Maccaferri Ltd

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Engineering a Better Solution

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.

GLOBAL ENGINEERS

In the second half of the 19th century, we invented Gabions and dramatically changed the civil engineering landscape. We are still changing today. We work every day to find better solutions for our clients at every degree of latitude and longitude. Our worldwide network grows through innovation and diversification of sectors of activity and through an increasing range of high quality and environmentally friendly products and applications.

OFFICINE MACCAFERRI GROUP PROFILE

Founded in 1879, our Group soon became a worldwide reference in the design and development of advanced solutions, with offices in over 70 countries and 30 factories worldwide.

Our mission is to pursue excellence through continuous improvement, while delivering to customers engineered solutions that are innovative, advanced and environmentally friendly. We are committed to outstanding safety, quality and sustainability, to create value for all stakeholders as well as our communities.

MACCAFERRI APPLICATIONS

- RETAINING WALLS & SOIL REINFORCEMENT
- SOIL STABILISATION & PAVEMENTS
- DRAINAGE OF STRUCTURES
- FENCING & WIRE
- HYDRAULIC WORKS
- BASAL REINFORCEMENT
- SAFETY & NOISE BARRIERS
- AQUACULTURE NETS/CAGES
- ROCKFALL PROTECTION & SNOW BARRIERS
- COASTAL PROTECTION, MARINE STRUCTURES & PIPELINE PROTECTION
- LANDSCAPE & ARCHITECTURE
- ENVIRONMENT, DEWATERING & LANDFILLS
- EROSION CONTROL

MACCAFERRI

MACCAFERRI

Engineering a Better Solution

INTRODUCTION

In 1879 we invented the gabion and changed the course of civil engineering. We are still changing it today.

We provide engineering services across many market sectors, solving their geotechnical problems. We are a vertically integrated company; we research, design, manufacture and supply materials and support the construction of our solutions.

The global footprint of our offices and manufacturing facilities means you are never far from Maccaferri's engineers and the support they can bring to your projects.

Our knowledge capital is shared throughout our business and with our clients; global capability is delivered locally through our specialists.

We endeavour to 'Engineer a better solution'; minimising the carbon footprint, waste and by reusing site materials whenever possible.

We thrive on innovation, whether in the solutions we provide or the combinations of materials we use. The Maccaferri Innovation Center (MIC) is our R & D hub; advances made here in materials, design and manufacturing bring benefits to our clients.

CONTENTS

Our Applications:

We manufacture and supply high quality durable materials which:

- Enhance the service life of the works
- Reduce environmental impact
- Provide client reassurance

Many of our products are certified by international or local accreditation bodies.

This guide provides a short introduction to the range of Maccaferri solutions. Detailed technical information, brochures, design guides and more are available from your local Maccaferri website and office.

Interrelation between sectors and applications

Applications	Market Sectors: Transportation Infrastructure	Urban Infrastructure	Mining	Oil & Gas / Energy	Coastal & River Control Works	Environmental Protection	Defence & Security	Emergency & Flood	Building, Industry, Sport	Agribusiness
Basal Reinforcement	✓	✓	✓	✓						
Coastal Protection, Marine Structures & Pipeline Protection				✓	✓	✓				
Drainage of Structures	✓	✓	✓	✓	✓	✓			✓	✓
Environment, Dewatering & Landfills			✓	✓		✓				✓
Erosion Control	✓	✓	✓	✓	✓	✓		✓		✓
Hydraulic Works	✓	✓	✓	✓	✓			✓		✓
Landscape & Architecture		✓				✓				
Retaining Walls & Soil Reinforcement	✓	✓	✓	✓	✓	✓		✓		✓
Rockfall Protection & Snow Barriers	✓	✓	✓	✓						
Safety & Noise Barriers	✓	✓	✓	✓			✓			
Soil Stabilisation & Pavements	✓	✓	✓				✓			✓

HYDRAULIC WORKS

Managing the power of water

With over 130 years of expertise in hydraulic works, we support clients by selecting solutions appropriate to the hydraulic erosion risk they face. With a wide range of products, we are able to tailor the intervention to optimise value and performance. Our solutions are flexible, permeable and durable, essential in these dynamic hydraulic environments.

Including soil bioengineering measures within the hydraulic works encourages revegetation, integrating it back into nature.

Our solutions include:

Channelling works

Reno Mattresses and gabions are typically used to fully contain and protect the watercourse within a specific alignment.

Longitudinal structures

The protection of individual river banks and areas of focused erosion depends on the hydraulic forces expected; geosynthetics (MacMat® geomat range) and biodegradable geomats (Biomac® C range) for lower energy flows to Reno Mattresses and gabions for demanding, high energy flows.

