

1000 kJ

PRODUCT MANUAL GBE-1000A

**European Technical
Approval ETA-09/0262**

**ETAG 027: category A
Energy class 3: 1000 kJ
Height: 4 – 5 m**

Date: 26.09.2016

Edition: 158-N-FO / 13

Test institute:
Federal Research Institute WSL
Birmensdorf, Switzerland

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CH-8590 Romanshorn



European Technical Approval
www.eota.eu

**We changed
our standard
wire rope clips!**

All manuals will be
updated soon.



Notifikovaná osoba č. 1301

TECHNICKÝ A SKÚŠOBNÝ ÚSTAV STAVEBNÝ, n. o.
BUILDING TESTING AND RESEARCH INSTITUTE
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Certificate of constancy of performance

1301 – CPR – 0573

In compliance with Regulation 305/2011/EU of the European Parliament and of the Council of 9 March 2011 (the Construction Products Regulation or CPR), this certificate applies to the construction product

Rockfall Protection Barrier GBE – 1000A

Energy level classification

3

Classification for residual height for MEL

Category A

with the intended use to stop moving rock blocks on a slope with the Service Energy Level 330 kJ and with the Maximum Energy Level 1000 kJ and covers a range of ambient temperatures from - 20 °C to + 50 °C.

Produced by manufacturer

**Geobrugg AG
Geohazard Solutions
Aachstrasse 11, CH-8590 Romanshorn
Switzerland**

and produced in the manufacturing plant

**Geobrugg AG
Geohazard Solutions
Aachstrasse 11, CH-8590 Romanshorn
Switzerland**

This certificate attests that all provisions concerning the assessment and verification of constancy of performance described in the ETA

ETA 09/0262


under system 1 for the performances set out in this certificate are applied and that

the construction product fulfils all the prescribed requirements for these performances.

This certificate was first issued on 21 January 2010 (under the CPD) and will remain valid as long as the ETA remains valid and the manufacturing conditions in the plant or the factory production control itself are not modified significantly, unless suspended or withdrawn by the product certification body.

Bratislava, 26 September 2014




Dipl. Ing. Daša Kozáková
Head of Notified Body 1301

066236



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European Technical Assessment

ETA 09/0262
of 16/09/2014

General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: **Technický a skúšobný ústav stavebný, n. o.**

Trade name of the construction product

Rockfall Protection Barrier GBE – 1000A

Product family to which the construction product belongs

Product area code: 34
Building Kits, Units and Prefabricated elements

Manufacturer

Geobrugg AG
Geohazard Solutions
Aachstrasse 11
CH-8590 Romanshorn
Switzerland
<http://www.geobrugg.com>

Manufacturing plant

Geobrugg AG
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This European Technical Assessment contains

27 pages including 16 annexes which form an integral part of this assessment.

Annexes 5/8/9 contain confidential information and are not included in the European Technical Assessment when that assessment is publicly available.

This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of

ETAG 027, edition September 2012 amended April 2013, used as European Assessment Document (EAD).

This version replaces

ETA-09/0262 with validity from 28.09.2009 to 27.09.2014

PURPOSE AND ORGANIZATION OF THE MANUAL

This product manual ensures that Geobrugg Rockfall protection systems are manufactured free from defects in accordance with the latest technology and that the range of applications is clearly defined, the functional efficiency is given, and the installation of the system is professionally carried out and controlled.

System drawing, See Appendix at the end of the manual

The product manual is divided into the following sections:

- Proof of quality assurance
- Installation manual
- System drawing / rope assembly drawing
- ISO 9001 certificate


No claims are made that this document is complete. The manual describes standard applications and does not take into account project-specific parameters. Geobrugg cannot be held liable for any extra costs that may be incurred for special cases. In case of uncertainties, please contact the manufacturer. The General Sales Conditions of Geobrugg AG are applicable.

RESPONSIBLE FOR THE CONTENT OF THIS MANUAL

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Romanshorn, 26st September 2016

Geobrugg AG
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(Stamp / legal signatures)

I RANGE OF APPLICATION

The design of rockfall protection systems is based on detailed investigations by specialized engineering firms, particularly taking into account the following geotechnical aspects to define the range of possible applications:

- Previous Rockfall events
- Condition of the rockfall breakout zone
- Stability assessment of the entire rockfall zone
- Rockfall frequency
- Size of the blocks to be intercepted
- Trajectories and bounce heights of stones
- Calculation of kinetic energies
- Positioning of the barrier (considering the local topography)
- Anchorage conditions

II QUALITY OF THE SYSTEM COMPONENTS

Geobruagg AG, the former Geobruagg Protection Systems Division of Fatzer AG, Romanshorn has been certified since August 22nd 1995 under the registration no. CH-34372 in accordance with the Quality Management System Requirements (ISO 9001, 2008, revised 2013). The certifying body is the Swiss Association for Quality and Management Systems (SQS), which belongs to IQ-Net 9000. The quality manual completely specifies how to test the system components (raw material, commercial and end products) comprehensively in order to exclude deficiencies in quality. The relevant certificates are attached as appendices.

III FUNCTIONAL EFFICIENCY OF THE BARRIER SYSTEMS

The functional efficiency of the system is based on one-to-one rockfall tests, carried out and tested in accordance with the guidelines for approval of rockfall protection nets ETAG 027. The one-to-one rockfall tests are carried out by dropping a block vertically into the middle field of a three-field barrier. The distance between posts is 10 m, and an impact velocity of 25 m/s is reached. The full-scale test were approved by a notified test body and the European Technical Approval (ETA) has the number ETA – 09/0262.

IV QUALITY CONTROL FOR INSTALLATION

This product manual describes in detail the different steps for installation of the barriers. These steps must be faithfully followed by local contractors.

V PRODUCT LIABILITY

Rockfall, landslides, debris flows or avalanches are sporadic and unpredictable. The cause is human (buildings, etc.), for example, or forces beyond human control (weather, earthquakes, etc.). The multiplicity of factors that may trigger such events means that guaranteeing the safety of persons and property is not an exact science.

However, the risks of injury and loss of property can be substantially reduced by appropriate calculations that apply good engineering practices, and by using predictable parameters along with the corresponding implementation of flawless protective measures in identified risk areas.

Monitoring and maintenance of such systems are an absolute requirement to ensure the desired safety level. System safety can also be diminished through events, natural disasters, inadequate dimensioning or failure to use standard components, systems and original parts, but also through corrosion (caused by environmental pollution or other man-made factors as well as other external influences).

In contrast to the one-to-one rockfall tests, which indeed test an extreme load case but still only demonstrate a standardized situation, in the field the layout and design of a protection system can vary greatly because of the topography. The influence of such alterations and adaptations cannot always be determined exactly. Critical points are, for example, post spacing, changes in direction, placement angle of the rope anchor, and the direction and velocity of impact.

Geobrugg can assist with estimating the influence of larger deviations and special situations, and can offer recommendations for feasible solutions. Geobrugg cannot, however, guarantee the same behavior as in the one-to-one rockfall tests. In critical cases, it is advisable to reinforce particular components as compared with the standard barrier.

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EXPLANATION OF USED SYMBOLS



Safety indication: essential to follow



Note / Reminder that the system is correctly installed easily



A consultation with Geobrugg is recommended



upslope



downslope

1 HAZARD STATEMENT

QUALIFICATION OF THE GROUP LEADER



The management of installation may only be done by a qualified group leader.

CABLES WITH PRETENSION



Cables are under tension. During installation and pretensioning of the cables, make sure that there are no persons in the danger zone.

RELEASING OF PARTS WITH PRETENSION



Releasing or cutting of components with pretension should be avoided. Should there still be necessary, the utmost caution.

2 INSTALLATION TOOLS

MARKING	<ul style="list-style-type: none"> • 30 – 50 m measuring tape • Measure stick • 5 red and white ranging poles • Inclinator • Spray can • Wooden peg or iron peg (min. 3x for each field) • Hammer/mallet • Manual
INSTALLATION	<ul style="list-style-type: none"> • Open-ended or ring wrench • Socket wrench set with ratchet • Torque wrench, range 25 – 400 Nm (see tightening torque required for wire rope clips and base plate fastening nuts) • Open-ended wrench for base plate fastening nuts • Felco C16 or C112 wire rope cutter or similar; 12 mm cutting capacity • Cutting-Off wheel or hammer wire cutter; 28 mm cutting capacity • pincers, flat-nose pliers • 2 mm galvanized wire strands or wire • Angle spirit level • Roll of adhesive tape • Rope clamp, small 8 – 16 mm/large 14 – 26 mm (min. 2x) • At least 2 tension belts • Cable winch hoist, e.g. LUG-ALL® • Chain hoist or HABEGGER wire rope hoist, min. 1.5 t (15 kN) • Auxiliary ropes

3 USE OF WIRE ROPE CLIPS

CAUTION: Changeover of wire rope clips

Starting from fall 2016 we will deliver a new type of wire rope clip FF-C-450 type 1 class 1. To ensure correct assembly please use the table below and the rope assembly drawings in the attachment of this manual.

Please use this document for installation of wire rope clips. The details contained in the manuals are no longer correct.

Instructions below apply to all wire rope clips according FF-C-450 type 1 class 1 (similar EN 13411-5 type 2) delivered by Geobrugg AG.

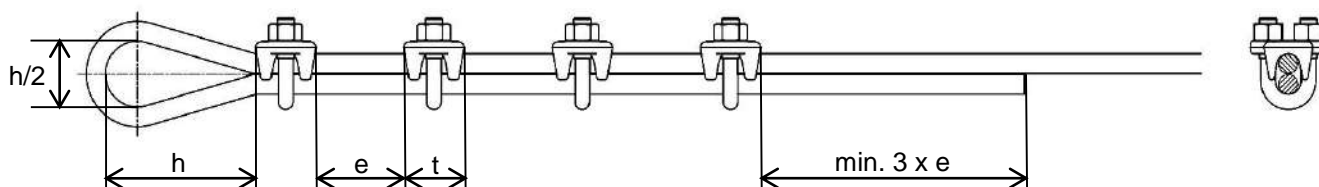
The distance e between the wire rope clips should be at least $1 \times t$ but not exceed $2 \times t$, where t is the width of the clamping jaws. The loose rope end has to be $3 \times e$ at a minimum. Geobrugg recommends looping up the remaining free section and fixing it directly behind the last wire rope clip on the tightened rope.

If you are using a thimble in the loop structure, the first wire rope clip must be attached directly next to the thimble. For loops without a thimble the length h between the first wire rope clip and the point of load incidence must minimally be 15-time the nominal diameter of the rope. In unloaded condition the length h of the loop should be not less than the double of the loop width $h/2$.

The clamping brackets (U-brackets) must always be fitted to the unstressed end of the rope, the clamping jaws (saddle) must always be fitted to the strained rope („never saddle a dead horse“).



FF-C-450 type 1 class 1



The required tightening torques with lubrication apply to wire rope clips whose bearing surfaces and the threads of the nuts have been greased with Panolin CL 60 multipurpose lubricant spray (or an equivalent lubricant).

During tightening the nuts have to be tensioned equally (alternately) until the required tightening torque is reached.

Wire rope diameter [mm]	Size of the wire rope clip	Required amount of wire rope clips	Required tightening torque lubricated [Nm]	Required tightening torque unlubricated [Nm]	Wrench size [mm]
3 - 4	1/8"	2	4	8	10
6 - 7	1/4"	2	10	25	15
8	5/16"	3	20	50	18
9 - 10	3/8"	3	30	75	19
11 - 12	7/16"	3	40	110	22
14 - 15	9/16"	3	50	150	24
16	5/8"	3	90	170	24
18 - 20	3/4"	4	90	180	27
22	7/8"	4	150	330	32
22 GEOBINEX	7/8"	5	150	330	32



After the first load application the tightening torque has to be checked and if not fulfilled adjusted to the required value.



A visible contusion of the wire ropes positively indicates that the wire rope clips have been tightened to the required tightening torque.



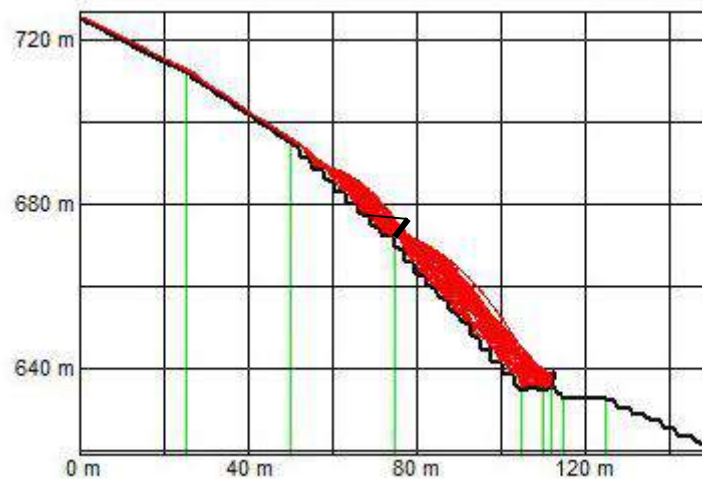
Wire rope clips always have to be installed and used with the required tensioning torque. It is not allowed to re-use clips once they have been detached.

4 STAKING OUT DEPENDING ON THE TERRAIN

GENERAL PRINCIPLES FOR STAKING OUT

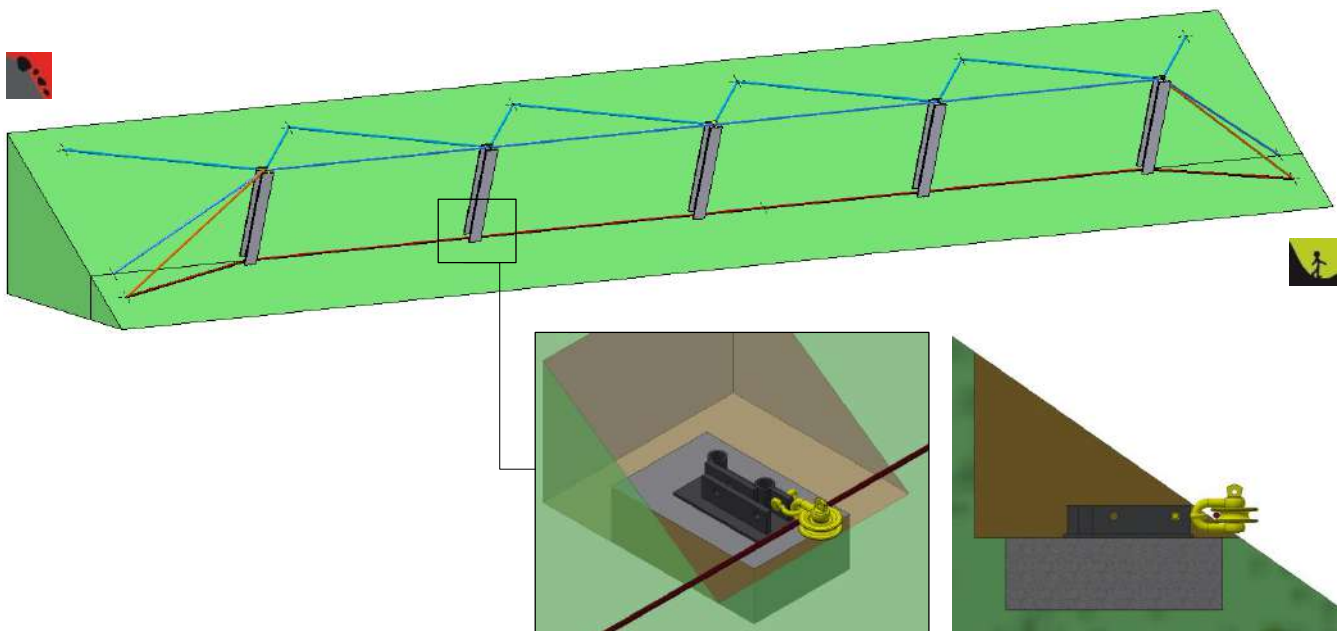
Position of barrier

To determine the optimal position of the barrier Geobrugg suggest carrying out rockfall modeling using simulation software, as this will provide some indicative information on bounce heights and where shadowing may occur.



