

**SPIDER® Avalanche**



**Avalanche barriers with SPIDER® spiral rope net S4/230**

## **SPIDER® Avalanche Avalanche barriers**

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### **FUNCTION PRINCIPLE**



The main part of the avalanche protection system is based on the high tensile strength steel wire spiral rope net SPIDER®, extending across the slope and reaching to the surface of the snow.

The supporting effect created by the retaining surface prevents possible creeping within the snow cover and sliding of the snow cover on the terrain surface. Breaking-away of avalanches is thus prevented at the starting zone, while occurring snow movements are restricted to the extent that they remain harmless.

The forces resulting from the snow pressure are absorbed by the snow nets and carried off over the swivel posts and anchor ropes into the anchor points.



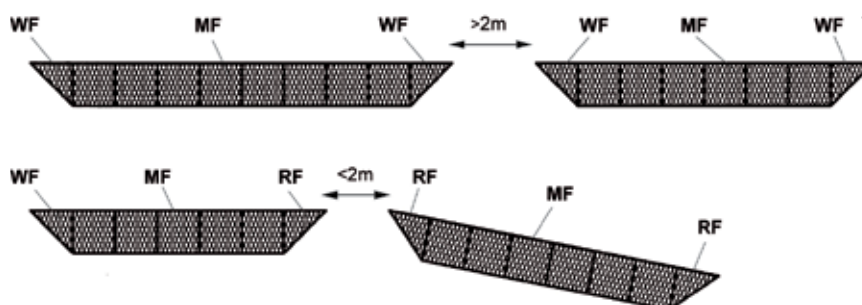
## SCOPE OF APPLICATION

- During the snow-free period the SPIDER® avalanche barriers provide a comparatively effective protection against rockfalls. Their elastic design allows them to absorb high dynamic energies without suffering damage.
- SPIDER® avalanche barriers enable an ecological protection against avalanches. The lightweight construction based on high-strength elements means that only little material needs to be brought in.
- Thanks to the filigree design the constructions are virtually invisible in both summer and winter. This makes them particularly suitable for protective purposes in tourism and recreation areas.
- The growth of young plants is not restricted by cast shadows.
- The installation is possible also under difficult topographical circumstances.
- Geobruigg protection systems are also suitable in rough and narrow gullies where heavy construction elements demand a major manual effort for installation.
- A decisive advantage is the economical installation by helicopter. This thanks to the low weights and the large units of up to 10 m construction length per flight.

## FUNDAMENTALS

The decisive dimensioning principles are provided by the Guidelines for Avalanche Prevention Structures in the Starting Area, Issue 04/2007 of the Federal Institute for Forest, Snow and Landscape Research (WSL), the Swiss Federal Institute for Snow and Avalanche Research (SLF), 7260 Davos and the Federal Office for the Environment (FOEN), 3003 Bern.

With only few exceptions, these guidelines are acknowledged worldwide as dimensioning documentation for constructions designed to prevent avalanches.

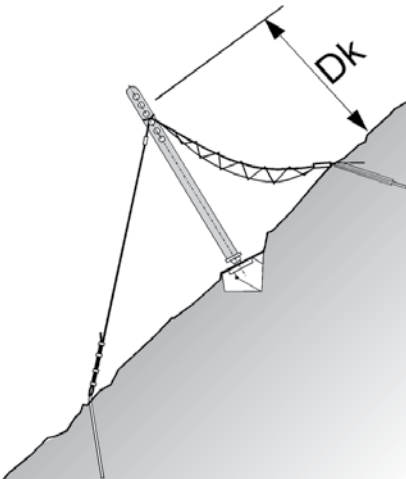


The individual sections within a row of construction elements are named as follows:

**WF: End section**  $\triangleq$  reinforced edge section (with additional boundary forces) with boundary triangular net

**RF: Boundary section**  $\triangleq$  normal edge section (with additional boundary forces) with boundary triangular net

**MF: Middle section**  $\triangleq$  SPIDER® rectangular spiral rope net



## PARAMETERS / DELIVERY PROGRAMME

Sliding factor:	$N = 2.5$
Height factor:	$fc = 1.1$
Slope inclination:	100 % (45°)
Snow thickness:	$Dk = 2.5 \text{ m}$
(effective mesh height)	$Dk = 3.0 \text{ m}$
	$Dk = 3.5 \text{ m}$

Deviations from the above parameters are possible on request.

