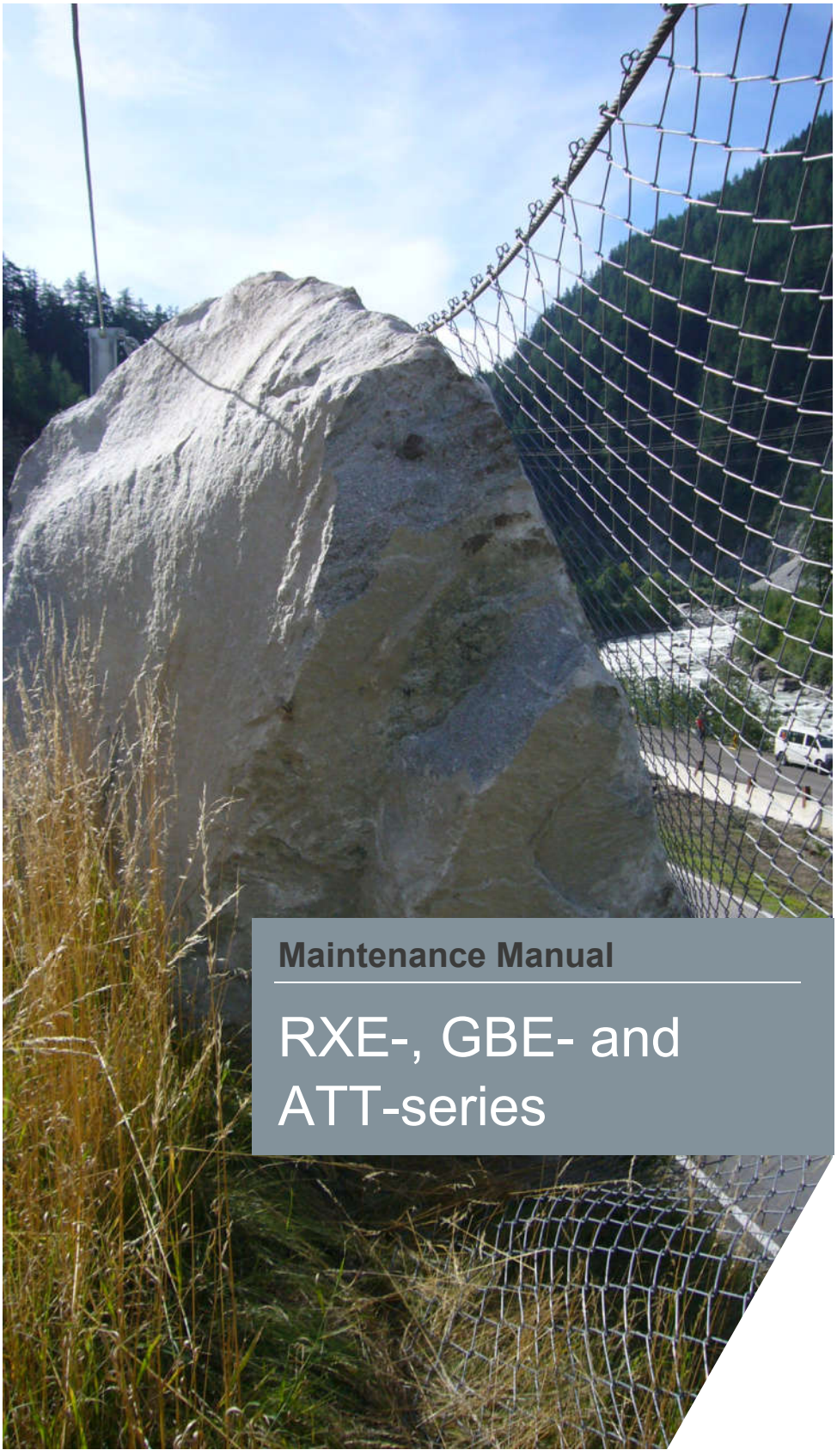
GEOBRUGG
BRUGG
Safety is our nature

GBE-100A
GBE-100A-R
GBE-500A
GBE-500A-R
GBE-1000A
GBE-1000A-R
GBE-2000A
GBE-3000A

RXE-500
RXE-500-LA
RXE-1000
RXE-2000
RXE-3000
RXE-5000
RXE-8000
RXE-10000

ATT-20
ATT-40
ATT-60
ATT-80



Maintenance Manual

RXE-, GBE- and ATT-series

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8590 Romanshorn

CE European Technical Approval
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PURPOSE AND ORGANIZATION OF THE MAINTENANCE MANUAL

This maintenance manual is intended for the proper maintenance and repair of a rockfall protection system, in order to ensure a long lifespan for the barrier, and its unrestricted and safe functioning following impacts and throughout its lifespan. The maintenance manual is to be understood as a recommendation. Only standard situations are described. In the event of unusual situations, this manual may under certain circumstances be inappropriate or inadequate for servicing or repairing the barrier. In certain cases, it is recommended that technical advice is obtained from the manufacturer.

This maintenance manual consists of the following sections:

- Lifespan
- Inspections
- Criteria for repairs and replacement
- Emptying and clearing of barriers
- Repairing and replacing components
- Inspection checklist
- ISO 9001 certificates

No claims are made that this document is complete. It is designed for general 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 the event of uncertainty, please contact the manufacturer. The General Terms of Business of Geobrugg AG apply.

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Romanshorn, 11.10.2018

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Switzerland

(Stamp / legally valid signatures)

I AREA OF APPLICATION

This maintenance manual applies for the Geobrugg rockfall barrier systems of the GBE and RXE series. Reference is made to the corresponding system drawings:

GBE-100A	(100 kJ)	System drawing GS-1218
GBE-100A-R	(100 kJ)	System drawing GS-1131
GBE-500A	(500 kJ)	System drawing GS-1100
GBE-500A-R	(500 kJ)	System drawing GS-1122
GBE-1000A	(1000 kJ)	System drawing GS-1104
GBE-1000A-R	(1000 kJ)	System drawing GS-1128
GBE-2000A	(2000 kJ)	System drawing GS-1109
GBE-3000A	(3000 kJ)	System drawing GS-1113

RXE-500	(500 kJ)	System drawing GS-1196
RXE-500-LA	(500 kJ)	System drawing GS-1216
RXE-1000	(1000 kJ)	System drawing GS-1142
RXE-2000	(2000 kJ)	System drawing GS-1150
RXE-3000	(3000 kJ)	System drawing GS-1157
RXE-5000	(5000 kJ)	System drawing GS-1125
RXE-8000	(8000 kJ)	System drawing GS-1138
RXE-10000	(10000 kJ)	System drawing GS-1552

ATT-20	System drawing GS-1556
ATT-40	System drawing GS-1567
ATT-60	System drawing GS-1568
ATT-80	System drawing GS-1569

II QUALITY OF THE SYSTEM COMPONENTS

Geobrugg AG, Romanshorn, has been certified according to the quality management system requirements (ISO 9001: 2008) under registration number CH-34372 since August 22, 1995. The certifying body is the Swiss Association for Quality and Management Systems (SQS), a member of IQNet. The quality manual describes in full how the individual system parts (input material, commercial products and end products) are comprehensively checked in order to exclude inadequate quality.

