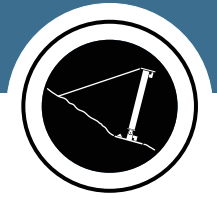


Rockfall protection system



Installation Manual TSA-3000-ZD Attenuator - 3 Valley Gap



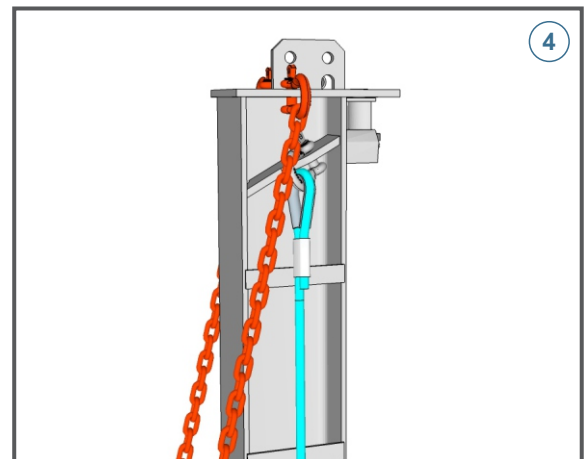
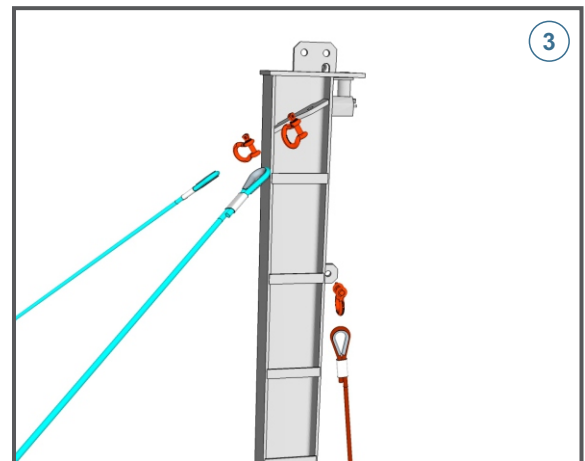
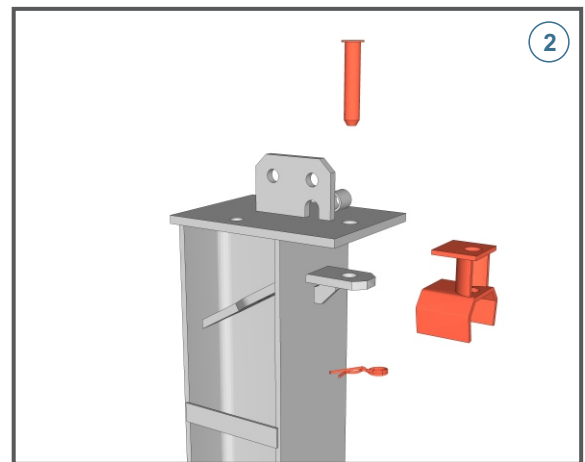
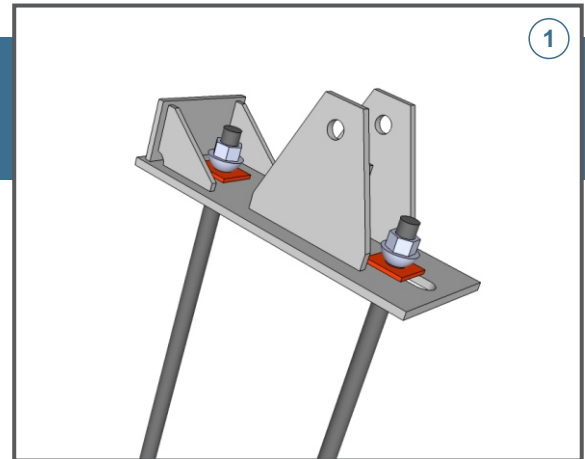
Site Preparation and Layout

- SP1)** The layout of the system and anchor design is provided by the responsible project engineer and must be followed. Any deviations must be approved by the engineer.
- SP2)** Anchor locations should be clearly marked following the design and under the supervision of the project engineer as it is often necessary to adjust anchor locations based on site conditions.
- SP3)** It is important that the anchor orientation allows an efficient transfer of load. Poorly placed anchors can have negative impacts on system performance.
- SP4)** During the installation of the anchor, it is important that a sufficient length is left protruding from the slope to allow the appropriate hardware to be attached.

Post Preparation

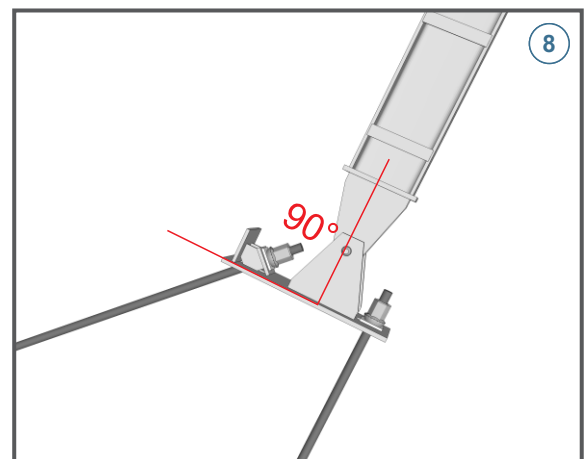
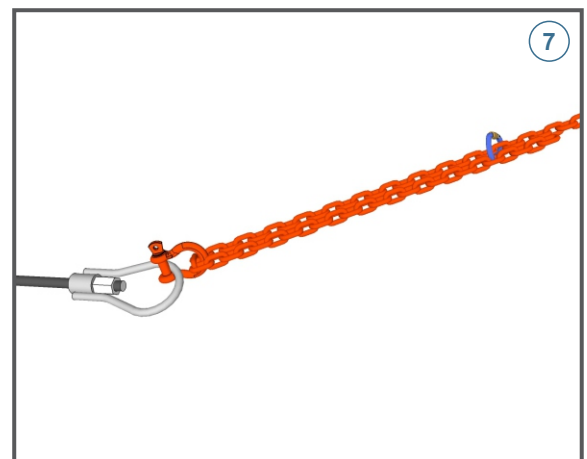
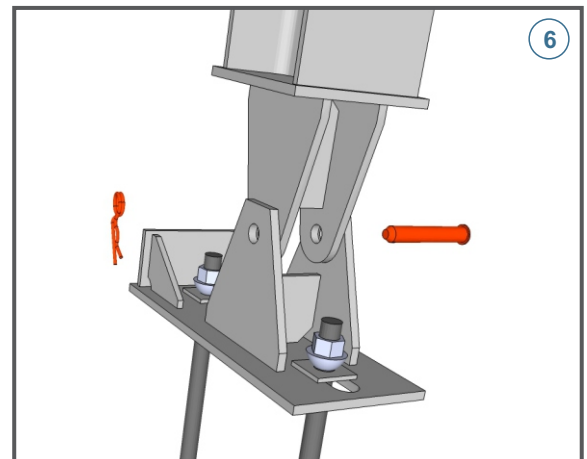
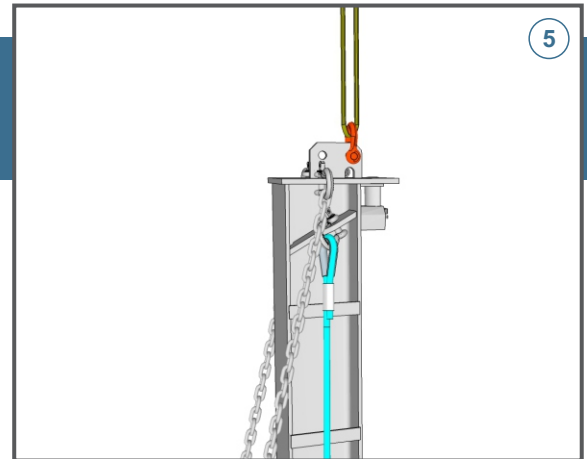
- PP1)** Install base plates at post locations. Both the upslope and downslope anchors are oriented at 90 degree to the base plate. The anchor guard is located on the upslope side of the base plate. Appropriate washers and anchor nuts must be used. Ensure the base plate has full contact with the ground and that the anchor nuts are sufficiently tight. **(1)**
- PP2)** Layout the posts at a preparation site so that the receptacle for the rope guidance is facing upward.
- PP3)** Attach the rope guide to the post head with a $\text{\O} 35$ mm pin and $\text{\O} 8$ mm cotter. The guide must have its bent tabs pointing downward and the round half-pipe towards the beam. **(2)**
- PP4)** Attach the retaining ropes to the tongues located near the post head, between the flanges of the beam with a 1" shackle and the pre-pressed eye. **(3)**
- PP5)** Attach the downslope rope to the tongue located below the rope guidance on the front of the post with a 1" shackle and the pre-pressed eye. **(3)**
- PP6)** If used, attach temporary chains or similar to the post head by an appropriate means **(not provided)** using the holes at the sides of the post head. **(4)**

The chains must be long enough to reach the retaining rope anchor and are used to hang the posts so that the retaining ropes can be installed. Each post weighs approximately 600 kg (5 m post).

