Steelgrid® HR Installation Manual

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Quality System Certified AS/NZS.ISO 9001:2008

Version 2.1 March 2013

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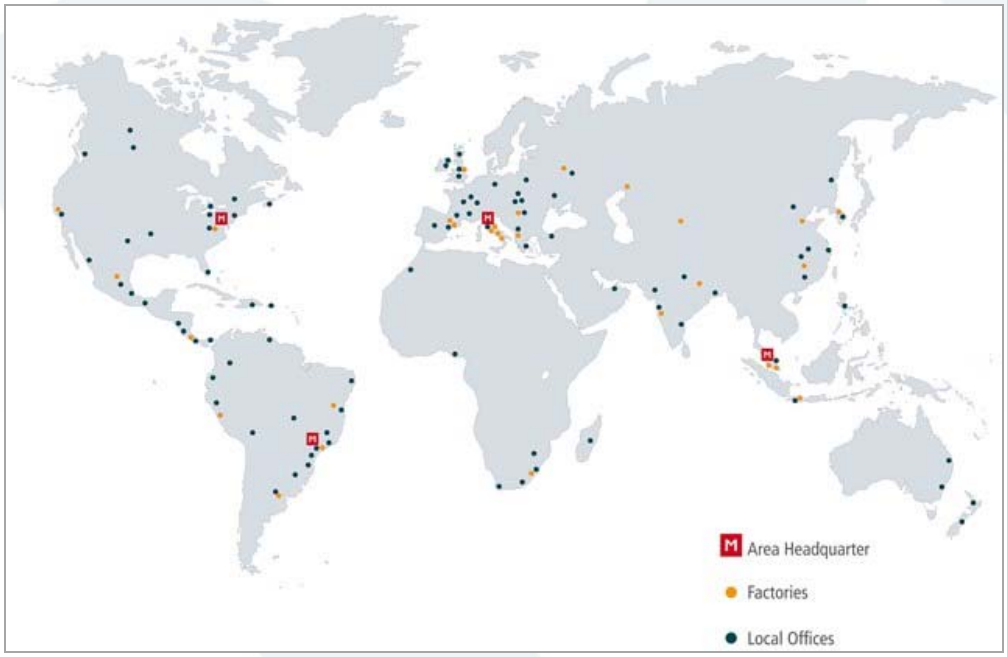


1. Introduction

Important notes regarding mesh installation

This document gives technical specification data and installation recommendations for the Steelgrid® HR & HR-PVC range of high strength mesh products.

It must be noted **that this document is NOT a design document** and is provided only for the information of engineering designers, installers and installation supervisors. Any recommendations provided in this document are provided for the purposes of information only, they are generalized and will not apply to some sites and may not be relevant under all geotechnical / geological conditions.

The information provided in this document should be used by designers and installers to help them to create a site/project-specific installation method statement that is suitable and correct for their site. The site-specific installation method statement (developed by the designer) should be checked and approved for use by suitably experienced and qualified personnel BEFORE works commence.

It must be noted that installation can be a hazardous process involving machinery, complicated processes, working at height and potentially dangerous substances. Installation should only be undertaken by suitably experienced and qualified persons using all appropriate personal protective equipment and the correct tools and machinery to the approval of the project engineer and in accordance with any prevailing local or national laws or standards/codes of practice.

The connection specifications in this document are based Maccaferri best practice guidance which is developed from extensive on site experience but also comprehensive laboratory testing. The connections shown and detailed in this manual are based on the use of one type of rope grip and other connection accessories. It should be noted that the client/contactor may choose to use other types of rope grips, rope connection devices or ancillary items. It should be noted however that while both Steelgrid® HR & HR-PVC have been tested using different types of connection it is strongly recommended that Steelgrid® HR-PVC is only connected using the types of grips (HR-Grips) as shown in this manual or ones that exceed the relevant specification of those shown.

2. Installation Guidelines – Steelgrid® HR & HR-PVC

Product Technical Information

Steelgrid® HR & HR-PVC are woven geocomposite meshes made from steel wire and ropes, woven together during hexagonal double twist wire mesh production. The Steelgrid® HR & HR-PVC geocomposites are particularly suitable for use as a rockfall protection drapery system or for improvement of surface or 'soil veneer' slope stability. When used in combination with the bespoke Steelgrid® HR-Plates (especially when used in combination with externally applied horizontal or oblique/'zigzag' wire ropes) the mesh offers considerable installation related advantages when employed in a cortical stabilization/pinned drapery role.

The principle advantages of Steelgrid® HR & HR-PVC are its high strength, high mechanical stiffness and the efficient coupling of the loads acting on the system to the crestline anchors; performance which arises from the longitudinally interwoven steel wire ropes. The steel wire used in the manufacture of the double twisted wire mesh is heavily galvanized to Class A with Galmac, a Zinc/Aluminium alloy (see technical datasheets for detailed information). In the case of Steelgrid® HR-PVC, the Class A Galmac galvanized wires are also coated in a layer of PVC. The double twist nature of the mesh helps to prevent unravelling of the mesh should any individual wires rupture.

Steelgrid® HR is available in three variants: 30, 50 and 100. In the four variants the 8mm diameter high tensile steel (1770N/mm^2) ropes are coated to Class A grade using Galmac galvanizing and are used in place of the conventional selvedge wire and are also longitudinally inter-woven within the mesh at nominal spacings of 30 cm, 50 cm and 100 cm respectively. Steelgrid® HR-PVC is also available in three variants: 30, 50 and 100. In the case of Steelgrid® HR-PVC the ropes are first coated to Class A grade using Galmac galvanizing and secondly coated in a continuous layer of PVC before being woven into the mesh.

Definition of Installation-Related Terms

Steelgrid® HR & HR-PVC mesh is most commonly applied to geological or geotechnical situations and the generalized installation instructions presented in this document are related to Steelgrid® HR mesh installed onto inclined rock/soil slopes. (Steelgrid® HR can also be installed in a variety of other scenarios including direct application to buildings, walls, dams, chimneys etc.)