III FUNCTIONAL EFFICIENCY OF THE BARRIER SYSTEMS

The system functionality is based on rockfall tests that replicate real-life conditions, performed in Walenstadt (SG), Switzerland, in accordance with the European Guideline ETAG 027 “Falling Rock Protection Kits” and the Swiss guideline for type-testing rockfall protection kits. In the rockfall tests under real-life conditions, the rocks are thrown vertically into the central field of a three-field barrier with a 10 m distance between the posts of each field. An impact speed of at least 25 m/s is achieved. These investigations are inspected by notified testing centres and obtain European approval, known as ETA (European Technical Assessment), as well as partly a Swiss inspection certificate from the Federal Office for the Environment (FOEN).

IV QUALITY CONTROL FOR MAINTENANCE

An inspection of damage should be made using the checklist in the maintenance manual. The maintenance manual describes in detail the individual steps for how the barriers must be maintained by local contractors. The recording of damage is, however, always subject to subjective criteria. In the event that doubts should arise for this reason, the manufacturer should be contacted in order to ensure the continued quality and functional efficiency of the barrier.

V PRODUCT LIABILITY

Rockfall, landslides, debris flows or avalanches are sporadic and unpredictable. The cause may be 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.

The monitoring and maintenance of such systems is an absolute requirement to ensure the desired safety level. System safety can also be compromised 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 1:1 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 anchors, 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 behaviour as in the 1:1 rockfall tests. In critical cases, it is advisable to reinforce particular components as compared with the standard barrier.

CONTENTS

EXPLANATIONS OF THE SYMBOLS USED

Safety note: Must be followed

Note/reminder that will help you to install the system easily and correctly

Consultation with Geobrugg is recommended

Upslope

Downslope

1 HAZARD NOTES

QUALIFICATION OF THE GROUP LEADER

Only a qualified group leader may be put in charge of the maintenance.

TENSIONED ROPES

Ropes will be tensioned. When installing and pretensioning ropes, ensure that there are no persons within in the danger area.

RELEASING TENSIONED PARTS

Releasing or separating tensioned parts should be avoided wherever possible. If this is necessary, however, please exercise the utmost caution.

2 LIFESPAN

2.1 Lifespan of the components in general

2.1.1 Individual parts

The lifespan of an individual part is defined by its load-bearing capacity. This includes e.g. the ropes, the rod anchors, the securing splints for the U-brake bolts etc.

2.1.2 Assemblies

The lifespan of an assembly is defined by its load-bearing capacity as well as by its mechanical functional efficiency. Typical assemblies include e.g. the installed barrier itself, the U-brakes and the running wheel groups.

2.1.3 Safety factors

If the functional efficiency or load-bearing capacity of the components is reduced as a result of damage or corrosion, such that the minimum required safety factors can no longer be fulfilled, the components must be replaced.

3 INSPECTIONS

In order to ensure that no damage or advanced corrosion impairs the functional efficiency or load-bearing capacity of the components such that the minimum required safety factors can no longer be fulfilled, regular inspections of the barriers must be carried out.

3.1 Regular inspections

3.1.1 Interval for regular inspections

The appropriate interval depends primarily on the following parameters:

- Frequency of rockfall
- Corrosion class of the area
- Vegetation

3.1.2 Minimum number of inspections

Under normal environmental conditions, two checks a year are sufficient. If frequent rockfall occur, more inspections are appropriate. These should be carried out before the start of winter and after winter has ended.
A useful aid for the systematic checking of the barrier is the “Barrier Inspection” checklist in the Annex.

3.2 Inspection following incidents

An inspection must be carried out immediately following any notified or recorded incidents.
A useful aid for the systematic checking of the barrier is the “Barrier Inspection” checklist in the Annex.

3.3 Accessibility

The barrier must be accessible so that all the components to be checked can be inspected without the risk of accidents. The infrastructure required for this depends on the terrain.

4 CRITERIA FOR REPAIR AND REPLACEMENT

If the functional efficiency or load-bearing capacity of the components is reduced as a result of damage or corrosion, such that the minimum required safety factors can no longer be fulfilled, the components must be replaced.

4.1 Debris in the barrier

Any debris that accumulates in the barrier should not exceed a maximum of a third of the usable height. Routine clearing of the barriers is essential to ensure unimpeded functioning.

4.2 Remaining usable height following an incident

The remaining usable height of the barrier following an incident is an initial indicator of the level of damage that has occurred. Clear sagging of the support rope or the net and a significant change in the angle of the posts indicate an elongation of one or more U-brakes, which may need to be replaced.

4.3 U-brake

In the course of the EOTA certification tests, depending on their installation position the U-brakes became elongated to varying degrees. Accordingly, following several minor incidents their energy absorption capacity for a subsequent maximum incident varies.

Type	Maximum Elongation
U-150	30 cm
U-300	60 cm
U-400	80 cm

If the initial elongation exceeds this value, the brake must be replaced. Once the U-brakes have become elongated, the usable height of the barrier has decreased. By re-tightening the support ropes, the usable height can be restored to its original value.

4.4 Meshes and nets

Even in the case of distorted wires or strands, as a rule it is not necessary to replace whole fields.

4.4.1 TECCO

If there are compressed, heavily distorted or torn mesh loops, these areas should be repaired.

4.4.2 SPIDER

If there are compressed, heavily distorted or superficially or completely torn mesh loops, these areas should be repaired.

4.4.3 ROCCO

- If individual wires have slipped out of a clip, they should be secured with a wire rope clip of a suitable size.

- If there are compressed, heavily distorted, superficially or completely torn rings, these areas should be repaired.

4.4.4 Wire mesh

If there are compressed, heavily distorted or torn mesh loops, these areas should be repaired.

4.5 Ropes as per the rope assembling drawings

4.5.1 Corrosion

Replacement of the rope, or a section thereof, is necessary if more than approx. 10% of the cross-section is affected.

4.5.2 Mechanical damage

Mechanical damage is indicated by sharp kinks and squashed or torn outer wires. Within a few years, the rope becomes brittle and loses the required load-bearing capacity. In cases of doubt, a section of the rope must be cut out in order to test the breaking strength of the rope. In the event of a poor test result, the entire rope must be replaced.
If one or more strands are torn, the rope, or this section thereof, must be replaced.

4.6 Posts

The posts hold the upper support ropes at the corresponding height and thus determine the usable height of the barrier. Slightly bent posts up to an angle of 15° do not need to be replaced.

