

500 kJ

GBE-500A-R PRODUCT MANUAL

**European Technical
Approval ETA-11/0034**

**ETAG 27: Category A
Energy class: 500 kJ
Height: 3 - 3.5 m**

Date: 28.10.2016
Issue: 156-N-FO / 13

Associated test institute:
Eidg. Forschungsanstalt WSL
Birmensdorf, Switzerland

This manual is not
subject to change.

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CH-8590 Romanshorn, Switzerland





Notifikovaná osoba č. 1301

TECHNICKÝ A SKÚŠOBNÝ ÚSTAV STAVEBNÝ, n. o.
BUILDING TESTING AND RESEARCH INSTITUTE
Studená 3, 821 04 Bratislava, Slovenská republika

Certificate of constancy of performance

1301 – CPR – 1172

In compliance with Regulation (EU) No 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 – 500A-R

Energy level classification

2

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 (SEL) 170 kJ and with the Maximum Energy Level (MEL) 500 kJ and covers a range of ambient temperatures from - 20 °C to + 50 °C.

Placed on the market under the name of

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 16/0329, issued on 13/06/2016

and

ETAG 027 (used as EAD)

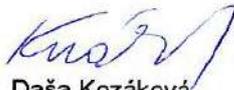
under system 1 for the performance set out in the ETA are applied and that the factory production control conducted by the manufacturer is assessed to ensure the

constancy of performance of the construction product.

This certificate was first issued on 14 June 2016 and will remain valid as long as neither the ETA, the ETAG, the construction product, the AVCP methods nor the manufacturing conditions in the plant are modified significantly, unless suspended or withdrawn by the notified product certification body.

Bratislava, 14 June 2016




Dipl. Ing. Daša Kozáková
Head of Notified Body 1301

078675



European Technical Assessment

ETA 16/0329 version 01
of 13/06/2016

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 – 500A-R

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
Aachstrasse 11
CH-8590 Romanshorn
Switzerland

This European Technical Assessment contains

31 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-11/0034 issued on 14/06/2011

PURPOSE AND STRUCTURE OF THE MANUAL

This system manual ensures that Geobruigg 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. Geobruigg cannot be held liable for any additional costs that may be incurred in special cases. Please contact the manufacturer if anything is unclear. Geobruigg AG's General Terms and Conditions of Contract apply.

RESPONSIBLE FOR CONTENT:

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Romanshorn, October 28th, 2016



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(Stamp / legally-binding signatures)

I 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: 2000 rev. 2007) since August 22, 1995. The certification body is the SQS (Swiss Association for Quality and Management Systems), which belongs to IQNet 9000. 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" in Walenstadt, 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-500A-R system is ETA – 16/0329.

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.

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EXPLANATION OF SYMBOLS USED



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"> • 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 WORK	<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.

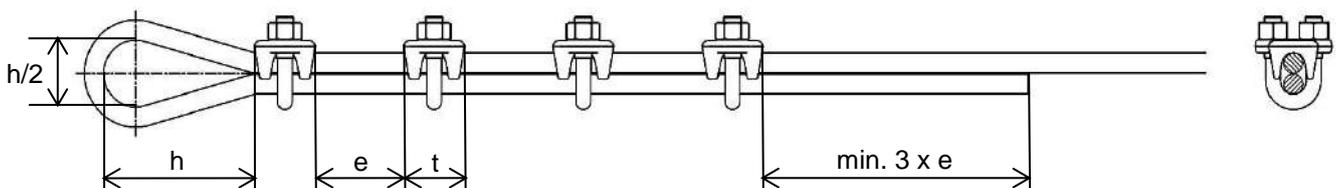
The distance e between the wire rope clips should be at least $1 \times t$ but not exceed $2 \times t$, where t is the width of the clamping jaws. The loose rope end has to be $3 \times e$ at a minimum. Geobrugg recommends looping up the remaining free section and fixing it directly behind the last wire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



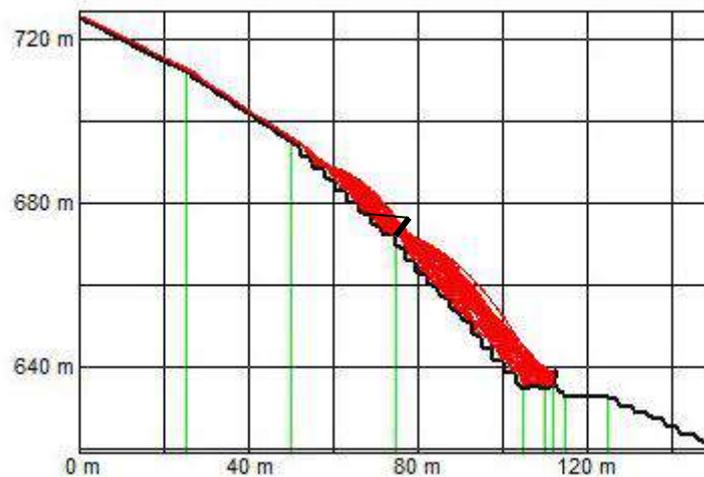
Wire rope clips always have to be installed and used with the required tensioning torque. It is not allowed to re-use clips once they have been detached.

4 STAKING OUT SUBJECT TO TERRAIN

GENERAL PRINCIPLES FOR STAKING OUT

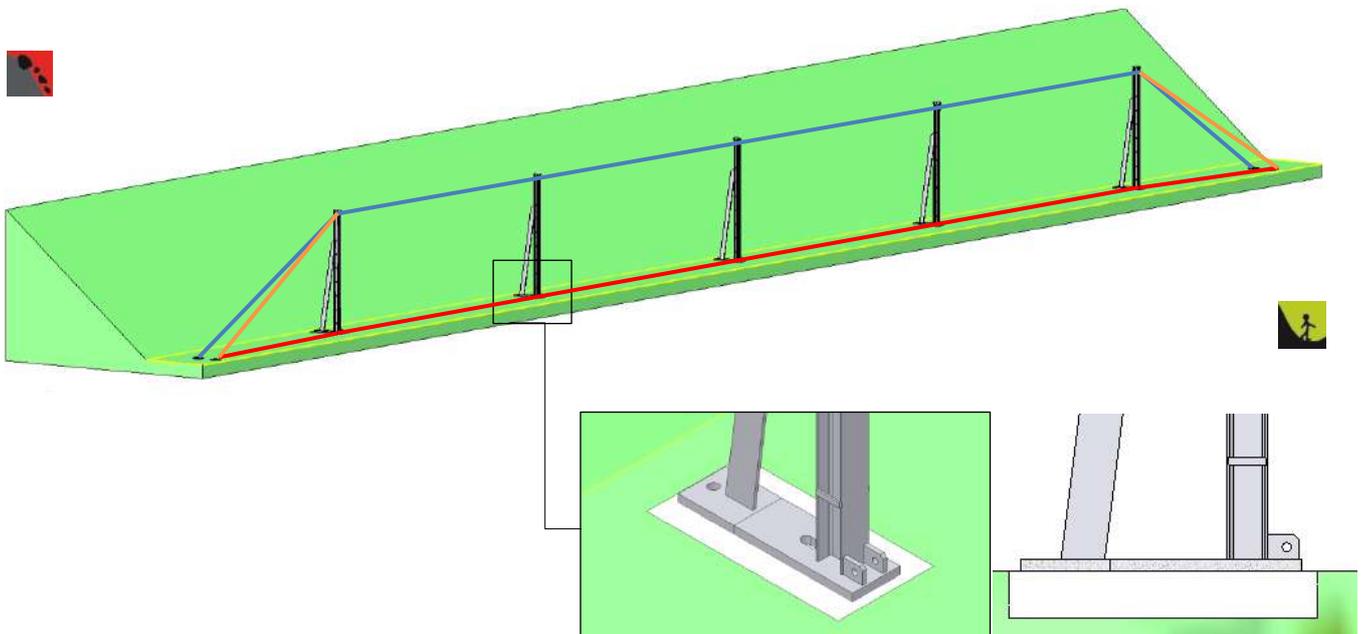
Position of the barrier

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.

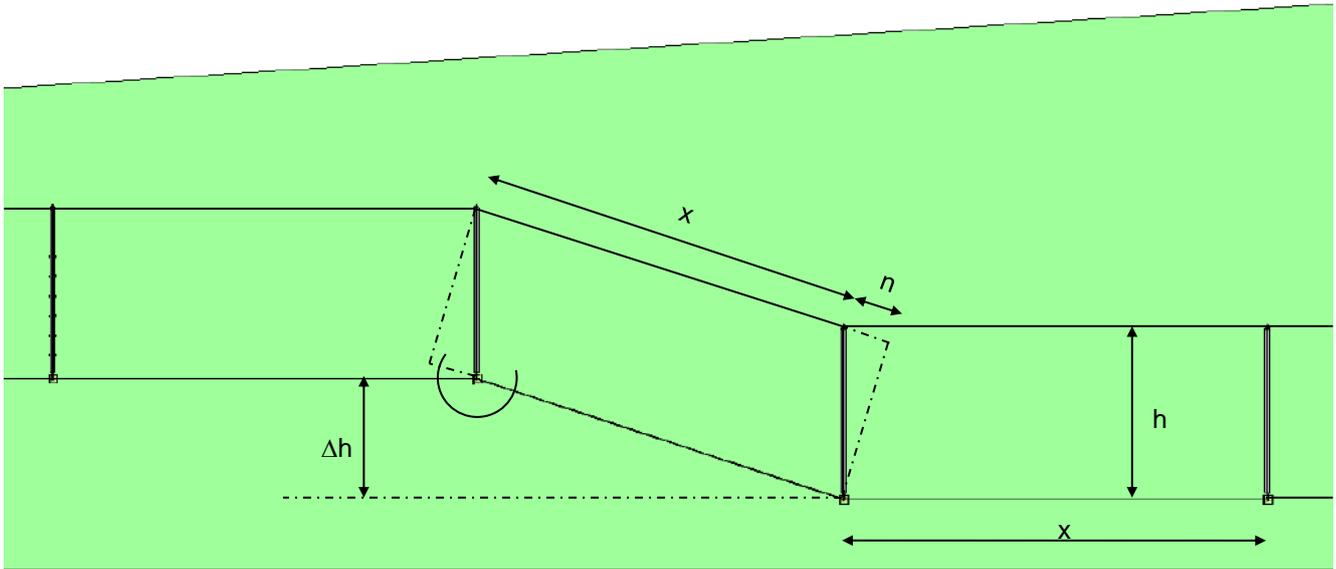


Placing the foundations

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

The foundations must be placed 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

$\Delta h < 2 \text{ m}$: No adjustment necessary

$\Delta h > 2 \text{ m}$: Height difference outside standard staking-out parameters. Net must be adjusted

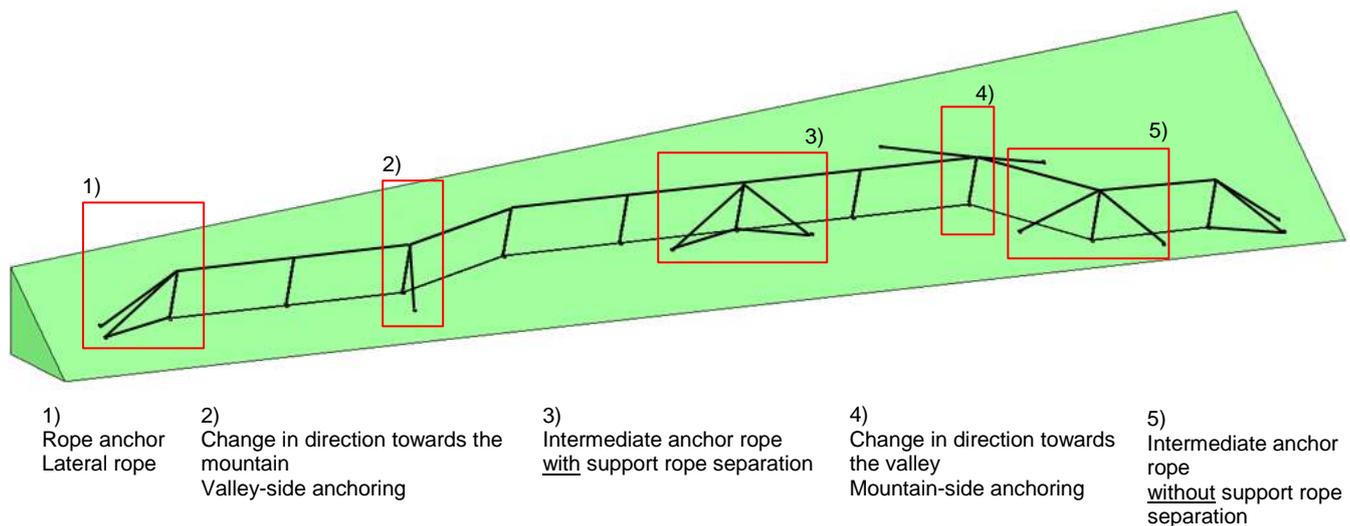
The standard net length is acceptable up to a height difference in the barrier line of 2 m and if the distance between the posts is between 6 m and 12 m.