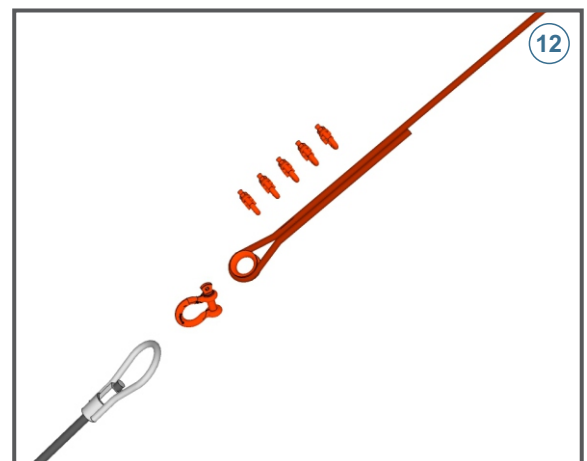
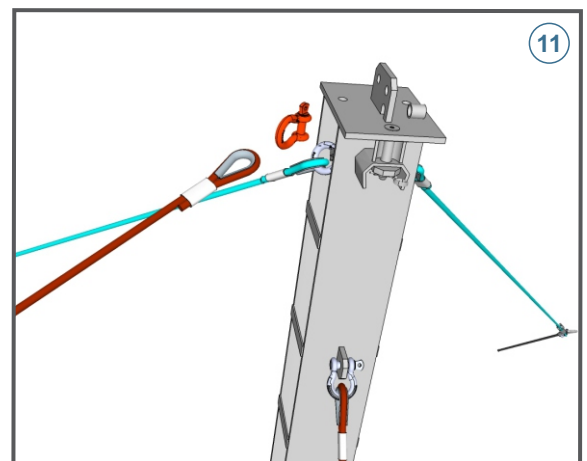
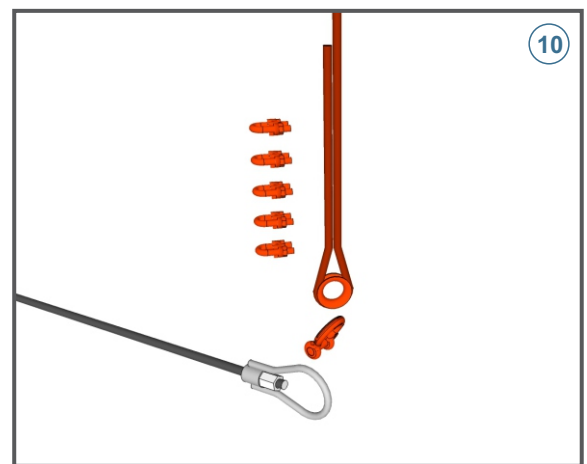
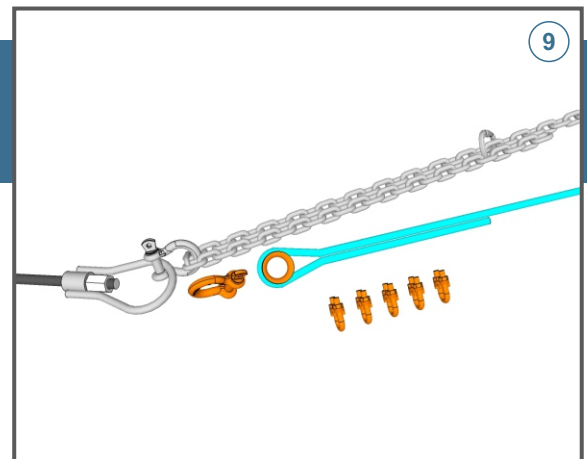


Post Installation

- PI1)** Attach a sling or similar (**not provided**) to the post head to be used for lifting the post package. The holes in the vertical plate at the post head can be used for this purpose. **(5)**
- PI2)** Transport the post package to the base plate location using a crane or helicopter.
- PI3)** Set the post in the base plate so that the tongues of the post are between the tongues of the base plate and with the rope guidance on the downslope side of the post.
- PI4)** The post is secured to the base plate using a \varnothing 40 mm pin and \varnothing 6.3 mm cotter. **(6)**
- PI5)** Lead the temporary chains to the retaining anchor and secure it to itself (not to the shackle) by an appropriate means (e.g. a carabineer). **(7)**
- PI6)** While securing the post, position it so that the post is approximately near it's final angle.
- PI7)** The correct angle of the post is to be determined by the project engineer. Ideally, if the base plate is installed at an angle parallel to the average slope, the angle between the post and base plate should close to 90 degrees. **(8)**

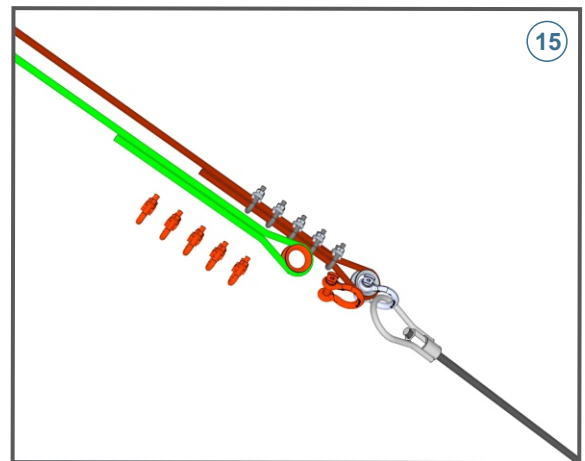
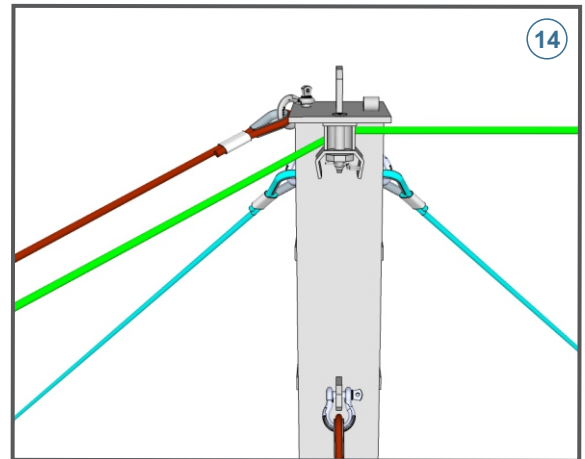
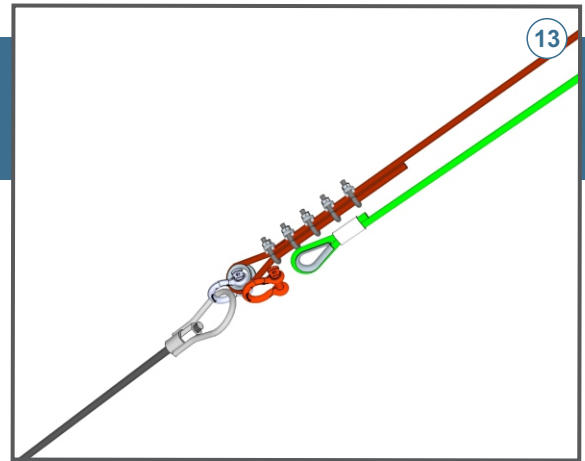


- PI9)** Attach a 1" round thimble to the appropriate anchor for the retaining rope using a 1 1/8" shackle. **(9)**
- PI10)** Lead the retaining rope around the thimble and tension the rope using a come-along or similar, pulling the post to the correct angle. Secure using 5 pieces of 1" wire rope clips according to industry standards (see Appendix A). **(9)**
- PI11)** After installing and securing the retaining ropes, the temporary chains can be removed.
- PI12)** It is important that the retaining ropes have approximately equal tension so that symmetrical loading of the post occurs during an impact.
- PI13)** The outer retaining anchor for end posts will only have one retaining rope attached to it.
- PI14)** Attach a 1" round thimble to the appropriate anchor for the down slope rope using a 1" shackle. **(10)**
- PI15)** Lead the down slope rope around the thimble and tension the rope using a come-along or similar. Secure using 5 pieces of 1" wire rope clips according to industry standards (see Appendix A). **(10)**
- PI16)** A side stabilization rope is attached to the end posts of each fence line. It is not required on a cross-over post where two sections join. However, a temporary stabilization rope may be useful during installation.
- PI17)** Attach the side stabilization rope to the post head using the provide holes and a 1" shackle and the pre-pressed eye. **(11)**
- PI18)** Attach a 1" round thimble to the appropriate anchor for the side stabilization rope using a 1 1/8" shackle. **(12)**
- PI19)** Lead the side stabilization rope around the thimble and tension the rope using a come-along or similar. Secure using 5 pieces of 1" wire rope clips according to industry standards (see Appendix A). **(12)**
- PI20)** Follow the above steps for each post until a complete section of fence is installed.
- PI21)** After the final installation of the system, including the hanging of nets, etc., post angles may require re-adjustment.