The avalanche prevention system based on wire rope nets is a development of Geobruigg and has been proving its worth in an exemplary way in the most varied countries within and outside Europe since 1951.

The new developed SPIDER® avalanche barrier is based on this enormous experience. The decisive basic design has not been changed. The avalanche barriers with the SPIDER® spiral rope net are an economical and ecological alternative to the rigid snow barriers made of steel.

## SYSTEM ELEMENTES

The avalanche barrier construction consists of a flexible retaining surface of SPIDER® spiral rope net, swivel posts, downslope anchor ropes and wire rope anchors. The elements can be assembled in a modular way to suit the topography as well as the prevailing ground and anchorage circumstances. They are characterized by a high degree of effectiveness and a longn life. Assembly on site is accomplished rapidly and efficiently using standard equipment.

*Single elements can be transported by helicopter and installed on site.*

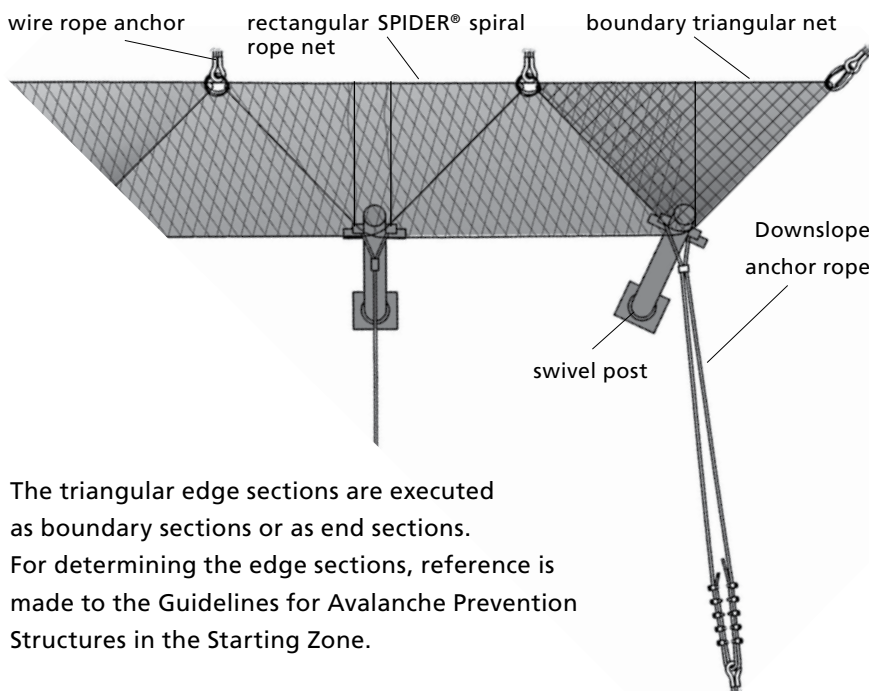
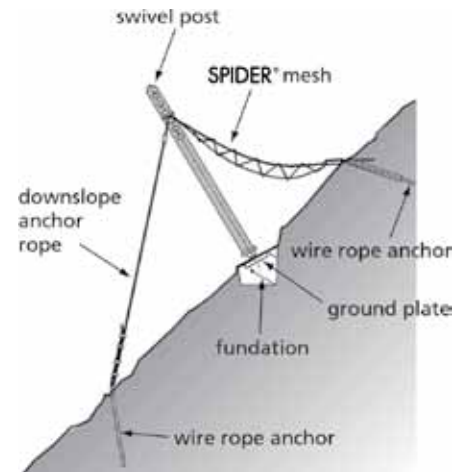


**Modular structure**

The system is made up of only a few individual components. One element consist of a rectangular SPIDER® spiral rope net with support ropes or triangular boundary net, as well as upslope and downslope anchor ropes with their anchorages.

The modular system permits to place any number of elements in a line as required. Each element is 3.5 m or 4.0 m long.

The length of the construction is calculated as a multiple of the distance between the upslope anchor points.



The triangular edge sections are executed as boundary sections or as end sections. For determining the edge sections, reference is made to the Guidelines for Avalanche Prevention Structures in the Starting Zone.

**Advantages:**

- suitable for all kind of topography
- only few individual parts





### **SPIDER® net S4/230**

The SPIDER® avalanche barriers consist of rectangular meshes, which are interconnected within the range of the posts in an overlapping way. The end section and the boundary section consist of triangular mesh panels.