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.

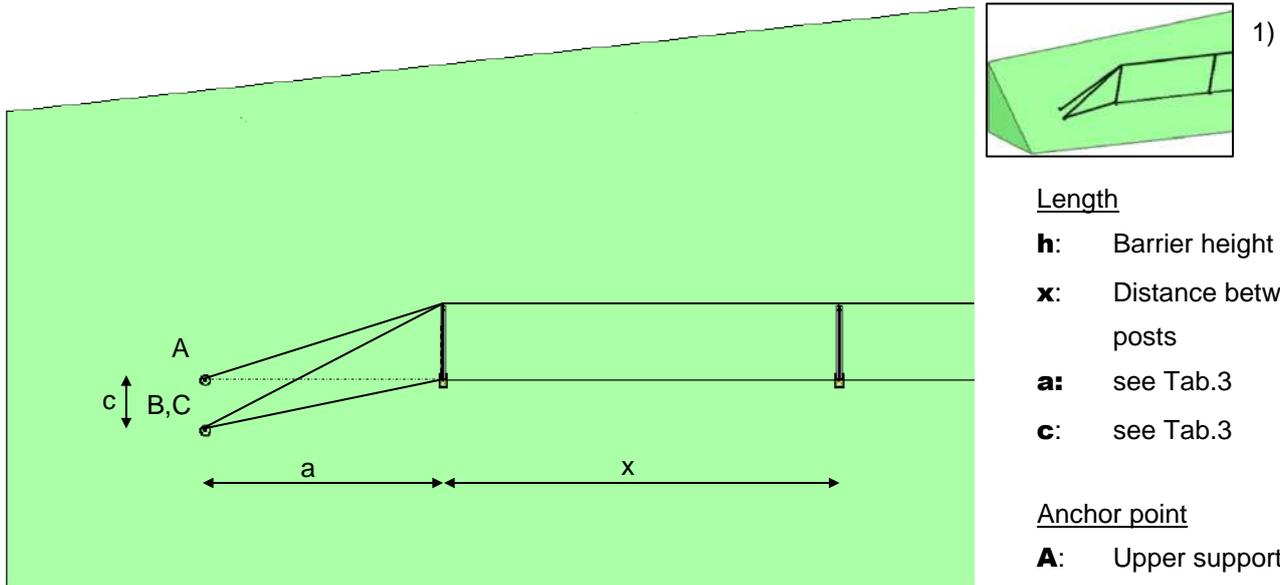
Adapting to the terrain

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 GeobruGG 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



Length

- h:** Barrier height
- x:** Distance between posts
- a:** see Tab.3
- c:** see Tab.3

Anchor point

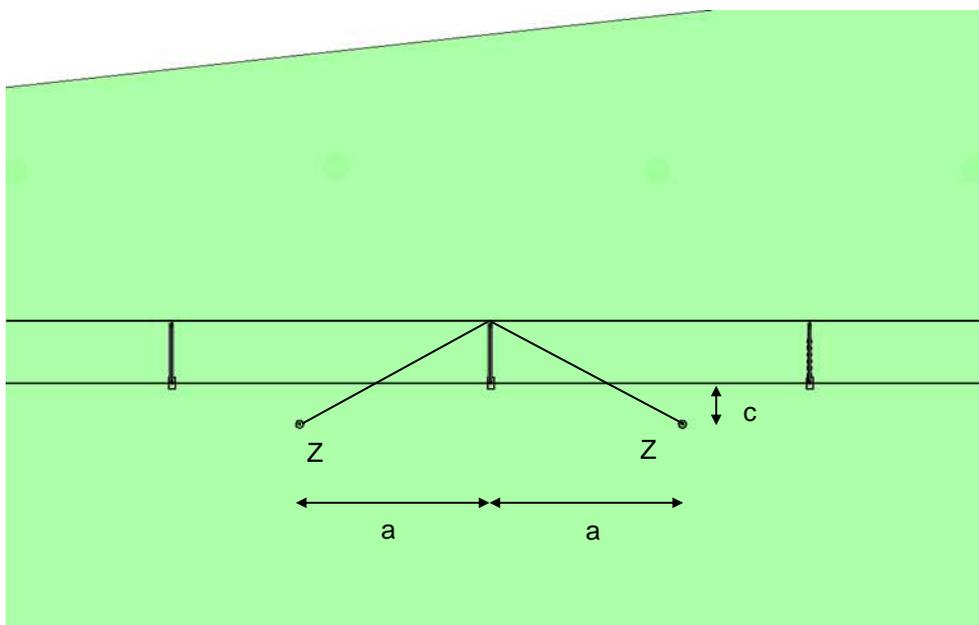
- A:** Upper support rope
- B:** Lower support rope
- C:** Lateral rope

The table below is valid for slopes of 30°- 90°.
Dimensions in m; Dimensional tolerance ± 0.20 m

Tab. 3

h	a	c		e
2.00	3.00	0.65		1.00
3.00	4.50	1.00		1.50
3,50	5,30	1,15		1,75
4.00	6.00	1.30		2.00

ANCHOR POINT FOR INTERMEDIATE ANCHOR ROPE



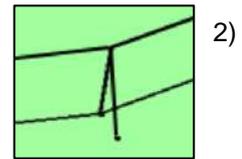
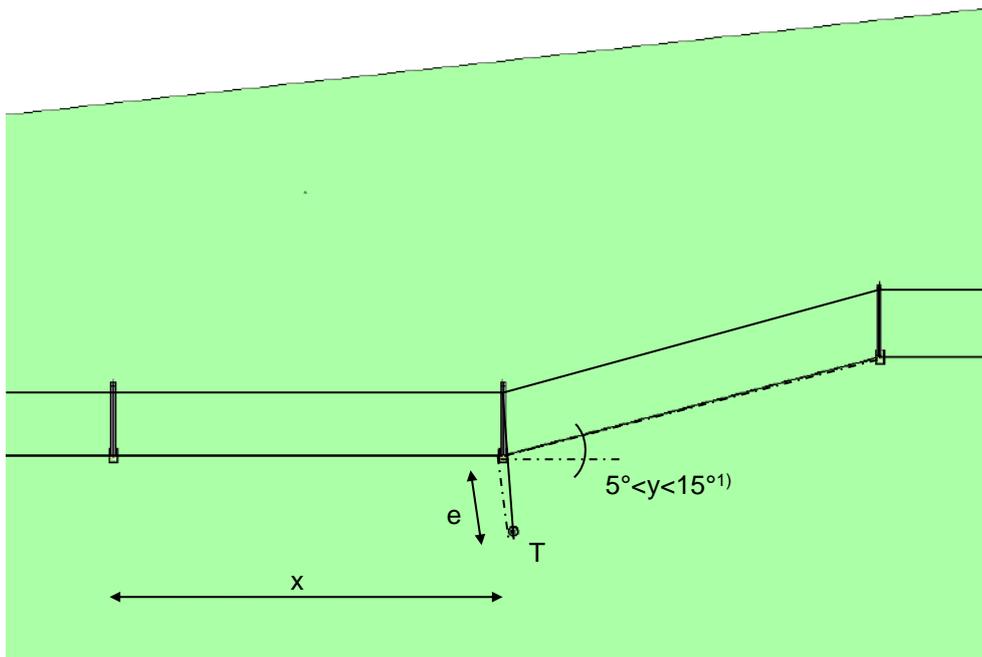
Length

- a:** see Tab.3
- c:** see Tab.3

Anchor point

- Z:** intermediate suspension

CHANGE IN DIRECTION TOWARDS THE MOUNTAIN



Length

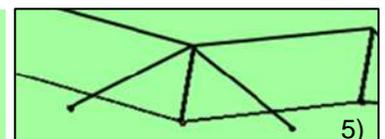
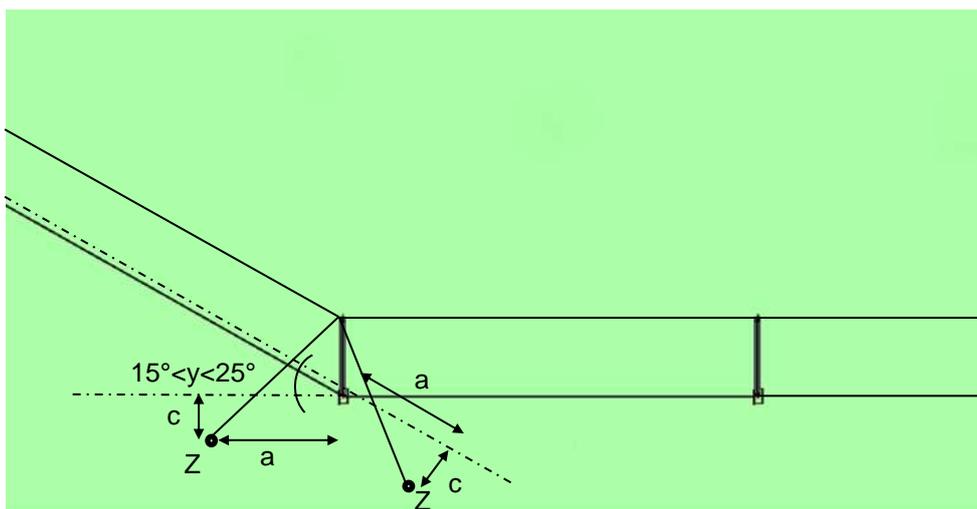
- e:** See Tab. 2
- x:** Distance between posts
- y:** Angle of change in direction

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 $d = 14 \text{ mm}$.

INTERMEDIATE ANCHOR ROPE



Length

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

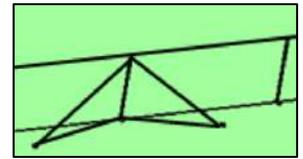
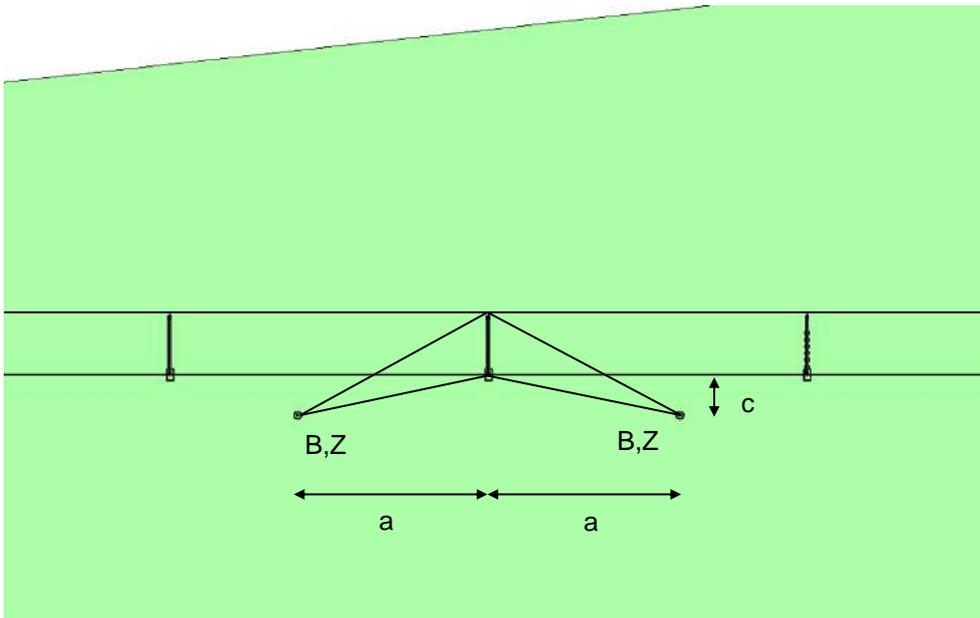
Anchor point