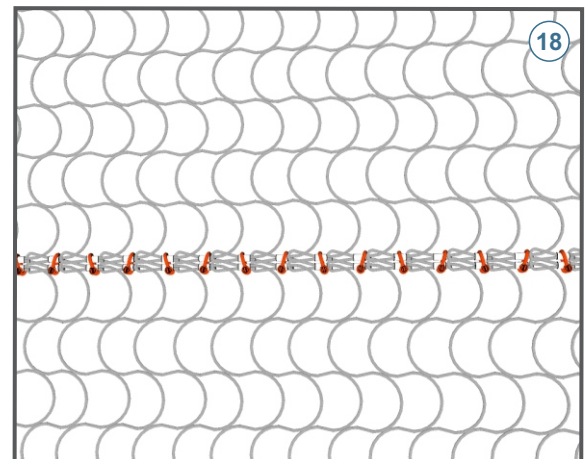
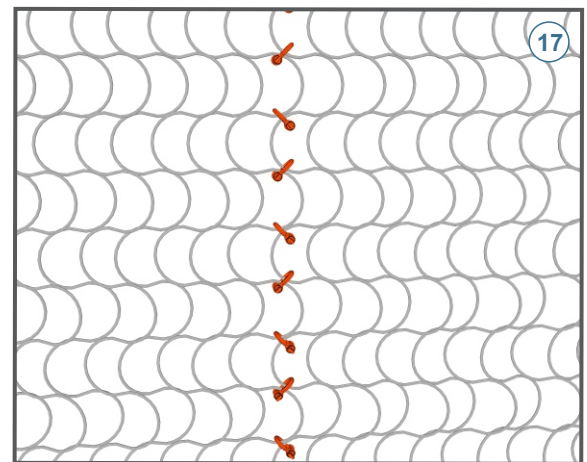
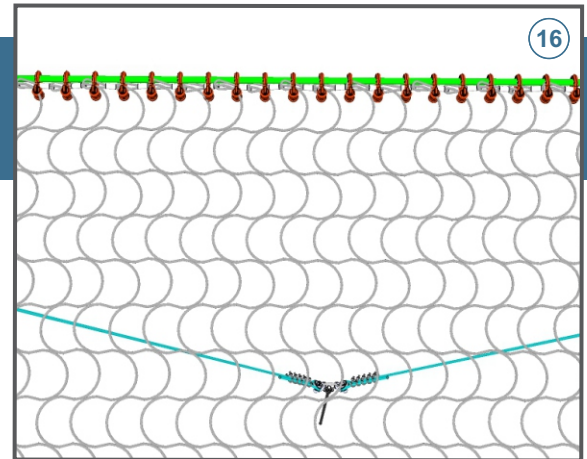
Bearing Rope Installation

- BR1)** There is typically one bearing rope that stretches across one section of fence system. Where post spacing is excessive, a second bearing rope may be required.
- BR2)** Attach the bearing rope to the appropriate anchor using the pre-pressed eye and a 1 1/8" shackle. **(13)**
- BR3)** Lead the bearing rope through the rope guide of the first post and through each subsequent post until reaching the opposite lateral anchor of the fence section. **(14)**
- BR4)** Attach a 1" round thimble to the appropriate anchor for the bearing rope using a 1 1/8" shackle. **(15)**
- BR5)** Lead the bearing rope around the thimble and tension the rope using a come-along or similar. Secure using 5 pieces of 1" wire rope clips according to industry standards (see Appendix A). **(15)**
- BR6)** Repeat the above steps for the second bearing rope if used.



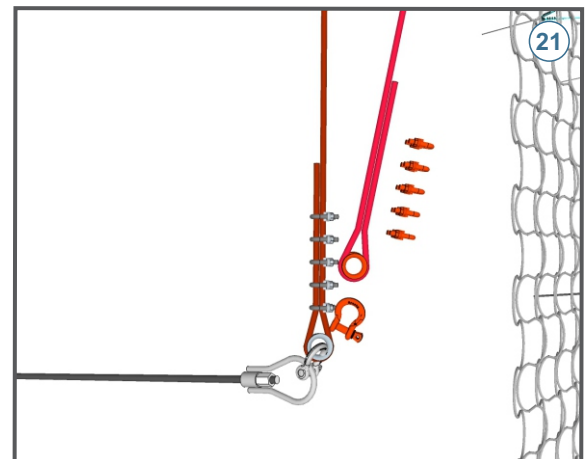
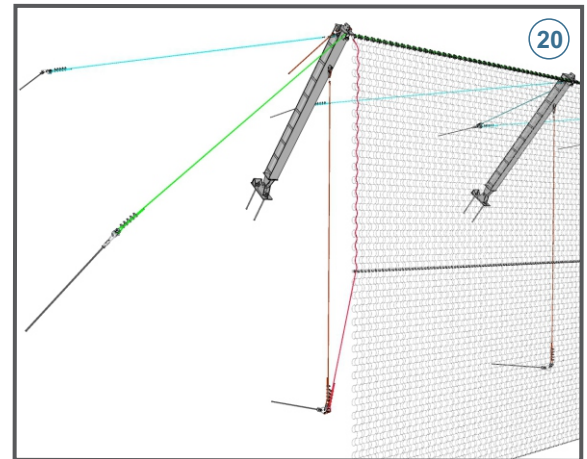
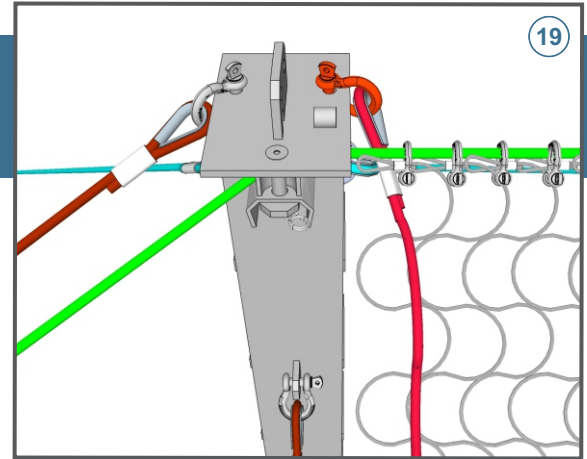
Omega-Net Installation

- ON1)** Both the upper and lower nets consist of Omega-Net 9.0/185.
- ON2)** Net panels come as a folded package. The panels are 3 m wide by 6 tall m and weigh approximately 125 kg each.
- ON3)** The net panels are hung so that the strand is vertical and are attached to the bearing ropes using shackles.
- ON4)** It is important to note that the nets are directional and have one corner marked with GREEN paint. This corner must have the same orientation throughout the fence line, though it is irrelevant what the orientation is (e.g. it must always be in the upper right).
- ON5)** In a lay down area, spread out the net panel noting the orientation.
- ON6)** Heave the net to the upper bearing ropes and attach using one 3/4" shackle per strand (use 1" shackles for double bearing ropes). In this regards, it may be useful to use a rake or spreader bar (**not provided**) of some sort to deliver the panel in a spread-out form. **(16)**
- ON7)** The net can be temporarily secured using a smaller number of shackles prior to the full installation.
- ON8)** Where panels cross over a post head, it may be necessary to leave out a shackle or two.
- ON9)** Vertical seams between adjacent panels are made using 7/16" shackles as shown. **(17)**
- ON10)** When connecting to an adjacent, existing system, the same vertical seam is used.
- ON11)** Once all of the upper nets are installed, the lower net panels are attached to the bottom of the upper net panels.
- ON12)** Heave the net to the lower boundary of the upper net panel and attach using one 1/2" shackle per strand. **(18)**



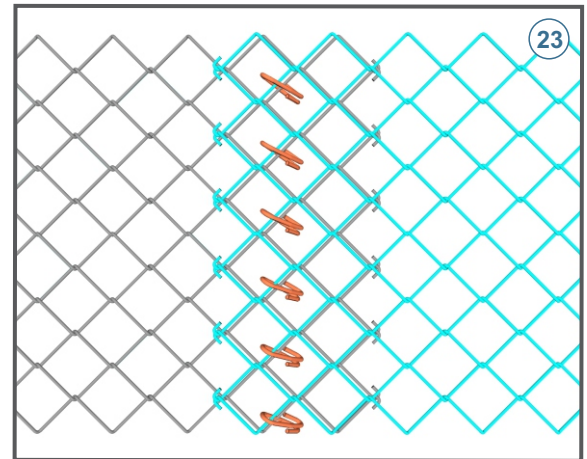
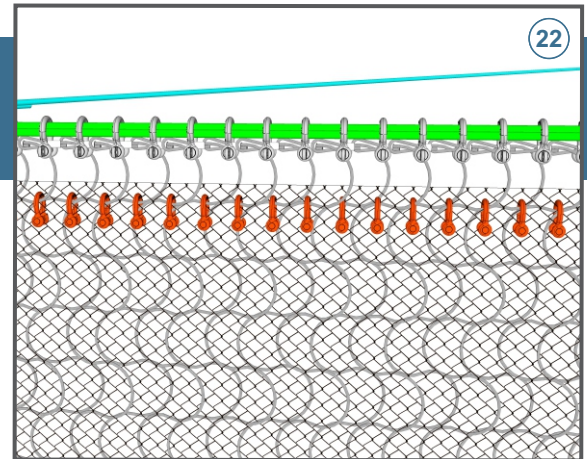
Border Rope Installation

- B11)** A border rope is attached to the end post of each fence line. It is not required on a cross-over post where two sections join.
- B12)** Attach the border rope to the inner side of the post head with a 1" shackle. **(19)**
- B13)** Weave the border rope down the side of the upper net through each mesh opening and exiting at an appropriate height to continue to the down slope anchor. **(20)**
- B14)** Attach a 1" round thimble to the anchor eye loop using a 1" shackle. **(21)**
- B15)** Lead the border rope around the thimble and hand tension the rope. The rope should be slack. **(21)**
- B16)** Secure using 5 pieces of 1" wire rope clips according to industry standards (see Appendix A). **(21)**



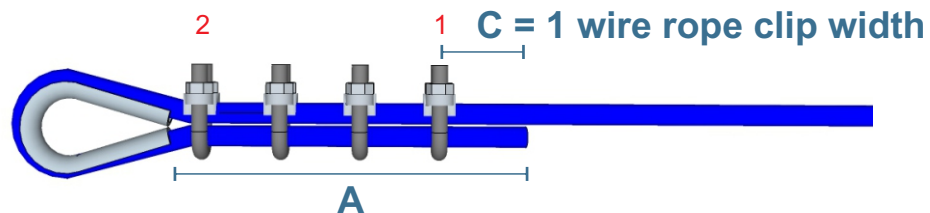
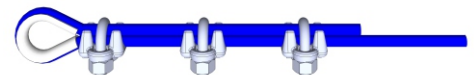
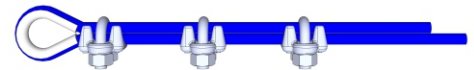
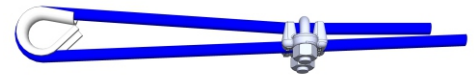
Secondary Netting Installation

