutes exceeds 0.04 inch, the maximum test load shall be maintained an additional 50 minutes and movements shall be recorded at 20 minutes, 30, 50 and 60 minutes.

The Engineer will review all proof tests to determine if the nail is acceptable. A nail will be accepted if the following three criteria are met:

1. A total creep movement of less than 0.04 inch per log cycle of time between the 1 and 10 minute readings or a total creep movement of less than 0.08 inch 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.
2. The total measured movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the test nail unbonded length.
3. A pullout failure does not occur at the maximum test load. Pullout failure is defined as the load at which attempts to further increase the test load simply result in continued pullout movement of the test nail. The pullout failure load shall be recorded as part of the test data.

Test nails meeting the above requirements shall be completed by satisfactorily grouting up the unbonded test length. Maintaining the temporary unbonded test length for subsequent grouting is the Contractors responsibility. If the unbonded test length of production proof test nails cannot be satisfactorily grouted subsequent to testing, the proof test nail shall become sacrificial and shall be replaced with an additional production nail installed at no additional cost.

For nails that the Engineer finds unacceptable, the Contractor shall submit a written proposal containing a suggested course of action.

- 3.15 Hollows shall be formed around each nail head in preparation for mesh placement and pretensioning. The hollows shall be between [REDACTED] deep. The threads of the exposed nail shall be cleaned of mortar remnants.
- 3.16 If shown on the contract drawings, geotextile shall be placed on the slope in accordance with the appropriate item. Holes shall be cut in the mat at the location of each nail as directed by the System representative
- 3.17 Lay the wire mesh on the slope by positioning the mesh roll at the top of the slope and unrolling it down the slope, or as directed by the System representative. Adjacent mesh sheets are to overlap by the width of one mesh, and be secured by one compression claw over each boundary knot as directed by the System representative. Splices made to connect ends of successive rolls of mesh shall be as directed by the System representative.

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3. CONSTRUCTION DETAILS: (cont'd)

- 3.18 Lay the rope net over the wire mesh by positioning the net roll at the top of the slope and unrolling it down the slope, or as directed by the System representative. Adjacent rope net sheets are to overlap by the width of one mesh, and be secured together using [REDACTED] pin anchor shackles at every vertex. Rope net shall be secured to the support rope using [REDACTED] pin anchor shackles at every vertex. Perimeter nails shall be located such that the diamond plate catches the edge vertex and the support rope.
- 3.19 Install support ropes as directed by the TECCO® System representative.
- 3.20 The spike plates and anchor ball nuts shall be fitted over each nail head and pretensioned to the load given in the contract drawings (between [REDACTED]). The method of applying and measuring the pretensioning load shall be as indicated on the contract drawings.
- 3.21 Corrosion protection shall be applied to the exposed nail head as detailed on the contract drawings.

4. METHOD OF MEASUREMENT:

- 4.01 The unit of measurement for the soil nailed slope with rope net over wire mesh system shall be the number of square yards of slope face satisfactorily installed between the payment lines shown on the Plans or as revised, in writing, by the Engineer.

5. BASIS OF PAYMENT:

- 5.01 The unit price bid per square yard shall include the cost of furnishing all labor, equipment, materials and tests required to construct the soil nailed slope with rope net over wire mesh system.