



# **THE ROCKFALL PROTECTION SPECIALIST**

# ROCKFALL SYSTEMS

## NATURAL HAZARD & ROCKFALL MITIGATION

Rockfall protection and natural hazard mitigation systems are key elements in the security and safety of roads, railways, mining operations and infrastructure networks. Even small rockfalls or debris flows can obstruct infrastructure and have far-reaching economic effects beyond the immediate disruption. This also applies to buildings or other installations at risk of damage from rockfalls, debris flows or avalanches.

With over 60 years' experience in rockfall protection systems and natural hazard mitigation, Maccaferri offers a wide range of systems to stabilise rock faces, soil slopes and snow masses, reducing risks to people, buildings and infrastructure.

Maccaferri's philosophy is to offer a graded range of engineered systems working together with each other, to reduce overdesign and unnecessary cost.

Certified and tested by leading institutes and in accordance with the latest standards, Maccaferri solutions are designed using state-of-the-art modelling software and techniques.

Developed in conjunction with contractors, Maccaferri Mac.RO™ Systems are simple to install, durable and effective. Components have been selected to reduce contractor workload.

Maccaferri Mac.RO™ Systems are installed daily, worldwide, in demanding applications, reassuring clients with safe, cost effective and reliable natural hazard protection.

### ROCKFALL EMBANKMENTS

- **TERRAMESH AND GREEN TERRAMESH**

### MESH SYSTEMS

- **ROCKFALL NETTING**
- **STEELGRID HR**
- **HEA PANELS**
- **RING NETS**
- **MESH SYSTEMS TESTING & DESIGN**

### DEBRIS FLOW AND SHALLOW LANDSLIDE BARRIERS

### DYNAMIC ROCKFALL BARRIERS

- **ROCKFALL CATCH FENCE**
- **HYBRID/ATTENUATOR FENCE**

### FLEXIBLE STRUCTURAL FACING FOR SOIL NAILING

- **STEELGRID HR**
- **HEA PANELS**
- **MACMAT R**



# INTERVENTION STRATEGIES

## OF NATURAL HAZARDS



Rockfall and Landslide Embankments

Mesh Drapery Systems

Debris Flow & Shallow Landslides

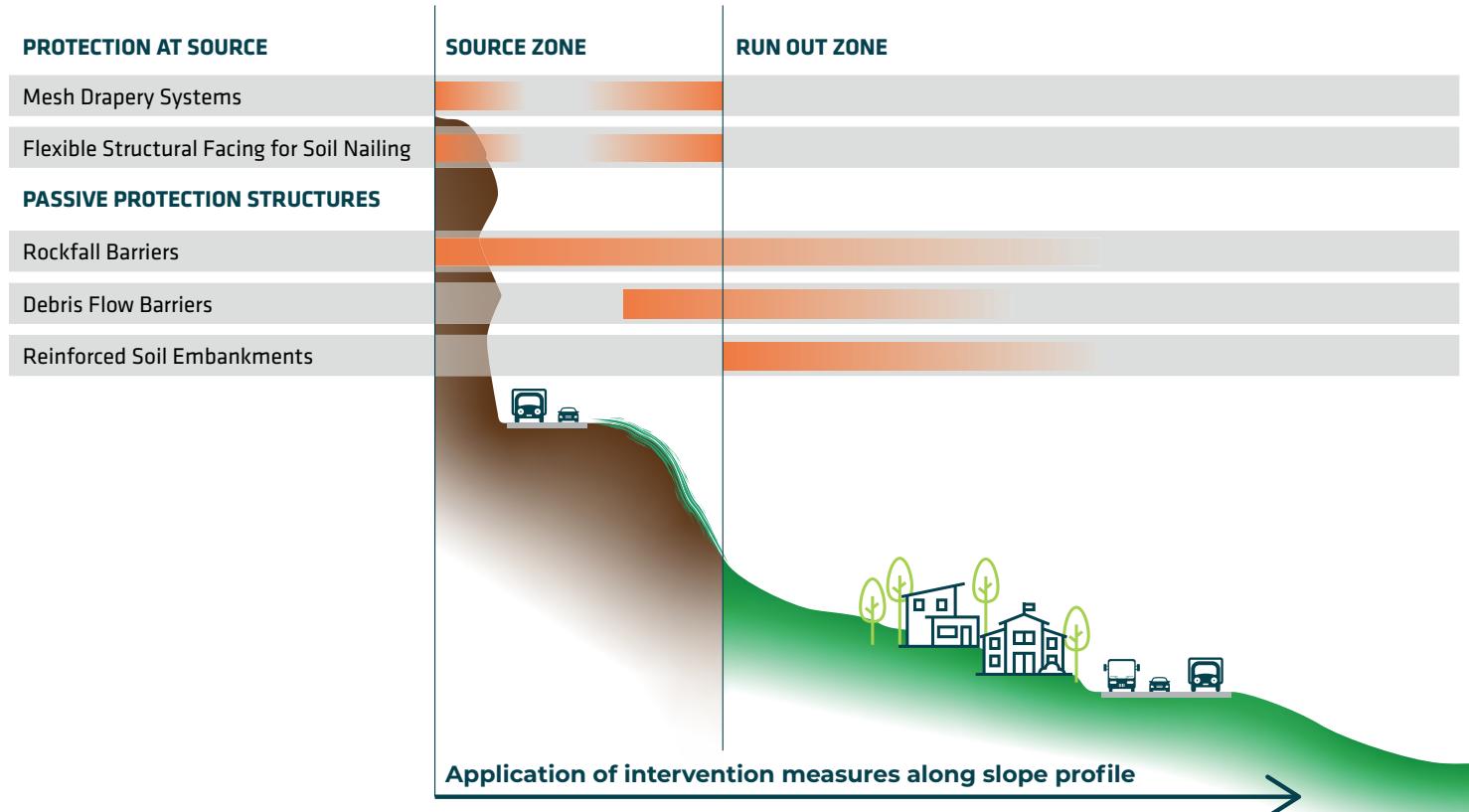
Dynamic Rockfall Barriers

Flexible Structural Facing for Soil Nailing

## SOLUTION SUITABILITY & LOCATION

There are many factors to consider when selecting appropriate interventions to mitigate natural hazards. Understanding the suitability and effectiveness of the systems and where they offer optimal performance is important.