4.7 Hinge bolt between post and base plate

In the event of impacts into the post, the hinge bolt between the post and the base plate may be bent or broken (predetermined breaking point, in order to avoid damage to the base plates and anchors). Bent or broken hinge bolts must be replaced.

4.8 Base plate

Plastic deformations to the base plate do not impair the functioning of the base plate significantly. Attention should therefore be focused on the weld seams. If weld seams are torn, the base plate must be replaced.

4.9 Rod anchor of the base plate or post foot

If a rod anchor (GEWI anchor) is significantly bent (>15°), if cracks are visible, or if the anchor is pulled out of the ground by more than 3cm, it must be replaced, since under certain circumstances its load-bearing capacity may no longer be sufficient.

4.10 Spiral rope anchor

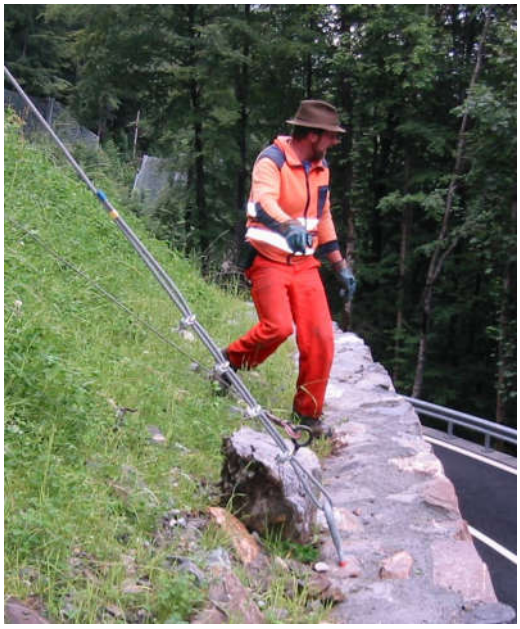
Spiral rope anchors need only be replaced if there is serious damage to wires. If a steel pipe of an anchor head is damaged, this does not reduce the loading limit. However, this may lead to a shorter lifespan, because of the reduced corrosion protection. If the anchor is pulled out of the ground by more than 3 cm, it must be replaced, since under certain circumstances its load-bearing capacity may no longer be sufficient.

5 CLEARING THE BARRIER

Various methods may be used for clearing stones, rubble or soil from rockfall barrier systems. The optimum method depends on the local framework conditions and the quantity and type of material in the nets.

A filled barrier is always under tension. The greatest care should be taken when releasing or separating components.

The barrier can be cleared using hand tools or a machine (e.g. a front-loader or similar). Care must be taken that the net is not damaged, and it must be ensured that stones rolling down the slope do not cause any damage (see illustration below).
Dug channels or large plastic pipes are useful for directing stones, debris and rubble safely towards the valley.



Lowering stones safely (secured with a rope)

5.1 Breaking stones down

Large blocks that cannot be lifted out or transported away must be broken down. Depending on the situation, the following methods can be considered:

- Manual
- Explosives (see following illustration)
- Expanding cement (“cold explosives”). For this, the stones are drilled into and filled with the “propellant” (e.g. that manufactured by Betonamit) and water is added. After about one day, the stone is broken and can be cleared away.

Breaking a block down using explosives

If a crane is available, the stones can be fitted with a haulage anchor and brought down to the valley safely.

Fitting the block with haulage hooks

Lifting the block out with the aid of a crane

6 TOOLS FOR SERVICING ROCKFALL BARRIERS

The following tools should be kept available for servicing:

- One or two six-meter ladders
- Two cable pulley devices with 30 kN tensile strength (e.g. HABEGGER)
- Two cable winch hoist, with 7.5 kN tensile strength (e.g. LUG-ALL®)
- Various slings, each 1 meter in length
- Shackles according the barrier type
- Torque wrench, range 25 – 400 Nm (see tightening torque required for wire rope clips and base plate fastening nuts)
- Socket wrench set with ratchet or open-ended wrench set
- Hammer, flat-nose pliers, roll of adhesive tape
- Auxiliary ropes
- 30 – 50 m measuring tape
- Inclinometer
- Cutting-Off wheel
- Two rope clamps, small 8 – 16 mm
- Four rope clamps, large 14 – 26 mm

7 USE OF WIRE ROPE CLIPS

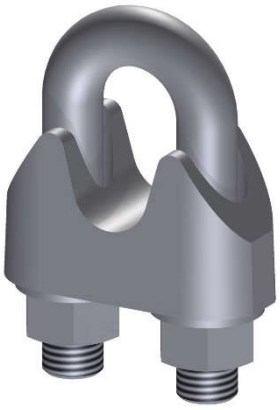
Wire rope clips have to be retightened biannually until the settlement behaviour has finished.

In 2016 Geobrugg switched from wire rope clip EN 13411-5 type 1 to type FF-C-450 type 1 class 1. It is important to use the correct installation details.

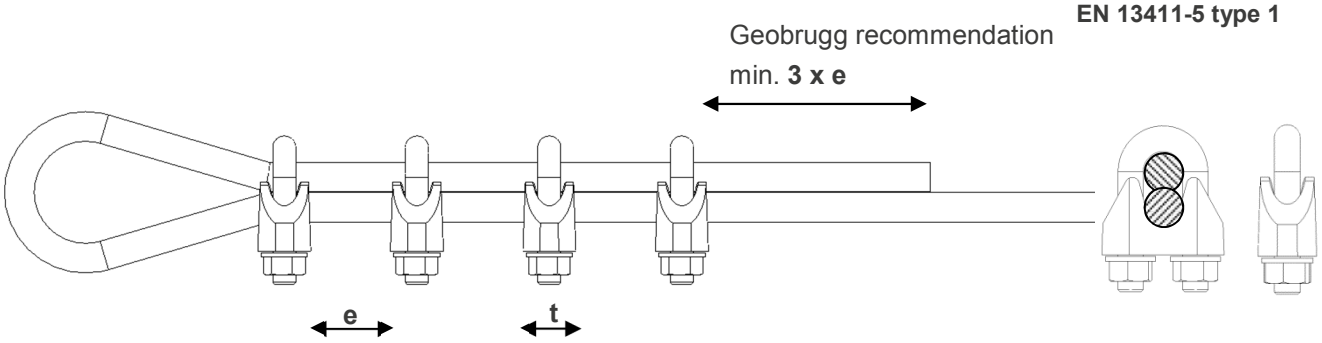
7.1 Type EN 13411-5 type 1 (old type)

The distance **e** between the wire rope clips should be at least **1.5 x t** but no more than **3 x t**, where **t** is the width of the clamping jaws.

If you are using a thimble in the loop structure, the first wire rope clip must be attached directly to the thimble.
The clamping brackets (U brackets) must always be fitted to the unstressed end of the rope and the clamping jaws (saddle) must always be fitted to the stressed rope (“never saddle a dead horse”).



