

SECTION 00398 - ROCK SLOPE STABILIZATION AND REINFORCEMENT

(Follow all instructions and make all edits with "Track Changes" turned on. If there are no instructions [purple text] above a subsection, paragraph, sentence, or bullet, then include it in the Project. Delete all purple text before preparing the final document. All other modifications to this Section will require ODOT Technical Resource and State Specifications Engineer approval.)

Comply with Section 00398 of the Standard Specifications modified as follows

00398.02 Definitions:

Replace the definition "**Anchored High Tensile Strength Wire Mesh Slope Protection**" with the following definition:

Anchored High Tensile Strength Wire Mesh Slope Protection - A system of woven, diamond-patterned mesh made of a single type of high tensile strength wire, supported by wire ropes secured with Slope Protection Anchors, and held against the slope with a pattern of Anchor Nails, Spike Plates, and Boundary Ropes.

Replace the definition "**High Tensile Strength Wire Mesh Slope Protection**" with the following definition:

High Tensile Strength Wire Mesh Slope Protection - A system of woven, diamond-patterned mesh made of a single type of high tensile strength wire draped over a rockfall slope and anchored with Slope Protection Anchors. High Tensile Strength Wire Mesh Slope Protection is used where Rocks are generally less than 4 feet in diameter.

Replace the definition "**Spike Plate**" with the following definition:

Spike Plate - A diamond-shaped steel plate used with an Anchor Nail in an anchored Wire Mesh Slope Protection system to structurally connect the wire mesh to the Anchor Nail.

00398.03(b)(1) Working Drawings - Replace the paragraph that begins "Working Drawings shall..." with the following paragraph:

Submit Working Drawings including at least the following information:

00398.03(b)(2) Working Plan - Replace the bullet that begins "Color(s) for powder coating or otherwise ..." with the following bullet:

- Color(s) for powder coating or otherwise coloring all wire rope and cable to match the mesh color, if mesh color is specified or shown. Furnish colors according to Federal Standard 595C.

00398.03(b)(3) Field Construction Manual - Replace this subsection, except for the subsection number and title, with the following:

Provide a field construction manual, prepared by the manufacturer of the proprietary flexible rockfall barrier system, including step-by-step directions for constructing the system. Include the manufacturers' anchor testing procedures and acceptance criteria.

00398.03(b)(4) Field Maintenance Manual - Replace this subsection, except for the subsection number and title, with the following:

Provide a field maintenance manual, prepared by the manufacturer of the proprietary flexible rockfall barrier system, including:

- Step by step instructions for maintaining the system.
- A Project specific list of all proprietary components with stock or product reference numbers and illustrations.
- A Project specific list of all non proprietary components.

00398.03(c) Anchored High Tensile Strength Wire Mesh Slope Protection Submittals - Replace the bullet that begins "Documentation demonstrating satisfactory performance..." with the following bullet:

- Documentation demonstrating satisfactory performance of the steel mesh provided by this Supplier in other projects completed for use as part of an anchored high tensile strength steel mesh system where the site conditions were similar to the conditions on this Project.

Replace the bullet that begins "Color(s) for powder coating or otherwise ..." with the following bullet:

- Color(s) for powder coating or otherwise coloring all wire rope and cable to match the mesh color, if mesh color is specified or shown. Furnish colors according to Federal Standard 595C.

00398.10(a) Steel Anchor Bolts - Replace this subsection, except for the subsection number and title, with the following:

Furnish 1 inch diameter, continuously threaded or deformed, Grade 75 steel anchor bolts, complete with keyhole plate, grout tube, washer, and nut, meeting the requirements of AASHTO M 31 (ASTM A615). Furnish anchor bolts made of one continuous bar. Welding and couplers are not allowed. Galvanize all steel anchor bolts according to AASHTO M 232 (ASTM A153). Furnish grout tubes, grout sealers, and other grouting accessories for grouting anchor bolts of type recommended by the manufacturer and as approved.