Combinations of systems often provide the most cost-effective solutions, where a balance is found between technical performance, risk, client value and ease/safety of installation; there is no single product to solve all natural hazard problems.







# ROCKFALL AND LANDSLIDE EMBANKMENTS

**Rockfall protection embankments are an effective option to intercept rockfalls or shallow landslides; especially when there are very frequent rockfalls that needs to be intercepted or when the anticipated impact energies are too high for a standard rockfall catch fence to handle.**

## WHAT CAN YOU USE IT FOR?

When the expected energy of the rockfall is high with frequent rockfall occurrences, reinforced soil embankments or bunds are an excellent choice as a passive protection structure to intercept material from natural hazards such as; landslides, rockfalls and avalanches. They can also be an alternative to a standard ETAG27 certified rockfall catch fence when low maintenance and long-term durability is required for the site.

## WHERE CAN YOU USE IT?

When the source areas are too large for meshing alone and after extensive at-source treatment - some residual risk still exists, the reinforced soil embankment/bund can be constructed at the toe of the slope as a passive protection structure. They are typically constructed over flat or gentle slope profiles and will be designed as the last defence system with the consideration of clearance/removal of intercepted material in the up slope side.

Maintenance is minimal as the ductile nature of the reinforced soil embankments absorb rockfall impacts without collapsing, hence minimal patch up works required.

## ADVANTAGES

- Cost effective solution (\$/kJ capacity)
- Low whole of life cost in the long term
- Long durability
- Almost unlimited capacity (>20,000 kJ)

- Withstand multiple impacts without repair
- Contain vast quantities of debris
- Very low maintenance
- Can divert debris flows away from infrastructure



# TERRAMESH & GREEN TERRAMESH

**Maccaferri Terramesh and Green Terramesh are versatile, modular systems for mechanically stabilised earth walls and reinforced slope systems or bunds. For soil slopes and embankments that require vegetation, the front face of Maccaferri Green Terramesh units can be filled with soil and planted, creating a green slope.**

Maccaferri Green Terramesh units provide a permanent facing unit in the front face of reinforced soil slopes as well as act as temporary formwork during the installation of the steep face structure. The front face is normally soil filled with topsoil and planted to achieve a vegetated solution however, where required rock can be used in the front face. This versatility along with the construction and technical advantages offered by Green Terramesh have seen the widespread use of this system throughout Australia and New Zealand.

## WHAT CAN YOU USE IT FOR?

The reinforced soil embankment can be designed to accommodate extreme rockfall impacts (potentially up to 20,000 kJ) and to divert potential debris flows. Unlike rockfall catch fences, rockfall embankments can sustain multiple impacts and rockfall events with only very minimal localised patch up repair. FEM modeling is used to validate the results and simplified design charts developed to assist engineers to quantify the bund geometry.

## WHERE CAN YOU USE IT?

Maccaferri Green Terramesh units can be used individually with their integral double twist soil reinforcement mesh tail or combined with geogrid reinforcement (Paragrid and Paralink). Very tall structures can be achieved and designed for with the inclusion of Paragrid or Paralink geogrid reinforcement, structure height of >50 m are not uncommon and highly possible with this technique.





## ADVANTAGES

- The fixed face angle and vertical lift simplifies construction.
- Proven embankment performance through full scale tests and actual rockfall events.
- Simplified design charts available to assist engineers with the sizing geometry.
- Structures can exceed 50 m in height when combined with geogrid.
- Galmac coated wire mesh, protected by PoliMac® polymer coating for improved abrasion resistance and system longevity.
- A permeable front face to allow drainage of the backfill.
- Structurally safe in the face of fire.
- Reduces environmental impacts by incorporating vegetation.
- Quick installation.
- Tests have proven its durability and strong performance in coastal applications.
- Green Terramesh structures allow for geogrid to be terminated at the face, minimising the risk of exposure of the geogrid to UV, fire or vandalism
- The Maccaferri Green Terramesh system has independent BBA technical approval.
- Long design life of 120 years.

## INSTALLATION

Each rockfall embankment is designed specifically to suit site requirements. Our team can assist with preparation of design suggestions, as well as refer specialist installers.

To protect the quality of your project, Geofabrics provides on-site installation training as well as guidelines and diagrams to assist contractors. The installers can construct sample units on-site before works begin to ensure products are installed as per our recommendations.



# MESH DRAPERY SYSTEMS

**Geofabrics Rockfall offers a complete range of Maccaferri mesh systems for rockfall protection. The Maccaferri range of high strength mesh systems encompasses a group of high durability products with a range of strengths and corrosion protection options.**

All Maccaferri high strength mesh systems are designed to work in conjunction with high strength anchorages, to increase the stability of the unstable surficial layer of a rock slope.

Selection of the mesh types and optimum solution is based upon the analysis of the project site conditions (geology, topography, environment, static and dynamic loading conditions) and client requirements (design life, maintenance).