Weirs, culverts and transverse structures

By controlling and dissipating energy in focused locations, grade control structures reduce the hydraulic gradient of the river and hence the erosion forces. Gabion and Reno Mattress weir structures are flexible and simple to install.

Water control structures guide flows into and out of culverts and often have two functions; hydraulic erosion protection and geotechnical stability. Gabions and Terramesh® System can retain headwalls and stabilise banks.

Waterproofing of reservoirs, lakes & channels

Our MacLine® impermeable membranes and geosynthetic clay liners are often used to contain water within hydraulic works. They prevent water from draining away or cross-contaminating ground water. These geomembranes are often used in conjunction with our package of MacTex® geotextiles and MacDrain® drainage geocomposites.

Channelling works containing river in an urban area

MAC.R.A. Suite

Our software is used to design channel protection and transverse structures. These enable the designer to rapidly perform preliminary hydraulic studies to evaluate the bank protection or the weir structure required.

Longitudinal protection on major river

Weir structures can be large or small

RETAINING WALLS & SOIL REINFORCEMENT

When our clients need a small retaining wall in a housing development, a tall crusher wall in a mine or massive reinforced soil structures on a major infrastructure project, they trust Maccaferri to help. We offer cost-effective, value engineered, scalable solutions for clients with earth retention problems.

Mass Gravity Retaining Walls

Tried and tested for over a century, our gabions are brought up to date with state-of-the-art manufacturing, corrosion resistance and design. Gabions offer a good value, attractive and long-lasting retaining wall.

A global leader in double-twist woven wire mesh products, our flexible gabion units offer strength and high drainage capacity. They absorb differential settlement and deformations with ease.

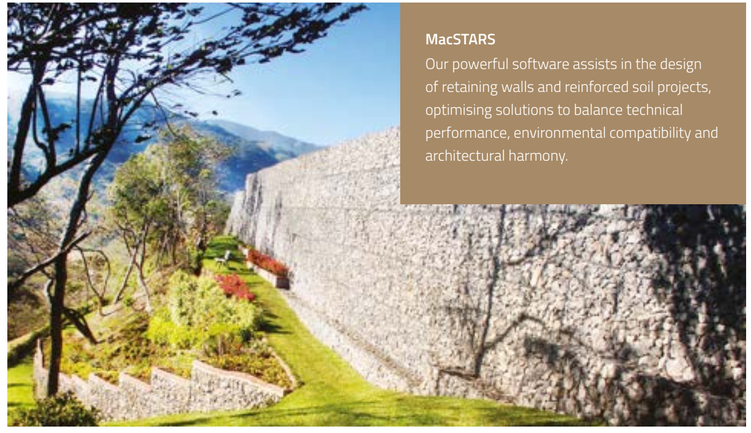
Reinforced Soil Walls & Slope Reinforcement

Reinforcing soils with geogrids enables them to perform better than in their unreinforced state; standing steeper, accommodating higher loads and settling less. This is useful when reducing the footprint of a new highway embankment, or to gain development area on a sloping site. Maccaferri geogrids including MacGrid® WG, ParaGrid® and ParaLink® are high-strength, low-strain grids with excellent soil interaction.

Terramesh® and Green Terramesh® combine the rapid installation of a modular system with the flexibility of soil reinforcement. Used in conjunction with our polymeric geogrids, we can offer super-tall hybrid structures; we have completed numerous walls over 30m high in seismic zones.

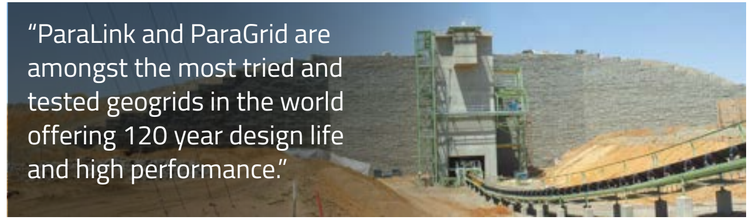
Green Terramesh® enables vegetation to be established on reinforced soil slopes.

Retaining Walls & Soil Reinforcement solutions



MacSTARS

Our powerful software assists in the design of retaining walls and reinforced soil projects, optimising solutions to balance technical performance, environmental compatibility and architectural harmony.



"ParaLink and ParaGrid are amongst the most tried and tested geogrids in the world offering 120 year design life and high performance."

Vertical Walls with Concrete Facing

When only a narrow construction corridor is available, or a reinforced soil structure with a vertical face is required, Maccaferri MacRes® system can be used.

