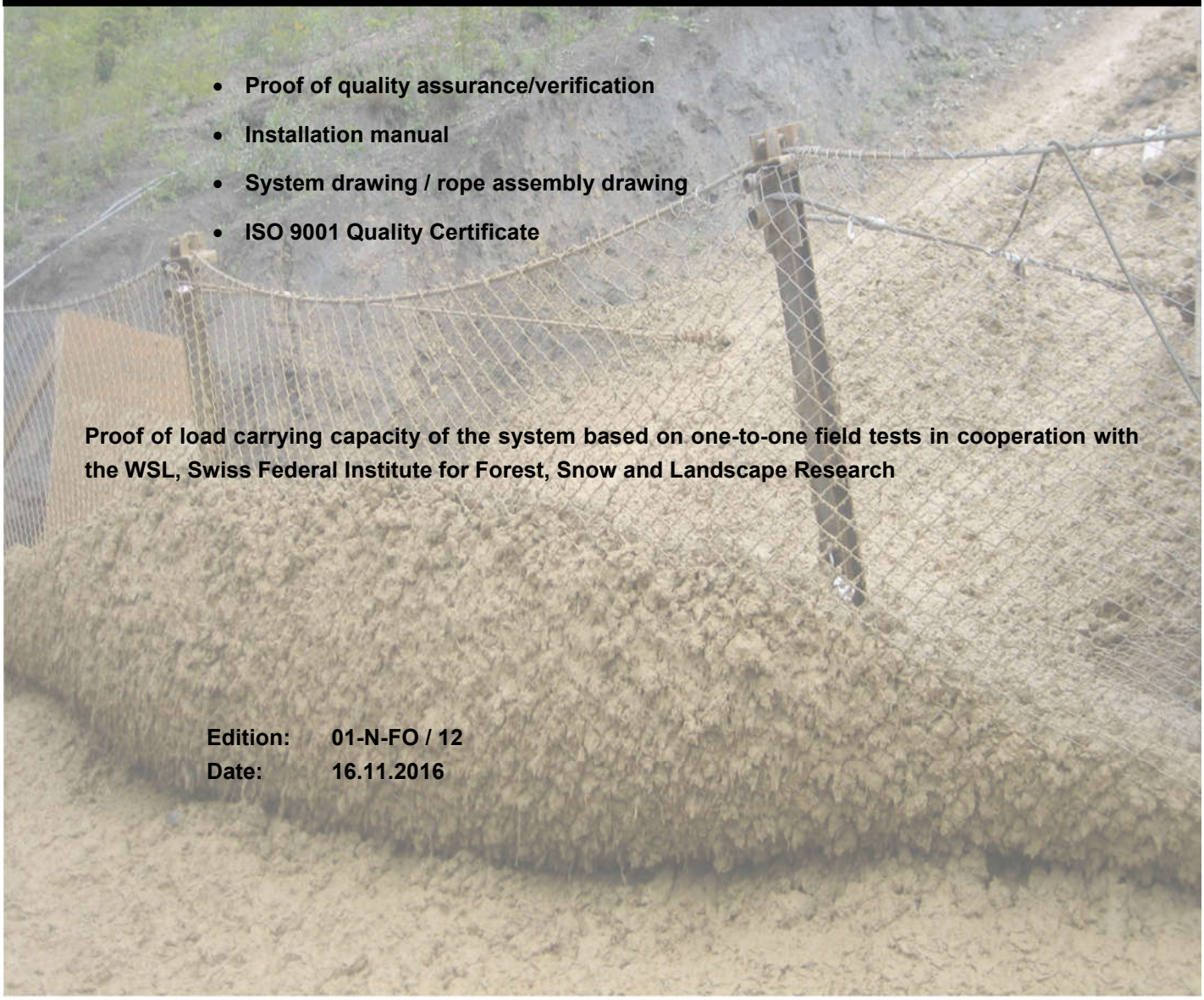
TECCO®

SL-100 manual

Product manual SL-100



- Proof of quality assurance/verification
- Installation manual
- System drawing / rope assembly drawing
- ISO 9001 Quality Certificate

Proof of load carrying capacity of the system based on one-to-one field tests in cooperation with the WSL, Swiss Federal Institute for Forest, Snow and Landscape Research

Edition: 01-N-FO / 12
Date: 16.11.2016

Purpose and organization of the manual

This product manual ensures that Geobrugg shallow landslide 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.

The product manual is divided into the following sections

- Proof of quality assurance / verification of conformity
- 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.

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I Range of application

The design of shallow landslide 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:

- Former shallow landslide events
- Condition of the slope (outcropping of springs, macro porosity, concave areas in the slope, bedrock layer below ground layer, slope inclination)
- Estimated rainfall intensity
- Slide input parameter (volume, density, middle front velocity, height of failure, crack width)
- Composition of debris flow (debris fraction, water content, density)
- Probability of occurrence
- Barrier location (consideration of local topography and localization of the structure to be protected)
- Anchorage conditions

II Quality of the system components

Geobrugg AG, the former Geobrugg Protection Systems Division of Fatzer AG, Romanshorn has been certified since August 22nd 1995 under the registration no. 34372 in accordance with the Quality Management Systems Requirements (ISO 9001, 2000, revised 2007). The certifying body is the Swiss Association for Quality and Management Systems (SQS), which belongs to EQ-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 field tests at the Veltheim test site (Canton AG, Switzerland). The tested barrier could retain two surges with 60 m3 each and a maximum impact speed of 11 m/s.

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 building contractors.

V Product liability

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 protection 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 exposure 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 protection 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).

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 behaviour as in the one-to-one landslide barrier tests. In critical cases, it is advisable to reinforce particular components as compared with the standard barrier.

Contents

1 Introduction

1.1 Validity of the installation instructions

1.2 Construction

The shallow landslide barrier system consists of the following components:

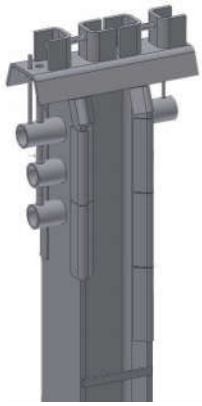
- **Spiral rope anchors**

The support and retaining ropes are anchored in the soil or rock by means of Geobrugg spiral rope anchors. The spiral rope anchors are equipped with a flexible head, which ensures that forces not working directly in the pulling direction can also be transmitted. Two galvanized tubes over the anchor head, plus the galvanized spiral rope, provide double corrosion protection.

- **Base plate**

The base plates are the base for the posts and are either set on a concrete foundation. The concrete foundation is fixed with tension and pressure anchors in the ground. The posts are hinged on the plates. All elements that come in contact with the ropes are finished without sharp edges to avoid rope damage.

Hinged posts



The function of the posts is to guide the ropes on which the net is suspended. HEB type steel posts are used. The rope guides at the post head are finished without sharp edges to protect the ropes. The posts are held in position with the help of retaining ropes. The order in which the ropes are arranged on the post head corresponds to the installation sequence.

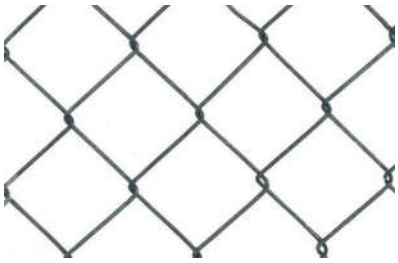
- **Support and retaining ropes**

The job of the support ropes is to transmit the forces occurring in the net over the posts to the anchors. The retaining ropes hold the posts in position. Rope construction is in accordance with EN 12385-4 (DIN 3060/3064). The ropes are available in galvanized or Geobrugg Supercoating quality.

- **Brake rings GS-8002**

The task of the built-in Geobrugg brake elements (brake rings) is to dissipate energy via plastic deformation and friction, and to protect the support ropes from overload. They are built into the support ropes laterally in such a way as to permit easy replacement. The steel tubes also protect the rope from corrosion and mechanical damage.

- **TECCO® G65/4**



The TECCO® G65/4 is the most important component of the system and it consists 4.0 mm diameter wire forming a diamond shaped mesh of 63 mm internal diameter. The TECCO® net is also anchored to the ground with nails (erosion control apron) and attached to the lower support rope with shackles.

- **Shackles**

The connection between the TECCO® net and the lower support rope and the vertical ropes is made with shackles. They guarantee that the net can slide on the rope witouth damaging it. The nets are also connected vertically with shackles. In general, the shackle is designed to produce a stronger connection than the net itself. The shackles can be bonded with adhesive (e.g., with Loctite) if they are required to be theft-proof.

- **Wire rope clips**

The ropes are supplied with pressed loops wherever possible. After tensioning, the free end of the rope is fastened with wire rope clips in accordance with EN 13411-5 (DIN 1142). It is very important to use the right number of wire rope clips with the required torque values. The wire rope clips can be bonded with adhesive (e.g., with Loctite) if they are required to be theft-proof.

- **Nails**

Earth nails ϕ 16 mm, l = 600 mm are used to anchor the TECCO® mesh to the ground.

- **HELIX spring G65**

The mesh panel and the support ropes are connected by HELIX springs. These guarantee that the mesh panel can slide on the rope. The springs are constructed so that they are easy to install.

System drawing of border area

The supporting ropes are guided over the post heads or base plates to the anchors. The brake elements are fitted at the end of the corresponding support ropes. The lateral anchor rope braces the structure downslope, stabilizes the border posts in an event and also makes installation easier. The vertical rope forms the border termination of the net.

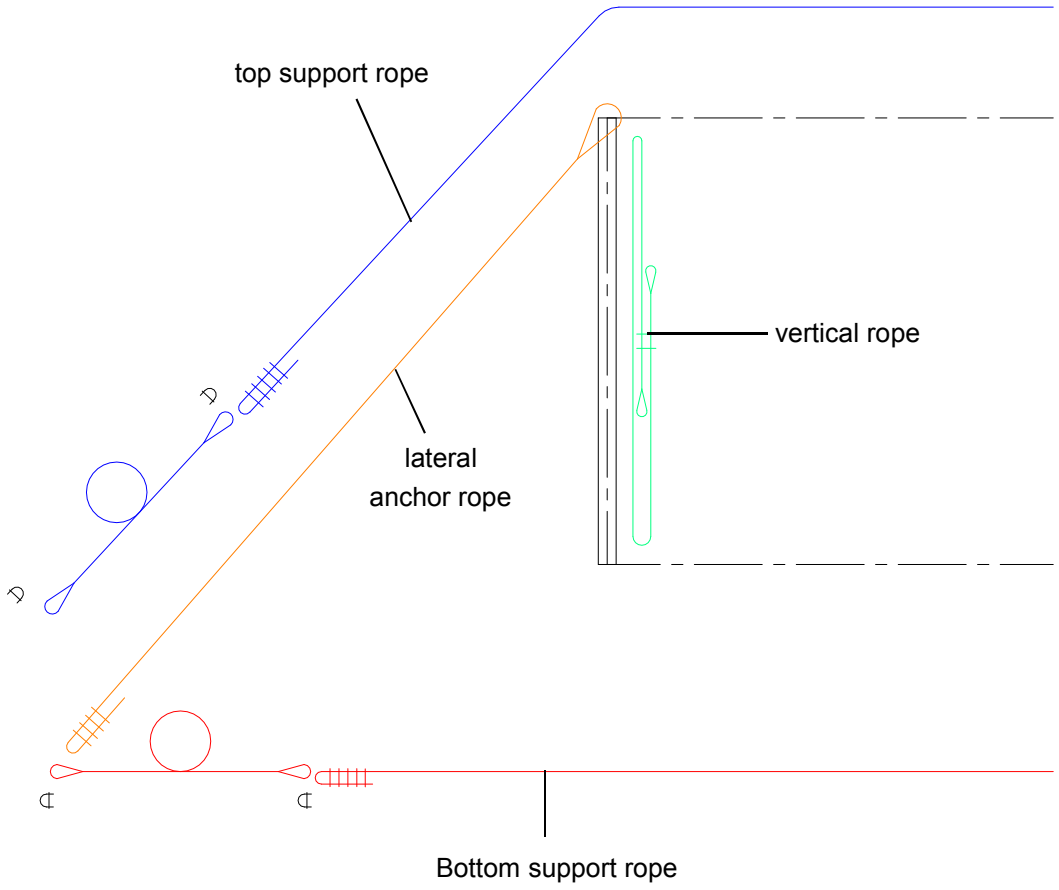


Figure 1 Border post

System drawing: support rope separation (with intermediate anchor rope)

The support ropes must be separated at least every 30 m in accordance with the drawing below, if there is no need to do so more frequently because of topographic constraints.