A wide range of mesh products have been developed by Maccaferri to offer a broad range of performance characteristics, so that an appropriate solution or mesh type can be selected to suit the specific needs. The product range can be categorized below:

 <b>ROCKFALL NETTING (DOUBLE-TWIST MESH)</b>	 <b>STEELGRID HR (30, 50 &amp; 100)</b>	 <b>HEA PANELS (8MM/10MM/12MM)</b>	 <b>RING NETS (4V OR 6V CONFIGURATION)</b>
<b>STIFFNESS:</b> MODERATE	<b>STIFFNESS:</b> HIGH	<b>STIFFNESS:</b> VERY HIGH - EXTREME	<b>STIFFNESS:</b> LOW
<b>STRENGTH</b> MODERATE	<b>STRENGTH</b> HIGH	<b>STRENGTH</b> VERY HIGH - EXTREME	<b>STRENGTH</b> EXTREME



From an application of mesh on slope surface point of view, there can be two approaches depending on the design intentions.

## SOLUTIONS

### Simple Drapery

Mesh is hung down the slope face from a secure top rope. Rock debris falling from the slope is contained safely behind the mesh and collects at the toe of the slope. Periodic removal of collected debris is needed.



### Secured/ Pinned Drapery

Similar to a simple drapery, but the mesh system is enhanced by anchors (with or without face ropes) securing the mesh back to the slope. Loads in the system are transferred back to these anchors, enhancing the stability of the slope.



# ROCKFALL NETTING

**Geofabrics range of Maccaferri rockfall drapery systems are designed to control rockfall movements by guiding falling debris to a collection point at the toe of the slope thus protecting structures from debris damage.**

Produced by Maccaferri for over 140 years, double twist mesh is the most established technical rockfall protection solution in the world. Hexagonal woven mesh is supplied as rolls (both width and length selected by customer) for ease and economy of use.

Unlike single twist ('chain link') mesh the construction of DT mesh inhibits the propagation of tears making it an extremely durable and easy to use product. DT mesh is most commonly used in the form of a protective curtain/drapery. The mesh is suspended from and restrained by steel wire ropes and anchors, with adjacent rolls connected into a continuous curtain using high strength C-rings applied by mechanical or pneumatic tools.

## WHAT CAN YOU USE IT FOR?

Maccaferri Rockfall Netting or Double Twist Mesh is typically used in both simple drapery systems and secured/pinned drapery systems. Typically for smaller rock sizes or thin layers of loose surface material when used for secured drapery with less undulating slope.

## WHERE CAN YOU USE IT?

Double Twist steel wire mesh is a highly efficient mesh combining ease and flexibility of use with unsurpassed cost-effectiveness. It is typically used as an 'at source protection' measure. Used around the world, Maccaferri rockfall netting mesh is proven to offer robust, long lasting and cost-effective rockfall protection. On moderately steep slopes, or those where some vegetation may grow, the mesh should be kept as close to the slope as possible. The mesh is always secured at the top of the slope and can either be anchored or left unanchored at the toe depending on the available run-out space.

## ADVANTAGES

- Does not unravel if wire breakage occurs making it cost effective with low maintenance requirements
- Flexible and versatile to match existing slope and rock profiles
- Different levels of coating protection for durability in a wide range of environments

- Does not inhibit regrowth of vegetation
- No overlapping mesh on lateral connections means fast installation and minimal material wastage.

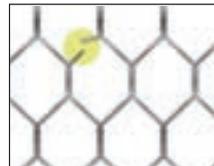


## Double Twist vs Single Twist

### Mesh

Unlike Single Twist (chain-link) style mesh, the construction of Double Twist ('DT') mesh inhibits the propagation of tears in the mesh.

Research shows that damage to a DT mesh remains local and the mesh does not unravel/unzip, due to the Double Twist 'locked yet flexible' connection between adjacent wires.



## INSTALLATION

Talk to our team about installation methods and referral to expert installers for your project.

FEATURE	BENEFIT
<b>Double Twist mesh construction</b>	Does not unravel in the event of wire breakage
<b>Flexible in 3 dimensions</b>	Excellent containment of debris. Easy to install on site
<b>Light-weight</b>	Ease of installation
<b>Variety of coatings</b>	Balance commercial and performance requirements
<b>C-Rings and tools</b>	No overlapping mesh on lateral connections = fast installation and minimal material wastage
<b>Variety of lengths and widths of mesh rolls</b>	Different lengths and widths are available to suit site conditions, saving install time and waste

# STEELGRID HR



**Maccaferri SteelgridHR is a high strength, high stiffness geocomposite combining the versatility and practical benefits of double twist mesh with the excellent stiffness and mechanical durability of high tensile steel cables.**

This patented mesh is an engineered combination of Double Twist steel wire mesh and high tensile (1770 N/mm<sup>2</sup>) wire ropes in a single, easy to install product. The presence of the steel cables woven within the mesh during manufacturing enables better stress distribution in the upper longitudinal cables and reduced strain in the drapery system.

## WHAT CAN YOU USE IT FOR?

Steelgrid HR is ideal for use on highly undulating rock faces and slopes with a long drop or where large volumes of debris are expected. The integral longitudinal steel ropes enable the efficient transfer of loads to the top ropes and anchors, with minimal mesh deformation.

The wires and ropes are coated with Zinc-Aluminium Galmac galvanising to Class A thickness and can be additionally coated with a thermally bonded layer of polymer for maximum durability. Steelgrid HR has a range of system tensile strengths ranging from 80kN/m up to 180kN/m. This allows projects to be both cost effective and a technically optimised solution for clients and designers alike.