Slope terminology used in this manual includes the following:

C *Crest area of the slope,*

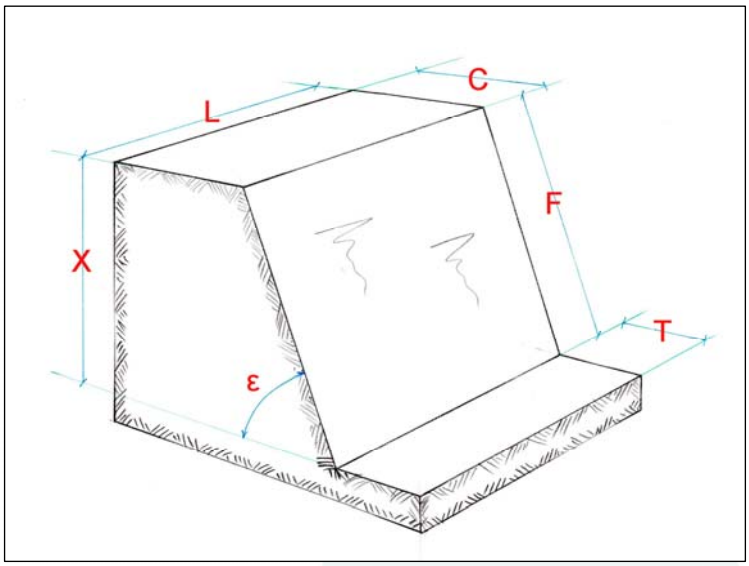
F *Face of the slope*

T *Toe area of the slope*

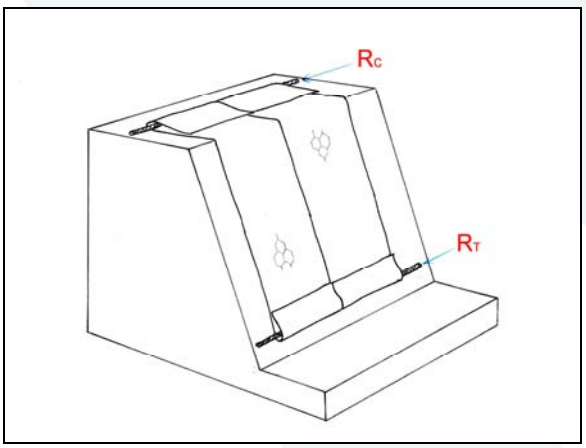
ε *Slope face angle*

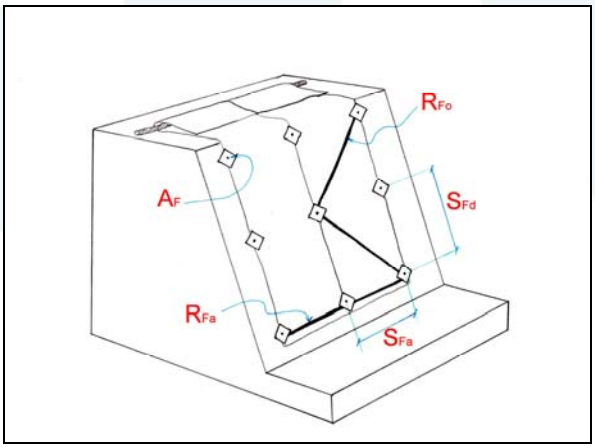
X *Effective total height of slope*

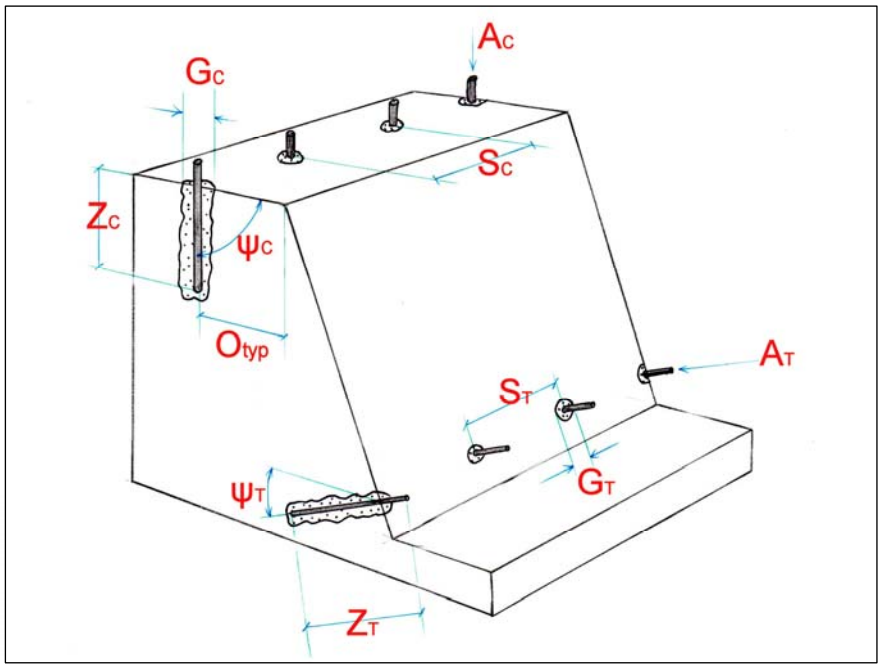
L *Length of a slope*



Mesh is most commonly installed - in geological and geotechnical situations - either as simple drapery (below left) or as cortical stabilization/pinned drapery (below right). In simple drapery, the mesh is hung as a curtain, suspended by ropes at the crest and toe (R_C and R_T). In cortical stabilization/pinned drapery installations the mesh curtain is additionally retained using a network of anchors (A_F) located at calculated spacings (S_{Fa} or S_{Fo}) and fitted with wire ropes (R_{Fa} or R_{Fo}).