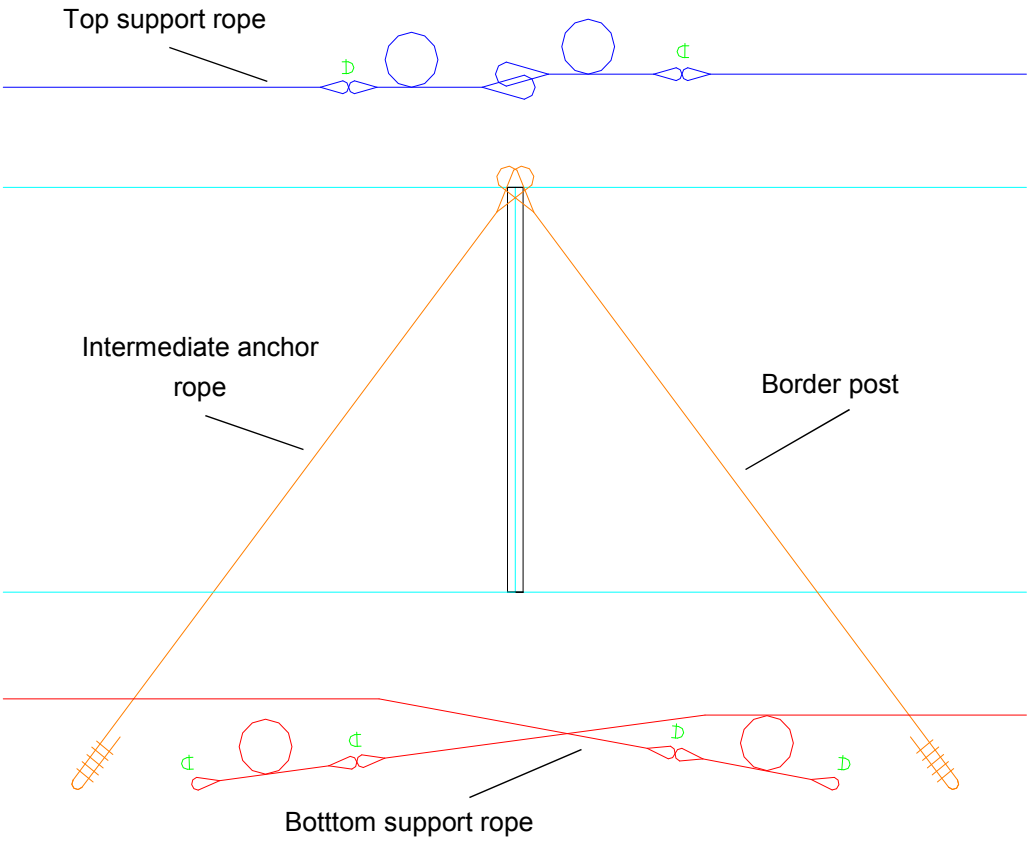


Figure 2 Support rope separation (with intermediate anchor rope)

1.3 Anchor forces

The force caused by a shallow landslide event can be very high. Therefore the underground engineering and installation work have to be done precise and accurate. The length of the anchors is based to the measured rope forces of the 1:1 field tests and depending on the quality and the soil bearing capacity. The anchor length has to be determined by a regional involved geologist or engineer.

2 Installation of the barrier

2.1 Installation steps of SL-100 barriers

The step of installation is divided in the following topics. The detailed steps are described in each chapter.

Preliminary work **chapter 3**

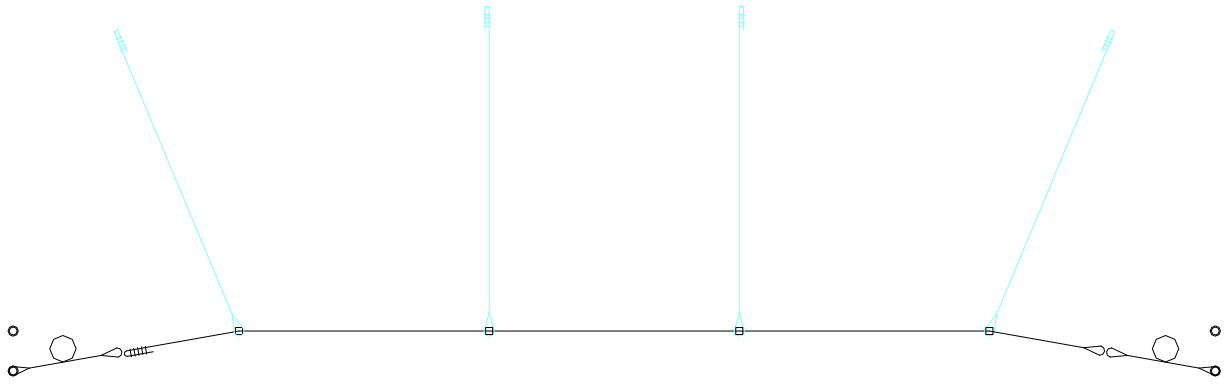
- Site preparing
- Stake out the anchor positions

Foundation construction **chapter 3**

- Drilling of the anchors and inject them (use base plate as template)
- If self drilling anchors are used, the flexible heads have to be connected to the anchors
- Post foundation:
    - Excavate foundation pit
    - Install appropriate reinforcement
    - Insert the two anchors
    - Pour concrete foundation

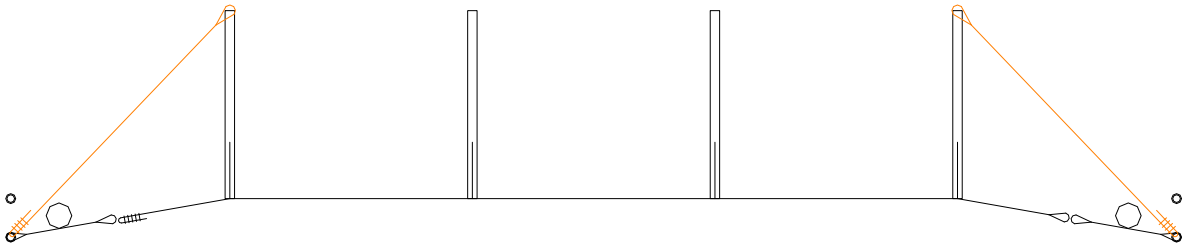
Construction of the superstructure **chapter 4**

- Installations of the posts and the retaining ropes (by hand, with crane or helicopter)

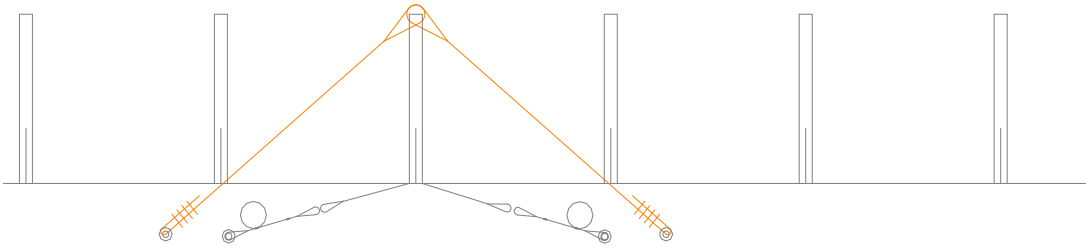


- Install the overturn securing ropes (immediately after installing posts)

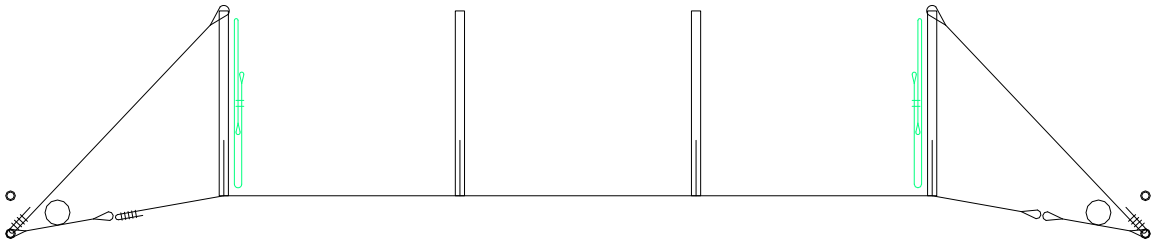
- Lateral anchor ropes (posts) when inserting 1 bottom support rope



- Intermediate anchor ropes (separation posts)



- Installation of the vertical ropes on both outside posts



Installation of the TECCO® nets **chapter 5**

Installation of the secondary mesh **chapter 6**

Final inspection and acceptance **chapter 7**

2.2 Recommended installation tools

Marking	• Tape measure 30 to 50 m (98.4 to 164 ft) • 2 meter folding rule • 5 red-white surveyor's pegs • Inclinometer • spray paint • small wooden or iron pegs (min. 3 pieces per field) • hammer • product manual
Installation	• fork or ring wrench SW 22 and 24 • socket wrench with ratchet • torque wrench SW 27 and 24 mm, range 180 Nm (required torque) • fork wrench for anchor nuts: GEWI 32 --> SW 60 • wire rope cutters Felco C16 or C112; cutting capacity 12 mm • motor disc cutter or hammer wire rope cutter; cutting capacity 28 mm • pincers, flat nose pliers • galvanized stranded wire binding cord 2 mm or wire • angle spirit level (water-level) • roll of adesive tape • at least 2 tension belts / straps • come-along/pulley, e.g., type LUGAL • chain hoist or Habegger, at least 3.5 metric tons (35 kN) • auxiliary ropes

Table 1 Installation tools

2.3 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.

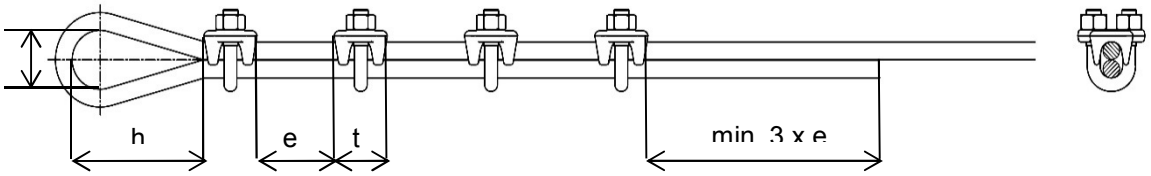
Instructions below apply to all wire rope clips according FF-C-450 type 1 class 1 (similar EN 13411-5 type 2) delivered by Geobrugg AG.

