TERRE ARMEE | TRUMER Schutzbauten

Rectangular netting products are developed for low to medium strength applications. It can be used for stabilizing slopes by pinning them with a combination of mesh and rock or soil anchors, as well as installed as a drape to control erosion. Thus, the frequency and magnitude of events such as rockfall and shallow slumps can be reduced.

SLOPE STABILIZATION:

Slope Retention

Slope Mesh - draped verus anchored systems

Draped mesh systems serve a different purpose than slope retention systems (anchored mesh). A draped mesh is meant to control the movement of debris along the slope, while the anchored mesh is designed to retain the masses in situ and prevent erosion and shallow landslides. Depending on the physical characteristics of the site, budget, and maintenance requirements, the best-suited system is proposed.

An integral part of a slope retention system is the method of connection between the mesh and soil/rock anchors. The strength of this connection must be known through rigorous testing (puncture strength tests).

Plates used for the connections vary in form and function. In general, they use a combination of corner spikes and welded-on pins to ensure optimum interlocking with the mesh. Some also have additional connections for bearing ropes.

For those systems using bearing ropes, positive and non-positive couplings are available for both boundary ropes as well as interior ropes. The style used is dependent on the reinforcement requirements and the boundary conditions at the site.

Draped Mesh System

- \+ lower installation costs;
- \+ lower material costs;
- \+ dewatering of slope is uninhibited;
- \+ lower engineering efforts required;
- − slope erodes (hazard process ongoing);
- − re-vegetation not possible;
- − catchment area/ditch required;
- − higher maintenance costs.

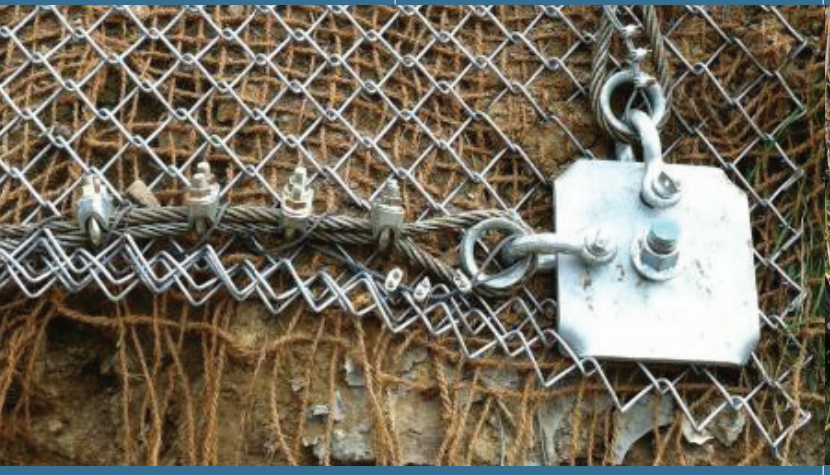
Slope Retention System

- \+ slope retains geometry(hazard process stopped);
- \+ re-vegetation is possible;
- \+ dewatering of slope is uninhibited;
- \+ no catchment area/ditch required;
- \+ lower maintenance;
- − more engineering efforts required;
- − higher installation costs due to number of anchors;
- − higher material costs.

Anchored mesh system (slope retention system) using a high tensile mesh and anchor system based on loading conditions.

Draped mesh system using a rectangular netting that is supported only along the boundaries of the system.

A standard single and double rope guide spike plates.



Corner plates are designed to receive bearing ropes using a shackle and thimble connection to ensure full strength and for ease of installation and maintenance.

A non-positive/fixed connection to a boundary rope of a system.

Anchor spacing is defined by analyzing the failure mechanism and defining the potential mass that can be mobilized. This can be done in combination with the strength parameters of the anchors, mesh facing and their coupling. The slope is broken down into cells and by the action forces must be lower than the resistance forces plus a factor of safety.

