Introduction to Geohazard Standard Specification for Simple Drapery
Up to now, there is no standard specification for geohazard solutions in North America. Often projects specifications are referring to a unique product or the wrong ASTM designation or Federal Specification.

Also some specification refers to European specifications not available in USA.
Why a standard specification is required?
Better Sourcing for Products

Easier for the designers, contractors and owners to compare different products for the same application.
Federal Highway Administration 23 CFR 635.411, "Material or product selection".

“Federal funds shall not participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the plans and specifications for a project”
As an Example: High strength fasteners with minimum tensile strength as per ASTM A975-11 for Hexagonal double twisted steel wire mesh connection.
ETAG 027 GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL OF FALLING ROCK PROTECTION KITS - 2008
The design methodology is based on the analysis of the total weight acting on geohazard fabric. The geohazard fabrics works mainly on tensile strength.

\[ W_m \cos \beta \tan \delta \]

\[ W_m : \text{weight of the net} \]
\[ W_d : \text{weight of debris} \]

Diagram of forces

Drapery mesh net layout

Anchorage

Net

Debris

[Diagram showing forces and layout of a simple drapery system]
Simple Drapery
Secured Drapery

Equilibrium Design Theory
F= Forces developed by the block sliding
T= Mesh tensile resistance from secured by the upper anchors
M= Punch resistance from the mesh under the block sliding
Secured Drapery
Existing Standards for Geohazard Drapery System.
- Weight

- Deformability to the concentrated load (PUNCHING TEST)

- Strength and deformability to the longitudinal tensile force (TENSILE TEST)
ISO Standard (draft)

ISO/CD 17746
Steel wire rope net panels and rolls - Definitions and specifications

ISO/CD 17745
Steel wire ring net panels - Definitions and specifications
ASTM A975  Standard Specification for Double–Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire With Poly(Vinyl Chloride) (PVC) Coating)
USA - Working Groups for Developing New Standards

- Association Geohazard Professional
  * Standard Specification Committee

- ASTM (American Society for Testing and Materials)
  * D18.25.06 Geohazard Protection Systems

The long term goal is to develop standard specifications for all the geohazard solutions in collaboration with different agencies like ASTM.
Latest Development
Definitions

Rockfall, n. In geohazard mitigation; The gravity induced downward motion of detached rock involving free falling, bouncing, rolling, and/or sliding.

Geohazard Fabric, n. In geohazard mitigation; A material made typically from steel wire and/or wire rope, interwoven in such a manner to create a continuous interlaced flexible structure usually used in rockfall, slope stabilization, avalanche and/or debris flow applications.

Wire Net: n. In geohazard mitigation; A geohazard fabric consisting of multiple steel wire rope or strands forming a uniform grid pattern.

Wire Mesh, n. In geohazard mitigation; A geohazard fabric consisting of single steel wires forming a uniform grid pattern.
Definitions

**Ring Net, n.** In geohazard mitigation; A geohazard fabric consisting of interlocking steel rings connected to multiple adjoining rings.

**Secured Drapery System:** In geohazard mitigation; A drapery system means a system made up by the association of net, anchors and other structural elements which have the purpose to prevent the detachment and/or the movement of rocks.

**Simple drapery system:** In geohazard mitigation; A system made with geohazard fabric, anchored at the top and could be eventually at the toe, with the goal of containing the stones in motion.
Geohazard Fabric Testing

- Unit Weight
- Mesh Opening
- Corrosion Protection
- Punch Test
- Tensile Strength
The laboratory sample should be free from imperfections or other areas not representative of the material sampled prior to installation. The number of test specimens shall be a minimum of five, cut so that they are representative of the entire roll width and with a combined total minimum area of 10 m² (100.76 ft²). Each test specimen shall be equal in area not less than 1 m x 1 m (3.28 ft x 3.28 ft). Each sample shall be cut to make sure to have full mesh openings.
The laboratory sample should be free from imperfections or other areas not representative of the material sampled prior to installation. The minimum mesh opening dimension shall be measured from the diameter of the largest circle that will pass through the mesh opening. It shall be from a standard production roll and with a minimum average of 5.
Available Standard:

European UNI & ASTM A975
Equilibrium Design Theory
F= Forces developed by the block sliding
T= Mesh tensile resistance from secured by the upper anchors
M= Punch resistance from the mesh under the block sliding
The geometrical characteristics of the press are (ref. Figure):