Lining

Where possible, the barrier should be installed so that it is in a straight line and that all posts are at the same level horizontally. This will make the installation process easier.

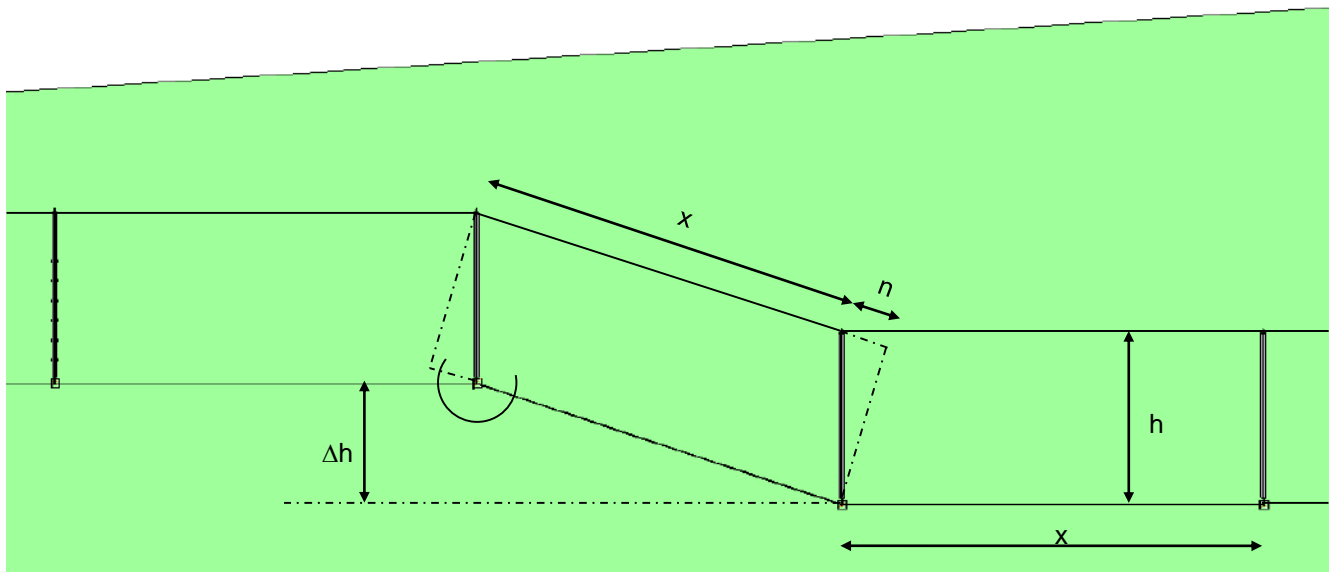


Foundation

The baseplate foundation is to be implemented to the terrain that the bottom support rope is kept close to the ground.

The placement of the foundations is to be designed that the bottom support rope bypass the foundation edges and it is not damaged on the foundation edges.

Difference in level of the barrier line



- h:** barrier height
x: post distance
n: modification of length of the mesh
Δh: difference in height between two neighboring posts

Tab. 2

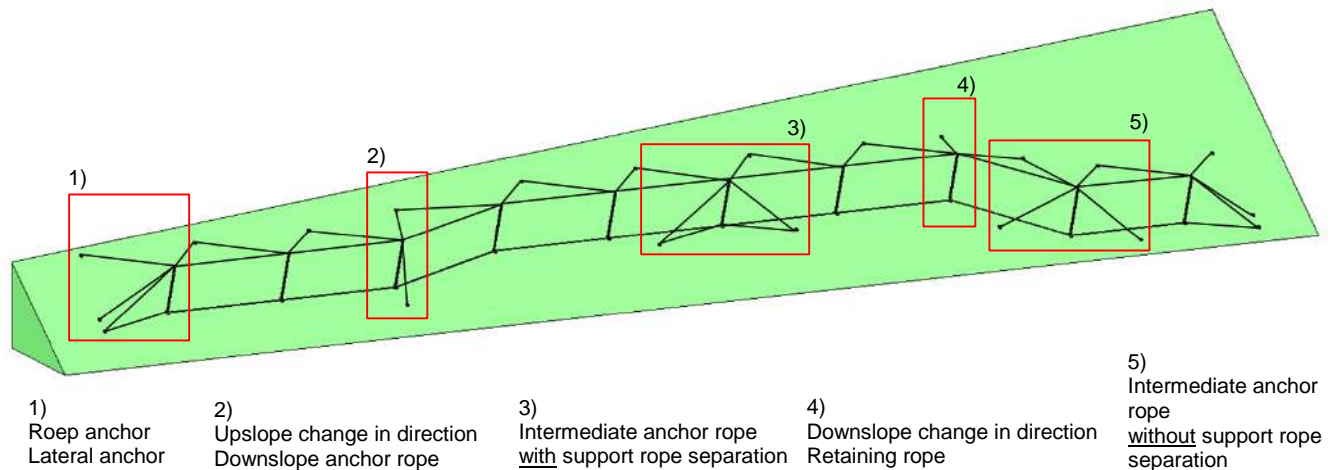
Post distance	6-8 m	8-10 m	10-12 m	
Δh	<0.50 m	<1,00 m	<1.50 m	No adjustment necessary
Δh	>0.50 m	>1,00 m	>1.50 m	Net must be adjusted



If the height difference is greater than in Tab.2 you must contact Geobrigg to enable the correct length of nets to be determined.

5 STAKING GEOMETRY

GENERAL PRINCIPLES FOR STAKING OUT GEOMETRY



Standard staking out dimensions

If the standard staking out dimensions and tolerances are adhered to, the barrier can be installed easily and will function correctly.

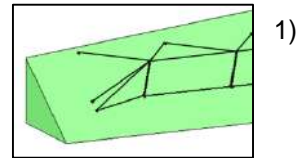
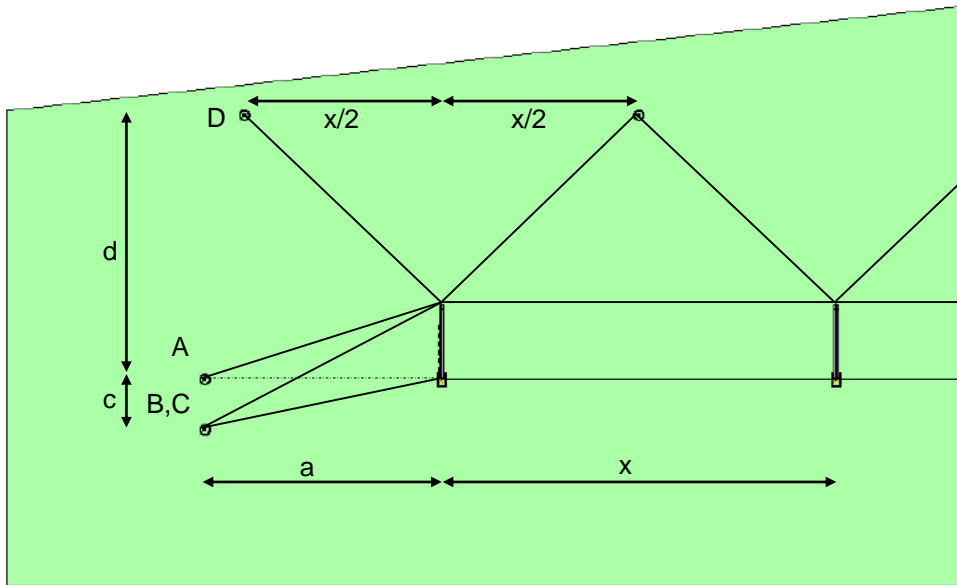
Adaptation to the terrain

Depending on the the terrain, the following stake out procedure may not be able to be observed. If this is the case, small adjaustments may have to be made to the barrier components th ensure if will function correctly.



If Geobrugg is informed of any problems with the stake out, a customized solution may be possible.

STANDARD STAKING OUT IN STRAIGHT BARRIER LINE



lengths

h: barrier height

x: post spacing

anchor point

A: top support rope

B: bottom support rope

C: lateral rope

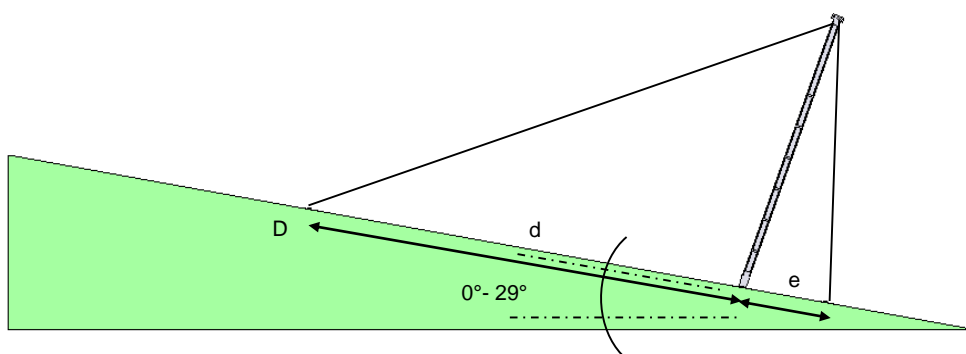
D: retaining rope

The following table applies to a ground slope of 30° - 90°

Dimensions in m; dimension tolerance $\pm 0,20$ m

Tab. 3

h	a	c	d¹⁾	e
3,00	4,50	1,00	5,10	1,50
4,00	6,00	1,30	6,80	2,00
5,00	7,50	1,65	8,50	2,50



Length

d: see Tab.3

e: see Tab.3

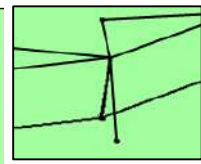
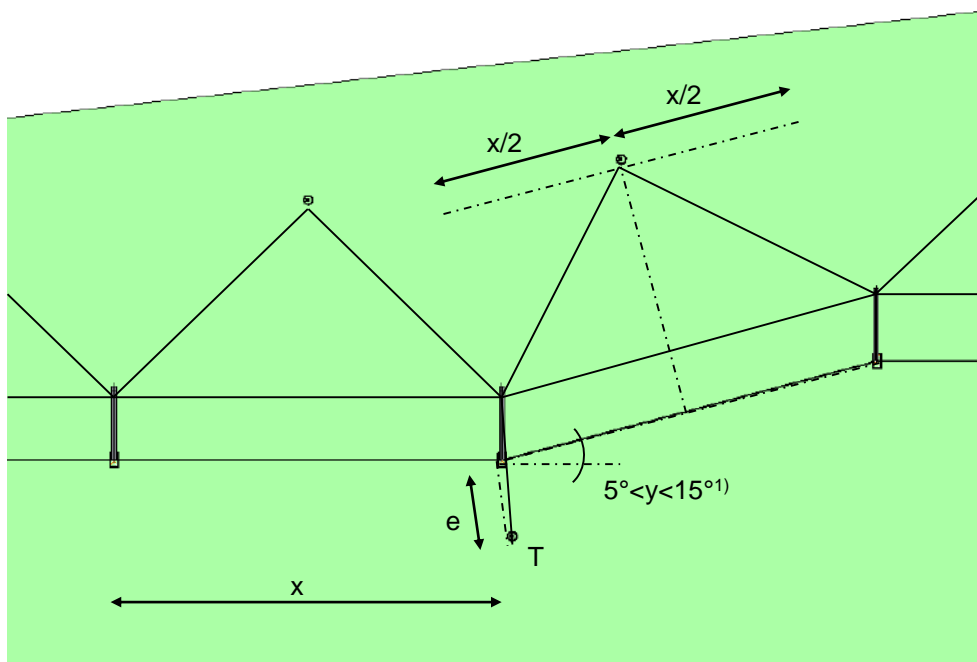
Anchor point

D: retaining rope anchor



¹⁾ In a ground slope of less than 30°, the distance between post and retaining rope anchor is modified.

UPSLOPE CHANGE IN DIRECTION



2)

Length

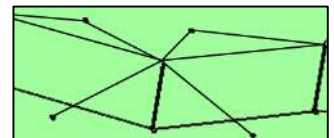
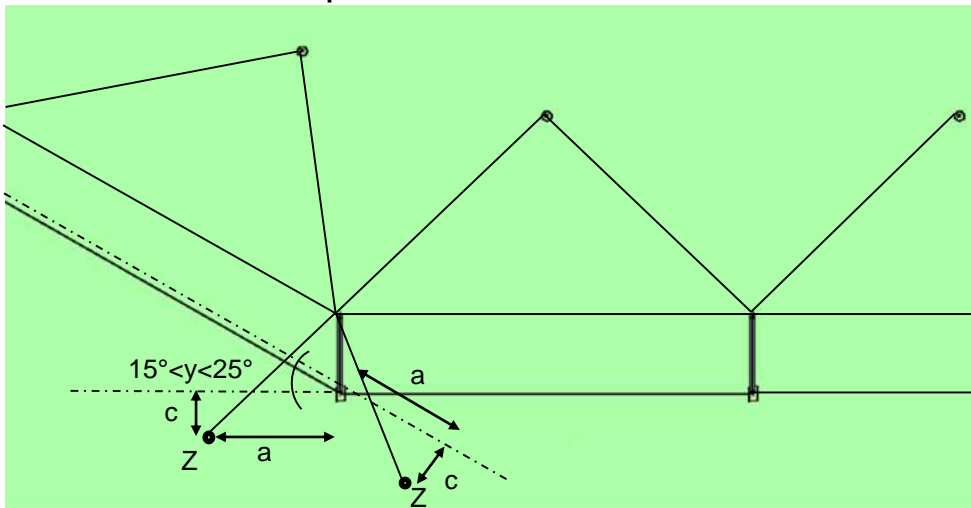
- e:** see Tab.3
- x:** post distance
- y:** angle of change in direction

Anchor point

- T:** downslope anchor rope

An additional downslope anchor rope (T) is required if the barrier changes its direction by an angle of 5° - 15° upslope. The rope anchor is located downslope at a distance of (e) from the post. The downslope anchor rope has a rope diameter of d=16 mm.