On the basis of our original SPIDER® spiral rope net, which was developed for block stabilization, the mesh was amended systematically and adapted to the new conditions. The secondary mesh layers guarantee an optimized snow retaining capacity in all different kind of snow.

#### **Advantages:**

- the SPIDER® spiral rope nets is an extremely light weight construction element
- protection against falling rocks
- optimized snow retaining capacity
- virtually invisible



#### **Technical data S4/230**

##### **SPIDER® spiral rope nets**

mesh shape: rhomboid  
diagonal:  $x \cdot y = 180 \cdot 300 \text{ mm (+/- 5\%)}$   
mesh width:  $D_1 = 230 \text{ mm (+/- 5\%)}$   
Angle of mesh:  $\varepsilon = 50 \text{ degrees}$

##### **SPIDER® steel wire**

wire diameter:  $3 \times 4 \text{ mm}$   
tensile strength: min.  $1770 \text{ N/mm}^2$   
material: high-tensile carbon steel wire

**SPIDER® corrosion protection**

surface coating: GEOBRUGG SUPERCOATING®  
(Zn-Al-coated) according to EN 10264-2  
layer thickness: 150 g/m<sup>2</sup>

**Ground plate**

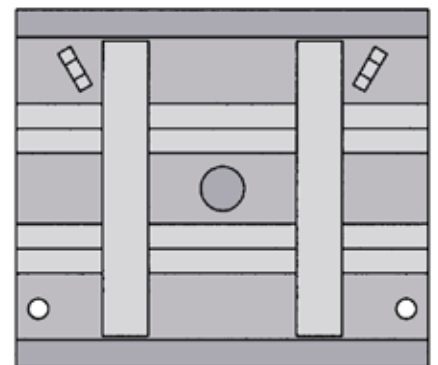
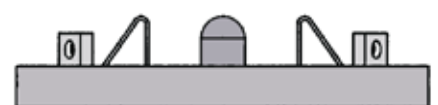
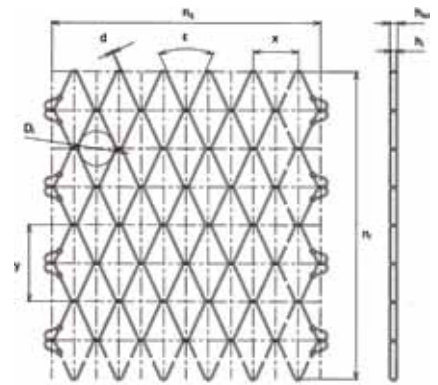
The ground plate transfers the forces from the post directly into the ground without anchors. The torsion-stiff ground plates are connected with wire ropes to the upslope anchors, so that the position of the plate does not change.

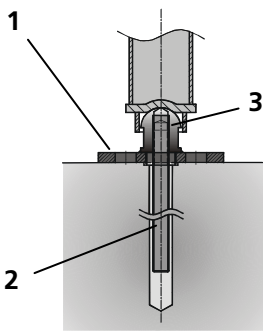
This anchorage method has a clear economic advantage. The anchorage costs are smaller. Only small ground excavations or adjustments are necessary, because the ground plate is aligned approximately perpendicular to the post.

This method is suitable for different underground conditions. In the permafrost an anchorless ground plate has a decisive advantage for later adjustments.

**Advantages:**

- smaller anchorage costs
- fewer adjustments in the underground for placement of the plate





**Alternative anchorage of posts**

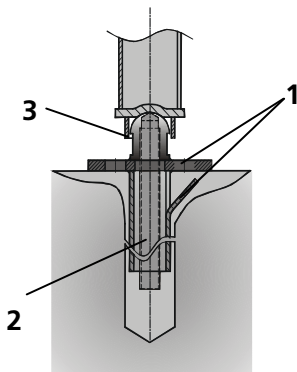
Adapted anchorage systems are available to suit the different compositions of the ground. The anchor lengths depend on the anchor forces and ground conditions and must be determined in compliance with the guidelines issued by the SLF.

