



**SPECIAL PROVISIONS
FOR
PERMANENT SOIL NAIL SLOPE REINFORCEMENT**

**Dubuque County
NHSX-032-1(50)--3H-31**

**Effective Date
January 17, 2018**

THE STANDARD SPECIFICATIONS, SERIES OF 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150378a.01 DESCRIPTION.

A. General.

1. The Work shall consist of constructing permanent soil nails for slope reinforcement as shown on the plans. The Contractor shall furnish all labor, materials and equipment required for completing the Work. The Contractor shall select the method of drilling, and grouting procedures to meet the performance requirements specified in the contract documents.
2. The Work shall include excavating to the limits shown in the plans, drilling holes to the minimum length and specified orientation indicated on the plans, providing, placing and grouting steel bars (nails) in the drilled holes, installing turf reinforcement mat over the slope, attaching connection plates. Turf reinforcement mat installation is covered under separate sections of the special provisions.
3. The Contractor is responsible for locating and verifying the as-built location of all utilities within the ground mass to be soil nailed prior to starting the Work. As-built information shall be submitted to the Engineer for review in accordance with the submittals procedures.
4. Contractor may elect to submit alternate reinforcement designs in accordance with the provisions of this special provision.

B. Quality Assurance.

1. Prior to starting the Work, the Contractor shall submit a list identifying the superintendent, drill rig operators, and on-site supervisors assigned to the project. The list shall contain a summary of each individual's experience, and shall be sufficiently complete for the Engineer to evaluate the individuals' qualifications. The Contractor shall not use consultants or manufacturer's representatives to satisfy the requirements of this section. The Contractor's superintendent

shall have at least 3 years experience installing soil nails and shall be responsible for the workmanship of his crew.

2. The Engineer will approve or reject the Contractor's qualifications within 10 days after receipt of a complete submission. Work shall not be started nor materials ordered until written approval of the Contractor's qualifications is given.
3. The Engineer may suspend work if the Contractor substitutes non-approved personnel for approved personnel. The Contractor shall be fully liable for additional costs resulting from the suspension of work and no adjustments in the contract time resulting from the suspension of work shall be allowed.
4. Nail grout shall be tested at a frequency of four cylinders for each day nails are grouted or every 50 cubic yards whichever is less. Cylinders shall be broken at 3, 7 & 28 days.

C. Submittals.

1. Unless otherwise required by the project documents, the Contractor shall submit:
 - a. The proposed schedule and a detailed construction sequence.
 - b. Methods of staged excavation and excavation equipment types.
 - c. Drilling methods and equipment including auger size and any variation of these within the excavation.
 - d. Nail grout mix design including:
 - Brand and type of Portland cement used.
 - Source, gradation, and quality of all aggregates.
 - Proportions of mix by weight.
 - Manufacturer and brand name of all admixtures.
 - Compressive strength tests verifying the design 7 and 28 day compressive strengths.
 - e. Nail grout placement procedures and equipment.
 - f. Certified mill test results for nail bars together with properly marked samples from each heat specifying the guaranteed ultimate strength, yield strength, elongation and composition.
2. In addition, nail installation logs and daily production reports for each nail shall be submitted to the Engineer at the beginning of the following production week.
3. The Contractor shall submit the necessary information and survey data summarizing all nail locations and other as-built design information as required by the special provisions.

D. Handling and Storage.

1. Cement shall be stored in suitable moisture-proof enclosures. Cement that has become caked or lumpy shall not be used.
2. Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles in contact with the ground shall not be used.
3. Reinforcement shall be carefully handled and shall be stored on supports to keep the steel from contact with the ground. Damage to the nail steel as a result of abrasion, cuts, nicks, welds, and weld splatter shall be cause for rejection. The nail steel shall be protected if welding is to be performed in the vicinity. Grounding of welding leads to the nail steel will not be allowed. Nail steel shall be protected from and sufficiently free of dirt, rust, and other deleterious substances prior to installation. Heavy corrosion or pitting of nails shall be cause for rejection.