Intermediate anchor rope



5)

Length

- a:** see Tab.3
- c:** see Tab.3
- y:** angle of change in direction

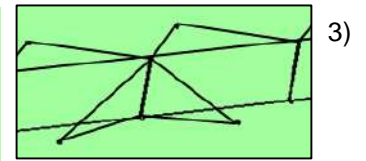
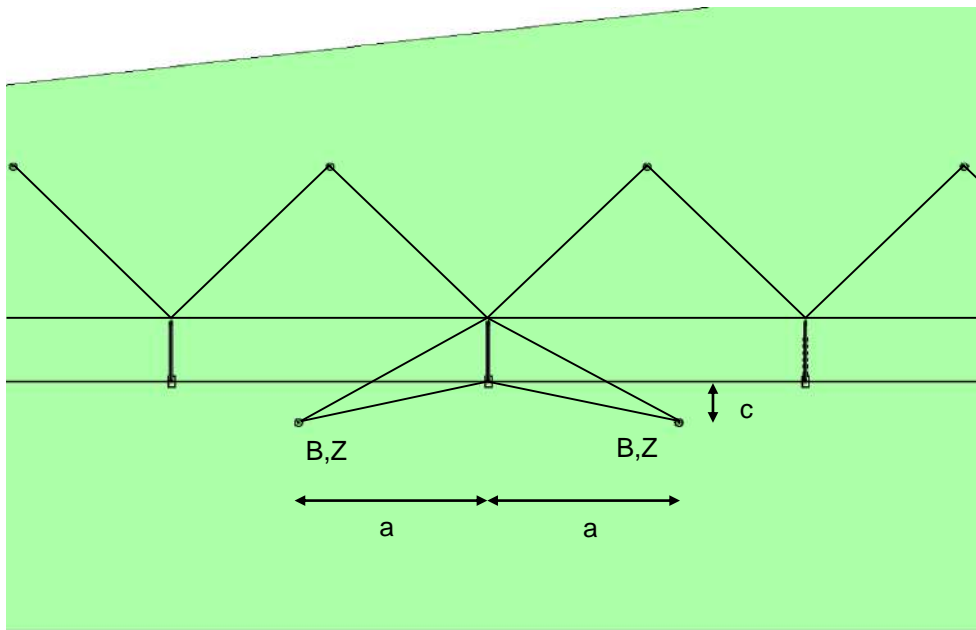
Anchor point

- Z:** intermediate suspension



If the barrier line changes upslope more than 15° an intermediate anchor rope is required. In this case the downslope anchor rope is no longer necessary.

ROPE ANCHOR FOR SUPPORT ROPE SEPARATION WITH INTERMEDIATE SUSPENSION



Length

a: see Tab.3

c: see Tab.3

Anchor position

B: bottom support rope

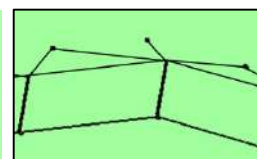
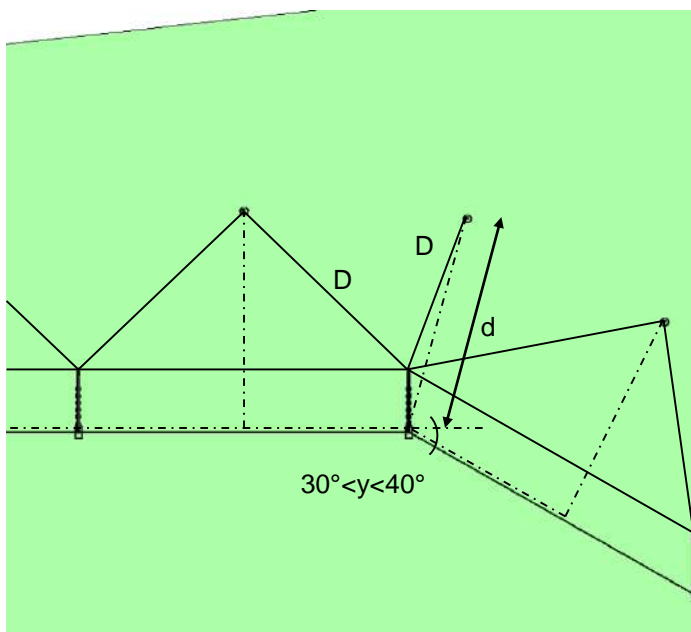
Z: intermediate suspension

A support rope separation includes a intermediate suspension. A support rope separation is needed every 80m – 100m.



Note: If the upslope change in direction is more than 25° a support rope separation is to install in addition to the intermediate suspension.

DOWNSLOPE CHANGE IN DIRECTION



Length

d: see Tab.3

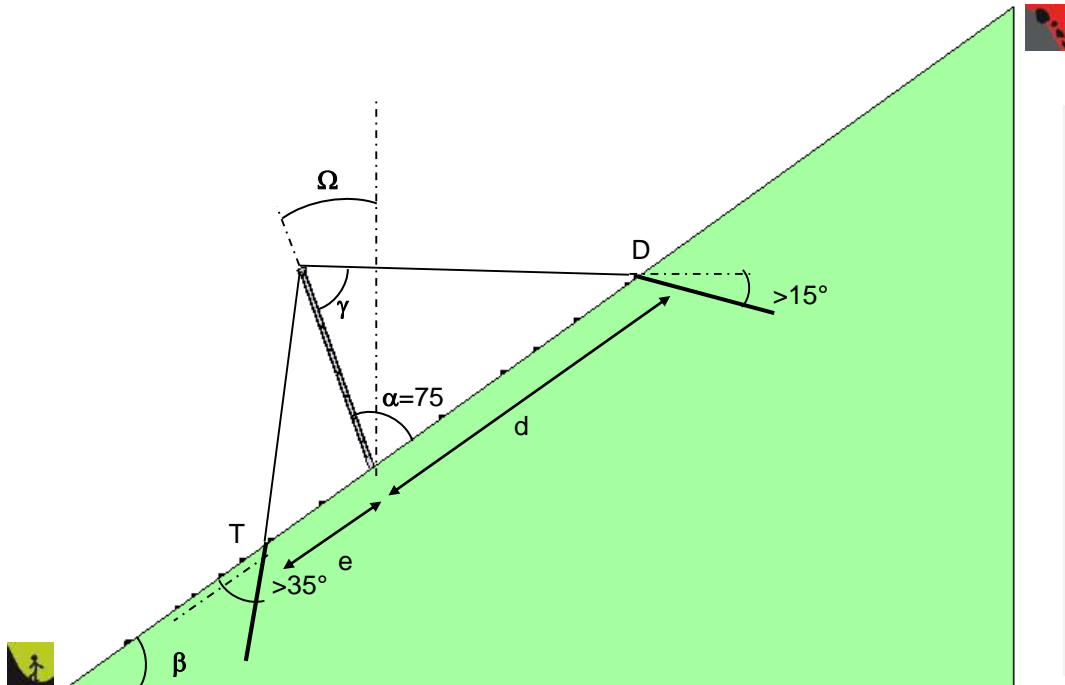
y: angle of direction change

Anchor position

D: retaining rope

For a downslope change in direction of more than 30° an additional retaining rope (D) is mounted on the post head (three ropes instead of two). The maximum angle for a downslope change in direction is 40°.

6 ROPE ANCHOR - PLACEMENT



Tab. 4

β	Ω
0°-30°	15°
32°	17°
34°	19°
36°	21°
38°	23°
40°	25°
42°	27°
44°	29°
45°	30°

γ : The angle must be between 65° - 85°.

α : The angle between slope and post is 75° as standard.

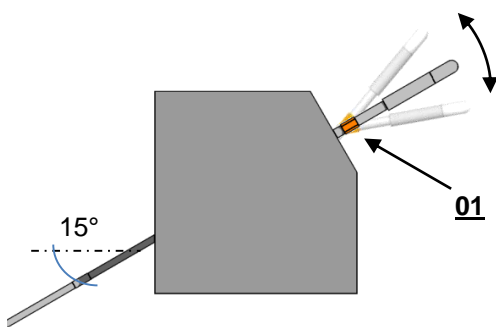


The post angle is dependent on the terrain slope, see table 4.

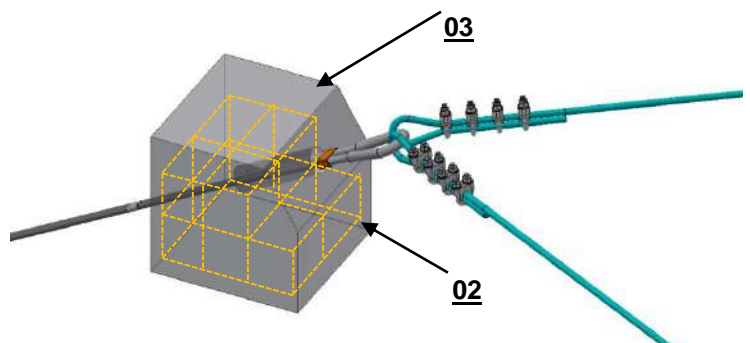


For a slope inclination with $\beta < 30^\circ$ and $\beta > 45^\circ$ small adjustments may be made with respect to the stake-out such as length of the retaining ropes, angle between retaining rope and post inclination of the ground plate, etc.

The anchor holes are drilled in the pulling direction, with a minimum angle of $> 15^\circ$ to the horizontal.



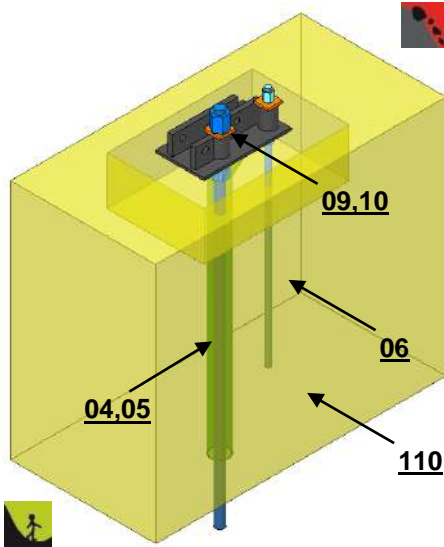
The anchors **01** are horizontal when mortared up to the marking and insert into the anchor hole.



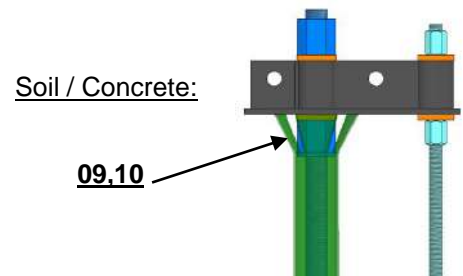
In use of rod anchors with flex head the foundation **03** must be designed with reinforcement **02** against the shear forces.

7 ANCHORING IN GROUND PLATE

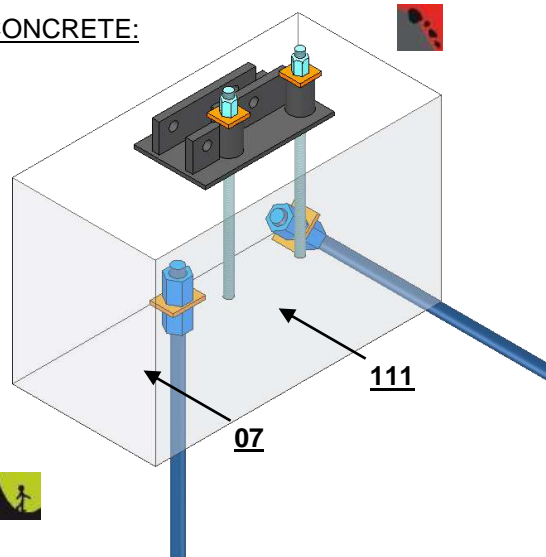
SOIL:



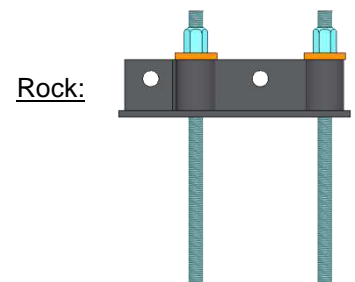
- Base plate inclined 0° - 30° from horizontal
- Drill main anchor 0° – 30° from vertical
- Insert main anchor **05**, washer plate **09** and nut **10**.
- Optional: stabilization tube **04**
- Grout the main anchor in soil **110**, length is variable
- Optional: head foundation made of reinforced concrete.
- Drill and install securing anchor **06** by using the base plate as template. Length is 1000mm.



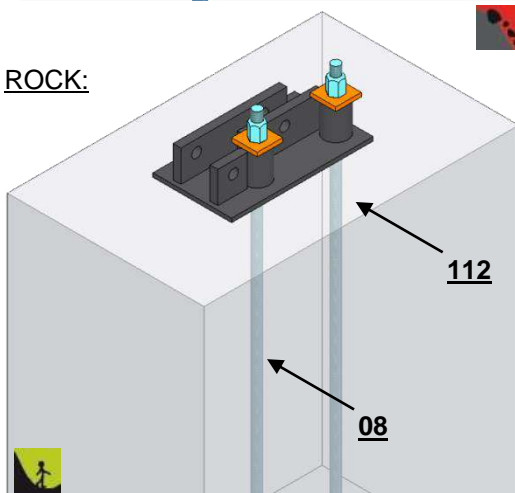
CONCRETE:



- For all types of soil and rock
- Excavate foundation pit
- Optional: Drill and install soil or rock anchors for tie back **07**
- Install appropriate foundation (formwork and reinforcement)
- Insert the two anchors (use the base plate as template), Length is L=500mm
- Pour the concrete foundation **111**



ROCK:



- Level the rock 0° - 30° from horizontal
- Drill into rock **112** the two holes perpendicular to the ground plate
- Grout in the anchors **08**. Length is variable.
- Curing of the grout
- Put the ground plate and fasten with washers/nuts.
- The anchor length is to adjust to the ground conditions.



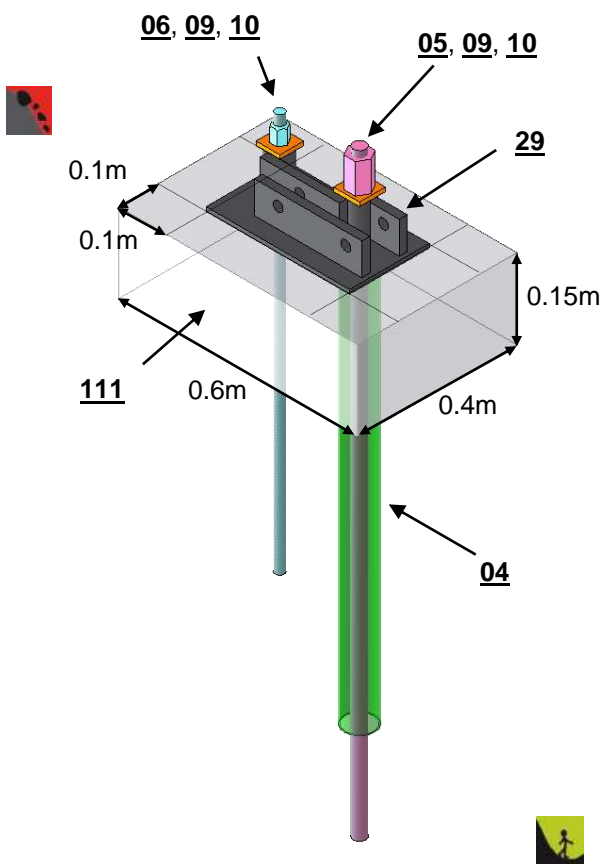
The forces generated in a rockfall event are not to be underestimated. The civil engineering and installation work are therefore to be expertly.



