

3000 kJ

PRODUCT MANUAL GBE-3000A

**European Technical
Assessment ETA-10/0084**

**ETAG 027: Category A
Energy Class 6: 3000 kJ
Height: 5 – 6 m**

**Date: 27.09.2016
Edition: 164-N-FO / 15**

**Associated test institute:
Federal research institution WSL
Birmensdorf, Switzerland**

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CH-8590 Romanshorn**

**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 – 0630

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 – 3000A

Energy level classification

6

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 1000 kJ and with the Maximum Energy Level 3000 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 10/0084 – version 02

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 19 July 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conditions in the plant or the factory production control itself are not modified significantly, unless suspended or withdrawn by the product certification body.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, 17 August 2015




Dipl. Ing. Daša Kozáková
Head of Notified Body 1301

070225



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European Technical Assessment

ETA 10/0084 – version 02
of 27/07/2015

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 – 3000A

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
Geohazard Solutions
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This European Technical Assessment contains

34 pages including 19 annexes which form an integral part of this assessment.

Annexes 5/9/10/11/12 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-10/0084 issued on 15/07/2010

PURPOSE AND STRUCTURE OF THE MANUAL

This system manual ensures that Geobrugg rockfall protection systems are manufactured free from defects in accordance with the latest technology, that their range of applications is defined, their functional reliability is ensured, and that the installation of the systems is carried out professionally and is also inspected.

See the appendix at the end of the manual for the system overview

The system manual is divided into the following sections:

- Proof of quality assurance
- Staking out
- Assembly details
- System overview / rope system
- ISO 9001 certificate

This document does not claim to be exhaustive. The manual describes general standard applications and does not take any project-specific parameters into account. Geobrugg cannot be held liable for any additional costs that may be incurred in special cases. Please contact the manufacturer if anything is unclear. Geobrugg AG's General Terms and Conditions of Contract apply.

RESPONSIBLE FOR CONTENT:

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Romanshorn, September 27th 2016

 
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(Stamp / legally-binding signatures)

RANGE OF APPLICATION

The engineering of rockfall protection systems is based on detailed investigations by specialist engineering companies, which take the following geotechnical aspects in particular into account to define the range of applications:

- Previous rockfall events
- Condition of the rockfall breakout zone
- Assessment of the stability of the entire rockfall zone
- Frequency of rockfall
- Size of the rocks to be caught
- Trajectories and bounce heights of the rocks
- Calculations of the kinetic energy
- Barrier position (taking the local topography into account)
- Anchoring conditions

II QUALITY OF THE INDIVIDUAL SYSTEM COMPONENTS

Geobrugg AG, formerly the Geobrugg Protection Systems division of Fatzer AG, Romanshorn, Switzerland, has been certified with registration number CH-34372 in accordance with the quality management system requirements (ISO 9001:2008) since August 22, 1995. The certification body is the SQS (Swiss Association for Quality and Management Systems), which belongs to IQNet. The quality manual provides a complete specification regarding how the individual system components (primary materials, third-party products, and finished products) are to be comprehensively tested in order to rule out any deficiencies in quality. The relevant certificates can be found in the appendix.

III FUNCTIONAL RELIABILITY OF THE BARRIER SYSTEMS

The system's functional reliability is based on 1:1 rockfall tests, performed and tested in accordance with European Technical Approval Guideline ETAG 027 "Falling Rock Protection Kits" and Swiss Guideline (FOEN) in Wädenswil, SG (Switzerland). The 1:1 rockfall tests involve performing vertical impacts into the middle field of a three-field barrier, where the posts are spaced at 10 m and an impact speed of at least 25 m/s is reached. The tests are accepted by a notified body and receive an approval, known as an ETA (European Technical Approval). The approval no. of the GBE-3000A system is ETA – 10/0084.

IV QUALITY CONTROL FOR INSTALLATION

This system manual provides a detailed description of how to design and install the barrier.

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.

TABLE OF CONTENT

1	HAZARD WARNINGS	8
2	TOOLS FOR INSTALLING ROCKFALL BARRIERS	9
3	USE OF WIRE ROPE CLIPS.....	10
4	STAKING OUT SUBJECT TO TERRAIN	12
5	STAKING-OUT GEOMETRY	14
6	ROPE ANCHOR – INSTALLATION.....	18
7	ANCHORING OF THE BASE PLATE	19
8	PREPARATION OF THE NETS AND POSTS	21
9	CRANE OR HELICOPTER INSTALLATION	24
10	INSTALLING THE SUPERSTRUCTURE	25
11	ASSEMBLY DETAILS	27
12	ADDITIONAL SOLUTION TO THE STANDARD.....	37
13	FINAL INSPECTION.....	38

EXPLANATION OF SYMBOLS



Safety instruction: must be strictly observed



Note / reminder to enable system to be installed easily and correctly



Consultation with Geobruugg is recommended



Mountain-side



Valley-side

1 HAZARD WARNINGS

GROUP LEADER QUALIFICATIONS



Only a qualified group leader may be responsible for overseeing the installation.

ROPES UNDER TENSION



Ropes are under tension. During the installation and tensioning of the ropes, you must make sure that no persons are present in the hazard area.

REMOVAL OF PARTS UNDER TENSION



The removal or separation of components under tension is to be avoided whenever possible. Should such work be necessary, however, the utmost caution must be taken.

2 TOOLS FOR INSTALLING ROCKFALL BARRIERS

STAKING-OUT WORK	<ul style="list-style-type: none"> • Tape measure 30 to 50 m • Measure stick • 5 red and white surveyor's pegs • Inclinator • Aerosol can • Small wooden or iron pegs (min. 3 pegs per field) • Hammer • Product manual
INSTALLATION WORK	<ul style="list-style-type: none"> • Fork or ring wrench • Socket wrench with ratchet • Torque wrench, range 25-400 Nm (see specified tightening torque for wire rope clips and anchor nuts) • Open-ended wrench for anchor nuts • Felco C16 or C112 wire rope cutter or equivalent; cutting capacity 12 mm • Motorized disk cutter or hammer wire rope cutter; cutting capacity 28 mm • Pliers, flat-nose pliers • 2 mm galvanized wire rope strand or wire • Angle spirit level • Roll of adhesive tape • Rope clamp – small 8-16 mm / large 14-26 mm (at least 2) • At least 2 tension belts • Cable winch hoist, e.g. LUG-ALL® • Chain hoist or come-along, at least 1.5 tons (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.

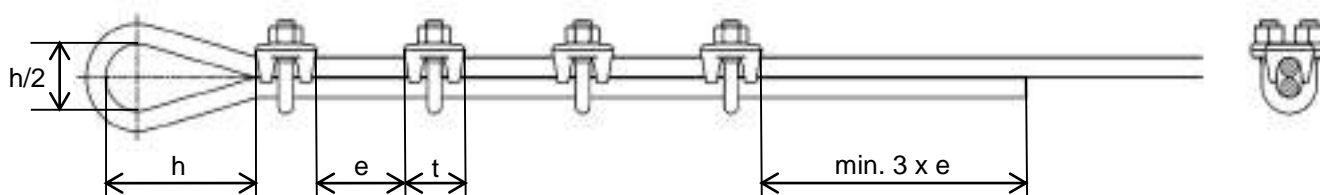
The distance e between the wire rope clips should be at least $1 \times t$ but not exceed $2 \times t$, where t is the width of the clamping jaws. The loose rope end has to be $3 \times e$ at a minimum. Geobrugg recommends looping up the remaining free section and fixing it directly behind the last wire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



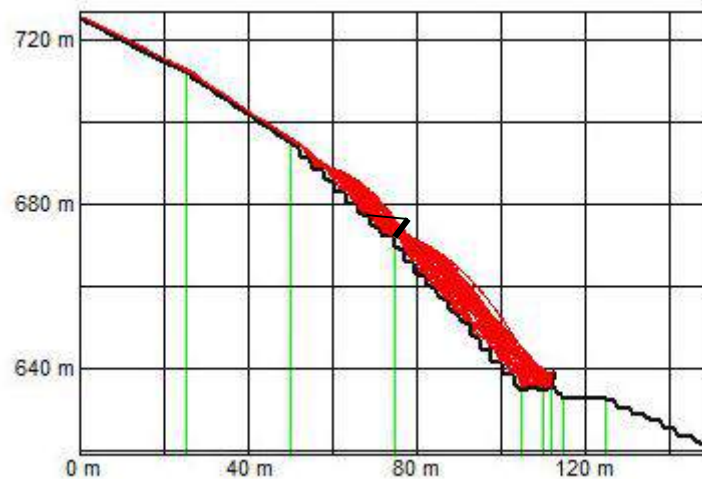
Wire rope clips always have to be installed and used with the required tensioning torque. It is not allowed to re-use clips once they have been detached.

4 STAKING OUT SUBJECT TO TERRAIN

GENERAL PRINCIPLES FOR STAKING OUT

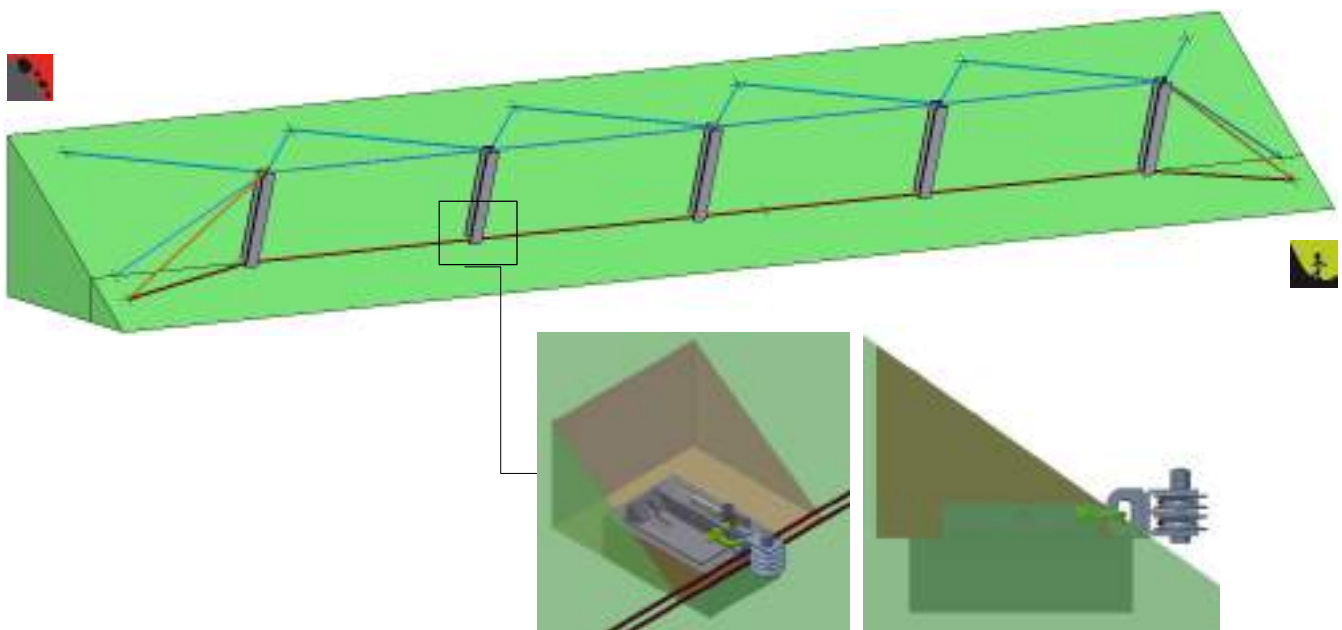
Position of the barrier

Established simulation programs are available for calculating the optimum position of the barrier. Unfavorable locations with excessive bounce heights or shadows are identified.



Barrier line

The barrier line must be designed so that it is as straight and horizontal as possible. An irregular course as well as depressions and cambers in the terrain between the posts must be avoided or corrected wherever possible.

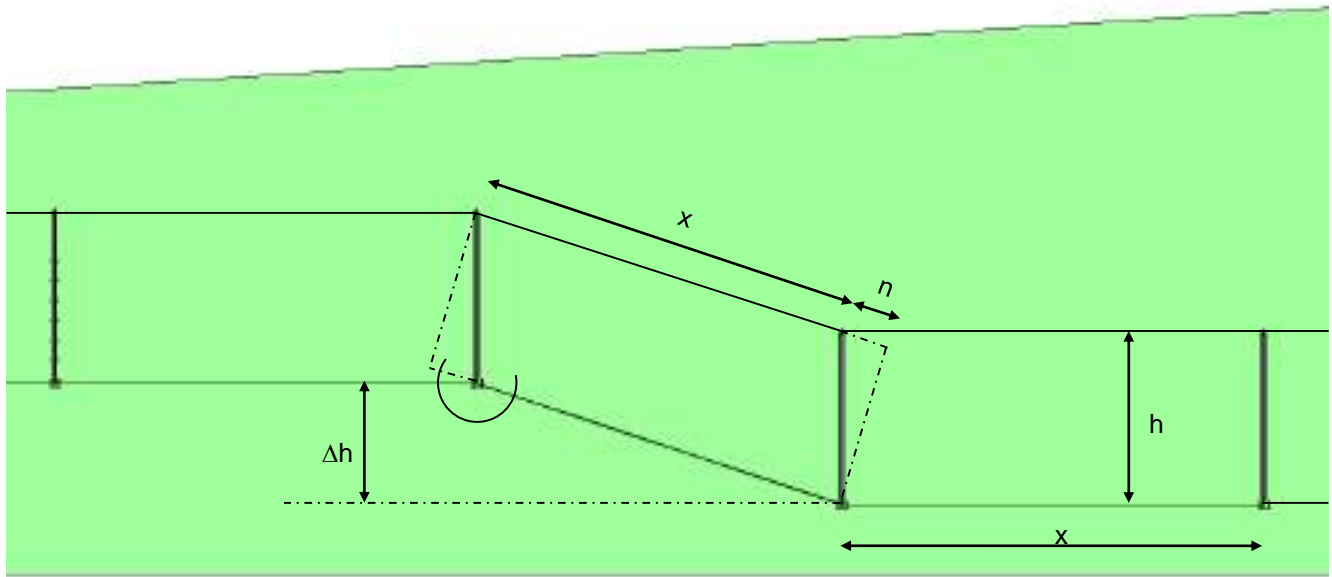


Placing the foundations

The baseplate support of the foundation must be designed based on the terrain so that the lower support rope remains close to the ground.

The baseplate must be positioned in such a way that the lower support rope is routed past the edges of the foundations without being damaged by them.