FF-C-450 type 1 class 1

The distance e between the wire rope clips should be at least 1 x t but not exceed 2 x t , where t is the width of the clamping jaws. The loose rope end has to be 3 x 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“).



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 lubri-cated [Nm]	Required tightening torque unlubricated [Nm]	Wrench size [mm]
14 - 15	9/16“	3	50	150	24
18-20	3/4	4	90	180	27

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 re-quired 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.

3 Anchorages

3.1 Marking of the anchor locations

The line followed by the barrier should be planned so as to be as straight and horizontal as possible. Larger irregularities in the terrain must be bypassed or evened out as needed (fill up holes, flatten bumps or mark off along the contour line).

The base line is marked off and divided into the prescribed distances between posts (x) (measured parallel to the slope). The positions of the posts are then marked.
In cases of deviations of more than 3° out of the horizontal, special mesh panes (B) must be used instead of standard ones (A). Therefore the elevation difference must measured and communicated to Geobrugg in an appropriate form.

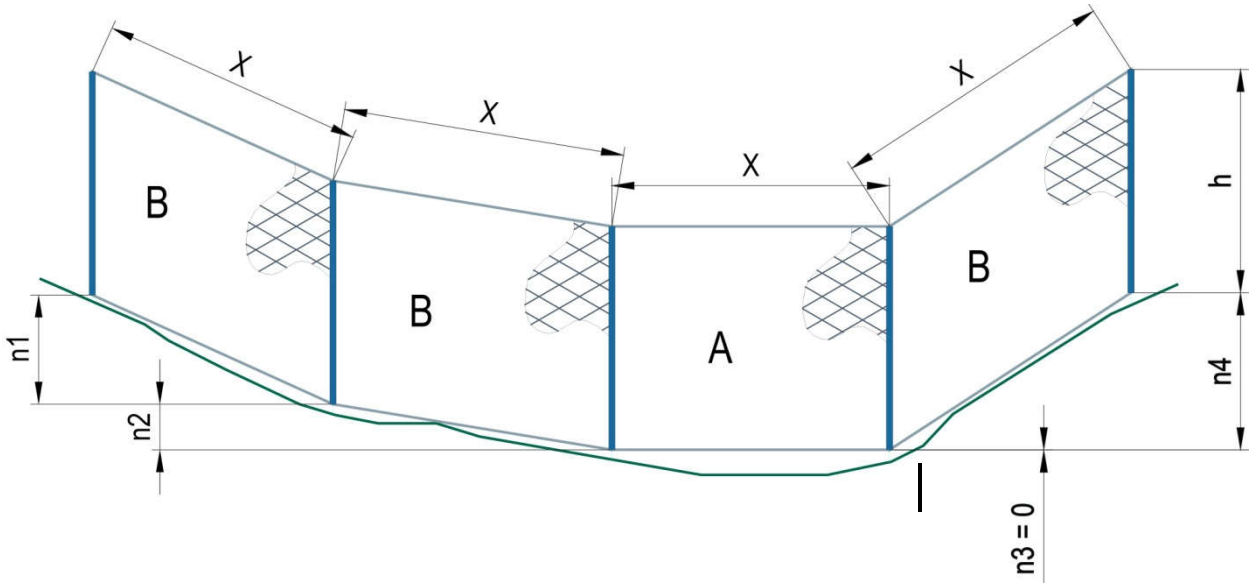


Figure 3 Net arrangement

x: post spacing measured parallel to the slope, tolerance ± 5 cm
n1-n4 elevation differences
h: net height = barrier height
A: Standard mesh panel
B: Special mesh panel

3.2 Rope anchors for retaining ropes

The rope anchors are positioned behind the posts in perpendicular direction to the base. The angle between the retaining ropes and the posts should be 60-85° in all cases.

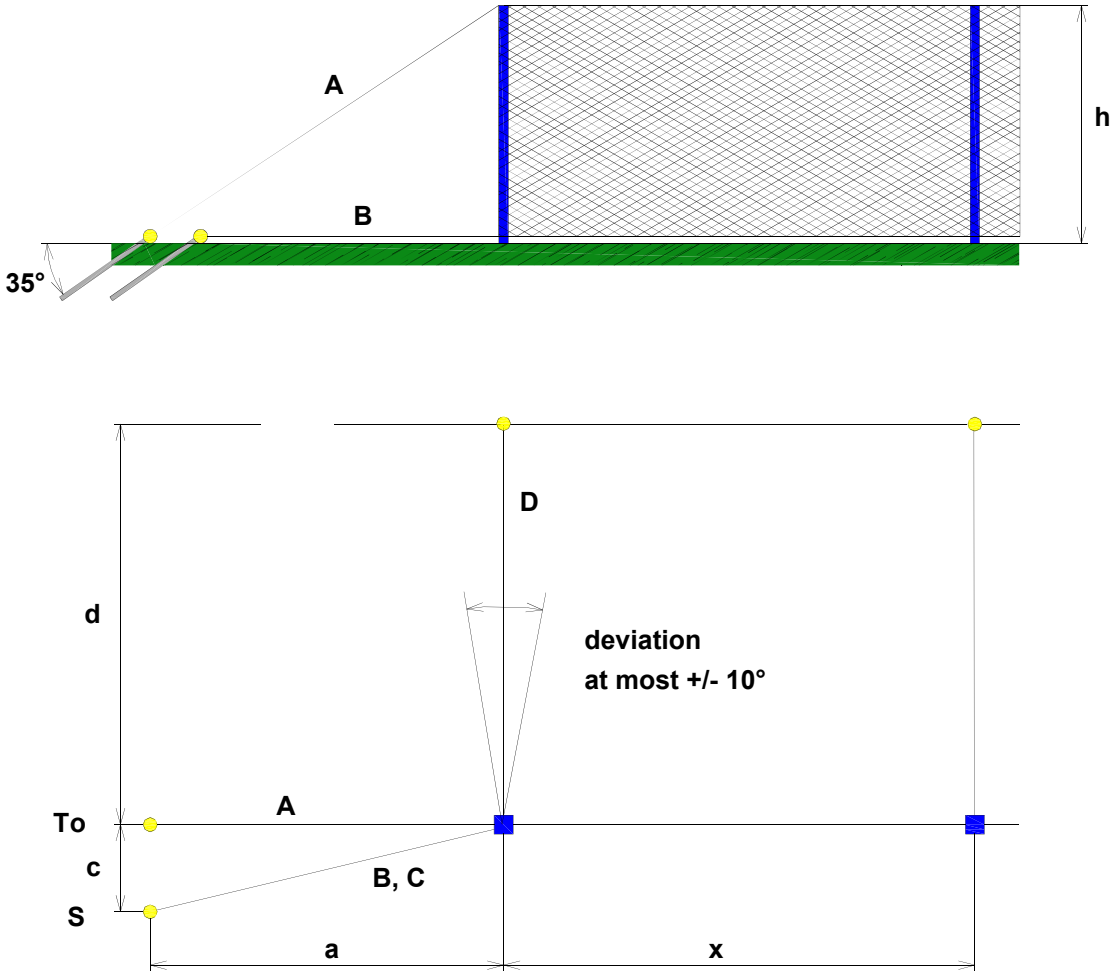


Figure 4 Upslope and lateral anchor points

h	a	c	d
2.00	4.5	0.65	3.5

Table 2 Distances [m]

h: System height
A: Top support rope
B: Bottom support rope
C: Lateral anchor rope
D: Upslope anchor rope

3.3 Rope anchors for support ropes and lateral anchor ropes

One bottom support rope is used. Both the bottom support rope and lateral anchor rope require the same anchor, which is located at **a** and **c** distance away from the nearest base plate (**S** position), the anchors for the top support rope are in line with the barrier and are located at a distance **a** away from the last base plate. (**To** position).

3.4 Rope anchors for support rope separation

An intermediate anchor rope requires two anchors that are located **a** and **c** away from the respective posts. The intermediate anchor ropes are guided to these anchors.