- SN1)** The secondary netting consists of high-tensile Sigma Netting 50/3.2.
- SN2)** Netting comes in rolls that are 3.5 m x 12 m that weigh approximately 116 kg each.
- SN3)** The netting is attached to the upper net at the bottom of the first mesh opening using shackles.
- SN4)** Heave the unrolled netting panel into place and secure to the Omega-Net using 5/8" shackles, one per Omega-Net strand (or approximately every 3 mesh openings). **(22)**
- SN5)** Make sure the shackle is not in the last mesh opening of the Sigma Netting.
- SN6)** Netting panels must be overlapped by two mesh openings.
- SN7)** Vertical seams are made using S47 clips as shown. **(23)**

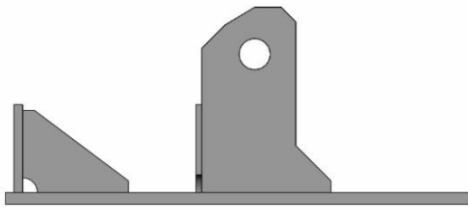


Appendix A: Wire Rope Clip Installation - EN 13411-5, Type 2

- AA1)** The following table provides the specifications for the installation of wire rope clips.
- AA2)** It is very important that these specifications are observed.
- AA3)** Before installation, a visual inspection of the clips is mandatory in order to ensure that they are free from defects. Any defective clips must be discarded.
- AA4)** The noted tightening moments in the table below are only applicable for threads and nut washers that have NOT been greased but that are clean.
- AA5)** The U-bolts must always be put on over the end of the rope that is not subject to stress ("Never saddle a dead horse ")
- AA6)** Lead the rope around the thimble back on itself the specified distance **A** in the table above.
- AA7)** Install the first wire rope clip (1) a distance of **C** from the rope end. Tighten the nuts of the U-bolt evenly, by alternating between the first and second nut continuously until reaching the specified torque moment.
- AA8)** Install the second wire rope clip (2) as near the thimble as possible, again tightening in an alternating fashion as per Step 2.
- AA9)** When more than two wire rope clips are required, divide the space between the two existing clips into equal segments and install the necessary number of clips as per Step 2..



Ropeø [mm]	Wire Rope Clip Size [inch]	Number of Clips [pcs]	Distance A [mm / inch]	Wrench/Socket Size [inch]	Tightening Moment [Nm / ftlb]
3-4	1/8	2	85 / 3.25	3/8	6.1 / 4.5
5	3/16	2	95 / 3.75	7/16	10.2 / 7.5
6-7	1/4	2	120 / 4.75	9/16	20.3 / 15
8	5/16	3	133 / 5.25	11/16	40.7 / 30
9-10	3/8	3	165 / 6.5	3/4	61 / 45
11-12	7/16	3	178 / 7	7/8	88 / 65
13	1/2	3	292 / 11.5	7/8	88 / 65
14-15	9/16	3	305 / 12	15/16	129 / 95
16	5/8	3	305 / 12	15/16	129 / 95
18-20	3/4	4	460 / 18	1 1/16	176 / 130
22	7/8	4	480 / 19	1 1/4	305 / 225
24-26	1	5	660 / 26	1 1/4	305 / 225



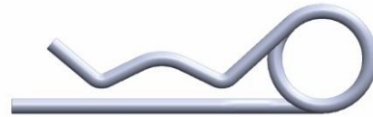
Base Plate (12 pcs + 1 extra)



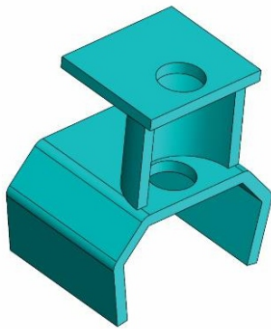
Rope Guidance Pin (12 pcs + 1 extra)



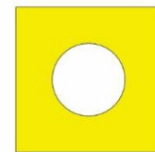
Post (12 pcs + 1 extra)



Cotter Pin (24 pcs + 2 extra)



Rope Guidance (12 pcs + 1 extra)



Washer (24 pcs + 2 extra)



Base Plate-Post Pin (12 pcs + 1 extra)

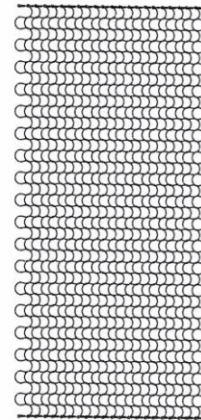


Thimble, Round 24 mm (43 pcs)

Thimble, Tear-Drop 1" (16 pcs)



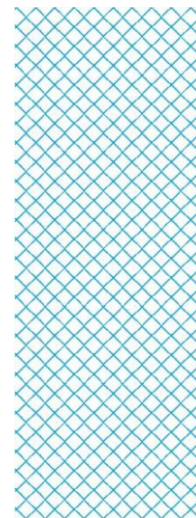
Retaining Rope, 24 mm, 30 m (29 pcs)



**Omega-Net 9.0/185, 3 x 6 m
(76 pcs)**



**Side Stabilization/Downslope Rope, 24 mm,
20 m (22 pcs)**



**Sigma Netting 50/50/3.2, 3.5 x 20 m
(44 rolls)**



Bearing Rope, 24 mm, 100 m (2 pcs)



S-Clip (14,500 pcs)



Bearing Rope, 24 mm, 50 m (3 pcs)



1 1/8" Shackle (43 pcs)



1/2" Shackle (1064 pcs)



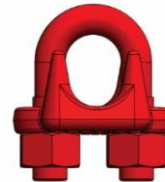
1" Shackle (340 pcs)



7/16" Shackle (2680 pcs)



3/4" Shackle (910 pcs)

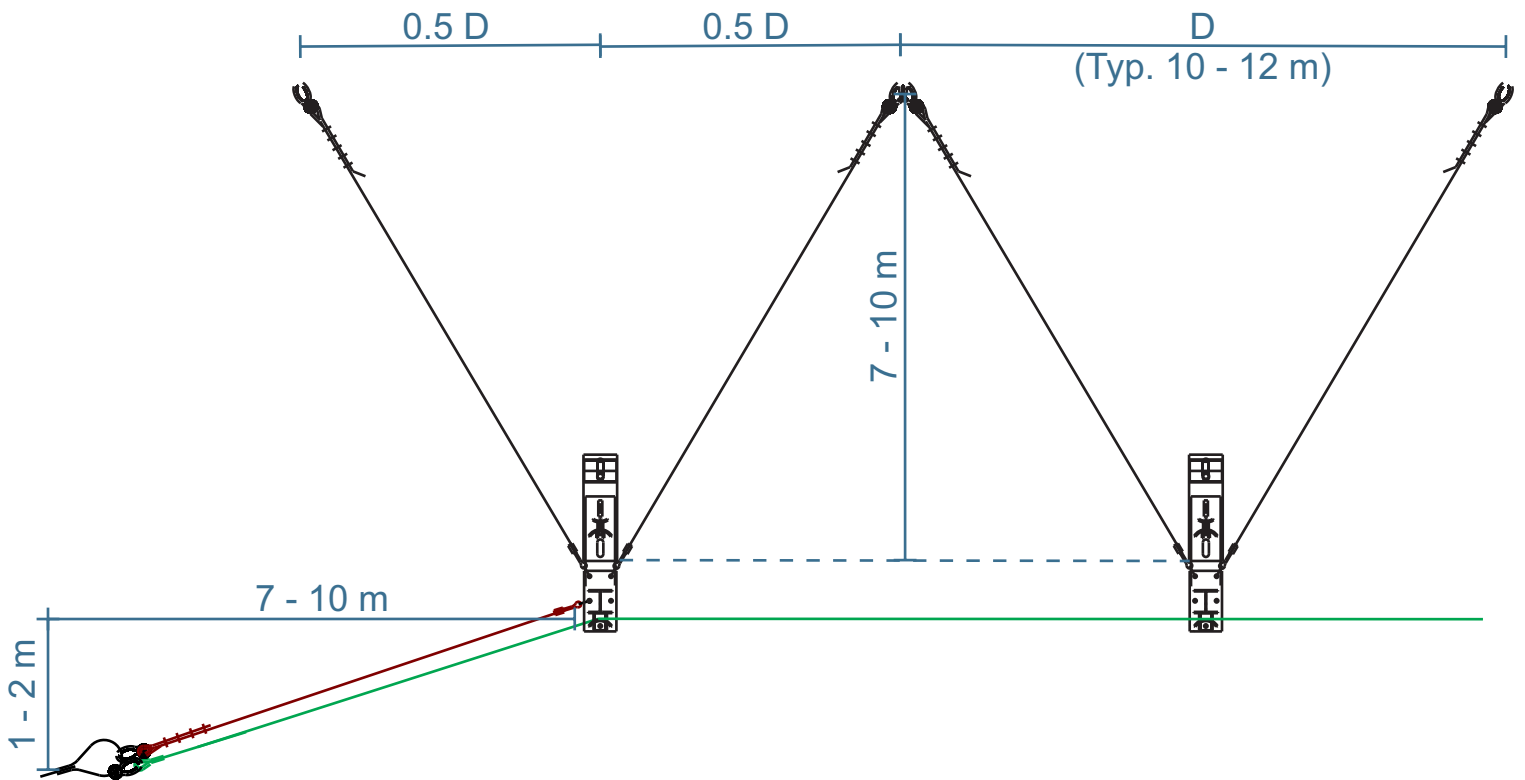


1" Wire Rope Clip (435 pcs)

