European Technical Approval
ETA–13/0225
ETAG 027: Category A
Energy class 3: 1000 kJ
Height: 4 - 5m

Testing certificate S 13-1
Federal office of environmental
Switzerland

Test institute
Federal Research Institute WSL
Birmensdorf, Switzerland

Date: 08.10.2018
Edition: 17

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CH-8590 Romanshorn

Product Manual
RXE-1000
ROCKFALL BARRIER
Certificate of constancy of performance

1301 – CPR – 0882

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

Falling Rock Protection Barrier RXE-1000
Energy level classification
3
Classification for residual height for MEL
Category A

with the intended use to stop moving rock blocks on a slope with the Service Energy Level 330 kJ and with the Maximum Energy Level 1000 kJ and covers a range of ambient temperatures from -20 °C to +40 °C.

Placed on the market under the name of
Geobrugg AG
Geohazard Solutions
Aachstrasse 11, 8590 Romanshorn
Switzerland

and produced in the manufacturing plant
Geobrugg AG
Geohazard Solutions
Aachstrasse 11, 8590 Romanshorn
Switzerland

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

ETA 13/0225, issued on 12/04/2018
and
ETAG 027, April 2013 (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 24 April 2013 (under the CPD) 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product, the AVCP methods nor the manufacturing conditions in the plant are modified significantly, unless suspended or withdrawn by the notified product certification body.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, 13 April 2018

Dipl. Ing. Daša Kozáková
Head of Notified Body 1301
European Technical Assessment

ETA 13/0225 – version 01 of 12/04/2018

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

Falling Rock Protection Barrier RXE-1000

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

33 pages including 22 annexes which form an integral part of this assessment.

Annexes 8/9/12/13/14 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


This version replaces

European Technical Approval ETA-13/0225 with validity from 15.04.2013 to 14.04.2018
FUNCTION AND STRUCTURE OF THE MANUAL

This product manual ensures that Geobrugg rockfall protection systems are manufactured without errors in accordance with the latest technical findings, that their area of application is clearly defined, that their functionality is guaranteed, and that their installation is performed and checked properly.

The product manual is divided into the following parts:

• Proof of quality assurance
• System overview/rope guide
• Staking out
• Assembly details
• ISO 9001 certificate

This document does not claim to be exhaustive. Before starting an installation, it must be ensured that the copy of the product manual is up-to-date. It is designed for general standard applications and does not take into account any project-specific parameters. Geobrugg cannot be held liable for any additional costs which may arise in special cases. If anything is unclear, please contact the manufacturer. Geobrugg AG’s general terms and conditions apply.

RESPONSIBILITY FOR THE CONTENT:

Geobrugg AG
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info@geobrugg.com
www.geobrugg.com

Romanshorn, 08.10.2018

[Stamp / legally valid signatures]
I  RANGE OF APPLICATION

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

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

II  QUALITY OF THE SYSTEM COMPONENTS

Geobrugg AG, formerly the Geobrugg Schutzsysteme (Geobrugg Protection Systems) department of Fatzer AG, Romanshorn, has been certified according to the quality management system requirements (ISO 9001:2008) under the registration number CH-34372 since August 22nd, 1995. The certification center is the SQS (Swiss Association for Quality and Management Systems), which is a member of IQNet. The quality manual specifies in full the way in which the individual system components (basic material, commercial products, and end products) are checked extensively to eliminate poor quality. You can find the corresponding certificates in the appendix.

III FUNCTIONAL EFFICIENCY OF THE BARRIER SYSTEMS

The functional efficiency of the system is based on one-to-one rockfall tests, carried out and tested in accordance with the guidelines for approval of rockfall protection nets ETAG 027 and the Swiss guideline of type approval of rockfall barriers in Walenstadt, Switzerland (SG). The one-to-one rockfall tests are carried out by dropping a block vertically into the middle field of a three-field barrier. The distance between posts is 10 m, and an impact velocity of 25 m/s is reached. The full-scale tests were approved by a notified test body and the European Technical Approval (ETA) has the number ETA – 13/0225 and the Swiss testing certificate of the federal office of environmental (BAFU) with the testing-No. S 13-1.