Height differences in the barrier line



- h:** Barrier height
- x:** Distance between posts
- n:** Adjustment of the net lengths
- Δh:** Height difference between two adjacent posts

Tab. 2

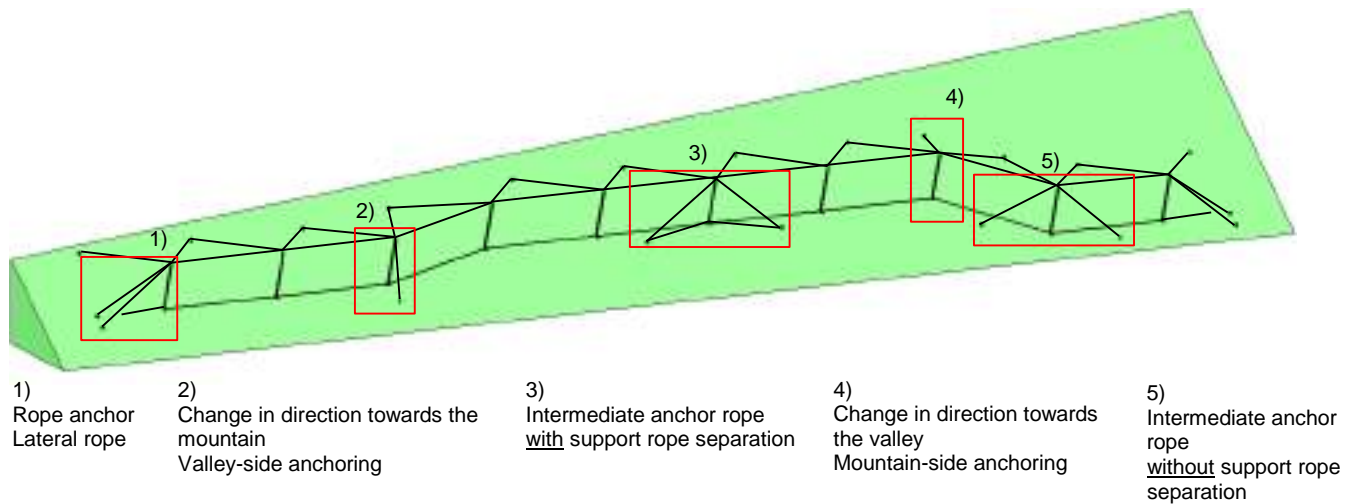
Post distance	6-8 m	8-10 m	10-12 m	
Δh	< 0.50m	< 1.00m	< 1.50m	No adjustment necessary
Δh	> 0.50m	> 1.00m	> 1.50m	Net must be adjusted



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

5 STAKING-OUT GEOMETRY

GENERAL PRINCIPLES FOR STAKING-OUT GEOMETRY



Standard staking-out dimensions

If the standard staking-out dimensions shown on the following pages and their dimensional tolerances are adhered to, the supplied barrier can be installed without any problems and every component will function correctly should a rockfall event occur.

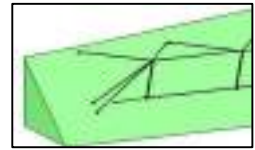
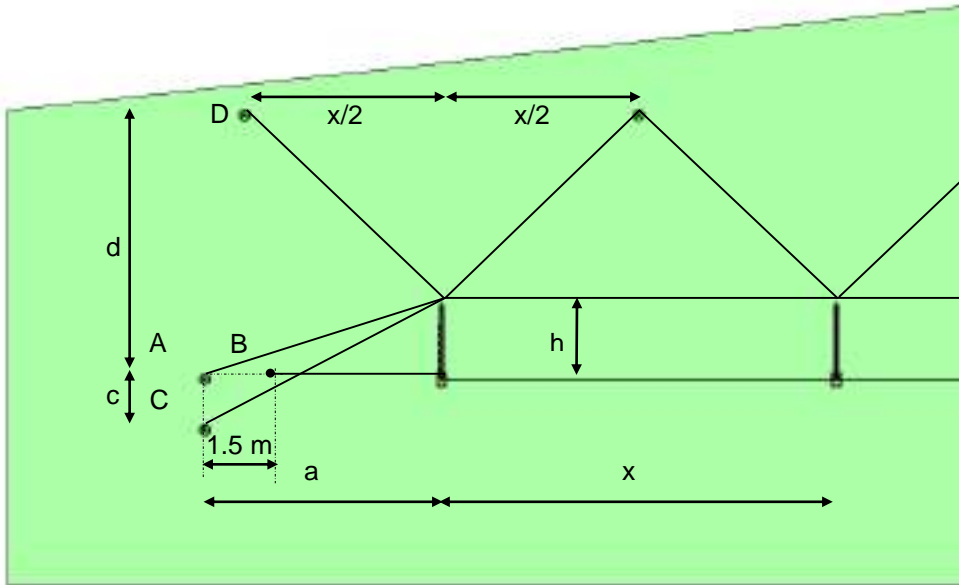
Adapting to the terrain

The type of terrain may mean that it is not possible to adhere to the standard staking-out parameters. Making a number of small adjustments relating to the cross-section or length of nets, ropes, or posts, etc. will ensure that the barrier will function correctly in these cases too.



Informing Geobrudd about the deviations enables you to work together to quickly find a solution that is adapted to your requirements.

STANDARD STAKING-OUT PARAMETERS FOR A STRAIGHT BARRIER LINE



1)

Length

- h:** Barrier height
- x:** Post distance
- a:** see Tab.3
- c:** see Tab.3
- d:** see Tab.3

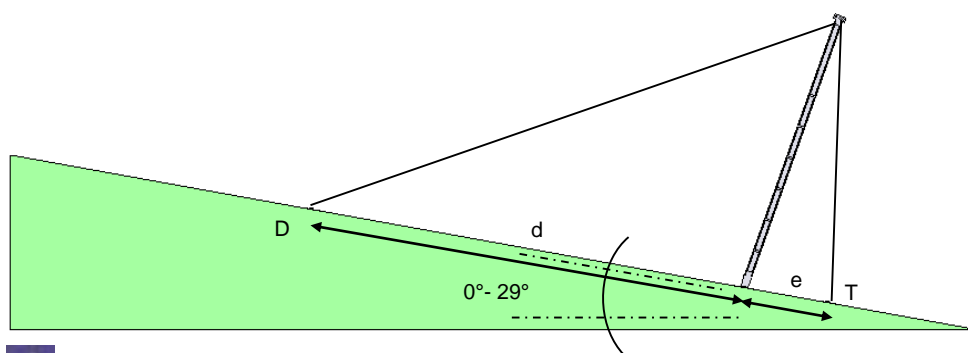
Anchor point

- A:** Top support rope
- B:** Bottom support rope
- C:** Lateral rope
- D:** Retaining rope

The table below is valid for slopes of 30°- 90°.
Dimensions in m; Dimensional tolerance $\pm 0,20$ m

Tab. 3

h	a	c	d ¹⁾	e
4.00	6.00	1.30	6.80	2.00
5.00	7.50	1.65	8.50	2.50
6.00	9.00	2.00	10.20	3.00



Length

- d:** see Tab.3
- e:** see Tab.3

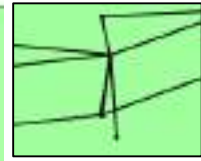
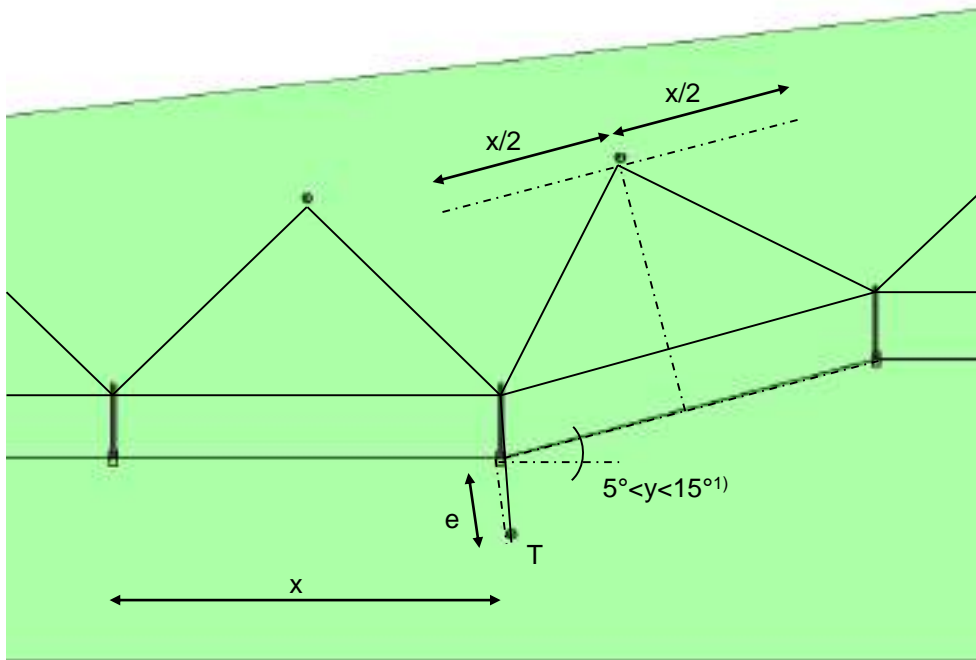
Anchor point

- D:** Retaining rope
- T:** downslope anchor rope



In a ground slope of less than 30°, the distance between the retaining rope is to be adapted.

CHANGE IN DIRECTION TOWARDS THE MOUNTAIN



2)

Length

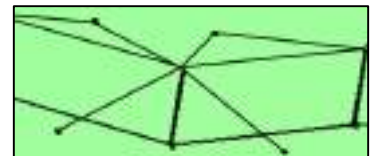
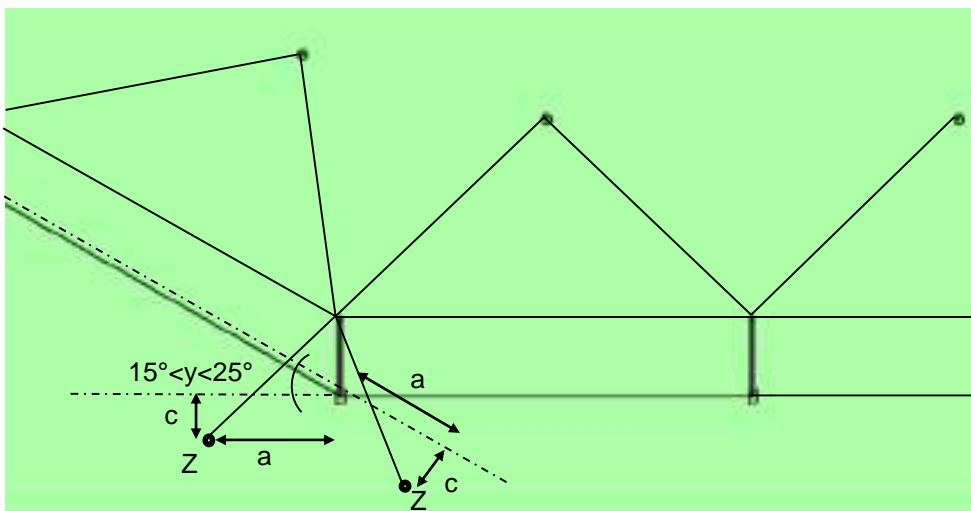
- e:** see Tab.3
- x:** post distance
- y:** angle of change in direction

Anchor point

- T:** valley side anchoring

In the case of a change in direction towards the mountain at an angle of $5^\circ - 15^\circ$, valley-side anchoring (T) is additionally required. The rope anchor will be positioned on the valley side at the distance (e) from the post. The valley-side anchoring has a diameter of $d = 22 \text{ mm}$ GEOBINEX.

INTERMEDIATE ROPE SUSPENSION



5)

Length

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

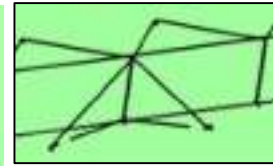
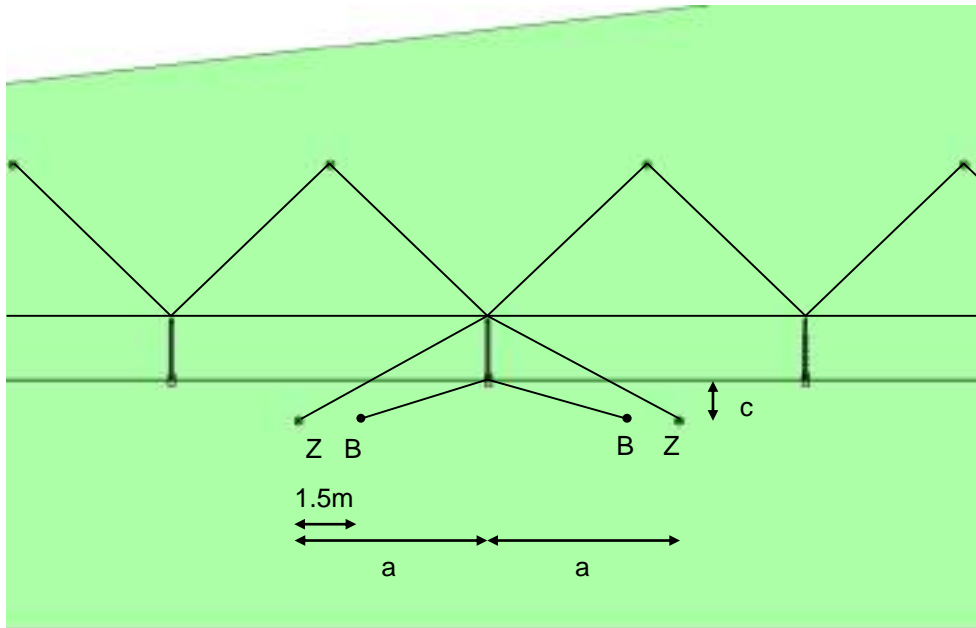
Anchor point

- Z:** intermediate suspension



In the case of a change in direction towards the mountain of more than 15° , an intermediate anchor rope must be installed and the valley-side anchoring is omitted.

ROPE ANCHORS FOR SUPPORT ROPE SEPARATION WITH INTERMEDIATE ANCHOR ROPE



3)

Length

a: see Tab.3

c: see Tab.3

Anchor point

B: bottom support rope

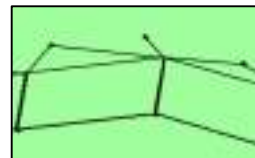
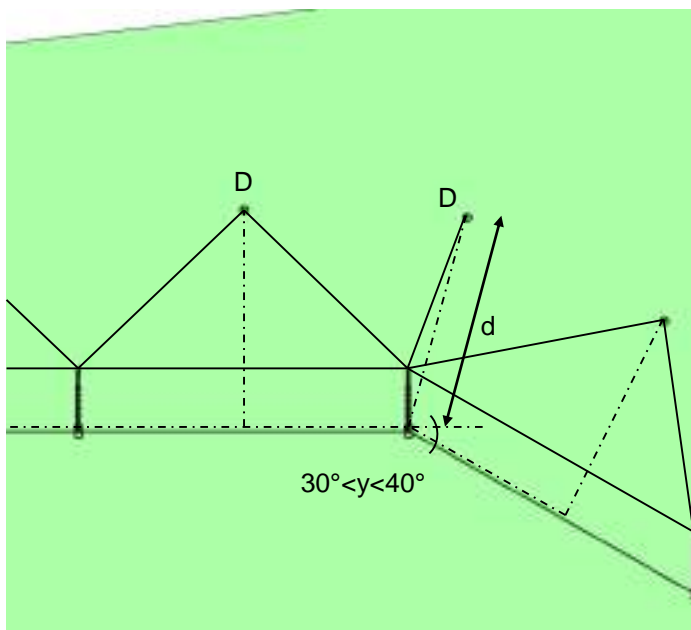
Z: intermediate suspension

A support rope separation also contains an intermediate anchor rope. In straightforward terrain conditions and when using appropriate equipment, we recommend positioning a support rope separation after approx. 80 m – 100 m.