EN 13411-5 type 1



Tab. 1

Nominal size *) [mm]	Distance “e” [mm]	Required tightening torque **) [Nm]	Required number of wire rope clips	Width across flats [mm]
13	50 - 80	35	4	19
16	50 - 90	55	4	22
19	50 - 90	75	4	22
22	50 - 90	120	5	24
22 GEOBINEX	50 – 90	120	10	24

*) Nominal size describes max. rope diameter
**) Only applies to lubricated wire rope clips

When establishing the connection and before commissioning, the union nuts must be tightened to the tightening torque specified in the table.

The recommended tightening torques apply to wire rope clips with lubricated bearing surfaces and nut threads.

After the control structure has been installed, check and readjust the tightening torque of the rope connections again.

The recommended tightening torques are 10% higher than the torques specified in the standard. This is because of the tolerance that applies in standard torque wrenches.

7.2 Type FF-C-450 type 1 class 1 (new type)

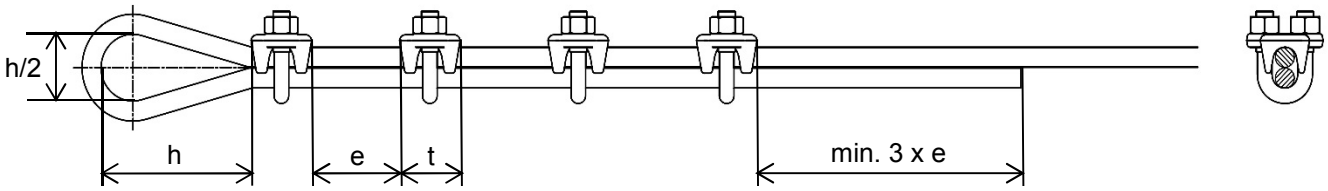
Instructions below apply to all wire rope clips according FF-C-450 type 1 class 1 (similar EN 13411-5 type 2) delivered by Geobrugg AG.

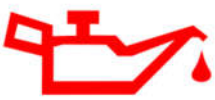
FF-C-450 type 1 class 1

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“).

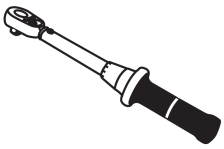




The required tightening torques with lubrication apply to wire rope clips whose bearing surfaces and the threads of the nuts have been greased with Panolin CL 60 multipurpose lubricant spray (or an equivalent lubricant).

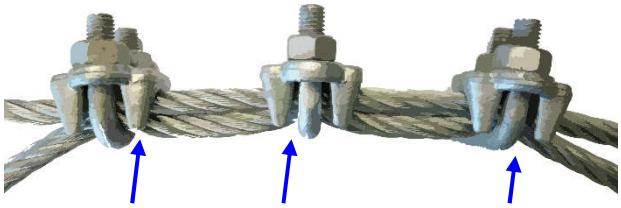
During tightening the nuts have to be tensioned equally (alternately) until the required tightening torque is reached.

Wire rope diameter [mm]	Size of the wire rope clip	Required amount of wire rope clips	Required tightening torque 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.



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

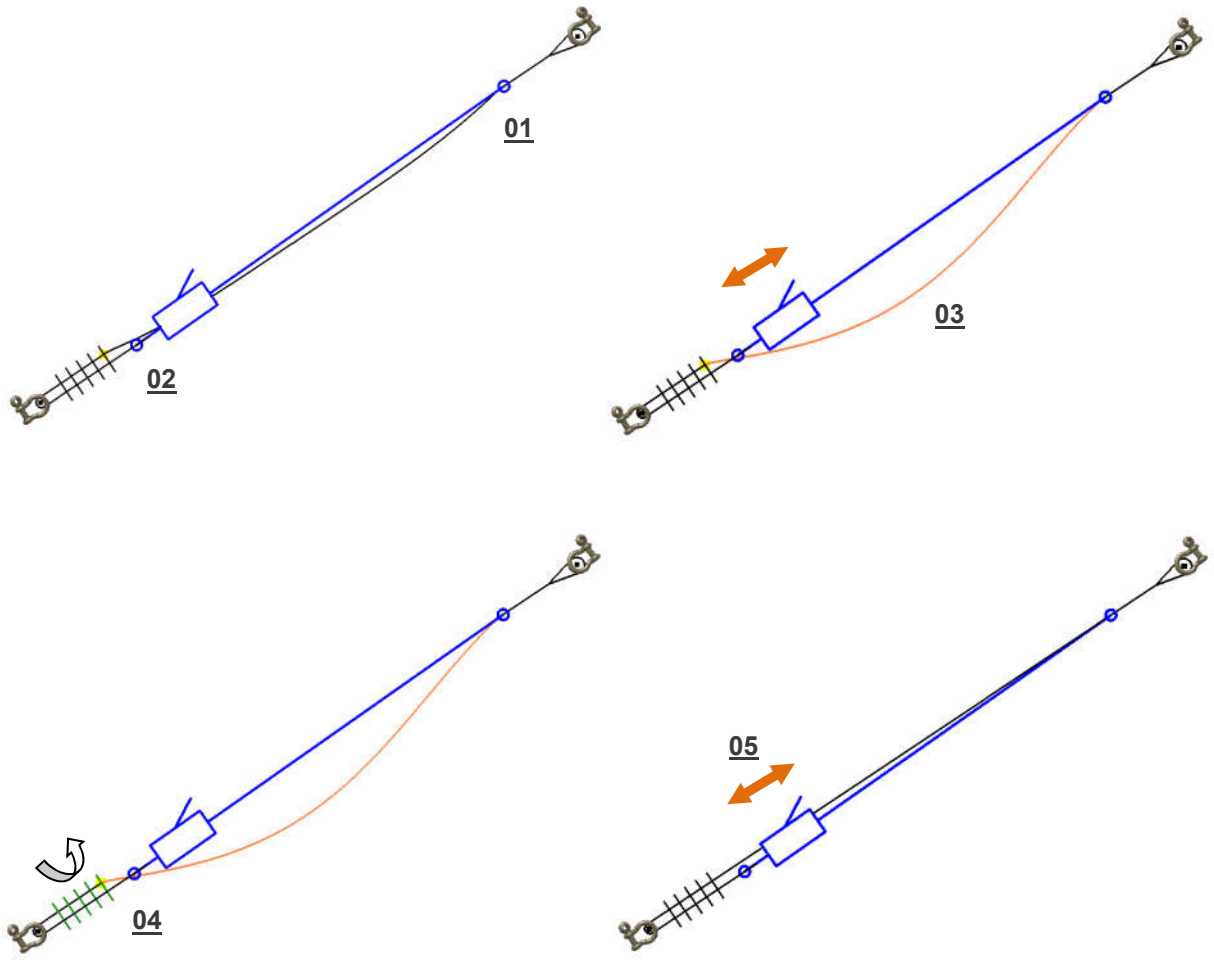
Wire rope clips always have to be installed and used with the required tensioning torque.