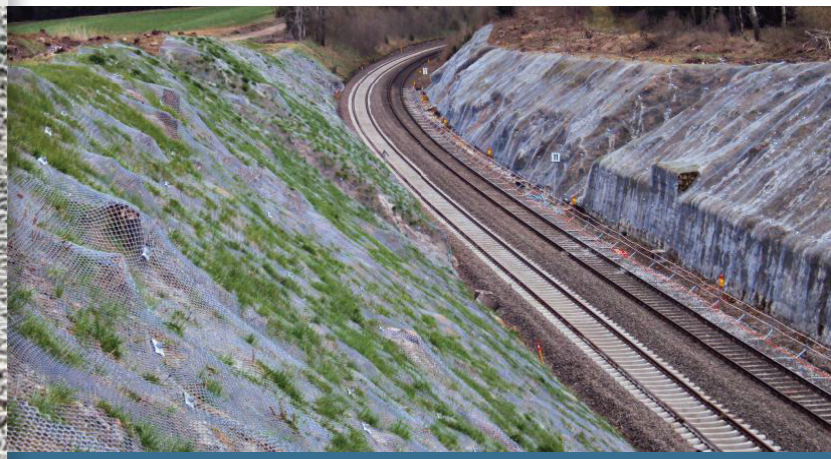
Slope retention systems should be designed on a site-to- site basis. Depending on the site characteristics and strength requirements, a large variety of net and netting products are available. Additionally, the orientation of the mesh, support cables, and cable connections can be arranged to suit virtually any condition.

Re-stabilization of the slope using mesh and natural re-vegetation is highly encouraged. Furthermore, netting can accommodate pre-existing vegetation such as tree trunks with very little effort. Supplemental bio-mats and seeding mixtures can also be applied to produce a safer slope that blends in with nature.

The following nets and nettings are available:

	Diameter (mm)	Mesh (mm)	Galvanization Class			
			Zn A	Zn B	Zn-Al A	Zn-Al B
Omega-Net	4.5-10.5	100 to 350	✓		✓	
Sigma	3.2	50				✓
HPN+	4.6	60 x 60			✓	
Rectangular	2.5/3.1/3.8	60 x 60	✓		✓	
Rectangular	3.1/3.8	50 x 50	✓		✓	
Rectangular	2.5	30 x 30	✓		✓	
Hexagonal	3.05	80 x 100	✓		✓	
Hexagonal	2.7	60 x 80	✓		✓	
Hexagonal	2.5	50 x 70	✓		✓	

An example of interior anchors using a standard spike plate for the coupling. Anchor points are typically set in topographical lows whenever possible.



Railway cuts and existing walls stabilized using High Performance Netting.

Rock wall reinforced using High Performance Netting.

Hexagonal Mesh -
the original stabilization

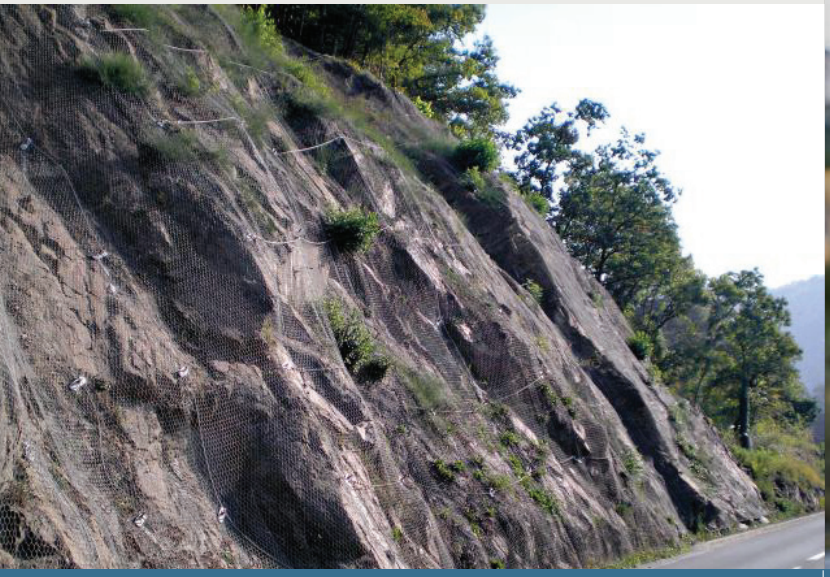
The double-twisted wire mesh is the most often used product and has been used for decades to stabilize slopes across the world.