Available with punching resistance up to 150kN, Steelgrid HR is also designed to work in conjunction with anchors to increase the stability of the unstable superficial layer of a rock or soil slope. Due to the close rope spacing within the mesh, the chances of anchor plates to engage with the mesh is increased. This is essential for efficient transfer of load.

## INSTALLATION

Installation of Steelgrid HR is straightforward; the adjacent lateral rolls of mesh do not need to be overlapped, reducing product wastage and saving installation cost and time compared to other meshes.

The Steelgrid HR mesh kit is a complete system containing all the components needed to install the mesh by a specialist contractor. Maccaferri also has the capacity to manufacture non-standard rolls to suit, for site specific requirements.

## ADVANTAGES

- Does not unravel in the event of wire breakage
- Flexible and versatile to match existing slope and rock profiles
- Different levels of coating protection for durability in a wide range of environments
- Does not inhibit vegetation growth
- Able to transmit loads efficiently to the top anchors and consequently reduce the stress on the mesh
- High strength at low strain and high punch resistance at low deformation



FEATURE	BENEFIT
<b>Integral steel ropes</b>	Low strain, high strength composite mesh
<b>Integral steel ropes</b>	"2 products in 1" reduces installation time and cost
<b>Integral steel ropes</b>	No overlap required between adjacent rolls of mesh on the slope = reduced material wastage
<b>Flexible in 3 dimensions</b>	Excellent containment of debris and easy to install on site
<b>Variety of coatings</b>	Balance commercial and performance requirements

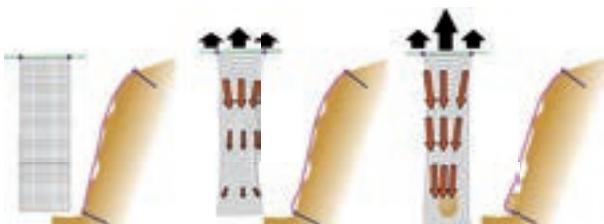
## SECURED/ PINNED DRAPERY

Available with tensile strengths up to 180 kN/m and up to 150 kN for punch resistance, Steelgrid HR is also designed to work in conjunction with anchors to increase the stability of the unstable superficial layer of a rock or soil slope.

Due to the close rope spacing within the mesh, the chances of anchor plates to engage with the mesh is increased. This is essential for efficient transfer of load.

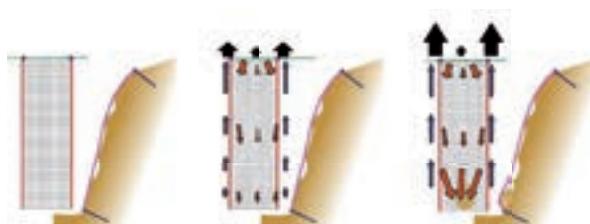
The HR Anchor Plate transfers loads from the mesh into the anchors. The four spikes on the corners of the HR Anchor Plate engage with the Steelgrid® HR and effectively restrain the steel cables.

## TRADITIONAL MESHES



1. Theoretical case 2. Mesh weight 3. Weight of the debris

## STEELGRID HR



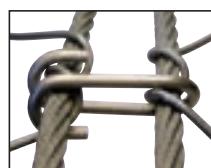
1. Theoretical case 2. Mesh weight 3. Weight of the debris

➡ Forces acting on the system

⬅ Reaction of the system

## ACCESSORIES

The Steelgrid HR mesh kit is a complete system containing all of the components needed to install the mesh onto the anchors on a project site. The kit contains: the HR or HR-PVC mesh, HR Anchor Plate (where required), HR-Grips and HR-Link mesh connectors.



HR LINK



HR GRIP



HR PLATE



# HEA PANELS

**For applications where low deflection and extreme strength are required High Energy Absorption (HEA) Panels offer containment of unstable rocks at low strain.**

They are the stiffest product within the Maccaferri mesh systems. Stiffness is more important than tensile strength of meshes as it affects the deflection of the system under load.

## WHAT CAN YOU USE IT FOR?

HEA panels are normally used when large boulders are present on a localized area on a slope surface or when the slope surface is highly undulating.

The panels are woven from a single continuous length of high tensile strength steel wire rope with a patented HEA 'double knot' connection at each crossing point. This 'double knot' connection offers the highest level of the tear resistance and pull apart resistance among the many different connection systems.

## ADVANTAGES

- Double knot connection for maximum strength transfer
- Multi-axial configuration for superior multi-directional strength performance
- High stiffness to limit rock detachment
- Heavily galvanised for durability
- Flexible for conforming to irregular rock shapes
- Customisable product reducing installation time and minimizing waste

## WHERE CAN YOU USE IT?

HEA Panels are used in secured drapery applications where the least amount of surface deformation is acceptable. Due to the multi-axial performance of the panel, loads are transferred effectively to the anchors on the slope face regardless of the anchor layout.

Unlike single twist spiral rope nets, the construction of HEA panels provides exceptional stress/strain performance with the lowest possible deformation.

## INSTALLATION

HEA is supplied in panel form rolled up for ease of transport and handling. In rock face stabilisation works the HEA panel is installed once the anchors have been installed and the drapery mesh has been fixed in place. The rockfall netting drapery is required where detachment of rocks smaller than the HEA cable mesh aperture are expected.

Panels are fixed from the top down and are laid side by side with no overlaps. A top horizontal cable having a thickness of 12-16 mm is used to support the HEA panels along the crest and anchored into position. Anchors are installed and HEA placed and fixed into position at each anchor point for treatment of individual unstable rocks. Installation by a specialist contractor is recommended.