- 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



Length

a: See Tab.3

c: See Tab.3

Anchor point

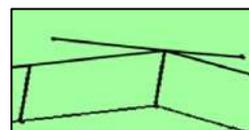
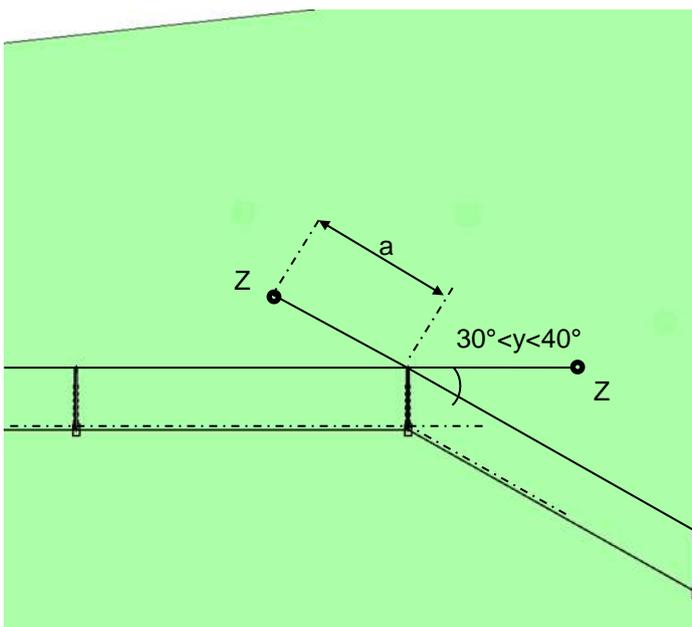
B: Lower support rope

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



Length

a: see Tab.3

y: angle of change i direction

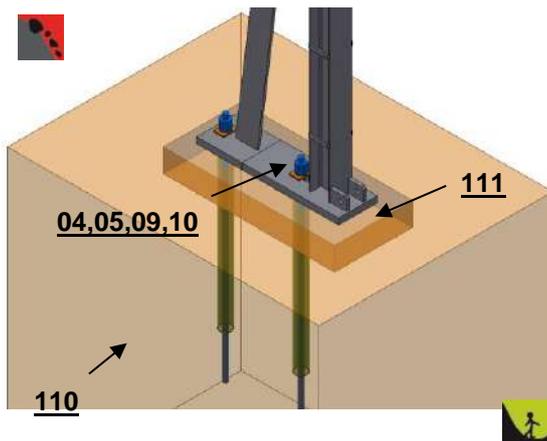
Anchor point

Z: intermediate suspension

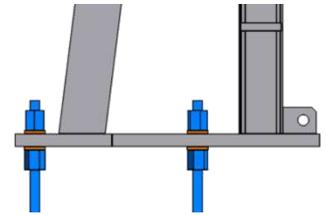
In the case of a change in direction towards the valley of more than 30°, two additional retaining ropes (D) are mounted on the post. The change in direction towards the valley must not exceed 40°.

6 ANCHORING THE BASEPLATE

Soil:

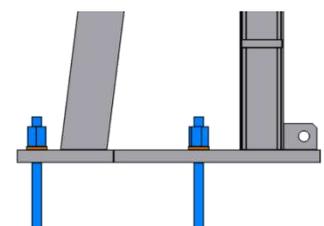


- Baseplate inclined 0-30° from the horizontal
- Bore hole for main anchor 0-30° from the vertical
- Optional: Install the stabilization tube **04**
- Install main anchor **05**, support plate **09**, and fastening nuts **10**
- Cement the main anchor into the loose rock **110**, length is variable
- Optional: Lightly reinforced head foundation **111**
- Bore the retaining anchor **06** by hand, use the baseplate as a template. Length is $L = 1000 \text{ mm}$

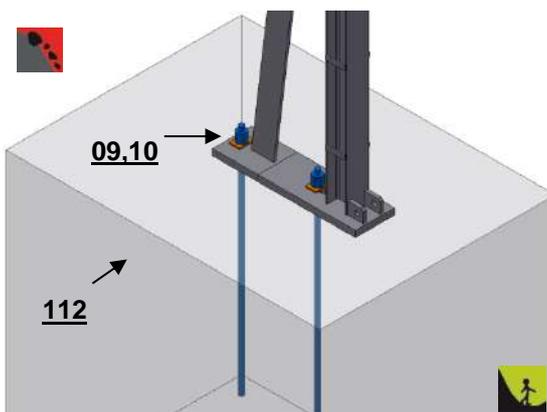


Concrete

- The dimension and the reinforcement of the foundation **111** is given by the project engineer.
- Install both anchors **08** using a template.
- Grout the concrete foundation



Concrete / rock:



- Taper the ground around the baseplate to 0-30° from the horizontal
- Bore both holes for the anchor rods into the rock **112** vertically to the baseplate
- Cement the rock anchor **08**, length is variable
- Place the baseplate in the bed of cement
- Tighten the fastening nuts once the cement has fully cured
- The anchor length must be adapted to the environmental conditions



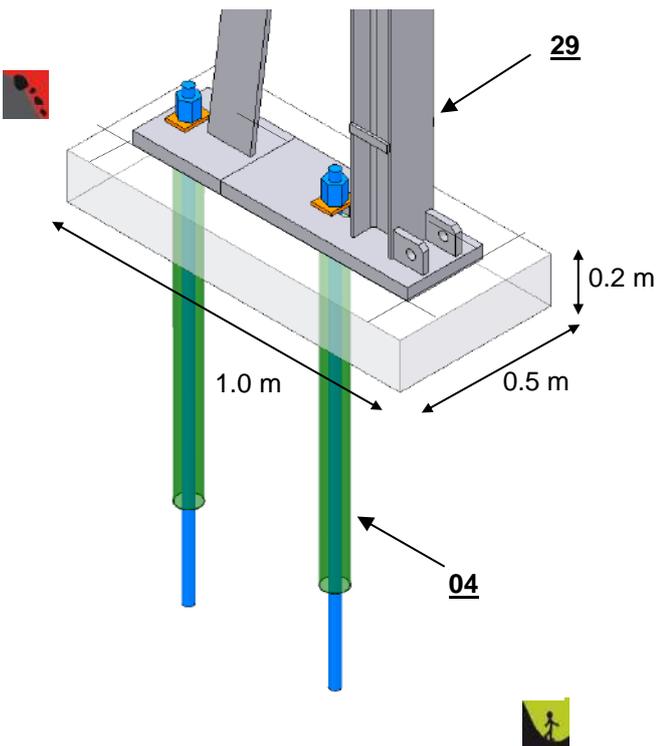
The forces generated during a rockfall event are not to be underestimated. The civil engineering and installation work must therefore be completed professionally.



Cement that is resistant to de-icing salt must be used.
Reinforcement: 12-mm steel diameter at a distance of 150 mm



You must ensure that the anchors have sufficient contact with the cement, produce a strong structure, and have a sufficient lateral surface to the surrounding material.



A reinforced concrete foundation with the dimensions indicated opposite is recommended for soil.

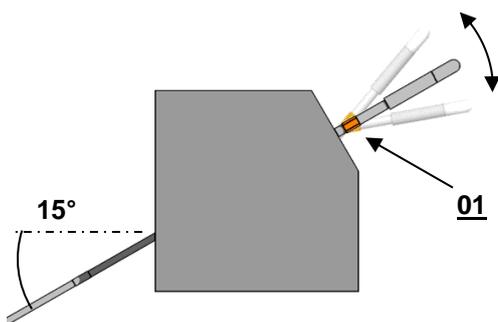
2 bar anchors **05** with support plate **09** and fastening nuts **10**

2 optional stabilization tubes **04**

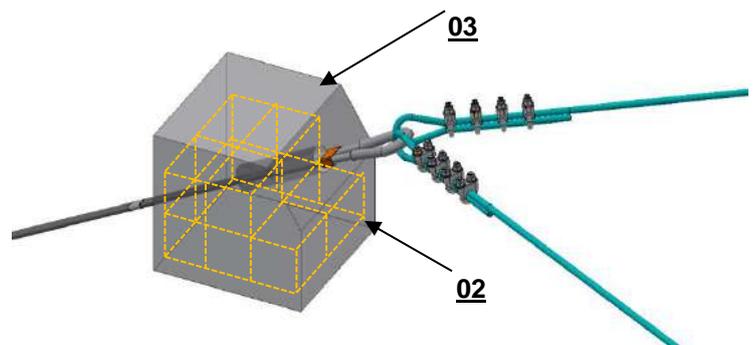
Baseplate with post **29**

The manufacturer of "Swiss Gewi NG 28/32/40" bar anchors recommends that the nuts are tightened to a torque of approx. 400 Nm, which corresponds to a preload force of approx. 30 kN.

The anchor holes are bored in the direction of movement at a minimum gradient of $> 15^\circ$ from the horizontal.
Example:



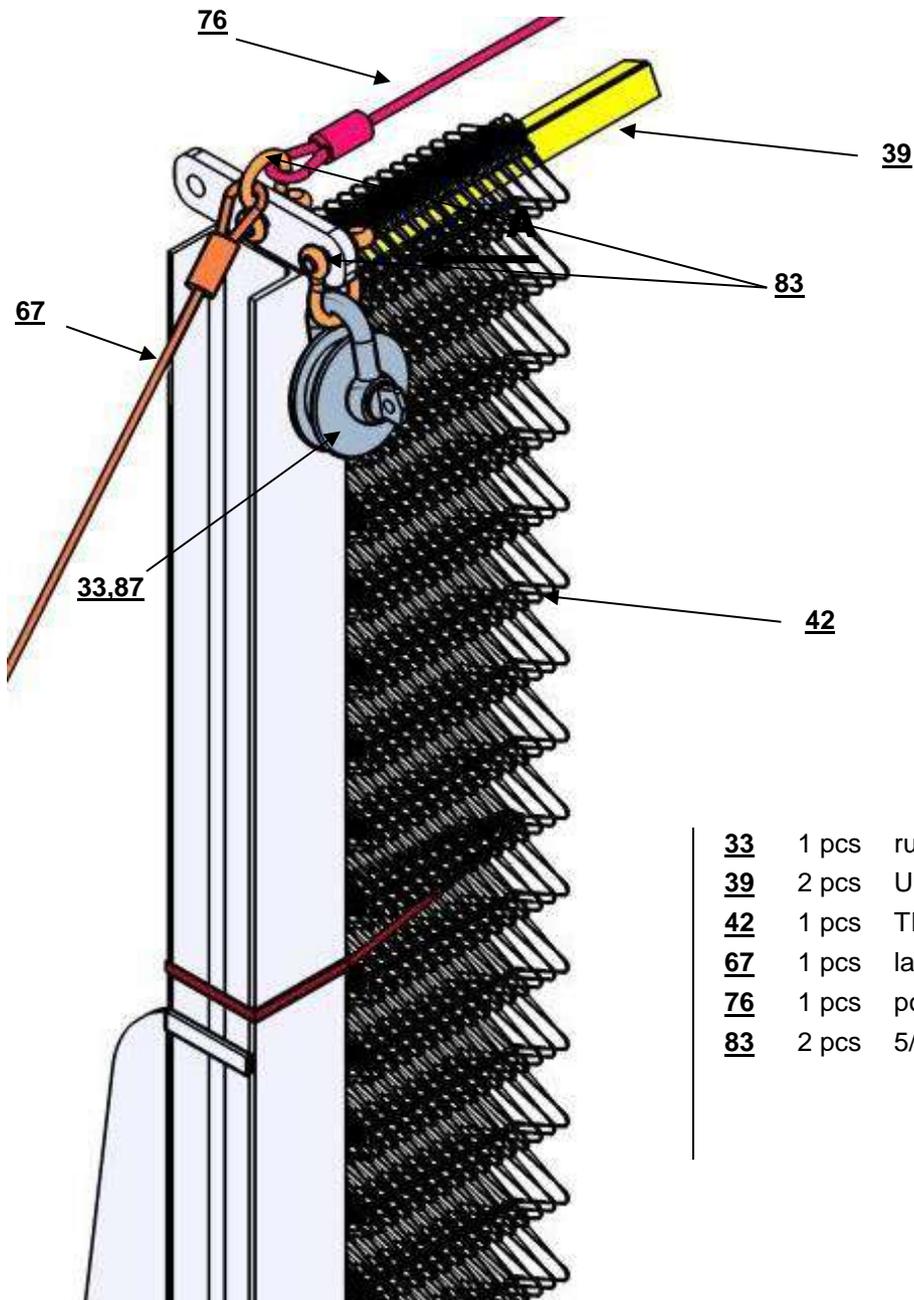
During cementing, the anchors **01** are to be inserted into the borehole horizontally up to the orange marker.



When using bar anchors with flex head inserts, the foundations **03** must be installed with reinforcement **02** to prevent shear forces.