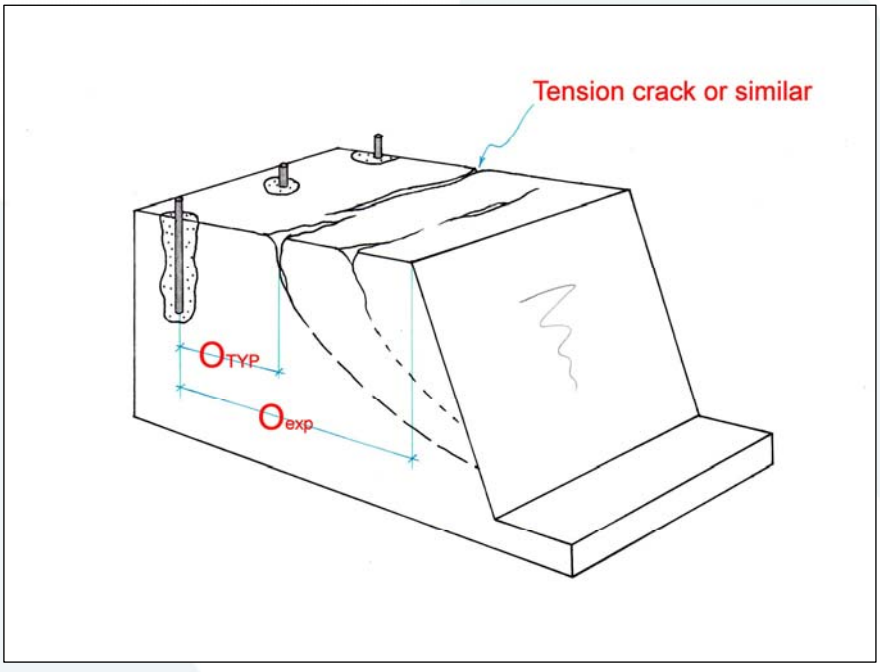






The mesh and any imposed loads are supported from anchorages. These can be positioned in the crest (A_C), toe (A_T) and face (A_F) of a slope depending on site-specific factors. Anchorages are normally placed in a line and fitted with suitable terminations (eye nuts or similar) to accept the ropes. At the toe of the slope it is also common for a row of anchors (A_T) and a rope (R_T) to be installed however other restraints are sometimes used. **All anchorage details must be in exact accordance with the engineering design.**

It is most common for the crest anchors to be offset some distance back from the break of slope (O_{typ}). The offset (O_{typ}) will be defined by the engineer. In cases where the top of the face or the down-slope edge of the crest is unstable a larger 'exceptional' offset (O_{exp}) will be required. The layout of all anchorages must be carried out in exact accordance with the engineering design.



Suggested/sample stages of Installation

Preliminary stages (i. to iv) are pre-works stages performed by the designer:

i. **Assessment of the slope**
ii. **Preliminary design**
iii. **Detailed design & design checking**
iv. **Preparation & checking of installation method statements**

Main installation works (1-11) for both drapery and cortical stabilization systems are:

1. **Establishment on site and negotiation of access and logistics**
2. **Receipt of materials and checking**
3. **Clearing slope face and crest (loose material and dense vegetation)**
4. **Setting out of the site (anchor and rope positions etc.)**
5. **Installation of crest-line anchors (A_C)**
6. **Lifting, placement and temporary securing of the mesh**
7. **Installation of crest-line rope (R_C)**
8. **Adjustment and permanent connection of mesh runs (β)**
9. **Permanent connection (α) of mesh to crest-line rope (R_C)**
10. **Installation of toe-line anchors (A_T) and toe-line rope (R_T)**
11. **Permanent connection of mesh to toe-line rope (R_T)**

Additional stages (a-d) required to convert a simple drapery into cortical stabilization/pinned drapery are:

a. **Setting out of face anchor (A_F) positions (S_{Fa} and S_{Fd})**
b. **Drilling and securing/grouting (G_F) of face anchors (A_F)**
c. **Installation of face anchor (A_F) termination accessories**
d. **Installation, tensioning and securing of face ropes (R_{Fa}/R_{Fo})**

Installation Stages 1 to 4

1. **Establishment on site and negotiation of access and logistics**
2. **Receipt of materials and checking**
3. **Clearing slope face and crest (loose material and dense vegetation)**
4. **Setting out of the site (anchor and rope positions etc.)**

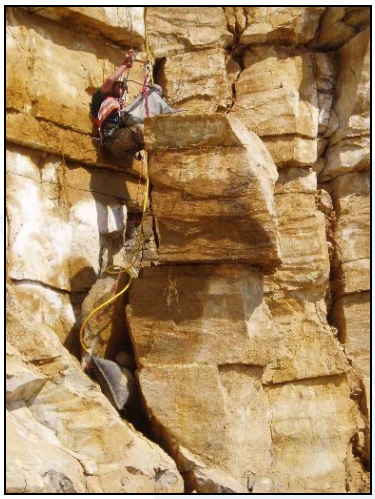
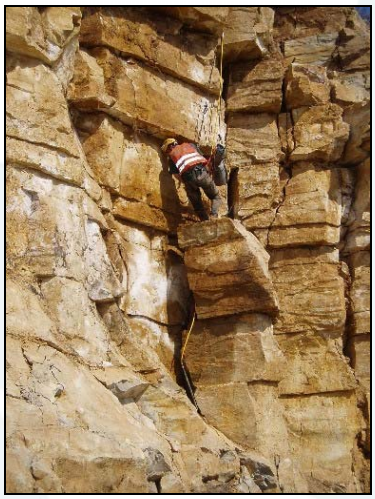
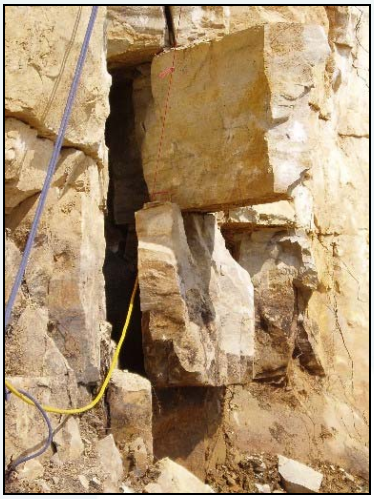
Following materials delivery all items should be checked. Items may then need to be moved to the relevant areas on the site, at times this may require the use of mechanical handling equipment such as tele-handlers or cranes (see example below).

Before the installation of any materials the crest area and slope face should be prepared.

The crest should be cleared of all significant or dense vegetation (see right) to promote easy and safe access and to enable simple manipulation and placement of mesh etc.

Following the crest clearing the slope face must be cleared by the process of “de-scaling”. This will typically include removal of loose rocks, soil and excessive vegetation growth from the slope face using hand tools such as mattocks, rakes and pry-bars. This work must be overseen by the engineer and care should be taken to avoid excessive material removal.