00398.10(b) Steel Plates, Washers, and Nuts - Replace this subsection, except for the subsection number and title, with the following:

Furnish steel plates, washers, and nuts for steel anchor bolts meeting the requirements of ASTM F432. Furnish 3/8-inch, flat steel plates that provide not less than 6 by 6-inch area for each bolt. Furnish steel or malleable iron beveled washers and hardened steel machine

washers. Furnish heavy hexagonal type nuts. Galvanize all plates, washers, and nuts according to AASHTO M 232 (ASTM A153), Class C. Furnish Class A castings and Class B forgings.

00398.10(c) Wire Rope - Replace this subsection, except for the subsection number and title, with the following:

Furnish wire rope for Slope Protection Anchors meeting the current requirements of Federal Specification RR W 410 and ASTM A1023. Furnish general purpose, 3/4-inch diameter, 6x19 independent wire rope core (IWRC), galvanized wire rope, with the wire rope core made from extra improved plow steel and a minimum breaking force of 58,800 pounds. Attach ferrules to the rope to prevent withdrawal from the encapsulating concrete during testing. Galvanize ferrules and thimbles according to AASHTO M 232 (ASTM A153).

00398.10(e) Cement Grout - Replace this subsection, except for the subsection number and title, with the following:

Furnish non-epoxy cement grout for anchors in Rock, approved by the Engineer, from section 02080.20 of the QPL. Follow the manufacturer's recommendations for water-cement ratio, mixing and set times.

00398.11 Posts, Braces, and Appurtenances for Post Supported Wire Mesh - Replace this subsection, except for the subsection number and title, with the following:

Furnish Schedule 40, hot-dip galvanized steel pipe according to ASTM A53, Grade B, for posts, post sleeves, and braces. Furnish posts and braces that are 4-inch outside diameter. Furnish post sleeves that are 4.5 inch outside diameter (to accommodate post). Furnish post caps, strap clamps, bolts, and nuts that are hot dip galvanized according to AASHTO M 232 (ASTM A153). Repair all cutting, welding, and drilling as well as other damage to the galvanizing according to 02420.10(d).

00398.12 Top Horizontal Support Rope and Support Post Retaining Rope - Replace the paragraph that begins "Furnish top horizontal Support Rope..." with the following paragraph:

Furnish top horizontal Support Rope and support post retaining rope of the sizes shown and meeting the current requirements of Federal Specification RR-W-410 and ASTM A1023. Furnish Type 1, general purpose, Class 2, 6x19 IWRC, galvanized wire rope, with the wire rope core made from extra improved plow steel.

00398.13 Hardware for Post Supported Wire Mesh - Replace the paragraph that begins "Furnish rings and eyes of drop-forged..." with the following paragraph:

Furnish rings and eyes of drop-forged steel, heat treated after forging. Furnish wire rope thimbles and clips sized for the wire rope shown. Galvanize all rings, eyes, thimbles, wire rope clips, U-bolts and miscellaneous hardware according to AASHTO M 232 (ASTM A153), Class C. Furnish galvanized Class A castings and Class B forgings according to AASHTO M 232 (ASTM A153), Class C.

00398.14(c) Gabion Wire High Tensile Steel Fasteners and Lacing Wire - Replace this subsection, except for the subsection number and title, with the following:

Furnish 11-gauge, high tensile steel fasteners meeting the requirements of ASTM A975 and ASTM A764, with Class 3 zinc coating according to ASTM A641 and minimum panel to panel connection strengths meeting the requirements of ASTM A975.

If stainless steel fasteners are shown, furnish fasteners according to ASTM A313, Type 302.

Furnish lacing wire with the same coating Material as the gabion wire mesh fabric and according to ASTM A641 and ASTM A975. If PVC coating is required, provide the same color as the gabion wire mesh fabric.

00398.14(d) High Tensile Strength Wire Mesh Fabric - Replace this subsection, except for the subsection number and title, with the following:

Furnish wire mesh fabric of woven construction with the ends of each wire formed into a loop and twisted. Fasten the loops of the wire mesh together to prevent unraveling of the mesh. Furnish wire that is alloyed, high-strength carbon steel wire with minimum diameters and tensile strengths complying with ASTM A1007 (Level 3 drawn Zn5 Al wire). Minimum wire diameter is shown. Hot-dip galvanize the wire with a zinc/aluminum coating with a minimum weight of 0.40 ounce per square foot for Level 3 drawn Zn5 Al wire according to ASTM A1007.

