

# Mac.RO™ Systems

## Natural Hazard and Rockfall Mitigation

Rockfall protection and natural hazard mitigation are key elements in the security and safety of road, rail, 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 logical

graded range of engineered systems working in sympathy 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 and a global network of factories offers local product availability.

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

***\*Please note that Avalanche Protection and deep-seated slope instability are covered in other Maccaferri literature.***





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## **Mesh Systems**

- *Rockfall Netting*
  - *Steelgrid® HR*
  - *HEA Panels*
  - *Ring Nets*
  - *Evidence and Testing*
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## **Dynamic Rockfall Barriers**

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## **Debris Flow and Shallow Landslide Barriers**

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## **Hybrid and Attenuator Systems**

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## **Rockfall Embankments**

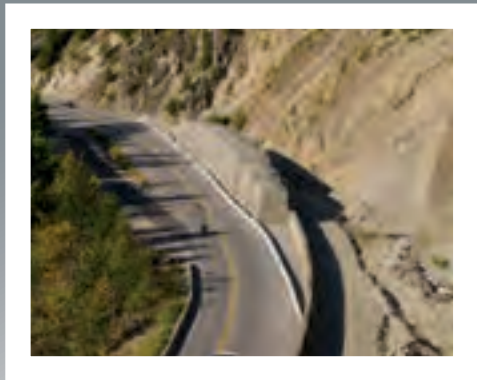
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## **Soil Nailing and Surface Protection**

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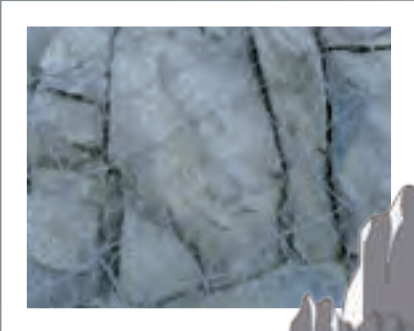
# General Concepts of Natural Hazards



Rockfall and landslide embankments



Mesh systems - Simple Drapery



Mesh Systems - Secured drapery / Surface stabilisation



Debris Flow & Shallow Landslides

Dynamic rockfall barriers, hybrid and attenuator systems



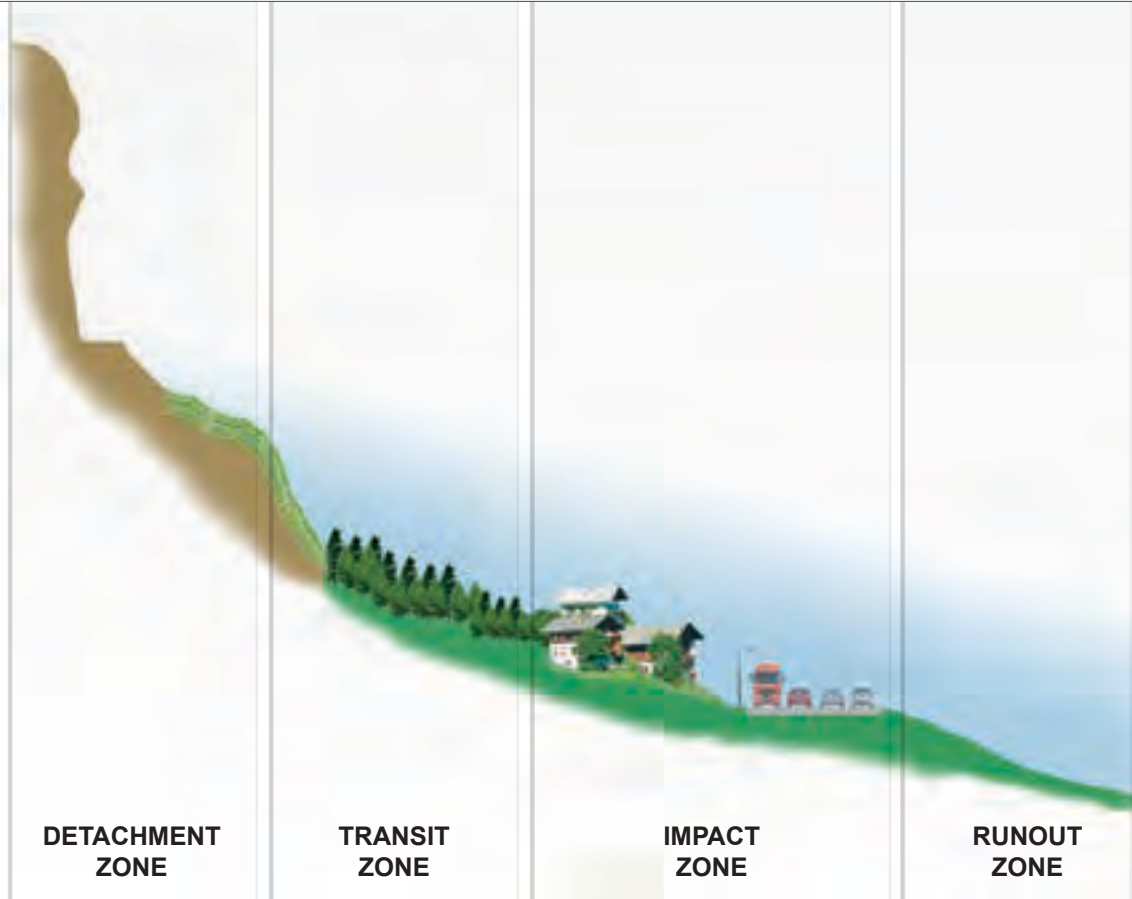
Soil nailing and Surface protection



# General Concepts

## Solution Suitability and Location

Product	Detachment Zone	Transit Zone	Impact Zone	Runout Zone
Mesh Systems	[Red bar spanning Detachment, Transit, and Impact zones]			
Attenuator Systems		[Red bar in Transit zone]		
Hybrid Systems		[Red bar in Transit zone]	[Red bar in Impact zone]	
Rockfall Barriers		[Red bar spanning Transit, Impact, and Runout zones]		
Debris Flow Barriers		[Red bar spanning Transit and Impact zones]		
Rockfall Embankments		[Red bar spanning Transit, Impact, and Runout zones]		