Note: In the case of changes in direction towards the mountain of more than 25°, support rope separation must also be positioned for the intermediate anchor rope.

CHANGE IN DIRECTION TOWARDS THE VALLEY



4)

Length

d: see Tab.3

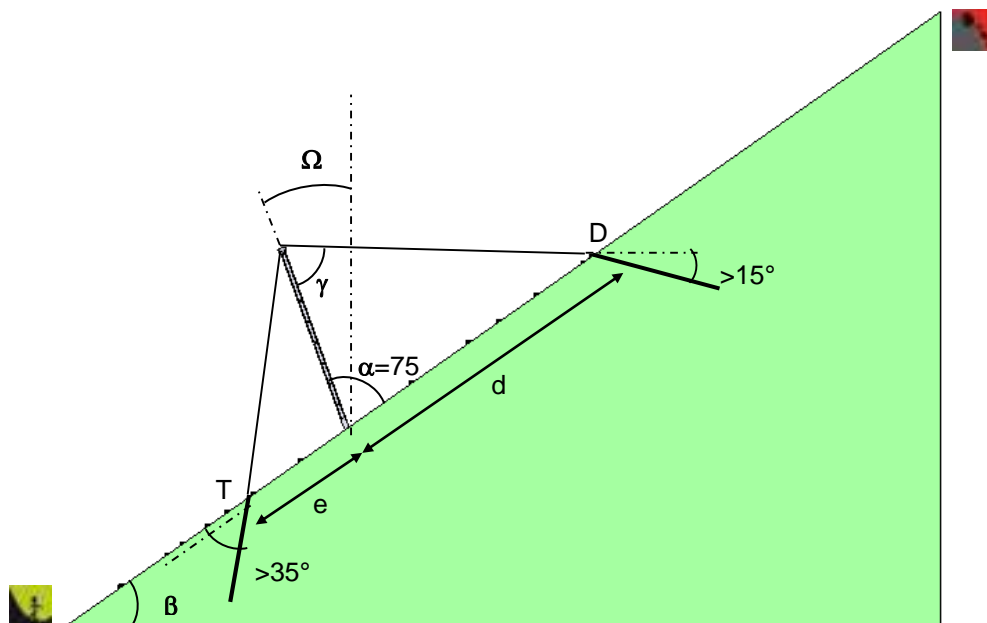
y: change in direction

Anchor point

D: Retaining rope

In the case of a change in direction towards the valley of more than 30°, two additional retaining ropes (D) are mounted on the post. The change in direction towards the valley must not exceed 40°.

6 ROPE ANCHOR – INSTALLATION



γ : The angle must be between 60° - 85°.
 α : The angle between slope and post is 75° as standard.

Tab. 4

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



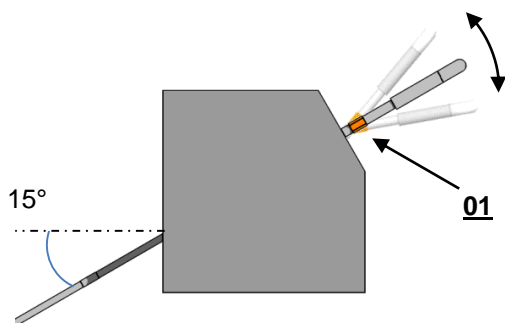
The post angle is dependent on the terrain slope, see table 4.



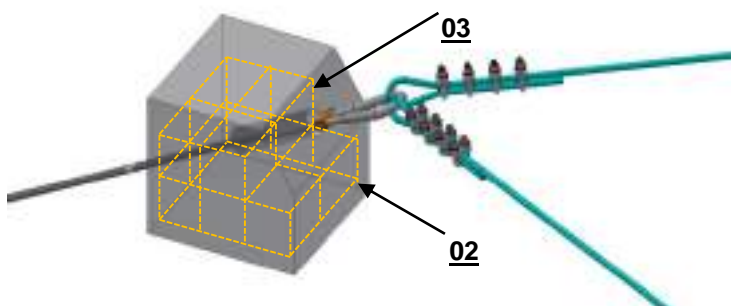
For a slope inclination with $\beta < 30^\circ$ und $\beta > 45^\circ$ small adjustments may be made with respect to the stakeout such as length of the retaining ropes, angle between retaining rope and post inclination of the ground plate, etc.

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

Example: foundation with flexhead anchor



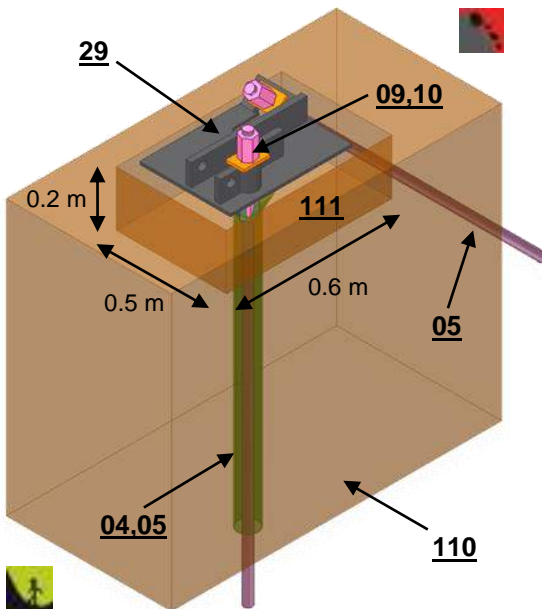
The anchors **01** are horizontal when mortared up to the marking and insert into the anchor hole.



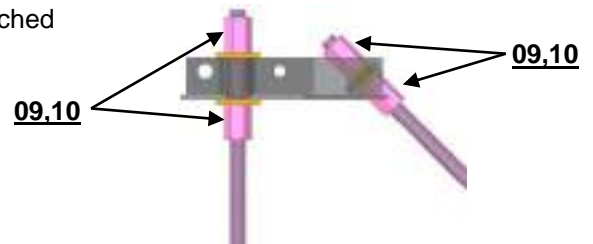
In use of rod anchors with flex head the foundation **03** must be designed with reinforcement **02** against the shear forces.

7 ANCHORING OF THE BASE PLATE

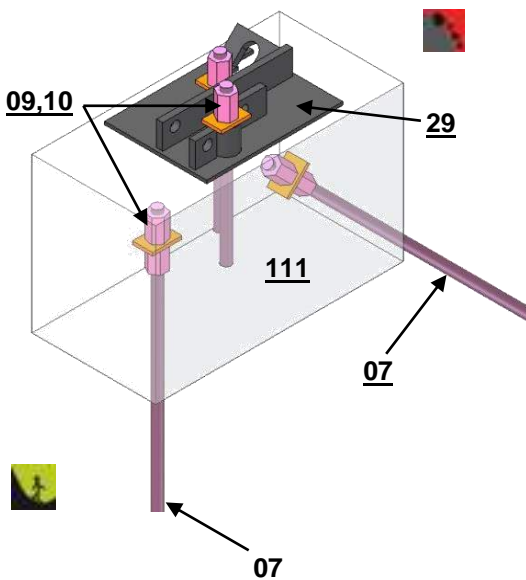
SOIL:



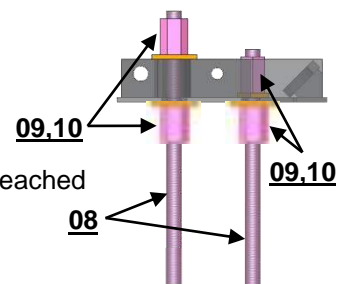
- Base plate inclined $0^\circ - 30^\circ$ from horizontal
- Drill the anchor holes (vertical and 45° inclined to the base plate)
- Prepare foundation 111; dimension and reinforcement of the concrete foundation 111 is set by the project engineer (reccomendation Geobrugg: $0.6 \times 0.5 \times 0.2$ m)
- Insert anchor 05, washer plate 09 and nuts 10, the calculation of the anchor length is set by the project engineer
- Optional: stabilization tube 04 for vertical anchor
- **Important: Washer plates and nuts must be installed on both sides of the base plate 29**
- Grout the anchor 05 in soil 110
- Pour concrete foundation 111
- Fasten the nuts 10 until an initial tensile force of approx. 30 kN is reached



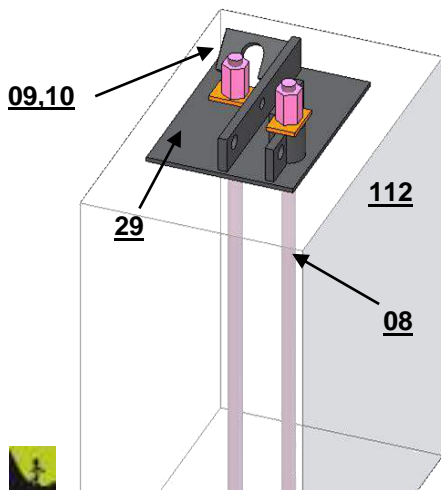
CONCRETE:



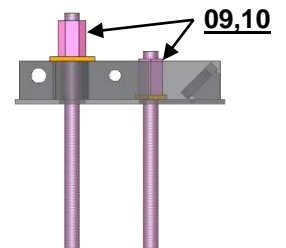
- **For all types of soil and rock**
- Excavate foundation pit 111
- Drill the holes for tie back anchoring 07, the calculation of the anchor length is set by the project engineer
- Prepare concrete foundation 111 dimension and reinforcement of the concrete foundation 111 is set by the project engineer
- Grout tie back anchoring 07 with nuts 10 and washer plates 09
- Install both anchors 08 with help of the base plate 29, washer plates and nuts must be installed on **both sides** of the base plate 29;
Length of anchor 08 = 500 mm
- Pour concrete foundation 111
- Fasten the nuts 10 until an initial tensile force of approx. 30 kN is reached



ROCK:



- Level the rock 0° - 30° from horizontal underneath the base plate 29
- Drill into rock 112 the two holes perpendicular to the base plate 29
- Grout in the anchors 08, the calculation of the anchor length is set by the project engineer
- A thin leveling layer ensure a stable placement of the base plate
- Position base plate 29 into leveling layer
- Fasten the nuts 10 until an initial tensile force of approx. 30 kN is reached



Tightening torque for nuts to reach an initial tensile force of approx. 30 kN:

	Swiss Gewi NG 28	Swiss Gewi NG 32
Tightening torque	400 Nm	400 Nm



Frost and icing-salt resisant mortar has to be used
Reinforcement: 12 mm-rod diameter in distance of 150 mm



If requestet a drilling template can be supplied.



It is important to ensure that the anchors have sufficient contact with the mortar and make good bond, and a sufficient area to the surrounding material.



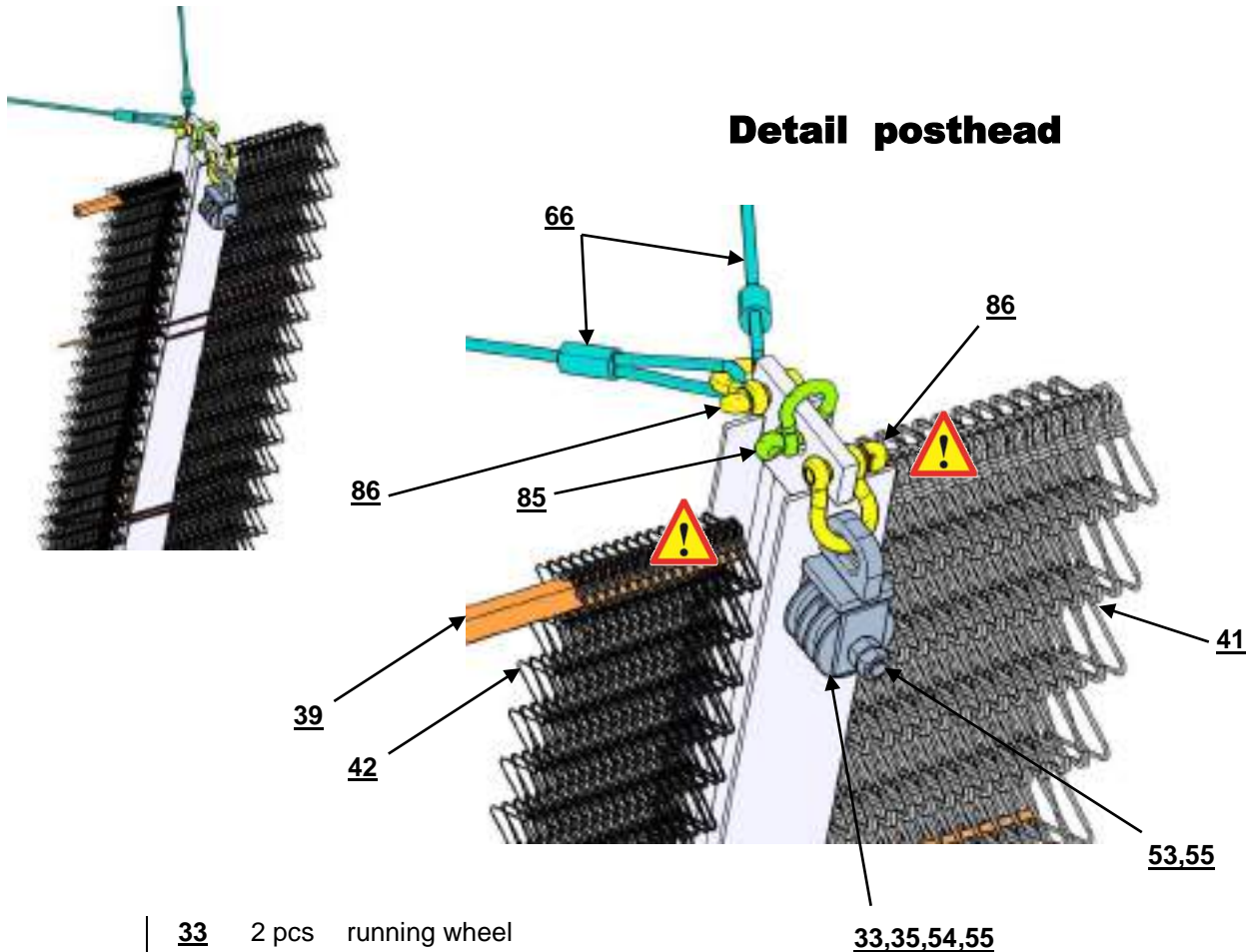
Further information about the anchoring of the base plate can be found on the anchor forces date sheet.