IV QUALITY CONTROL FOR INSTALLATION

This product manual describes in detail the different steps for installation of the barriers. These steps must be faithfully followed by local contractors.
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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<th>CONTENT</th>
<th>PAGE</th>
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</thead>
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<tr>
<td>14. FINAL INSPECTION</td>
<td>51</td>
</tr>
</tbody>
</table>
EXPLANATION OF USED SYMBOLS

Safety indication: essential to follow

Note / Reminder that the system is correctly installed easily

A consultation with Geobrugg is recommended

Upslope

Downslope

1 HAZARD STATEMENT

QUALIFICATION OF THE GROUP LEADER

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

CABLES WITH PRETENSION

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

RELEASEING OF PARTS WITH PRETENSION

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

### MARKING
- 30 – 50 m measuring tape
- Measure stick
- 5 red and white ranging poles
- Inclinometer
- Spray can
- Wooden peg or iron peg (min. 3x for each field)
- Hammer/mallet
- Manual

### INSTALLATION
- 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. USING THE WIRE ROPE CLIPS

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”).

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.
<table>
<thead>
<tr>
<th>Wire rope diameter [mm]</th>
<th>Size of the wire rope clip</th>
<th>Required amount of wire rope clips</th>
<th>Required tightening torque lubricated [Nm]</th>
<th>Required tightening torque unlubricated [Nm]</th>
<th>Wrench size [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>5/8''</td>
<td>3</td>
<td>90</td>
<td>170</td>
<td>24</td>
</tr>
<tr>
<td>18 - 20</td>
<td>3/4''</td>
<td>4</td>
<td>90</td>
<td>180</td>
<td>27</td>
</tr>
<tr>
<td>22</td>
<td>7/8''</td>
<td>4</td>
<td>150</td>
<td>330</td>
<td>32</td>
</tr>
</tbody>
</table>

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.

Undamaged wire rope clips could be reused. Especially the threads and clamping jaw have to be checked.

Wire rope clips always have to be installed and used with the required tensioning torque.
4. STAKING OUT DEPENDING ON THE TERRAIN

GENERAL PRINCIPLES FOR STAKING OUT

Position of barrier
To determine the optimal position of the barrier are available proven simulation programs. Unfavorable locations with large jump heights or ground shadows are detected.

Lining
Basically, the barrier line is to be planned so that it runs as straight as possible and horizontally. Irregular lines and lowering terrain and terrain curvatures between the posts are to avoid or compensate if possible.

Foundation
The base plate support of the foundation must be laid against the terrain in such a way that the lower bottom support rope remains close to the ground. The base plate must be positioned in such a way that the bottom support rope bypasses and is not damaged by the edges of the foundation.
Height difference in barrier line

\[ \Delta h \]

\( h \): barrier height
\( x \): post distance
\( n \): modification of the length of the mesh
\( \Delta h \): difference in height between two neighboring posts

**Tab. 2**

<table>
<thead>
<tr>
<th>Post distance</th>
<th>6-8 m ( \Delta h )</th>
<th>8-10 m ( \Delta h )</th>
<th>10-12 m ( \Delta h )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta h )</td>
<td>&lt; 0.50 m</td>
<td>&lt; 1.00 m</td>
<td>&lt; 1.50 m</td>
</tr>
<tr>
<td>( \Delta h )</td>
<td>&gt; 0.50 m</td>
<td>&gt; 1.00 m</td>
<td>&gt; 1.50 m</td>
</tr>
</tbody>
</table>

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 dimension
If the standard staking out dimensions and dimensional tolerances are kept, the delivered barrier can be installed easily, and all components are functioning properly at an event.

Adaptation to the terrain
Depending on the terrain the standard staking cannot be kept. To ensure the proper functioning of the barrier often small adjustments in cross section or length of the nets, ropes, posts are sufficient.