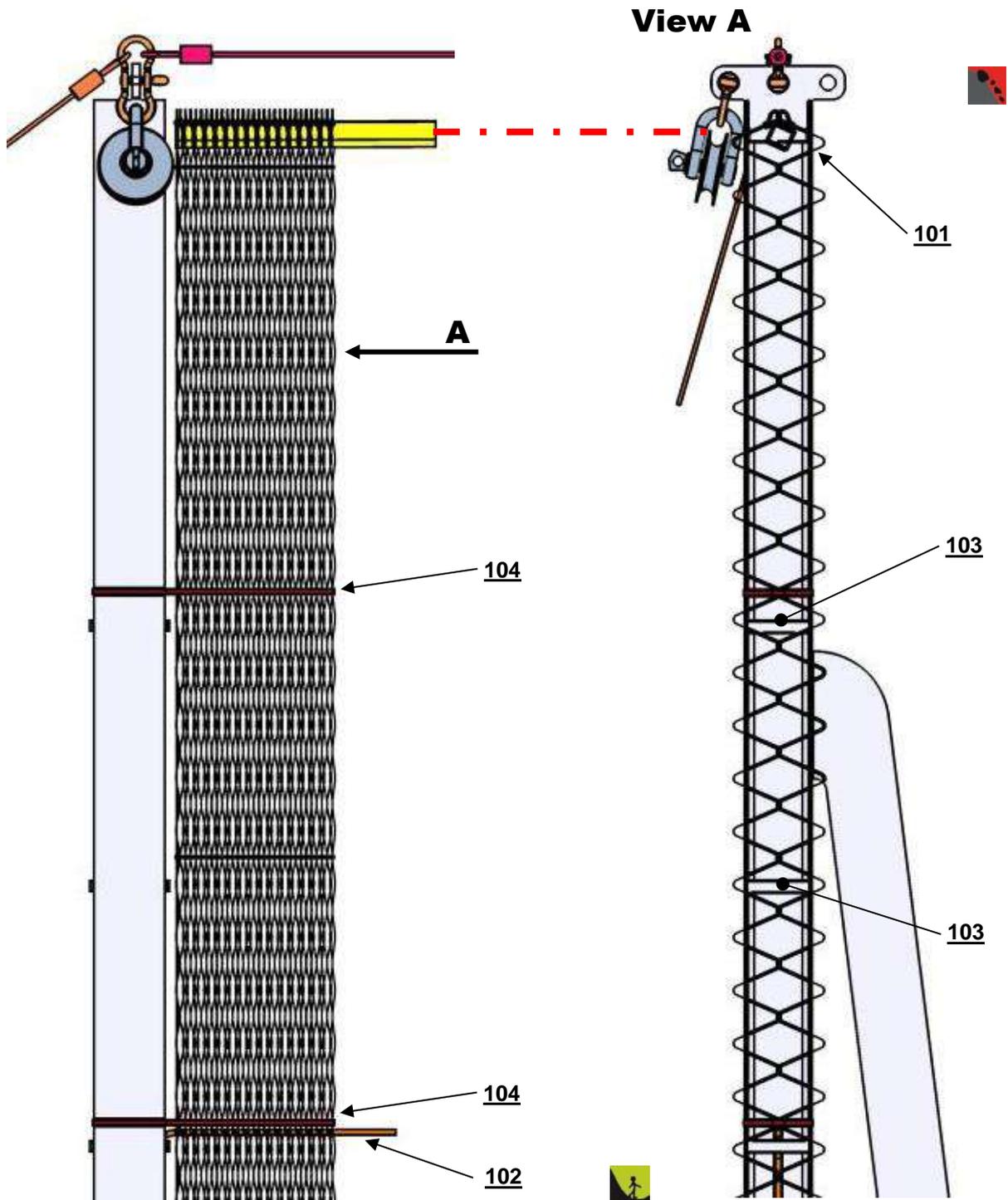
7 PREPARING THE POSTS AND NETS

PREPARING THE POSTS



- 33 1 pcs running wheel
- 39 2 pcs U-profiles as support rope guide
- 42 1 pcs TECCO mesh bundle
- 67 1 pcs lateral rope
- 76 1 pcs post head rope
- 83 2 pcs 5/8" shackles

THE CORRECT HEIGHT OF THE NET BUNDLE

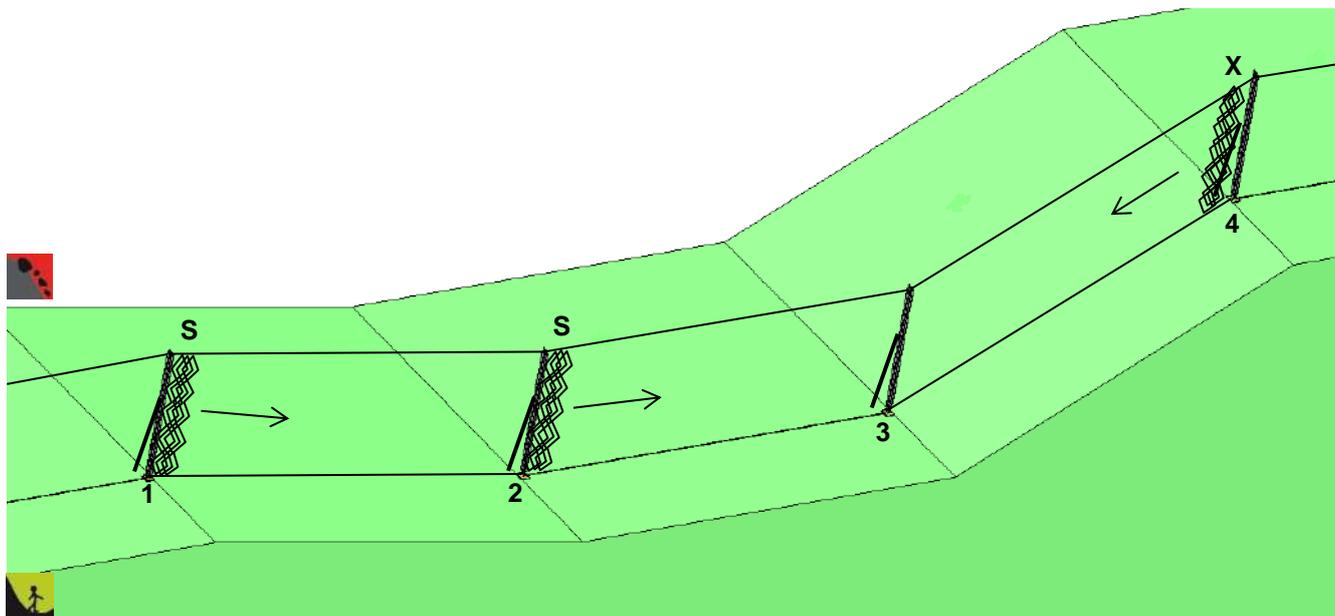


The height of the uppermost row of mesh **101** is somewhat above the height of the preinstalled running wheels. The mounting bracket **102** is placed at the correct height between the rungs **103** and the post wall.



The net bundle is placed on the mounting bracket and securely fastened with **104** bands.

THE CORRECT SIDE OF THE NET BUNDLE



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



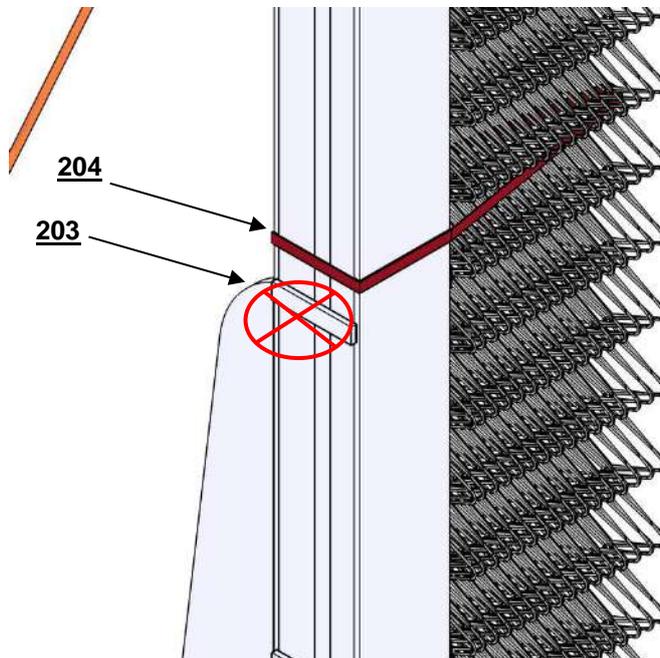
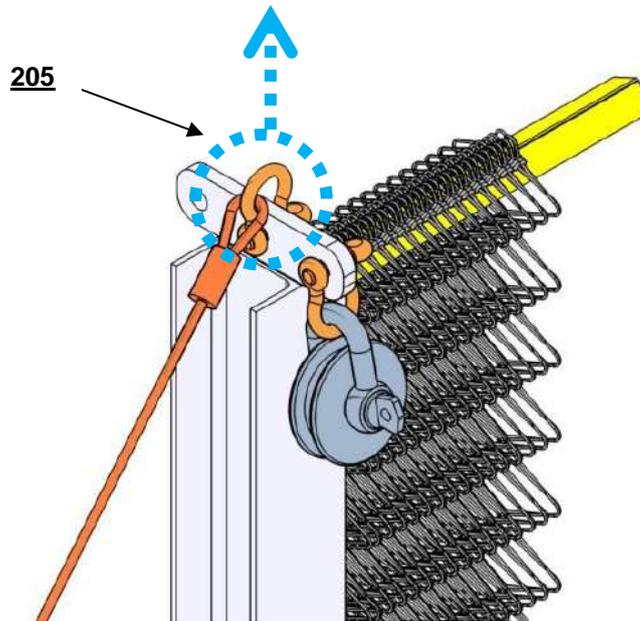
S: The mesh bundles are mounted on the right of the post as standard.

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, GeobruGG will also supply the bundles on the desired side of the post.

8 CRANE OR HELICOPTER INSTALLATION



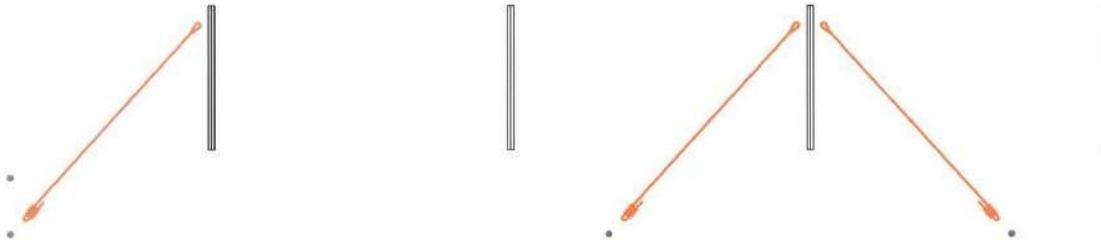
Fasten the mesh bundle using bands **204** and the mounting bracket so that it cannot fly away.



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

9 INSTALLING THE SUPERSTRUCTURE

- Install the lateral ropes and intermediate anchor ropes.



- Install the post head rope on the two outermost posts.



- 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.



- Install the U-brakes on the anchors, fasten the bottom support rope to the baseplates, and then tension the lower support rope.



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

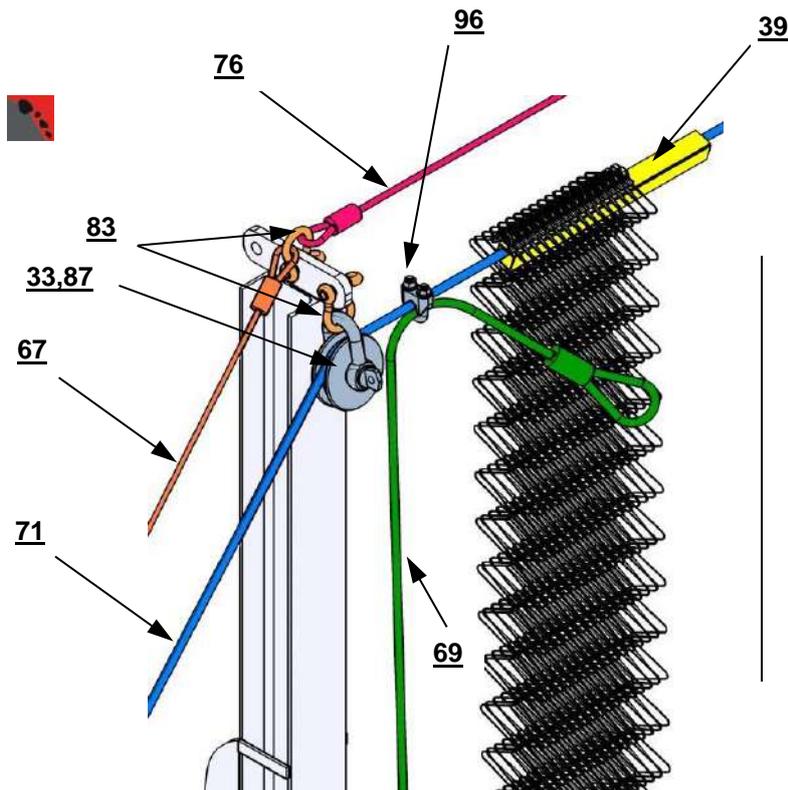
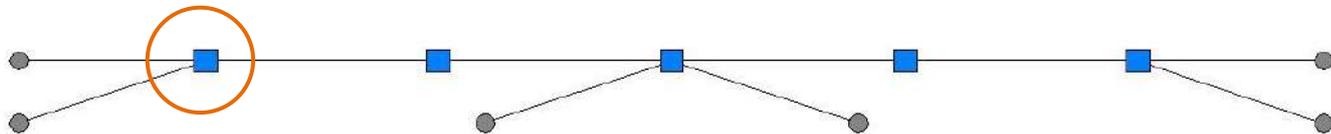


- Raise the nets on the upper and lower support rope.