Sometimes more robust methods of de-scaling may be required including mechanical methods, pneumatic or hydraulic jacking (pictured below) or controlled blasting. Safe methods of working must be developed and approved before the start of works and all necessary safety precautions must be taken.

In some cases vulnerable infrastructure below the slope may require protection. This can include proprietary Maccaferri dynamic rockfall barriers installed below the works area.

Installation Stage 5

5. Installation of crest-line anchors

The drilling procedure should be carried out by suitably qualified personnel using equipment appropriate to the type of anchors specified by the engineer in the geotechnical design. Drilling may be carried out either by hand held equipment or using mechanized equipment (pictured below) to the approval of the engineer.

Following drilling of the holes, the anchors should be secured into the slope, this is most commonly carried out by the introduction of either polymeric resin or cement based grout - all anchor and grout details all specified by the engineering design.

For high strength meshes like Steelgrid® HR anchor properties (i.e. high strength and flexibility) may need to be enhanced to the stage that cable/rope anchors are required such as those offered by Maccaferri (ICAF-44 shown below).

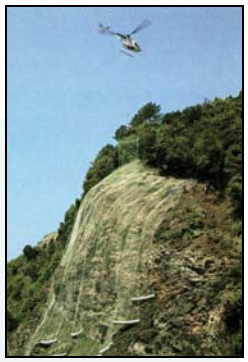
Installation Stage 6 & 7

1. **Lifting, placement and temporary securing of the mesh**
2. **Installation of crest-line rope (R_C)**

The runs of mesh should be placed into a suitable position on the slope to allow for temporary securing BEFORE installation of the top rope.

Two methods are commonly used to place the mesh **"bottom-up"** and **"top-down"**. **"Bottom-up"** involves moving the rolls to the base of the slope face and then lifting the runs up towards the crestline - lifting the rolls using winches, mechanical lifting equipment such as cranes or tele-handlers or through the use of helicopters (shown below).





"Top-down" installation involves transporting the rolls to the crest-line of the slope and guiding them down the face to un-roll them into position (see below).



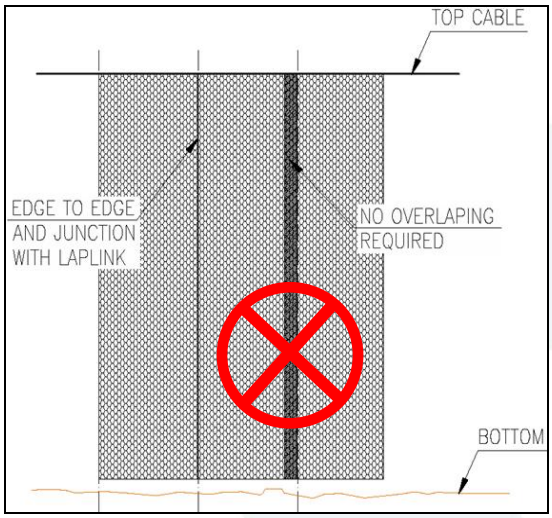
Following un-rolling and positioning of the mesh, the top rope should be installed. The specification, corrosion protection and diameter of the crestline rope (R_C) will be specified in the engineering design. It is normal practice for the crest-line rope to be divided up along the length (L) of the mesh installation. This helps to increase the overall factor of the safety of the whole installation and makes installation easier.

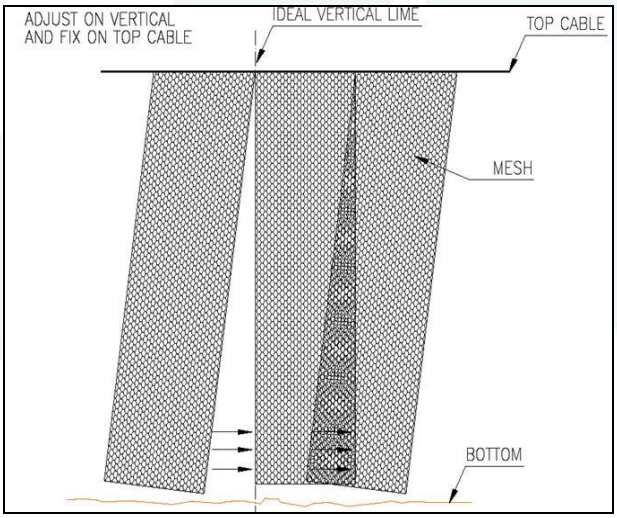
Installation Stage 8

8. Adjustment and permanent inter-connection of mesh runs

Following the installation of the crest-line rope it is necessary to carry out adjustment of the position of the mesh. This process is most frequent performed either by roped access personnel descending down across the mesh (below) however in some circumstances it can also be achieved from the basket of a 'cherry picker' or mobile access platform (below).

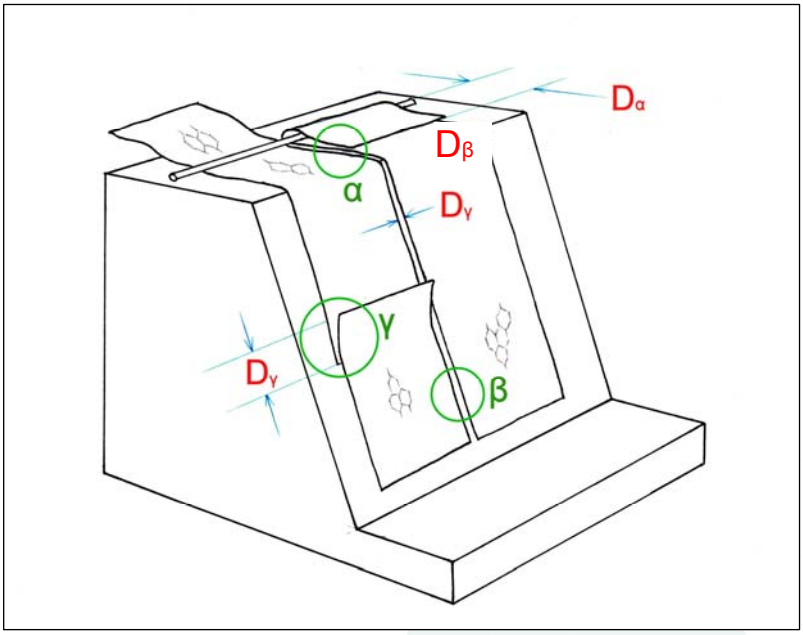
During adjustment excess slack should be removed from the mesh, the panels should be aligned to the desired orientation and any overlaps removed (below left). Any gaps that arise due to the surface topography of the slope face (below right) should be closed with a lacing of steel wire rope to the engineer's approval (typically a similar grade and diameter to the mesh selvedge rope will be used for this purpose).