E. Drainage Control.

1. Perched water has been observed in test borings conducted for the project and may be encountered throughout the excavation.
2. The Contractor shall provide and maintain adequate site drainage to remove and dispose of all surface water and groundwater entering the excavation, or other parts of the Work.
3. Surface water during construction shall be diverted or otherwise prevented from entering excavated areas to the greatest extent practicable without causing damage to adjacent property.

F. Tolerances.

The nails shall not extend beyond the limits shown on the Plans. Bars shall be centered using centralizers as required herein. Individual nails shall be positioned plus or minus 12 inches from the design locations shown in the Plans. Location tolerances shall be considered applicable to only one nail and not accumulative over large wall areas. The nail inclination shall be ± 5 degrees of that shown in the Plans. Nails which encounter obstructions during drilling shall be re-installed at locations selected by the Engineer.

150378a.02 MATERIALS.

Materials for construction of soil nail reinforcement shall be furnished new and without defects. Defective materials shall not be used but shall be removed from the job site by and at the expense of the Contractor. Materials for soil nail reinforcement shall consist of the following:

A. Centralizers.

PVC, steel or other material not detrimental to the nail steel; wood shall not be used. Centralizers shall fully expand to the diameter of the drill hole and, allow uninhibited grout flow into hole.

B. Nail Grout.

1. The grout shall be non shrinking with a 7 day strength of 3000 psi, a minimum cement content of 10 sacks per cubic yard, sand/cement mixture.
2. The cement shall conform to ASTM C150, Type I, II or III.
3. The fine aggregate shall consist of clean, natural sand conforming to ASTM C33.

C. Bearing Plates.

The bearing plates shall conform to AASHTO M183/ASTM A36. Center hole shall be threaded.

D. Solid Bar Nails.

The solid nail bars shall conform to AASHTO M31/ASTM A 615, Grade 60, AASHTO M275/ASTM A 722, Grade 150, or Grade 75 continuous, without splices or welds, deformed, and threaded at least 12 inches on one end, new, straight and undamaged.

150378a.03 CONSTRUCTION.

The construction sequence shall be as specified herein, unless otherwise approved by the Engineer.

A. Excavation.

1. With reference to the terms and conditions of the construction standards for excavations set forth in the OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, the Contractor shall employ a competent person and, when necessary, a registered professional designee, to act upon all pertinent matters of the Work of this section.

2. Contractor shall coordinate mass grading and nail installation according to the approved excavation sequence submitted by the Contractor. Overexcavating the ground surface beyond the final slope grade shall not be allowed.
3. The Contractor shall ensure that installed nails are not damaged during excavation. Nails damaged or disturbed during excavation shall be repaired or replaced by the Contractor to the satisfaction of the Engineer.
4. Excavations shall not be advanced more than 15 feet below the level of installed nails until nail installation of preceding lifts are complete and acceptable to the Engineer. Prior to advancing the excavation, nail grout on the preceding lift shall have reached 50% of the 7 day strength.
5. Construction sequences other than those described herein shall be considered provided that submittal requirements as described herein are satisfied.
6. Cobbles and boulders may be encountered at the soil face during excavation. Contractor shall remove all cobbles and boulders that protrude from the soil face more than two inches shown on the plans and shall fill the voids with soil.
7. Facial raveling at the face or local instability of the exposed cut due to the presence of perched groundwater, problematic soil conditions, equipment vibration or other causes shall be brought to the immediate attention of the Engineer. Work shall be suspended in these areas until remedial measures are submitted and approved by the Engineer and have successfully arrested facial instability.