00398.15 Cable Net - Replace the paragraph that begins “Furnish cable net consisting of individual...” with the following paragraph:

Furnish cable net consisting of individual square or diagonal panels joined along their edges. Furnish cable net panels composed of woven wire ropes or strand with a maximum opening size of 12 by 12 inches. Bind interior wire rope junctions with either double knots of 1/8-inch diameter corrosion resistant wire, or high-strength, corrosion resistant clips with slotted bottoms made from 0.08-inch plate.

Replace the paragraph that begins “Wire rope or cable...” with the following paragraph:

Furnish wire rope or cable for net panels that have a breaking strength of at least 9,200 pounds.

00398.16 Rock Reinforcing Bolts and Rock Reinforcing Dowels - Replace this subsection, except for the subsection number and title, with the following:

Galvanize or epoxy coat Rock Reinforcing Bolts, Rock Reinforcing Dowels, and all appurtenant hardware prior to installation. Cement grout is not allowed as a substitute for the required protective coatings.

(a) Rock Reinforcing Bolts - Furnish Rock Reinforcing Bolts, including mechanical anchorage system, plates, washers, and nuts from the QPL. If mechanical anchorage is not selected, use a Rock Reinforcing Bolt system from a manufacturer regularly engaged in the manufacturer of Rock Reinforcing Bolts.

Furnish grout tubes, grout sealers, and other grouting accessories for grouting Rock Reinforcing Bolts of types recommended by the manufacturer and as approved.

(b) Rock Reinforcing Dowels - Furnish Rock Reinforcing Dowels, plates, washers, and nuts from a manufacturer regularly engaged in the manufacture of Rock Reinforcing Dowels. Furnish grout meeting the requirements of 00398.10(e).

00398.18 Anchored High Tensile Strength Steel Wire Mesh Slope Protection - Replace this subsection, except for the subsection number and title, with the following:

Furnish all mesh and components, except Anchor Nails, with powder coating applied by the Supplier. The Engineer will select the color from the color(s) submitted according to 00398.03(c).

(a) Anchor Nails (Predrilled) - Furnish Grade 75 all-thread rods, Grade 75 bolts, or equivalent, of the diameter shown, with a corrosion allowance of 0.079-inch zinc galvanization included in their diameter. Furnish nails with a minimum ultimate strength of 55,000 psi that are groutable using a tremie tube grouting system and capable of being post-tensioned to the minimum design load shown. Required minimum nail length is shown. Provide centralizers every 5 feet along each nail and a tremie tube for grouting.

(b) Anchor Nails (Self-Drilling) - Furnish self-drilling, hollow-core Anchor Nails of the diameter shown, that comply with ASTM A615 and are supplied with a 3-inch diameter sacrificial bit. Furnish self-drilling Anchor Nails made from high-strength steel with a minimum ultimate strength of 55,000 psi, that are groutable and capable of being post-tensioned to the minimum design load shown.

(c) High Tensile Strength Wire Mesh - Furnish a wire mesh of woven construction, with the ends of each wire formed into a loop and twisted. Fasten loops of the wire mesh together to prevent unraveling of the mesh. Furnish alloyed high strength carbon steel wire with minimum diameter and tensile strength conforming to ASTM A1007 (Level 3 drawn Zn5 Al wire). Minimum wire diameter is shown. Hot-dip galvanize the wire with a zinc/aluminum coating, with a minimum weight of 0.40 ounce per square foot for Level 3 drawn Zn5 Al wire.

(d) Connection Clips - Fabricate connection clips from high-strength steel wire with a minimum diameter of 0.15 inch and a minimum ultimate tensile strength of 4,900 pounds according to ASTM A1007 (Level 3 drawn Zn5 Al wire). Furnish clips that measure 2.36 by 0.83 inches and have two reversed end hooks on one side of the clamp and galvanize the wire with a 95 percent zinc and 5 percent aluminum coating, with a minimum weight of 0.49 ounce per square foot.

Hog ring connectors are not allowed.

(e) Spike Plates - Provide Spike Plates with dimensions appropriate for the High Tensile Strength Steel Wire Mesh. Hot-dip galvanize Spike Plates according to ASTM A123 (ASTM A123M) with a minimum layer thickness of 85 microns.