10 ASSEMBLY DETAILS

CONNECTING THE POST AND THE ROPE ANCHORS

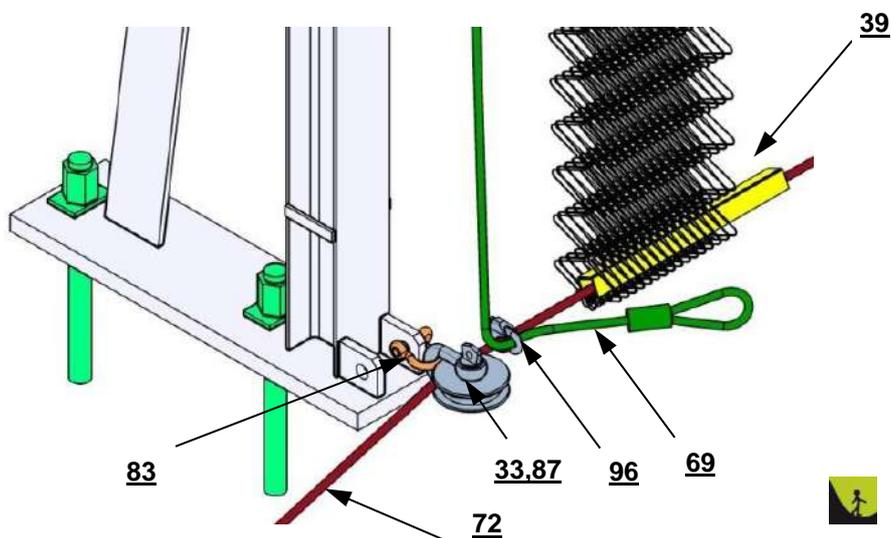
BORDER POST



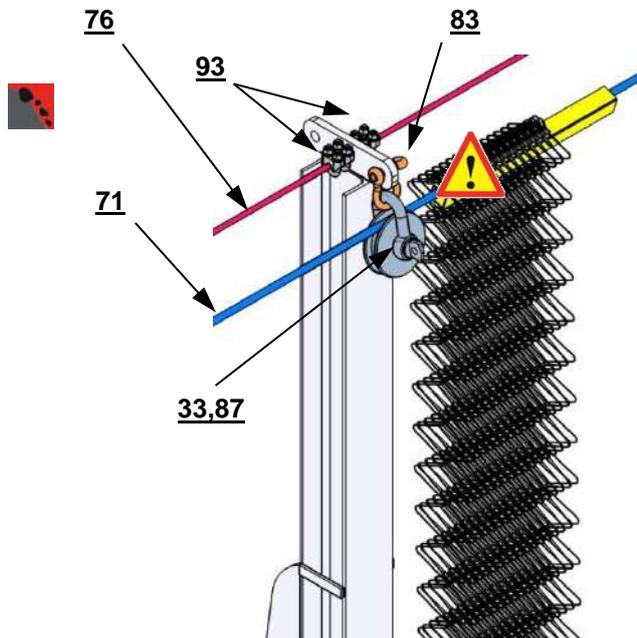
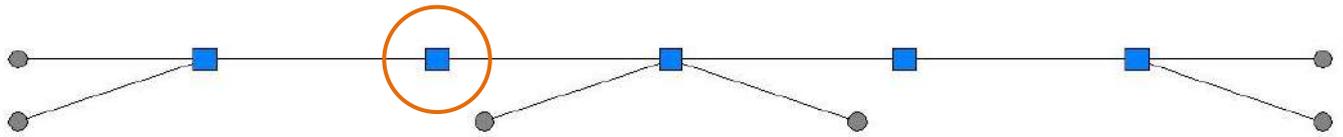
- | | | |
|-----------|---|-----------------------|
| <u>33</u> | 2 | running wheels |
| <u>39</u> | 4 | running wheels |
| <u>67</u> | 1 | lateral rope |
| <u>69</u> | 1 | vertical rope |
| <u>71</u> | 1 | top support rope |
| <u>72</u> | 1 | bottom support rope |
| <u>76</u> | 1 | post head rope |
| <u>83</u> | 3 | 5/8" shackles |
| <u>87</u> | 2 | 1" shackles, straight |
| <u>96</u> | 2 | NG19 wire rope clips |



The mesh is shown in the diagram; make sure you pay attention to the number of loops that are kept free.



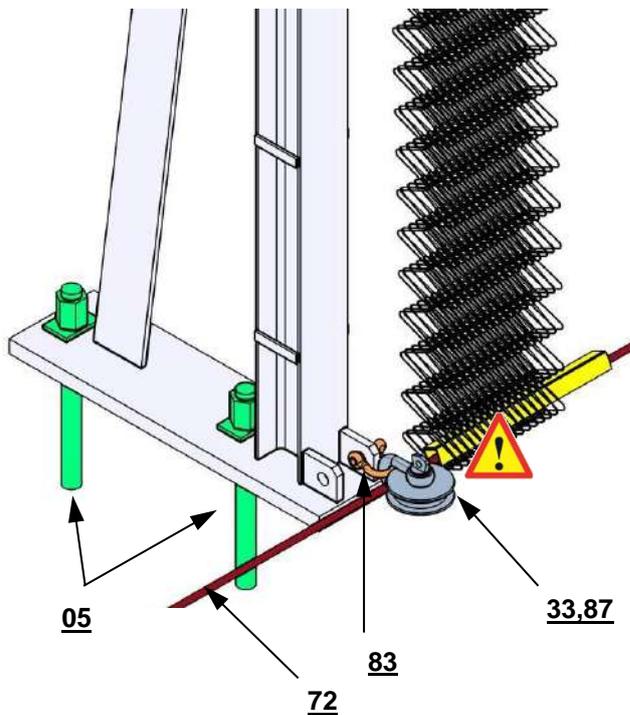
MIDDLE POST



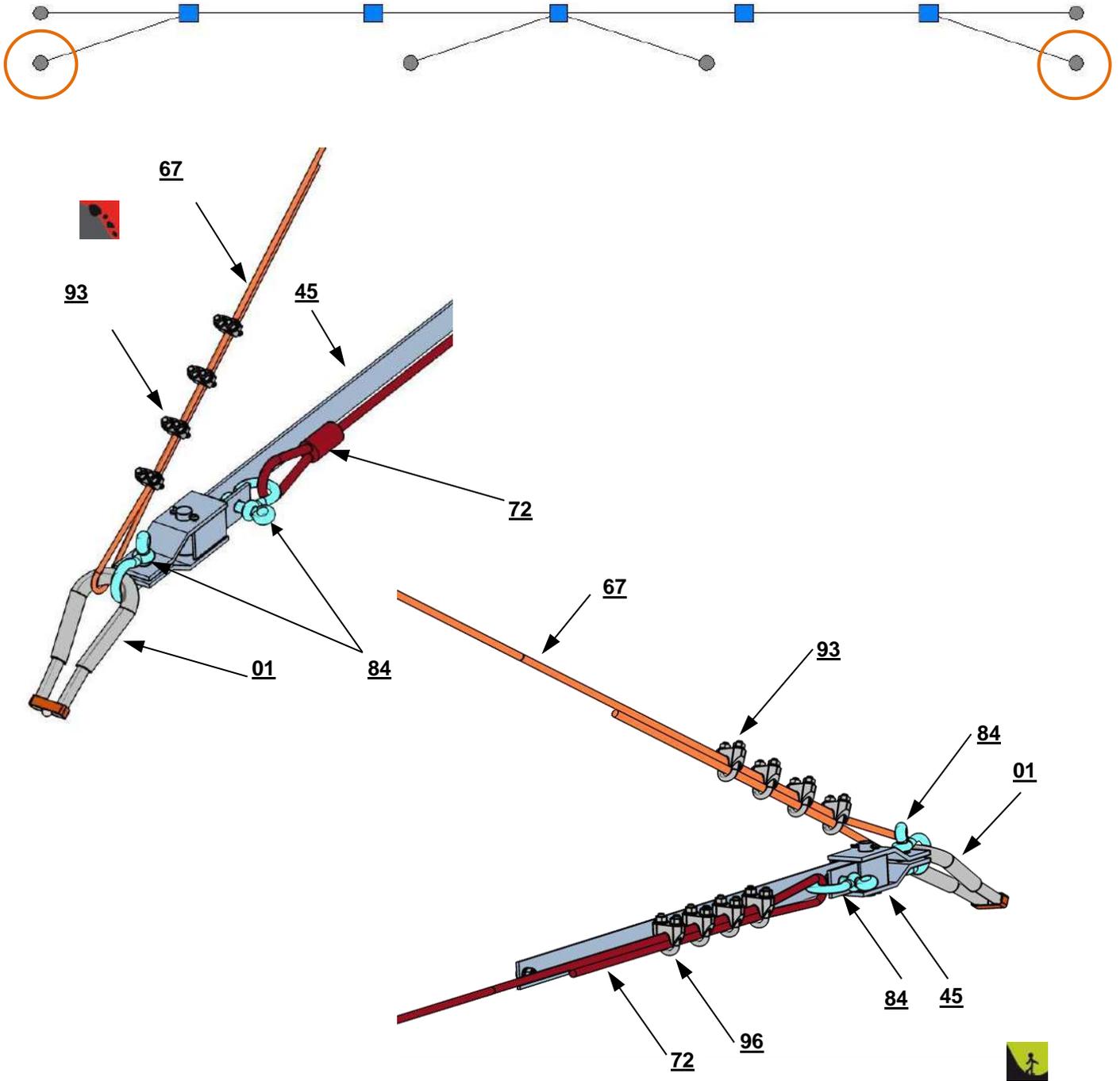
- | | | |
|-----------|---|---|
| <u>05</u> | 2 | main anchors |
| <u>33</u> | 2 | running wheels |
| <u>71</u> | 1 | top support rope |
| <u>72</u> | 1 | bottom support rope |
| <u>76</u> | 1 | post head rope |
| <u>83</u> | 2 | 5/8" shackles |
| <u>87</u> | 2 | 1" shackles, straight |
| <u>93</u> | 4 | NG13 wire rope clips, $M_A = 35 \text{ Nm}$ |