**in compact rock**

Micro-pile (Var. 1) consisting of:

- 1 anchor plate
- 2 micro-pile (GEWI anchor)
- 3 anchor head

Bore hole at least 1.5 x diameter of the anchor

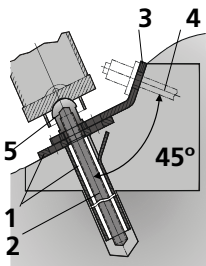


**in poor rock**

Micro-pile with stabilization tube (Var. 2) consisting of:

- 1 anchor plate with stabilization tube
- 2 micro-pile (GEWI anchor)
- 3 anchor head

Bore hole diameter min. 90 mm

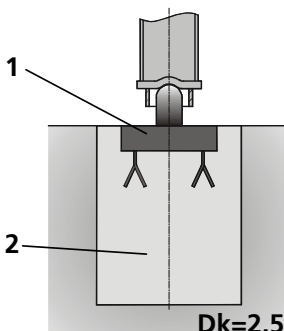


**in unconsolidated rock / overlay of loose material**

Micro-pile with stabilization tube and tension anchor (Var.3) consisting of:

- 1 anchor plate with stabilization tube
- 2 micro-pile (GEWI anchor)
- 3 extra plate for tension anchor
- 4 GEWI tension anchor
- 5 anchor head

Bore hole diameter minimum 90 mm

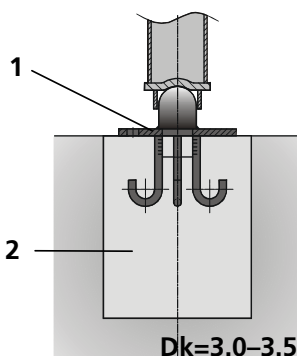


In case of loads > 350 kN on the post or depending on the depth and quality of the overlay, an additional reinforced concrete foundation of minimum 0.60 x 0.35 x 0.50 m must be installed.

**in unconsolidated rock (alternative)**

Ground plate with anchor head and tie bolts made from flattened iron consisting of:

- 1 ground plate with tie bolts and anchor head
- 2 reinforced concrete foundation depending on the composition of the ground, minimum 0.40 x 0.40 x 0.50 m



**in unconsolidated rock (alternative)**

Ground plate with anchor head and tie bolts made from round steel consisting of:

- 1 ground plate with tie bolts and anchor head
- 2 reinforced concrete foundation depending on the composition of the ground, minimum 0.40 x 0.40 x 0.50 m



### Accessoires

The accessory parts of the entire construction such as boundary reinforcing ropes, anchor ropes, fixation ropes and wire rope clips are delivered in packaging units suitable for the building site.

The ropes are made up in advance at the works and feature all necessary pressed loops. This means that the installation effort on site is reduced to the minimum.

### Swivel posts

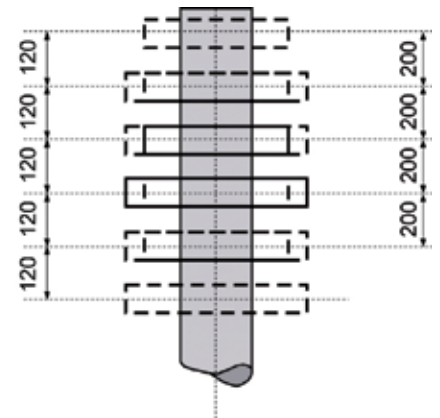
The swivel posts are made from steel tubes. The foot of each post has the shape of a socket and fits the ball head featured by the groundplate. Together with the ground plate the foot of the post forms a ball-and-socket joint.

The ball-and-socket joint allows the post to move freely in all directions under the changing load conditions. The joint is extremely sturdy and requires no maintenance at all. It ensures a clearly defined introduction of the force into the ball head.

The head of each post is equipped with pegs which can be inserted at different heights for the suspension of the snow nets. This enables an optimal adaptation to the terrain. The peg adjustability is 0.48 m and 0.6 m, respectively. The modular system permits also to use posts of the next bigger Dk (snow height) if more difference in height has to be compensated due to the topography.

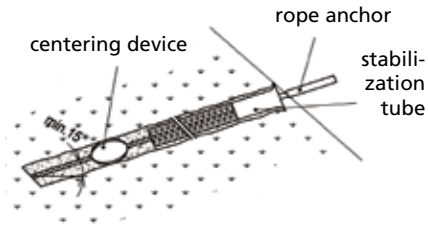
### Advantages:

- clearly defined introduction of the force
- no rigid connections
- hight adjustability



### Upslope and downslope anchors

Rope anchors with double corrosion protection are used for upslope and downslope anchors. Their flexible head permits an introduction of the force which does not have to be exactly in the axis of the bore hole. Deviations of up to 30° between the axis of the bore hole and the direction of the tension are admissible. In this way the anchor design takes care of the changing geometry as the construction gets snowed in. Apart from this the flexibility of the rope anchors makes them insensitive to rockfalls. In loose material the rope anchor is reinforced by a stabilization tube to ensure that transverse forces are optimally introduced into the ground. Centering devices are also available to obtain an optimal mortar jacket around the anchor.