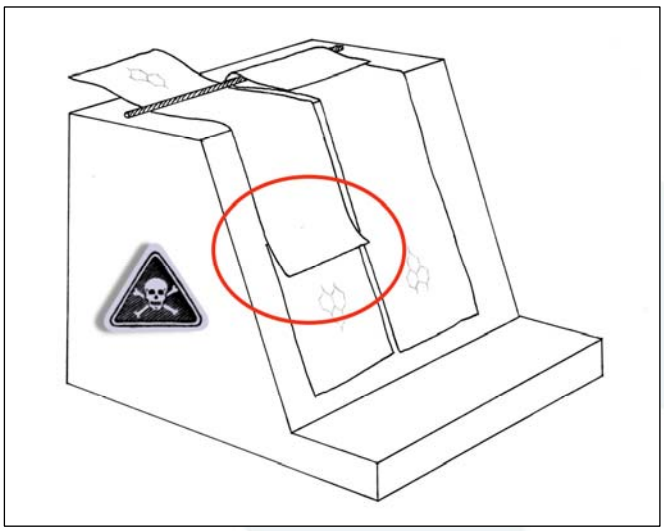


For the permanent connection of the mesh panels three types of connection are used (below) **Crest-line / overlap – 'α' connections** (these can be considered as similar to those required at the toe-line ropes), **Lateral / butt – 'β' connections** and **Longitudinal / lap – 'γ' connections**.

Steelgrid® HR mesh is formed from both steel wire ropes and wire mesh. The extensive testing of the mesh shows that it is only necessary to connect the ropes to gain the full performance of the mesh.



The steel wire ropes will need to be joined for both 'α' and 'γ' connections. The ropes should be connected using friction-type rope grips (detailed later). The specification, number and spacing of which should be in accordance with the prevailing standard operational on the project or as stated in the engineering design. The wire mesh should be connected using the proprietary "HR-Link connectors (datasheet available). The table (presented overleaf) gives minimum connection standards applicable for Steelgrid® HR & HR-PVC meshes. Connection requirements can vary and the engineer's specification must always be followed.



N.B. mesh overlap direction is extremely important for 'γ' connections – the overlap direction must be of the opposite sense to roof tiles (see left). Failure to observe this critical advice can cause failure of the connection and the development of dangerous or fatal consequences.

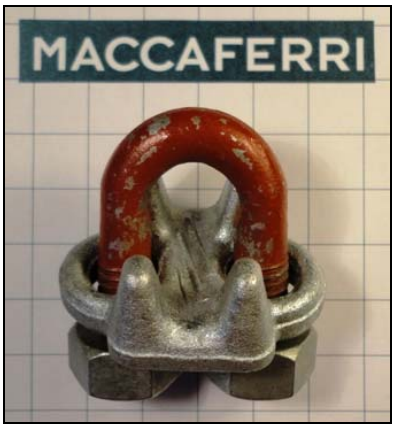
STEELGRID		CONNECTION TYPE	α : CRESTLINE (overlap)			β : LATERAL (butt)		γ : LONGITUDINAL (lap)		
			Layout	Rope	Wires	Layout	Rope	Layout	Rope	Wires
HR30	Mesh	Connection not required	200 mm overlap (nominal)	-	n / a	NO overlap required	HR-Link Galmac 160 mm (nominal)	300 mm overlap (nominal)	-	n / a
	Rope	Rope Grip (EN13411-5 typeB*)		2 no./rope [@ 35 Nm]	-				3 no./rope [@ 35 Nm]	-
HR50	Mesh	Connection not required	200 mm overlap (nominal)	-	n / a	NO overlap required	HR-Link Galmac 160 mm (nominal)	300 mm overlap (nominal)	-	n / a
	Rope	Rope Grip (EN13411-5 typeB*)		2 no./rope [@ 35 Nm]	-				3 no./rope [@ 35 Nm]	-
HR100	Mesh	Connection not required	200 mm overlap (nominal)	-	n / a	NO overlap required	HR-Link Galmac 160 mm (nominal)	300 mm overlap (nominal)	-	n / a
	Rope	Rope Grip (EN13411-5 typeB*)		2 no./rope [@ 35 Nm]	-				3 no./rope [@ 35 Nm]	-

*This manual recommends one type of rope grip. Others may be used according to the scheme designer’s specification.

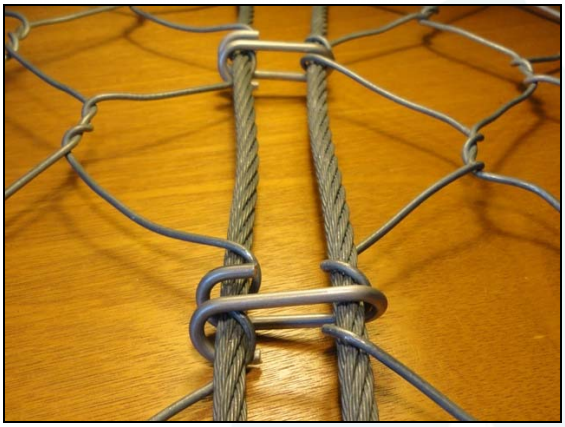
STEELGRID		CONNECTION TYPE	α : CRESTLINE (overlap)			β : LATERAL (butt)		γ : LONGITUDINAL (lap)		
			Layout	Rope	Wires	Layout	Rope	Layout	Rope	Wires
HR30-PVC	Mesh	Connection not required	200 mm overlap (nominal)	x	n / a	NO overlap required	HR-Link Stainless 160 mm (nominal)	300 mm overlap (nominal)	x	n / a
	Rope	Rope Grip (EN13411-5 typeB*)		2 no./rope [@ 27 Nm]	x				3 no./rope [@ 27 Nm]	x
HR50-PVC	Mesh	Connection not required	200 mm overlap (nominal)	x	n / a	NO overlap required	HR-Link Stainless 160 mm (nominal)	300 mm overlap (nominal)	x	n / a
	Rope	Rope Grip (EN13411-5 typeB*)		2 no./rope [@ 27 Nm]	x				3 no./rope [@ 27 Nm]	x
HR100-PVC	Mesh	Connection not required	200 mm overlap (nominal)	x	n / a	NO overlap required	HR-Link Stainless 160 mm (nominal)	300 mm overlap (nominal)	x	n / a
	Rope	Rope Grip (EN13411-5 typeB*)		2 no./rope [@ 27 Nm]	x				3 no./rope [@ 27 Nm]	x

*This manual recommends one type of rope grip for use with HR-PVC inferior alternatives must not be used.