(f) Boundary Rope - Furnish galvanized 1/2-inch diameter wire rope for attaching the mesh at installation boundaries. Furnish Type 1, general purpose, Class 2, 6x19 IWRC rope, with a minimum breaking strength of 23,940 pounds, according to Federal Specification RR-W-410 or equivalent, including galvanizing.

Furnish anchors for Boundary Rope according to 00398.10(c).

(g) High Early Strength Grout - Furnish non-shrink, Type III portland cement grout capable of attaining a minimum unconfined compressive strength of 4,000 psi in not more than 3 Days, as confirmed according to AASHTO T 106. Test non-shrink properties according to AASHTO T 160. Percent length change is not allowed to exceed 0.05 percent at 28 Days for water-cured samples. Add fluidifying agents as needed.

(h) Miscellaneous Materials - Furnish all miscellaneous Materials for system installation, such as wire rope clips, thimbles, and other miscellaneous items from the Supplier of the high tensile strength steel wire to assure and compatibility of system components.

(i) Supplemental Anchor Nails - Furnish Anchor Nails according to 00398.18(a) or (b) with a minimum length of 5 feet.

00398.21 Anchor Testing Equipment - Replace this subsection, except for the subsection number and title, with the following:

Provide all torque wrenches, jacks, pressure gauges and other Equipment required to perform proof testing of installed anchors, Rock Reinforcing Bolts, and Rock Reinforcing Dowels. Use pressure gauges and load cells of the types and sizes commonly used in the testing of Rock bolts and anchors.

Calibrate torque wrenches, jacks, and pressure gauges before use. Perform calibration tests, using an independent testing laboratory, within 60 Calendar Days of the date calibration data is submitted. Provide torque wrenches having a capacity at least 20 percent greater than the Rock Reinforcing Bolt manufacturer's recommended torque to achieve the design and test loads. Provide torque wrenches that have an accuracy of at least ± 2 percent of the full-scale reading, and a resolution of at least 1 percent of the full scale reading.

00398.30 Personnel Qualifications - Replace this subsection, except for the subsection number and title, with the following:

Provide personnel skilled in the installation of Rock Reinforcing Bolts and Rock Reinforcing Dowels. Provide an on-site supervisor and drill operator with no less than 2 years of demonstrated experience in Rock Reinforcing Bolt and Rock Reinforcing Dowel installation relevant to anticipated Rock conditions and size of Rock Reinforcing Bolts and Rock Reinforcing Dowels being installed. Submit documentation of experience to the Engineer at least 10 Calendar Days prior to the preconstruction conference. Include names and current phone numbers of references, project names and locations, and the year of project completion.

00398.31 Measurement Assistance - Replace this subsection, except for the subsection number and title, with the following:

Provide labor, at no additional cost to the Agency, to assist with the measurement of quantities of Wire Mesh Slope Protection systems and Cable Net Slope Protection system placed on the slopes.

00398.42 Support Posts - Replace the paragraph that begins "Dimensions of footings shall..." with the following paragraph:

Minimum footing dimensions are shown. Moisten the sides of the excavation to a depth of 2 inches and remove all loose Soil and Rock in the hole prior to placing concrete. Place the concrete with contact against firm Soil at the sides and bottom and tamp around anchor bolts, Slope Protection Anchors, or post sleeves while holding the anchor bolts, Slope Protection Anchors, or post sleeves firmly in proper position. If the hole is over-excavated, fill the entire cavity with concrete. Strike off, slope, or crown the surface of the concrete at the ground level and smooth it to shed water.

00398.46 Slope Protection Anchor Proof Testing - Replace the paragraph that begins "Slope Protection Anchors shall..." with the following paragraph:

Furnish Slope Protection Anchors with a minimum pullout capacity of 20,000 pounds per foot. Field verify pullout capacity by testing not less than 25 percent of the total number of anchors installed. The Engineer will determine the anchors to be tested.

Replace the paragraph that begins "Perform lateral testing by..." with the following paragraph:

Perform lateral testing by attaching a steel cable to the anchor and connecting it to a load cell at the base of the slope. Do not allow the cable to come in contact with the slope below the crest of the slope. Position the load cell far enough away from the toe of the slope that the cable under tension is near parallel to the slope. Determine applied test loads with either a calibrated pressure gauge or a load cell according to 00398.21.