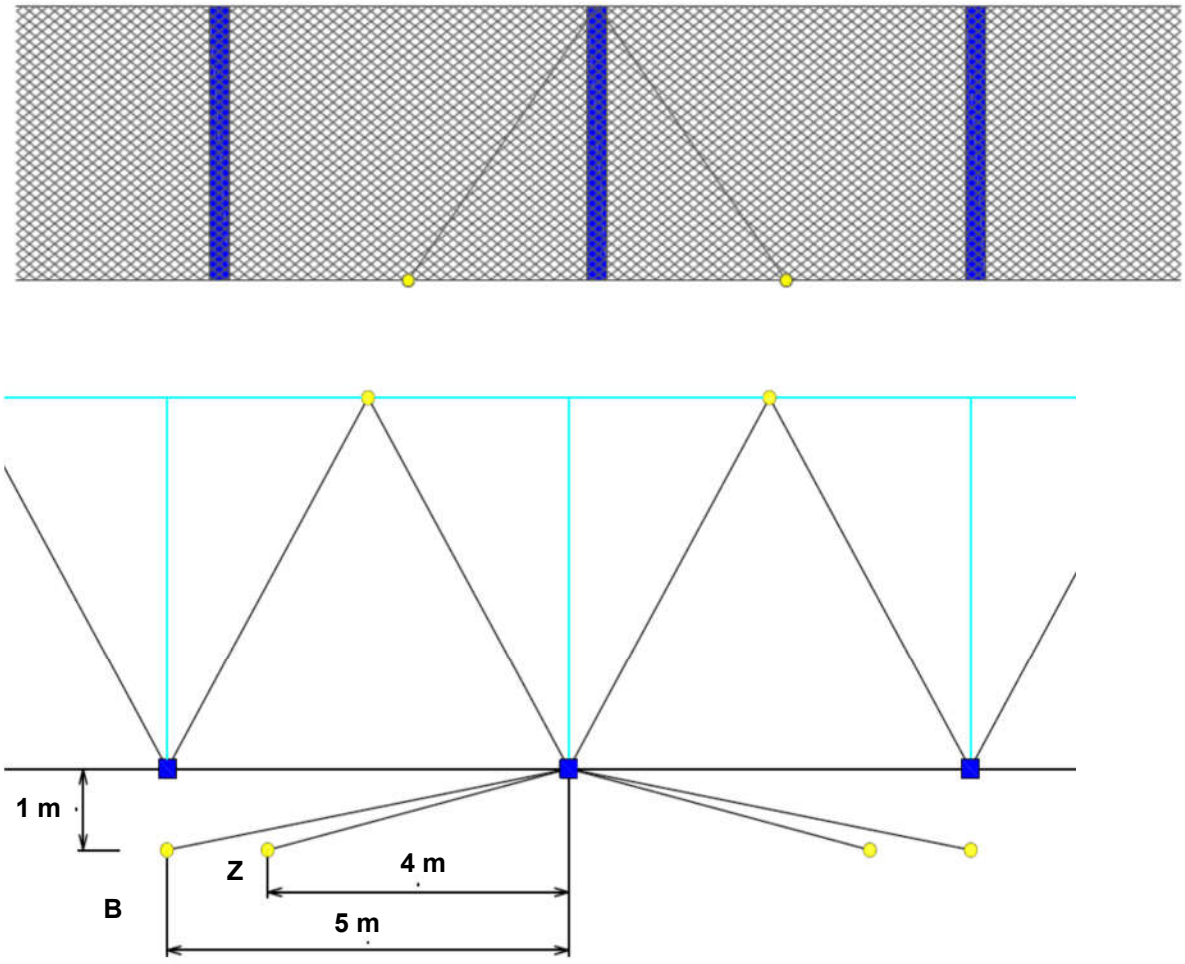


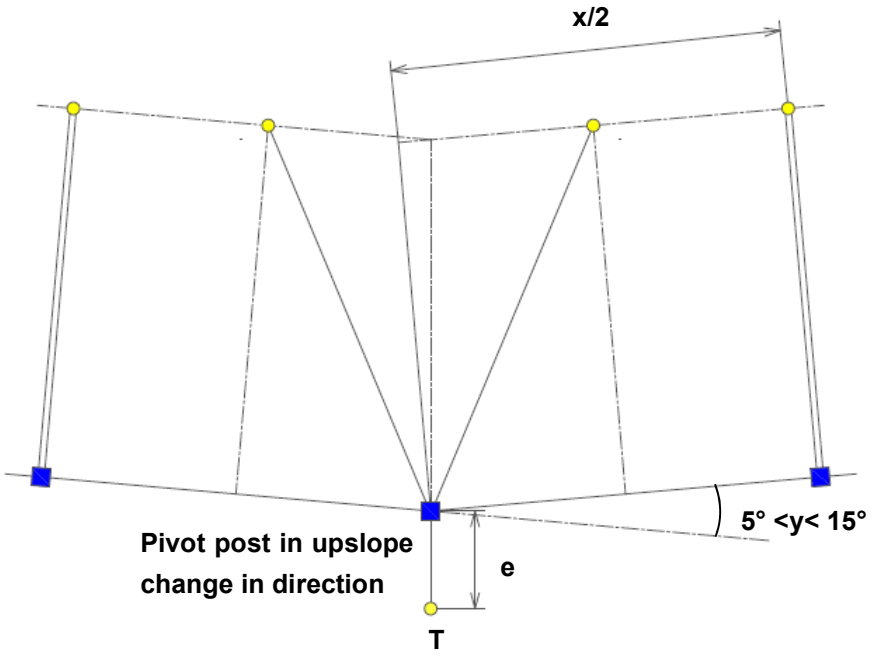
Figure 5 Support rope separation with intermediate anchor rope

A total of 4 anchorages are required for a support rope separation with an intermediate anchor rope. Two of them, those for the intermediate anchor rope, are located downslope at distances **a** and **c** from the foot of the post. The other two are required for bracing the bottom support rope. These are set upslope at a distance of 1.0 m (6.6 ft) perpendicular to the net and behind the next posts

.

3.5 Change in direction upslope or going over a crest

An additional downslope anchor rope (T) is necessary if there is an upslope change in direction with an angle 5°–15° or if the barrier goes over a crest. The rope anchor will lie downslope at a distance **e** from the post (see Figure 6). Care must be taken that there is sufficient terrain covering (i.e., at least 35 steeper than the inclination of the slope).



T: downslope anchor rope
e: 1.0 m
y: angle of bend

Figure 6 Anchor location for a downslope anchor rope

If the barrier line changes upslope more than 15°, then an intermediate anchor rope in accordance with section 3.4 is required, in which case the downslope anchor rope is no longer necessary.

3.6 Downslope change in direction

For a downslope change in direction of over 30°, two additional upslope retaining anchor ropes (at a distance of x/2 from a line perpendicular to the base line) are installed on the post (three retaining ropes instead of one or two, see Figure 7). The maximum downslope change in direction is 40°.

D: retaining rope
d: 3.5 m

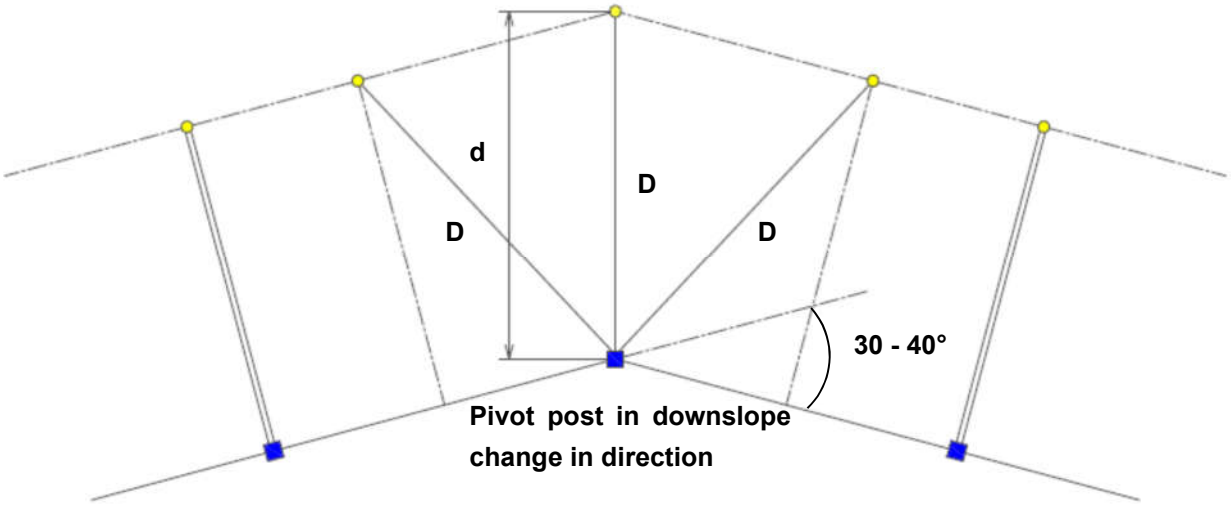


Figure 7 Downslope change in direction

3.7 Anchorage of the post foundation

The reinforced post foundation transfers the horizontal and vertical load from the foundation over the anchorage to the ground. The post foundation is anchored with one compression anchor and two tension anchors. The compression anchor has to be drilled in vertical direction and the two tension anchors have to be built in 45° to horizontal direction and 10° inclined to the earth flow direction.
To have the optimum load transfer it is necessary to put quadratic steel plates at the end of the anchors and to fix them with a nut. The connection between the foundation and the base plate is done with two shorter bars built in vertical direction. The base plate has to be installed to these bars having the elongated holes valley site.

Installation steps:

- Dig out the foundation hole
- Drill the anchorage. Place tension anchor with 45° to the ground plate line
- Shutter the foundation and build in the reinforcement. Put on top the anchor plates.
- Build in the two bars for the base plate (Use the base plate as a face mould).
- Concrete the foundation. Please round the foundation edges because support rope is led along the foundation.
- The fastening of nuts may not be tightened until the concrete has cured completely.

3.7.1 Post foundation

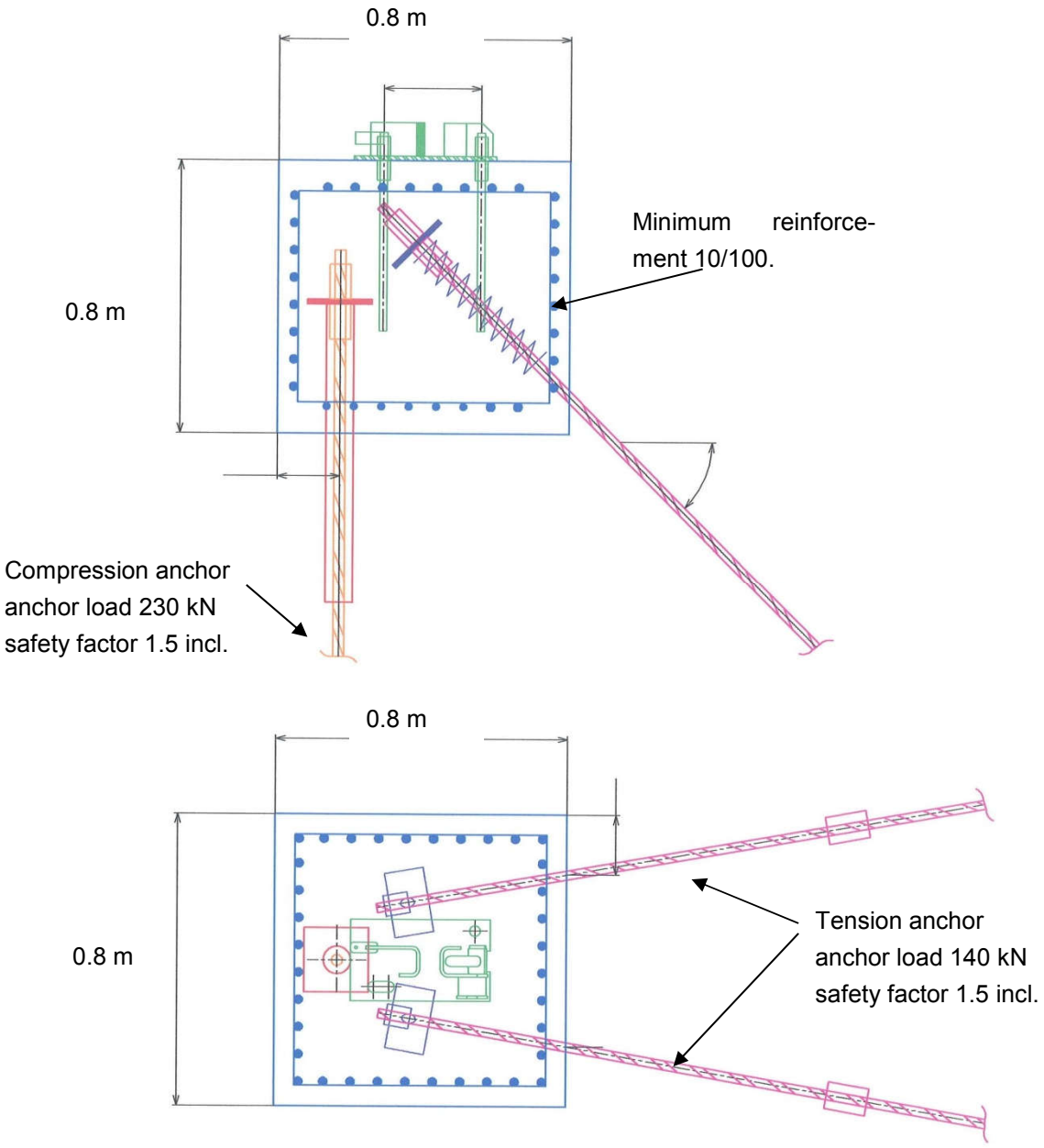


Figure 8 Post foundation, sectional and plan view

3.8 Anchorage of the retaining ropes

The anchor holes are drilled in the pulling direction with a minimum inclination of 15° to the horizontal. When grouting the anchors must be inserted into the hole to the orange marking (approximately center of the anchor head casing). **Make sure to insert the anchor correctly into the borehole: the spiral ropes of the anchor lie beneath, not on top of each other (see Figure 9).**