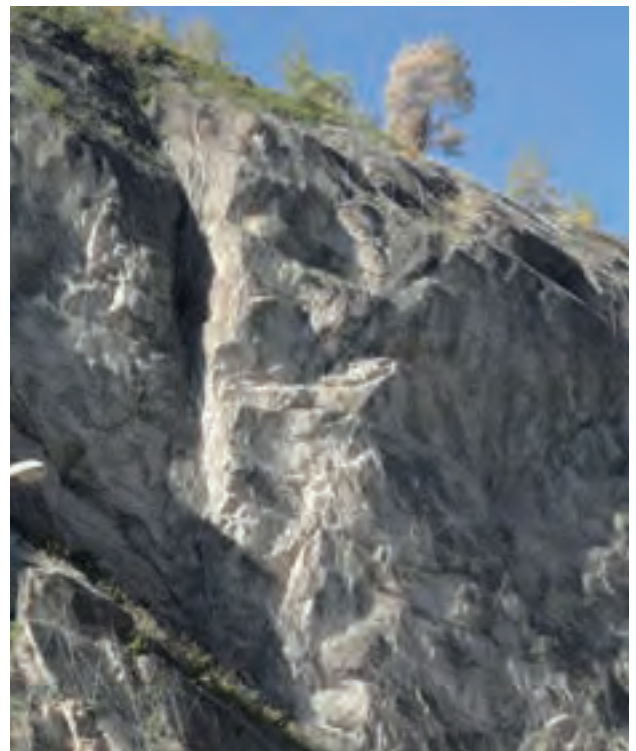
There are many factors to consider when selecting appropriate interventions to mitigate natural hazards. Understanding the suitability and effectiveness of the systems and where they offer optimal performance is important.

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; one product cannot solve all natural hazard problems.

# Mesh Systems Introduction

Maccaferri offers a complete range of mesh systems for rockfall protection. Selection of the 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).

Solutions	
<b>Drapery</b>	Mesh is hung down the slope face from a secure crest 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.
<b>Secured Drapery / Surface Stabilisation / Pinned Drapery</b>	As above, 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, augmenting the stability of the slope.



Maccaferri technical software MACRO 1, MACRO 2 and BIOS, enable designers to select the appropriate system and grade of product.

The stiffness and puncture resistance of the mesh are more important than the tensile strength as this affects the deflection of the system under load on the project site. Accordingly, the mesh range includes both high and low stiffness products to suit project needs; one product cannot solve all problems!

Corrosion resistance of Maccaferri mesh systems is provided by heavily galvanised zinc and zinc-aluminium alloy coated steel with optional polymer coatings. For aggressive environments, the new Maccaferri PA6 polymer coated rockfall protection mesh and polymer coated Steelgrid® HR and HEA panels are available. The performance of these far exceed galvanised (even zinc-aluminium alloy coated) products, especially in coastal applications.

System	Stiffness	Strength
DT Mesh	Moderate	Moderate
Steelgrid® HR	Very High	High
HEA Panels	Extreme	Very High
Ring Nets	Low	Extreme



