**ROCK SLOPE MATERIALS: (3-17-15)**

**Description**

This provision addresses rock anchors and bolts, wire mesh and nets and rockfall barriers to be used for rock slope stabilization and drapes, rockfall protection and other applications in accordance with the contract. Provide rock slope materials as shown in the plans and as directed.

**Materials**

Refer to Division 10 of the *Standard Specifications*.

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| --- | --- |
| **Item** | **Section** |
| Grout | 1003 |
| Portland Cement Concrete | 1000 |
| Steel Plates | 1072-2 |

Use neat cement grout for Type 2 grout for anchors and bolts and Class AA concrete for foundations. Provide Type 3 material certifications for rock slope materials in accordance with Article 106-3 of the *Standard Specifications*. Store materials on blocking at least 12" above the ground and protect it at all times from damage; and when placing in the work make sure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials. Load, transport, unload and store rock slope materials so materials are kept clean and free of damage. Bent, damaged or defective materials will be rejected.

1. **Rock Anchors and Bolts**

Provide rock anchors and bolts consisting of grouted steel bars, anchor plates, nuts and if applicable, bearing plates and washers. Use deformed steel bars that meet AASHTO M 275 or M 31, Grade 75 and splice bars in accordance with Article 1070-9 of the *Standard Specifications* unless required otherwise in the contract. Use steel plates for anchor and bearing plates and steel washers and hex nuts recommended by the Anchor Manufacturer. Galvanize bars, plates, nuts and washers in accordance with Section 1076 of the *Standard Specifications*. Use sheaths for unbonded lengths of rock bolts that meet Article 6.3.4 of the *AASHTO LRFD Bridge Construction Specifications*.

Fabricate centralizers from schedule 40 PVC plastic pipe or tube, steel or other material not detrimental to steel bars (no wood). Size centralizers to position bars within 1" of drill hole centers and allow tremies to be inserted to ends of holes. Use centralizers that do not interfere with grout placement or flow around bars.

1. **Wire Mesh and Nets**

At the Contractor’s option, use galvanized steel plates recommended by the Wire Mesh/Net Manufacturer instead of anchor plates required above to anchor wire mesh or nets to excavation or slope faces.

Provide support ropes to suspend wire mesh or nets from rock anchors. At the Contractor’s option and when noted in the plans, suspend wire mesh or nets from grouted cable anchors instead of rock anchors and connect cable anchors to support ropes with shackles.

Provide any wire mesh and net components or hardware not addressed in this provision in accordance with the Wire Mesh/Net Manufacturer’s recommendations. Galvanize steel components not addressed in this provision in accordance with Section 1076 of the *Standard Specifications*.

* 1. Hardware

Use shackles that meet Federal Specification RR-C-271, Type IVA or IVB, Grade B, Class 2 or 3 with a zinc-coated finish. Use thimbles that meet Federal Specification FF-T-276, Type III and clamps, i.e., U-bolt wire rope clips that meet Federal Specification FF-C-450, Type I, Class 1. Provide shackles, thimbles and clamps of a size recommended by the Wire Mesh/Net Manufacturer.

* 1. Steel Wire and Wire Ropes

For double-twisted hexagonal mesh wire, use carbon steel wires that meet ASTM A641, Class 3 or A Coating or better, Soft Temper with a tensile strength of at least 60,000 psi. If PVC coated double-twisted hexagonal mesh wire is required, provide PVC coating (gray color) that meets ASTM A975. For high-strength wire, use cold-drawn nonalloy or hard-drawn carbon steel wires that meet either of the following:

* 1. ASTM A764, Tensile Class I or II with Class 3 or A Coating or better that meets ASTM A856 or
  2. European Standard EN 10264-2, Grade 1370 or better, Class A or B Coating.

Use galvanized stranded carbon steel wire ropes with a steel core (SC) that meet ASTM A1023 for wire ropes. Use wire ropes with an independent wire rope core (IWRC), 6D19 construction, at least 1/2" diameter and minimum breaking force recommended by the Wire Mesh/Net Manufacturer for boundary and support ropes and cable anchors. Use wire ropes with 7D7 or 7D19 construction, at least 5/16" diameter and minimum breaking force recommended by the Wire Mesh/Net Manufacturer for lacing cables, seam and perimeter ropes and wire nets.

* 1. Wire Mesh

Provide high-strength mesh or double-twisted hexagonal mesh with wire ropes woven into mesh, if necessary, for wire mesh. Use double-twisted hexagonal mesh that meets ASTM A975 and high-strength wires for high-strength mesh. Use boundary or perimeter ropes at ends of wires or fasten ends of wires together to prevent wire mesh from unraveling. Provide wire mesh types that are on the NCDOT Approved Products List and in accordance with the contract. Use wire mesh with properties that meet the following:

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| **WIRE MESH REQUIREMENTS** | | | |
| **Property** | **Requirement** | | |
| **Type 1** | **Type 2** | **Type 3** |
| Minimum Mesh Tensile Strength in Longitudinal DirectionA | 3,500 lb/ft | 8,900 lb/ft | 8,900 lb/ft |
| Minimum Mesh Tensile Strength in Transverse DirectionB | 1,400 lb/ft | 3,400 lb/ft | 6,200 lb/ft |
| Maximum Mesh Opening Width | 4" | | |
| Minimum Double-Twisted Hexagonal Mesh Wire Diameter | ASTM A975, Table 1  (8 by 10 mesh type) | | |
| Double-Twisted Hexagonal Mesh Wire PVC Coating Thickness | None | ASTM A975, Table 1  (8 by 10 mesh type) | |
| Minimum High-Strength  Wire Diameter | 0.079"  (2 mm) | 0.118"  (3 mm) | 0.157"  (4 mm) |