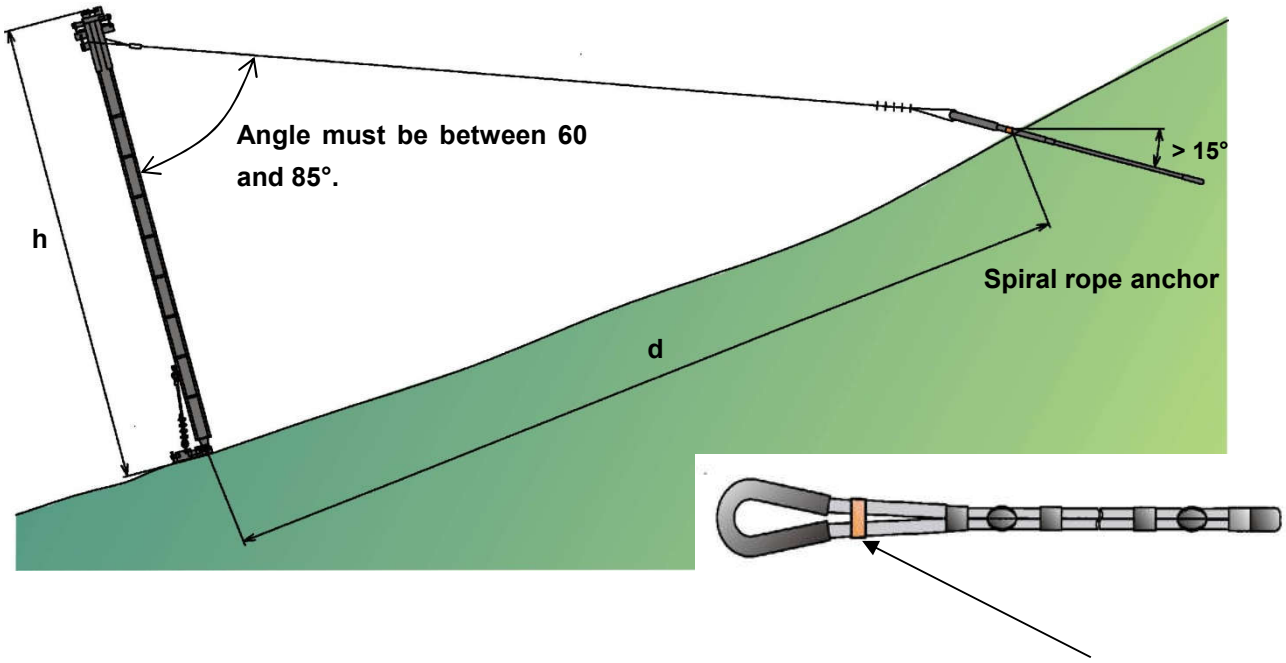


Figure 9 Anchorage of the retaining ropes

h	d
1.50 m	2.50 m
2.00 m	3.40 m

Table 3 Distances [m]

3.9 Anchorage of the lateral anchor ropes

The anchor S (see Figure 4) for the lateral anchor rope should be installed as nearly as possible in the pulling direction of the lateral anchor rope.

3.10 Anchorage of the support ropes

The bottom support rope is fastened to anchor **S**, which should be installed as flat as possible (but at least 35° to the surface of the ground). The top support rope is fastened to anchor To in the line of the barrier in a distance of 4.5 m (14.8 ft).

3.11 Anchorage of lateral and additional ropes

If there is a change in direction upslope or over a crest, an additional downslope lateral anchor rope (**T**) is necessary. Here the drill hole for the anchor should be placed as nearly as possible in the pulling direction of the anchor rope. Care must be taken that the terrain affords enough covering (i.e., at least 35° steeper than the slope inclination).

If this change in direction is greater than 15°, intermediate anchor ropes (**Z**) are installed instead of the downslope anchor rope (**T**), (in this case, it is again important that the terrain afford enough covering, i.e., at least 35° steeper than the surface of the ground).

4 Installation of the base plates, the posts and the ropes

4.1 Post sets

The posts sets consist of the posts, base plates, securing elements and the overturn securing rope. There are two types of SL-posts, border and middle posts.

Base plate and overturn securing rope

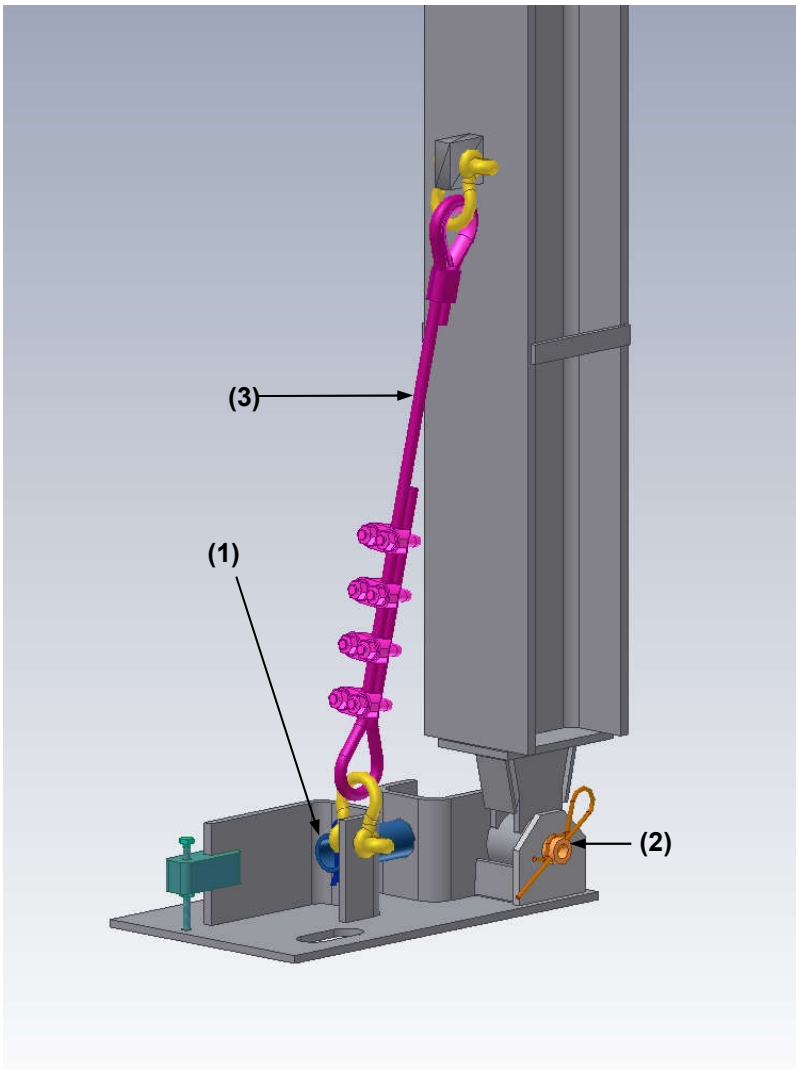


Figure 10 Base plate and overturn securing rope

The base plate and overturn securing rope require the following parts:
The rope guiding tube (1) is secured with two cotter pins of length 63 mm. The hinge tube (2) connects base plate and post and is secured with two large spring cotters. The overturn securing rope (3) consists of a 14 mm wire rope, 2 5/8” shackles and 4 NG 16 wire rope clips.

Posts

Post height

The posts are ca. 500 mm higher than the defined useful height of the system, in order to guarantee that the useful height is also achieved in the center of the field. This factor must be considered if clearance is restricted above the barrier.

Border posts

Description: Border posts have five rope guiding tubes on the heads, three in front and two behind.

Installation area: The border posts occur in all positions where lateral anchor ropes as well as vertical ropes are attached. For this reason each barrier has a border post on both borders as well as on the positions of the support ropes separations and/or intermediate anchor ropes.

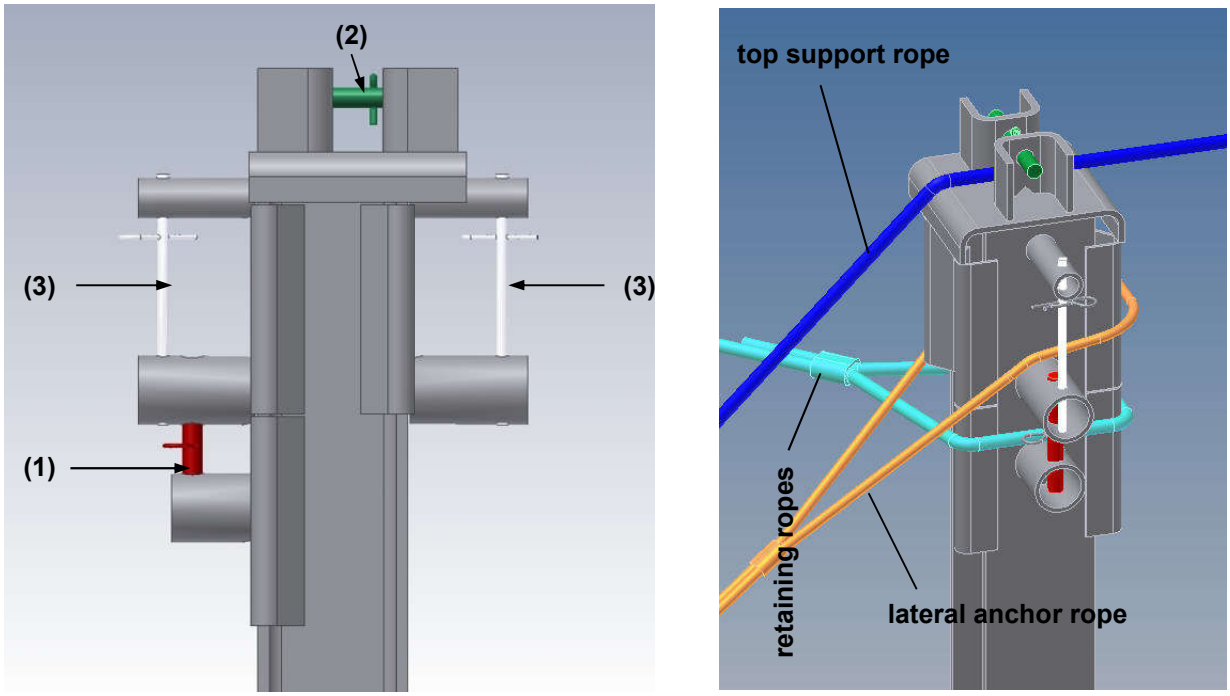


Figure 11 Border posts and their ropes

The border posts require the following securing elements:
The retaining ropes are held with a securing rod, which is secured with a small spring cotter (1). The support rope is held by an identical securing rod, which however is secured with a 40 mm long cotter pin (this securing device must be able to turn with the securing rod without breaking off) (2) (see also kap.4.6).

Middle posts

Description: Middle posts have two rope guiding tubes on the head in front. The upslope side has no rope guiding tubes!