# Mesh Systems

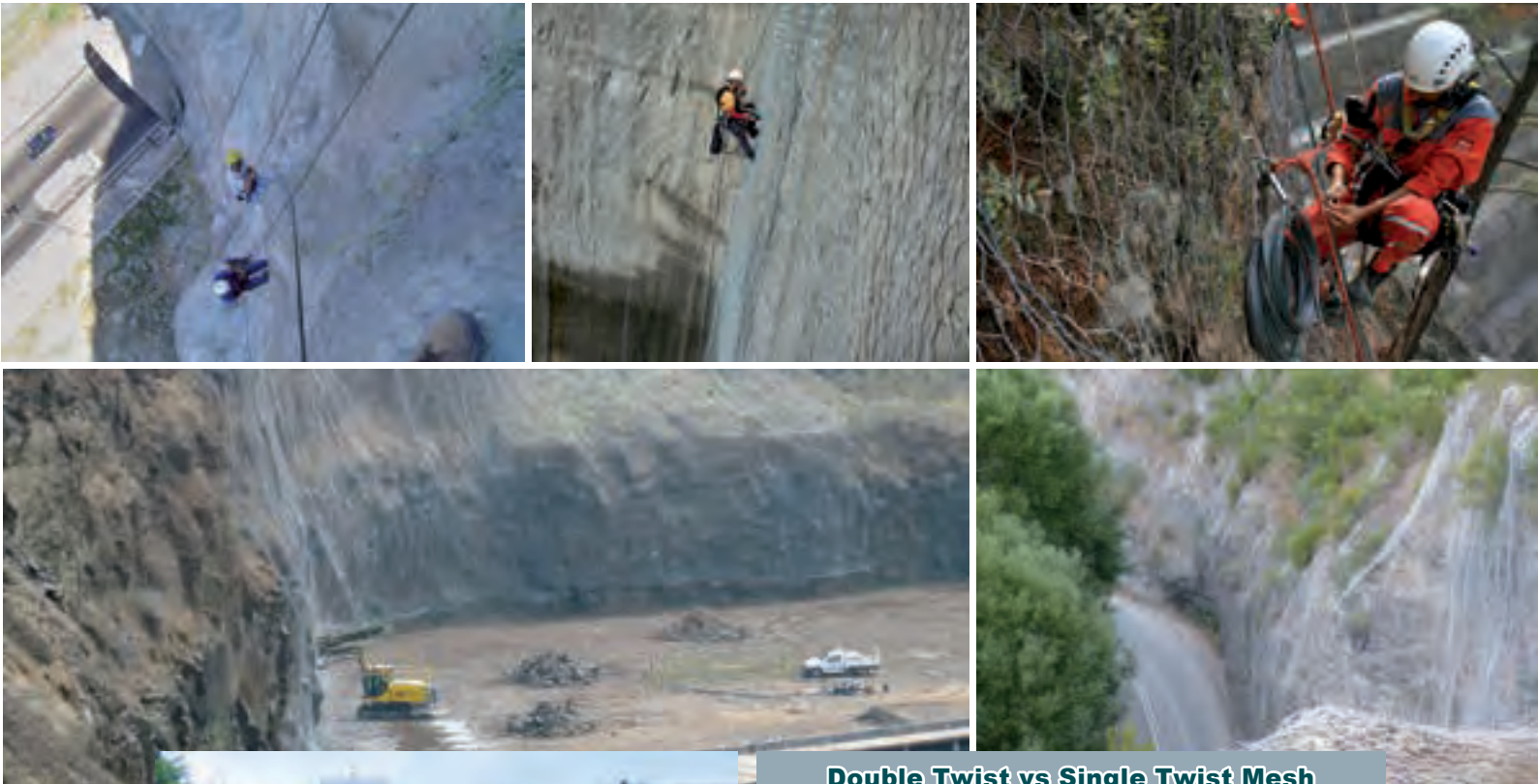
## Rockfall Netting

Double twist ('DT') steel wire mesh is a highly efficient mesh combining ease and flexibility of use with unsurpassed cost effectiveness. Used around the world for over 60 years, Maccaferri DT mesh is proven to offer robust, long lasting and cost effective rockfall protection.

Commonly used as 'drapery', DT mesh provides a protective curtain on the slope; any rocks and debris detaching from the slope are contained behind the mesh.

Maccaferri DT mesh is available in a variety of puncture (punch) resistances and corrosion protection coatings to suit the project design and exposure conditions. It can be supplied with a range of installation accessories including C-rings and installation tools to increase site productivity.

Feature	Benefit
Double twist mesh construction	Does not unravel in the event of wire breakage
Flexible in 3 dimensions	Excellent containment of debris Easy to install on site
Light-weight	Ease of installation
Variety of coatings	Balance commercial and performance requirements
C-Rings and tools	No overlapping mesh on lateral connections = fast installation and minimal wastage
Variety of lengths and widths of mesh rolls	Lengths and widths are available to order to suit site conditions saving install time and waste



### 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.



# Mesh Systems **Steelgrid® HR**

Steelgrid® HR is a breakthrough in composite mesh technology offering high stiffness: high tensile strength at low strain and high punch resistance with low deformation.

This patented mesh is an engineered combination of double twist steel wire mesh and high tensile (1770N/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.

Steelgrid® HR combines the flexibility and simplicity of installation of double twist mesh with the high tensile strength, low extension and durability of steel wire rope.

Steelgrid® HR is used as a drapery or as a high stiffness (low extension) bolted facing when anticipated loads exceed the capability of traditional DT Mesh.

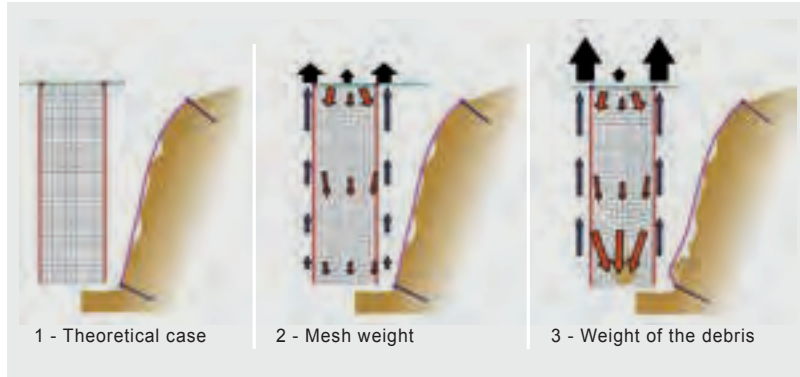
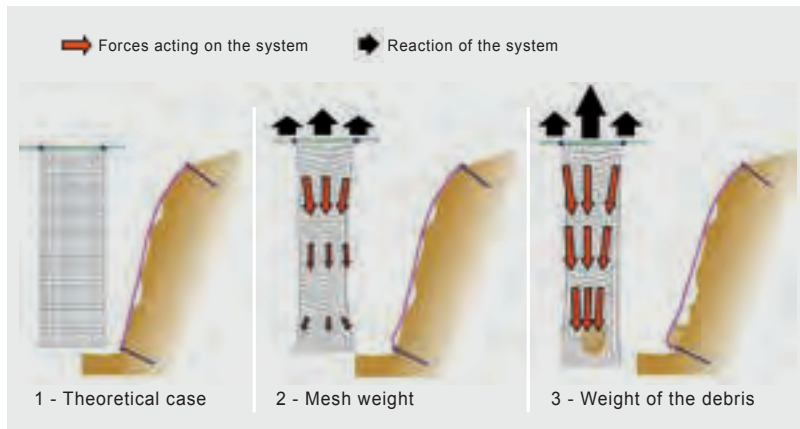
Steelgrid® HR is available in a variety of strengths (up to 180kN/m tensile resistance and up to 155 kN/m for punch resistance), enabling designers to optimise solutions both technically and commercially.

The product is available in two levels of corrosion resistance:

- Steelgrid® HR: Mesh wires and ropes galvanised with GalMac® (Zn/Al) alloy Class A
- Steelgrid® HR-PVC: As Steelgrid® HR, but with an additional continuous polymer coating on mesh and ropes.