00398.48 Support Rope and Post Retaining Rope Attachment - Replace the paragraph that begins "For Post Supported Wire Mesh Slope..." with the following paragraph:

For Post Supported Wire Mesh Slope Protection and Post Supported Rock Protection Screen Behind Barrier or Guardrail, install top horizontal Support Ropes on the posts as shown. Ensure that the top horizontal Support Rope will move freely in the U bolt hangers. Use one continuous length of cable for each complete section of screen. Attach the top horizontal Support Rope to the end anchors as shown. Tension the rope so that the in place wire mesh is fully supported. Take up additional tension with turnbuckles. Ensure that a minimum of 4 inches of take up remains in the turnbuckle when full tension has been applied.

00398.50(a) General - Replace the paragraph that begins "Protect Rock Reinforcing Bolts and..." with the following paragraph:

Protect Rock Reinforcing Bolts and Rock Reinforcing Dowels at all times from damage and corrosion. Corrosion, pitting or damage to the Rock Reinforcing Bolt is cause for rejection. Damage includes, but is not limited to, abrasions, cuts, nicks, welds, and weld splatter. Prior to installation, remove all mill scale, flaking rust, and grease.

00398.50(b)(3) Proof Testing Bolts - Replace the paragraph that begins "Tension each installed bolt ..." with the following paragraph:

Tension each installed bolt to 120 percent of the design load, using a calibrated hollow ram hydraulic jack. Hold that tension for a minimum of 10 minutes. Any loss of load during the 10-minute time period will result in failure of the test. If a bolt fails this test, the bolt is rejected. Install, at no additional cost to the Agency, a replacement bolt in a separate hole adjacent to

the failed bolt, and repeat the test. The Engineer may require additional proof testing if any bolt fails.

00398.50(c)(2) Proof Testing Dowels - Replace the paragraph that begins "Proof test at least 10 percent..." with the following paragraph:

Proof test at least 10 percent of the installed dowels, but not less than three dowels. The Engineer will interpret the results. Tension the Rock Reinforcing Dowel to 10 kips with a calibrated hollow ram hydraulic jack. Hold the load for 10 minutes with no loss of load. A Rock Reinforcing Dowel is considered to have failed if any movement of the dowel occurs. The Engineer may require additional proof testing if any Rock Reinforcing Dowel fails. Replace failed dowels with a new dowel installed in a separate hole, at no additional cost to the Agency.

00398.51 Flexible Rockfall Barrier Systems - Replace the paragraph that begins "Provide for a representative (the "Field Representative")..." with the following paragraph:

Provide for a representative (the "Field Representative") from the proprietary flexible rockfall barrier system vendor or manufacturer to be present at the start of system construction. Before beginning Work involving the flexible Rockfall barrier system, schedule a meeting with the Engineer and include the Contractor's supervisory personnel, together with any Subcontractors and their supervisory personnel who are to be involved in the flexible Rockfall barrier system installation Work, and the representative from the proprietary flexible rockfall barrier system vendor or manufacturer for a flexible rockfall barrier system preconstruction conference at a time mutually agreed upon. If all invitees are not in attendance, reschedule the flexible rockfall barrier system preconstruction conference for the start of system construction.

00398.52(c) Anchor Nail Installation - Replace the paragraph that begins "For installations through..." with the following paragraph:

For installations through Soil, excavate a nominal 14-inch diameter by 8-inch-deep hole around each nail head to accommodate the Spike Plate and to ensure optimal load transfer from the nail head to the mesh.

00398.80 Measurement - Add the following paragraph to the end of this subsection:

Concrete barrier will be measured according to 00820.80.

00398.90 Payment - Delete the paragraph that begins "Item (g) includes..."

Add the following paragraph after the paragraph that begins "Item (k) includes ...":

Concrete barrier will be paid for according to 00820.90.

Replace the paragraph that begins "Payment will be payment..." with the following paragraph:

Payment will be payment in full for furnishing and placing all Materials, and for providing all Equipment, labor, and Incidentals necessary to complete the Work as specified.