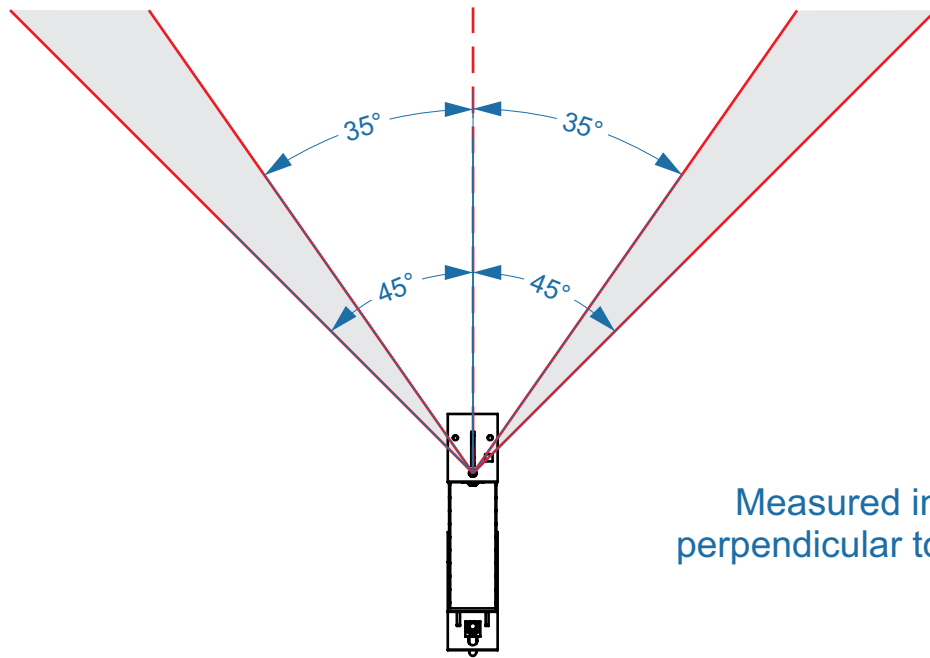


5/8" Shackle (1002 pcs)