It is to use a frost resistant and de-icing salt resistant grout.
Reinforcement: 12mm-rod diameter in distance of 150mm



It is important to ensure that the anchor have sufficient contact with the grout and make good bond, and that they are long enough to have sufficient area to transfer the anchor loads.



A reinforced concrete foundation with adjacent dimensions is recommended for soil.

1 pcs. rod anchors **05** with plate washer **09** and nut **10**

1 pcs. stabilization tube **04** optional

1 pcs. securing anchor **06** with washer plate **09** and nut **10**

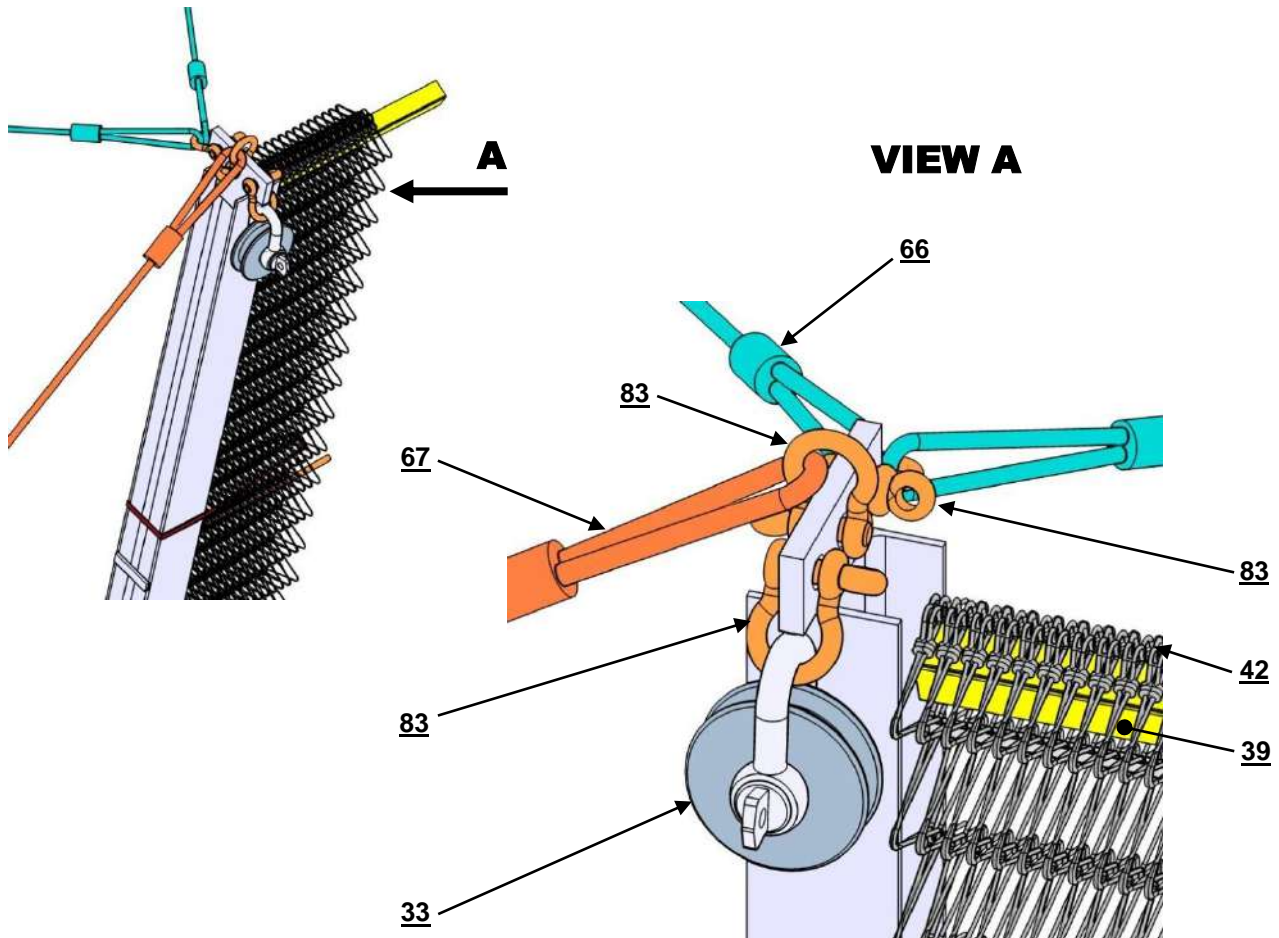
Ground plate **29**

For the nuts of the anchor rods „Swiss Gewi NG 28/32/40“ a torque of 400Nm is recommended by the manufacturer, which corresponds to a prestressing force of $F=30\text{kN}$.

8 PREPARING THE POSTS AND NETS

PREPARING THE POSTS

Example: Border post

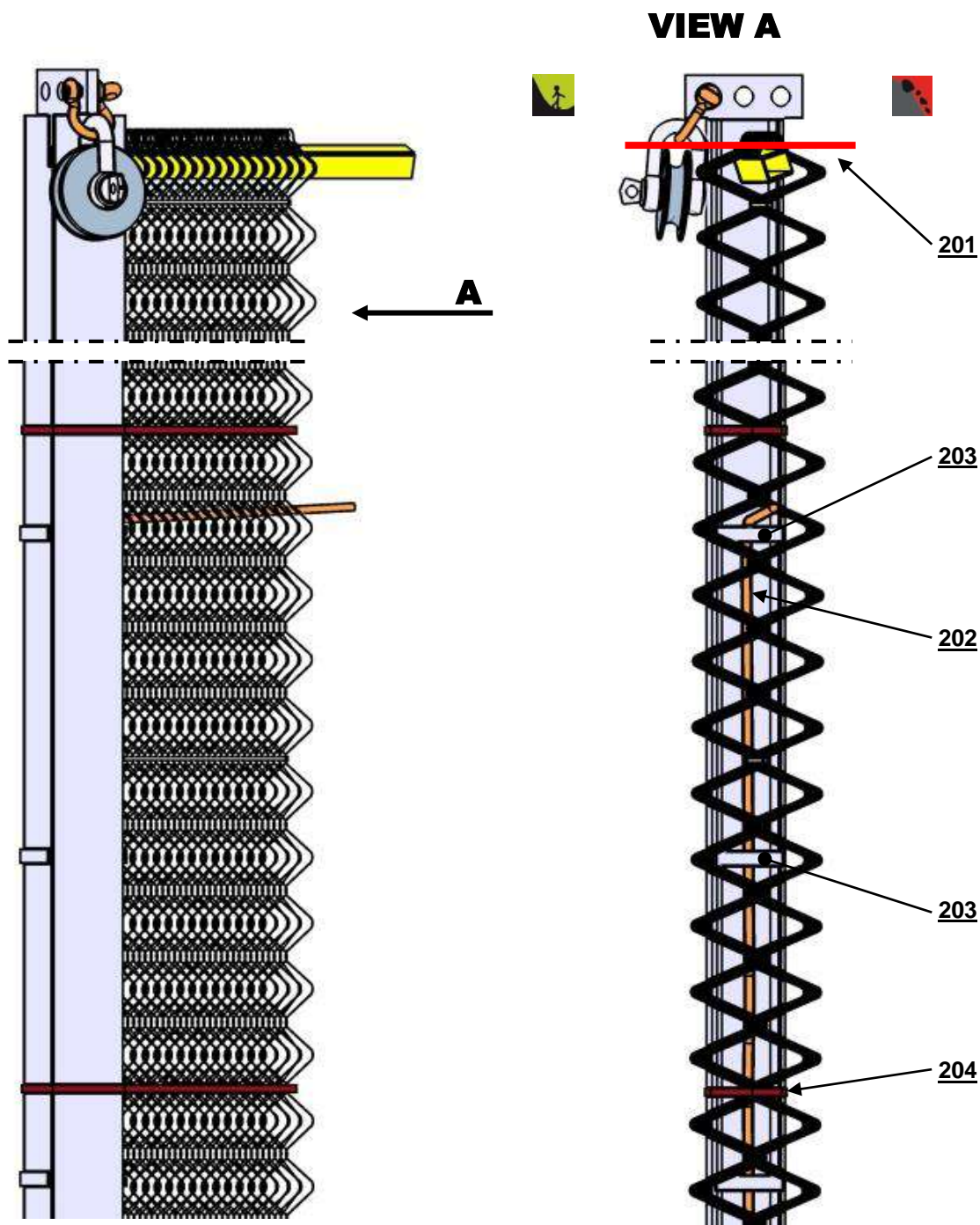


- | | | |
|-----------|--------|--|
| <u>33</u> | 1 Stk. | running wheel with straight shackle 1" |
| <u>39</u> | 2 Stk. | U-Profile as support rope guide |
| <u>42</u> | 1 Stk. | TECCO mesh bundle |
| <u>66</u> | 2 Stk. | Retaining rope d=14mm |
| <u>67</u> | 1 Stk. | Lateral rope d=14mm |
| <u>83</u> | 1 Stk. | Shackle 5/8" |



11 meshes on the top and 11 meshes on the bottom of the net panel are marked, that means the meshes are free. The support rope is not guided through the meshes. See page 33.

THE CORRECT HEIGHT OF THE NET BUNDLE



The height of the uppermost row of mesh **201** is somewhat above the height of the preinstalled running wheels. The mounting bracket **202** is placed at the correct height between the rungs **203** and the post wall.

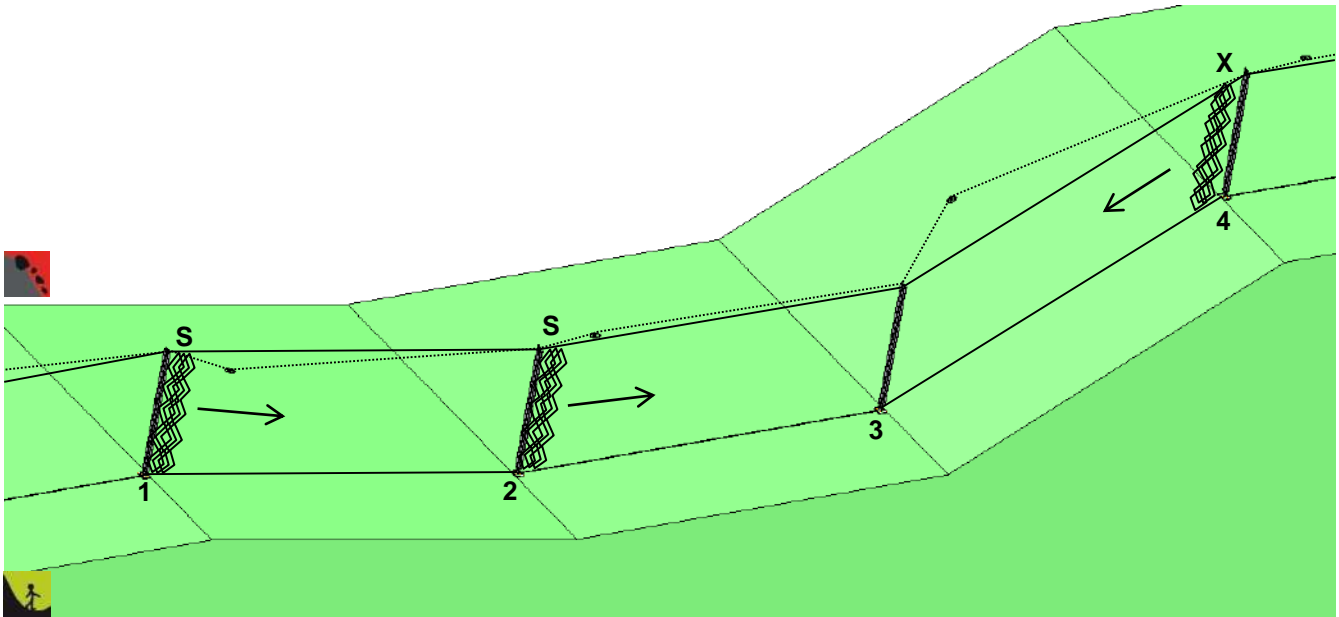


The net bundle is placed on the mounting bracket and securely fastened with **204** bands.



11 meshes on the top and 11 meshes on the bottom of the net panel are marked, that means the meshes are free. The support rope is not guided through the meshes. See page 33.

THE CORRECT SIDE OF THE NET BUNDLE



The posts are numbered from left to right (viewed from the valley side).



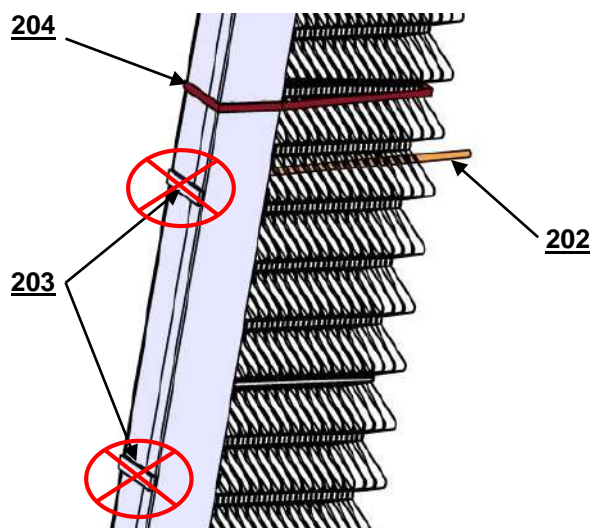
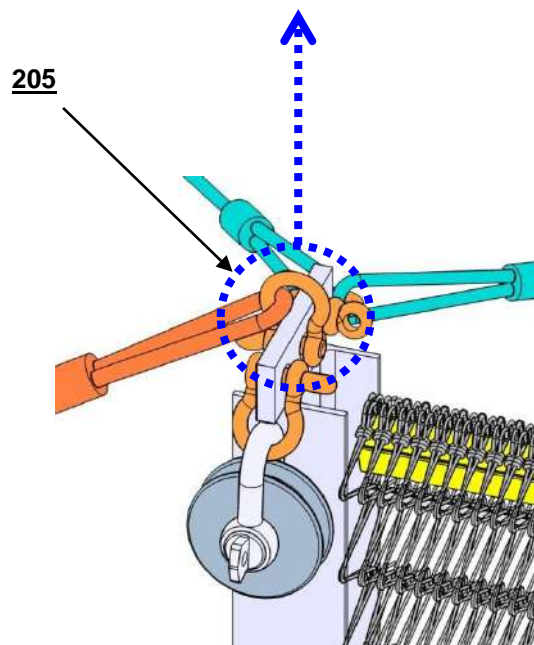
S: The mesh bundles are mounted on the right of the post as standard.

X: If there are large differences in height, it is easier to pull the mesh down from the higher post to the lower post.



On request, Geobugg will also supply the bundles on the optimal side of the post.

9 IN CASE OF CRANE OR HELICOPTER INSTALLATION



Fasten the mesh bundle using bands **204** and the mounting bracket **202** so that it cannot fly away.



Use the center 5/8" shackle on the top of the post **205** to lift the posts.
Never use the rungs **203**!