When site conditions are more aggressive (for example in some locations next to the sea), or the project demands a longer design life than that offered by the Class A GalMac® (Zn/Al) coating, PVC coated Steelgrid® HR is uniquely able to provide reliable long-term performance.

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.



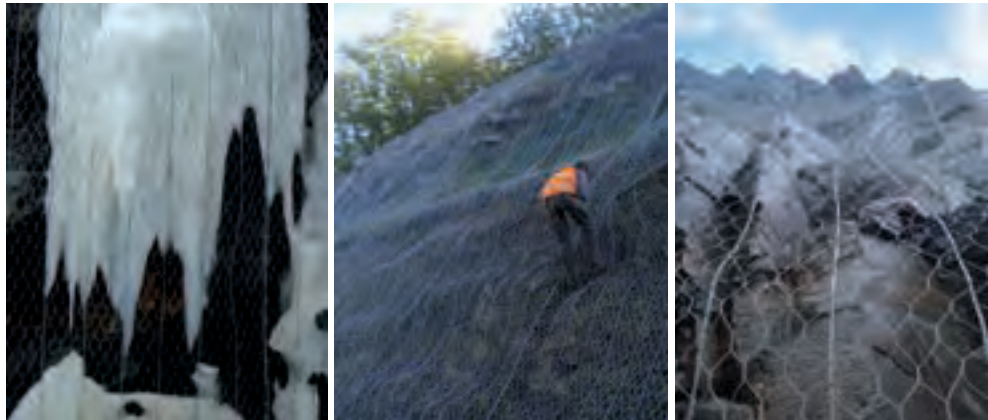
Feature	Benefit
Integral steel ropes	Low strain, high strength composite mesh
Integral steel ropes	"2 products in 1" reduces installation time and cost
Integral steel ropes	No overlap required between adjacent rolls of mesh on the slope = reduced material wastage
Flexible in 3 dimensions	Excellent containment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



## High Strength Drapery

Steelgrid® HR is ideal for use on high rock faces and slopes with a long drop or where large volumes of debris are expected; the integral longitudinal steel ropes enable the efficient transmission of loads to the crestline ropes and anchors, with minimal mesh deformation.

Certain types of un-reinforced drapery (especially some types of single twist or 'chain link' type meshes) can exhibit considerable heterogeneous deformation during loading from the accumulation of fallen material between the mesh and the slope and due to other factors such as self-weight and ice accumulation.



## Bolted facing and surface stabilisation

Available with tensile strengths up to 180 kN/m and up to 155 kN/m for punch resistance, Steelgrid® HR is also designed to work in conjunction with anchorages to increase the stability of the unstable surficial layer of a rock or soil slope.

Due to its structure, Steelgrid® HR is flexible in terms of anchor positioning, thereby saving time and cost on site. The HR Anchor Plate transfers loads from the mesh into the anchors. The four spikes on the corners of the HR

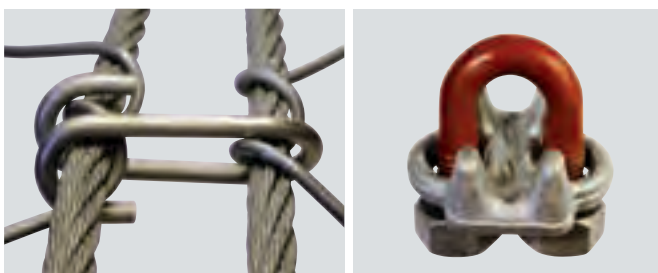
Anchor Plate engage with the Steelgrid® HR and effectively restrain the steel cables.

Steelgrid® HR is also available with an integral erosion protection mat providing two products in one; MacMat® HS.

It features a 3D matrix of polymer monofilaments extruded onto the reinforced mesh during manufacture. The polymer matrix provides immediate erosion protection from rainfall runoff, encourages revegetation of the soil slope and provides root reinforcement.



**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, HR-Link mesh connectors and HR-Cap rope protectors.



# Mesh Systems

## HEA Panels

HEA Panels are the stiffest products within the Maccaferri Mac.RO™ Systems mesh range offering extreme strength at low strain. The panels are woven from a **single continuous length** of high tensile strength steel wire rope, joined at each crossing point with the patented HEA ‘double knot’ connection. Unlike single twist spiral rope nets, the construction of HEA Panels provides exceptional stress/strain performance with the lowest possible deformation. HEA Panels are used in secured drapery applications where a low deflection and high strength system is required. 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. HEA panels made from polymer coated cables are also available for demanding exposure conditions.

### Customisable Product

Maccaferri offers standard HEA Panels, however bespoke HEA Panels can be made for specific needs; they can be connected together in the factory to suit project dimensions, and even secondary small aperture meshes applied.

This reduces installation time on the rock face, and minimises wastage. Contact Maccaferri for details.



### Junction resistance

Type of junction	Resistance to tear	Resistance to pull apart
	kN	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 explosively.
Steel wire rope construction	Mechanical durability and resistance to abrasion
Multi-axial configuration	Multi-directional strength / 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

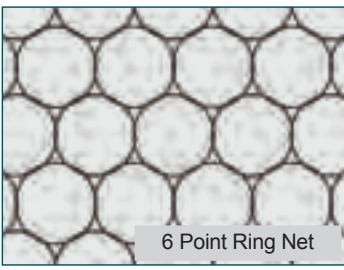
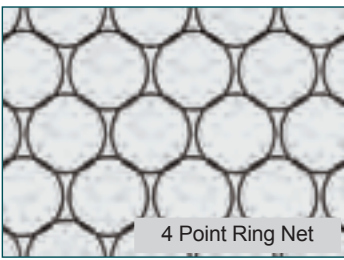


# Mesh Systems

## Ring Nets

Maccaferri Ring Nets have the highest strengths of any mesh in the Mac.RO™ Systems range. With high strain performance, Ring Nets are ideal for situations where there is a high risk of dynamic impacts. The nets are also used to face rock slopes featuring large rock masses prone to failure; Maccaferri Ring Nets can accommodate these high local stresses without sustaining damage.