Ideal for tall walls in mine works or infrastructure where working loads are high, MacRes® features corrosion-free ParaWeb® geostrip soil reinforcement, connected to large concrete facing panels.

A more formal and urban architectural aesthetic is offered with our MacWall® segmental blockwork faced reinforced soil wall.

Benefits of Soil Reinforcement:

- Maximise the opportunity to reuse site-won materials as structural backfill
- Embrace sustainability and reduce polluting truck movements
- Cost effective
- Wide variety of face finishes including vegetation, rock, concrete block and panel
- Accommodate differential settlements and seismic loads better than rigid solutions

ROCKFALL PROTECTION & SNOW BARRIERS

With over 60 years' experience, our rockfall protection and natural hazard mitigation systems are key elements in the security and safety of people, roads, railways, mining operations and property.

Simple Drapery

Our steel wire double twist drapery mesh is flexible and conforms easily to the rock slope to contain loose and falling rock debris. For higher slopes and increased debris loads (or snow/ice loads), Maccaferri Steelgrid® HR high strength drapery mesh can be used.

Surface Strengthening & Support

Our range of high strength meshes are designed to work in conjunction with anchorages, to form a system that increases the stability of the unstable surficial layer of the rock slope.

Featuring high tensile steel cables, our patented HEA Panels and Steelgrid® HR meshes offer high stiffness (load vs deformation) performance, ideal to limit rock detachment on critical slopes.

Dynamic Rockfall barriers

Installed on the slope to intercept falling rocks and boulders, Maccaferri's dynamic rockfall barriers offer an energy absorption capacity of 250 – 8600kJ.

Patented energy dissipation systems absorb the kinetic energy efficiently with industry leading after-impact residual height and deflection limit.

Debris Flow Barriers

Our Debris flow barriers are positioned within the anticipated path of debris flows or shallow landslides, often in natural gullies, channels or chutes on the slope.

Rockfall embankments

Scalable to suit the hazard, embankments are used where large or repeated impacts are expected including landslides, rockfalls, and avalanches. Featuring reinforced soil technology, they can often re-use site won materials in their construction. Embankments can be designed to accept impact energy capacities of over 20,000kJ.

Our dynamic rockfall barriers are tested and certified in accordance with the European Test and Approval Guideline ETAG 027 of the European Organisation for Technical Approvals (EOTA) and provided with CE marking.

MACRO Studio

Our flexible software enables engineers to design and optimise rockfall drapery and surface stabilisation solutions.

Soil nailing

Our solutions include the use of soil nails in conjunction with HEA panels or Steelgrid® HR mesh, or with MacMat® R or MacMat® HS when slope revegetation is required.

Snow fences & Avalanche Protection

Certified by the Swiss Federal Institute for Snow and Avalanches, our snow nets stabilise the layer of snow at the avalanche initiation zone preventing it triggering.

A system of snow fence posts and anchors transmit forces from the snow pack into the ground.

Steelgrid® HR protecting railway

Debris Flow Barrier

Avalanche Protection

SOIL STABILISATION & PAVEMENTS

Whether constructing a railway track-bed, gravel forestry track over soft soil, or resurfacing a multi-lane highway, our leading range of solutions help to improve performance:

- Help reduce maintenance requirements
- Reduce material use
- Reduce fatigue, reflective, thermal and settlement cracking
- Reduce carbon-footprint
- Lower whole life costs

Asphalt Pavement Reinforcement

Maccaferri offers a wide range of asphalt pavement reinforcements to reduce whole-life costs; Road Mesh® structurally reinforces the pavement and provides lateral restraint whilst MacGrid® AR geogrids inhibit reflective cracking in overlays.

Stress concentrations in the asphalt matrix are relieved and redistributed by the reinforcement.

Sub-grade Improvement

Haul roads in mines, access roads on construction sites or tracks made from unbound materials can suffer from many issues that prematurely age the road, reducing operational efficiency.

Maccaferri's geosynthetics including MacGrid® and MacTex® work with the unbound granular layers extending its life by preventing bearing capacity failure and excessive rutting. Additionally, MacGrid® EG and WG can reduce the thickness of the construction layers cutting the carbon footprint.

Sub-grade and Pavement Drainage

Removing unwanted water from the beneath or adjacent to the road increases its performance. MacDrain® drainage geocomposites replace traditional granular drainage stone with reliable, lab-tested hydraulic performance. They reduce excavation and drainage gravel volumes saving clients' money and carbon footprint.

Road Mesh®

MacREAD

(Maccaferri Road Equivalent Assistant for Design) software is used to optimise the road structure, including both unbound and bound layers, in standard and improved conditions through the addition of geosynthetics within the various layers.