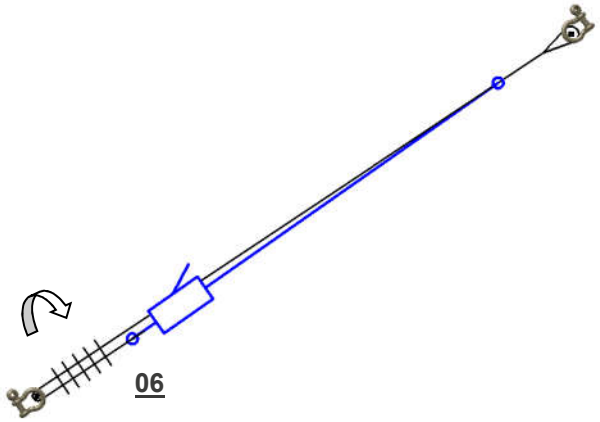
8 REPAIRING AND REPLACING COMPONENTS

8.1 Geometrical arrangement of the components

When carrying out repairs, the geometrical condition of the barrier must be restored to match that on initial acceptance. If this is no longer possible, a technically acceptable solution must be agreed with Geobrugg. The correct geometrical arrangement of the individual components can be found in the product manual.

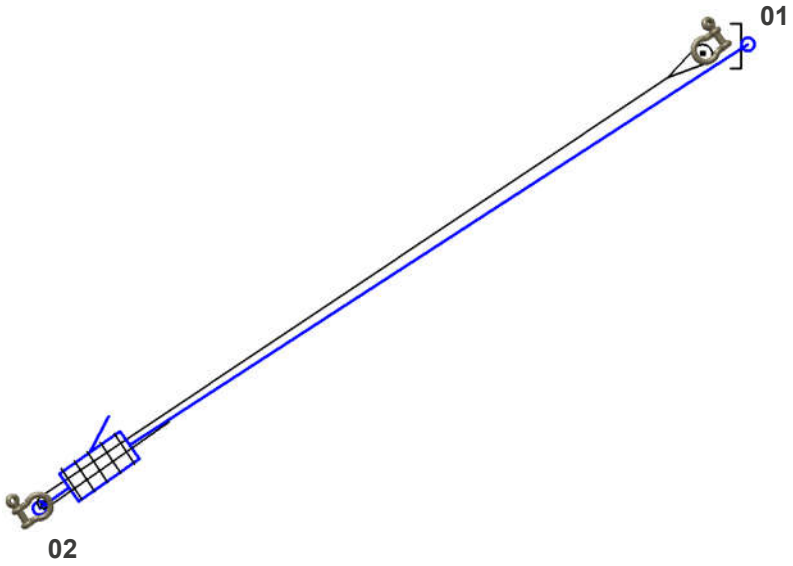
8.2 Tightening sagging ropes





- Fasten the clips of the cable pulley device on the rope **01** and its shackled end loop **02**.
- Actuate the cable pulley device until it is taut **03**.
- Release the wire rope clips of the rope **04**.
- Actuate the cable pulley device until the rope is tightened as desired **(05)**.
- Tighten the wire rope clips of the rope with the required tightening torque **(06)**.
- Detach the cable pulley device.

8.3 Replacing ropes



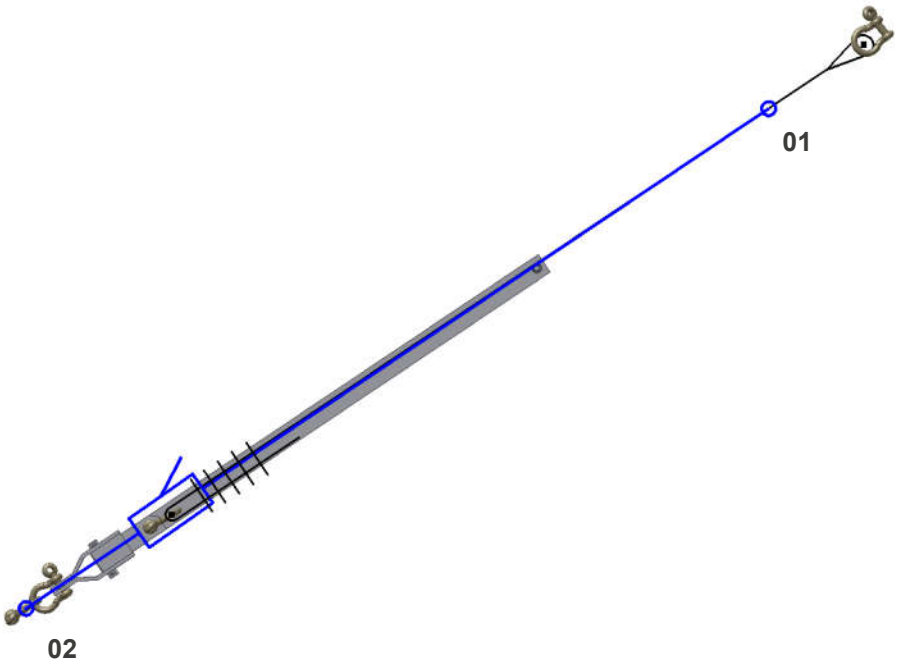
- Fit the clips of the cable pulley device to the post (e.g. with the auxiliary strap) **01** and to the fastening of the U-brake (e.g. rope anchor) **02**.

Carry out the remaining steps as described in section 8.2:

- Actuate the cable pulley device until the rope that is to be replaced is loose.
- Release the wire rope clips of the rope and remove them.
- Fit the new rope.
- Tighten the wire rope clips for the new rope with the required tightening torque.

- Release the cable pulley device so that the tensile force is transferred to the new rope.
- Detach the cable pulley device.

8.4 Replacing U-brakes



- Fit the clips of the cable pulley device to the rope of the U-brake **01** and the fastening of the U-brake (e.g. rope anchor) **02**.

Carry out the remaining steps as described in section 8.28.1:

- Actuate the cable pulley device until the entire tensile force is on the cable pulley device.
- Remove the shackle of the U-brake from the loop of the rope.
- Replace the U-brake and return the shackle to the loop.
- Release the cable pulley device so that the tensile force is transferred to the U-brake rope.
- Detach the cable pulley device.

8.5 Repairing nets and meshes

8.5.1 TECCO: repairing smaller mesh areas

If the mesh loops of a smaller mesh area have been pulled along in sympathy, a correspondingly small mesh can be laid over the damaged area and fastened to the intact mesh loops with shackles.
Care must be taken to ensure that the mesh loops are aligned horizontally as they are for intact meshes.