The technical performance of the ring nets has been optimised 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.



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



# Mesh Systems Testing and Design

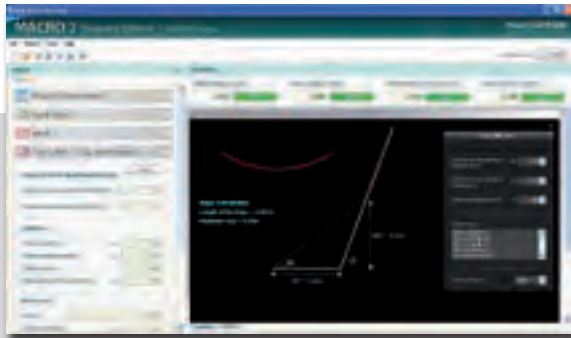
Maccaferri meshes have been extensively tested at recognised technical institutions and on project sites throughout the world. Quality Management processes continuously improve the systems.

Wherever possible, full-scale samples and testing is carried out to most accurately model real-world situations and load conditions.

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**:

<b>MACRO 1</b>	Secured Drapery design
<b>MACRO 2</b>	Simple Drapery design
<b>BIOS</b>	Soil Nail Facing design



MACRO 2 Studio: Simple Drapery 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.

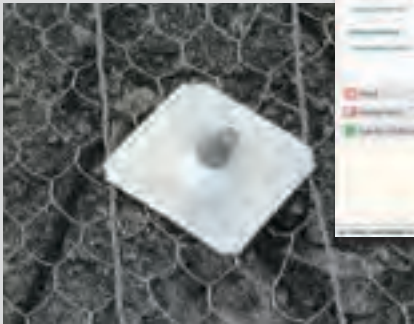


## 2

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

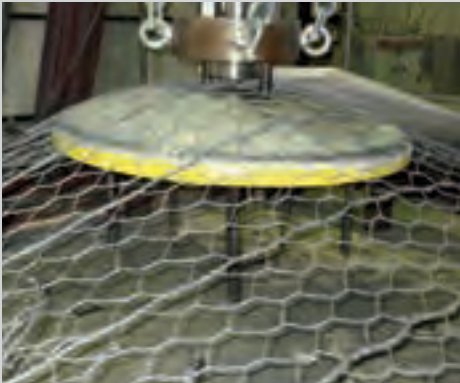


MACRO 1 Studio: Secured Drapery design



## 3

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.



MACRO 1 Studio: Secured Drapery design

# Dynamic Rockfall Barriers

When commercial, safety, access or other conditions prohibit the implementation of a solution within the Detachment Zone, barriers within the Transit or Impact zones can be very effective at protecting infrastructure.

**Maccaferri offers a range of barriers to suit most project problems;**

- Debris Flow barriers
- Dynamic Rockfall barriers
- Hybrid and Attenuator barriers

Maccaferri dynamic rockfall barriers are available with energy absorption capacity up to 8,500kJ.

The barriers are designed to progressively deflect under loads, absorbing the impact. A key feature enabling this is the patented "compression brake" within all Maccaferri barriers; under impact the brake is compressed.

Maccaferri's barriers have been developed in conjunction with specialist contractors. Therefore, the barriers include features to make the installation faster and safer, reducing time on site.

**Selection of the appropriate barrier is based upon design and commercial analysis considering the type and volume of material to impact the barrier, the physical characteristics of the slope above and the infrastructure to be protected.**

**This determines the type, location, height and capacity of the barrier.**

### Limited slope space?

For occasions where there is limited space or access to install uphill anchors for the catch fence, Maccaferri also offers a solution; available in lower energy absorption capacities, Maccaferri ICAT dynamic rockfall barriers provide protection without the need for uphill anchors, saving installation costs on site.

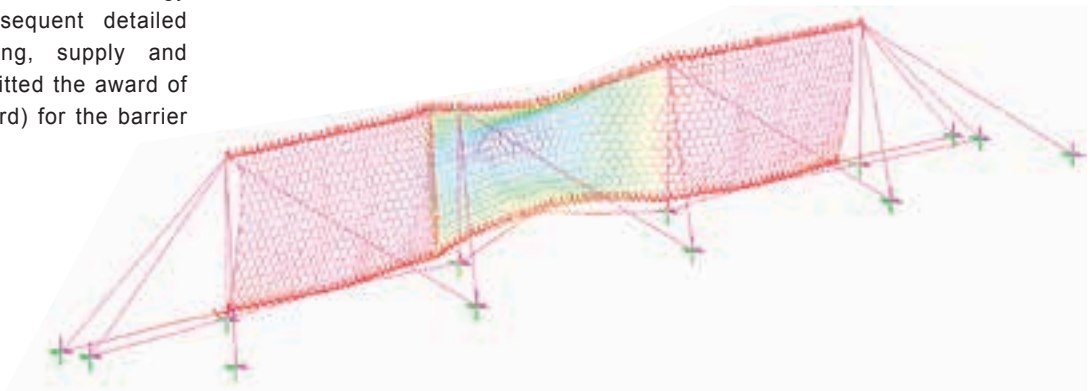


## ETA Approval & CE Marked Barriers

Maccaferri's dynamic rockfall barriers are tested and certified in accordance with the European Test and Approval Guideline 27 (ETAG 27) of the European Organisation for Technical Approvals (EOTA).

Maccaferri has been awarded European Technical Approval (ETA) for its range of barriers from 500kJ to 8,500kJ energy absorption capacities. Subsequent detailed verification of manufacturing, supply and assembly systems has permitted the award of the CE mark (quality standard) for the barrier systems.