For low strength applications, the double-twisted hexagonal mesh can be used for stabilizing slopes and can also be installed as a drape mesh. 60 x 80 mm and 80 x 100 mm both mesh openings and a variety of wire diameters (2.5, 2.7, and 3.05 mm) are available. It is available in both Zn galvanized or ZnAl galvanized forms, which guarantees the best corrosion prevention and durability.

Product Specifications

Mesh	**Type**	hexagonal
	Size	60x80/80x100 mm
Wire	**Diameter**	2.5 - 3.05 mm
	Tensile Strength	400 - 550 N/mm²
	Elongation	min. 10%
	Galvanization (Zn/ZnAl)	min. 255 g/m²
Roll	**Weight**	~ 1.75 kg/m²
	Width	3.0 m
	Length	25 m

Other wire diameters and mesh sizes available upon request



Hexagonal mesh can be used for slope retention systems where the forces are not high.

The thick, malleable wires used for hexagonal mesh, along with the twisted interlocking of the strands yields a flexible product with redundancies.

The light weight, long rolls make them ideal for covering large areas of slopes that are affected by unraveling and other mass wasting processes.

Example of a drape mesh system using hexagonal mesh.

Rectangular Netting - a multitude of mesh

Large variety of rectangular nettings are available that suits many low to moderate strength applications.

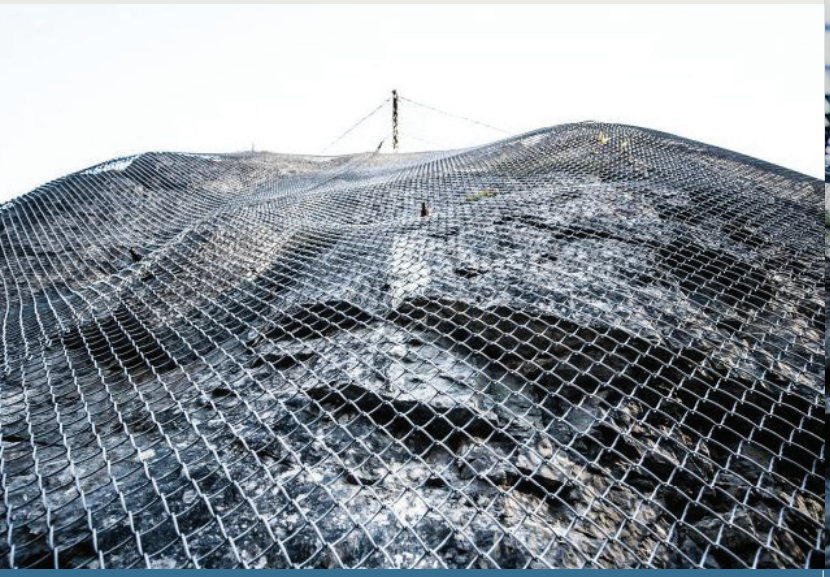
Rectangular netting is used for both draped and anchored mesh applications. Unlike hexagonal mesh, it has no roll "memory" and can more easily adapt to changes in topography. This allows the mesh to maximize the contact surface area which dictates the active portion of the mesh system. Like all mesh products, it is available with the highest class of galvanization according to EN 10223-6.

Its low cost, ease to handle and large variety of products makes it a staple for low-strength applications.

Anchors for slope retention systems can be drilled either prior to mesh installation or afterwards. This allows changes to be made during construction to increase the efficiency of the stabilization.