Installation area: all other posts

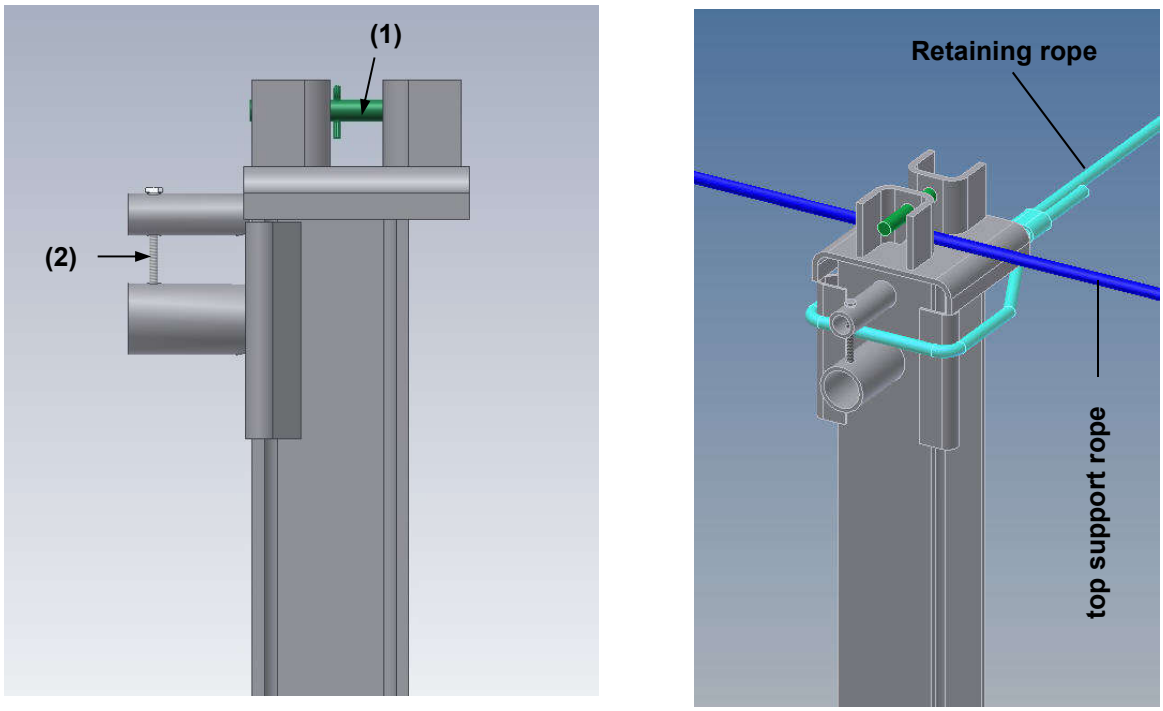


Figure 12 Middle posts and their ropes

The middle posts require the following securing elements:
The support ropes are held with a securing rod, which is secured with a 40 mm long cotter pin (this securing device must be able to turn with the securing rod, without breaking off) (1).

4.2 Installation of the base plates

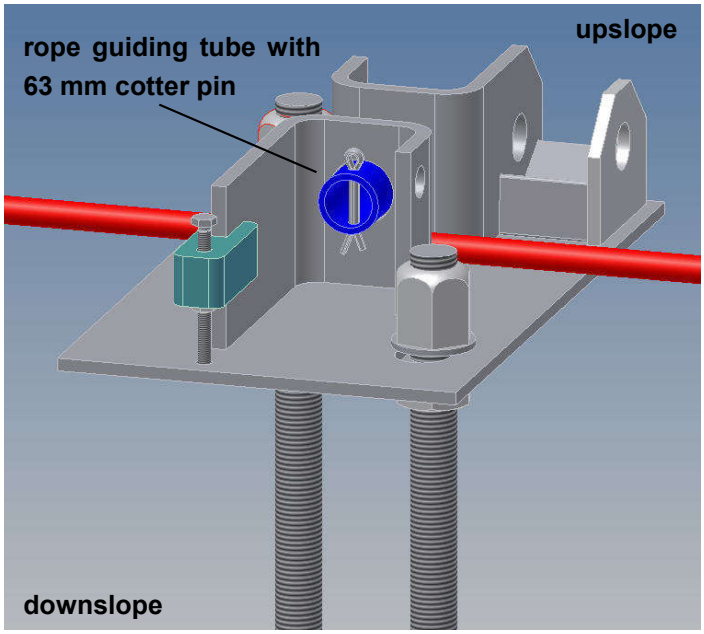
Mount the base plates with the slotted hole downslope onto the anchors. Then place washers onto the anchors and tighten the nuts. Grout must be cured before tightening.

4.3 Bottom support rope

a) The bottom support rope is inserted into the base plate. Then the rope guiding tubes are introduced and secured with 63 mm long cotter pins.

b) On each end install one rope sling with brake rings GS-8002 on the anchors **S**, and install the bottom support rope on one side on a rope sling with brake rings (connect with 7/8” shackles).

c) Tension the bottom support rope and fix it with five wire rope clips (connect to rope slings with brake rings with inserted thimbles and 7/8” shackles).



Bottom support rope

Figure 13 Bottom support ropes inserted in to the base plate

4.4 Installation of the posts

4.4.1 Installation of posts without helicopter or crane

a) The post is deposited on the upslope side of the base plate. The eyelet for the overturn securing rope must be turned away from the ground. Put the joint on the foot of the post onto the supporting block. Push the hinge tube through the eyelets of the base plate and through the joint, and secure with two large spring cotters.

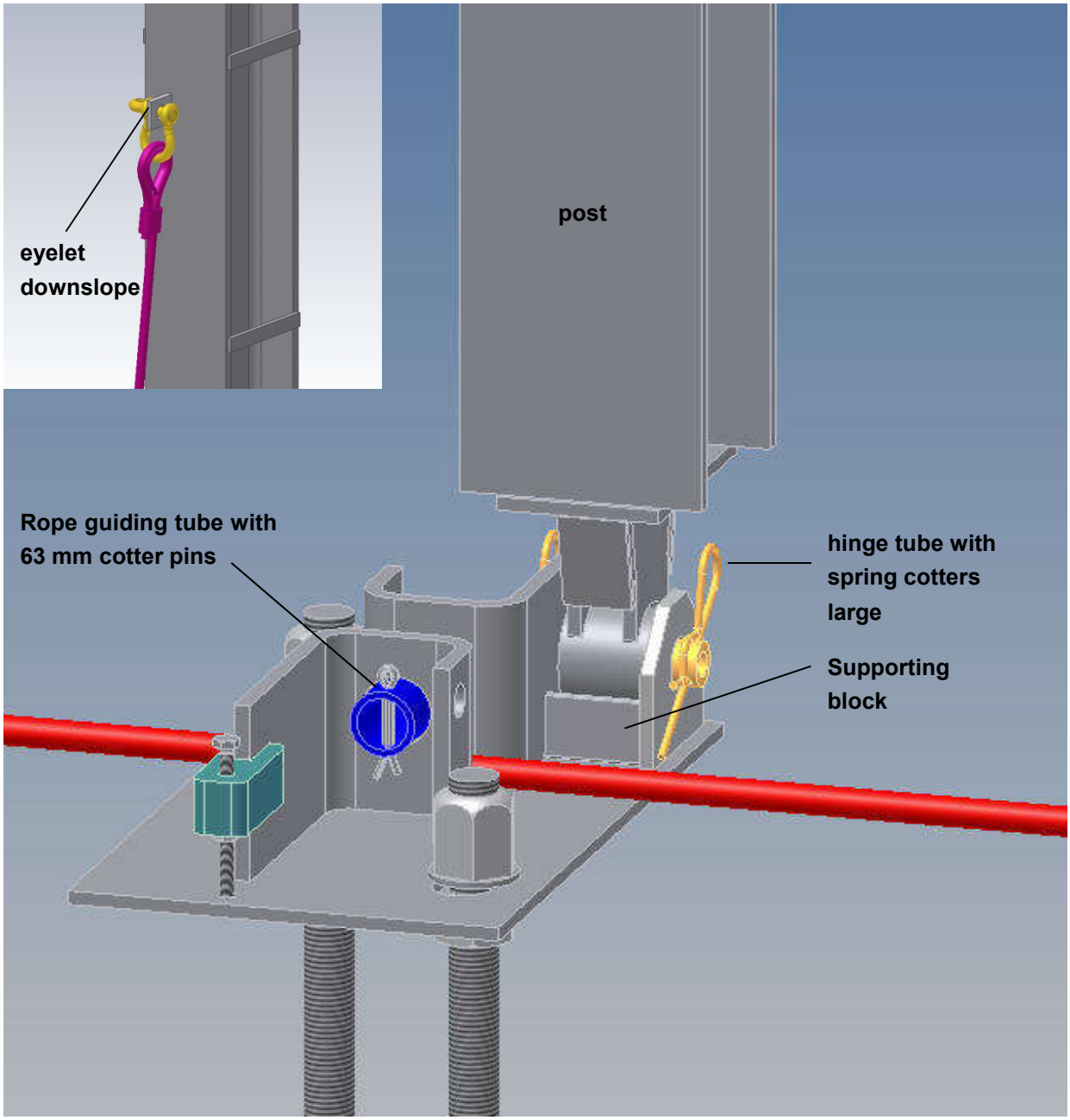


Figure 14 Connection of post to base plate

b) Lay the retaining rope with the loop around the post head. Thread the free end through the loop of the anchor. Figure 25 and Figure 26 show the position of the retaining ropes on the post head.

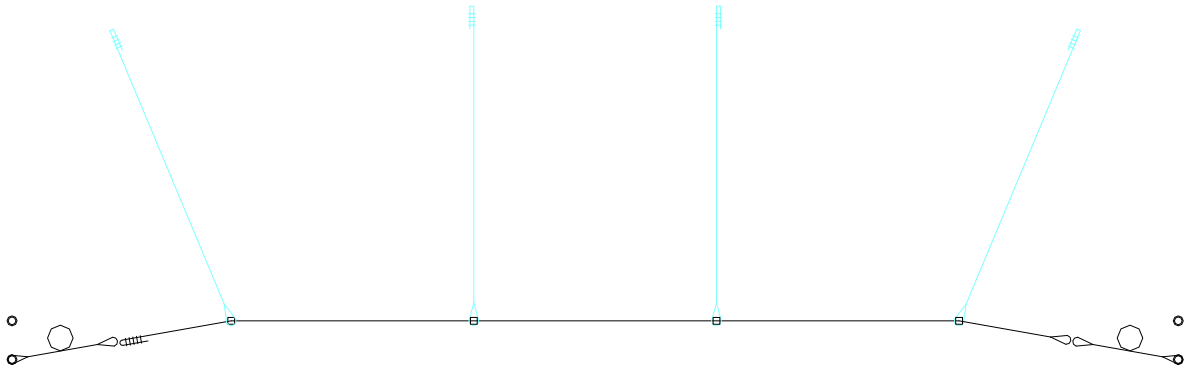


Figure 15 Retaining ropes

c) Stand post upright and install overturn securing rope (make sure that the eyelet for the overturn securing rope is facing downslope):
- If the slope of the terrain is up to 30° (0°<β≤30°), the post must be inclined 15° out of the perpendicular downslope.
- If the terrain is steeper, (30°<β≤45°) place the post at an angle of ca. 75° to the direction of the slope (however, at most 30° to the vertical).
- If the slope of the terrain is more than 100% (β>45°), the manufacturer should be contacted.

