

**STATE**

**OF**

**TENNESSEE**

(Rev. 1-30-10 VB)

January 1, 2021

**SPECIAL PROVISION**

**REGARDING**

**ROCKFALL BARRIER SYSTEMS**

**General Requirements**

The work under this special provision shall consist of installing a Rockfall Barrier System (i.e. Rockfall Fence) including posts, cables, braking elements, and required anchors within the limits shown on the plans, to the manufacturer's specifications and as directed by the Engineer.

The system shall be designed to withstand dynamic forces generated from rocks impacting the installed system. The rock fall protection system shall be capable of absorbing, arresting and retaining Maximum Energy Level (MEL) design impact loads of specified kinetic energy. When maintained in its original condition, the system shall be capable of arresting and retaining at least two Service Energy Level (SEL equal to 1/3 MEL) design impacts, retaining at least 70% of its original height after the first impact. When maintained in its original condition, it shall have the structural capacity to absorb the specified impact design load without passage of particles larger than 4 inches through the barrier. The rockfall barrier shall consist of standard components that can be replaced easily when needed. The rockfall barrier shall be resistant to corrosion, UV degradation and thermal deterioration. The system design shall have been previously used and shall have demonstrated satisfactory performance in similar applications and capacities. The wire mesh and net portions of the rockfall barrier system shall be replaceable after initial installation. Maximum horizontal displacement of net under design load, but before failure of system, shall be as shown on the drawings and not protrude into the traffic lane. A rockfall net shall be allowed to displace into paved shoulder during a rockfall event.

The contractor shall submit in writing documentation that the supplied rockfall barrier kit has performed satisfactorily in similar applications including field-testing, performance history, and locations of similar installations.

The manufacturer shall provide certification test data for the rockfall barrier kit design demonstrating satisfactory performance under MEL and SEL impact loads in a similar application and capacity. The manufacturer shall be regularly engaged in designing and manufacturing rock fall protection systems and have documented experience with manufacturing such systems used in a similar application and capacity. The manufacturer shall supply written evidence demonstrating certification of a quality assurance program, as well as proof and validity of seller's liability insurance.

Additional wire mesh may be required to be attached to the rockfall barrier system in order to retain rocks smaller than the openings in the barrier mesh panels. For rockfall fence mesh that cannot retain rocks greater than four inches in size, the secondary mesh shall be installed to the manufacturer's specification, as shown on the shop drawings, and as directed by the Engineer.

Concrete foundations and wire mesh shall be provided as shown on the design drawings. They shall be supplied and installed by the contractor as outlined in the plans and specifications.

**Field Installation Supervision**

The manufacturer shall include a minimum of two days and up to one (1) week at 8 hours per day installation supervision by a qualified Field Engineer in order to ensure the system is properly installed. Travel and living expenses shall be borne by the barrier manufacturer or supplier. The cost for the installation supervision shall be included in the cost for the system.

All materials shall be labeled by the manufacturer in order for the Contractor to identify the materials on the manufacturer's working drawings. The cable anchor foundations and post foundations shall be installed in accordance with the requirements of the manufacturer, as shown on the working drawings, as specified in this special provision, and as approved by the Engineer.

The foundation work for post foundations and cable anchor foundations shall be performed in accordance with rockfall barrier manufacturer's requirements and working drawings. The distance from centerline to centerline of the post for rockfall barrier shall be within 3 inches of the distance indicated on the plans.

The rockfall barrier shall be installed in accordance with the requirements of the manufacturer, as shown on the working drawings, as specified in this special provision, and as directed by the Engineer.

**Material Specifications**

Miscellaneous Materials: All miscellaneous hardware such as wire rope clips, thimbles, bolts, shackles, etc. shall be supplied by the manufacturer with the rockfall barrier kit. Shackles shall be used to fasten nets to each other and to the net support ropes, unless specifically not allowed by the manufacturer.

All structural steel components, including anchors and clamps, shall conform to the requirements in ASTM Designation A36. All bolts, nuts, and washers shall conform to the requirements in ASTM Designation A325 and as required to conform to the tested rockfall barrier kit.

Concrete: The minimum concrete strength is to be 4,000 pounds per square inch or as specified on the Plans. All concrete material, proportioning, mixing, transporting, and testing shall be in accordance with *TDOT Standard Specifications for Road and Bridge Construction* and *TDOT "Procedures for the Sampling, Testing, and Acceptance of Materials and Products (SOP 1-1)"*.