Product Specifications

Mesh	**Tensile Strength**	**Lengthwise**	23 - 50 kN/m
		Crosswise	30 - 55 kN/m
	Type		rectangular
	Size		50 - 60 mm
Wire	**Diameter**		2.5 - 3.8 mm
	Tensile Strength		400 - 550 N/mm^2
	Galvanization (ZnAl)		245 - 275 g/m^2
Roll	**Weight**		1.6 - 3.85 kg/m^2
	Width		2.0 m - 3.0 m
	Length		12.5 m - 30 m



Rectangular netting lays flat against the slope and can conform to changes in topography better than hexagonal mesh.

An example of a slope mesh system designed to protect a highway from falling ice that builds up on the slopes during the winter.

Slope stabilization using a combination of rectangular mesh and anchors.

HPN + improved strength and lower weight

Strong rectangular netting with a lower unit weight.

High Performance Netting Plus (HPN+) has evolved to be an even stronger product. A higher tensile wire is used that gives the desirable malleable characteristics but yields a higher strength product. Puncture strength increased to 102 kN when tested in open-air, 150 kN as per the ASTM A975 test and 392 kN with the supported puncture test. A mesh opening of 60 x 60 mm is small enough to work well with fine grained material. The wire maintains its highest class of zinc-alluminium galvanization (Class A according to EN 10244-2) for optimum corrosion protection.

There is no other single wire woven product in the market that has this level of strength, flexibility and corrosion protection.

Product Specifications

Mesh	**Tensile Strength**	**Lengthwise**	150 kN/m
		Crosswise	150 kN/m
	Puncture Strength*		102 kN
	Puncture Strength**		392 kN
	Type		rectangular
	Size		60 mm x 60 mm
Wire	**Diameter**		4.6 mm
	Tensile Strength		840 - 990 N/mm^2
	Galvanization (ZnAl)		min. 280 g/m^2
Roll	**Weight**		~ 5.6 kg/m^2
	Width		1.5 m - 3.5 m
	Length		6 m - 15 m

*"Open-air" test
** "Supported", deformable substrate test

HPN+ is highly flexible which allows it to maximize slope surface contact.

The use of HPN+ in combination with organic mats greatly reduces the lost of fine material and encourages revegetation.

Slope stabilization works and low-energy rockfall fence using HPN+.

Sigma Netting 50/3.2 -
High tensile ≥1770N/mm²

Sigma netting product rolls consist of galvanized high grade corrosion prevention using Zinc-Aluminium coating.

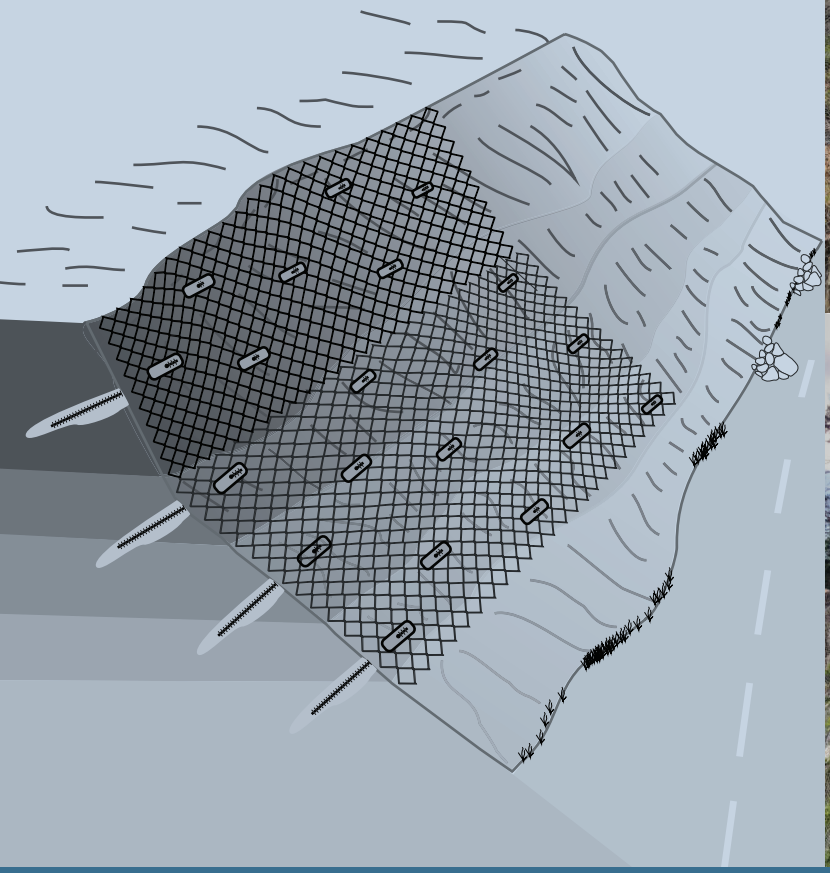
The panels are unrolled from the top to the bottom in the hazard zones. The different mesh layers are then connected by overlapping and sewing them together with high-tensile sewing rope in the vertical direction. Horizontal connections are made with an original wire strand yielding a seamless connection. Additionally, mesh can be secured by spike plates at anchor positions.