- radius of curvature 1,200 mm

- maximum diameter of the sample projected on a plane 1,000 mm

- radius of curvature at the side 50 mm
The following measurements must be taken continuously during the test:
- force exercised by the press;
- movement of the press relative to the reference plane.
DETAILED REPORT

- General description
- Nominal dimensions of specimen
- Instrumentations
- Detailed description of boundary conditions
- Deflection value
- Description of failure mode
- Maximum load
- Load-Displacement relationship
- Photographic documentation

Diagram:

Y

\text{displacement}

Load

\text{Load-Displacement relationship}
University of Venice (Punch Test)
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PUNCH TEST UNI - Ring Net
PUNCH TEST UNI
Equilibrium Design Theory
F= Forces developed by the block sliding
T= Mesh tensile resistance from secured by the upper anchors
M= Punch resistance from the mesh under the block sliding
**Pre-Tensioned Punch Test**

- An uncut section of 1.82 m (6 ft) in length) and not less than 0.91 m (3 ft)
- Clamps shall be centered along the width and the excess width will be allowed to fall free on each side of the clamped section.
- Tension sufficient to cause 10% elongation of the sample section between the clamps.
- Punch device 960 cm\(^2\) (1 ft\(^2\)) applied to the approximate center of the sample
MACCAFERRI

PUNCH TEST
Secured Punch Test—

- An uncut section of 1.24 m (4.1 ft) in length and not less than 0.9 m (3 ft) in width including all selvedge
- sides and the ends securely clamped at every mesh opening to a rigid frame
- load of 960 cm² (1 ft²) applied to the approximate center of the sample section between the clamps and in a direction perpendicular to the direction of the tension force.
PUNCH TEST – ASTM A975
PUNCH TEST – ASTM A975 FOR DT MESH

• The sample shall withstand, without rupture of any strand or opening of any mesh fastening, an actual load applied by means of a circular ram at a rate as indicated in equaling or exceeding the values shown in Table 2.

• The ram head used in the test shall be circular with a 350-mm (13.8-in.) diameter and have its edges beveled or rounded to prevent cutting of the wire strands.
Available Standard for Tensile Strength:

European UNI
ASTM A975
ISO
SIMPLE DRAPERY - TENSILE STRENGTH

1 – Theoretical case
2 – Mesh weight
3 – Weight of the debris

Forces acting on the mesh ➔ Reaction of the mesh
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TENSILE STRENGTH UNI

1- Fixed Frame
2- Moving Beam
3- Free Lateral Constrain
4- Side Beam
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TENSILE STRENGTH

(1)

(2)
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TENSILE STRENGTH UNI
Tensile strength - HEA Panel 300 mm with 8 mm Wire Rope

<table>
<thead>
<tr>
<th>Average Load (kN/m)</th>
<th>211.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Displacement (mm/m)</td>
<td>79</td>
</tr>
</tbody>
</table>
Tensile Strength Test

- The width of a specimen shall not be less than seven repetitions of a mesh pattern, nor shall the length be less than fourteen repetitions.
- Sides and the ends securely clamped at every mesh opening to a frame.
- The apparatus shall grip the wire in such a manner as to allow the wire failures to occur at least one mesh pattern away from the gripping points. If a failure occurs in a wire leading directly to a gripping point that specimen shall be rejected, and not included among the tests reported.
Tensile strength parallel to the pull direction

- Pulling apparatus (jacks)

- Clamping equipment. The mesh is hooked along the “V” points

- Roller clamps. They are used to provide a lateral restraint during the tensioning. They also allow for a free adjustment of the mesh as elongation occurs along the pull direction.

- Base clamping plate. It is bolted to the to the base of the apparatus

TEST ON “8 x 10” MESH TYPE
Test under run. Tension is being applied

Failure is reached as one or more wires break
ISO/EN TENSILE STRENGTH
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ISO/EN TENSILE STRENGTH
TENSILE STRENGTH TEST REPORT

- full description of sample (construction materials and relative strengths, construction characteristics, geometrical characteristics, technical details, etc.);
- identification of the test method used;
- nominal dimensions of test piece;
- detailed description of the test piece constraining condition, complete with photographic documentation;
- detailed description of the failure mode;
- actual tensile strength and maximum elongation;
- average tensile strength and maximum elongation;
- load - displacement diagram;
- photographic documentation of the test piece before and after the tests;
- description of instrumentation used and temperature during test.