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
"Eye" connectors on posts	For contractor fall-arrest system

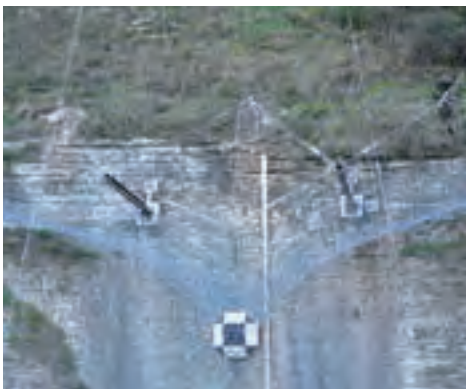
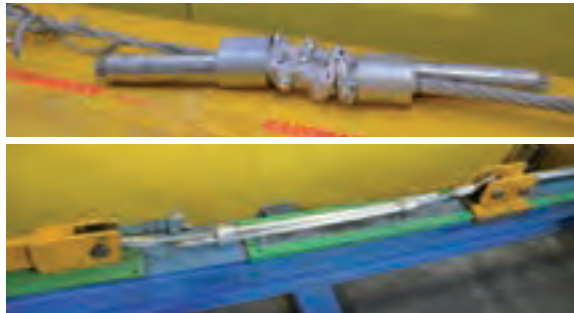


Following a major impact event, the barrier is deformed plastically. The residual height of the barrier post-impact is an important characteristic; the barrier may be exposed to a second rockfall impact in rapid succession before it has been repaired. All Maccaferri dynamic rockfall barriers exhibit residual heights within the highest category, **Class A in accordance with ETAG 027**.

### COMPRESSION BRAKES

Patented aluminium compression brakes form a fundamental part of the energy absorption capability of the barrier. Lightweight, corrosion resistant, easy to replace and very simple to inspect visually for evidence of impacts, however minor.

Barrier performance data, collected during the full scale impact tests required for ETAG 27, are used by engineers during the design process. A dynamic rockfall barrier system which has been tested in accordance with ETAG 027 provides confidence to clients and designers that the rockfall protection kit has been independently tested and assessed, in accordance with a rigorous set of guidelines to ensure standards of quality and performance.



Full-scale rockfall crash test

# Debris Flow and Shallow Landslide Barriers

Debris flows are highly mobile flows of mixed material and are triggered by the rapid build-up of water within the slope, saturating the ground. Debris flows can travel at high speeds and contain huge volumes of material and consequently pose a high risk to people, property and infrastructure.

It is predicted by meteorologists that global climate changes will increase rainfall in many areas and is likely to influence the incidence of debris flow and shallow landslides.

**Maccaferri DF Barriers** are positioned within the anticipated path of the debris flow or shallow landslide, often in natural gullies, channels or chutes on the slope.

The DF Barriers are customised to suit the dimensions of the project, the anticipated debris material and the expected volume of the flow.

Upon impact by the debris flow, the DF Barrier progressively deforms with the compression brakes and systems absorbing the energy. The hydrostatic pressure within the flow rapidly dissipates once the debris flow has been arrested, leaving the volume of debris within the barrier.

Maccaferri DF Barriers offer strength and performance without the aesthetic intrusion of other debris flow systems.



## After-impact maintenance

Once the Maccaferri DF barrier has deployed and arrested the debris flow, the debris is emptied and disposed of.

Compression brakes are replaced whilst support ropes and containment mesh are checked for serviceability before reuse or replacement.

The cost of replacing components is a minor consideration compared to emptying the debris from the barrier, or cleaning up after a debris flow event which has **not been stopped** by a barrier.



# Hybrid and Attenuator Systems

Hybrid and Attenuator Systems combine the energy absorption capabilities of a dynamic rockfall barrier with the reduced-maintenance advantages of drapery mesh. Rather than being secured to a lower support cable, the fence mesh is longer and drapes down the slope. Therefore, a falling rock is not captured and stopped as with a traditional rockfall barrier, but following impact with the barrier, the rock continues down the slope beneath the mesh draped down the slope face. The rock is progressively slowed beneath the mesh. Hybrid and Attenuator Systems are used on slopes where there is available 'run-out' space beneath the barrier in which the rocks can ultimately stop or be

collected harmlessly. The height, location and energy absorption capacity of the barrier are determined through the use of engineering software such as 'Rocfall'. Combinations of barriers are often deployed on slopes to optimise the protection provided with commercial and maintenance considerations. For example a series of attenuator systems could be placed on a slope to progressively slow large rocks, with a reception trench at the toe of the slope. On long slopes with available space, this solution could be simpler to maintain than a single high-capacity dynamic barrier high on the slope.

**Attenuator Systems:**

Multiple lines of barriers  
Shorter drapery down slope

**Hybrid Systems:**

Single line of barriers  
Long drapery down slope



# Rockfall Embankments

When the capacity of dynamic rockfall barriers is not sufficient, earth embankments and bunds are commonly used as protection from natural hazards; landslides, rockfalls, avalanches and more. Until recently, the dimensions of the footprint of these embankments have been limited by the geotechnical parameters of the material used to construct the embankment.

With over 30 years of geogrid and geosynthetic knowledge, Maccaferri has significant expertise in the use of soil reinforcement. Using Maccaferri's soil reinforcement solutions to construct rockfall embankments has numerous advantages:

- Footprint of embankment is dramatically reduced
- Slope face angles can be steeper
- Embankment is more stable and robust
- Site won materials can often be reinforced and re-used, embracing sustainability
- Maccaferri manufactures a wide variety of soil reinforcement geogrids and textiles to suit most sites and conditions
- Revegetating embankment face provides environmental benefits

FEM analysis has been used to design Maccaferri reinforced soil embankments offering a capacity of 20,000kJ.