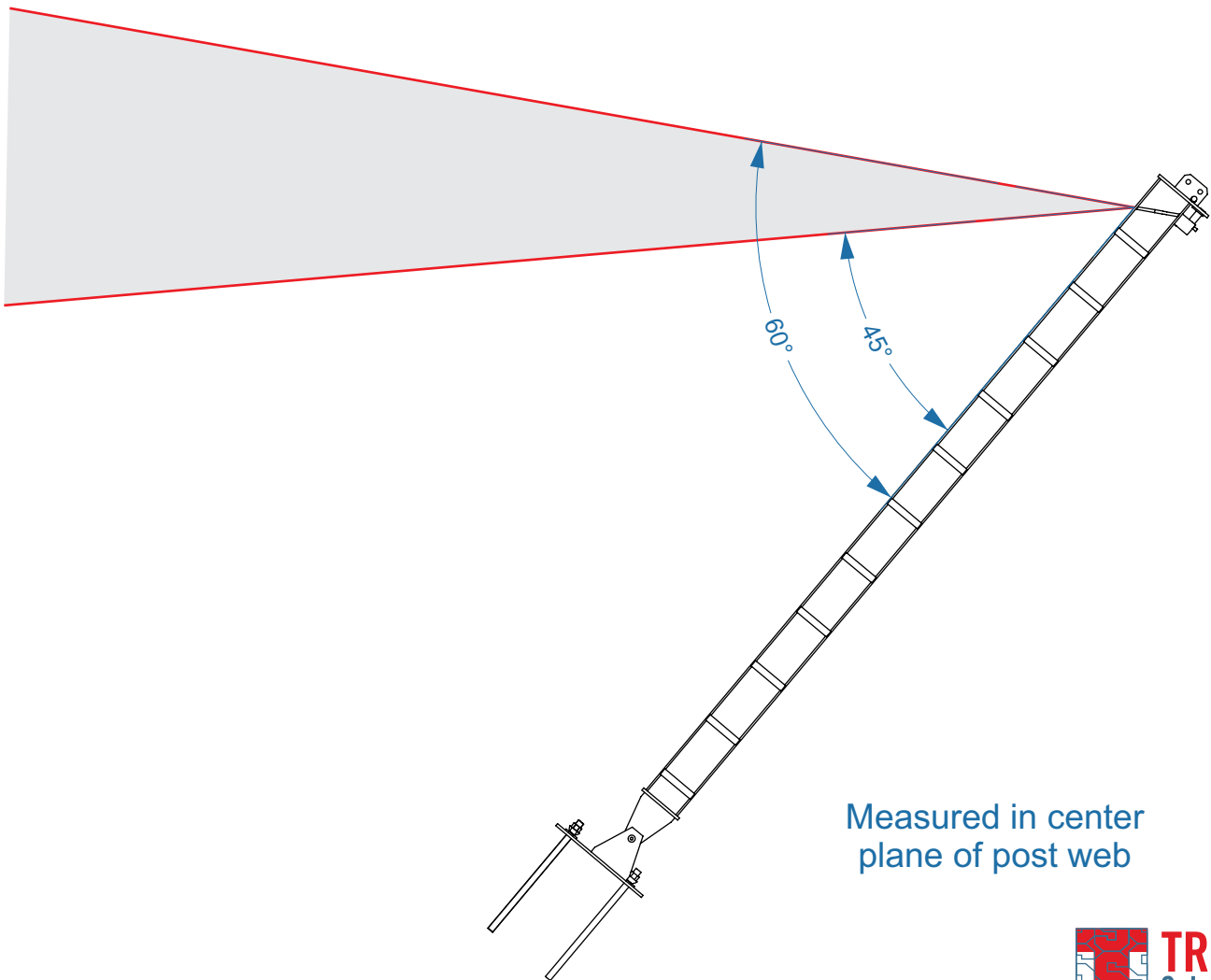
Typical Anchor Layout



Typical Retaining Rope Configuration

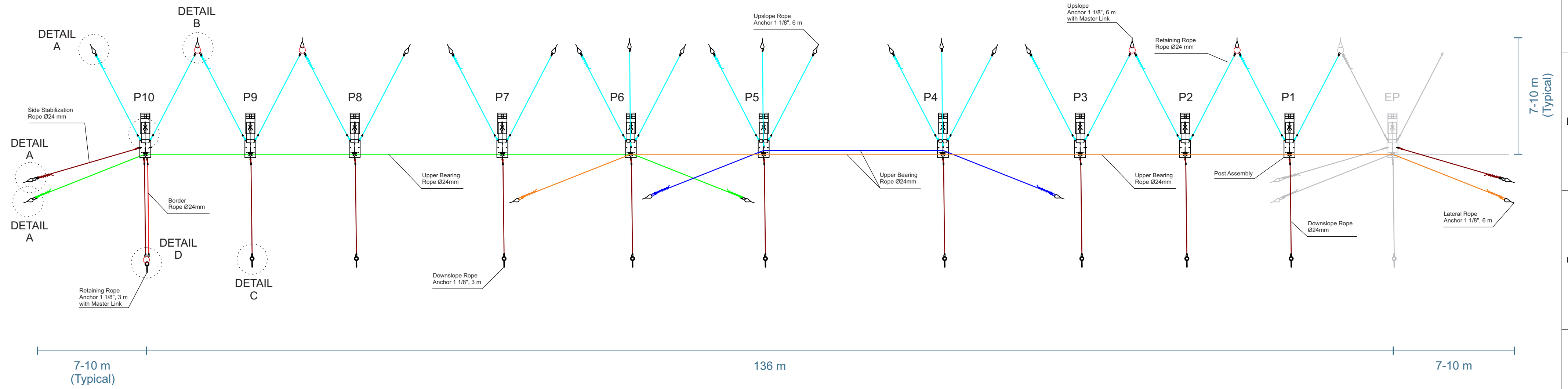


Measured in plane perpendicular to post axis

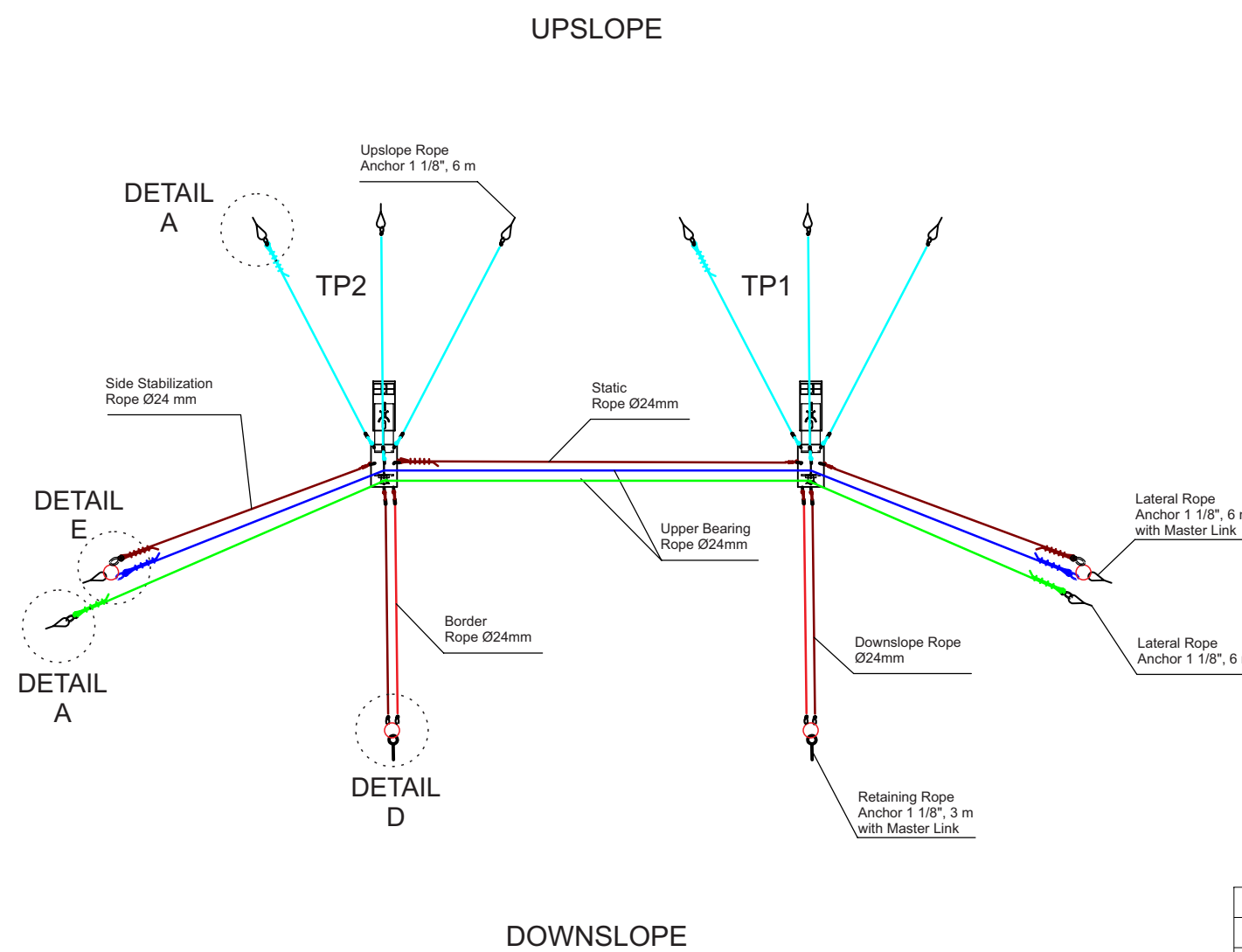


Measured in center plane of post web

FENCE 1


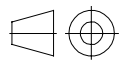


FENCE 2

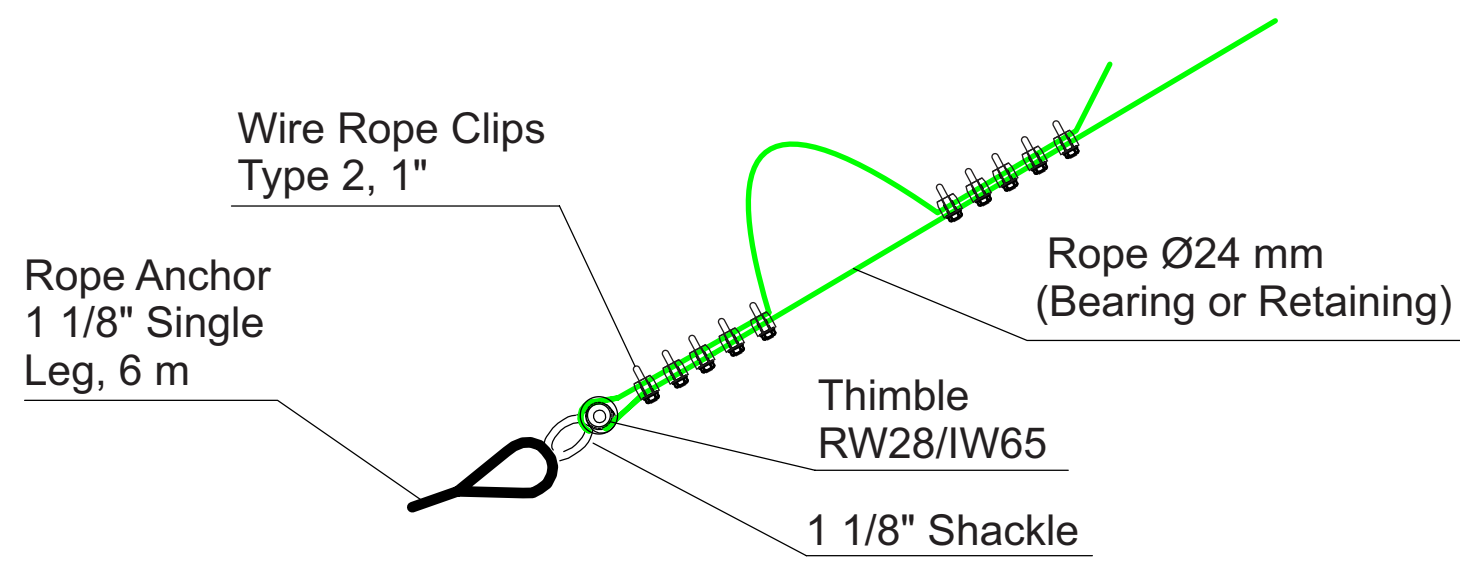


All dimensions will be fitted to site. Any dimensions indicated are only for general perspective.

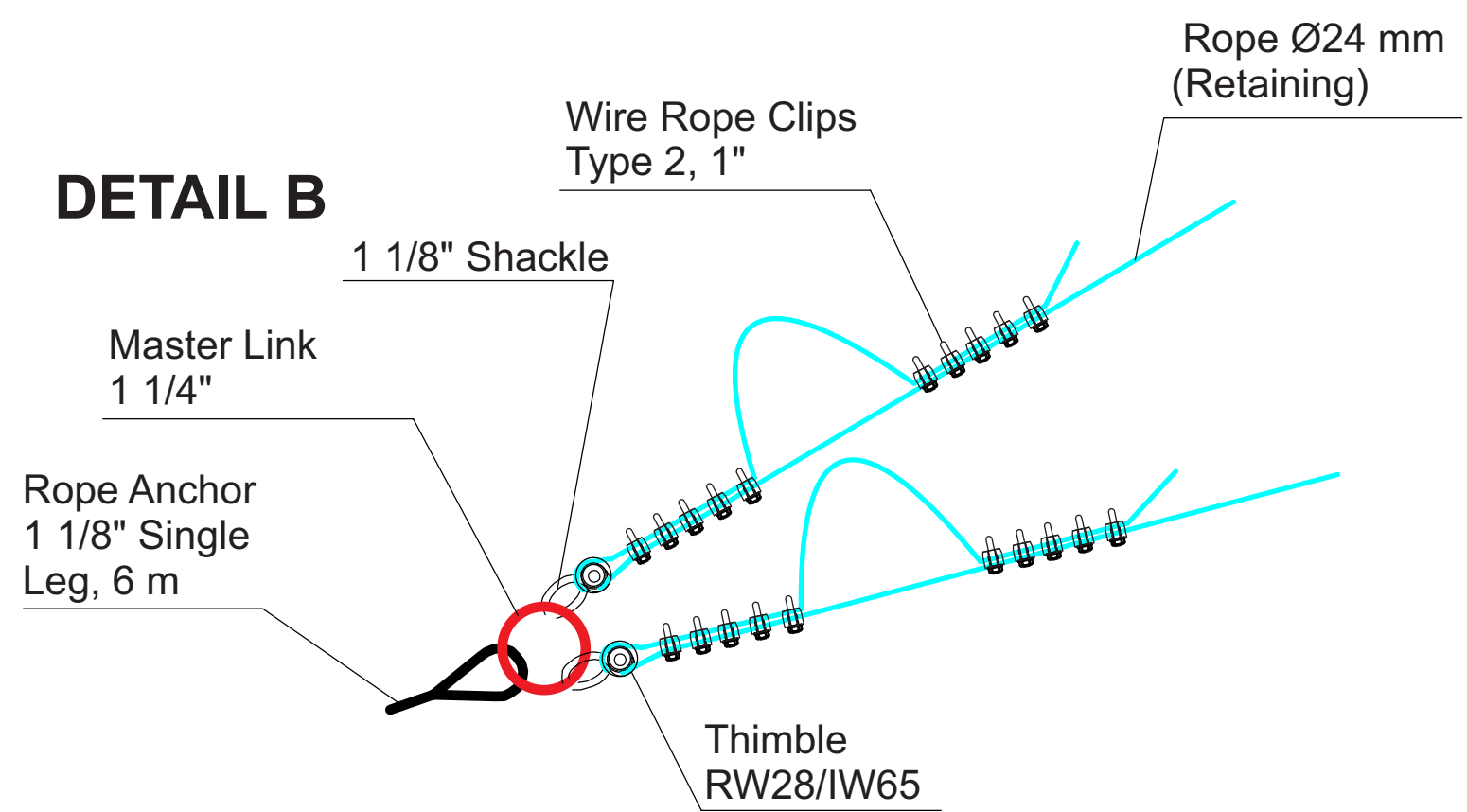
Für diese Zeichnung behalten wir uns alle Rechte nach DIN 34 vor

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Datum		Name		Zchnng. Nr.: Ers. f.: Ers. d.:
Gez.		Gepr.		
Ges.		Ges.		
Zust. Änd.-Nr.	Datum	Name		Werkstoff: Rohenteil: Halbzeug: Ers. f.:
Gewicht:				
Norm:				Format Blatt 1 von 5 Bl.