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

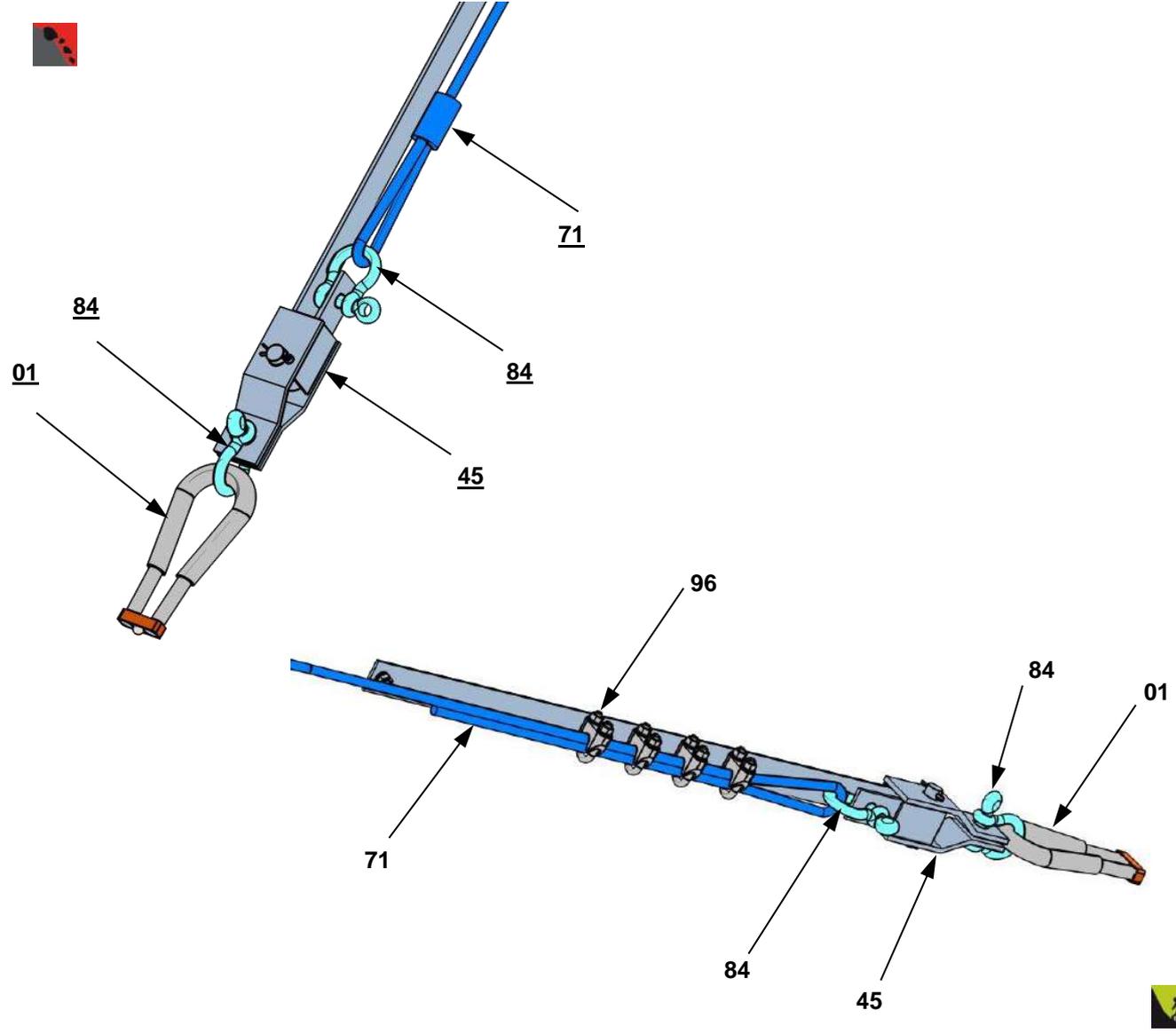
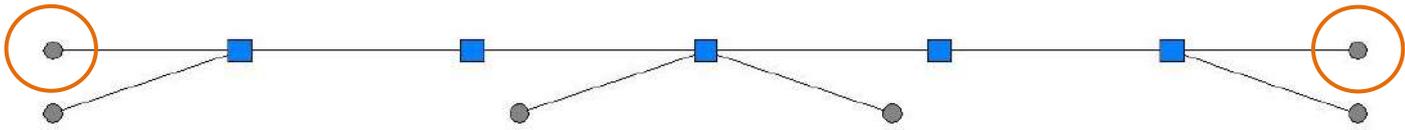


LATERAL ROPE AND BOTTOM SUPPORT ROPE ON THE ROPE ANCHOR

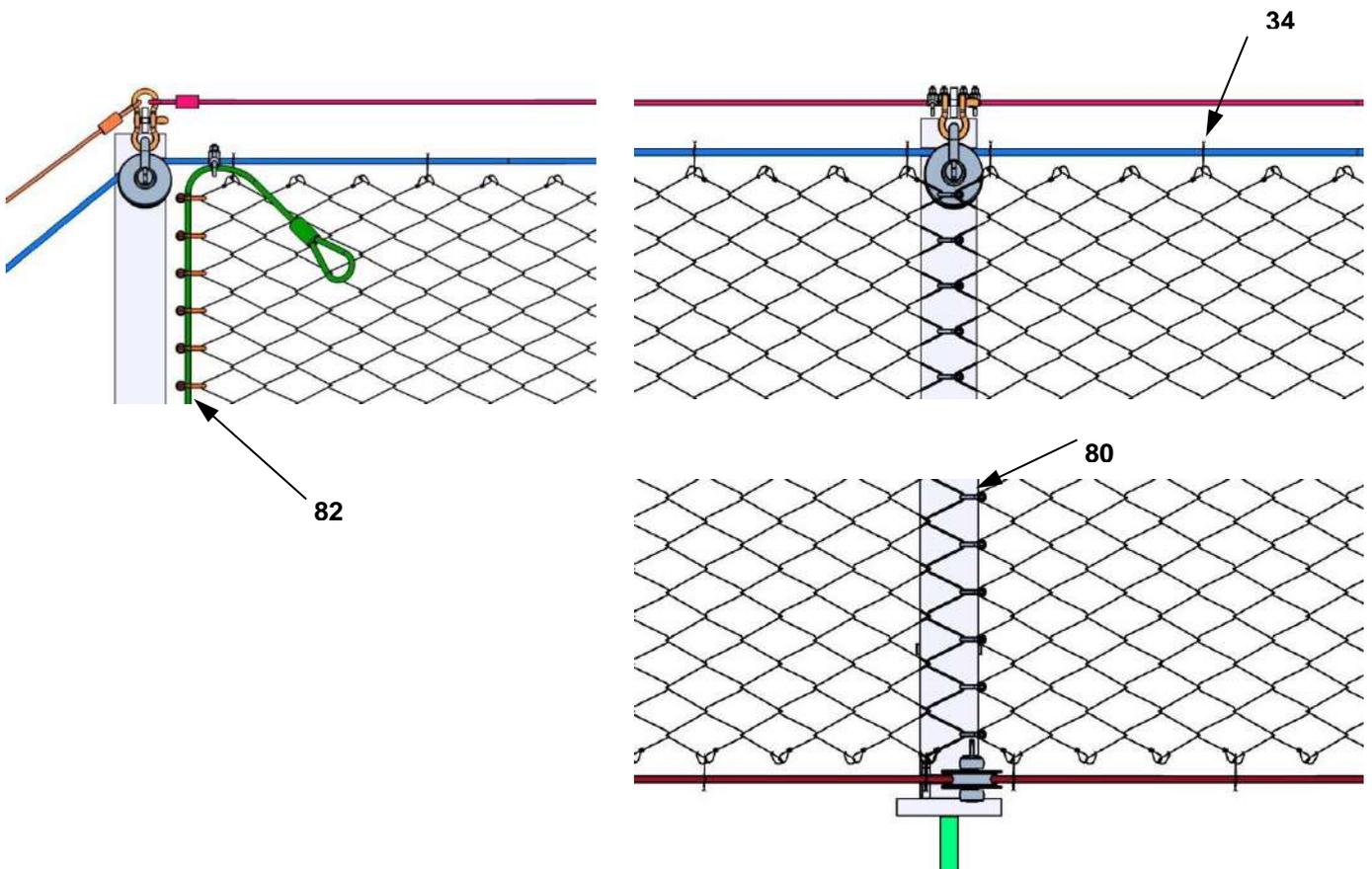
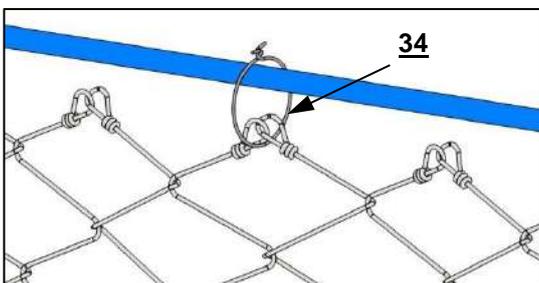
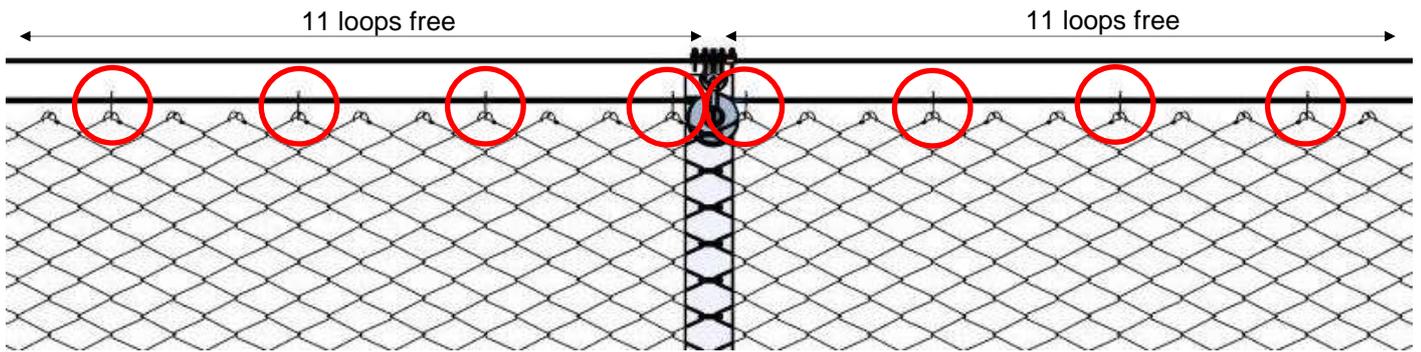


- | | | |
|-----------|-------|------------------------------|
| 01 | 1 pcs | spirale rope anchor |
| 45 | 1 pcs | U-brakeU-300 |
| 84 | 2 pcs | shackle 3/4" |
| 93 | 4 pcs | wire rope clip NG13 pro Seil |
| 96 | 4 pcs | wire rope clip NG19 pro Seil |