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

8 PREPARATION OF THE NETS AND POSTS

PREPARATION OF THE POST



<u>33</u>	2 pcs	running wheel
<u>35</u>	1 pcs	double clevis
<u>39</u>	2 pcs	U-Profile
<u>41</u>	1 pcs	panel Spider S4-130
<u>42</u>	1 pcs	panel Tecco G80/4
<u>53</u>	1 pcs	hexagonal bolt M30x180
<u>55</u>	2 pcs	hexagonal nut M30
<u>66</u>	2 pcs	retaining rope
<u>85</u>	1 pcs	shackle 7/8"
<u>86</u>	2 pcs	shackle 1"



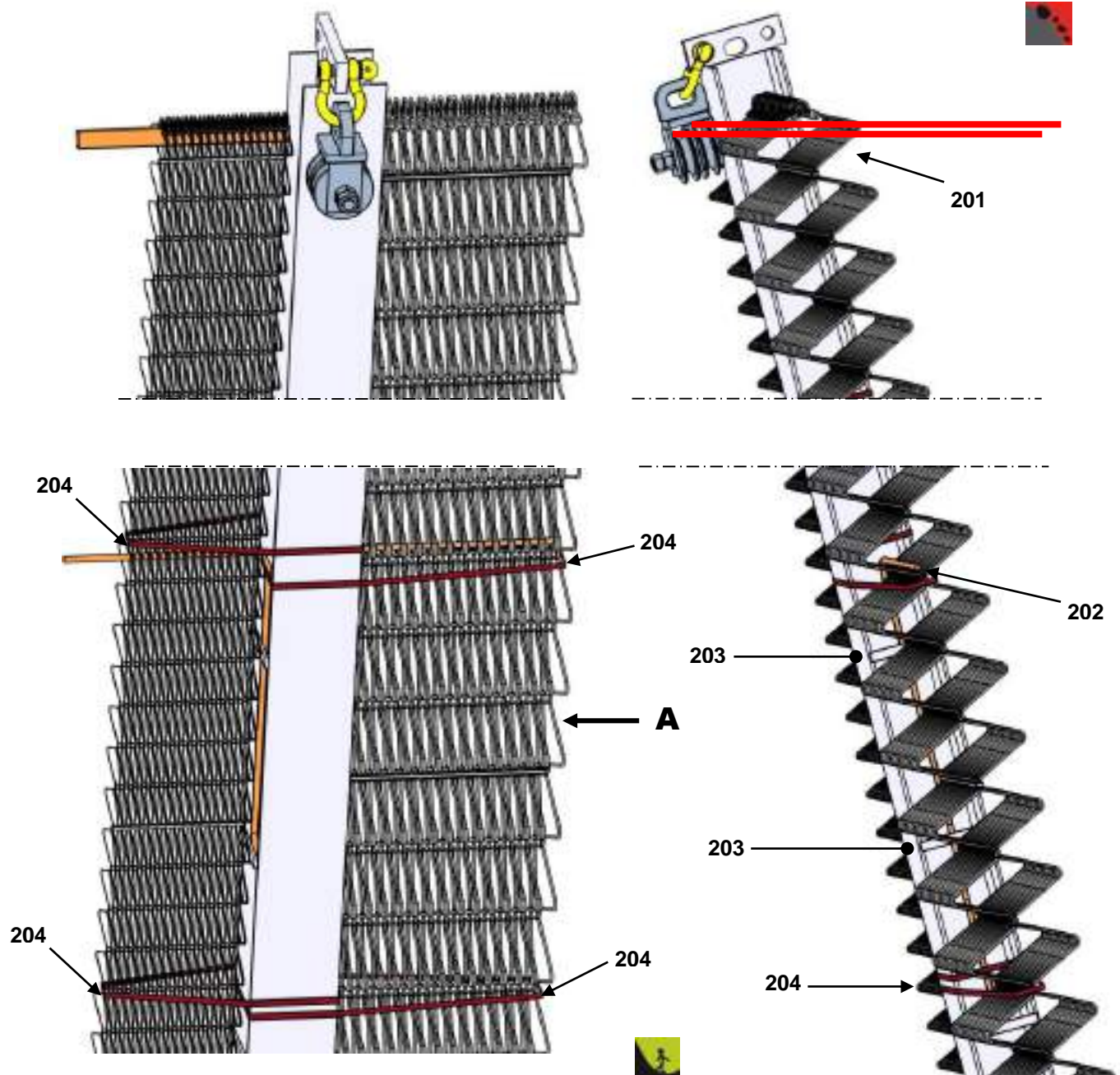
11 meshes on top and bottom of the TECCO mesh are left free. The TECCO ropes are only guided through the U-Profiles. Later each third free mesh will be attached to the TECCO rope with round clips (see page 32).



8 meshes on top and bottom of the SPIDER net are left free. The support ropes are only guided through the bundled and red marked meshes (see page 31). Later each second free mesh will be attached to the support ropes with round clips.

THE CORRECT HEIGHT OF THE NET BUNDLE

View A



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.

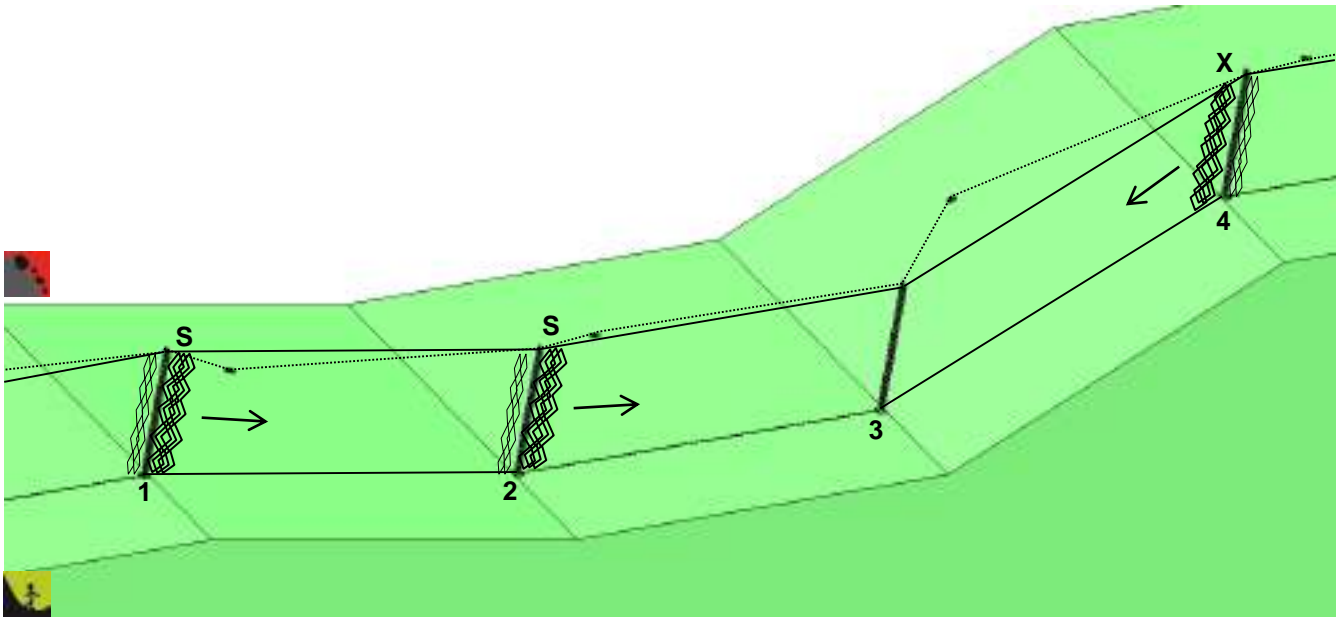


The net bundle is placed on the mounting bracket and securely fastened with bands **204**.



It has to be taken into account that the right number of meshes next to the posts are left free (see page 31/32).

CORRECT SIDE OF THE NET PANEL



The posts are counted from the left side to the right side (view from the valley).



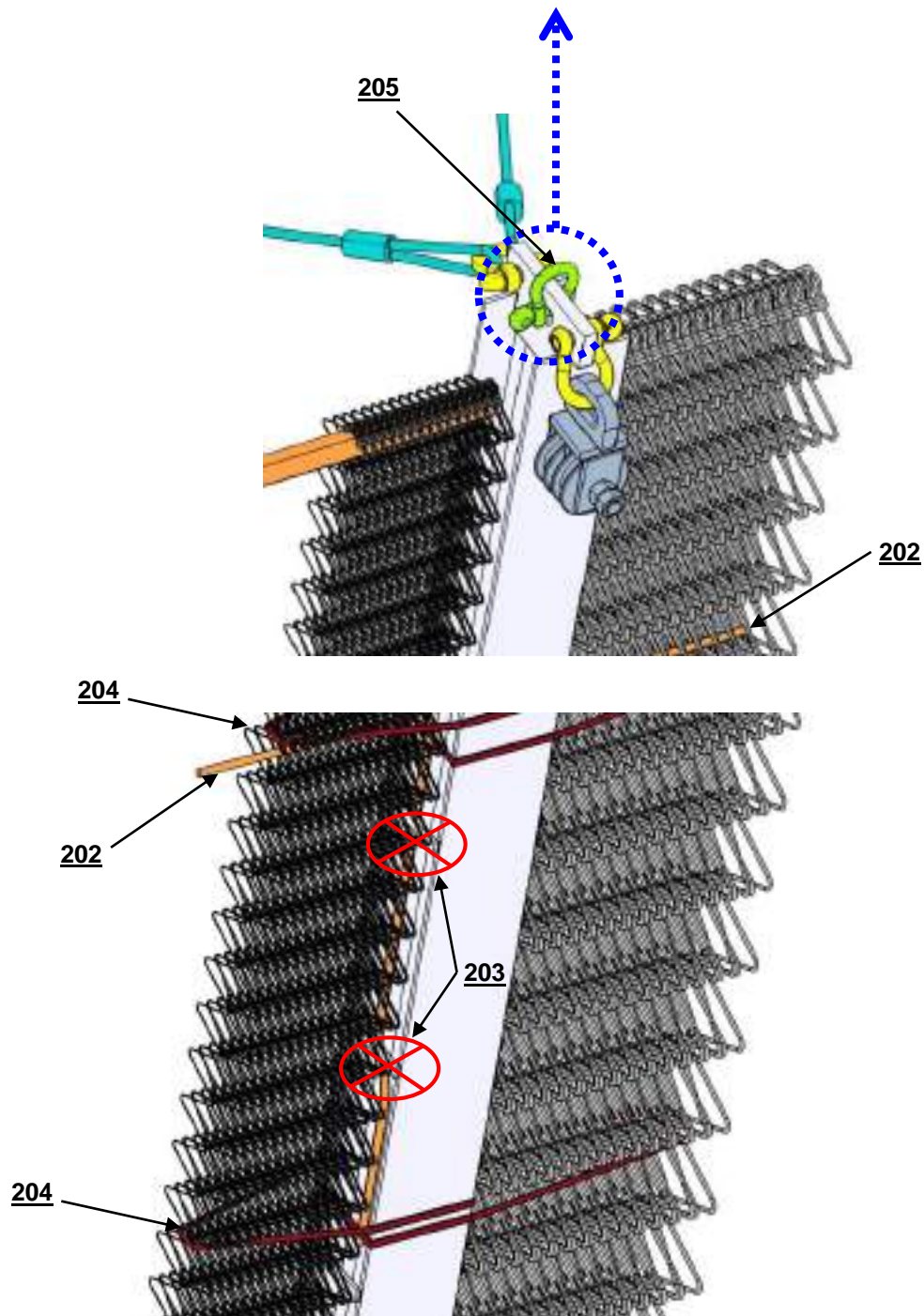
S: The net panels are pre-installed on the right side of the post as standard.

X: With larger height differences, it's easier to pull down the panels from higher to the lower post.



With appropriate ordering details Geobrugg provides the panel on the wished side of the post.

9 CRANE OR HELICOPTER INSTALLATION



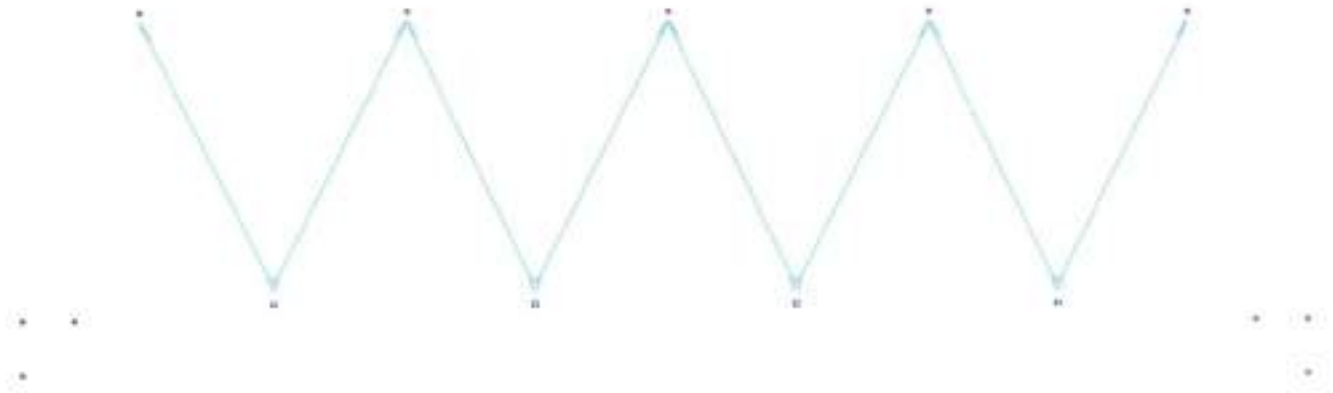
Fasten the mesh bundle using strips 204 so that it cannot fly away



Use the center 7/8" shackle 205 on the top of the post 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. The support ropes are guided through the relevant SPIDER meshes.



- Install the U-brake for the bottom support rope on the anchors. Fasten the bottom support rope to the base plates of the posts and tension the bottom support rope. The support ropes are guided through the relevant SPIDER meshes.



- Install the TECCO rope. Fixation to the U-brake of the tope support rope and bottom support rope. See page 29. The TECCO rope is guided through the U-profile of the TECCO panel.



- Install the vertical rope to the U-Brake. See page 29.