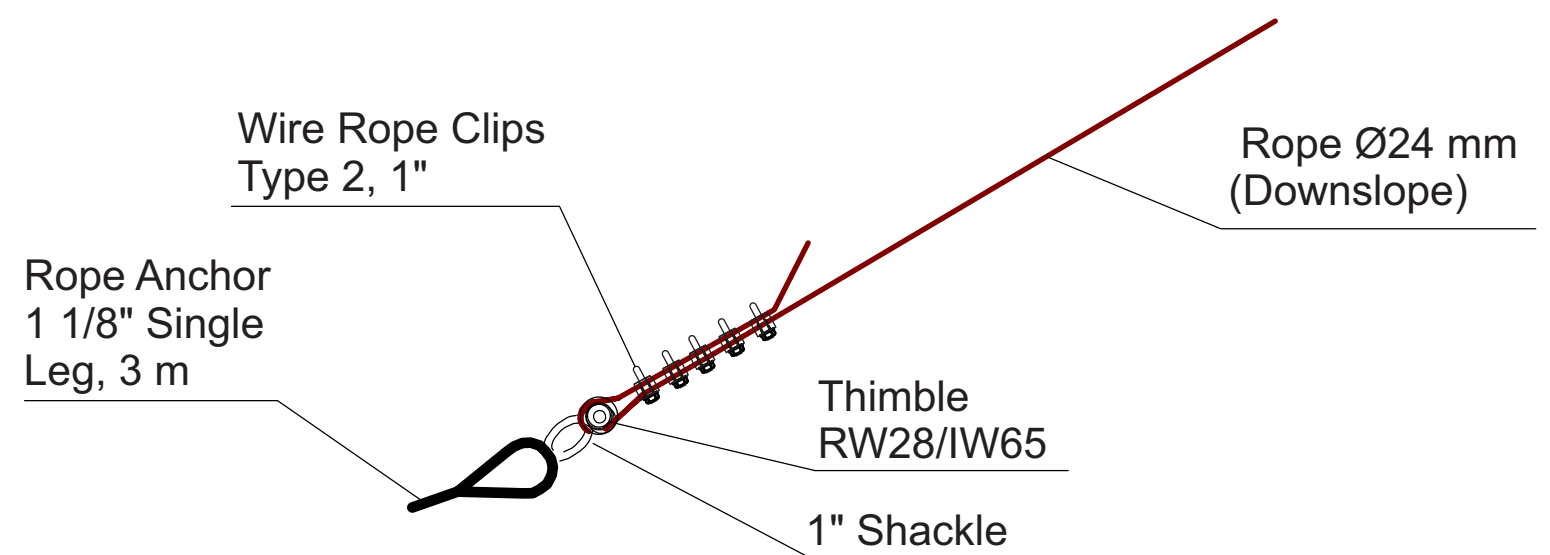
DETAIL A



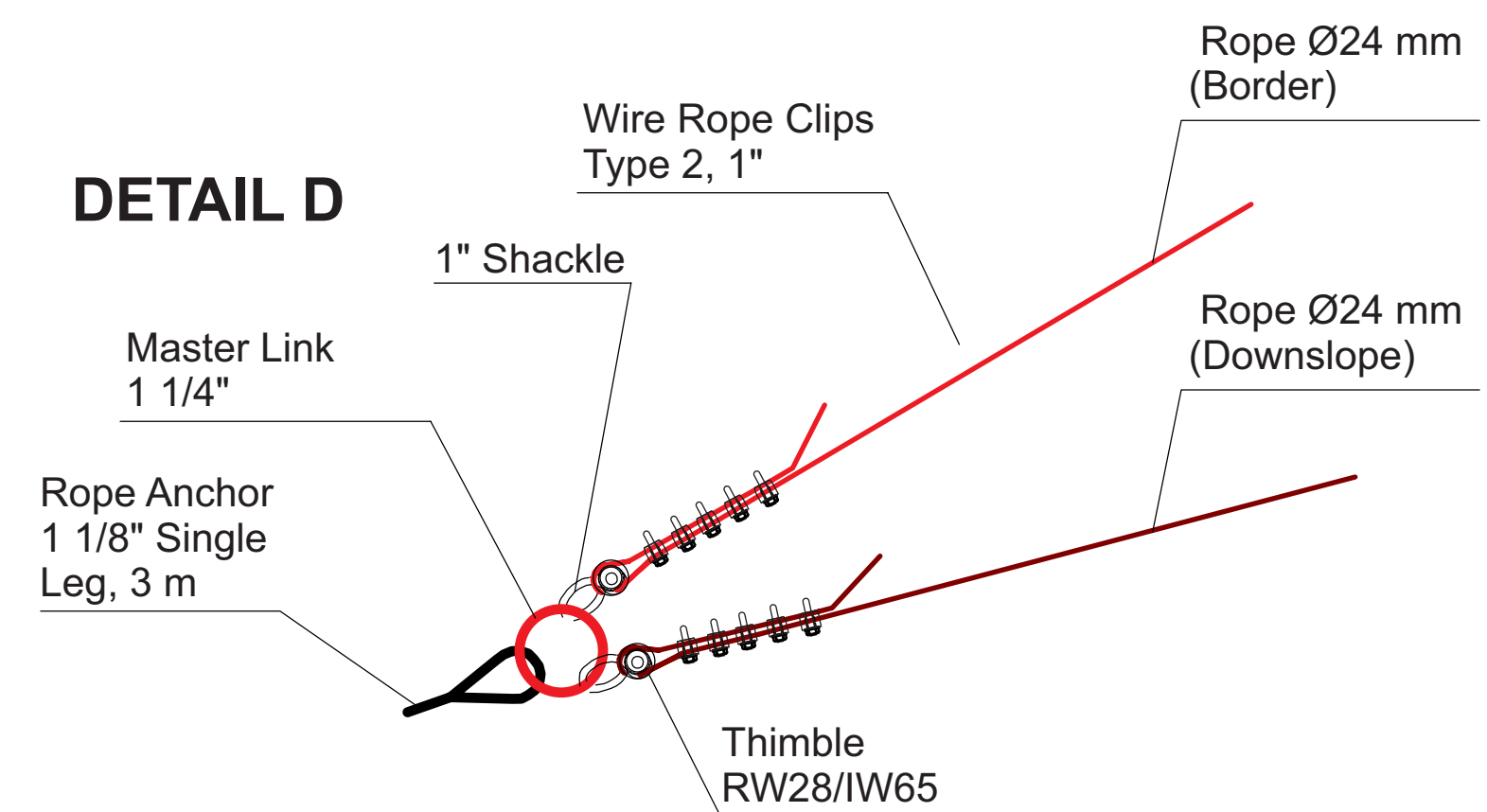
DETAIL B



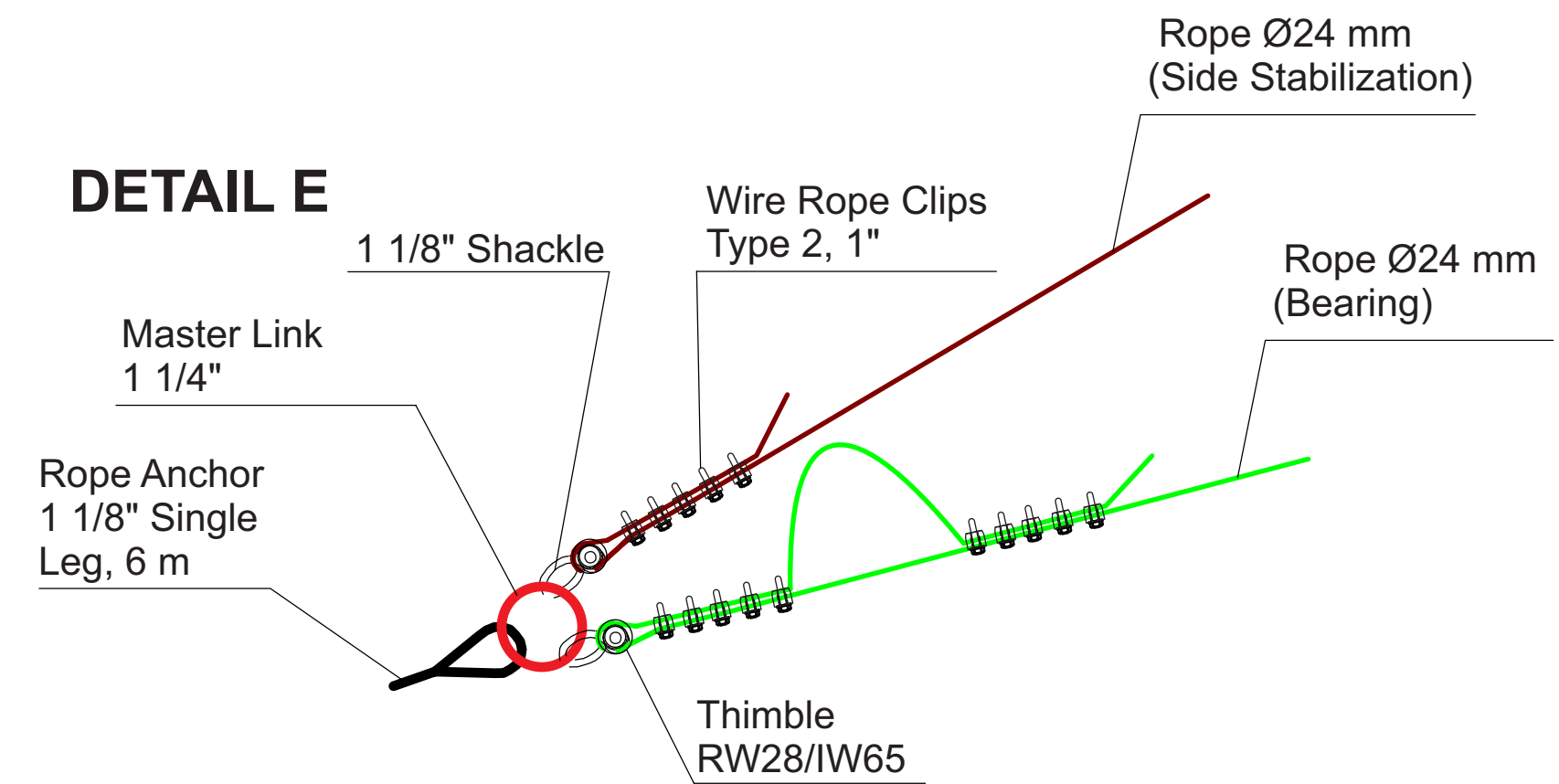
DETAIL C


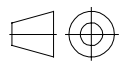


DETAIL D



DETAIL E



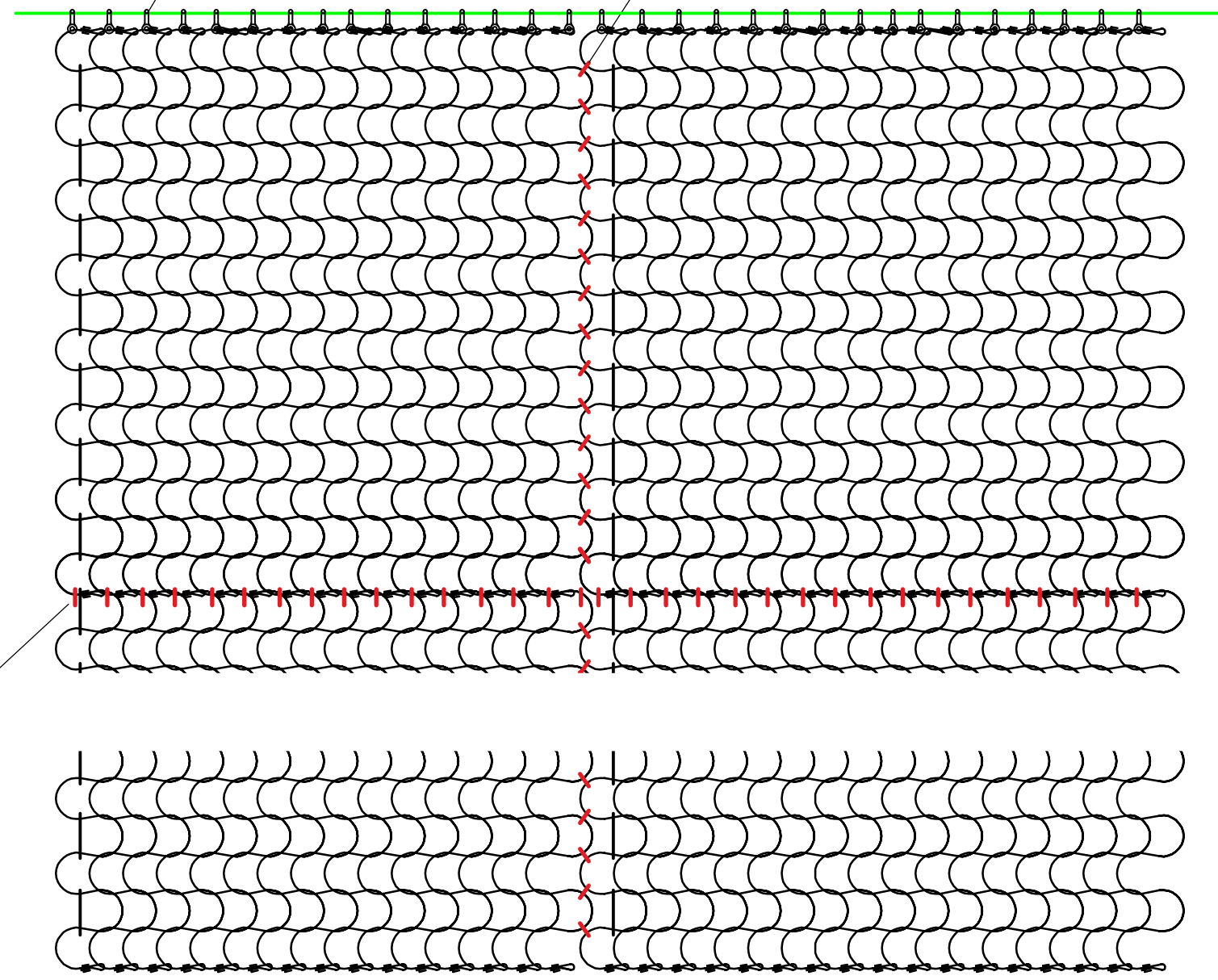
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Benennung:			3 Valley Gap TSA-3000-ZD Connection Detail		
Zust. Änd.-Nr.			Datum	Name	Zchnng. Nr.: Ers. d.:
Gewicht:			Werkstoff: Rohteil: Halbzeug: Ers. f.:		
Norm:					Format Blatt 2 von 5 Bl.


Für diese Zeichnung behalten wir uns alle Rechte nach DIN 34 vor

Bearing rope attachment with 3/4" shackles (1" for double bearing)

Vertical rope seam with 7/16" shackles

Horizontal rope seam with 1/2" shackles



				General tolerance:		Scale		 TRUMER Schutzbauten GmbH	
						Description:			
						3 Valley Gap TSA-3000-ZD Net Connection Detail			
						Prj. No:			
Stat.	Edit No.	Date	Name	Drawn	Date	Name	Drawing Nr.:	Format	Page 4
				Exam.					
				Seen					from 5 Pa.
Weight				Standard:					

Packing list

Pos. 1 Rockfall Protection System Custom TSC-3000-ZD Attenuator

Steel parts hot dip galvanised according to ISO 1461

Wire ropes according to EN 12385-4, Zn galvanised class B according to EN 10244-2

Omega-Net, Zn galvanised class A according to EN 10244-2

Description	Main System (Fence 1)	Upper System (Fence 2)	Extra Materials
Posts and base plates			
Post HEA 300 cross section, galvanised, S355J2, length of post: 4,655 mm	10	2	1
Base plate 790x330x20 mm, galvanised, S355J2, type custom	10	2	1
Rope guidance top for bearing rope, removeable, galvanised, \varnothing 38 mm, 190x159x120 mm	10	2	1
Hinge pin \varnothing 40 mm, length: 245 mm, galvanised spring pin included	10	2	1
Rope guide pin \varnothing 35 mm, length: 170 mm, galvanised, split pin included	10	2	1
Washers 100x100x10 \varnothing 45 mm, galvanised	20	4	2
Wire ropes			
Bearing rope \varnothing 24 mm no pressed eye			
Length: 100.0 m	2	0	0
Length: 50.0 m, secondary	1	0	0
Retaining rope \varnothing 24 mm one-sided pressed eye with thimble, length: 30.0 m	23	0	0
Side stabilisation rope \varnothing 24 mm one-sided pressed eye with thimble, length: 20.0 m	2	2	0
Downslope retaining rope \varnothing 24 mm one-sided pressed eye with thimble, length: 20.0 m	10	0	0