1. Direction of largest mesh opening
2. Direction perpendicular to longitudinal direction

Provide lacing cables, seam ropes, hog rings or connection clips to lace, seam or connect wire mesh sections together. Use fasteners, i.e., hog rings that meet ASTM A975 and connection clips consisting of high-strength wires with a wire diameter of at least 0.118" (3 mm). Weave lacing cables or seam ropes or install hog rings or connection clips in accordance with the plans and Wire Mesh Manufacturer’s instructions.

* 1. Wire Nets

Provide cable, rope or ring nets for wire nets. Provide cable and rope nets with secure intersections that do not separate when nets are loaded. Use wire ropes with 7D7 or 7D19 construction or better or high-strength wires with 1D3 construction or better for cable and rope nets. Use boundary or perimeter ropes at ends of wire ropes or fasten ends of ropes together to prevent ropes and nets from unraveling.

Provide ring nets with interlocking rings that pass through all adjoining rings to link rings together. Use rings consisting of coils of high-strength wires with at least 2 clips or sleeves spaced equally around each ring to hold coils together. Provide wire net types that are on the NCDOT Approved Products List and in accordance with the contract. Use wire nets with properties that meet the following:

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| --- | --- | --- | --- |
| **WIRE NET REQUIREMENTS** | | | |
| **Property** | **Requirement** | | |
| **Type 1** | **Type 2** | **Type 3** |
| *Wire Net Type* | *Cable/Rope Net* | *Cable/Rope/Ring Net* | *Ring Net* |
| Minimum Net Tensile Strength  in Longitudinal DirectionA,C | 12,300 lb/ft | 9,400 lb/ft | 15,900 lb/ft |
| Minimum Net Tensile Strength in Transverse DirectionB,C | 6,800 lb/ft | 9,400 lb/ft | 15,900 lb/ft |
| Maximum Net Opening Diameter | 12" | 14" | |
| Minimum Wire Rope Diameter | 5/16"  (8 mm) | | – |
| Minimum Number of  Coils per Ring | – | 7 | 10 |
| Minimum High-Strength  Wire Diameter | 0.157"  (4 mm) | 0.118"  (3 mm) | |

1. Direction of largest net opening for cable and rope nets
2. Direction perpendicular to longitudinal direction
3. Based on minimum breaking load for 3 ring chain in kilonewtons (kN) D number of rings per meter (m) in each direction for ring nets

Provide lacing cables, seam ropes or shackles to lace, seam or connect wire net sections together except shackles are required for nets anchored to excavation or slope faces. Weave lacing cables or seam ropes or install shackles in accordance with the plans and Wire Net Manufacturer’s instructions.

When shown in the plans, completely cover underside of wire nets with Type 1 wire mesh or chain-link mesh so mesh is between nets and excavation or slope faces. Use chain-link mesh with a mesh size of 2" that meets AASHTO M 181, Type I Fabric, Class C or D Coating. Align longitudinal direction of wire mesh with longitudinal direction of cable or rope nets. Attach wire or chain-link mesh to wire nets in accordance with the plans and Wire Net Manufacturer’s instructions. Use fasteners, i.e., hog rings that meet ASTM A975 to attach wire or chain-link mesh to wire nets.

1. **Rockfall Barriers**

Use hardware, steel wire and wire ropes that meet Sections (1) and (2) of this provision for rockfall barriers. If the diameter of wire mesh or net openings in barriers exceeds 4", completely cover mesh or nets with Type 1 wire mesh or chain-link mesh in accordance with Section (4) of this provision. Provide any rockfall barrier components or hardware not addressed in this provision in accordance with the Rockfall Barrier Manufacturer’s recommendations. Galvanize steel components not addressed in this provision in accordance with Section 1076 of the *Standard Specifications*.

The Engineer will determine subsurface conditions at barrier locations for foundation and anchor designs that depend on subsurface material types. Rockfall barrier systems are classified based on the maximum energy level (MEL) in kilojoules (kJ) of the rock the system is designed to stop. Use rockfall barrier systems designed for the height and MEL required in the contract. For MEL of 500 kJ or less, do not use systems with ropes or cables that anchor behind and upslope of rockfall barriers. For MEL of 500 kJ or more, provide rockfall barrier systems certified for the required MEL in accordance with the European Technical Approval Guidelines “Falling Rock Protection Kits” (ETAG 027).

For each rockfall barrier system, submit working drawings and a product manual for acceptance in accordance with Article 105-2 of the *Standard Specifications*. Submit working drawings showing plan views, barrier profiles, system components and details of anchors and foundations. Submit a product manual with installation instructions, component descriptions and specifications, QA/QC information and certifications. Provide rockfall barrier system submittals sealed by an engineer licensed in the state of North Carolina.



**PE SEAL NAME**

**PE #**