TYPE OF CONNECTION	RESISTANCE TO TEAR (KN)	RESISTANCE TO PULL APART (KN)
HEA Panel	24.4	11.9
High resistance clips	13.5	8.0
Low resistance clips	4.6	1.3



FEATURE	BENEFIT
Double knot connections	Creates high strength mesh and when overloaded, fail progressively, not abruptly
Steel wire rope construction	Mechanical durability and resistance to abrasion
Multi-axial configuration	Multi-directional stress / strain performance
Single rope architecture of main panel	Low number of connections provides robust product
Flexible in 3 dimensions	Excellent containment of debris and easy to install on site
High tensile steel wire cable construction	Market leading, lowest possible deflection under load
Heavily galvanised cables with optional polymer coating	Long design life to suit project requirements





# RING NETS

**Maccaferri Ring Nets have the highest strength of any mesh in the range. Ring Nets are ideal for situations where there is a combination of highly undulating slope face, large boulders and a high risk of dynamic impacts.**

The nets are also used on rock slopes in simple drapery applications with large rock masses prone to failure; Ring Nets with their high deformability characteristics can absorb impact load rupture. This high impact absorption characteristic is utilised in the rockfall catch fence application with a high energy level, typically >750kJ. There are different ring nets (either 4P or 6P) depending on the required tensile strength or absorption capacity.

The technical performance of the ring nets has been optimized to provide a balance of strength, weight and flexibility. The performance of the nets is dependent upon wire strand diameters, bundle configurations and the number of connection points to adjacent rings within the panel.

## ADVANTAGES

- Ring Nets allow high mechanical durability
- Multi-directional strength/strain performance
- Excellent dynamic impact resistance
- High durability and safety during maintenance operations
- Variety of coatings to balance commercial and performance requirements
- No overlapping mesh on lateral connections means fast installation and minimal waste
- Variety of lengths and widths available reducing installation time and waste

## INSTALLATION

Ring nets usually arrive on site folded into bundles on a pallet in their required dimension - e.g. 4m x 10m. The ring net bundles must be laid out on a flat ground into their respective dimensions.

The installation of ring nets on slopes as a drapery application are usually carried out with the help of either a crane or helicopter depending on site condition. The adjacent panels are connected with shackles at every ring location without overlapping. A specialist abseiling contractor is required for this operation.



FEATURE	BENEFIT
Ring based construction	High mechanical durability
Multi-axial configuration	Multi-directional strength / strain performance
High strength / High strain panel	Excellent dynamic impact resistance
Specialist termination of individual rings	High durability and safety during maintenance operations
Variety of coatings	Balance commercial and performance requirements
Connection elements	No overlapping mesh on lateral connections = fast installation and minimal waste
Variety of lengths and widths of mesh rolls	Lengths and widths are available to suit site conditions reducing installation time and waste



# MESH DRAPERY SYSTEMS

## TESTING & DESIGN

Maccaferri meshes have been extensively tested by recognised technical institutions and on project sites throughout the world. Quality Management processes continuously improve the systems.

Wherever possible, full-scale samples and testing is carried out to model on field situations and load conditions as accurately as possible.

The strain performance (stiffness) of the mesh is highly important in real-world applications as this determines the expected displacement of the mesh under load; a product with high tensile strength

is of limited use if it requires significant displacement in order to mobilise that resistance as this could cause serviceability failure.

The combination of the performance data determined from these tests has been included within Maccaferri's state-of-the-art design software, MACRO Studio:

MACRO 1	Secured Drapery design
MACRO 2	Simple Drapery design
BIOS	Soil Nail Flexible Structural Facing design

1

Tearing, pull-apart and local puncture tests represent rock penetration forces upon the mesh.

This models the resistance of the mesh to unravelling under extreme puncture loads.



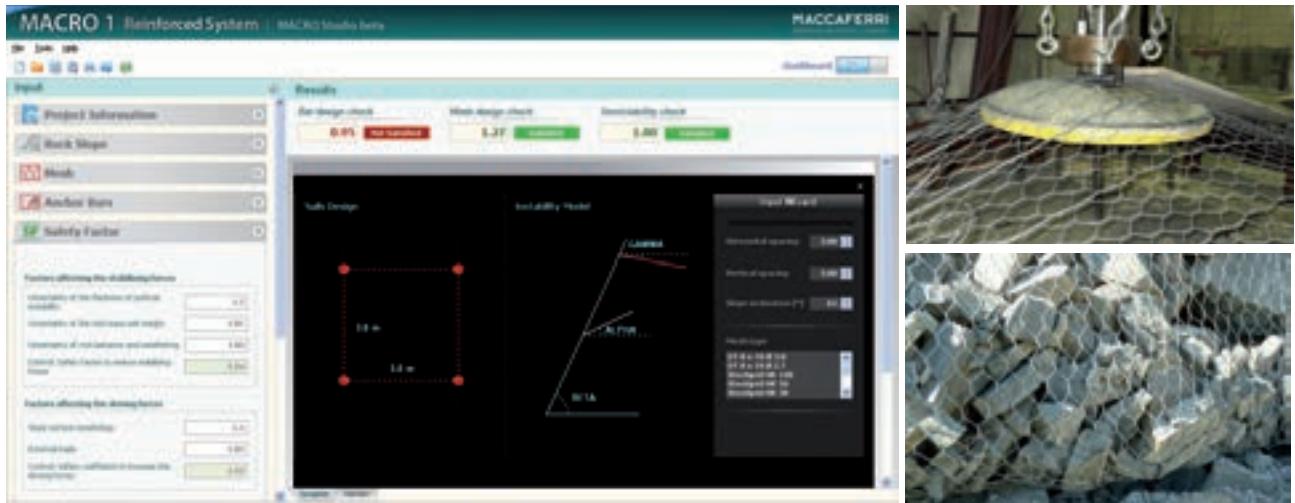
MACRO 2 Studio: Simple Drapery design



Testing of Maccaferri meshes has been carried out in accordance with UNI EN11437:2012.