10 INSTALLING THE SUPERSTRUCTURE

- Install the posts and the retaining ropes. The loops are fixed on the post head by shackles.



Install overturn securing rope immediately after post installation. In the danger zone, extreme caution should be exercised as posts can still flip over backwards.

- Install the lateral ropes and intermediate anchor ropes.



- Install the U-brake for the top support rope on the anchors. Fasten the top support rope to the tops of the posts and tension the top support rope. Pay attention to keep the meshes free according to the illustration on page 33.



- Install the U-brakes on the anchors, fasten the bottom support rope to the baseplates, and then tension the lower support rope after closing the nets. Pay attention to keep the meshes free according to the illustration on page 33.



- Install the vertical ropes close to the two outermost posts.

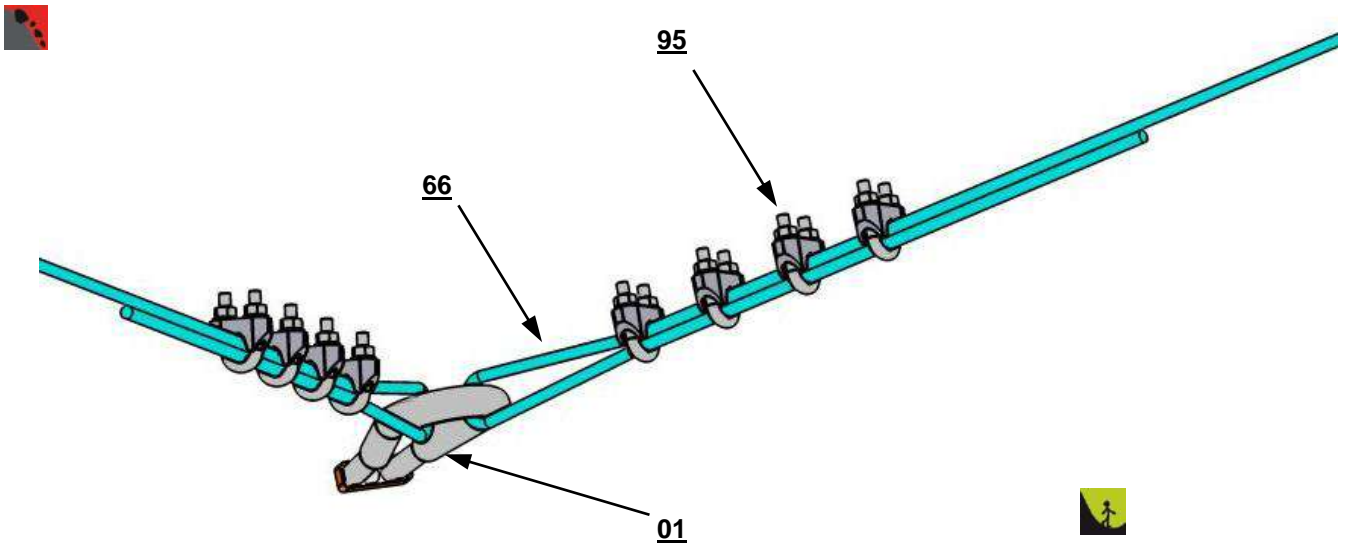
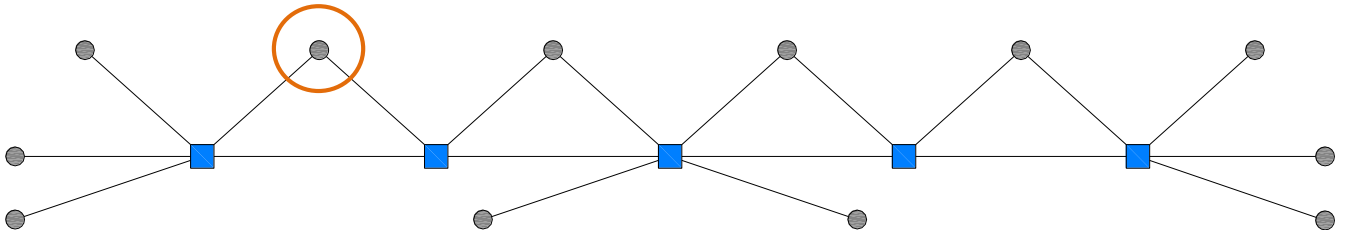


- The support ropes go through the meshes, except next to the post.

11 ASSEMBLY DETAILS

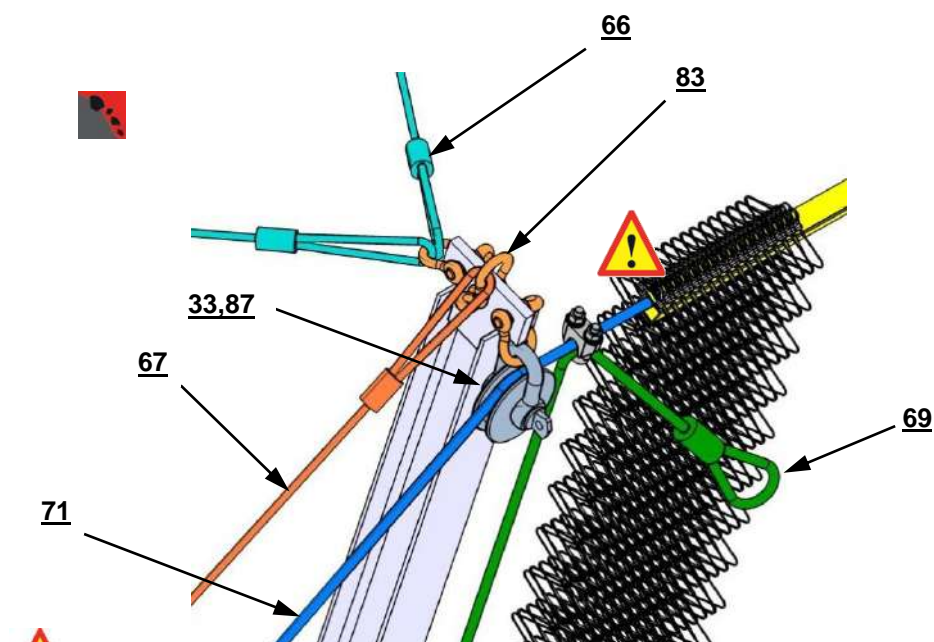
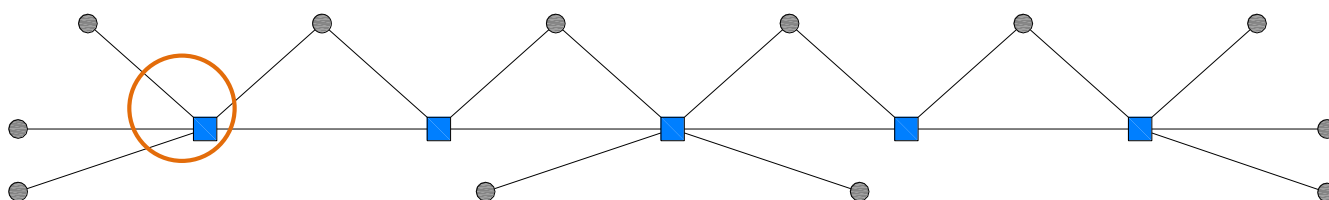
ROPE CONNECTION TO THE ANCHORS

RETAINING ROPES ON THE UPSLOPE ANCHORS

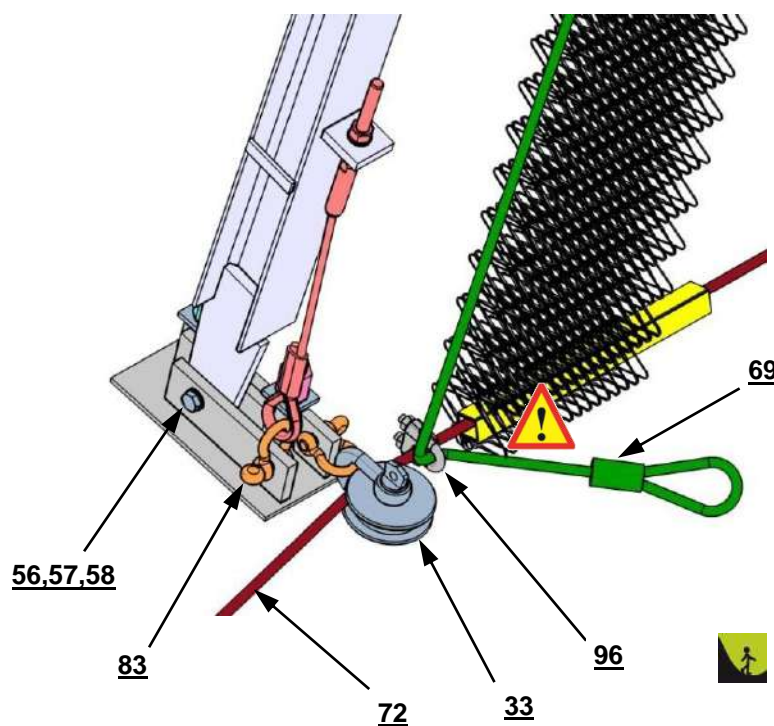


- | | | |
|------------------|-------|-----------------------------------|
| <u>01</u> | 1 pcs | Spiral rope anchor |
| <u>66</u> | 1 pcs | Retaining rope |
| <u>95</u> | 4 pcs | Wire rope clip NG16 for each rope |

BORDER POST

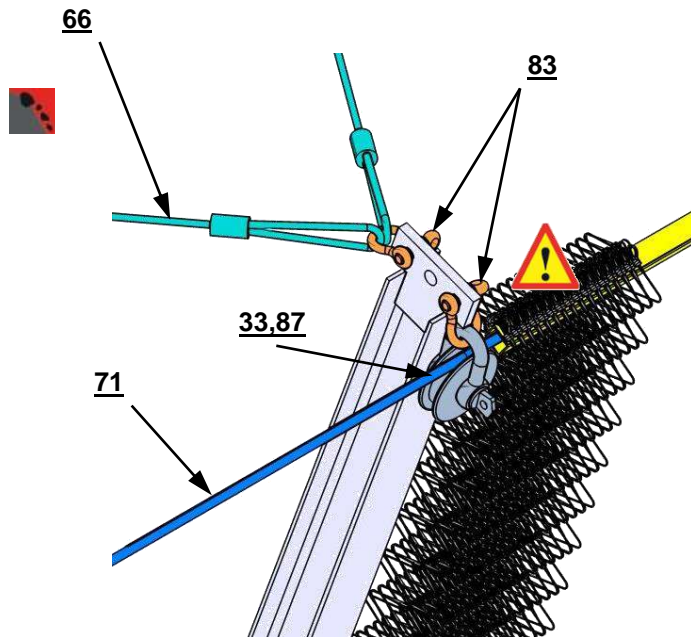
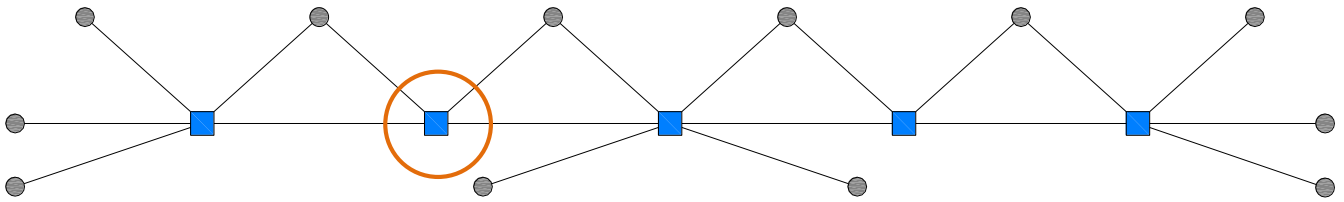


It is a schematic illustration of the net bundle, make sure that the right number of meshes rest free.

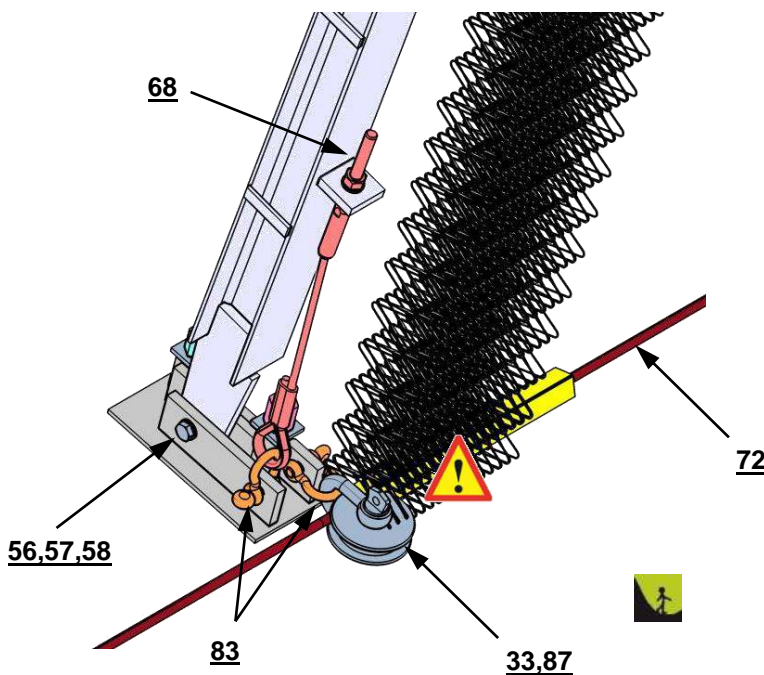


- | | | |
|-----------|--------|--|
| <u>33</u> | 1 pcs. | running wheel with straight shackle 1" |
| <u>56</u> | 1 pcs | 6kt bolt M20x110 |
| <u>57</u> | 2 pcs | washer M20 |
| <u>58</u> | 1 pcs | 6kt nut M20 |
| <u>66</u> | 2 pcs | Retaining rope |
| <u>67</u> | 1 pcs | Lateral rope |
| <u>69</u> | 1 pcs | Vertical rope |
| <u>71</u> | 1 pcs | Top support rope |
| <u>72</u> | 1 pcs | Bottom support rope |
| <u>83</u> | 1 pcs | Shackle 5/8" |
| <u>87</u> | 1 pcs | shackle 1", straight |
| <u>96</u> | 1 pcs | Wire rope clip NG19 |

MIDDLE POST



Install overturn securing rope immediately after post installation. In the danger zone, extreme caution should be exercised as posts can still flip over backwards.