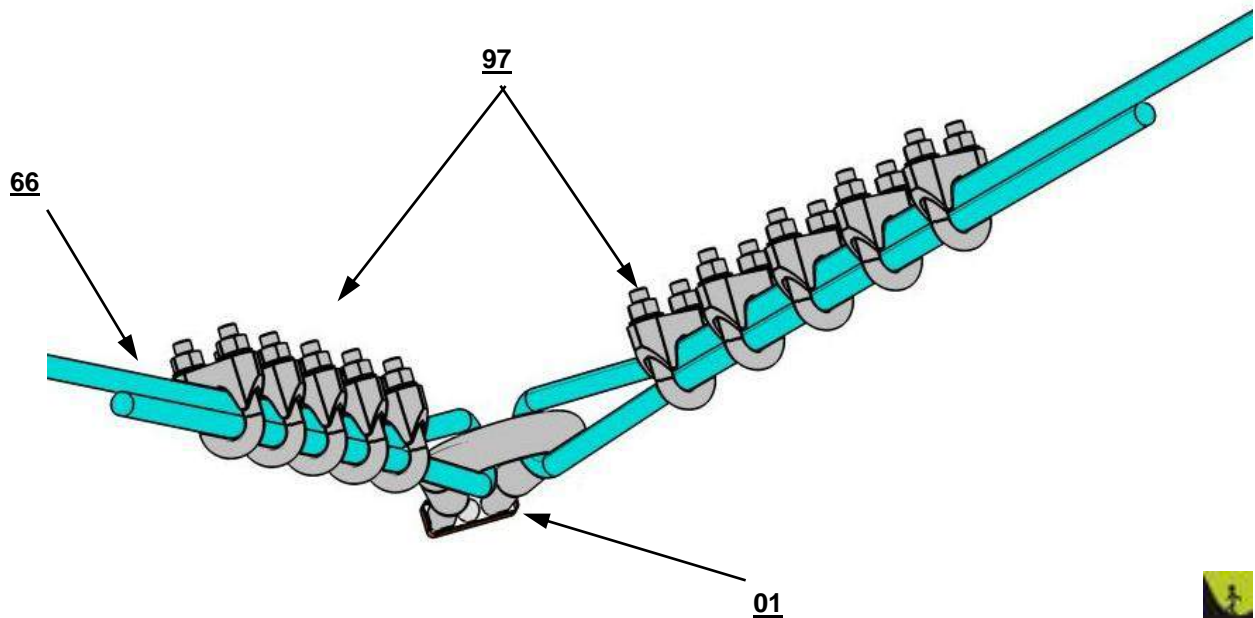
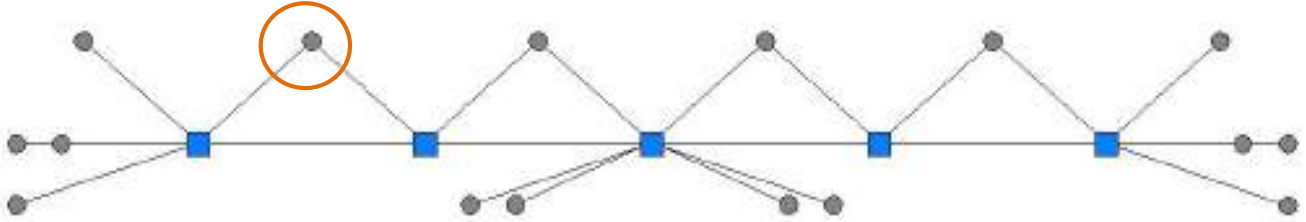


- Loose the U-profiles and open the panels. Connect the panels vertically.

11 ASSEMBLY DETAILS

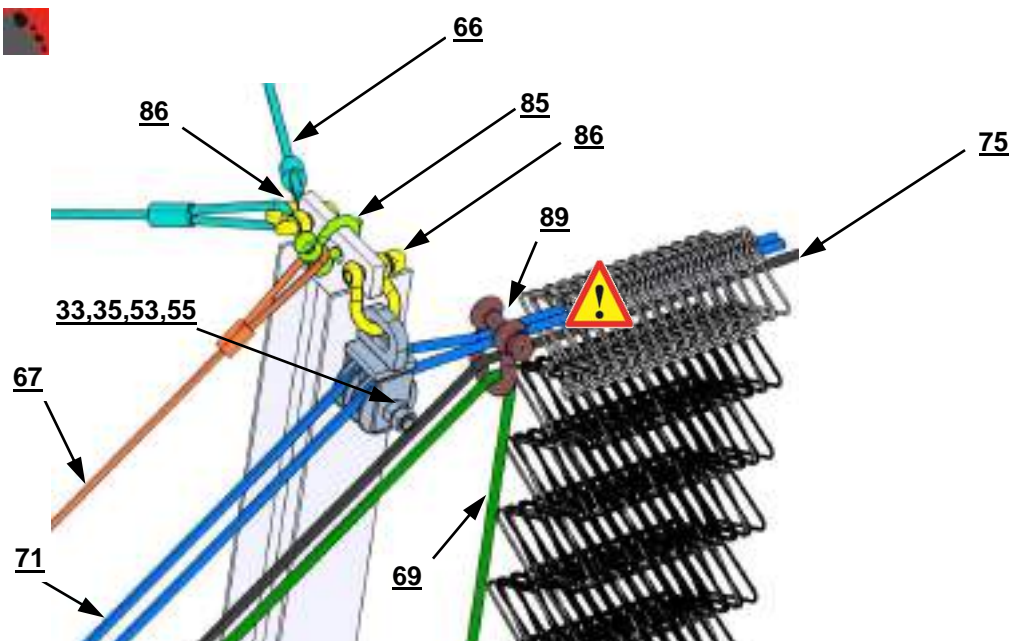
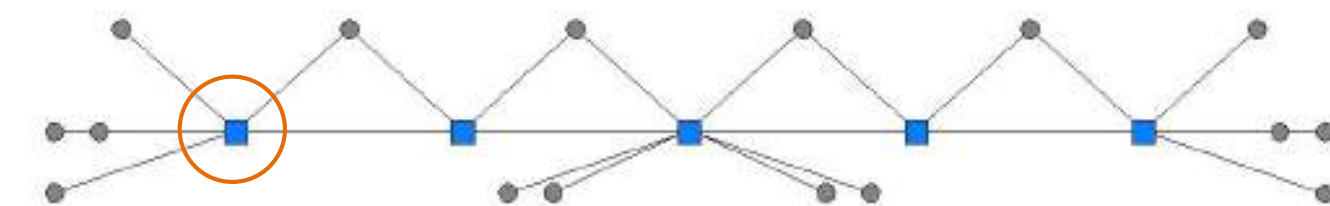
ROPE CONNECTION TO THE ANCHORS

RETAINING ROPES ON THE UPSLOPE

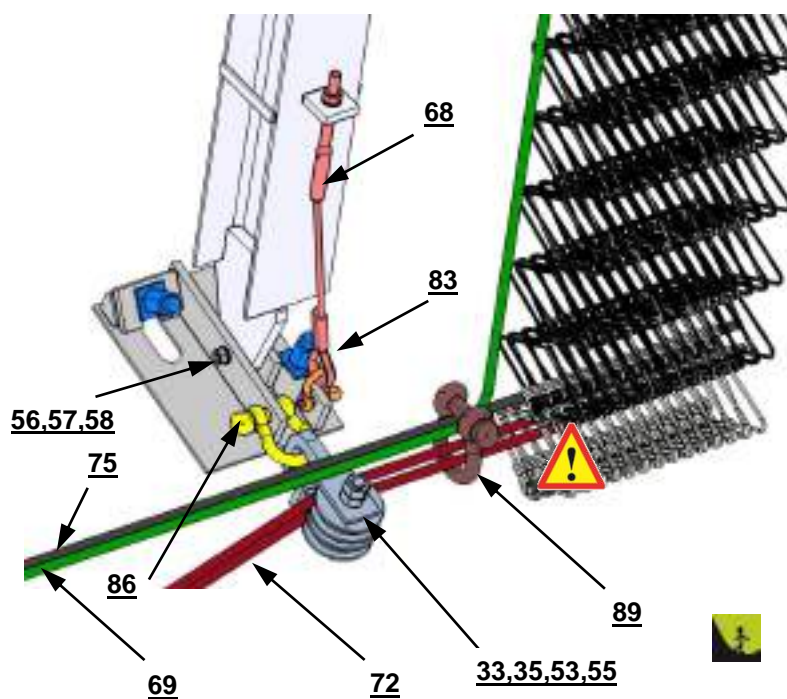


<u>01</u>	1 pcs	spirale rope anchor
<u>66</u>	2 pcs	retaining rope
<u>97</u>	5 pcs	wire rope clip NG22 per rope

BORDER POST

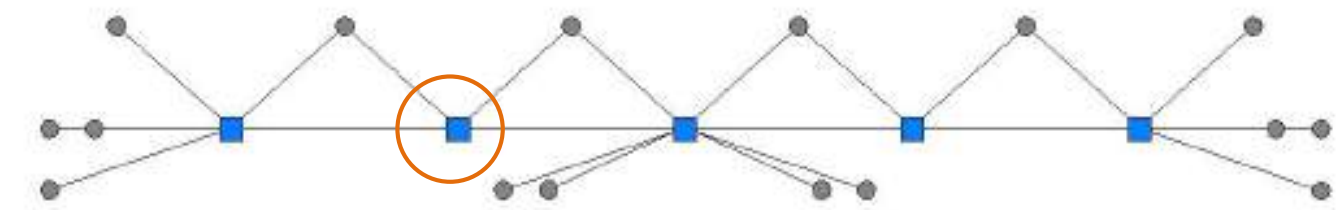


It is a schematic illustration of the net bundle, make sure that the right number of meshes rest free.



<u>33</u>	4 pcs	running wheel
<u>35</u>	2 pcs	double clevis
<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
<u>67</u>	1 pcs	lateral rope
<u>68</u>	1 pcs	overturn securing rope
<u>69</u>	1 pcs	vertical rope
<u>71</u>	2 pcs	top support rope
<u>72</u>	2 pcs	bottom support rope
<u>75</u>	2 pcs	Tecco rope
<u>83</u>	1 pcs	shackle 5/8"
<u>85</u>	1 pcs	shackle 7/8"
<u>86</u>	3 pcs	shackle 1"
<u>89</u>	2 pcs	shackle 1 1/4"

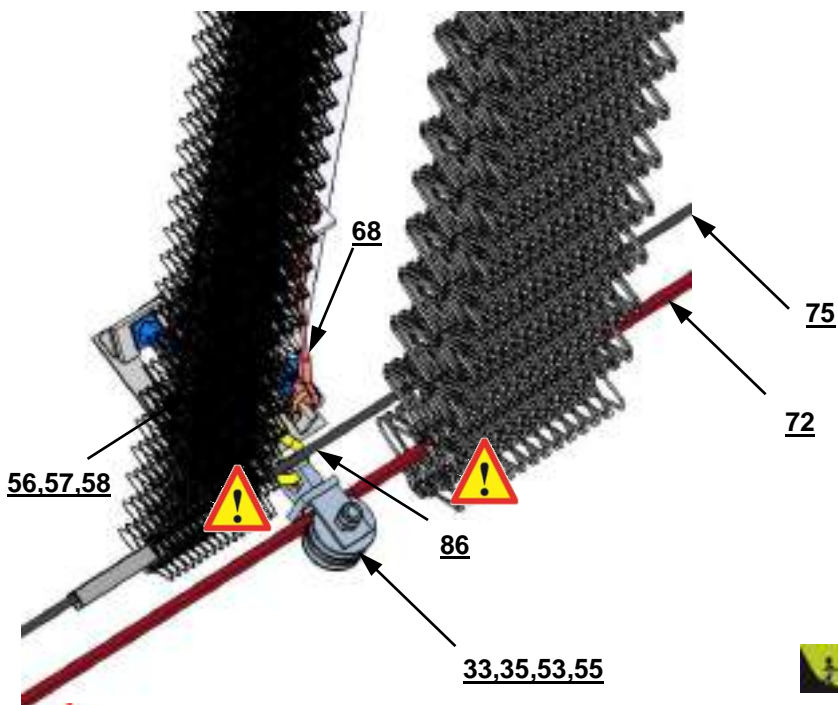
MIDDLE POST



Installation support , temporary



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

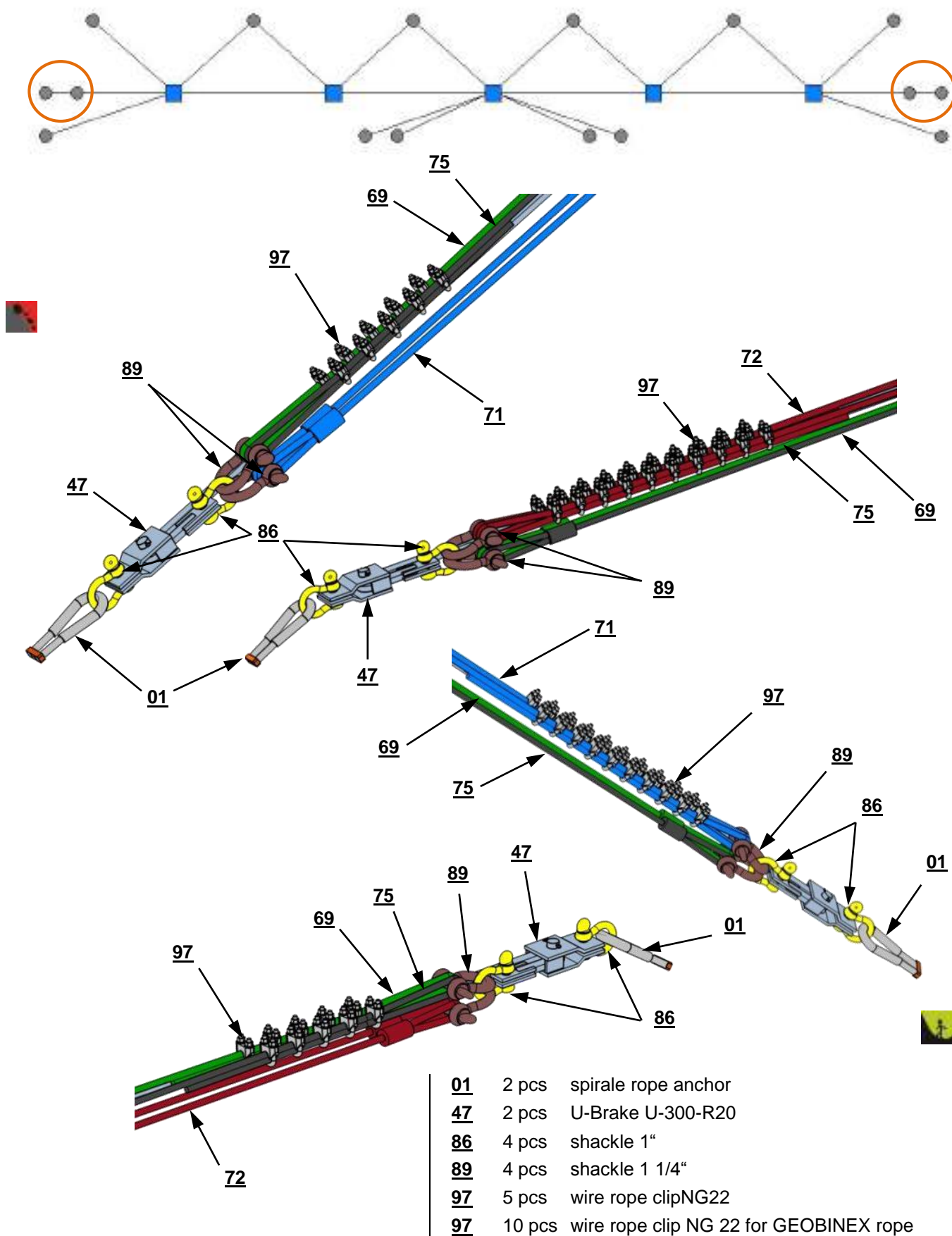


In case of a support rope separation, the overturn securing rope **68** is installed temporary.