8.5.2 SPIDER: repairing smaller net areas

If the mesh loops of a smaller net area have been pulled along in sympathy, a correspondingly small net can be laid over the damaged area and fastened to the intact mesh loops with shackles.
Care must be taken to ensure that the mesh loops are aligned horizontally as they are for intact meshes.

8.5.3 ROCCO: repairing smaller net areas

If the rings of a smaller net area have been pulled along in sympathy, a correspondingly small net can be laid over the damaged area and fastened to the intact rings with shackles.
Care must be taken to ensure that each ring has four connection points to the next ring.

8.5.4 Wire mesh: repairing smaller mesh areas

If the mesh loops of a smaller mesh area have been pulled along in sympathy, a correspondingly small mesh can be laid over the damaged area and fastened to the intact mesh loops with wire binders.

8.6 Replacing nets and meshes

8.6.1 TECCO: replacing a mesh field

As a basic principle, TECCO meshes are replaced in the same way as SPIDER nets. The replacement procedure is described in detail in 8.6.2 below.

a) Relieve the strain on the outermost spiral of the damaged area.

b) Open up the eyelet connection of the outermost spiral.

c) Unscrew the outermost spiral. ⇨ A separation is produced in the mesh area.

d) Cut open the mesh loops of the damaged mesh along the support rope and remove the damaged mesh.

e) Fasten the mesh loops of the new mesh to the support ropes with HELIX spirals (or shackles).

f) Connect the new mesh to the intact adjacent meshes with a TECCO spiral (or with shackles).

g) Connect the eyelets of the two TECCO spirals with a shackle and remove the strain relief.

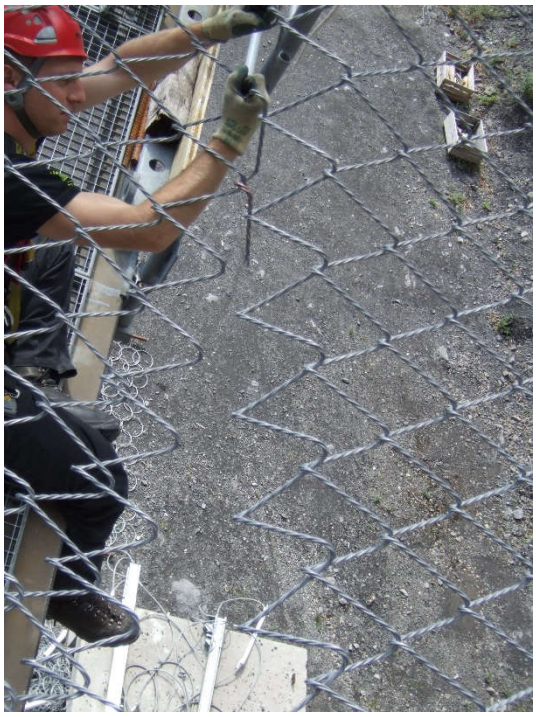
8.6.2 SPIDER : replacing a net field

The SPIDER net is replaced by unscrewing the outermost spirals of the damaged area, inserting the new net, and joining this to the intact nets with two new spirals (or with shackles).

a) Relieve the strain on the outermost spiral of the damaged area

b) Cut open the eyelet connection of the outermost spiral

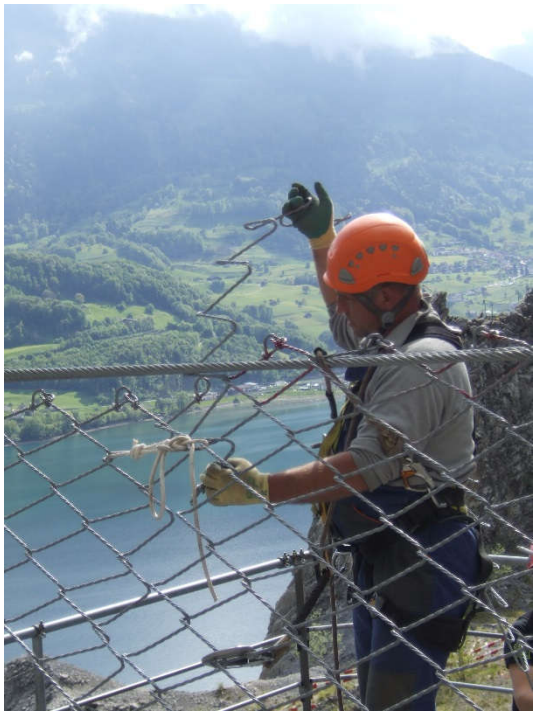
c) Unscrew the outermost spiral



A separation is produced in the net area

d) Cut open the mesh loops of the damaged net along the support rope and remove the damaged net.

e) Fasten the mesh loops of the new net to the support ropes with shackles.



f) Connect the new net to the intact adjacent nets with a spiral (or with shackles).

g) Connect the eyelets of the two spirals with a shackle and remove the strain relief.

8.6.3 ROCCO: replacing individual rings

The easiest way to replace individual rings is by fitting a replacement ring into the net with shackles. Corresponding prefabricated rings can be obtained via Geobrugg. The new ring is fastened to the adjacent rings with four shackles before the damaged ring is cut out.

If a ring is to be incorporated into the net, the following procedure is recommended:

a) Pull a piece of rope with a diameter of 4-8 mm through the 4 rings adjacent to the damaged ring and tighten it such that its diameter becomes smaller than that of the ring that is to be replaced.