<u>33</u>	2 pcs	running wheel
<u>56</u>	1 pcs	hexagonal bolt M20x110
<u>57</u>	2 pcs	washer M20
<u>58</u>	1 pcs	hexagonal nut M20
<u>66</u>	2 pcs	retaining rope d=14mm
<u>68</u>	1 pcs	overturn securing rope
<u>71</u>	1 pcs	top support rope d=20mm
<u>72</u>	1 pcs	bottom support rope d=20mm
<u>83</u>	1 pcs	Shackle 5/8"
<u>87</u>	2 pcs	Shackle 1" straight

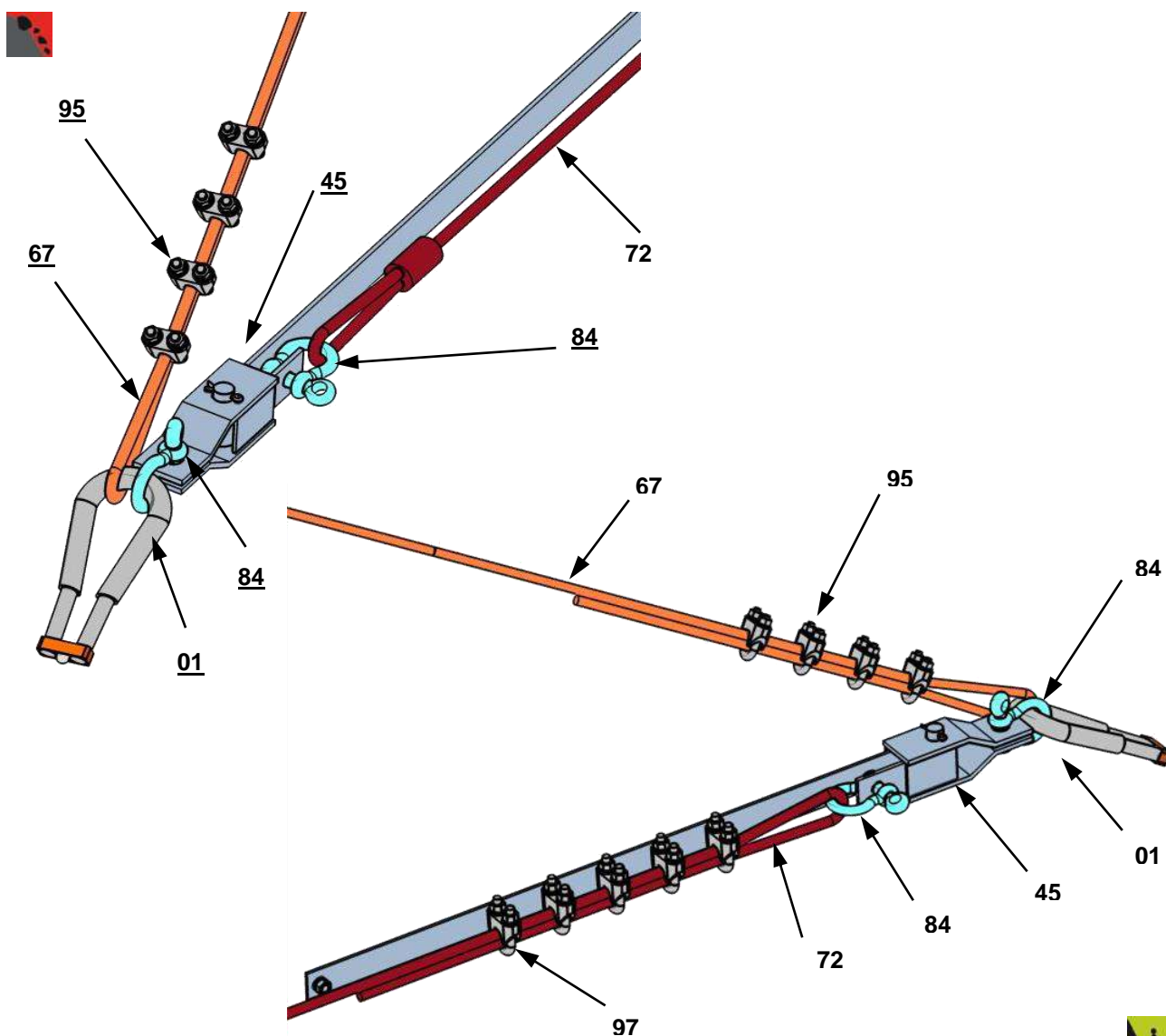
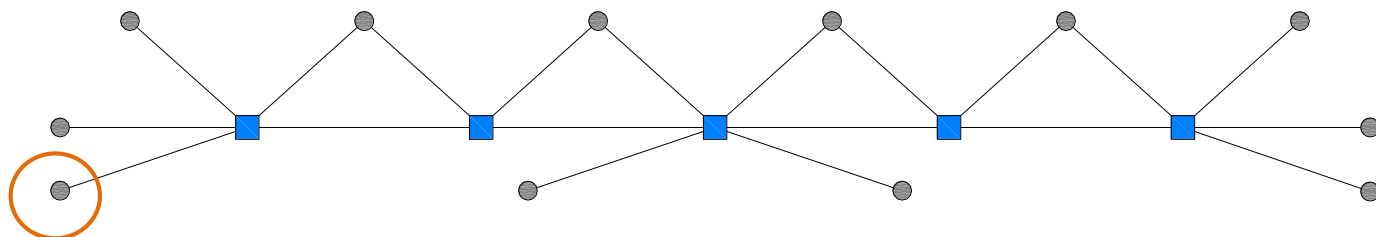


In case of a support rope separation, the overturn securing rope 68 is installed temporary.



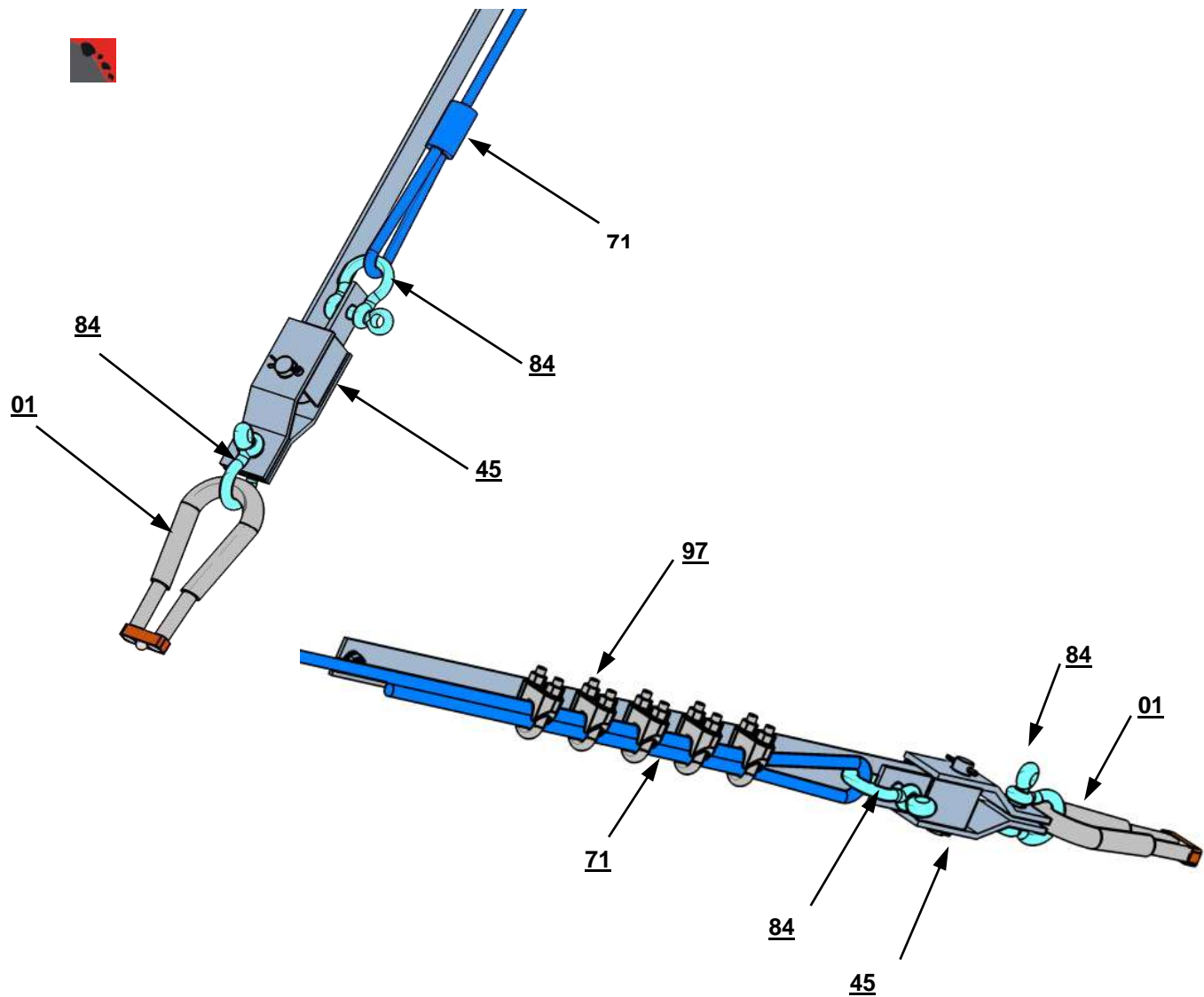
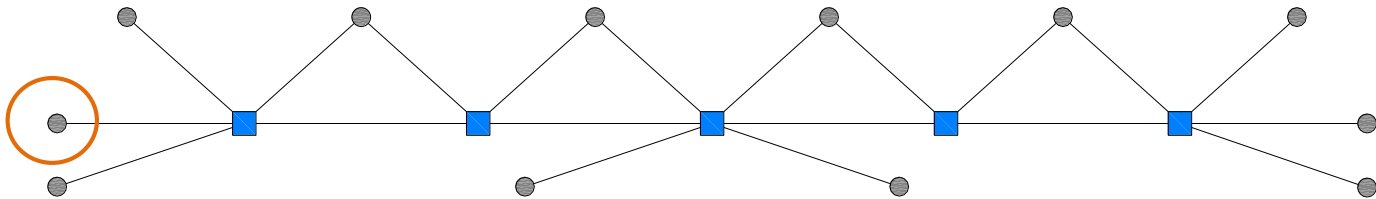
It is a schematic illustration of the net bundle, make sure that the right number of meshes rest free.

LATERAL ROPE AND BOTTOM SUPPORT ROPE ON THE ROPE ANCHOR

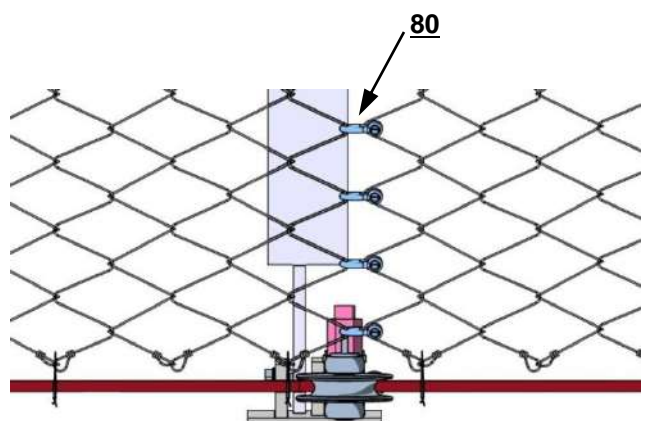
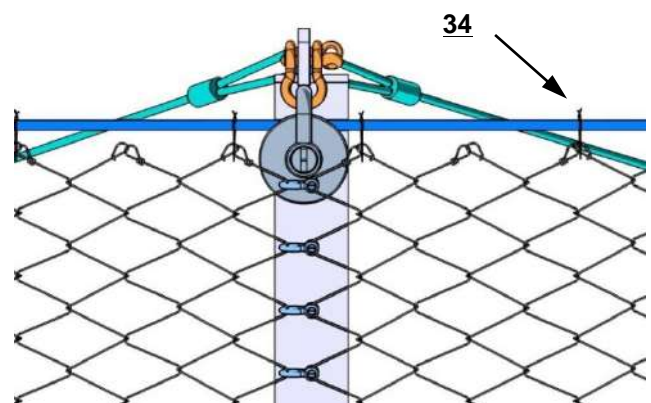
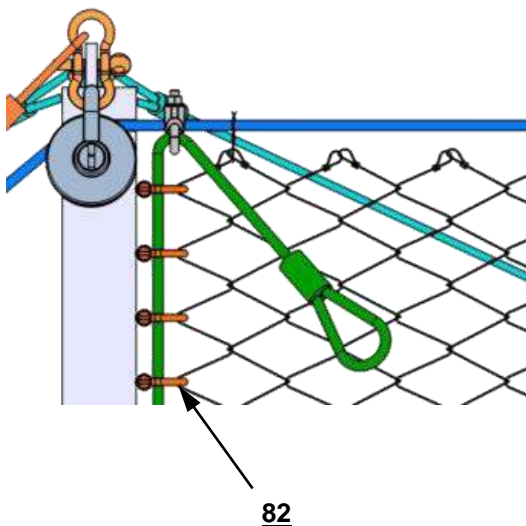
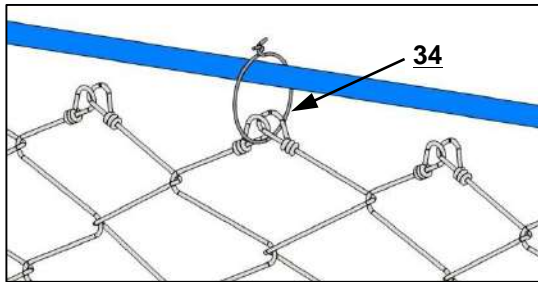
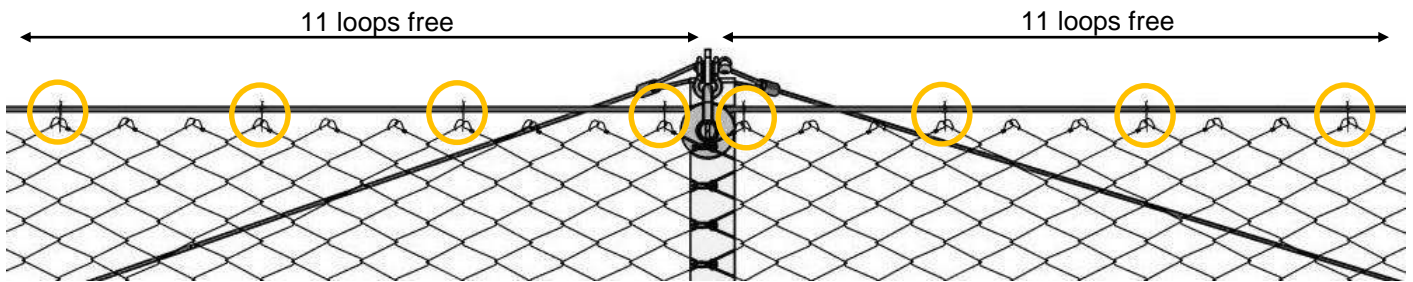


- | | | |
|-----------|-------|-------------------------------|
| 01 | 1 pcs | spirale rope anchor |
| 45 | 1 pcs | U-brake U-300 |
| 84 | 2 pcs | shackle 3/4" |
| 95 | 4 pcs | wire rope clip NG16 per rope |
| 97 | 5 pcs | wire rope clip NG 22 per rope |