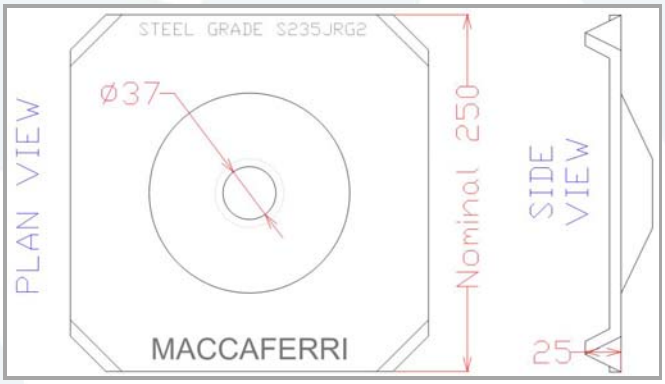
Connection mechanisms/items mentioned in the text and tables (previous) are shown below:



Above: heavily galvanized rope grips (EN13411-5 ‘type B’) used for ALPHA connection. Rope grips must always be used in accordance with manufacturer’s instructions.



Above: HR-Link connectors. Above left top shows Galmac version for use with Steelgrid® HR and above left lower shows the Stainless version for use with Steelgrid® HR-PVC.

Above: heavily galvanized ‘HR-Plate’ anchor plate. Specially designed and developed clawed steel plate to work specifically with the Steelgrid® HR system mesh.

Steelgrid® HR & HR-PVC meshes can be installed using standard light hand tools and require no specialist equipment (details of electro-hydraulic cutters are available from Maccaferri).


Cutting of the mesh (above) can be achieved through the use of either Felco-type hand cutters (size suitable for 8mm or 5/16” ropes) or abrasive cutting equipment to cut the ropes. Mesh wires can be cut with standard wire cutters (suitable for ≤3.0mm wire).

For the connections of the mesh, again only simple tools are required. The HR-Links and HR-Caps do not require the use of tools (installation video available).The above tools are required to form the standard rope grip connections: measuring tape, locking/’mole’ grips, 34mm* spanner (suitable for the flats on the rope grip saddle), ratchet + 11/16* socket, torque wrench (calibrated range from 10-40N/m), grease for threads of rope grip.

(* All tool sizes & compatibility should be checked with actual rope grips being used on the project.)

The following illustrates standard handling procedures for connecting Steelgrid® HR meshes.

First: Fold the mesh over the crest rope and align the mesh apertures to make installation easier. Pinch the rope with grips/pliers and install first rope grip (grease threads). This process is made easier if a piece of plywood or similar is inserted under the mesh being worked on as this prevents fouling and contamination with the ground along the crest.

Second: Tighten the rope grip and then apply full torque using calibrated torque wrench.

Third: Repeat for the relevant number of rope grips per rope and for each rope along mesh.

Fourth: Install protective plastic caps to the ends of the ropes (where required by design). Be certain to check torque of rope grips after 24-48 hours and at regular intervals over time thereafter as specified in the project design.

ALPHA (α) Connection

The above photograph shows an example ALPHA (α) connection / 'overlap connection' in Steelgrid® HR30, made using the appropriate number of suitable rope grips (EN13411-5 type B) to connect ropes. It can be seen in the photograph that the overlap required to form the connection is minimal (approximately 200mm to 220mm) and that it is only necessary to connect the ropes* [not the mesh] to form a full strength connection. (*see table on previous pages).

The connection is easier to make if a piece of plywood (or similar) is slid underneath the mesh as it lies, folded over the crest line rope, at the crest of the slope. By using this technique it is possible to minimize disruption to the installation of the rope grips and keep the working space as clean as possible.

It should be noted that the ropes used in Steelgrid® HR are moderately stiff. To make installation of the rope grips easier, it is advised that the rope be folded over and the mesh apertures aligned. Once the mesh is in the correct position, the folded rope (in the mesh) should be held in position using locking pliers, a ratchet clamp or similar hand tools.

BETA (β) Connection

The above photograph shows an example BETA (β) connection / 'selvedge connection' in Steelgrid® HR, made using the proprietary HR-Link connector to connect the selvedge ropes on the lateral edges of the runs of mesh. It is clear from the photograph that it is NOT required to use any overlap in order to form a full strength connection.

The HR-Links are installed by hand (installation video is available) and require no tools or specialist equipment. (For maintenance purposes it is possible to remove the HR-Links; a video illustrating the process is available from Maccaferri.)

Two types of HR-Link are available. The HR-Link Galmac version is for use with Steelgrid® HR mesh and the HR-Link stainless version is for use with Steelgrid® HR-PVC mesh.

It should be noted that in certain cases (such as slope faces with significantly undulating topography) the selvedge ropes may not lie close enough to enable the installer to use the HR-Link connectors along the full length of the selvedge. Where this is the case the gap should be closed using a lacing of 8mm O.D. rope of the same specification as the mesh (available from Maccaferri).

GAMMA (γ) Connection

The above photograph shows an example GAMMA (γ) connection / 'longitudinal lap connection' in Steelgrid® HR30, made using the appropriate number of suitable rope grips (EN13411-5 type B) to connect ropes. It can be seen in the photograph that the lap required to form the connection is minimal (approximately 300mm to 330mm) and that it is only necessary to connect the ropes* [not the mesh] to form a full strength connection. (* see table on previous pages).