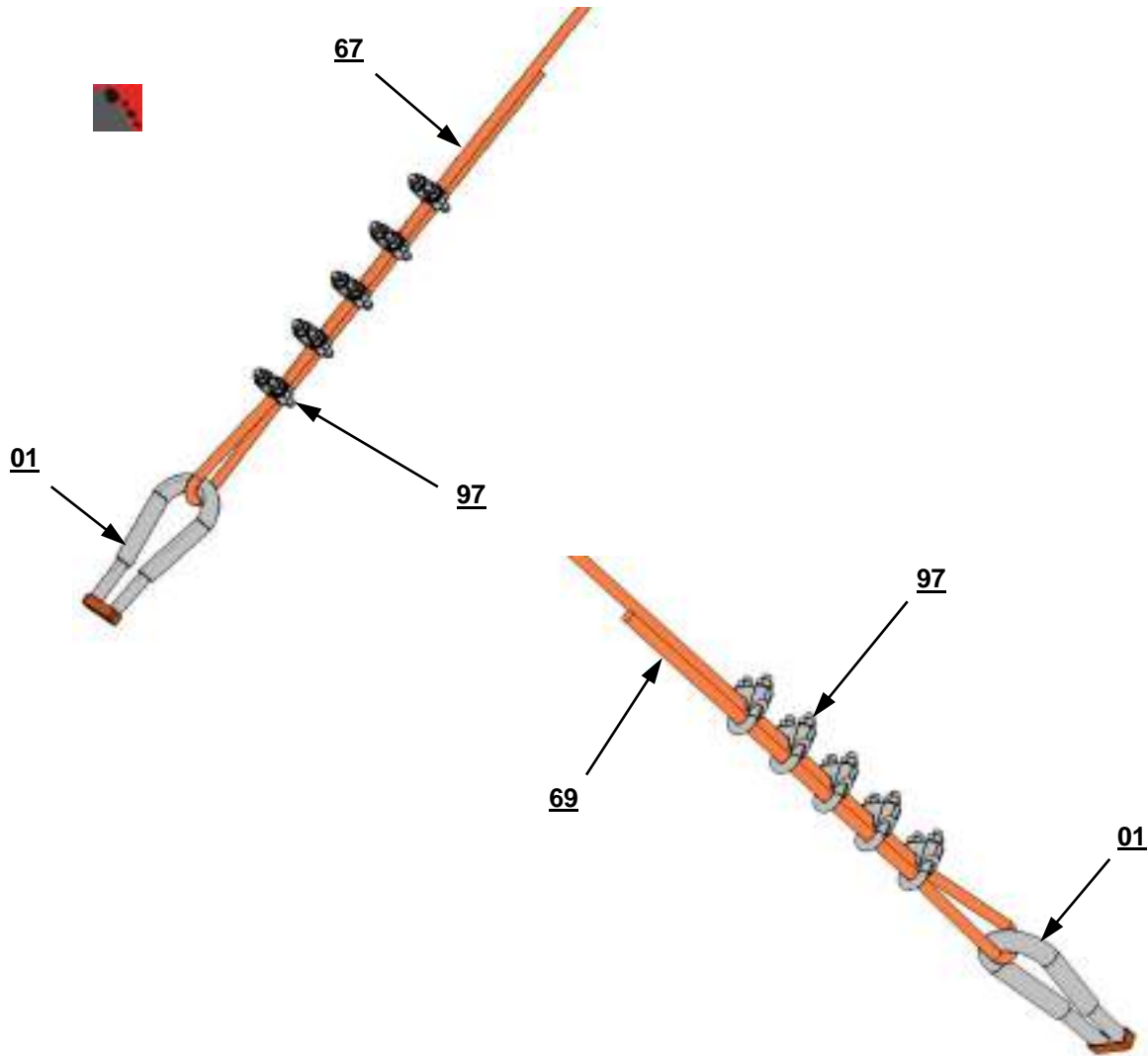
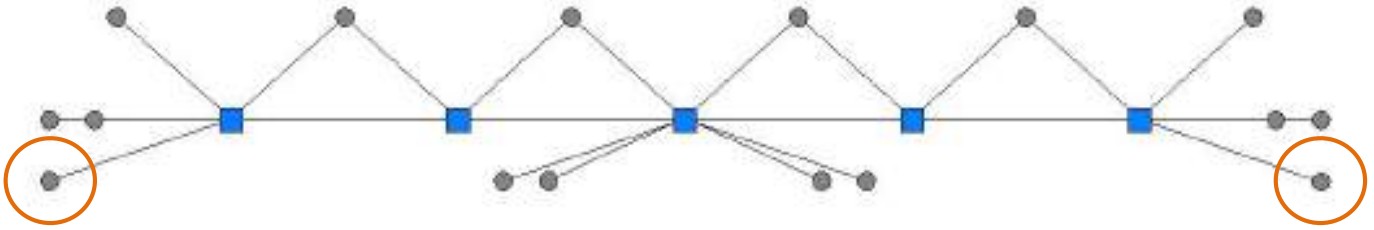
It is a schematic illustration of the net bundle, make sure that the right number of meshes rest free.

TOP AND BOTTOM SUPPORT ROPE ON THE ROPE ANCHOR



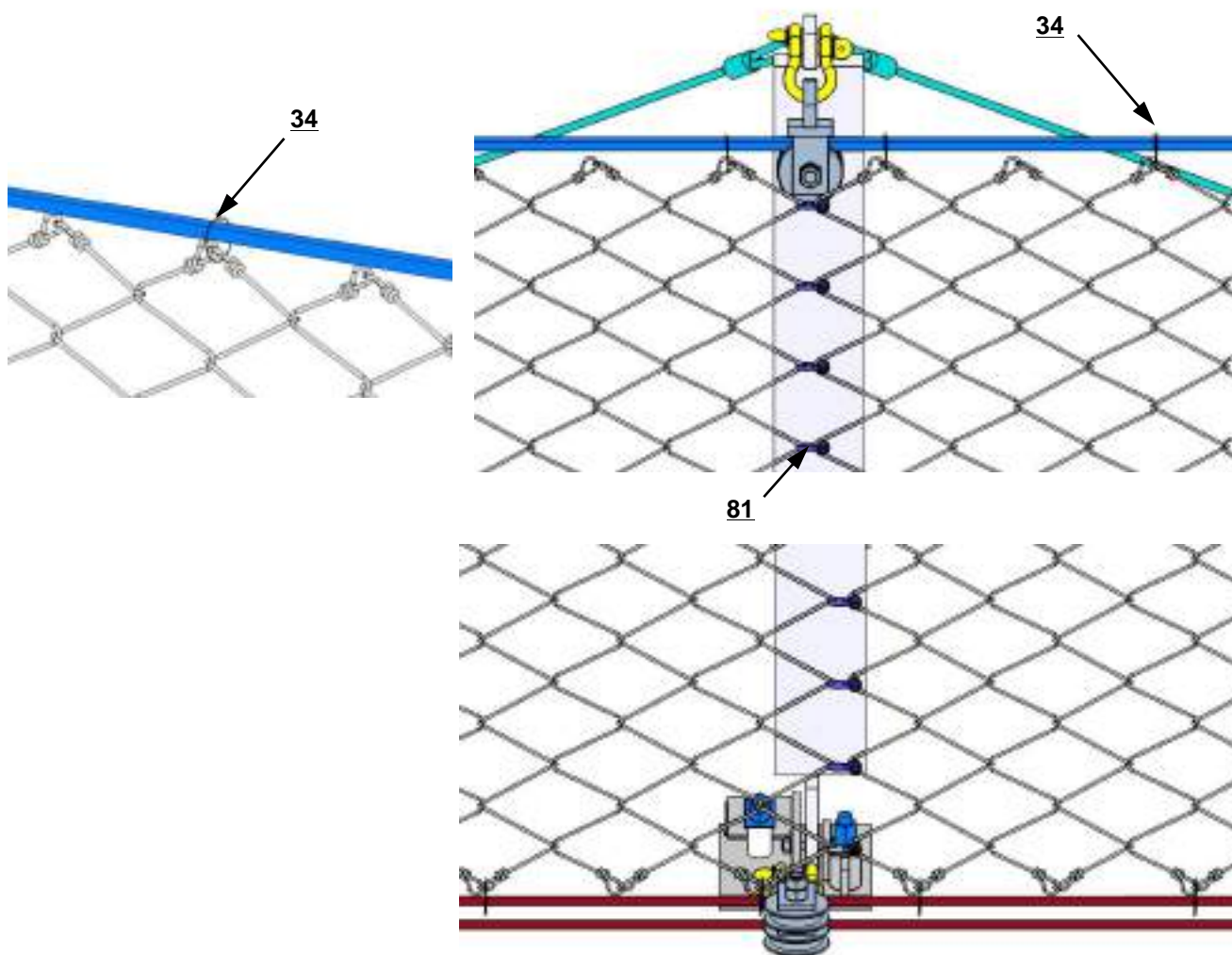
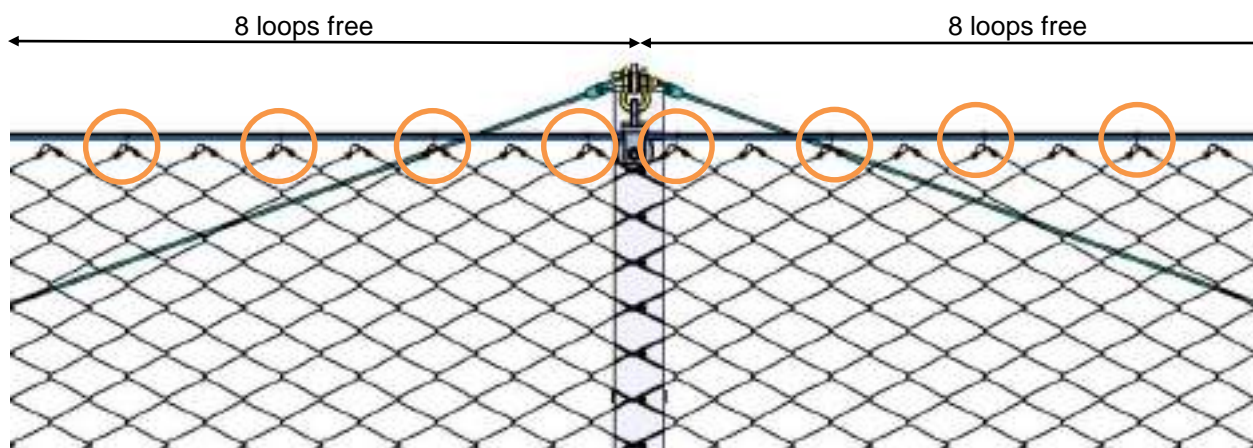
Install the vertical rope 69 and TECCO rope 75 with shackles before tensioning the support ropes, afterwards is not possible.

LATERAL ROPE ON THE ROPE ANCHOR



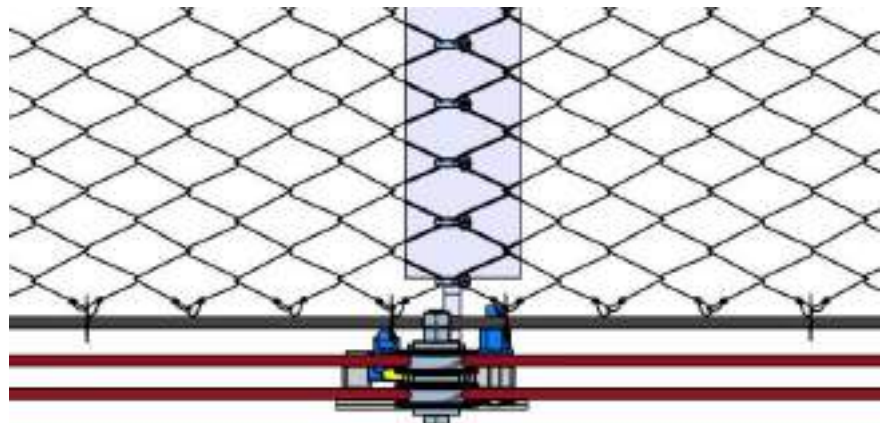
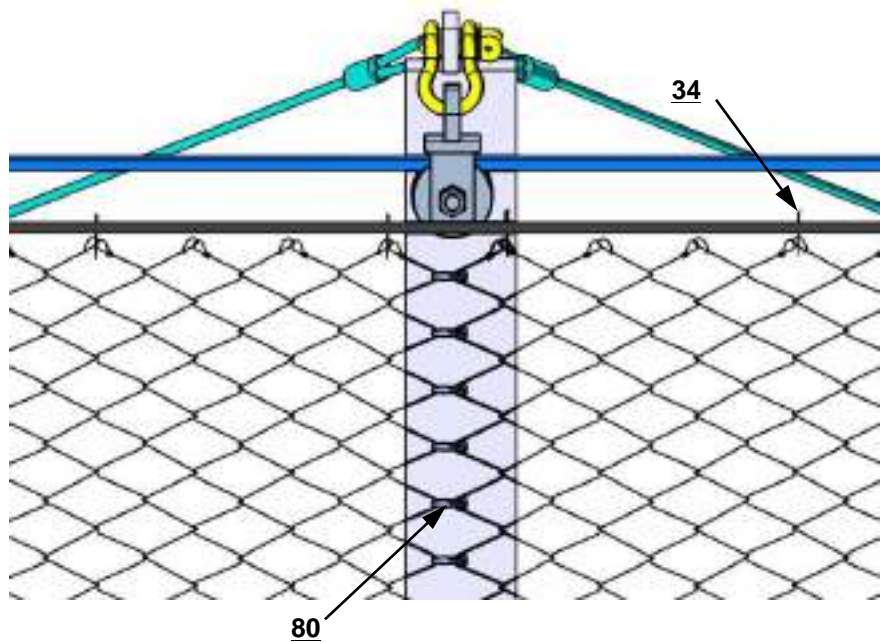
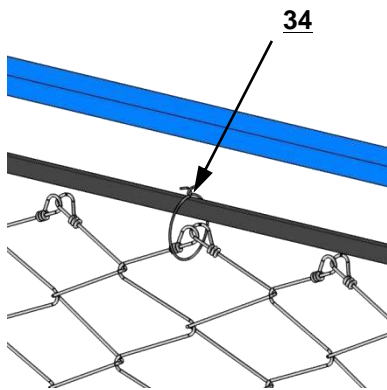
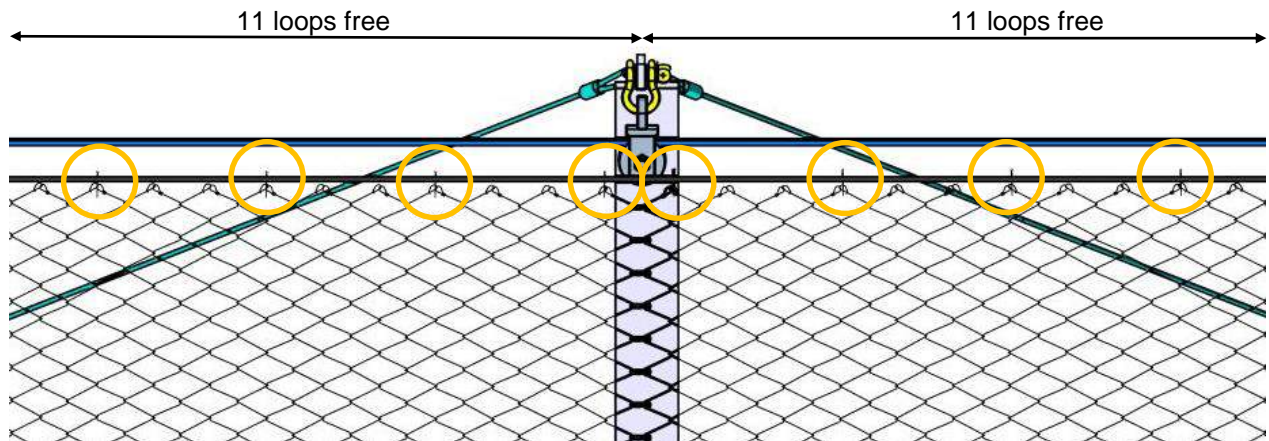
- | | | |
|-----------|-------|------------------------------|
| <u>01</u> | 1 pcs | spirale rope anchor |
| <u>97</u> | 5 pcs | wire rope clip NG22 per rope |