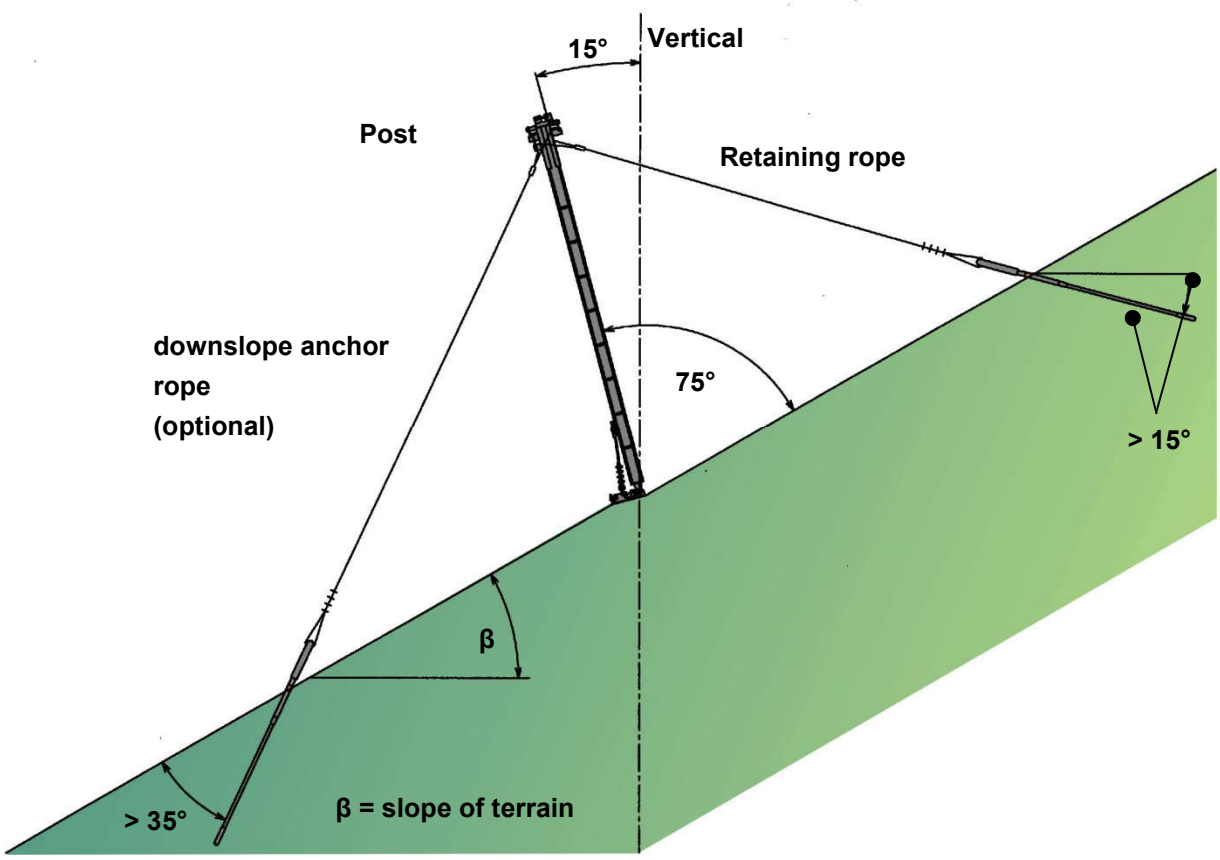
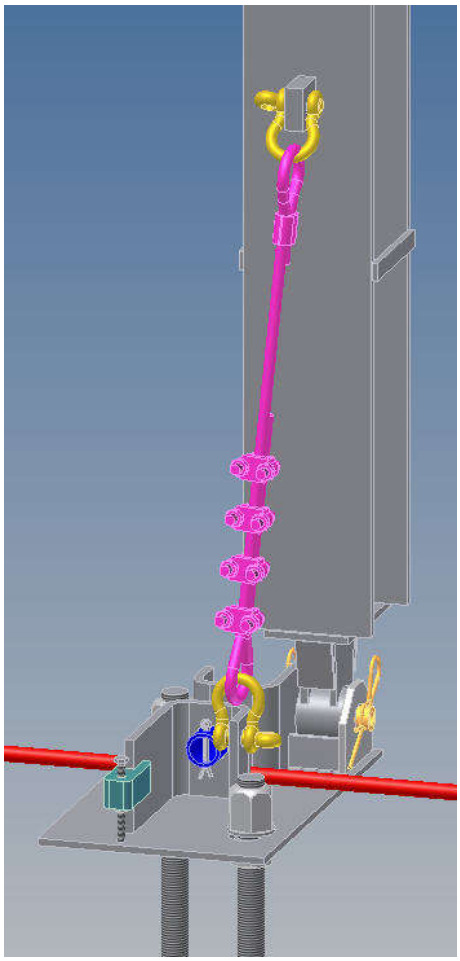


Figure 16 Alignment of posts



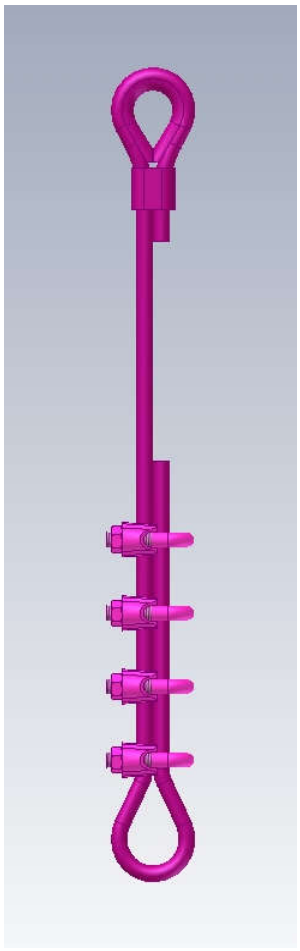


Figure 17 Overturn securing rope

d) While aligning the post, let the bottom retaining rope slip while still keeping it under control. In the final position, secure immediately with two wire rope clips EN 13411-5 (DIN 1142) each.

e) Tension retaining ropes and tighten wire rope clips in final position in accordance with EN 13411-5 (DIN 1142) (also see section 2.3).

f) Optional with a crest or an upslope change of direction < 15°: Fasten the pressed loop of the downslope anchor rope on the front u-shell of the post head cap and on the downslope anchor in accordance with EN 13411-5 (DIN 1142).

4.4.2 Installation of posts with helicopter or crane

Caution for installation using a helicopter:

The rungs that are welded laterally into the post profile are only there to facilitate climbing. They may not be used as “towing hooks” for purposes of transportation.

a) Before flying, hang the upslope retaining rope with the pressed loop on the post head and secure with the securing rod.

b) Fly the post or hoist with crane

c) While lowering the post, set the joint on the supporting block, insert the hinge tube and secure with large spring cotter.

d) Tilt the post downslope before realising it, temporarily fasten the retaining rope to the upslope rope anchor with two wire rope clips EN 13411-5 (DIN 1142), and install the overturn securing rope.

e) Align the post as described in the previous section.

f) Fasten the retaining rope to the rope anchor with 4 wire rope clips EN 13411-5 (DIN 1142).

4.5 Installation of lateral and intermediate anchor ropes

Hang the end with the pressed loop around the border post between the top two rope guiding tubes (see Figure 26). Pull the other end through the loop of the S anchor (same for the bottom support rope for normal speedy flows) or the anchor for the intermediate anchor rope, tension and fasten with wire rope clips in accordance with EN 13411-5 (DIN 1142).

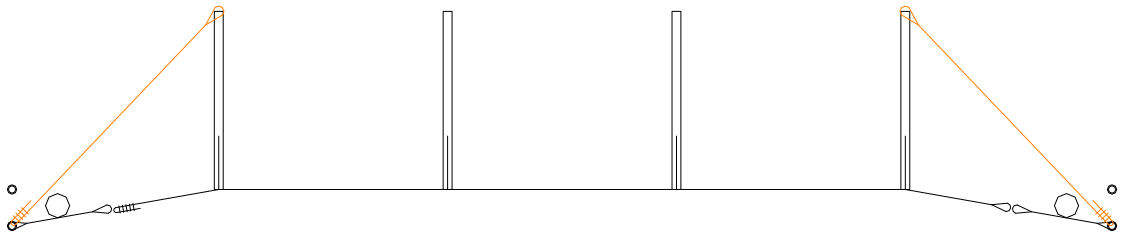


Figure 18 Lateral anchor ropes

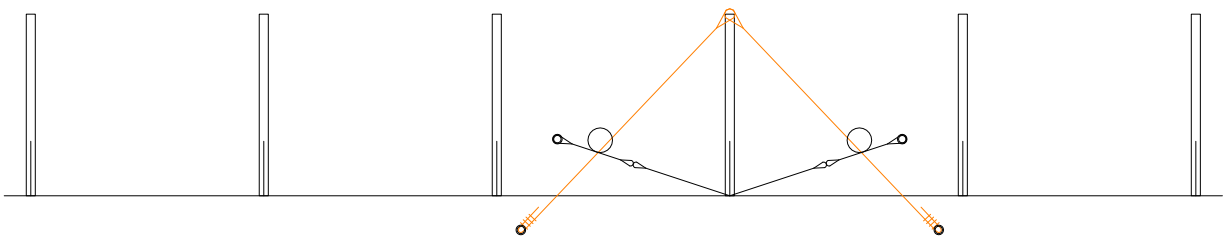


Figure 19 Intermediate anchor ropes

4.6 Vertical ropes at border posts

The vertical rope terminates the border of the net and forms at each end an endless loop, secured with a sleeve each. On the post head, guide it around the bottom upslope rope guiding tube and through the loops of the retaining ropes. On the base plate below, it runs through under the rope guiding tube. The vertical support rope closure is carried out by using a locking bride (seeVertical rope above and behind
Figure 22), the overlapping distance of both ends of the vertical rope should be equal to 50 cm.

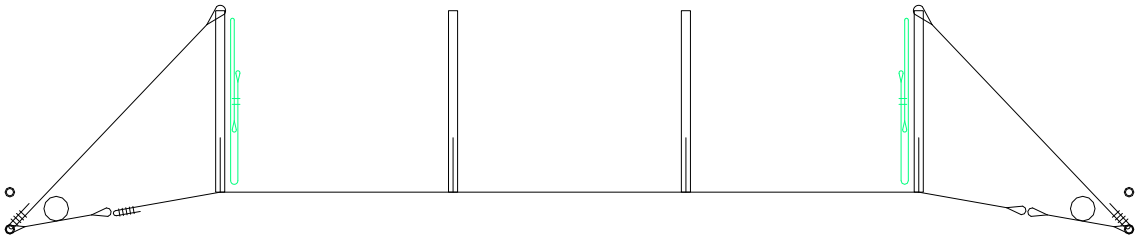


Figure 20 Vertical ropes

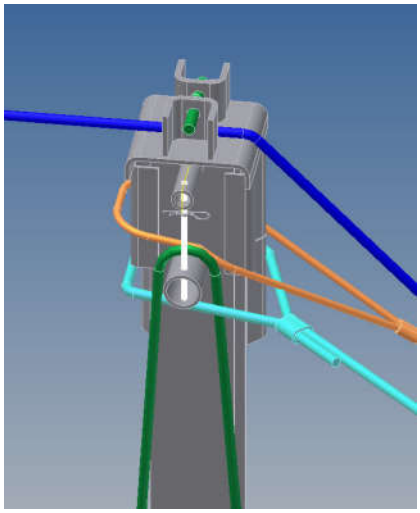


Figure 21 Vertical rope above and behind

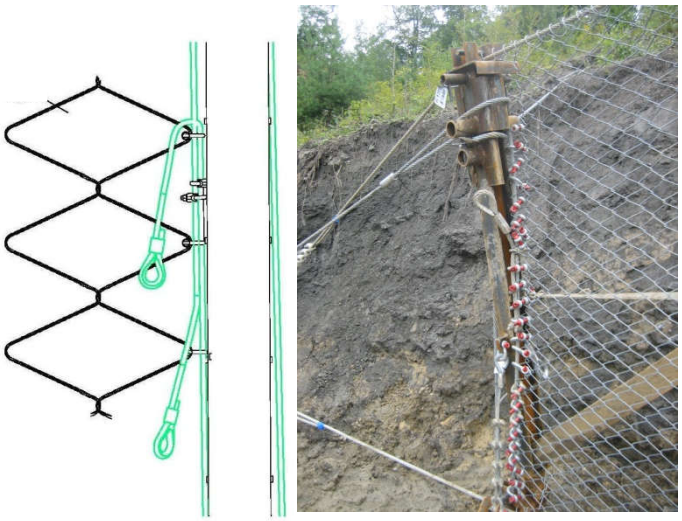


Figure 22 Vertical rope with two loops and 2 wire rope clips

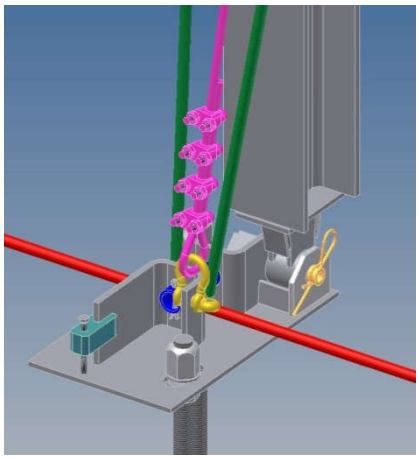


Figure 23 Vertical rope above and below

4.7 Top support rope

a) Guide the top support rope over the post heads (see Figure 25 and Figure 26) and secure with securing rods and 40 mm long cotter pins.

b) On both ends a rope sling with one brake ring GS-8002 is installed on the anchors To (connect with 7/8” shackles).

c) Tension the top support ropes and fix with five wire rope clips (use inserted thimbles and 7/8” shackles).