TOP SUPPORT ROPE ON THE ROPE ANCHOR

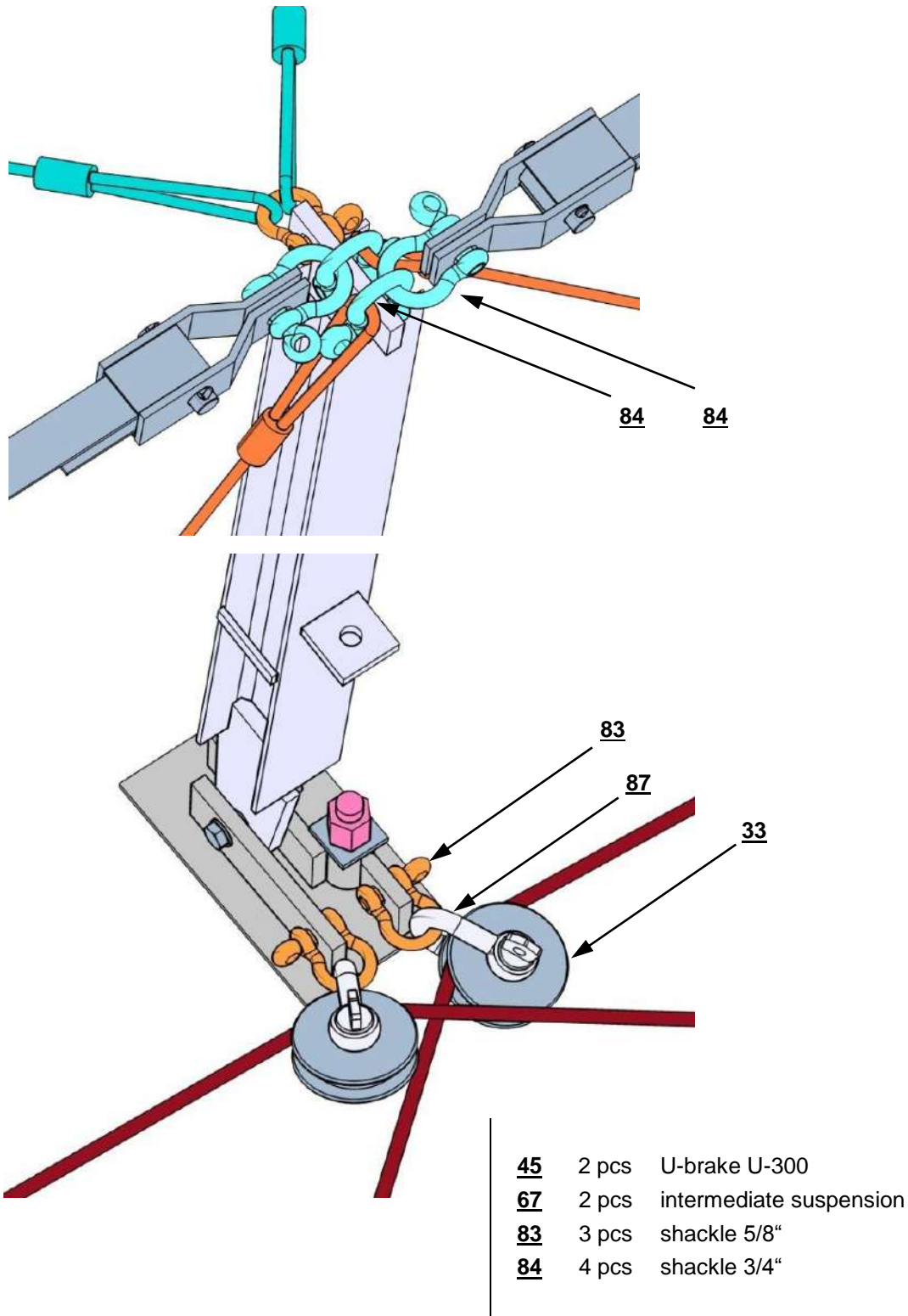


TECCO G80/4 ON THE SUPPORT ROPES



- 34** Mount 4 round clips on both the left and right of the post, starting with the post. Keep 11 loops free
- 80** 3/8" shackle per loop
- 82** 1/2" shackle per loop on vertical rope

SUPPORT ROPE SEPARATION



A support rope separation always contains an intermediate anchor ropes.

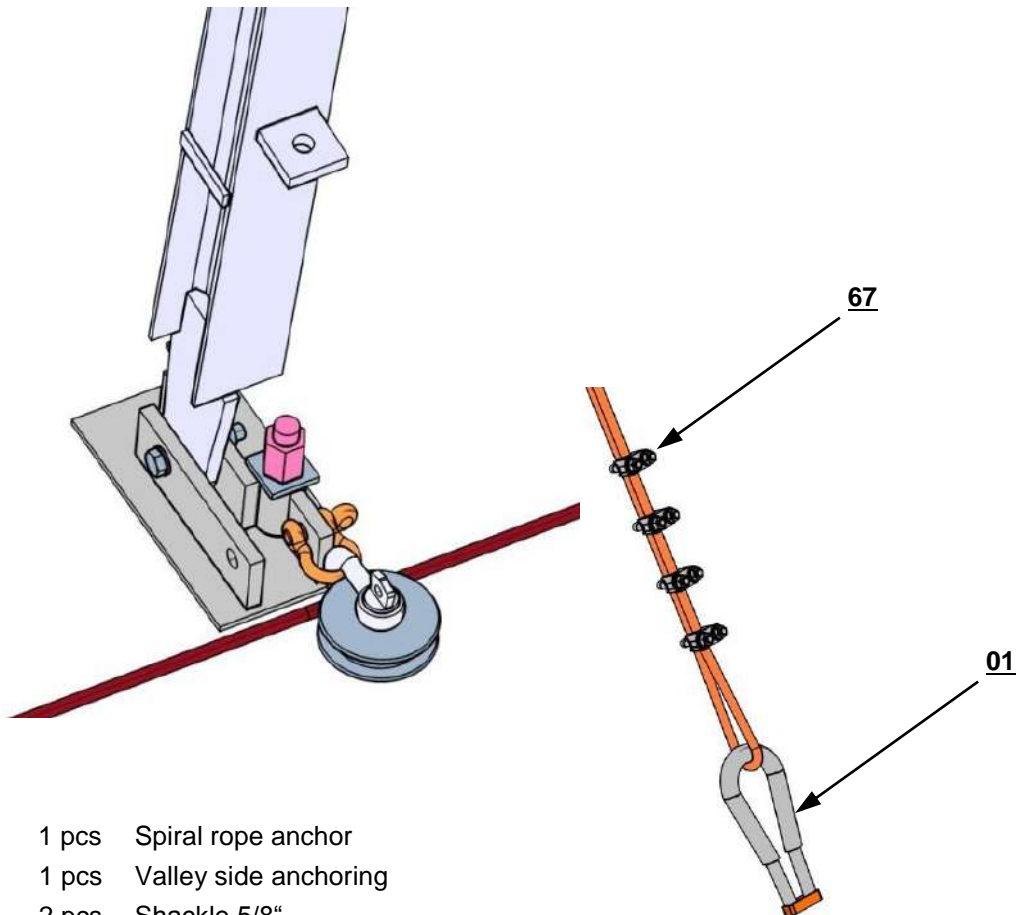
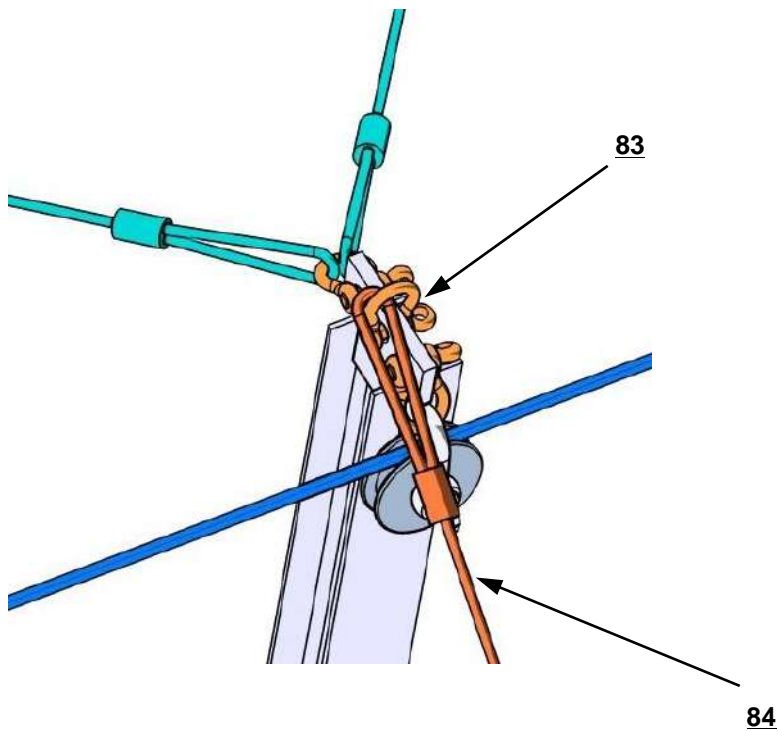


In the case of an intermediate anchor rope without support rope separation, the two lateral ropes at the center hole are fastened with a 5/8" shackle.



In case of a support rope separation, the overturn securing rope 68 is installed temporary.

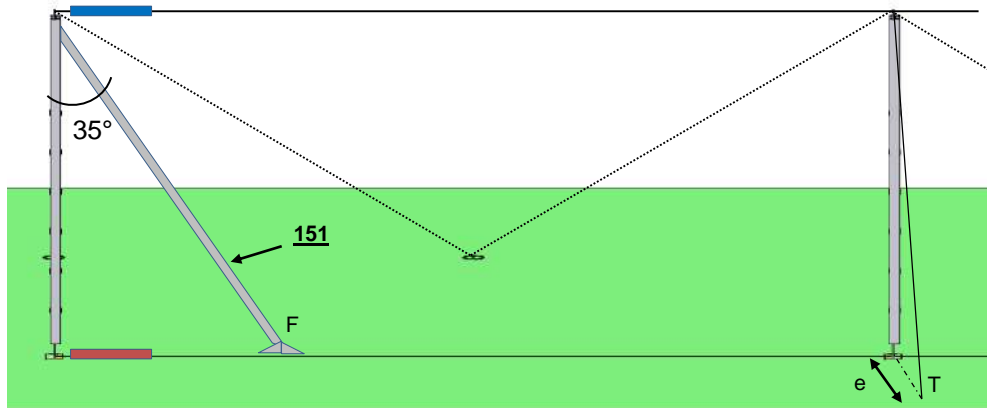
VALLEY-SIDE ANCHORING



- | | | |
|-----------|-------|-----------------------|
| 01 | 1 pcs | Spiral rope anchor |
| 67 | 1 pcs | Valley side anchoring |
| 83 | 2 pcs | Shackle 5/8" |
| 96 | 4 pcs | Wire rope clip NG16 |

12 ADDITIONAL SOLUTION TO THE STANDARD

BRACE ELEMENT SOLUTION



e: distance valley-side

F: strut

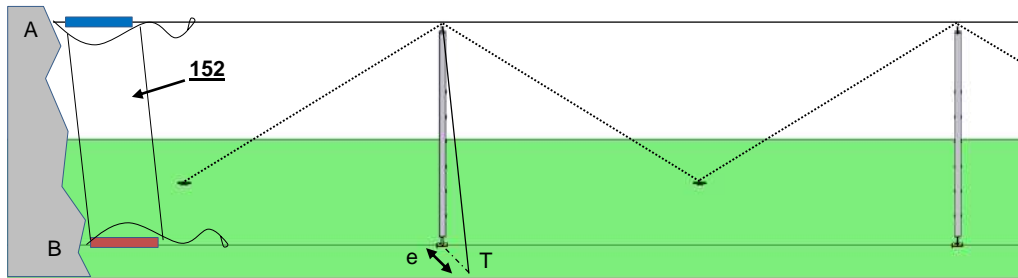
T: valley-side anchoring, optional

 Brake element



If there is not sufficient space to stake out the lateral anchors using the standard procedure, a strut solution **151** can be developed in consultation with Geoblogg AG.

ROCK FACE CONNENCTION



e: distance valley side

A: top support rope

B: bottom support rope

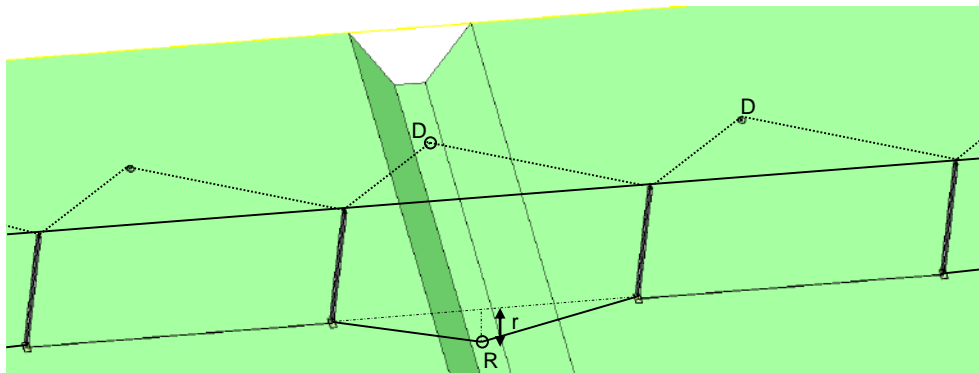
T: valley side anchoring optional

 brake element



If it is not possible to use the standard staking-out procedure, an option for solid rock can be developed in consultation with Geoblogg AG. This also involves installing towing nets **152** at the edges of the structure.

GAP FILLING SOLUTION



r: distance gap

R: gap anchor

D: retaining rope anchor

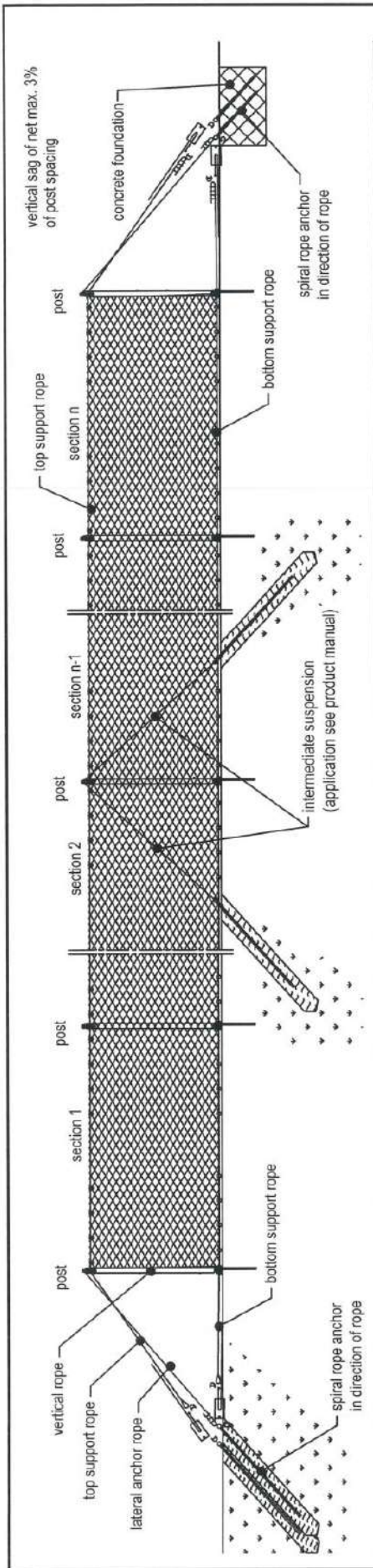


On steep mountain slopes with mountain torrents, there may be larger gaps between the ground and the lower support rope. Individual gap solutions can be developed in consultation with Geoblogg AG.