Bearing rope \varnothing 1" Length: 50.0 m	0	2	0
Retaining rope \varnothing 1" one-sided pressed eye with thimble, length: 30.0 m	0	6	0
Downslope rope \varnothing 1" one-sided pressed eye with thimble, length: 20.0 m	0	2	2
Static rope \varnothing 1" one-sided pressed eye with thimble, length: 20.0 m	0	1	0
Border rope \varnothing 1" one-sided pressed eye with thimble, length: 20.0 m	1	2	0
Static rope (EXISTING GEOBRUGG FENCE) \varnothing 1" one-sided pressed eye with thimble, length: 20.0 m	1	0	0
Omega-Net 9.0/185			
Upper and Lower Colour marking: green	W x H: 4.00 x 6.00 m Form of net: Rectangular	68	8
			0



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Description	Main System (Fence 1)	Upper System (Fence 2)	Extra Materials
Miscellaneous hardware			
Shackle 7/16" high-strength, cambered and galvanised	2,376	216	88
Shackle 1/2 " high-strength, cambered and galvanised	952	112	0
Shackle 5/8" high-strength, cambered and galvanised	888	104	10
Shackle 3/4" high-strength, cambered and galvanised	798	0	112
Shackle 1" high-strength, cambered and galvanised	201	141	0
Shackle 1-1/8" high-strength, cambered and galvanised	33	10	0
Round thimble RW28 / IW65 mm for wire rope ø 22 - 24 mm, galvanised	43	0	0
Standard thimble 1" for wire rope ø 1", galvanised	0	17	0
Wire rope clip acc. EN 13411-5, Type 2, NS 1 long life coating	350	0	0
Wire rope clip 1" Ministry Supplied	0	90	0
Connecting clips ø 4.7 mm for mesh panel connection	5,928	780	7,792

Mesh layer

Sigma netting 50/3.2 ZnAl class B galvanised, Roll dimensions: 12.0 x 3.50 m with inlayed tube	39 reels 1,638 m ²	5 reels 210 m ²	0
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DSI #14 Gr80 Threadbar Galvanized, 6 m long	20	4	2
DSI #14 Gr80 Threadbar Galvanized, 3 m long	19	0	0
DSI #14 Eye Nut Galvanized, 70 KIP Max Capacity	19	0	0
DSI Multi-leaf Spacer Type 15x10L	38	6	0
DSI #14 Cast Steel Hex Nut, Galvanized	22	4	0
DSI #14 Galvanized Flat Hardened Washer	22	4	0

WESCO 1-1/8" 6x36 IWRC Galvanized, Thimble eye 6 m long	22	8	3
WESCO 1-1/8" 6x36 IWRC Galvanized, Thimble eye 3 m long	9	0	3
WESCO 1-1/8" 6x36 IWRC Galvanized, Thimble eye with 1-1/4" Master Link 6 m long	4	2	0
WESCO 1-1/8" 6x36 IWRC Galvanized, Thimble eye with 1-1/4" Master Link 3 m long	1	2	0