The use of full-scale samples enables the test results using this methodology to be included in the MACRO Studio Design Software.

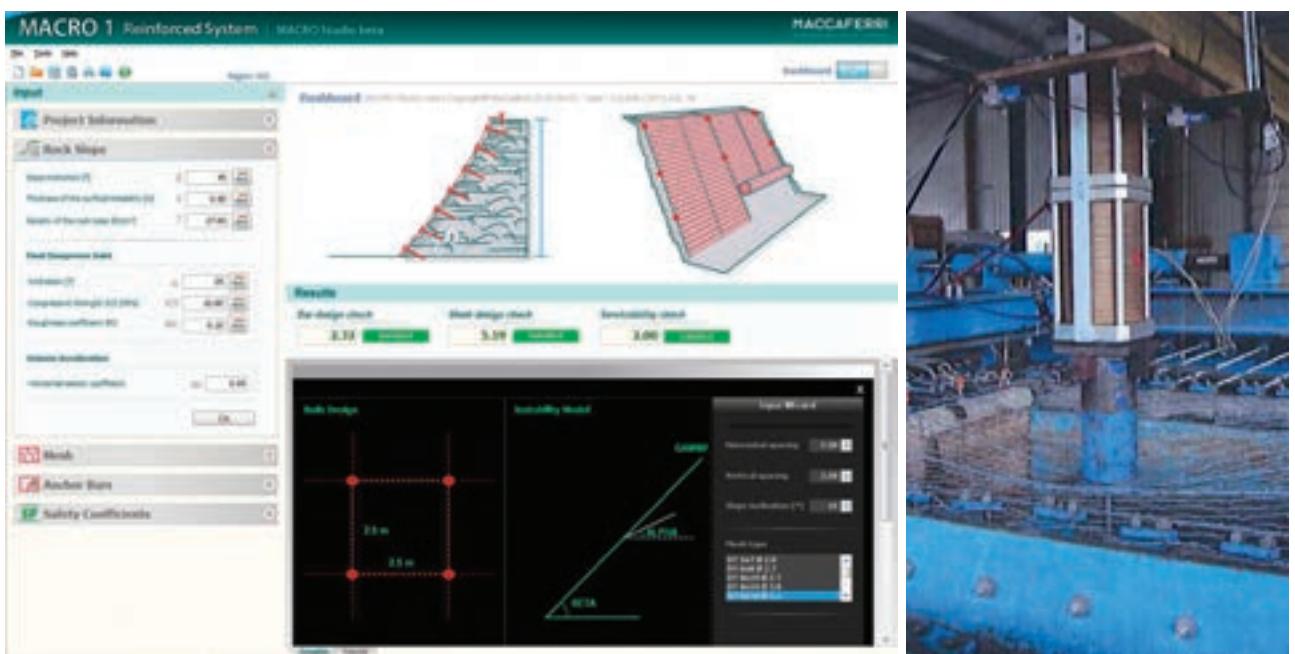
## 2



MACRO 1 Studio: Secured Drapery design

## 3

Soil box compression and tensile testing are carried out to simulate the action of anchor plates bearing upon the mesh and soil beneath.



MACRO 1 Studio: Secured Drapery design

# DEBRIS FLOW & SHALLOW LANDSLIDES

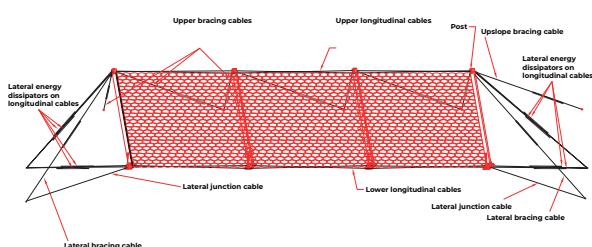
**Maccaferri Debris Flow Barriers have been developed to intercept soil/water flows or shallow landslides on slopes, channels and chutes.**

Depending on the slope and where these structures are installed, debris flow fences can be broadly categorized into 2 categories or a combination of both types:

## OPEN SLOPE TYPE/ SHALLOW LANDSLIDE

Open Slope Type debris flow fences are similar to rockfall barriers (catch fences) but may incorporate variations such as additional longitudinal ropes or larger rope diameters, additional energy absorption elements, reduced post spacing and variable geometries depending on the impact assessment.

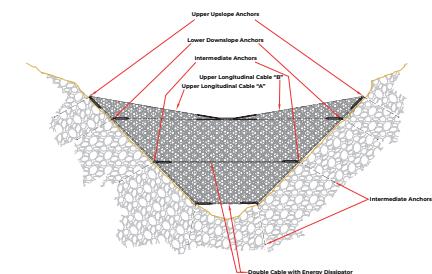
In addition, combinations of different diameter ring nets are often used as the containment mesh. Ring nets are ideal in these structures as they have excellent energy and pressure absorption capacity whilst undergoing deformation, before loads are transferred to the compression brakes.



## CHANNEL TYPE

Channel Type debris flow fences are custom manufactured fences to suit specific gully dimensions. Longitudinal ropes with intercepting panels are installed across the gully with anchors installed into the side slopes.

Sometimes this can also be a combination of utilizing a post on one side of the fence and butt against the side slopes on another. For this reason, accurate dimensioning of the gully is important for the design and manufacturing of the fence.