B. Nail Installation.

1. No classification of excavated materials from nail holes will be made except for identification purposes. Nail installation shall include the removal and subsequent handling of all materials encountered in excavating the nails to the depths required.
2. Drilling equipment shall be designed to drill straight and clean holes. The size and capability of drilling equipment shall be suitable for installation of nails as specified herein.
3. Each nail hole shall be excavated at the locations and to the minimum lengths indicated on the plans. Cuttings shall be removed by air flushing or augering methods. Flushing with water shall not be allowed. The nail hole shall be considered clean upon retraction of the auger unless hole has caved or other defect is observed. Overcleaning shall be avoided. No portion of the nail hole shall be left open for more than 120 minutes prior to grouting unless otherwise approved.
4. The Contractor shall provide positive support as the drilling proceeds as required to prevent sloughing and caving of the hole caused by excessive groundwater infiltration prior to grouting. Where caving and sloughing occurs, holes shall be continuously supported and drilled without the loss of ground through casing or auger-cast installation methods. Drilling fluids such as bentonite or water shall not be allowed as a means of hole support. All additional installation, material, and other costs due to casing holes shall be borne by the Contractor.
5. Casing shall be of steel or fiber construction and shall be of ample strength to withstand handling and installation stresses, grout pressure, and surrounding earth and groundwater pressures. Casings shall be removed as the grout is placed. The casing extraction shall be facilitated by the use of a vibratory extractor, if required. During removal, the casing shall be continually aligned with the hole, and the grout surface within the casing shall be continually observed for maintenance of "head" sufficient to offset the external groundwater/soil pressure. Casing seals shall not be broken until the level of grout within the casing provides adequate head to prevent unstable soil or groundwater from contaminating or diluting the grout. The

Contractor shall maintain at least 5 feet of grout head above the bottom of the casing at all times to preclude "blowins".

C. Production Nails.

1. No drilling or bar placement for production nails shall be allowed without prior written approval of the proposed drilling, installation and grouting methods. Only installation methods which have a record of successful performance shall be approved for production nail installation. Methods which fail to meet the verification acceptance criteria shall be rejected.
2. Nails shall be installed at the locations and to the minimum grouted lengths as shown on the plans. Nails may be added, eliminated, or relocated as determined by the Engineer to accommodate actual field conditions.
3. The diameter of the hole, drilling method, grout composition and installation method shall be as shown on the Plans. The nail hole shall have a diameter as shown on the plans to accommodate the required nail, couplers, and centralizers.
4. **Bar Installation.**

Bar sizes and grades shall be provided for each nail hole as indicated on the plans. The bar shall be fitted with centralizers as shown on the plans (at least two centralizers per bar) and inserted into the hole to the required depth without difficulty. Where the bar cannot be completely inserted, the Contractor shall remove the bar and clean or redrill the hole to permit unobstructed installation. Partially installed bars shall be rejected.
5. **Grouting.**
 - a. After installation of the nail bar the nail hole shall be grouted. Gravity flow of grout into the nail hole from the excavation face shall not be allowed. The grout shall be injected at the lowest point of each drill hole through a grouting conduit and the hole filled in one continuous operation; no cold joint shall be allowed. The grout shall be pumped through grout tubes, casing, or drill rods. The conduit delivering the grout shall be maintained at least five feet below the surface of the grout as the conduit is withdrawn. The grouting conduit shall be withdrawn at a slow and even rate as the nail hole is filled in a manner which precludes the creation of voids. A sufficient quantity of grout to fill the entire nail hole shall be available in delivery trucks at the site when the first grout is placed in each nail.
 - b. If the quality of construction operation results in a nail of questionable or inferior integrity, the steel and grout shall be removed from the hole, disposed of and replaced with fresh grout and undamaged steel.
 - c. The quantity and pressure of the grout shall be carefully controlled. The grout equipment shall produce a uniformly mixed grout free of lumpy and undispersed cement. A positive displacement grout pump shall be provided. The grouting equipment shall be sized to enable the entire nail to be grouted in one continuous operation. The mixer shall be capable of continuously agitating the grout during placement.

D. Site Monitoring.

1. The Contractor shall visit the site prior to any construction activities, observe and document the preconstruction condition of all structures, infrastructure, sidewalks, roadways, and all other facilities adjacent to the site. The Contractor shall make daily visual observation for signs of ground or building movements in the vicinity of each working front. The Contractor shall notify the Engineer within 24 hours both verbally and in writing, if signs of movements such as new cracks in structures, increased size of old cracks or separation of joints in structures, foundations, streets or paved and unpaved surfaces are observed.
2. The Engineer may direct the Contractor to monitor particular structures or areas more frequently using crack monitoring devices, or additional temporary bench marks.