TOP SUPPORT ROPE ON THE ROPE ANCHOR



TECCO G80/4 ON THE SUPPORT ROPE

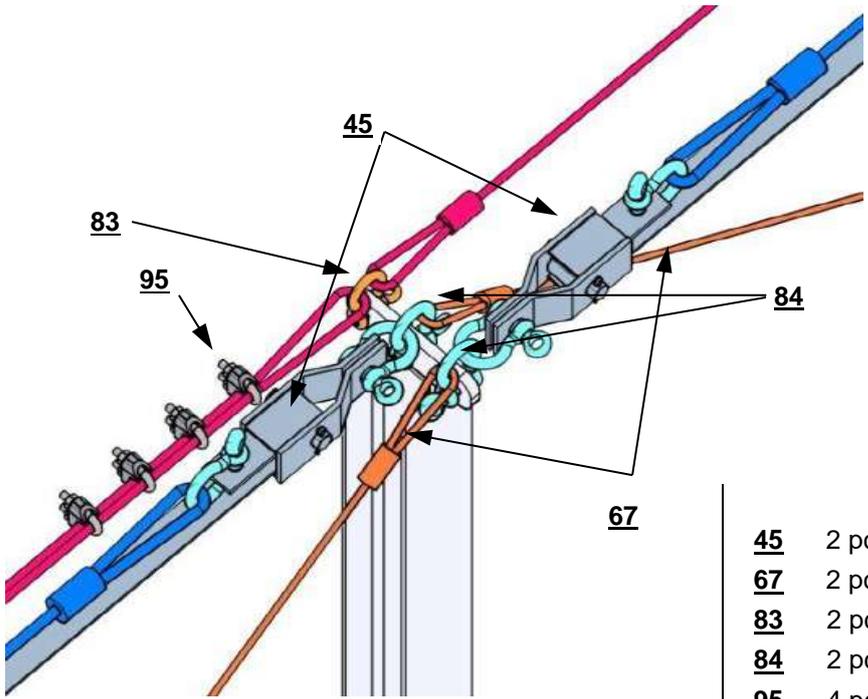


34 Mount 4 round clips on both the left and right of the post, starting with the post. Keep 11 loops free

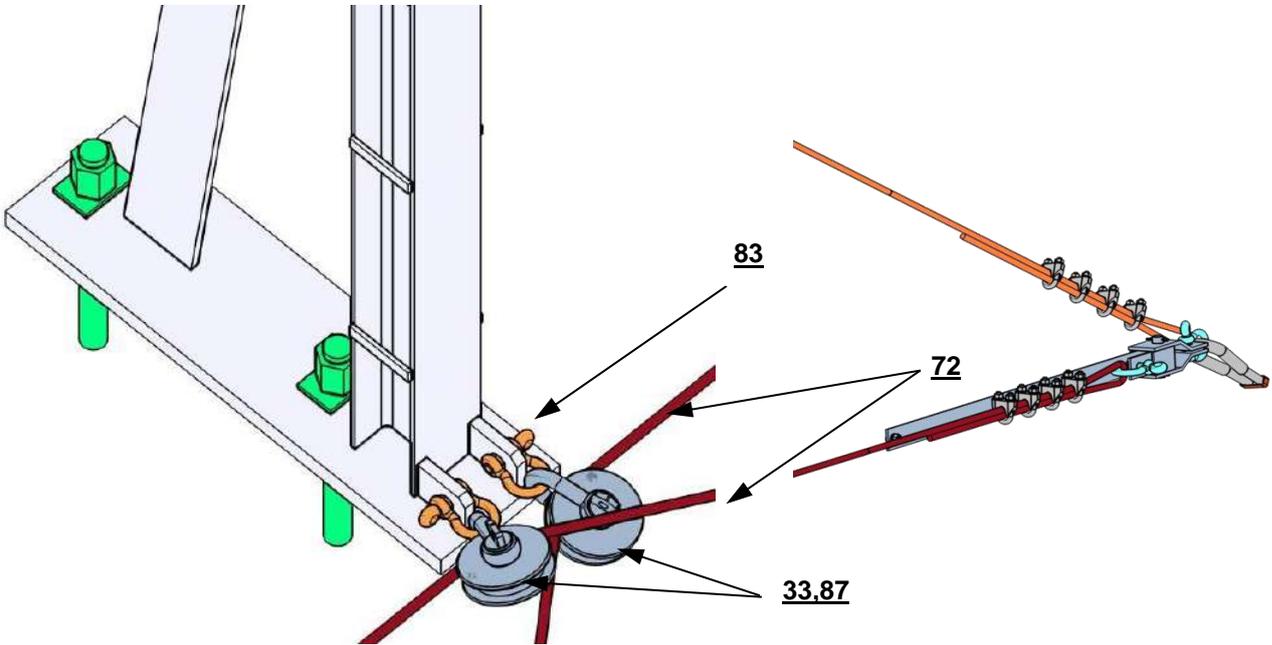
80 3/8" shackle per loop

82 1/2" shackle per loop on vertical rope

SUPPORT ROPE SEPARATION



- 45** 2 pcs U-brake U-300
- 67** 2 pcs intermediate suspension
- 83** 2 pcs shackle 5/8"
- 84** 2 pcs shackle 3/4"
- 95** 4 pcs wire rope clip NG 16

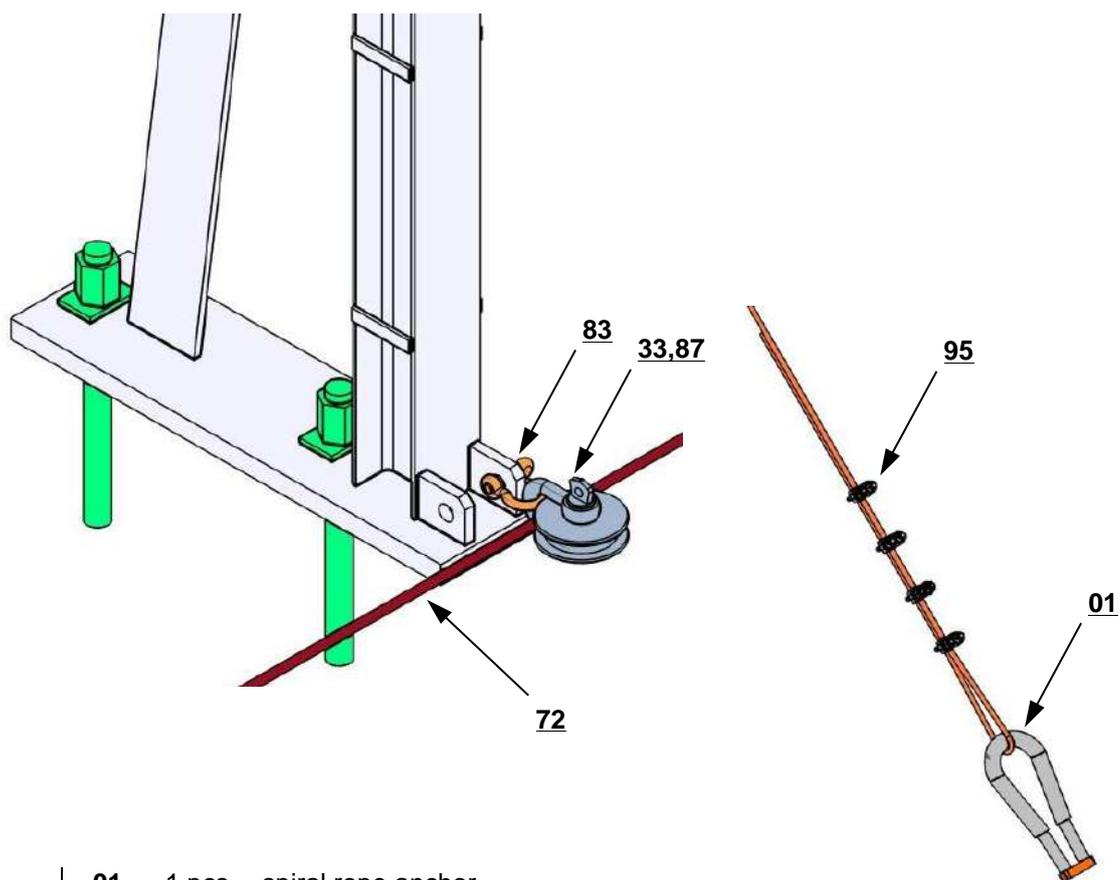
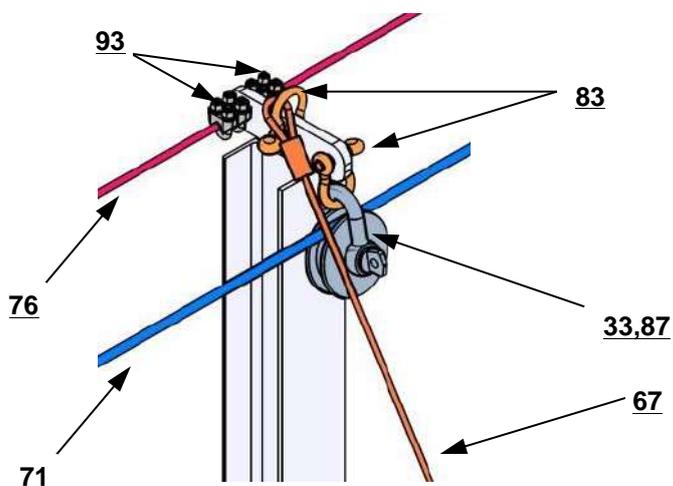


A support rope separation always contains an intermediate anchor rope.



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.

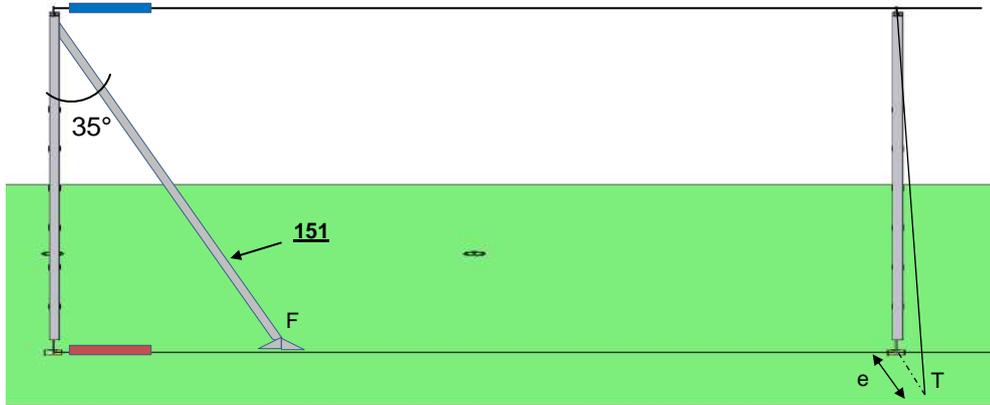
VALLEY-SIDE ANCHORING



- | | | |
|-----------|-------|-----------------------|
| 01 | 1 pcs | spiral rope anchor |
| 67 | 1 pcs | valley-side anchoring |
| 83 | 3 pcs | 5/8" shackles |
| 95 | 8 pcs | wire rope clips NG 16 |

11 ADDITIONAL SOLUTION TO THE STANDARD

BRACE ELEMENT SOLUTION



e: distance downslope

F: brace

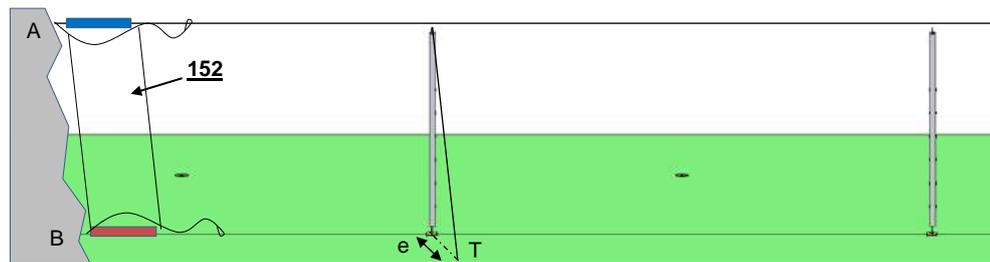
T: downslope rope
(optional)

 brake element



Are not sufficient space for standard stakeout for the lateral anchors available. This can be modified a brace element solution **151** in consultation with GEOBRUGG.

ROCK FACE CONNECTION



e: distance downslope

A: top support rope

B: bottom support rope

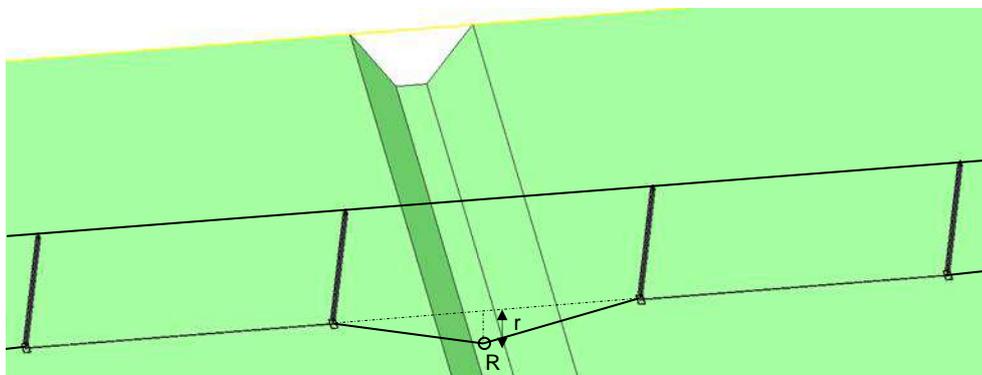
T: downslope rope
(option)

 brake element



A standard staking out is not possible, then can be developed a rock face solution in consultation with GEOBRUGG.

GAP FILLING SOLUTION



r: distance gap

R: gap anchor

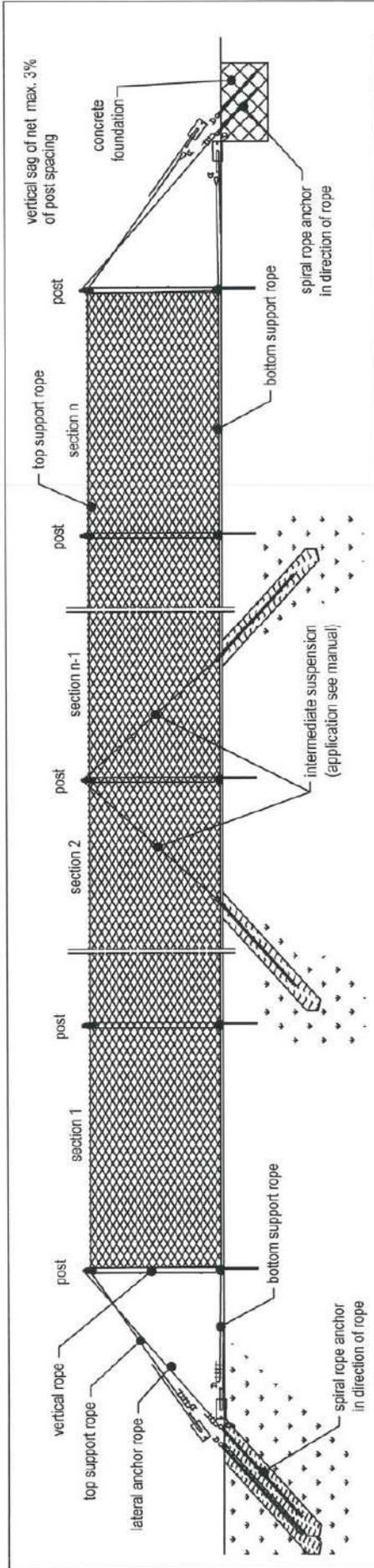


In steep mountain slopes with torrent channels large openings may arise between ground and bottom support rope. Gap fillings can be developed in consultation with GEOBRUGG.