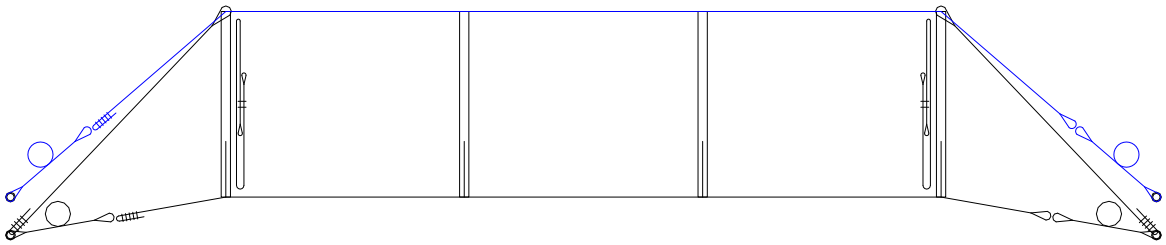


Figure 24 Installation of the top support rope.

The recommended value for slack in the top support rope is not more than 3% of the distance between posts.

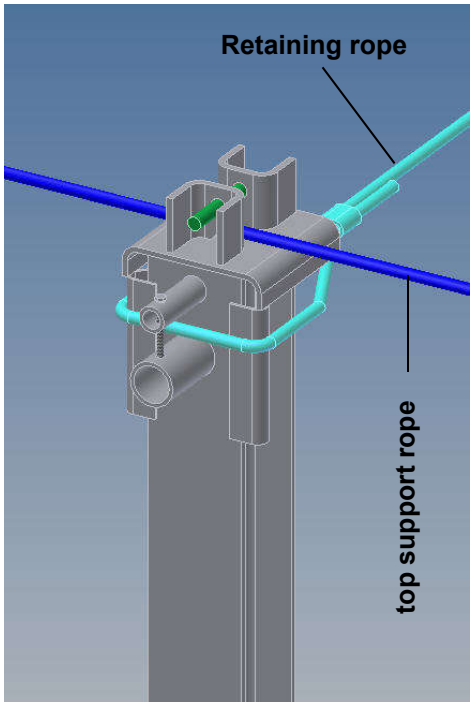


Figure 25 Middle post head

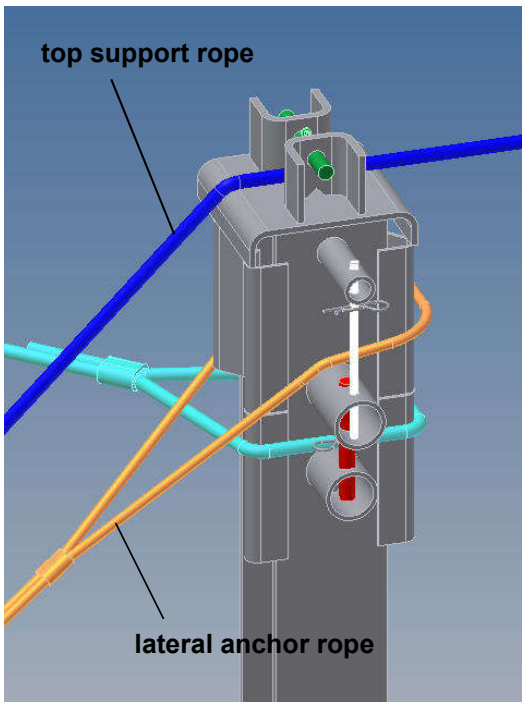


Figure 26 Border post head

4.8 Support rope separation

With a support rope separation, a border type post must be installed. The top support ropes are guided onto rope slings with brake rings that has a loop with thimble on one side and on the other side a loop with a length of 700 mm. Lay this around the post head (border type post) as shown in Figure 27. The TECCO® net is fixed with HELIX® springs onto rope sling.

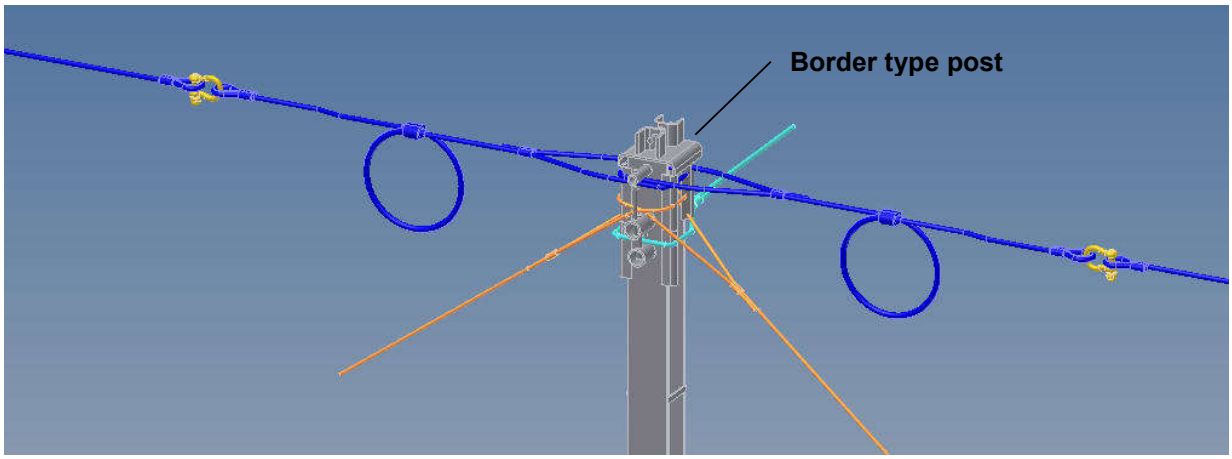


Figure 27 Support rope separation

Figure 28 Tension belts between the posts for installing the nets

5 Installation of the TECCO® mesh

a) Installing the top support and anchor rope on one side.

b) Inserting the top support rope in the first post head and thread the top support rope through the insert help of the TECCO® mesh panel. On both sides 6 meshes are left free.

c) Inserting the top support rope in the next post head and thread the top support rope through the next mesh panel. Repeat point b) and c) until the end of the barrier or until a support rope separation. Do not tension the support rope completely.

d) Inserting the bottom support rope through the base plates and the TECCO® mesh panels. On both sides 6 meshes are left free.

e) For the border fields, fasten the net to the vertical ropes with 5/8" shackles.

f) Telescope the meshes and connect them with 3/8" shackles.

g) Connect the free meshes with the HELIX spring G65.

h) Tension the support ropes.

i) A second TECCO® mesh roll 1.0 meter wide is placed on the ground and anchored with nails ϕ 16 mm and L=600 mm. The TECCO® net is shackled to the bottom support rope with 7/16" shackles (see Figure 30).

j) In case the barrier is longer than the net roll, the next roll will be unrolled and shackled together, on the contrary the two net rolls will be fastened with 7/16" shackles.

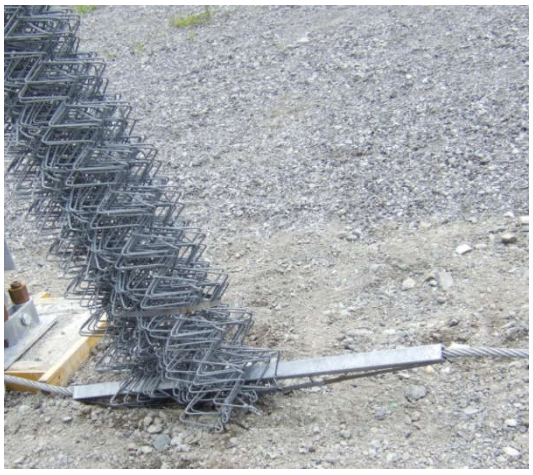


Figure 29 Insert help with support rope

Figure 30 TECCO® mesh anchored to the ground

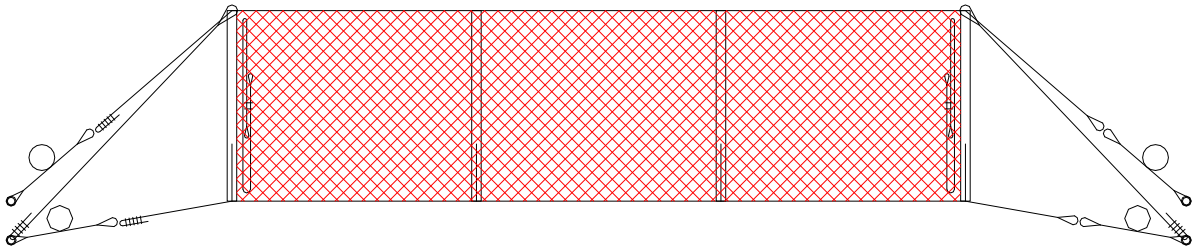


Figure 31 TECCO® net

5.1 Hint for easier installation

Wrap tension belts or a synthetic rope around the post and suspend in the rungs of the post profile between two posts, then tension it to produce a catwalk.

Alternatively, a long suspension rope can be spanned between the border posts using a chain hoist or a Habegger. On the middle posts, the suspension rope is fastened with shackles on the rungs.

Catwalk with long suspension rope
On the border posts, the suspension rope may not be fastened on the rungs!

6 Final inspection

After completion of the barrier the sire engineer must complete a detailed final inspection.

Above all, the following points must be checked:

a) Are the spiral rope anchors grouted in up to the orange markings?

b) Are the support ropes and lateral anchor ropes connected to the correct anchors?

c) Are the ropes guided correctly on the post head and foot?

d) For the support rope separation, do the bottom support ropes go to the appropriate anchors and not to the base plates?

e) Has the right number of wire rope clips been used at the end connections of the ropes? Are the wire rope clips correctly placed?

f) Is the vertical rope installed with two rope clips (50 Nm torque).

g) Check the torque on the wire rope clips on the end connections.

h) Is the TECCO® net roll placed in the right direction (largest diagonal in the horizontal direction)?

i) Are the nets connected to each other correctly?

j) Is the TECCO® net with chain link mesh anchored with nails to the ground?

k) Are the border nets connected to the vertical ropes correctly?

l) Is the sag of the top support ropes less than 3% of the post spacing?