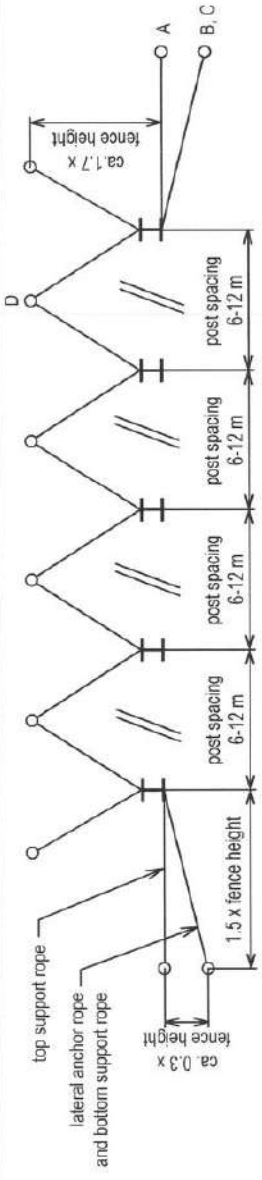
13 FINAL INSPECTION

Once installation has been completed, the following aspects in particular must be inspected:

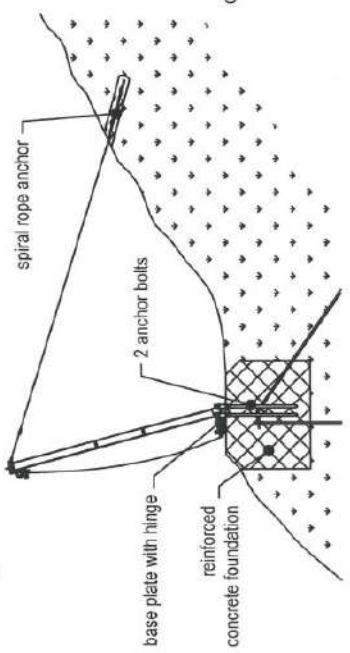
- a) Are the support ropes and the lateral rope connected to the correct anchors?
- b) Are the rope guides at the top and bottom of the posts installed correctly?
- c) Have the correct number of loops been left free on the left and right of the posts?
- d) Is the net correctly fastened to the support ropes?
- e) Have the correct number of wire rope clips been attached to the ends of the rope?
- f) Are the wire rope clips installed correctly?
- g) Has the correct torque been applied to the wire rope clips?
- h) Are the nets connected correctly?
- i) Are the end nets correctly fastened to the vertical ropes?
- j) Is the sag of the top support rope less than 3% of the distance between the posts?



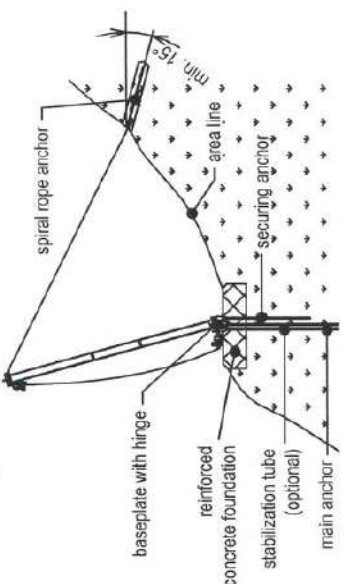
layout of anchor points
details in
product manual GBE-1000A



- anchoring concrete foundation:
for all types of soil



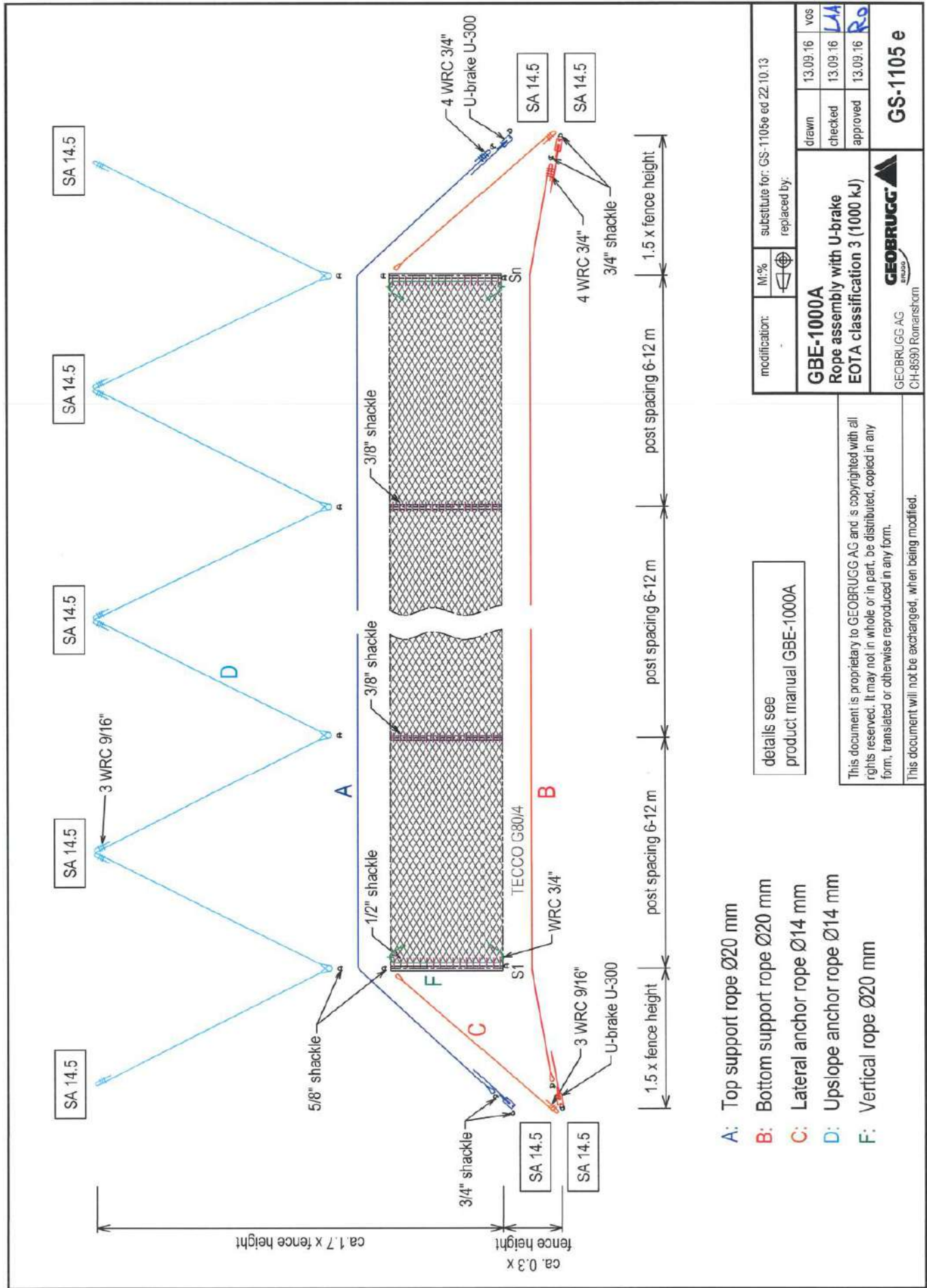
- anchoring in loose soil: with main and securing anchor
- anchoring in bedrock: with two rock anchors



NOTE:
Rockfall, landslides, debris flows or avalanches are sporadic and unpredictable. Causes can be e.g. human (construction, etc.) or environmental (weather, earthquakes, etc.). Due to the multiplicity of factors affecting such events it is not and cannot be an exact science that guarantees the safety of individuals and property. However, by the application of sound engineering principles to a predictable range of parameters and by the implementation of correctly designed protection measures in identified risk areas the risks of injury and loss of property can be reduced substantially. Inspection and maintenance of such systems are an absolute requirement to ensure the desired protection level. The system safety can also be impaired by events such as natural disasters, inadequate dimensioning parameters or failure to use the prescribed standard components, systems and original parts, and/or corrosion (caused by pollution of the environment or other man-made factors as well as other external influences).

modification:	M %	substitute for: GS-1100e ed 15.04.16	replaced by:	drawn	checked	approved	VCS
Rockfall protection barrier				15.09.16	15.09.16	15.09.16	VCS
GBE-1000A system							LM
EOTA classification 3 (1000 kJ)							Ro
GEOBRUGG AG				GS-1104 e			
CH-8590 Romanshorn							

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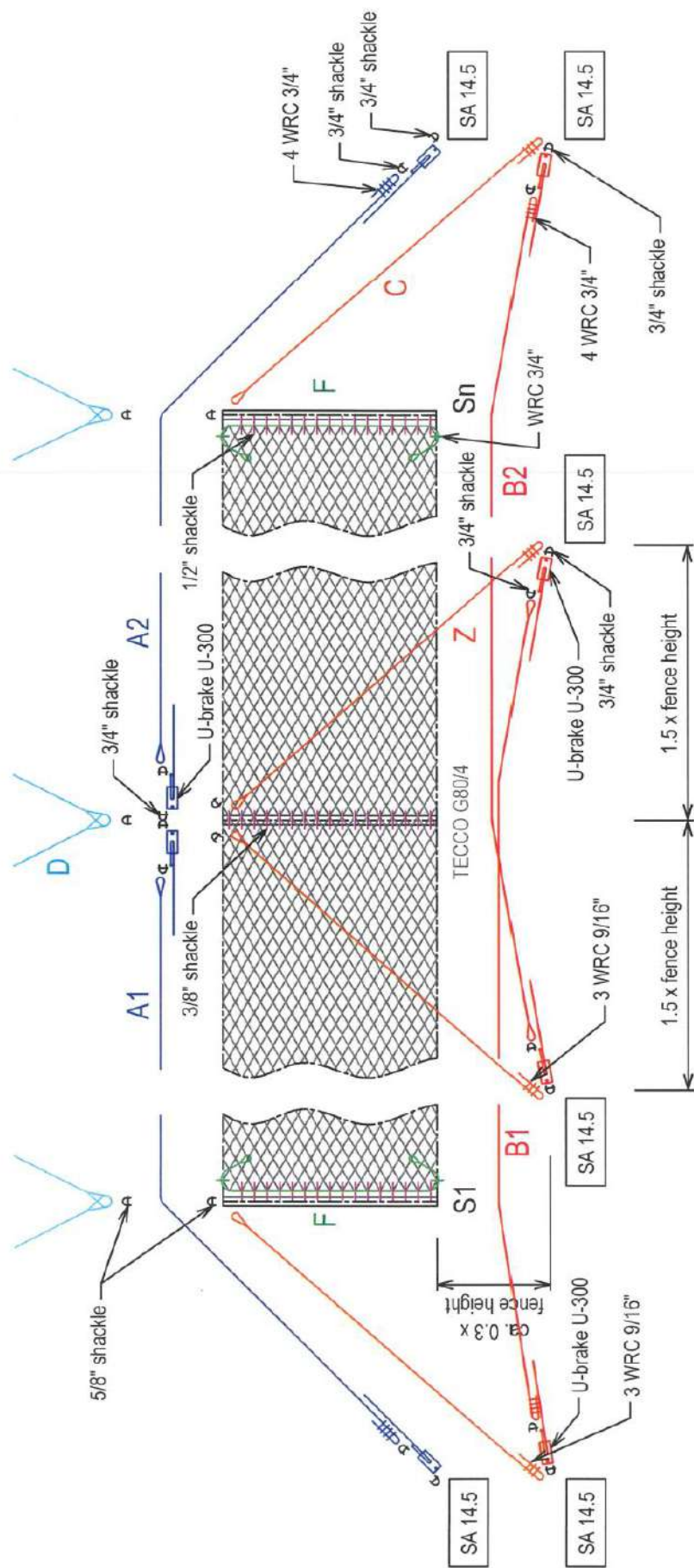


modification:	Mt%	substitute for: GS-1105e ed 22.10.13	drawn	13.09.16	vcs
		replaced by:	checked	13.09.16	LA
			approved	13.09.16	Ro
GBE-1000A Rope assembly with U-brake EOTA classification 3 (1000 kJ)			GS-1105 e		
GEOBRUGG AG (CH-8590 Romanshorn)			GEOBRUGG		

details see
product manual GBE-1000A

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details see
product manual GBE-1000A

- A: Top support rope Ø20 mm
- B: Bottom support rope Ø20 mm
- C: Lateral anchor Ø14 mm
- D: Upslope anchor rope Ø14 mm
- F: Vertical rope Ø20 mm
- Z: Intermediate anchor rope Ø14 mm

modification:	M: %	substitute for: GS-1106e ed. 31.07.14	drawn	13.09.16	VOS
		replaced by:	checked	13.09.16	LAA
			approved	13.09.16	Ro
GBE-1000A rope separation EOTA classification 3 (1000 kJ)					GS-1106 e
GEOBRUGG AG CH-8590 Romanshorn					

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Certificate

SQS herewith certifies that the company named below has a management system which meets the requirements of the standard specified below.



Geobrugg AG
8590 Romanshorn
Switzerland

Certified area

GEOBRUGG Geohazard Solutions
GEOBRUGG Safety Solutions
GEOBRUGG NETECH

Field of activity

Protection Technology and Protection Systems
Safety mesh applications and Safety Systems

Standard

ISO 9001:2008 **Quality Management System**

Swiss Association for Quality and
Management Systems SQS
Bernstrasse 103, CH-3052 Zollikofen
Issue date: August 4, 2016

This SQS Certificate is valid up to
and including September 14, 2018
Scope number 17
Registration number 34372



Trusted Cert

X. Edelman, President SQS



R. Gläuser, CEO SQS





THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

SQS and IQNet Partner hereby states that the organization

Geobrugg AG
8590 Romanshorn
Switzerland

for the following scope and type of activities

GEOBRUGG Geohazard Solutions
GEOBRUGG Safety Solutions
GEOBRUGG NETECH

Protection Technology and Protection Systems
Safety mesh applications and Safety Systems

has implemented and maintains a

Management System

which fulfills the requirements of the following standard(s)

ISO 9001:2008 / Quality Management System

for the validity date, please refer to the original certificate issued by SQS*

Scope No(s): 17

Issued on: 2016-08-04

Validity date: 2018-09-14

Registration Number: CH-34372




Michael Drechsel
President of IQNet


Roland Glauser
CEO SQS



IQNet Partners:**

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CISQ Italy CQC China CQM China CQS Czech Republic Cro Cert Croatia DQS Holding GmbH Germany
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IRAM Argentina JQA Japan KFQ Korea MIRTEC Greece MSZT Hungary Nemko AS Norway NSAI Ireland PCBC Poland
Quality Austria Austria RR Russia SIGE México SII Israel SIQ Slovenia SIRIM QAS International Malaysia
SQS Switzerland SRAC Romania TEST St Petersburg Russia TSE Turkey YUQS Serbia
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* This attestation is directly linked to the IQNet Partner's original certificate and shall not be used as a stand-alone document

** The list of IQNet partners is valid at the time of issue of this certificate. Updated information is available under www.iqnet-certification.com