Given enough space, almost unlimited energy absorption capacities are achievable.

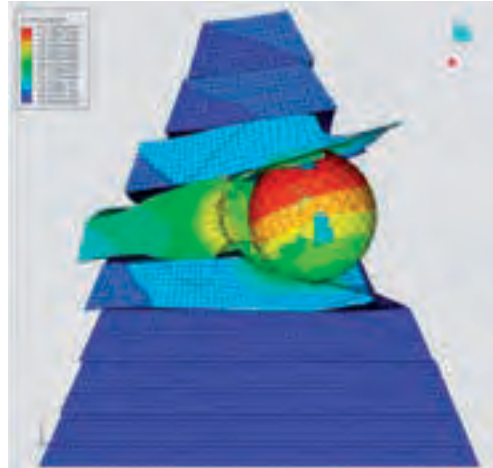
**Maccaferri soil reinforcement systems**

- Terramesh®
- Green Terramesh®
- Paragrid® & Paradrain®
- MacGrid® WG
- Duna® System

**Embankment benefits**

In situations where extensive natural hazards are expected, embankments can offer;

- Cost effective solution (\$/kJ capacity)
- Almost unlimited capacity (>20,000kJ)
- Withstand multiple impacts without repair
- Contain vast quantities of debris
- Very low maintenance
- Can divert flows away from infrastructure



# Soil Nailing & Surface Protection

Soil nailing is a technique that can be used either on natural or excavated slopes, where the slope is reinforced by the insertion of tendons. These nails address the global slope stability and are connected to a facing system which provides surficial stability. The facing system can be rigid, flexible or even a structural revegetating system such as MacMat® R. The facing system restrains the superficial portion of the slope which can mobilise between the anchorages, potentially destabilising the overall slope.

Where high performance and revegetation are required, the innovative MacMat® HS, combines the reinforcing benefits of Steelgrid® HR and a 3-dimensional geomat in one product; installation time is reduced and simplified.

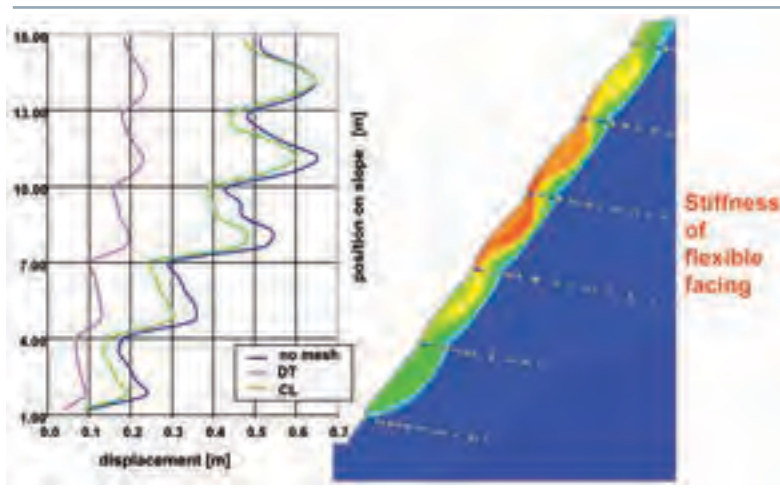
To design such facing systems, Maccaferri has developed BIOS; a new software to assist in the selection of flexible and soft facings. To check the overall (global) stability of the soil nail reinforced slope, suitable geotechnical design software is used, e.g. Maccaferri MacSTARS.

Maccaferri's numerous rockfall mitigation and erosion protection systems provide solutions (either

stand-alone or in combination) for the local surface stability including;

- Reinforcing flexible facings: DT mesh, HEA Panels, SteelGrid® HR, MacMat® R, MacMat® HS.

**Slope with nails and mesh**



To prevent ongoing erosion of the slope face between the soil nails, it is important to vegetate the slope with appropriate indigenous plant species. Once established, vegetation will continue to provide surface erosion protection. Due consideration must be given to the capability of the slope to sustain vegetation in terms of nutrients, moisture content and aspect (facing direction). The growth of vegetation will also be able to increase the slope superficial stability.

Maccaferri has also developed a range of products (bolts, facing accessories) to fulfil the specific requirements of flexible structural facings (mesh + deep nails) and soft facings (mesh + short nails).

Geotechnical investigation and design determine the suitability of soil nailing to reinforce an unstable slope. Maccaferri offers numerous other solutions, including retaining structures and soil reinforcement, in the event that soil nailing is not suitable.

#### Functions of the facing system;

- Protects the exposed surface from erosion
- Provides stability while vegetation becomes established,
- Connects the unstable surficial layers with the stabilised deep slope

#### Functions of the soil nailing system;

- Enhance the deep-seated stability of the slope
- Provide long-term reinforcement of the slope
- Be connected to the suitable fascia system

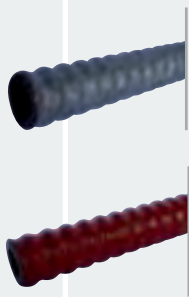


## System Accessories

Maccaferri also offers a variety of accessories, specifically selected for their compatibility with the range of rockfall mitigation solutions. Clients can select whether they require a package solution, or individual components to suit the project and local relationships.

### High Capacity Self-drilling bars

Available with a variety of diameters, steel strengths and corrosion protection treatments including electrolytic or hot dipped galvanised, or epoxy coated. Drill bits, couplers, plates and bolts are available to suit the project requirements and ground conditions.