SPIDER S4-130 ON THE SUPPORT ROPE



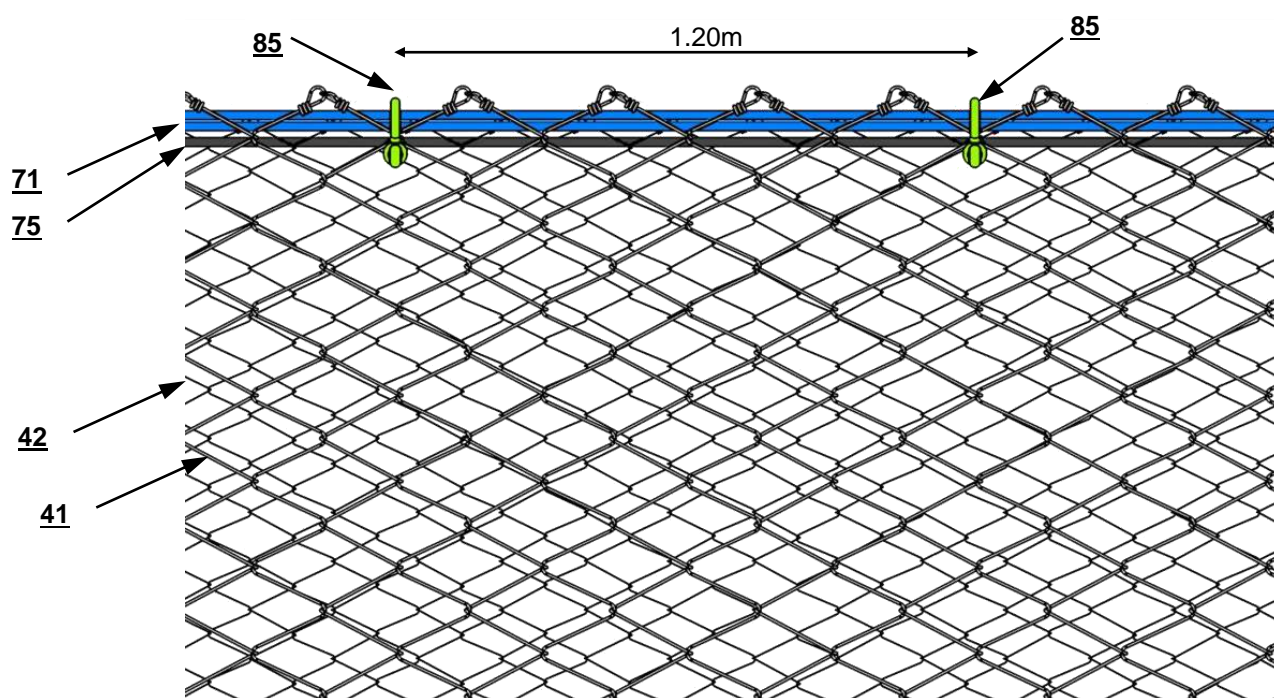
- 34** Mount 4 round clips on the left and 4 round clips on the right side of the post, start with the loop close to the post 8 loops free
- 81** shackle 7/16" per loop

TECCO G80/4 ON THE TECCO ROPE



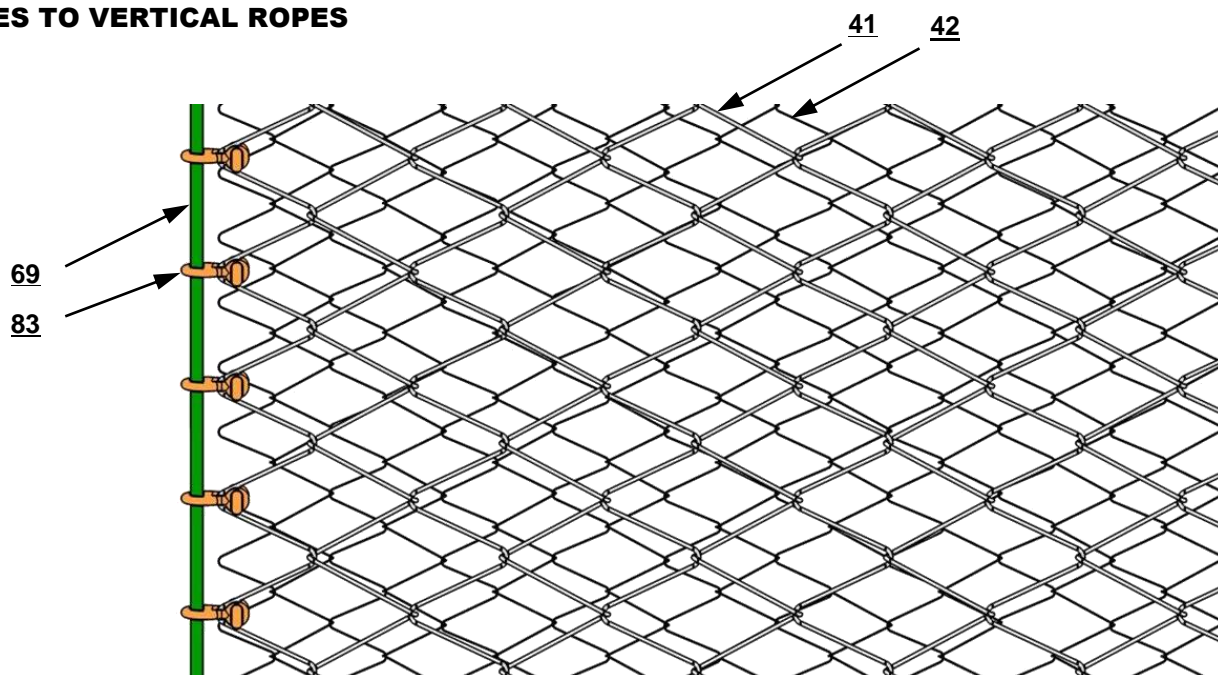
- 34** Mount 4 round clips on the left and 4 round clips on the right side of the post, start with the loop close to the post. 11 loops free
- 80** shackle 3/8" per loop

TECCO ROPE TO SUPPORT ROPE



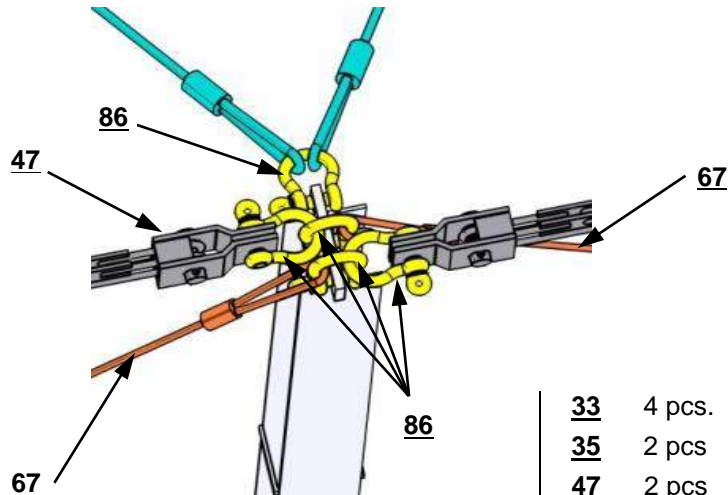
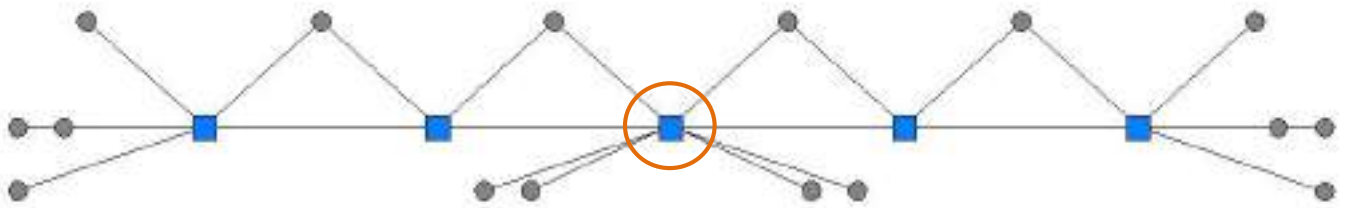
- Connect the TECCO® - rope 75 to the top and bottom support
- The TECCO® - rope is fixed by 7/8" shackles 85 to the support ropes. The distance from one shackle to the other one is in maximum 1.20m (appr. 4 SPIDER® net).
- The shackles are installed in the length where the support ropes are guided through the SPIDER net, only.

MESHES TO VERTICAL ROPES

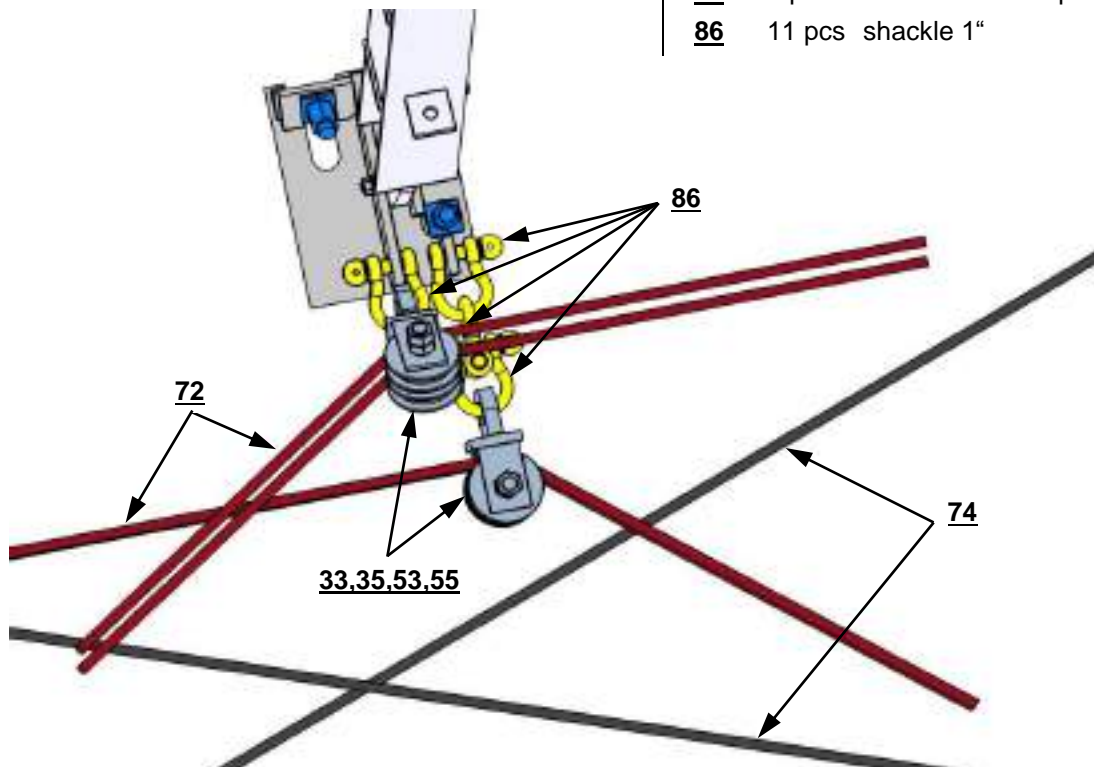


- SPIDER® - net 41 and TECCO® - mesh 42 are fixed to the vertical rope 69. The TECCO® -mesh is fixed by the same 5/8" shackles 83 like the SPIDER net is fixed to the vertical rope . That means every second TECCO mesh is fixed to the vertical rope 69.

SUPPORT ROPE SEPARATION



- | | | |
|-----------|--------|-------------------------|
| <u>33</u> | 4 pcs. | Running wheel |
| <u>35</u> | 2 pcs | double clevis |
| <u>47</u> | 2 pcs | U-brake U-300-R20 |
| <u>67</u> | 2 pcs | intermediate suspension |
| <u>86</u> | 11 pcs | shackle 1" |



Install one intermediate suspension and one U-brake for the top support rope on the same shackle to prevent a torsional moment to the post.