The connection is easier if the two pieces of mesh to be joined are held firmly in place before the installation of the rope grips. This can be achieved by firm temporarily connecting the mesh (using carabinas or similar) and then the mesh apertures should be aligned. Once the two pieces of mesh are in the correct position, the overlapped ropes (in the mesh) should be held in position using locking pliers, ratchet clamp or similar. Then the rope grips can be installed using the appropriate method (illustrated on previous pages).

It should be noted that the overlap direction/sense of the two meshes must be correct – the reverse of roof tiles. Failure to observe this rule may result in failure of the connection.

Installation Stages 9 and 10

1. **Permanent connection (α) of mesh to crest-line rope**
2. **Installation of toe-line anchors and toe-line rope**
3. **Permanent connection of mesh to toe-line rope**

The photograph (right) shows a Steelgrid® HR30 cortical stabilization/pinned drapery installation. Here the R_C is offset from the A_C using short lengths ('tails') of steel wire rope however the connection is fully formed and the DT mesh and wire ropes are overlapped and connected over R_C and the steel wire ropes are also connected to the crest-line anchor tails.

Toe-line anchors should be installed (photo below) in strict accordance with the engineering design. The toe-line rope should then be inserted and secured. Next it is necessary to form another 'α' connection of the mesh to the Toe-line ropes. The appropriate details/specification for the Toe-line 'α' connection should specified by the engineering design. (N.B. in some cases a toe-line rope may not be used.)

Optional Stages a & b

a. Setting out of face anchor (A_F) positions (S_{Fa} and S_{Fd})

b. Drilling and securing/grouting (G_F) of face anchors (A_F)

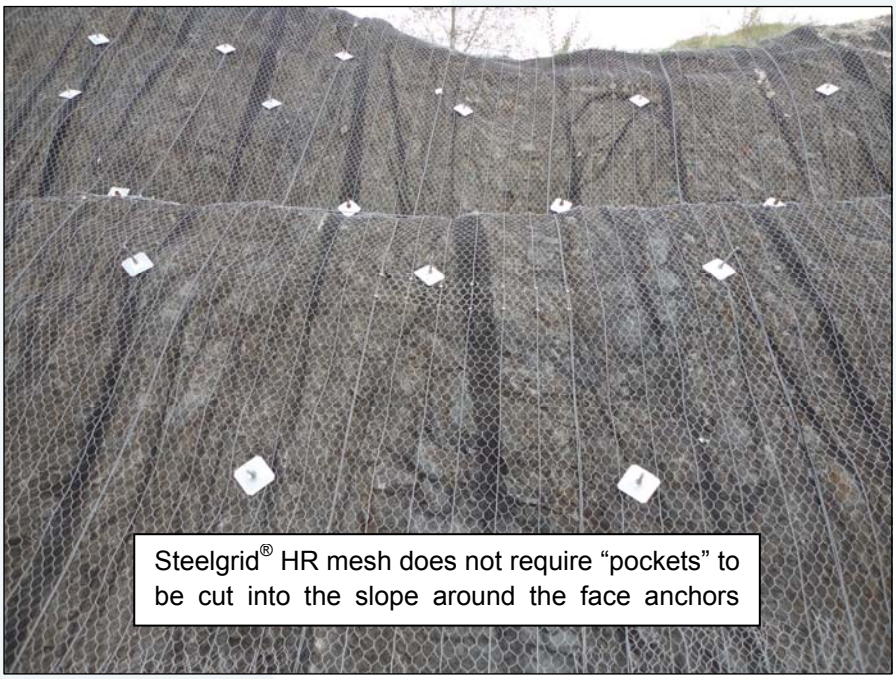
In certain circumstances the engineer may consider it necessary to install anchors (A_F), through the mesh, into the face of the slope, to convert a simple drapery installation into a cortical stabilization installation. Following the successful completion of a simple drapery-type installation (stages 1-11) the location of the face anchorages should be set out and drilled in strict accordance to the engineering design (to the satisfaction of the engineer).

Drilling equipment, techniques and procedures will vary widely. Hand-held drilling equipment will often be used for installation of face anchors however this practice is not permitted in some places/work environments meaning that mechanised drilling equipment will be used exclusively. It should be noted that drilling is potentially dangerous; where-ever drilling works are carried out it is of the highest importance that all safety regulations are followed and the appropriate personal protective equipment should be used.

The mesh aperture size of Steelgrid® HR and HR-PVC meshes permit the use of relatively large diameter drill bits or self-drilling anchor bars where the procedure of works requires the anchors to be drilled after the hanging of the mesh.

In some cases the engineer may specify for face anchorages to be installed before the installation of the mesh – Steelgrid® HR and HR-PVC are compatible with this method. Using either method, a significant advantage of Steelgrid® HR30/HR30-PVC is its insensitivity to exact anchor placement (pictured below).

When used in combination with the bespoke Steelgrid® HR-Plate, the plate will engage with one or two ropes, independent of the location of the anchors. This can help to significantly reduce the installation time and cost of Steelgrid® HR when compared to other meshes. It should be noted that the Maccaferri Steelgrid® HR mesh system does not require the formation of "pockets" under anchors in the face as is the case for some systems. Additionally the Steelgrid® HR system does not require the imposition or development of any "forces" in order to function and offer full performance or mechanical stiffness.



Steelgrid® HR mesh does not require "pockets" to be cut into the slope around the face anchors