If Geobrugg is informed of the discrepancies can be found a customized solution together.
STANDARD STAKING OUT IN STRAIGHT BARRIER LINE

The following table applies to a ground slope of 30° - 90°
Dimensions in m; dimension tolerance ± 0,20 m

<table>
<thead>
<tr>
<th>h</th>
<th>a</th>
<th>c</th>
<th>d</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00</td>
<td>4.50</td>
<td>1.00</td>
<td>5.10</td>
<td>1.50</td>
</tr>
<tr>
<td>4.00</td>
<td>6.00</td>
<td>1.30</td>
<td>6.80</td>
<td>2.00</td>
</tr>
<tr>
<td>4.50</td>
<td>6.75</td>
<td>1.45</td>
<td>7.60</td>
<td>2.25</td>
</tr>
<tr>
<td>5.00</td>
<td>7.50</td>
<td>1.65</td>
<td>8.50</td>
<td>2.50</td>
</tr>
<tr>
<td>6.00</td>
<td>9.00</td>
<td>2.00</td>
<td>10.20</td>
<td>3.00</td>
</tr>
</tbody>
</table>

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

Anchor point
- D: retaining rope anchor
- T: downslope rope

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

An additional downslope anchor rope (T) is required if the barrier changes its direction by an angle of $5^\circ - 15^\circ$ upslope. The rope anchor is located downslope at a distance of (e) from the post. The downslope anchor rope has a rope diameter of $d = 18$ mm.

**INTERMEDIATE ROPE SUSPENSION**

If the barrier line changes upslope more than $15^\circ$ an intermediate anchor rope is required. In this case the downslope anchor rope is no longer necessary.
A support rope separation includes an intermediate suspension. In simple terrain conditions and appropriate work equipment is recommended a support rope separation every 60 to 100 m.

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

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

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.
7. ANCHORING THE BASE PLATE

LOOSE GROUND:

- Permitted installation position of the base plate 29: Inclined 0 - 30° to the horizontal
- Drill holes for the anchors (vertical and inclined 45° to the base plate to accommodate inclined anchors)
- Prepare the concrete foundation 111; the concrete foundation 111 is dimensioned and reinforced in accordance with the information from the project engineer (Geobrugg recommendation: 0.6 x 0.5 x 0.2 m)
- Insert the anchor 05, spacers 09, and fastening nuts 10; the project engineer calculates the lengths of the anchors
- Optional: stabilization tube 04 for vertical anchors
- Important: Spacers and fastening nuts must be fixed on both sides of the base plate 29
- Mortar the anchor 05 in the loose ground 110
- Fill in the concrete foundation 111
- Tighten the fastening nuts 10 to approx. 30 kN pretensioning force

CONCRETE:

- Can be used for all types of soil and rock
- Dig a hole for the concrete foundation 111
- Drill the rear anchoring 07; the project engineer calculates the lengths of the anchors
- Prepare the concrete foundation 111; the concrete foundation 111 is dimensioned and reinforced in accordance with the information from the project engineer
- Mortar in the rear anchoring 07 with the fastening nuts 10 and spacers 09
- Install both anchors 08 with the help of the base plate 29. Spacers 09 and fastening nuts 10 must be fixed on both sides of the base plate:
  - length of anchor 08 L = 500 mm
- Fill in the concrete foundation 111 09,10
- Tighten the fastening nuts 10 to approx. 30 kN pretensioning force
ROCK:

- Remove rock around the base plate 29 at 0 - 30° to the horizontal
- Drill holes for the anchor 08 that are vertical to the base plate 29 into the rock 112
- Mortar in the anchor 08; the project engineer calculates the lengths of the anchors
- A thin leveling layer of mortar should ensure that the base plate is in a stable position
- Position the base plate 29 in the leveling layer of mortar
- Tighten the fastening nuts 10 with the spacers 09 to approx. 30 kN pretensioning force after the mortar has fully hardened

Tightening torque of the fastening nut for an anchor pretensioning force of approx. 30 kN:

<table>
<thead>
<tr>
<th></th>
<th>Swiss GEWI NG 25</th>
<th>Swiss GEWI NG 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tightening torque</td>
<td>300 Nm</td>
<td>400 Nm</td>
</tr>
</tbody>
</table>

Table 6

You must use mortar that is resistant to both frost and de-icing salt.
Reinforcement: 12 mm steel diameter, 150 mm apart

A mounting pattern can be supplied on request.