### Advantages:

- flexible anchor heads
- double protection against corrosion
- impact-proof anchor head



## CONSTRUCTION AND ASSEMBLY SEQUENCES

### Construction lengths

In the interest of correct functioning, walkability, forest management and wild animal paths, the individual rows of structures should not exceed a length of approx. 40 to 60 m. Even individual short structures consisting of just two posts and one rectangular SPIDER® spiral rope net can be erected.

### Work preparation: Stake out and drilling

The supplied sets of stake-out ropes and stake-out charts enable an easy definition of the anchorage points. Deviations from the straight line are possible and permit in principle an adaptation to any shape of terrain. The distances between the anchor points must be altered on the basis of the plan of stake-out and correction charts. Individual upslope or downslope anchorages can be placed, so that alternative ground suitable for anchors is obtained.

Clearing of the terrain must be carried out before drilling work, if this was not already done prior to staking out. The rocky slope must be freed of loose scree and rubble. For the drilling work it is recommended to use a special, light drilling machine. The bore holes are usually drilled without casing. The minimum bore hole diameters depend on the substrate and must not be less than the minimum diameters specified in the guideline. In loose material, drilling must be carried out at least with  $\varnothing$  90 mm as a matter of principle.

The bore holes must be cleaned with compressed air before the anchors are inserted.

Immediately after drilling, the anchors for the posts and the wire rope anchors must be inserted together with an injection hose and grouted.



### **Erection / assembly work**

Erection / assembly can be carried out manually or by means of the helicopter. Erection by helicopter has proved to be more economical and simpler:

- Sorting of the material in an intermediate storage location
- Preparation of units per flight (up to 3 posts and 2 meshes)
- Transport of the individual units to the construction site
- Placing the posts on the anchors and fixing, so that the unit stands by itself
- Fixing of downslope anchor rope to rope anchor
- Adjustment of the line
- Seaming of meshes vertical
- Upslope Fixing

A manual erection is necessary if the construction's location is inaccessible by helicopter (e.g. in dense forest).

The individual components are assembled at the final location in the following order:

- Placing of the posts
- Hanging up the meshes and ropes
- Placing the posts on the anchors and fixing, so that the unit stands by itself
- Fixing of the downslope anchor ropes to the downslope anchors
- Adjustment of the line
- Seaming of meshes vertical
- Upslope Fixing

*Pre-assembly of units per flight*





*Transportation by helicopter*



*Installation of pre-assembled units delivered by helicopter*



*Installation of pre-assembled units delivered by helicopter*

## CORROSION PROTECTION

Avalanche prevention structures are exposed to varying corrosive environments. The corrosion protection of the individual elements can be adapted to the prevailing situation in order to achieve an adequate life of the entire construction.

### Ropes

Standard:	galvanized drawn, layer thickness min. 20 % more than minimum values specified by EN 10264-2
optional:	additionally with green paint
optional:	GEOBRUGG SUPERCOATING® (Al/Zn-coated)

### Posts and ground plates

Standard:	black or hot-dip galvanized to min. 80 µm
optional:	galvanized, with green rust protection paint, or with green rust protection paint only

### Accessories

Wire rope clips:	DIN EN 13411-5 (DIN 1142), promatised
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### SPIDER® spiral rope net

Standard:	GEOBRUGG SUPERCOATING® (Al/Zn-coated)
optional:	green colored

### Rope anchors

Spiral rope:	heavy galvanized according to EN 10264-2
Loops + prot. pipe:	hot-dip galvanized

### SWISS-GEWI anchor

Standard:	black with rusting allowance as per SLF guidelines
optional:	hot-dip galvanized