Optional Stages c & d

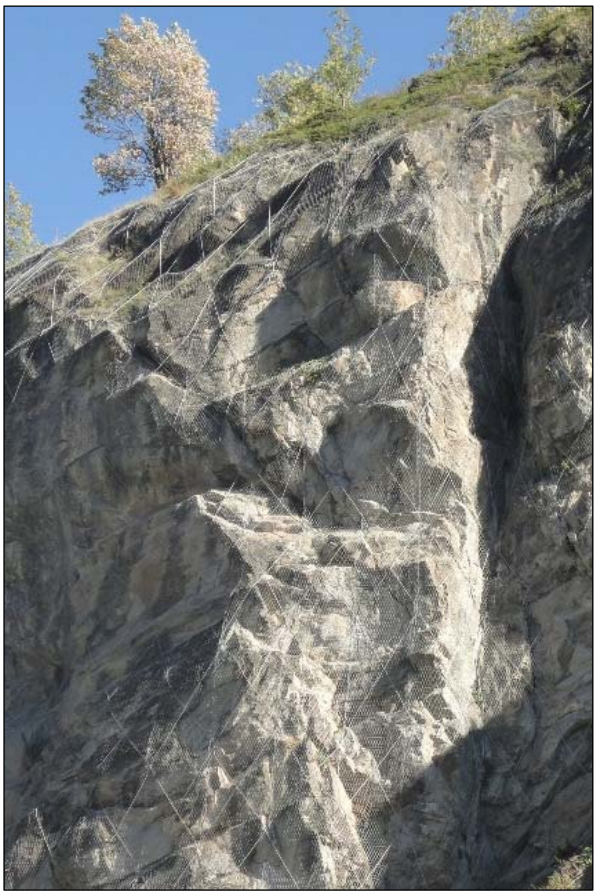
c. Installation of face anchor termination accessories

d. Installation, tensioning and securing of face ropes

In circumstances of serious slope instability (especially soil slopes) or where the slope face (F) has significant topography the engineering design may call for installation of a network of steel wire ropes or similar, over the top of the mesh, and connected to face anchors (A_F).

In the situations where the slope face has many undulations or irregularities, individual ropes or networks of ropes can be installed to draw the mesh into the undulations and thereby reduce the potential for falling blocks to fail the mesh. This situation can occur where falling blocks are given the chance to undergo free-fall and in doing so achieve higher velocities and energies if they then ricochet into the mesh. Where profiling ropes or external rope networks are installed over the mesh, rocks are prevented from falling and in this way the safety factor of the mesh is effectively increased.

Ropes can be restrained by a variety of terminations that are available for installation onto the free ends of the anchors (A_F). Typically the ropes are either retained under the anchor plates that are positioned to restrain the mesh or the ropes are threaded through eye nuts that may be installed on top of (or sometimes instead of) the anchor plate.



Various design philosophies are applied to the specification of slope face ropes and concerning the orientation of the ropes or the patterns formed on the face. It is recommended that the minimum rope to be used with Steelgrid® HR meshes should be 12mm diameter (1770 N/mm2 grade) however it is not uncommon for 16mm ropes to be used, particularly where angular rocks are present on/in the unstable slope or where the designer takes a conservative attitude to factors of safety for system components.

Steelgrid® HR mesh is not sensitive to the specific configuration of external rope networks. (It should be noted that the presence of the integral longitudinal ropes means that it should be unnecessary to install external ropes in this orientation.) A diamond or "zig-zag" rope pattern (pictured left) will be simple to install and will give highly favourable performance in terms of both punching resistance but also working cooperation with the integral longitudinal ropes. The cooperation between integral and external ropes acts to further increase the mechanical stiffness of the system, which is important for the control and limitation of mesh bulging caused by movement of loose surface layers or accumulations of material (pictured right). This unique type of mechanically efficient cooperation makes Steelgrid® HR mesh a highly effective product for cortical stabilisation or pin drapery applications.

3. Maintenance Information

All mesh systems require periodic inspection and maintenance to offer full functional performance in accordance with the engineer's design specification.

Steelgrid® HR and HR-PVC are robust, high strength products that come with a high level of corrosion protection (see the next section) and therefore maintenance of Steelgrid® HR meshes primarily comprises inspection of the mesh installation on a regular basis and corrosion and torque checking of any connection mechanisms used (e.g. rope grips, crest rope and anchor fittings etc.).

The results from the regular inspections should be compared to the post-completion inspection and approval documentation and to the results from any other periodic inspections in order to monitor the performance and condition of the installation and if these could be changing over time.

Inspection intervals are site-specific and must be specified in the engineering design. The exact inspection interval will be based on a combination of the following characteristics:

1. Material influx rate (of any spalling material)
2. Material influx characteristics (high velocity impacts or angular blocks etc.)
3. Local environmental conditions (rain, coastal proximity, aggressive conditions)
4. Local overall geotechnical/geology stability situation
5. If the mesh installation will be prone to heavy snow loading or avalanche actions

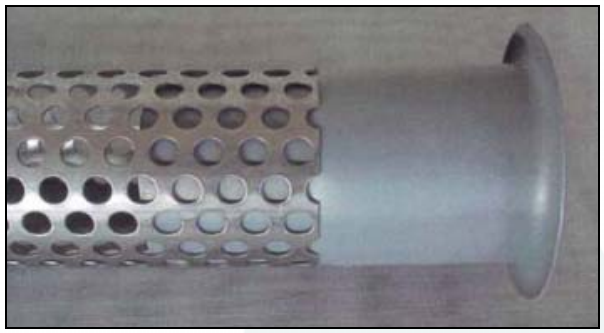
It should be noted that where water on or in the face is an issue at a site, or water control measures are part of the engineering design, specific inspection and maintenance procedures will be required on these systems and any parts of the mesh installation they inspect. These procedures will be specified in the engineering design.

In the case of installation in high corrosion areas or in aggressive environments the mesh should be inspected on a more regular basis than in general conditions. It is recommended that in these areas Steelgrid® HR-PVC mesh should be chosen. Special additional instructions are available for aggressive environments on request.

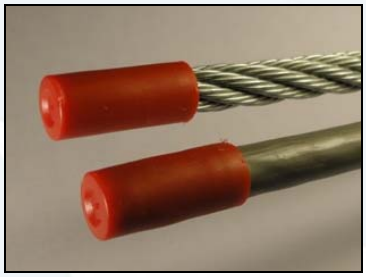
4. Accessory Products

Maccaferri can offer a large range of mesh connections, installation accessories, anchors and tools/equipment according to client requirements:

- HR-Link (Connectors - 2 types)
- HR-Grip (Rope Grips)
- HR-Cap (Protective Caps)
- HR-Plate (Clawed Anchor Plates)
- Steel Wire Ropes
- Bar Anchors (ATB/CTB)
- Bar Anchors (Self-Drilling Hollow)
- Cable Anchors (ICAF 44)
- Perforated Drill Hole Liners
- Anchorage Accessories






Please contact your local office for more information and datasheets concerning any of the spares, installation accessories and consumables that you may require for your projects.