Please ensure the anchors have sufficient contact with the mortar, create a good bond, and that enough of the surface contacts the surrounding material.

You can find more information about anchoring the base plate in the anchor data sheet.

The forces that may occur in the event of a rockfall event must not be underestimated. Civil engineering and installation work must therefore be carried out by experts.
8. PREPARATION OF THE NETS AND POSTS

CORRECT SIDE OF THE NET PANEL

The posts are numbered from left to right (from the downslope)

**S:** The net bundles are installed to the right of the posts as standard.

**X:** In the event of significant height differences, it is easier to pull the net down from the higher post to the lower post.

⚠️ If specified in the order instructions, Geobrugg will supply the bundles according to the customer’s request.
ROW NUMBERS FOR SUPPORT ROPES AND TRANSMISSION ROPES AT DIFFERENT HEIGHTS

Marking the different rows for barrier height $h = 3\, \text{m}$: Row-No. (1) (6) (12) (17)
Marking the different rows for barrier height $h = 4\, \text{m}$: Row-No. (1) (8) (14) (21)
Marking the different rows for barrier height $h = 4.5\, \text{m}$: Row-No. (1) (8) (16) (23)
Marking the different rows for barrier height $h = 5\, \text{m}$: Row-No. (1) (9) (17) (25)
Marking the different rows for barrier height $h = 6\, \text{m}$: Row-No. (1) (11) (19) (29)
RXE-1000: MARKING OF THE RINGS WITHOUT A SUPPORT ROPE SEPARATION

- **red colored rings:** Ring passes through the support ropes and transmission ropes.

- **Blue colored rings of border nets:** 2 rings on top and bottom are shackled to the U-rope. and 5 released rings which are not fixed with the transmission ropes.

- **Blue colored rings of middle nets:** 2 rings on the top and bottom are shackled to the U-rope.

⚠️ In case of divided field nets, only one side is colored in blue.

The 2 blue colored main rings are fixed to the intermediate ring at delivery.  
**b)** The 5 blue colored rings and the red colored rings are bundled at delivery.
RXE-1000: MARKING OF THE RINGS WITH A SUPPORT ROPE SEPARATION (SRS)

- **red colored rings:** Ring passes through the support ropes and transmission ropes.
- **Blue colored rings SRS net:** 2 rings on top and bottom are shackled to the U-rope.
  and 5 released rings which are not fixed with the transmission ropes and top support rope.
- **Blue colored rings of middle nets:** 2 rings on the top and bottom are shackled to the U-rope.

⚠️ In case of divided field nets, only one side is colored in blue.

**a)** The 2 blue colored main rings are fixed to the intermediate ring at delivery.
**b)** The 5 blue colored rings and the red colored rings are bundled at delivery.
**c)** The 5 blue colored main rings on the top are fixed to the intermediate ring at delivery.
PREPARATION OF THE POSTS

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>1 Stk. Running wheel</td>
</tr>
<tr>
<td>35</td>
<td>1 Stk. clevis</td>
</tr>
<tr>
<td>37</td>
<td>1 Stk. sleeve</td>
</tr>
<tr>
<td>40</td>
<td>1 Stk. ROCCO 7/3/300</td>
</tr>
<tr>
<td>53</td>
<td>1 Stk. 6kt bolt M30x180</td>
</tr>
<tr>
<td>55</td>
<td>2 Stk. 6kt nut M30</td>
</tr>
<tr>
<td>66</td>
<td>2 Stk. Retaining rope</td>
</tr>
<tr>
<td>67</td>
<td>1 Stk. Lateral rope</td>
</tr>
<tr>
<td>85</td>
<td>2 Stk. Shackle 7/8”</td>
</tr>
<tr>
<td>86</td>
<td>1 Stk. Shackle 1”</td>
</tr>
</tbody>
</table>
CORRECT HEIGHT OF THE NET PANEL

The height of the upper ring is set slightly higher than the height of the pre-mounted running wheel 201. The mounting bracket 203 is inserted in the appropriate height between the climbing iron and the post.

⚠️ The net panel is placed on the mounting bracket and securely fixed with straps 202.