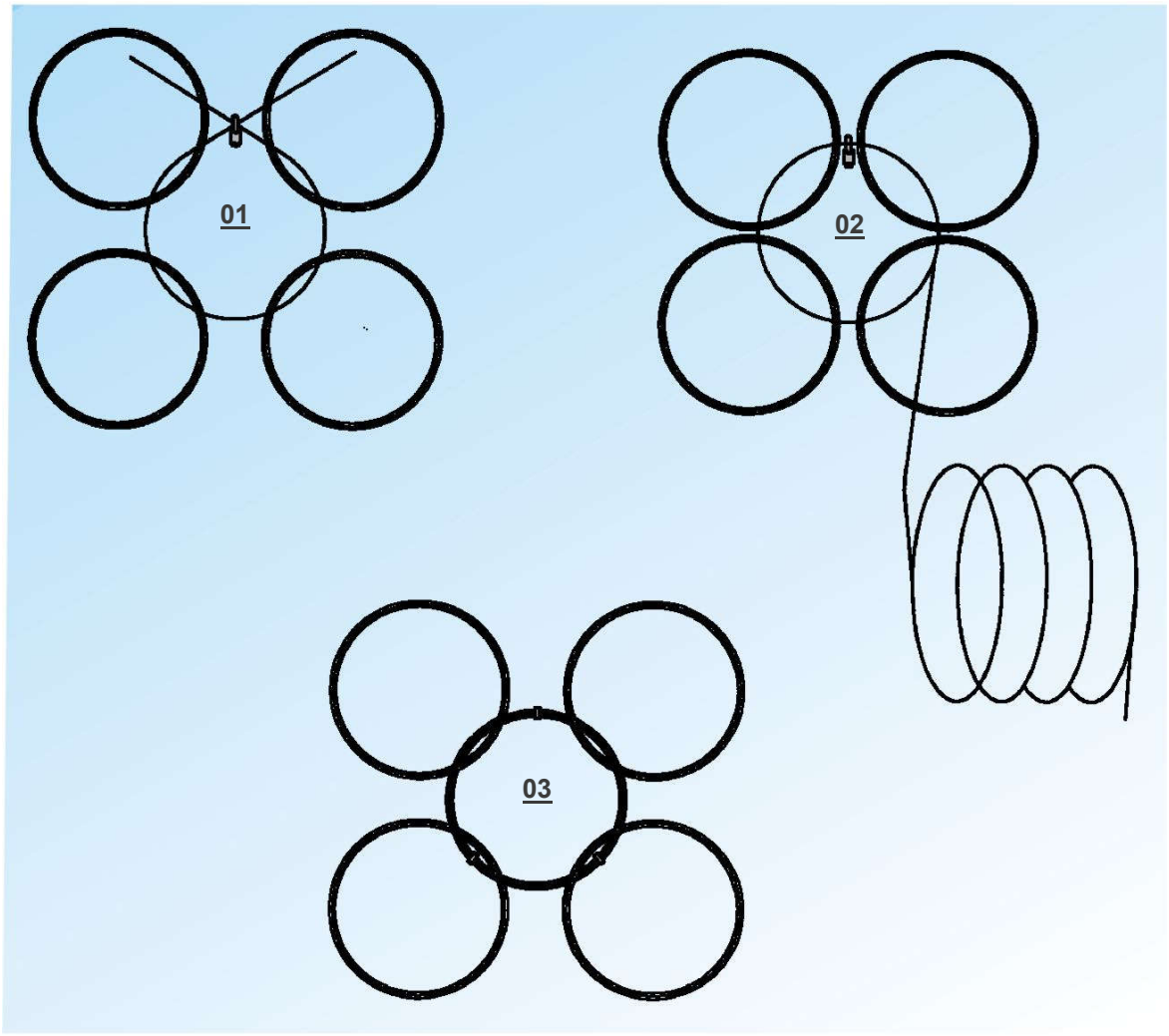
b) Secure the piece of rope that has been threaded through with a wire rope clip **01**.

c) Guide a piece of wire with a diameter of 3 mm and a tensile strength of at least 1770 N/mm^2 along the piece of rope that was threaded through and through the four rings **02**.

d) Repeat this until the number of turns of the adjacent rings has been reached.

e) Fix the circular shape of the resulting ring bundle with three wire rope clips **03** (7 turns: WRC 1/4"; 12 turns: WRC 5/16”; 16 turns: WRC 7/16”; 19 turns: WRC 9/16”).

f) Remove the piece of rope that was threaded through.



8.6.4 ROCCO: replacing a net field

a) Release the shackles to the adjacent nets.

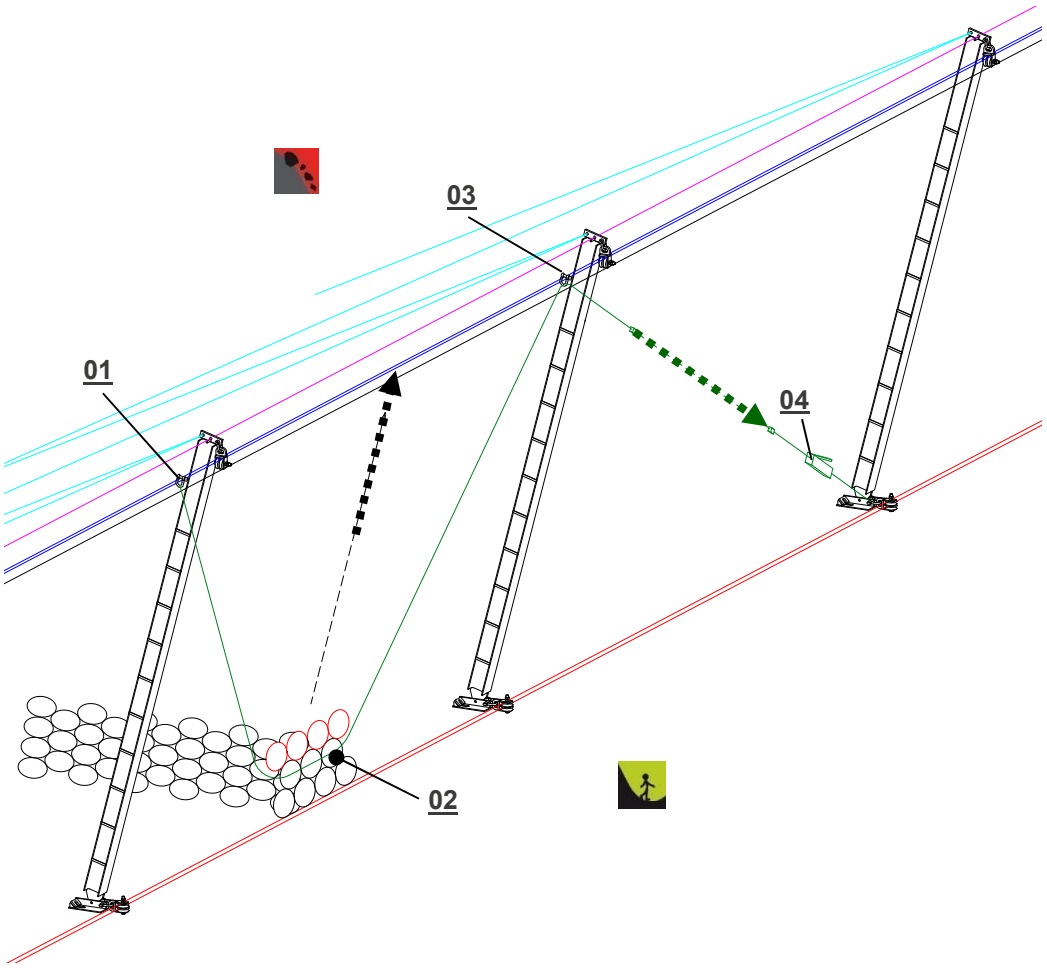
b) Cut open the rings on the support ropes and the arrestor cables, and remove the damaged net.

c) Lay the replacement net, still bundled, on the mountain side, between the two posts. The rows of rings for the support ropes and arrestor cables are marked in colour. Do not cut open the tied-up rows of rings yet.

d) Using a shackle, fasten an auxiliary rope to the top support rope next to the adjacent posts **01**, pull it through the rings in the second row of the replacement net **02**, and guide it through a second shackle **03** on the top support rope next to the other post, to the cable pulley device **04**. Tighten the rope until the first row of rings of the net is at the same height as the top support rope. Whilst pulling up, gradually cut open the tied-up rows of rings of the net.

e) Pull up the net like a curtain, and, using the corresponding shackles, join the net rings to the support ropes, the adjacent net fields and the arrestor cables.

f) Take care to ensure that the correct number of rings is fastened to the right and left of the post, not on the support ropes, but on the U-Ropes. Detailed information can be found in the corresponding product manual.