Ring Net: Ring net shall be defined as fabric consisting of interlocking steel rings with a diameter of no more than 14 inches. Each ring shall connect to the four or six adjoining rings by passing through them; they must be interlocked. Individual rings shall be fabricated from high tensile steel wire with a nominal steel wire diameter of .12-inch (3 mm) with a minimum breaking strength of 198,700 psi. For a type I or type II fence nominal steel wire diameter of 0.07-in (2 mm) with minimum wire breaking strength of 198,700 psi shall be allowed. A minimum of 5 strands shall be bundled into each ring. Steel wire used in the fabrication of the ring net shall be galvanized.

Cable Net / Woven Wire Rope Net: Cable/Woven wire rope nets shall have a uniform grid pattern, shall be constructed of galvanized aircraft cable, with a square or diamond weave, and must have no more than a 12 inch opening size. Nominal opening size for cable nets/wire rope nets may be specified on the contract documents as 6, 8, 10 or 12 inches. Connectors used to fasten adjacent panels shall have a connection strength equal to or greater than the connection strength of the net.

**High Tensile Wire Mesh:** High tensile wire mesh shall be of woven construction with a minimum nominal wire diameter of at least 0.15-inch (4-mm). The wire shall have ends formed into a loop and twisted with loops fastened together to prevent unraveling of the mesh. This wire shall have a minimum of 250,000 psi breaking strength. The mesh shall have a minimum longitudinal tensile strength or load capacity of at least 10,000 lbs/ft.

**Wire Mesh:** When added to a rockfall barrier system, wire mesh shall be securely attached to the cable or ring net fence. Spacing of tie wire or connectors shall be in accordance with manufacturer's recommendations. This mesh shall be flush with no gaps exceeding 4 inches. Tie wires or connectors used to fasten the wire mesh to the cable net of adjacent panels shall have a connection strength greater than or equal to the strength of the mesh.

**Net Support Columns:** Columns shall be fabricated from steel meeting ASTM A36 for preformed steel shapes except as otherwise approved in writing as part of an approved rockfall barrier system prior to letting of contract. Columns shall be as specified in the certified rockfall barrier kit equipment list and substitutions are not permitted unless columns for a higher capacity system by the manufacturer are substituted and the manufacturer certifies that the substitution is acceptable. Test results shall be required to prove that the system and columns are capable of resisting design loads as specified in general requirements above. Substitutions of different net support column members after contracts are issued shall not be allowed.

**Net Support and Lateral Bracing Ropes:** Braking element design shall have been verified through testing and certification of the rockfall barrier kit to ensure satisfactory performance and a minimum of required maintenance. Written documentation of testing of braking elements used with support or bracing ropes shall be supplied to the Engineer upon request.

**Rock and Soil Anchors:** Anchors in rock and soil shall be installed per manufacturer's recommendations for the Rockfall Barrier kit and all anchors needed for rockfall barrier kit, including installation shall be included in the rockfall barrier price. Cable anchors shall have a minimum pullout strength of 15 tons (or more if required by specific manufacturer fence design) and must be verified by the contractor in the field. The testing shall consist of a pullout test incorporating 20% of the total number of anchors with locations chosen by the Engineer. If more than 25% of the anchors tested fail, all anchors shall be tested. Failed anchors shall be replaced by the contractor at no additional cost to the owner. Testing shall be performed against a temporary yoke or load frame. No part of the yoke or load frame shall bear within 3 feet of the anchor.

**Corrosion Protection:** All cables and wire ropes shall meet Federal Specification RR-W-410D or MIL-W-83420E for zinc coating. All miscellaneous material associated with the rock fall barrier such as wire rope clips, bolts, nuts, thimbles, and shackles shall be at minimum hot dipped galvanized.

Spare Parts - The following spare parts are to be supplied with the system by the manufacturer:

Number	Part Name
4	Breaking Element Replacement Kits
2	Replacement Net Panels
2	Wire Rope Anchors
1	Column and column base

**Excavation and Foundations**

The excavation work by the contractor shall be in accordance with the design drawings. If allowed by the Engineer to leave excavated foundation material on the job, the contractor shall scatter excess excavated material around the vicinity of the rock fall barrier and dress it out to match the existing ground surface, in order to prevent the creation of jumping ramps for falling rocks.

The foundation work for the columns and rock and soil anchors shall be performed in accordance with the typical sections for fence system details shown on the design drawings. The distance from centerline to centerline of the columns must be kept as close as possible to that shown on the manufacturer’s approved design drawings. The spacing cannot exceed plus or minus 3 inches of the distance as indicated on the design drawings except as approved by the Engineer. All loose soil or rocks shall be removed from the holes.

**Quantities**

The Rock Fence will be measured and paid on a linear foot basis. The price for the system shall be full compensation for all material including freight, supervision, engineering, drawings and spare parts; plus labor, equipment, tools, royalties and other incidentals necessary to install a complete system ready to use.