ℹ️ The top strap is attached to the second row 205, so that in a subsequent assembly step, the two upper ring panel be turned away from the support rope to pass through the rings and the running wheel.
9. CRANE AND HELICOPTER INSTALLATION

- Fix the net panels with straps 207 to flight safely.
- Use the middle post head shackle 86 to lift the assembly. Never use the climbing steps 208!
10. INSTALLING THE SUPERSTRUCTURE

Simplified sketch of the whole barrier

The following steps describe a standard installation.
Find detailed information to each step in the chapter “assembly details”.

- Anchors are drilled and the foundations are finished.

⚠️ Fix the overturn securing ropes to the ground plates.

- Install the well prepared posts to the ground plates and secure them with the securing overturn ropes and the retaining ropes.

⚠️ Exercise extremely caution in the danger area around the posts as long the posts could topple backwards, forwards or to the lateral side.
• Install lateral ropes, intermediate rope suspensions and vertical ropes.

Pay attention that the ropes have to share the same shackle at the post head

• Fix the U-Brakes to the relevant anchors.

• Guide the top support rope from the left U-brake through the running wheel on the post head and the red colored rings of the net bundle to the U-brake at the right. Tension the top support rope.

To avoid crossing ropes do not install the U-rope before the top support rope.

The ring net will be opened later on after the installation of the transmission ropes.
• Guide the top U-rope from the left U-brake through the clevises on the post heads to the U-brake at the right. Do not tension the top U-rope yet.

![Diagram showing top U-rope guide](image1)

Guide the U-rope at the mountain side along the net.

• Guide the bottom support rope from the left U-brake through the clevises on the ground plates to the U-brake at the right. Do not tension the bottom support rope.

![Diagram showing bottom support rope guide](image2)

To avoid crossing ropes do not install the U-rope before the bottom support rope.

• Guide the bottom U-rope from the left U-brake through the clevises on the ground plate to the U-brake at the right. Do not tension the bottom U-rope.

![Diagram showing bottom U-rope guide](image3)
• Guide the transmission ropes from the left U-brake through the red colored rings of the net bundle to the U-brake at the right. Do not tension the transmission ropes.

• Cut the belts of the ring net bundles and fix the border rings of the first net to the left vertical rope.

• Open the net panels, connect them to each other and fix the border rings of the last net to the vertical rope at the right.

During opening the net panels the transmission ropes will be lifted to its final height.
• Tension the top U-rope, bottom support rope, bottom U-rope and transmission ropes

• Shackle colored rings to U-rope

• Attach the secondary mesh to the ring net at mountain side
11. ASSEMBLY DETAILS

INSTALLATION OF SAFE POSTS

- Exercise extremely caution in the danger area around the posts as long the posts could topple backwards, forwards or to the lateral side.

- Long posts with preassembled net tend to lateral tip over. Lateral guy ropes during installation prevent this.

- Overturn securing rope 68 mount for secure mounting of the posts.

<table>
<thead>
<tr>
<th>Part</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>64</td>
<td>2 pcs.</td>
<td>6kt nut M22</td>
</tr>
<tr>
<td>65</td>
<td>1 pcs.</td>
<td>washer M22</td>
</tr>
<tr>
<td>68</td>
<td>1 pcs.</td>
<td>Overturn securing rope</td>
</tr>
<tr>
<td>83</td>
<td>1 pcs.</td>
<td>Shackle 5/8&quot;</td>
</tr>
</tbody>
</table>
BORDER POST