## ADVANTAGES

- Debris flow fences are a cost-effective solution where it could save traffic disruption.
- The arrested volume of debris can be removed in stages whilst allowing the road/rail user to continue
- Maccaferri's in-house technical ability to design the fence based on either the energy approach for open slope fence or force approach for channel fence

## WHERE CAN YOU USE IT?

Debris Flow Barriers are positioned within the anticipated path of the debris flow or shallow landslide. They are customized to suit the dimensions of the project, the anticipated debris material and the expected volume of the flow.

Multiple intercepting structures can be constructed and designed along the flow path depending on the expected volume, pressure and impact. The upper channel fences are designed to contain the same volume of flow and at the same time attenuate the velocity for the lower structure to intercept.

Debris flow barriers design philosophy is to be in place until the vegetation in the up-slope triggering zone has re-established and the risk of another debris flow event has been identified to be minimal or mitigated. The barrier can then be removed, leaving the foundation intact or a new barrier installed.

## INSTALLATION

Depending on the site topography, these fences are often custom designed and made to suit site conditions. Customised drawings are produced for specific sites to help with installation.



# ROCKFALL CATCH FENCE

In certain rockfall hazard situations, it may not be practical to install rockfall drapery mesh protection or surface stabilization mesh due to scale, complexity, technical, topographic, access or economic issues. In these cases, a cost-effective solution is provided by installing dynamic rockfall barriers.

These dynamic barriers are positioned to intercept and stop falling rocks and boulders.

They are independently certified on their respective energy ratings under the ETAG27 test procedure. Fence energy ratings of 100kJ up to 8,600kJ have been tested and certified with respective ETA certificates.

Engineers can perform a rockfall trajectory analysis and determine the suitable fence type in the most appropriate location on the slope. Often, site installation and maintenance considerations may determine the best location of the fence along the rockfall trajectory path.

## ADVANTAGES

- Wide range of fences from 100kJ to 8,600kJ
- Category A performance (best in the market)
- Easy maintenance after impact
- Installer friendly
- Lighter post for every class of energy
- Least demanding on the foundation and anchor loadings
- Availability of Maccaferri Flexible Head attachment to rigid bar anchor
- Generally the best performers on the market in terms of residual height and elongation



BARRIER	TESTED ENERGY (MEL)	CERTIFIED HEIGHT	ETAG CLASS	ETA	CE MARK
RB 100-UAF	100kJ	2m	0	SEPTEMBER 2015 (ETA n. 15/0117)	SEPTEMBER 2015 (1301-CPR-1107)
RMC 050 ICAT/2	500kJ	3m	2	FEBRUARY 2013 (ETA n. 12/0455)	MARCH, 2013 (0969-CPD-001/13-BP)
RB 750	750kJ	3m	2	JANUARY 2014 (ETA n. 13/1039)	SEPTEMBER 2014 (1301-CPD-1012)
RB 1000	1000kJ	3.75m	3	SEPTEMBER 2016 (ETA n. 16/0263)	SEPTEMBER 2016 (1301-CPR-1198)
RB 1500	1500kJ	4m	4	OCTOBER, 2012 (ETA n. 11/0396)	NOVEMBER, 2012 (1301-CPD-0835)
RMC 200/A	2000kJ	4m	5	DECEMBER, 2011 (ETA n. 11/0294)	MARCH, 2012 (0969-CPD-003/12-BP)
RMC 300/A	3000kJ	5m	6	JULY, 2011 (ETA n. 11/0026)	SEPTEMBER, 2011 (0969-CPD-001/11-BP)
RMC 500/A	5000kJ	6m	8	DECEMBER, 2011 (ETA n. 11/0293)	MARCH, 2012 (0969-CPD-004/12-BP)
RMC 850/A	8600kJ	7m	8	MAY, 2013 (ETA n. 13/0017)	JUNE, 2013 (0969-CPD-002/13-BP)

\*There are instances where a fence is design to either the MEL or SEL approaches. The factors that will influence the design approach includes frequency of rockfall, ease of maintenance, expected level of energy and budget among others.

Maccaferri rockfall barriers feature a unique, patented, compression braking system. This energy absorption device is a simple, yet effective mechanism because it maintains performance throughout the entire design life of the structure.

Unlike traditional 'friction brake' devices, our compression tube brake is very easy to visually inspect by our clients' maintenance engineers as it progressively crushes as the fence is impacted. It also does not become clogged with grit or corrosion over the life of the fence, which could potentially reduce the effectiveness of the barrier under impact.

## INSTALLATION

Maccaferri rockfall barriers are supplied in "kit form" for specific height, length and energy absorption capacity. Installation manuals are available upon request for all fence energy ranges.

FEATURE	BENEFIT
Aluminium compression brakes	Easy to inspect for minor impact
Aluminium compression brakes	Corrosion free and easy to replace post-impact
Steps on posts	Simple contractor access
Support struts on post foot-plate	Easy to elevate posts to vertical



# HYBRID/ATTENUATOR FENCE

The rockfall Hybrid or Attenuator barriers combine the energy absorption capabilities of a dynamic rockfall barrier with the reduced maintenance advantages of drapery mesh and they are used in passive rockfall hazard mitigation.

Rather than being secured to a lower support cable, the fence mesh is longer and drapes down the slope where it dissipates the energy of falling rocks. The reduction in energy allows the falling rock to be more easily captured by other passive protection structures situated downward.

## WHERE CAN YOU USE IT?

Hybrid or Attenuator barriers are usually a modification from a standard ETAG27 certified rockfall catch fence. The main difference is that Hybrid fences do not stop the rocks at the interception zone but instead, attenuate the impact energy then further guide the rocks down to the toe of the slope through a drape tail.