Under most conditions, the Sigma Netting can easily and quickly be installed, thereby considerably reducing mitigation costs. Furthermore, corrosion protection is assured by a high-quality of metallic coating that increases the life and durability of the netting.

Product Specifications

Mesh	**Tensile Strength**	**Lengthwise**	≥ 150 kN/m
		Crosswise	≥ 150 kN/m
	Puncture Strength*		105.2 kN
	Puncture Strength**		481.8 kN
	Type		rectangular
	Size		50 mm x 50 mm
Wire	**Diameter**		3.2 mm
	Tensile Strength		≥ 1770 N/mm²
	Galvanization (ZnAl)		min. 150 g/m²
Roll	**Weight**		~ 2.75 kg/m²
	Width		2.0 m - 4.0 m
	Length		20 m - 25 m

*"Open-air" test
** "Supported", deformable substrate test



Omega-Net - where nothing else will do

Derived from rockfall and avalanche technology, this is the ultimate solution to high-strength needs where flexibility is the key.

The Omega-Net is a solution to higher strength applications. Various rope diameters are used to construct the nets, starting from 4.5 mm up to 10.5 mm, with a minimum mesh size of 100 mm. These nets are extremely flexible and panel sizes can be suited to individual projects, making them ideal for highly irregular rock slopes.

The structure of the Omega-Net is unique, consisting of pre-formed waves and interwoven strands of high-strength rope. The strands themselves are thick galvanized spiral ropes that - although meet at intersecting points, but are not connected since no clamps are used.

The Omega-Net is not only used for slope stabilisation but is also the primary interception structure for all high-energy rockfall catchment fences, debris flow and avalanche protection structures.

The Omega-Net can be made with a variety of mesh openings and wire diameters to best suit the strength requirements of the project.

The Omega-Net is a unique product that can easily fold together for transportation and installation.

Heavy rock stabilization using Omega-Net.

Installation of Omega-Net for slope stabilization.

Product Specifications

			Omega-Net 7.5/350	Omega-Net 7.5/250	Omega-Net 9.0/185
Mesh	**Tensile Strength**	**Net**	183 kN/m	218 kN/m	465 kN/m
		Strand	55 kN/m	55 kN/m	76 kN/m
	Type		semi-circular	semi-circular	semi-circular
	Size		250 mm x 350 mm	250 mm x 250 mm	185 mm x 185 mm
Wire	**Diameter**		7.5 mm	7.5 mm	9.0 mm
	Tensile Strength		1750 N/mm^2	1750 N/mm^2	1750 N/mm^2
Roll	**Weight**		~ 3.05 kg/m^2	~ 3.3 kg/m^2	~ 6.0 kg/m^2
	Width		made to order	made to order	made to order
	Length		made to order	made to order	made to order

Note: specifications are for the 7.5 and 9.0 mm diameter nets. Please inquire for specifications of other nets.

www.terrearmeeindia.com | **www.trumer.cc** | **E: infoasia@terre-armee.com**

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