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>2 pcs.</td>
<td>Running wheel</td>
</tr>
<tr>
<td>35</td>
<td>2 pcs.</td>
<td>clavis</td>
</tr>
<tr>
<td>37</td>
<td>2 pcs.</td>
<td>sleeve</td>
</tr>
<tr>
<td>39</td>
<td>1 pcs.</td>
<td>Bottom support rope</td>
</tr>
<tr>
<td>53</td>
<td>2 pcs.</td>
<td>6kt bolt M30x180</td>
</tr>
<tr>
<td>55</td>
<td>4 pcs.</td>
<td>6kt nut M30</td>
</tr>
<tr>
<td>56</td>
<td>1 pcs.</td>
<td>6kt bolt M20x110</td>
</tr>
<tr>
<td>57</td>
<td>2 pcs.</td>
<td>Washer M20</td>
</tr>
<tr>
<td>58</td>
<td>1 pcs.</td>
<td>6kt nut M20</td>
</tr>
<tr>
<td>67</td>
<td>1 pcs.</td>
<td>Lateral rope</td>
</tr>
<tr>
<td>69</td>
<td>1 pcs.</td>
<td>Vertical rope</td>
</tr>
<tr>
<td>71</td>
<td>1 pcs.</td>
<td>Top support rope</td>
</tr>
<tr>
<td>78.1</td>
<td>1 pcs.</td>
<td>Top U-Rope</td>
</tr>
<tr>
<td>78.2</td>
<td>1 pcs.</td>
<td>Bottom U-rope</td>
</tr>
<tr>
<td>85</td>
<td>4 pcs.</td>
<td>Shackle 7/8&quot;</td>
</tr>
<tr>
<td>86</td>
<td>1 pcs.</td>
<td>Shackle 1&quot;</td>
</tr>
<tr>
<td>95</td>
<td>3 pcs.</td>
<td>Wire rope clips 5/8&quot;</td>
</tr>
</tbody>
</table>
Before tensioning the lateral rope 67 the vertical rope 69 shackle with the ground plate and bolt of the shackle on the post head then position the loop 211 at half of the post.
MIDDLE POST

| 33  | 2 pcs. Running wheel |
| 35  | 2 pcs. clavis         |
| 37  | 2 pcs. sleeve        |
| 39  | 1 pcs. Bottom support rope |
| 53  | 2 pcs. 6kt bolt M30x180 |
| 55  | 4 pcs. 6kt nut M30 |
| 56  | 1 pcs. 6kt bolt M20x110 |
| 57  | 2 pcs. washer M20 |
| 58  | 1 pcs. 6kt nut M20 |
| 66  | 2 pcs. Retaining rope |
| 71  | 1 pcs. Top support rope |
| 78.1| 1 pcs. Top U-rope    |
| 78.2| 1 pcs. Bottom U-rope |
| 83  | 1 pcs. Shackle 5/8"   |
| 85  | 3 pcs. Shackle 7/8"   |

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RETAINING ROPE ON THE ROPE ANCHOR

- 01 pcs spirale rope anchor
- 66 pcs upslope anchor rope
- 96 pcs wire rope clip 7/8"

LATERAL ROPE ON THE ROPE ANCHOR

- 01 pcs spirale rope anchor
- 67 pcs lateral rope
- 95 pcs wire rope clip 5/8" per rope
TOP SUPPORT ROPE, TOP U-ROPE AND TOP TRANSMISSION ROPE AT ROPE ANCHOR

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>01</strong></td>
<td>1 pcs</td>
<td>spirale rope anchor</td>
</tr>
<tr>
<td><strong>50</strong></td>
<td>1 pcs</td>
<td>U-Brake U-300-K1620</td>
</tr>
<tr>
<td><strong>71</strong></td>
<td>1 pcs</td>
<td>top support rope</td>
</tr>
<tr>
<td><strong>73.1</strong></td>
<td>1 pcs</td>
<td>top transmission rope</td>
</tr>
<tr>
<td><strong>78.1</strong></td>
<td>1 pcs</td>
<td>top U-Rope</td>
</tr>
<tr>
<td><strong>86</strong></td>
<td>4 pcs</td>
<td>shackle 1”</td>
</tr>
<tr>
<td><strong>95</strong></td>
<td>3 pcs</td>
<td>wire rope clip 5/8”</td>
</tr>
<tr>
<td><strong>97</strong></td>
<td>4 pcs</td>
<td>wire rope clip 7/8”</td>
</tr>
</tbody>
</table>
BOTTOM SUPPORT ROPE, U-ROPE AND BOTTOM TRANSMISSION ROPE AT ANCHOR