E. Special Inspection.

1. All components of the system shall receive full-time special inspection by a qualified engineer or representative of the City.
2. Special inspection shall include the following:
 - a. Verify proper cleaning of drilled nail holes. Note any areas of sloughing.
 - b. Verify the nails are installed to the correct orientation, spacing, size/grade, and length.
 - c. Verify centralizers are used.
 - d. Verify proper grouting of the nails in the drilled hole.

150378a.04 ALTERNATE SOIL NAIL DESIGN REQUIREMENTS.

Contractor may elect to submit alternate reinforcement designs in accordance with the provisions of this special provision.

A. Experience and Requirements Submittals.

1. The Contractor shall be experienced in the construction of soil nails and shall provide documentation of a minimum of three projects performed in the two-year period preceding the bid date in which soil nails were installed successfully under subsurface and project conditions similar to those of the current project. The Contractor shall also provide documentation that the designated job site supervisor (foreman or crew chief) has had a minimum of three years of experience in supervision of the installation of soil nails. Drill rig operators shall be documented to have a minimum of 3 years experience installing soil nails.
2. The Contractor shall assign a Project Manager to supervise the work that has a minimum of 3 years experience with projects of similar size and scope. The Contractor shall not use consultants or manufacturers' representatives to satisfy the Project Manager requirements of this section. This person may also be the Design Engineer if the Project Manager/Design Engineer is an employee of the Contractor. A Design Engineer that is a Consultant cannot be the Project Manager.
3. The soil nail reinforcement shall be designed by the Design Engineer, a Professional Engineer licensed in the State of Iowa with experience in the design of at least three successfully completed projects over the past five years with soil nails of similar capacity to those required for the project. The Design Engineer may be either an employee of the Contractor or a separate Consultant Design Engineer meeting the stated experience requirements.
4. Five copies of the completed project reference list and personnel list shall be submitted by the Contractor at least 30 calendar days before the planned start of construction.
5. The personnel list shall identify the Contractor, Project Manager, drill rig operators, and job site supervisor to be assigned to the project. The personnel list shall contain a summary of each individual's experience and be complete enough for the Engineer to determine whether each individual satisfies the required qualifications. The Engineer will approve or reject the Contractor's qualifications within 10 calendar days after receipt of a complete submission.
6. The work shall be performed by the personnel listed on the submittals. If personnel changes need to be made during the course of the project, work shall be suspended until the replacement personnel are approved by the Engineer. Additional time required due to incomplete submittals, unacceptable submittals, or obtaining approval of replacement personnel will not be cause for a time extension or delay claims. All costs associated with incomplete, replacement, or unacceptable submittals shall be borne by the Contractor.

B. Soil Nail Design Submittals.

The soil nails and turf reinforcement mat shall be designed to provide an equivalent shear reinforcement of 175 psf measured parallel to the final slope grades within the upper 15 feet of the slope profile. Sufficient embedment beyond the upper 15 feet shall be provided to adequately anchor the slope reinforcement. A Creep-Limited bond strength of 9 psi shall be used for anchorage design. The design life of the reinforcement shall be 75 years.

1. At least 60 calendar days before the planned start of soil nail construction, submit complete design calculations and working drawings to the Engineer for review and approval. Include all details, dimensions, quantities, ground profiles, and cross-sections necessary to construct the slope reinforcement.
2. The working drawings and calculations shall be signed and sealed or stamped by the Contractor's Design Engineer or by the consultant Design Engineer (if applicable), previously approved by the Engineer. If the Contractor uses a consultant Design Engineer to prepare the design, the Contractor shall have overall contractual responsibility for both the design and construction.
3. The Engineer will approve or reject the Contractor's submittal within 30 calendar days after receipt of a complete submission. If revisions are necessary, make the necessary changes and resubmit. The Contractor will not be allowed to begin work until the submittal requirements are satisfied and found acceptable by the Engineer. Changes or deviations from the approved submittals must be re-submitted for approval. No adjustments in contract time or delay or impact claims will be allowed due to incomplete submittals.