**Step 1**  
Bar strength, steel type & corrosion protection

**Step 2**  
Various drill bits for to suit ground conditions

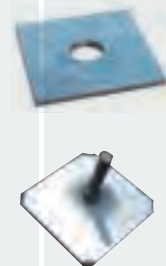
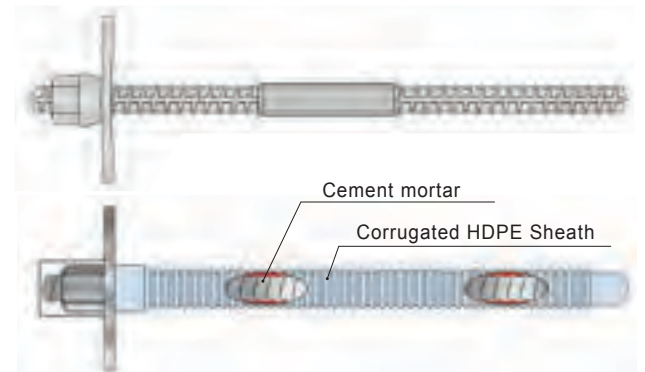
**Step 3**  
Coupler

**Step 4**  
Nuts & Plates

### Continuous Threaded Bars

Available in a variety of diameters, steel strengths and corrosion protection treatments including electrolytic or hot dipped galvanised, epoxy coated or with double corrosion protection. Couplers, perforated drill liners and plates are available to suit the project requirements.

MacRO™ Double Corrosion Protection bars (in accordance with EN 1537) feature high resistance continuous threaded bars protected with a cement mortar layer encapsulated within a 1.2 mm thick corrugated HDPE sheath.



**Step 1**  
Bar strength, steel type & corrosion protection

**Step 2**  
Coupler

**Step 3**  
Liner / Centralisers

**Step 4**  
Nuts & Plates

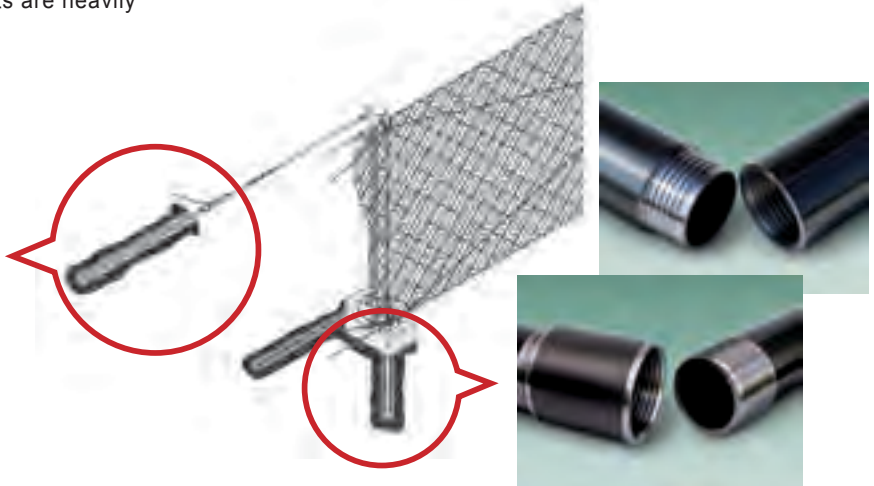
## Flexible Rope anchor

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.



## Micro-piles

Used to restrain foundations for rockfall, debris flow, hybrid and attenuator barriers. Can be supplied as a single length, with either a direct screw connection, or couplers depending on diameter and specification.



## Steelgrid® HR Mesh Kit - System Accessories

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

**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** 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.

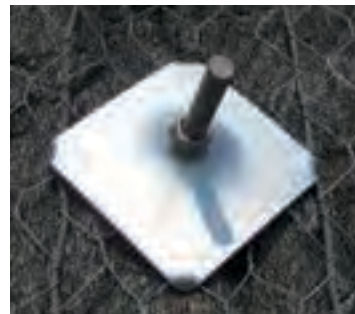
**HR Plates** are engineered to offer optimal performance with Steelgrid® HR by enhancing system stiffness. They can remove the sensitivity of anchor placement within secured drapery and 'profile-bolted' installations.

**HR Caps** are a recommended accessory for projects involving Steelgrid® HR-PVC and are used to enhance design life in highly aggressive environments.

HR Links



HR Grips



HR Plates



HR Caps

*Not all accessories are available in all Maccaferri companies worldwide. Please consult your local Maccaferri office for more information.*

## Officine Maccaferri Group Profile

Founded in 1879, **Officine Maccaferri** soon became a technical reference in the design and development of solutions for erosion control and retaining structures. Since then, through technological innovation, geographical expansion and focussed diversification, Maccaferri now offers solutions at a global level for a wide range of **civil and environmental engineering** applications.

## Consultancy and Partnership

Maccaferri's motto is 'Engineering a Better Solution'; We do not merely supply products, but work in **partnership** with our clients, offering technical expertise to deliver versatile, cost effective and environmentally sound solutions. We aim to build mutually beneficial relationships with clients through the **quality of our service and solutions**.

## Organisational Structure

Officine Maccaferri is at the heart of the Maccaferri Industrial Group. Its continued growth is based upon long-held values of innovation, integrity, excellent service and respect for the environment.

Maccaferri's vision is to become a leading international provider of advanced solutions to the civil engineering and construction market. Implementing a strategy of vertical integration, Maccaferri researches, manufactures, designs, supplies and constructs solutions within its target markets. The capability of the business continues to expand due to a strategic plan to open new markets and grow existing ones; Maccaferri now offers advanced engineered solutions from **beach nourishment to reinforced soil structures** and from **rockfall mitigation to tunnelling systems**.

With over 2000 employees, 26 manufacturing facilities and local operations in 100 countries around the world, Maccaferri can truly claim to have a global presence with local focus.

### Maccaferri: Engineering a Better Solution



Bureau Veritas Certified Quality System Company with ACCREDIA's and UKAS's accreditation



ENGINEERED ENVIRONMENTAL SOLUTIONS

# MACCAFERRI

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