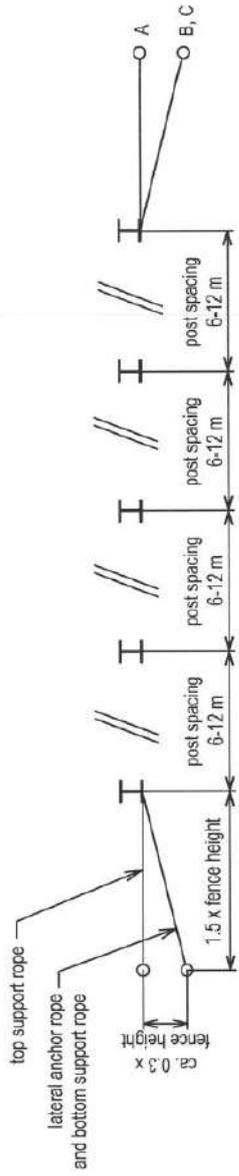
12 FINAL INSPECTION

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

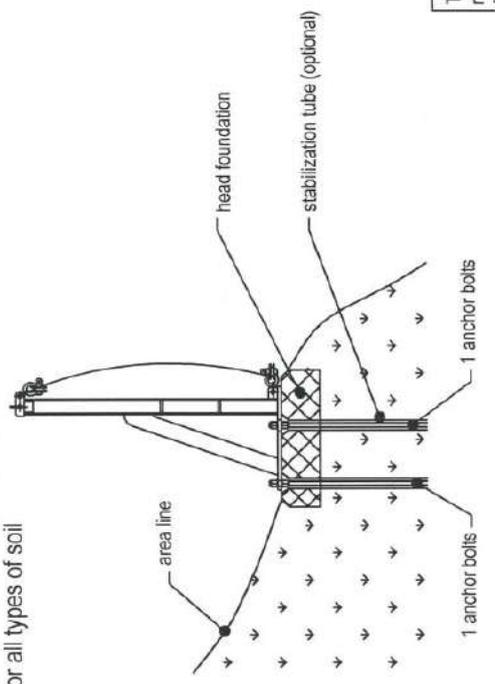
- a) Are the support and lateral ropes and the lateral rope connected to the correct anchors?
- b) Are the rope guides at the top and bottom of the posts installed correctly?
- c) Have the correct number of rings been left free on the left and right of the posts?
- d) Is the net correctly fastened to 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?



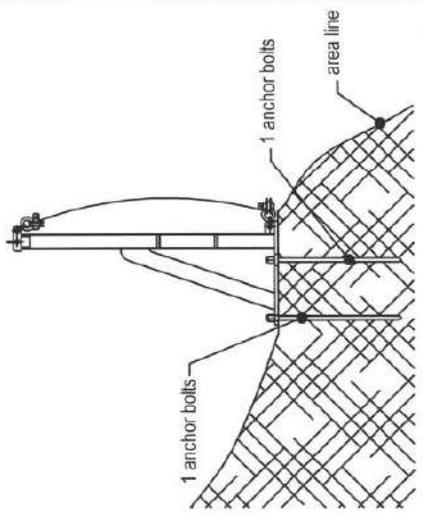
layout of anchor points
(details in
product manual GBE-500A-R)



anchoring concrete foundation:
for all types of soil



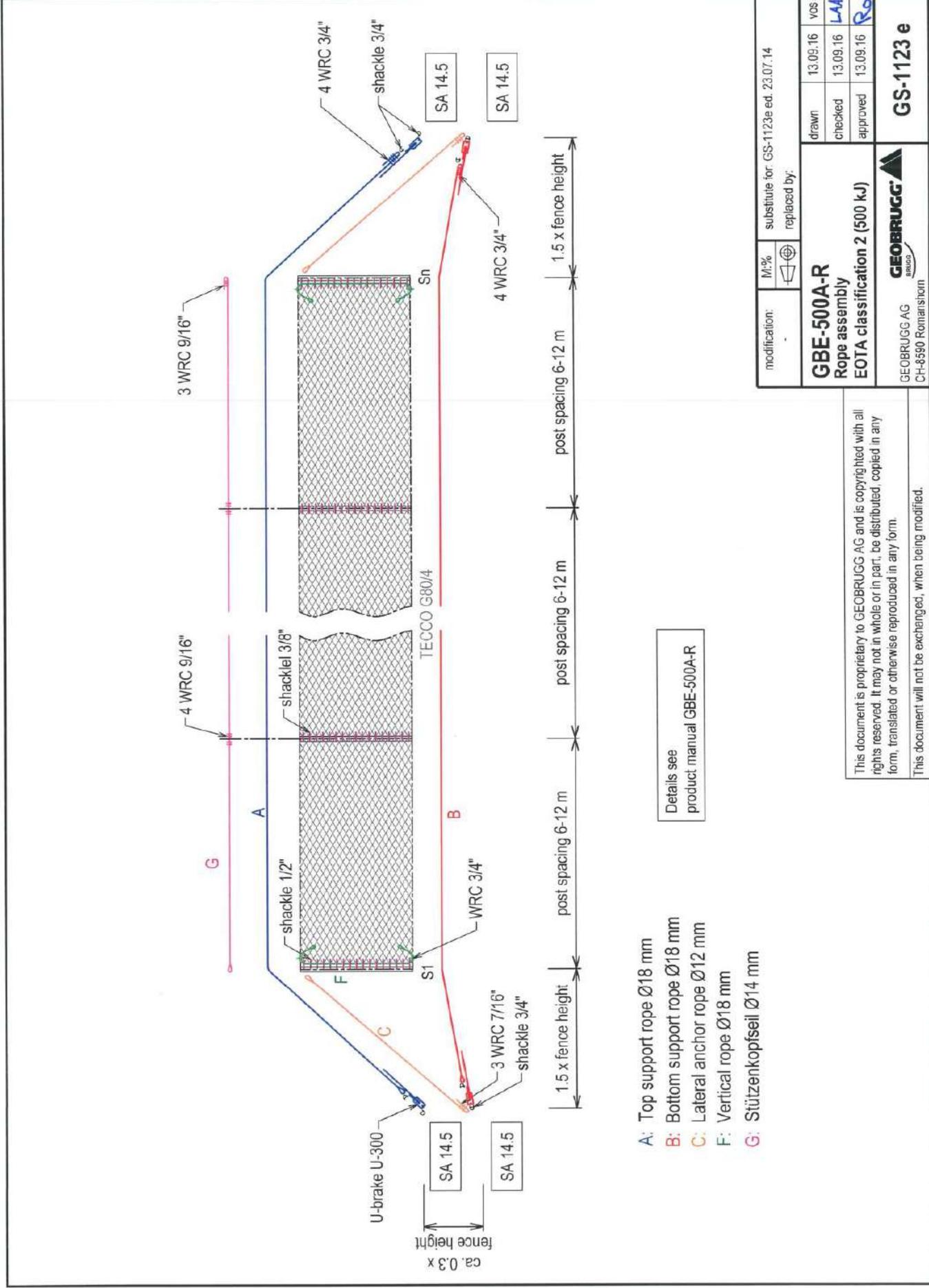
anchoring in bedrock: with 2 anchor bolts



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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 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-1122e ed. 07.01.14	drawn	15.09.16	VCS
		replaced by:	checked	16.09.16	LM
			approved	16.09.16	Rg
Rockfall protection barrier					
GBE-500A-R System					
EOTA classification 2 (500 kJ)					
GEOBRUGG AG CH-8590 Romanshorn			GEOBRUGG AG		
GS-1122 e					

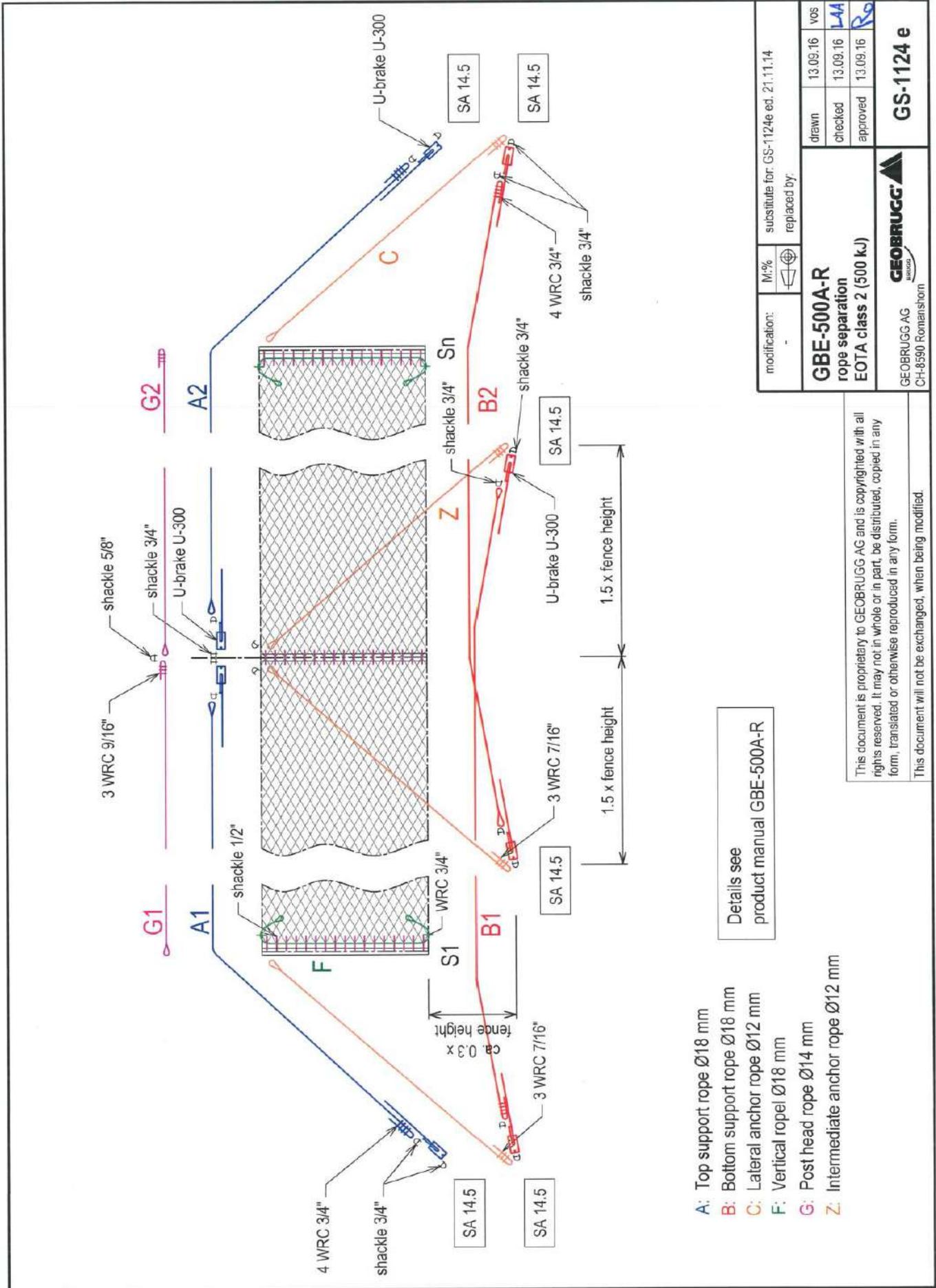


- A: Top support rope Ø18 mm
- B: Bottom support rope Ø18 mm
- C: Lateral anchor rope Ø12 mm
- F: Vertical rope Ø18 mm
- G: Stützenkopfseil Ø14 mm

Details see product manual GBE-500A-R

modification:	M: %	substitute for: GS-1123e ed. 23.07.14	drawn	13.09.16	VOS
		replaced by:	checked	13.09.16	LAM
			approved	13.09.16	RS
GBE-500A-R Rope assembly EOTA classification 2 (500 kJ)			GS-1123 e		
GEOBRUGG AG CH-8590 Romanshorn			GEOBRUGG AG		

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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.



Gebrugg 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. Glauser, 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



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