The fence, measured as provided for above, will be paid for at the contract unit price per linear foot for Rockfall Barrier. Such price and payment will be full compensation for all work covered by this special provision, including but not limited to furnishing all wire mesh, hog rings, clamps, rings, wire, anchors, rockfall barrier column installation, anchor installation, rope net placing and securing the wire mesh and rope net, and for all incidentals necessary to complete the work satisfactorily.

**Types of Rockfall Barrier Systems**

Rockfall barrier systems shall be specified on the plans as Tennessee Type I, II, III, IV, and may also have a supplementary minimum energy rating specified in the plans. If the energy rating on the plans is higher than the minimum energy rating shown for Tennessee Type, plans energy rating shall control. Height of rockfall fence, unless otherwise specified on the plans, shall be 10 feet. Tennessee Type system criteria are listed below:

Tennessee Type	Description	Rockfall Net Material Allowed	Minimum Energy Rating Ranges
I	Lower Impact	Ring Net, Cable Net/ Woven Wire Rope Net, High Tensile Wire Mesh	100 kJ (37 ft-ton) – 500kJ (185 ft-ton)
II	Moderate Impact	Ring Net, Woven Wire Rope Net, High Tensile Wire Mesh	500 kJ (185 ft-ton) – 1000 kJ (370 ft ton)
III	High Impact	Ring Net	1000 kJ (370 ft-ton) - 3000 ( ft-ton)
IV	Very High Impact	Ring Net	3000 kJ - 5000 kJ (1843 ft-ton)

Please note: double twisted hexagonal wire mesh is only acceptable as an added mesh to a rockfall barrier system and shall not be used as the primary net.

**Qualified Rockfall Barrier Systems Suppliers and Products:**

Note: Systems and manufacturers not on this list may be submitted for consideration to the Geotechnical Engineering Section at least 30 days prior to letting in order to be added to the qualified products list. No system shall be approved as substitution for those on this list without prior concurrence and acceptance by the TDOT Geotechnical Engineering Section.

Required for submittal to add product to list:

1. Name, specifications, drawings and design details for rockfall barrier system including materials used, braking element design, foundation design and anchoring system. Designs as submitted to the TDOT Geotechnical Engineering Section shall comply with this special provision.
2. Date and location of previous installations for the barrier system to be considered as well as contact information for an “owner” representative for whom this system was installed.
3. Test reports of rockfall net materials and rockfall systems verifying that the system and elements can withstand the design energy rating.

**Geobrugg North America**

551 West Cordova Road #730

Santa Fe, NM 87505

Phone: 505-438-6161

Tennessee Type I	AXI System, TXI System – Using “Tecco” Mesh or “Rocco Ring net
Tennessee Type II	RXI System, RX System – Using “Rocco Ring Net” or GBE System using “Tecco Mesh”)
Tennessee Type III	RXI System, RX System – Using “Rocco Ring Net”
Tennessee Type IV	RXI System – Using “Rocco” Ring Net

**Macafferri**

10303 Governor Lane Boulevard  
Williamsport, MD 21795  
301-223-6910

Tennessee Type I	CTR/05/07B
Tennessee Type II	CTR/05/07B, CTR/10/04/B
Tennessee Type III	CTR/20/04/A, CTR/30/04/A
Tennessee Type IV	CTR/30/04A, CTR/50/07/A

**Mountain Management**

Financial Plaza Building  
1135 Terminal Way, Suite 106  
Reno, Nevada, 89502-2145  
Phone: 866-466-7223

Fax: 450-455-8762

Tennessee Type I	2 mm Ring Net System Pending Certification
Tennessee Type II	2 mm Ring Net Pending Certification, B1000 (1000kJ)
Tennessee Type III	B1000 (1000kJ), SF200 (2000 kJ), SF300 (3000 kJ) Systems
Tennessee Type IV	SF500 Ring Net System Pending Certification

**Rotec**

P.O. Box 31536  
Santa Fe, NM 87594-1536  
505-753-6586

Tennessee Type I	Model Series L/40, M/80 and M-H/120
Tennessee Type II	Model Series M-H/185, M-H/275

Payment will be made under:

Item No.	Pay Item	Pay Unit
707-10.01	ROCKFALL FENCE (TYPE I)	Linear Foot
707-10.02	ROCKFALL FENCE (TYPE II)	Linear Foot
707-10.03	ROCKFALL FENCE (TYPE III)	Linear Foot
707-10.04	ROCKFALL FENCE (TYPE IV)	Linear Foot
707-10.08	WIRE MESH (DESCRIPTION)	Linear Foot