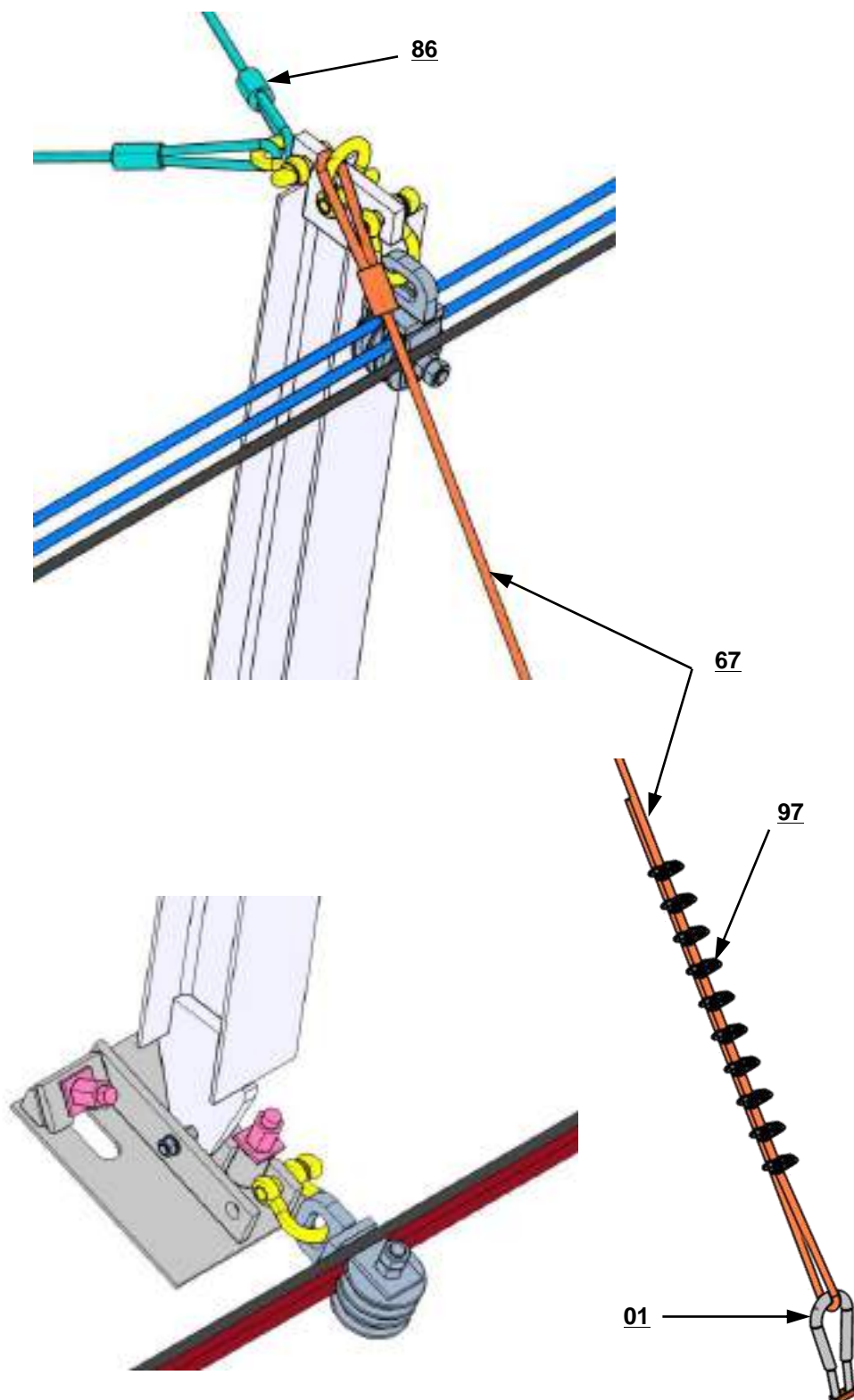


A support rope separation always contains an intermediate rope suspension.



In the case of an intermediate anchor rope without support rope separation, the two intermediate suspension ropes at the center hole are fastened with a 7/8" shackle.

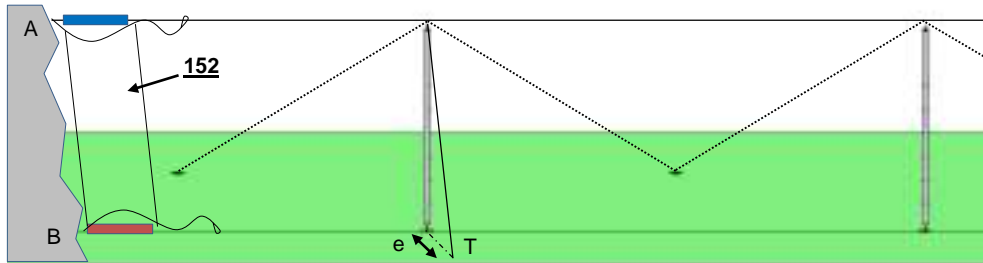
VALLEY SIDE ANCHORING




- | | | |
|------------------|--------|----------------------|
| <u>01</u> | 1 pcs | spirale rope anchor |
| <u>67</u> | 1 pcs | valley side rope |
| <u>86</u> | 1 pcs | shackle 1" |
| <u>97</u> | 10 pcs | wire rope clip NG 22 |

12 ADDITIONAL SOLUTION TO THE STANDARD

ROCK FACE CONNECTION

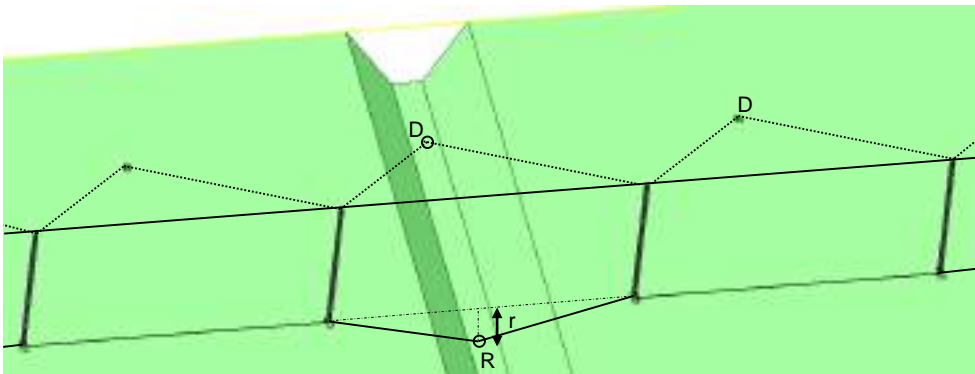


- e:** distance downslope
- A:** top support rope
- B:** bottom support rope
- T:** valley side anchoring (optional)
-  Brake element



A standard staking out is not possible, then can be developed a rock face solution in consultation with GEOBRUGG. Dabei werden zusätzlich Schleppnetze **152** im Randbereich installiert.

GAP FILLING SOLUTION



- r:** distance gap
- R:** gap anchor
- D:** retaining rope anchor

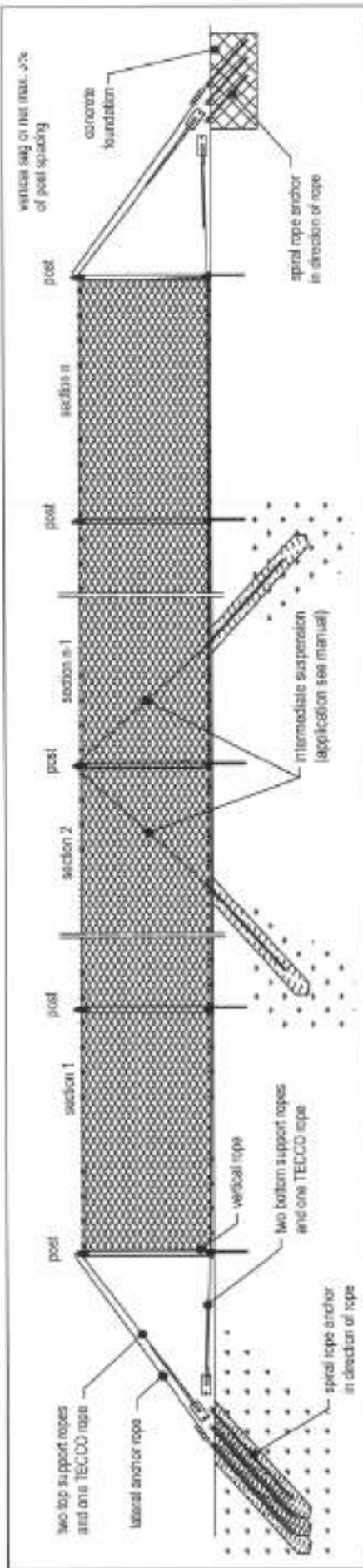


In steep mountain slopes with torrent channels large openings may arise between ground and bottom support rope. Gap fillings can be developed in consultation with GEOBRUGG.

13 FINAL INSPECTION

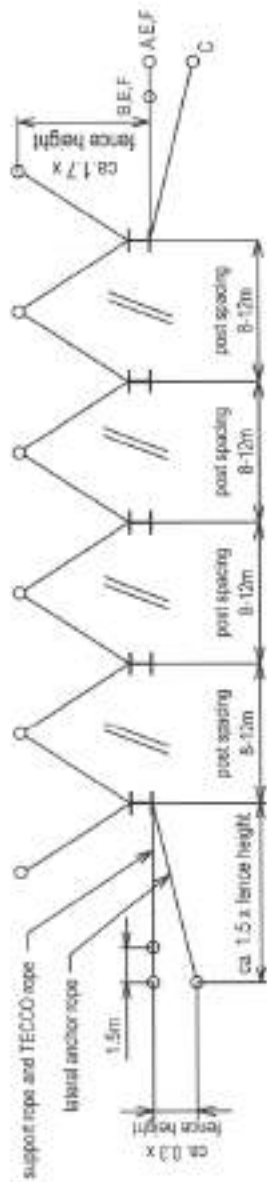
Once installation has been completed, the following aspects in particular must be inspected:

- a) Are the support and TECCO 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 / U-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?



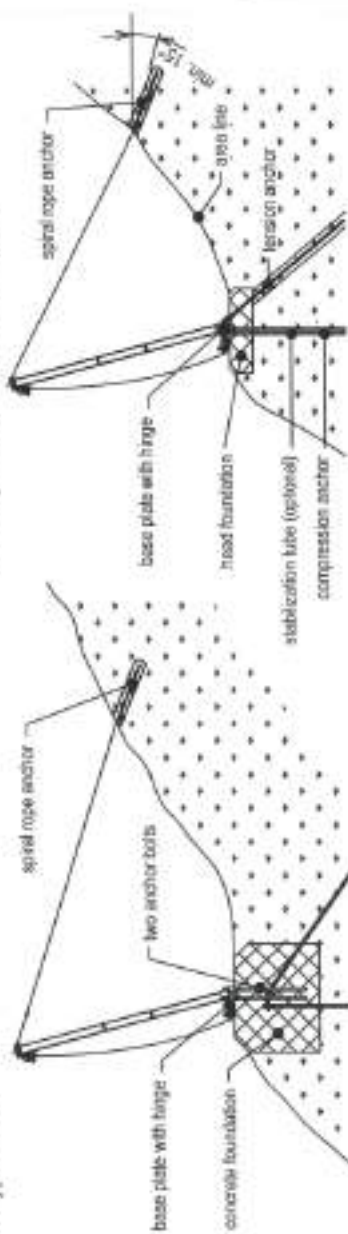
layout of anchor points

(details in product manual GBE 3000A)



anchoring concrete foundation for all types of soil

anchoring in loose soil: with tension and compression anchor
anchoring in bedrock: with rock anchors



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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 several engineering principles to a predictable range of parameters and by the implementation of correctly designed protective measures a controlled risk area the rate 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. This system safety can also be required by events such as natural disasters, tsunamis, disturbing phenomena or failures 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/S substituted for GS-1113e ed. 25.05.14

replaced by:

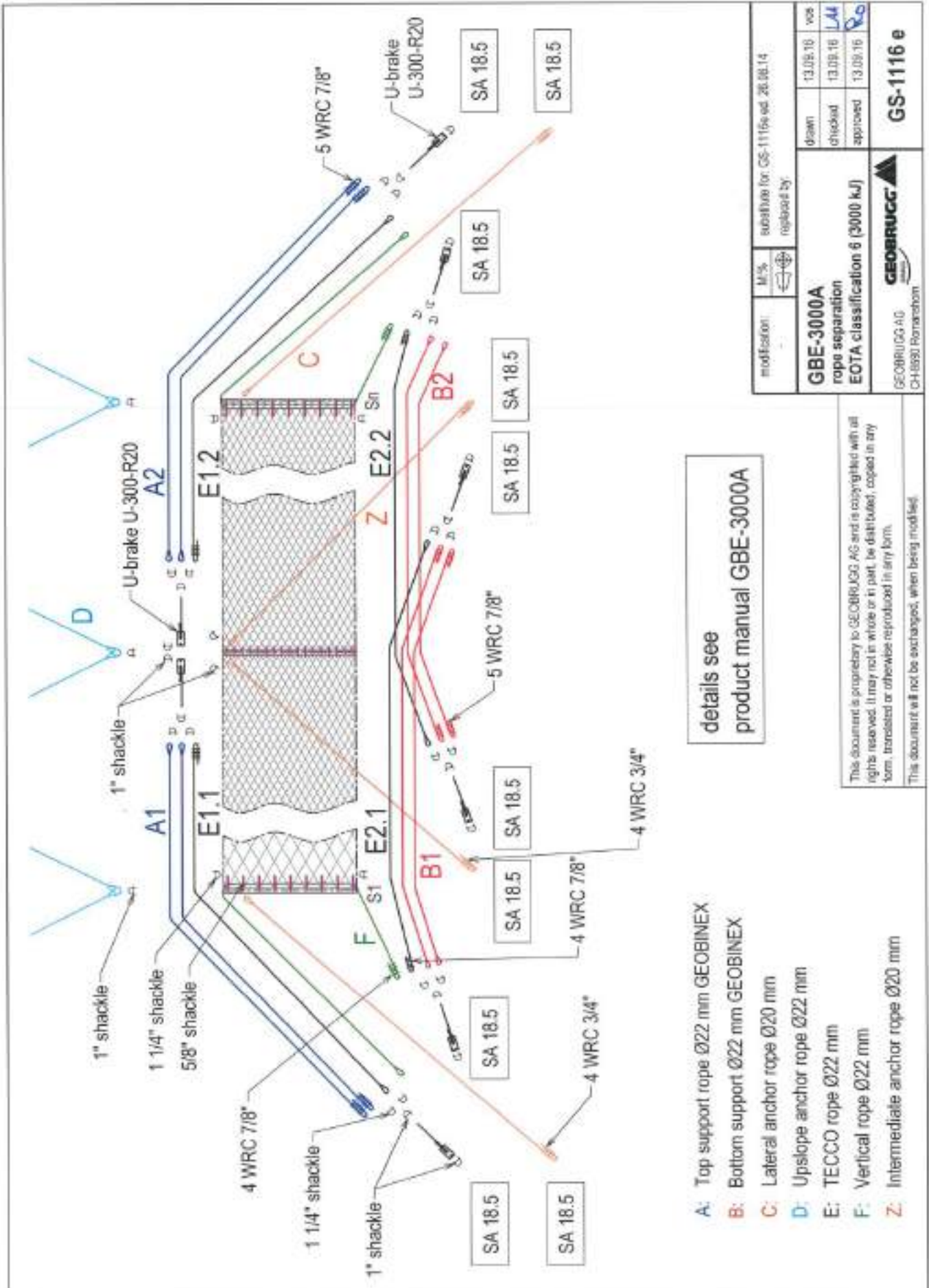
Rockfall protection barrier
GBE 3000A system
EOTA classification 6 (3000 kJ)

drawn	15.09.16	KOB
checked	15.09.16	LM
approved	15.09.16	Ro



GEOBRUGG AG
CH-8590 Romanshorn

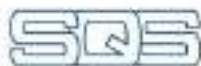
GS-1113 e



modification:	M%	substitute for GS-1116 ed. 26.08.14 replaced by:	drawn	checked	approved	vos
			13.09.16	13.09.16	13.09.16	LA
						RG
GBE-3000A rope separation EOTA classification 6 (3000 kJ)						GS-1116 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



X. Edelmann
X. Edelmann, President SQS



R. Glaser
R. Glaser, 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
Michael Drechsel
President of IQNet

Roland Glauser
Roland Glauser
CEO SQS



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