C. Design Calculations.

Design calculations shall include, but not be limited to, the following items:

1. A written summary report which describes the overall soil nail design.
2. Applicable code requirements and references.
3. Critical design cross-section(s), including soil/rock strata, piezometric levels, and location, magnitude and direction of applied loads.
4. Design criteria, including soil/rock shear strengths (friction angle and cohesion), unit weights, unit skin friction values, and unit end-bearing values. Any additional subsurface borings, laboratory work, or other subsurface data collected for the design shall also be included.
5. Safety factors used in the design.
6. Seismic design earthquake acceleration coefficient or other seismic design criteria applicable for the geographic area of the project.
7. Design calculation sheets (both static and seismic) with the project number, soil nail location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. Provide an index page with the design calculations.
8. Design notes including an explanation of any symbols and computer programs used in the design.

D. Working Drawings.

The working drawings shall include all information required for the construction and quality control. Working drawings shall include, but not be limited to, the following items unless provided in the contract plans:

1. A plan view of the slopes to be reinforced identifying:
 - a. A reference baseline datum.
 - b. Beginning and end station of soil nail installation.
 - c. Soil nail locations with horizontal and vertical nail spacing.
 - d. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures or other potential interferences.
 - e. The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the soil nail slope reinforcement.
 - f. Subsurface exploration locations shown on a plan view of the proposed alignment with appropriate reference base lines to fix the locations of the explorations relative to the reinforced slopes.
2. An elevation view of the reinforced soil slopes identifying:
 - a. Soil nail locations and elevations with vertical and horizontal spacing;
 - b. Existing and finished grade profiles.
3. General notes for constructing the soil nails including construction sequencing or other special construction requirements.
4. A listing of the summary of quantities.
5. Soil nail typical sections including spacing, diameter, reinforcing bar sizes, locations, and details; centralizers and spacers; and connection details to the turf reinforcement mat.

E. Construction Submittals.

1. At least 60 calendar days before the planned start of construction, submit complete construction submittals to the Engineer for review and comment. The Engineer will review and comment on the Contractor's submittal within 10 calendar days after receipt of a complete submission. If revisions are necessary, make the necessary changes and resubmit. The Contractor will not be allowed to begin work until the submittal requirements are satisfied and found acceptable by the Engineer. Changes or deviations from the approved submittals must be re-submitted for approval. No adjustments in contract time or delay claims will be allowed due to incomplete submittals.
2. Soil Nail Installation Plan. The Contractor shall use the Soil Nail Installation Plan to demonstrate, to the satisfaction of the Engineer, the dependability of the equipment, techniques, and source of materials to be used on the project. Reference to successful completion of projects with similar pile sizes in similar soil conditions using the proposed equipment and procedures should be included. The components of the plan shall meet the requirements contained in this specification. This plan shall include, but not be limited to, the following items:
 - a. List and sizes of proposed equipment, including drilling rigs, augers and other drilling tools, pumps for grout or concrete, mixing equipment, and similar equipment to be used in construction, including details of procedures for calibrating equipment as required;
 - b. Step-by-step description of nail installation procedures
 - c. A plan of the sequence of nail installation;
 - d. Target drilling and grouting parameters (along with acceptable ranges) for nail installation,
 - e. Details of methods of reinforcement placement and methods for centering the nails within the grout column
 - f. Mix designs for all grout to be used on the project
 - g. Other required submittals shown on the plans or requested by the Engineer.

150378a.05 METHOD OF MEASUREMENT.

Permanent Soil Nail Slope Reinforcement will be measured on a linear foot basis. The final pay quantities will be the design quantity increased or decreased by any changes authorized by the Engineer.

150378a.06 BASIS OF PAYMENT.

The quantity of Permanent Soil Nail Slope Reinforcement accepted for payment will be paid for at the contract unit price. The contract unit price for the Permanent Soil Nail Slope Reinforcement pay item will be full and complete payment for providing all design, materials, labor, equipment, and incidentals to furnish and install the soil nail reinforcement system in accordance with the contract documents.