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>1 pcs</td>
<td>spirale rope anchor</td>
</tr>
<tr>
<td>05</td>
<td>1 pcs</td>
<td>U-Brake U-300-K1620</td>
</tr>
<tr>
<td>72</td>
<td>1 pcs</td>
<td>bottom support rope</td>
</tr>
<tr>
<td>73.2</td>
<td>1 pcs</td>
<td>bottom transmission rope</td>
</tr>
<tr>
<td>78.2</td>
<td>1 pcs</td>
<td>bottom U-Rope</td>
</tr>
<tr>
<td>86</td>
<td>4 pcs</td>
<td>shackle 1&quot;</td>
</tr>
<tr>
<td>95</td>
<td>3 pcs</td>
<td>wire rope clip 5/8&quot;</td>
</tr>
<tr>
<td>97</td>
<td>4 pcs</td>
<td>wire rope clip 7/8&quot;</td>
</tr>
</tbody>
</table>

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The top support rope 71 and the bottom support rope 72 is guided by the edge rings (red) of the net.

In the net corner on top and on bottom two rings (blue) are not fixed to the support rope. The colored rings (blue) are fixed to the U-rope 78.x by shackles 1/2” 82.

The main rings 215 on the border are fixed to the vertical rope string 69 which is not fixed with wire rope clips. The shackles are ½” 82.
**BORDER POST: INSTALLATION OF THE TRANSMISSION ROPES**

The transmission ropes 73.1 and 73.2 are guided about 2m away from the border post by the corresponding ring series (red). For this, the first 5 rings of the net (blue) are released.

The transmission ropes are not connected to the post.

**MIDDLE POST: INSTALLATION OF THE TRANSMISSION ROPES**

The transmission ropes 73.1 and 73.2 are guided without interruption by the corresponding ring series (red).

The transmission ropes are not connected to the post.
The top support rope 71 and the bottom support rope 72 are guided by the edge rings (red) of the net. On both sides of the post the two rings (blue) are not fixed to the support rope. The colored rings (blue) are fixed to the U-rope 78.x by shackles ½” 82.
CONNECTION OF THE RING PANELS AMONG EACH OTHER

Two ring series are distinguished in the ring net. The main ring series (black) and the intermediate ring series (yellow).

The edges of each net are formed by main ring rows. If nets are connected to each other, they are fixed by main rings, only.

The main rings are connected by shackles ½" **82**, means the upper main ring is fixed by shackle to the next lower main ring of the other net (step 1). In next step, the lower main ring is fixed to the upper main ring of the other net by shackle ½".

---

**Step 1**

---

**Step 2**

---
INSTALLATION OF THE SECONDARY MESH

The individual fields are fitted with a diagonal wire mesh 50x50x2.4.

The wire mesh 221 is fixed with double wire ties 222 on the ring net 220. The wire tie is attached to each ROCCO ring in any intermediate series. The wire mesh strips overlap each other 10cm.
INTERMEDIATE ROPE SUSPENSION

DOWNSLOPE ANCHOR

<table>
<thead>
<tr>
<th>01</th>
<th>1 pcs</th>
<th>Spiral rope anchor</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td>1 pcs</td>
<td>Downslope anchor rope</td>
</tr>
<tr>
<td>85</td>
<td>1 pcs</td>
<td>Shackle 7/8&quot;</td>
</tr>
<tr>
<td>95</td>
<td>3 pcs</td>
<td>Wire rope clip 5/8&quot;</td>
</tr>
</tbody>
</table>
12. SUPPORT ROPE SEPARATION WITH INTERMEDIATE SUSPENSION

NET RINGS AT RUN ROPE AND RELEASED RINGS OF THE TRANSMISSION ROPES

The Run top rope and run bottom rope are guided through the blue colored rings.
5 rings left and 5 rings right on the top and 2 rings left and 2 rings right on the bottom.