The best location for the Hybrid fence is therefore usually crossing a gully or at the crest of a steeper slope with a continuous flatter angle slope on top.

## ADVANTAGES

- Less maintenance than standard catch fence especially in difficult terrain
- An intermediate dissipating structure for very tall slopes with very frequent rockfall to reduce energy
- Lower foundation and anchor loadings
- Protect larger slope area compared to standard drapery mesh
- Can be installed at upper slope zone hence, intercept rocks at lower energy without increased maintenance



# FLEXIBLE STRUCTURAL FACING FOR SOIL NAILING

**The objective of using Flexible Structural Facing is to provide stability of the face by supporting the soil in between the soil nail locations and transmitting the load from the soil to the nail heads via mesh membrane stiffness.**

Flexible structural facing is an intermediate option between soft and hard facing for soil nail slopes. They are commonly used for cut slopes of moderate height with a slope angle between 33 and 60 degrees. The aim of having the flexible structural facing is to provide surficial stability while vegetation establishments take place.

While soil nailing (a technique where the slope is reinforced by the insertion of grouted steel bar) improves the internal and global stability of the slope, most soil nail structures must have a facing to provide surficial stability.

The facing system can be rigid such as shotcrete or a flexible structural revegetating system such as MacMat® R. While greater mesh stiffness is required with steeper slope or wider nail spacing, SteelgridHR mesh or HEA panels (in conjunction with lighter secondary DT mesh) can be another option.

## ADVANTAGES

- Protects the exposed surface from erosion
- Provides stability while vegetation establishes
- Stabilises the unstable surficial layers
- Cost effective option to hard facing
- Aesthetically pleasing with vegetation establishment



**HEA PANELS**



**STEELGRID HR**



**MACMAT R**

# MACMAT R

**MacMat R was developed to meet the need for permanent erosion control material which was both strong and environmentally acceptable.**

It's a mesh reinforced three-dimensional geomat that can be applied as an erosion control mat for sloped embankments, channel linings and soil-veneer applications.

It's made from an open three-dimensional mesh with a high open area to hold soil and provide a medium for root reinforcement. The double twist mesh provides resistance to rupture of the geomat on steep slopes when soil filled as well as improving the efficiency of soil anchors.

## ADVANTAGES

- Increases the shear resistance along the soil surface
- Protects seeded topsoil from washout
- Provides a zone for encouraging growth of vegetation
- Independently tested for hydraulic performance
- Combined use of a geocomposite reduces to 50% the installation costs over a double layer system
- Extremely high tensile strength
- Mesh gives stability to mat for very steep slopes where soil cover is limited
- Mesh limits damage to polymer mat.

## INSTALLATION

After grading the slope to remove unevenness MacMat R is anchored along the crest of the slope and rolled down the slope and laced together. Steel pins are used to hold down MacMat R. The frequency of pins depends on slope gradients and should ensure good contact between MacMat R and the prepared soil.



## RECOMMENDED INSTALLERS

We recommend that installation of all of our Rockfall products is performed by a certified installer

Contact your local branch or Geofabrics Slopes and Walls specialist and we can supply a range of ideal installers for all of our systems and products.

## TECHNICAL & DESIGN SUPPORT

To support the design of rockfall protection we offer an advanced suite of software free to our clients.

To assist with the design process, the Geofabrics Rockfall team of engineering specialists are available to give technical advice in the use of the software as well as provide training in-house or via seminars.



# SYSTEM ACCESSORIES

## STEELGRID® HR MESH KIT

This range of accessories are used within the high strength Steelgrid® HR system;



### HR LINKS

HR Links connect laterally adjacent panels of Steelgrid® HR mesh and require no tools. These links clip around the steel cables, connecting them intimately. Available in two finishes, GalMac® galvanised (Class A) and stainless steel (for use with PVC coated Steelgrid® HR).



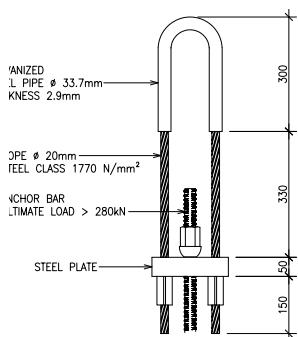
### HR GRIPS

HR Grips are technically superior to traditional rope grips and are used to connect the interwoven cables within Steelgrid® HR over the crest and toe ropes on the rock or slope face. Produced from forged carbon steel and hot-dip zinc coated, HR Grips offer optimum performance, reliability and design life.



### HR PLATES

HR Plates are engineered to offer optimal performance with Steelgrid® HR by enhancing system stiffness. They can remove the sensitivity of anchor placement within secured drapery and 'profile-bolted' installations.



### TF280 FLEXIBLE HEAD

TF 280 is a flexible head for self-drilling or any rigid bar anchor type with a diameter <40mm. It is highly recommended to be used in rockfall protection works whenever the direction of the pull-out forces is variable or inclined to the axis of the anchor. It is commonly used in conjunction with rigid bar anchors for top crest anchors of drapery systems and flexible structural facings meshes, lateral and up slope anchors for dynamic rockfall barriers, foundations for strapping systems for discrete boulders and debris flow barriers.

### FLEXIBLE ROPE ANCHOR

Used when the direction of the pullout forces is variable or inclined to the axis of the anchor. Uses include; as a top anchor on drapery systems and the ground anchors for the support cables of rockfall and debris flow fences and snow supporting structures. Available in a variety of strengths and lengths, all the steel components are heavily galvanized for durability.



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