## GEOBRUGG SUPERCOATING® Brief description

### Process

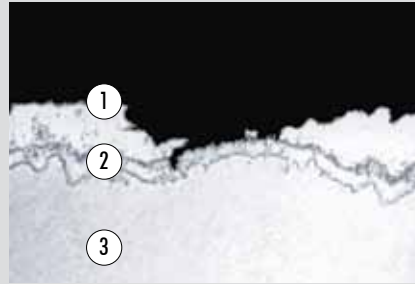
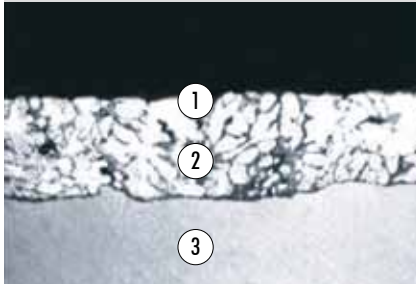
By adding aluminum in the galvanizing process (95% Zn + 5% Al), a more homogeneous anti-corrosion layer is achieved than with the conventional galvanizing methods.

### Application

Proven galvanizing process applied on wire meshes, wire ropes, ROCCO® ring nets and small components of steel.

**GEOBRUGG SUPERCOATING® and hot dip galvanizing: a comparison after 14 years...**

Both transverse sections were made with an electron microscope after the wires had been exposed to environmental influences for over 14 years.



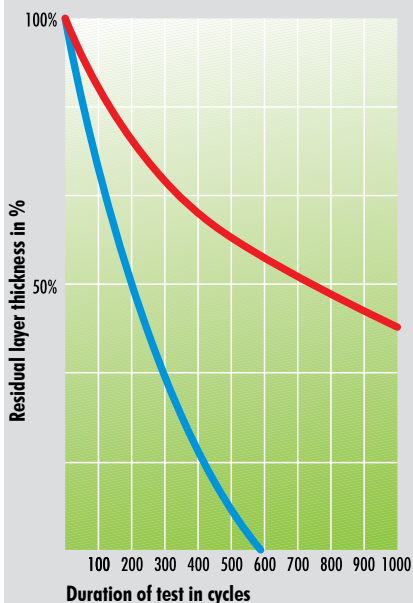
**GEOBRUGG SUPERCOATING®**

- (1) smooth surface (aluminum oxide layer)
- (2) homogeneous coating (zinc/aluminum)
- (3) wire (Fe)

**Hot-dip galvanizing**

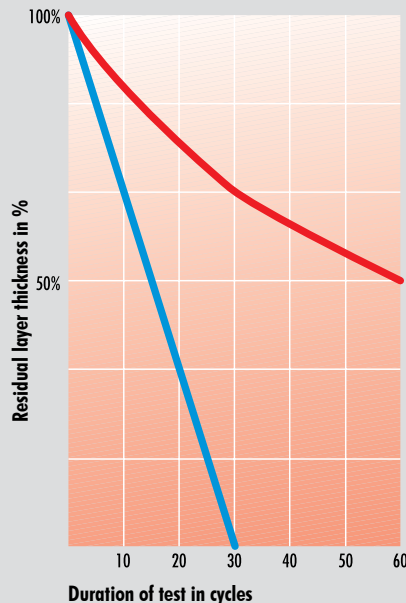
- (1) heterogeneous surface (zinc), partially complete disintegration and/or already with rust formation
- (2) hard zinc layer (iron/zinc)
- (3) wire (Fe)

In the **salt spray test (NaCl)** according to DIN 50021-SS/ASTM B117 the Supercoating layer took 3 to 4 times longer than zinc to disintegrate.



— GEOBRUGG SUPERCOATING®  
— Hot-dip galvanizing

The **SO<sub>2</sub> test** in accordance with DIN 50018 shows an improvement in corrosion protection by a factor of 3 to 4 as compared to customary galvanizing



— GEOBRUGG SUPERCOATING®  
— Hot-dip galvanizing

(Source: Prof. Dr.-Ing. Rolf Nünninghoff)



**Rockfall barriers**

**Rockfall drapes**

**Slope stabilization systems**

**Debris flow barriers**

**Avalanche prevention structures**

**Open pit rockfall barriers**

**Special applications**

### **Geobrigg protects people and infrastructures from the forces of nature**

It is the task of our engineers and partners to analyze the problem together with you in detail and then, together with local consultants, to present solutions. Painstaking planning is not the only thing you can expect from us, however; since we have our own production plants on three continents, we can offer not only short delivery paths and times, but also optimal local customer service. With a view towards a trouble-free execution, we deliver pre-assembled and clearly identified system components right to the construction site. There we provide support, if desired, including technical support – from installation right on up until acceptance of the structure.



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