The blue colored rings are released by the transmission ropes and are guided to the U-Brakes on post head and bottom support anchor.
5 rings left and 5 rings right of the post are free.
DETAILS ON POST HEAD LEFT SIDE

50 1 pcs. U-Brake U-300-K1620
310 1 pcs. Structural Bolt M27x115
66 1 pcs. Retaining rope
67 1 pcs. Intermediate suspension
71 1 pcs. top support rope
74.1 1 pcs. Run top rope
78.1 1 pcs. Top U-Rope
85 1 pcs. Shackle 7/8"
86 6 pcs. Shackle 1"
97 1 pcs. wire rope clip 7/8" as connection of run top rope and top support rope
212 Bring the bypass rope with the round clip on the shackle in height. Guide both ends of the bypass rope through the blue colored rings. Then fix the bypass rope to the support rope with a wire rope clip.
213 Torque 50 Nm
DETAILS AT POST HEAD RIGHT SIDE

34  1 pcs.  Round clip
50  1 pcs.  U-Brake U-300-K1620
66  1 pcs.  Retaining rope
67  1 pcs.  Intermediate suspension
71  1 pcs.  Top support rope
74.1 1 pcs.  Run top rope
78.1 1 pcs.  Top U-Rope
86  4 pcs.  Shackle 1"
97  1 pcs.  Wire rope clip NG22 as connection of run top rope and top support rope
212  Bring the bypass rope with the round clip on the shackle in height. Guide both ends of the bypass rope through the blue colored rings. Then fix the bypass rope to the support rope with a wire rope clip.
213  Torque 50 Nm
DETAILS AT POST BASE

72 L 1 pcs. Bottom support rope left
72 R 1 pcs. Bottom support rope right
74.1 1 pcs. run bottom rope
78.2 L 1 pcs. Bottom U-rope left
78.2 R 1 pcs. Bottom U-rope right
85 4 pcs. Shackle 7/8"
97 2 pcs. Wire rope clip NG22 as connection of run top rope and bottom support rope
212 Guide both ends of the bypass rope through the 4 blue colored rings. Then fix and pretension the bypass rope to the support rope.
213 Torque 50 Nm
214 correct position of the wire rope clip. The sattle is fixed to the bypass rope because of an easy pretension of the wire rope clips.
13. SPECIAL SOLUTION ADDITIONAL TO THE STANDRAD

**BRACE ELEMENT SOLUTION**

⚠️ If there is not sufficient space available to stake out the lateral anchors in the standard way, a brace element solution can be developed in consultation with Geobrugg AG.

For brace element solutions in Switzerland, the specifications of the Expert Commission on Avalanches and Rockfall (EKLS) must be complied with.

**ROCK FACE CONNECTION**

⚠️ If it is not possible to stake out in the standard way, a rock face connection variant can be worked out in consultation with Geobrugg AG.

**GAP-FILLING SOLUTION**

⚠️ On steep slopes with torrent channels, there may be large gaps between the ground and the bottom support rope. In these cases, individual gap-filling solutions can be developed in consultation with Geobrugg AG.
14. FINAL INSPECTION

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

a) Are the support, U-ropes and transmission 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?
A: Top support rope Ø22 mm
B: Bottom support rope Ø22 mm
C: Lateral anchor rope Ø16 mm
D: Upslope anchor rope Ø18 mm
E: U-rope Ø16 mm
F: Vertical rope Ø16 mm
H: Transmission rope Ø22 mm

details see product manual RXE-1000

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This document will not be exchanged, when being modified.
A: Top support rope Ø22 mm
B: Bottom support rope Ø22 mm
C: Lateral anchor rope Ø16 mm
D: Upslope anchor rope Ø18 mm
E1/E2: U-rope Ø16 mm
E3/E4: Bypass rope Ø22 mm
F: Vertical rope Ø16 mm
H: Transmission rope Ø22 mm
Z: Intermediate suspension Ø16 mm

details see product manual RXE-1000
EXTRACT FROM THE FOEN TEST CERTIFICATE NO. 13-1

Type approval of safety nets for protection against rockfall
Test Certificate No. S 13-1

System description

- System designation RXE-1000
- Address of manufacturer Geobrugg AG, Aachstrasse 11, 8592 Romanshorn
- System description
  - Energy class 1000 kJ

Overall assessment

☒ Test passed ☐ Test passed with reservations


RESERVATION: Should deficiencies arise following certification of the safety net, FOEN may revoke product release and delete it from the type approval list.

Date
22.10.2013

Name, position
Dr. Josef Hess, Vice-Director

Signatures

Federal Office for the Environment FOEN
Risk Prevention Division
3003 BERNE
http://www.bafu.admin.ch/typenpruefung