8.6.5 Wire mesh: replacing a length of mesh

a) Cut open the wire binders of the damaged length of mesh and remove the length of mesh.

b) Restore the geometric state of the barrier by e.g. tightening ropes, replacing U-brakes, etc.

c) Using wire binders, fasten the new length of mesh to the main net in accordance with the product manual.

8.7 Repairing ropes

As a basic principle, ropes are replaced rather than repaired.

8.8 Replacing ropes

Ropes must be replaced if the rope is damaged according to section 4.5. Often, only the elongated U-brakes need to be replaced.
Depending on the situation, replacement is done in accordance with sections 8.2 / 8.3 / 8.4.
The required tightening torques are listed in section 7.

8.9 Replacing posts

8.9.1 Replacing middle posts

In most cases, the middle post can be replaced without dismantling the net or the ropes.

d) Secure the faulty post with auxiliary ropes.

e) Dismount the shackle with the running wheel on the post head.

f) Remove the hinge bolt of the post.

g) Lift the post out of the base plate using a winch, and place it, secured, on the ground on the mountain side.

h) Transfer the retaining ropes from the faulty post to the new post.

i) Place the post foot into the base plate and fit the hinge bolt.

j) Erect the post in a secured manner.

k) Refit the running wheel to the post head.

l) Remove the securing ropes.

8.9.2 Replacing edge posts

The lateral ropes brace the entire barrier via the edge posts on the slope. It is therefore essential to loosen the lateral ropes when replacing an edge post. Depending on the situation, the subsequent middle posts can be used to perform the function of the edge posts during repairs. In this case, the middle post is secured on the valley side and the lateral ropes are fixed to the middle post using suitable equipment. The edge post is then replaced as described in section 8.9.1. If this is not possible, a certain number of fields or the entire barrier must first be laid securely facing up the mountain until the edge post can be replaced.

8.10 Replacing the hinge bolt between post and base plate

The post is raised using a winch and the faulty bolt is removed and replaced by a new hinge bolt.

8.11 Replacing a base plate

It is not possible to replace a base plate while it is still connected to the post. For this reason, first of all the post is removed as described in section 8.9. The running wheel of the bottom support rope is also dismounted. The faulty base plate is then replaced by a new one and the barrier is refitted.

8.12 Replacing base plate anchors

Replacing base plate anchors requires the base plate and the post to be removed in accordance with section 8.9 / 8.10 / 8.11. Depending on the type of damage to the foundation or the anchors, it may be necessary to recreate the foundation in a suitable location nearby in accordance with the product manual and the anchor forces sheet.

8.13 Replacing spiral rope anchors

To replace a rope anchor, it must first be relocated in a suitable location nearby in accordance with the product manual and the anchor forces sheet.

9 FINAL CHECK

After servicing has been completed, above all the following points must be checked:

a) Are the support ropes and arrestor cables, as well as the lateral bracing, joined to the correct anchors?

b) Are the rope guides at the foot and head of the post laid out correctly?

c) Has the correct number of mesh loops or rings been left free to the left and right of the posts?

d) Is the net fitted correctly to the support ropes or U-Ropes?

e) If support ropes have been separated, are the bottom support ropes joined to the corresponding anchor and not to the base plate?

f) Is the number of wire rope clips on the rope end connections correct?

g) Are the wire rope clips fitted correctly?

h) Has the correct tightening torque been applied to the wire rope clips?

i) Have the nets been connected to one another correctly?

j) Have the border nets been fastened to the vertical ropes correctly?

k) Is the slack of the top support rope less than 3% of the post spacing?

"BARRIER INSPECTION" CHECKLIST

This checklist is intended for the inspection of a barrier. Please enter your observations, tick the corresponding boxes, and take photographs or video recordings.

The paragraph numbers next to the boxes (e.g. no. 4.1) are reference numbers for the corresponding description in this maintenance manual.
The paragraph describes the criteria for repair and replacement.

Location:

General remarks:	**Impact area:**

Objects in the barrier

Leaves / soil / wood	Up to 20 cm	☐		
Rubble / pebbles	> 20 cm	☐	4.1	
Stones	Up to 100 kg	☐		Stones up to approx. 35 cm in size
	> 100 kg	☐	4.1	
	> 500 kg	☐	4.1/ 4.2	Stones over 60 cm in size
	.....	☐		

Visible damage:

A) Support and transmission ropes / U-brakes

Deformed rope	Yes	☐	4.5.2
	No	☐	
Net sags between posts	Up to 20 cm	☐	
	> 20 cm	☐	4.2 / 4.3
	> 50 cm	☐	4.2 / 4.3
	> 1 m	☐	4.2 / 4.3
Elongated brakes	Up to 30 cm	☐	4.3
	> 30 cm	☐	4.3
	> 60 cm	☐	4.3
	> 80 cm	☐	4.3

B) Retaining ropes

Deformed rope	Yes	☐	4.5.2
	No	☐	
Angle between post and ground	approx. 70°	☐	
	approx. 80°	☐	4.2 / 4.3
	> 90°	☐	4.2 / 4.3

C) Remaining ropes (without brakes)

Deformed rope	Yes	☐	4.2
	No	☐	

D) Spiral rope anchor

Damaged loop	Yes	☐	4.10
	No	☐	
Pulled out of the ground (in cm)	< 3 cm	☐	
	> 3 cm	☐	4.10

E) Mesh / net

Compressed mesh loops / rings	Yes	☐	4.4
	No	☐	
Torn wires	Yes	☐	4.4
	No	☐	

F) Wire mesh

Torn down / punctured	Yes	☐	4.4.4
	No	☐	

G) Post / base plate

Deformed post	Yes	☐	4.6
	No	☐	
Hinge bolt bent / broken	Yes	☐	4.7
	No	☐	
Deformed base plate	Yes	☐	4.8
	No	☐	

Damaged rod anchor	Yes	☐	4.9
	No	☐	
Rod anchor pulled out of the ground	> 3 cm	☐	4.9

H) Wire rope clips

All wire rope clips have the right torque	Yes	☐	7
	No	☐	7

Remarks / Notes / Sketches:

Name of validator: ……..

Date: …… Signature: …….