Soil stabilisation & pavement solutions

BASAL REINFORCEMENT

When construction is carried out upon weak ground, there is the possibility of differential settlement occurring. This is caused by geological effects including subsidence, sink holes and solution features and by man-made effects such as old mine workings.

Construction over soft soils

Embankments constructed on cohesive or alluvial soils may be subject to settlement and geosynthetics are often used to meet the service life and serviceability settlement requirements of the project including:

- ParaLink® high strength-low strain geogrids to reinforce the embankment foundations
- ParaGrid® and MacGrid® geogrids
- MacTex® W1 and W2 woven geotextiles to reinforce and separate the foundation materials
- MacDrain® vertical wick drains to accelerate the consolidation of the soil
- MacTex® H geotextiles to separate poor strata from better quality embankment construction materials

Piled embankments

A piled foundation is often used to limit the vertical settlement of an embankment. ParaLink® or MacGrid® WG geogrids, offer high strength with low strain characteristics and when used in conjunction with piles can replace an embankment foundation slab.

These geogrids, with design lives in excess of 120 years, work with the soils, absorbing the forces from the embankment above and transferring them vertically into the piles. This enhanced technical performance often enables an increase in the pile spacings reducing construction cost and time.

Construction over voids

There is a risk of catastrophic failure due to sudden settlements in locations prone to mining subsidence, natural voids or solution features. Paralink® geogrid reinforced soil foundations are used to prevent the most serious effects of these phenomena.

ParaLink® basal reinforcement

We use our MACBARS (Maccaferri Basal Reinforcement Software) to solve these problems.

EROSION CONTROL

Erosion of the land by wind, rain or storm water run-off can have far reaching consequences.

We offer a graded, logical range of erosion control solutions so that the level of intervention is appropriate to the erosion risk encountered:

- Biomac® biodegradable biomats
- MacMat® reinforced and un-reinforced geomats
- MacTex® EC
- Traditional double twist steel wire-based products gabions, Reno Mattresses® and wire mesh

Slope Protection

Soil slopes are subject to continuous erosion forces, whether natural or caused by man. Erosion control systems offer short-term (Biomac® biodegradable mats) or long-term (MacMat® geomats, Reno Mattresses®) protection of the slope surface.

In addition to providing immediate protection from the erosion forces, these systems are designed to facilitate the re-establishment of vegetation on the slope.

Soil Veneer Applications

When placing soil onto surfaces with a low friction angle, there is the risk that the soil will slump down the slope. This is common when capping landfills, on the banks of lakes, or simply where a layer of soil is required to revegetate a sterile slope.

Geosynthetics including MacMat® and our reinforced MacMat® R geomats, selected according to the thickness and tensile strength required, provide a grip-layer which supports the soil veneer.

Working with our engineers, it is even possible to provide a soil veneer within landfills

This approach is common in landfill capping applications where MacMat® R is used in conjunction with geosynthetic membrane liners MacLine®, MacLine® GCL and drainage geocomposites MacDrain®.

If the slope is structurally unstable, more complex systems will also be needed, for example soil reinforcement or soil nailing systems in combination with the surface protection measures.

Erosion control solutions

ENVIRONMENT, DEWATERING & LANDFILLS

We offer a range of integrated systems for landfills and other situations where there is a need to protect the existing ground from contamination by external sources including:

- Mining leachate lagoons or heap-leach pads
- Storm water attenuation ponds next to highways
- Slurry storage cells in agriculture
- Waste fluids from industry

Lining systems – base and capping

Our solutions can combine natural and geosynthetic materials to achieve the required safety levels and waste regulations and also to optimise construction efficiency.

Products in our wide range include:

- MacLine® geomembranes
- MacLine® GCL bentonite clay liners
- MacDrain® drainage geocomposites
- MacTex® geotextiles for separation, filtration and protection
- ParaLink®, ParaGrid® , MacGrid® WG soil reinforcement geogrids
- ParaDrain® hybrid geogrid with integral drainage function
- MacMat® geomats for erosion control and soil veneer grip layers

We supply complete systems for the lining systems at the base of the containment facility and also the final capping; packages of products which protect, waterproof and drain are designed to work in sympathy.

Our MacMat® and BioMac® geomats support the naturalisation of the site post-closure and its rehabilitation into the landscape; especially important in abandoned mine works or historic landfills.

Reinforcement of marginal soils & waste

We help operators to maximise the storage volumes in their existing facilities through the use of geogrid reinforced soil structures. These are used within landfill cells to successfully increase cell capacities delivering environmental and cost benefits.

Heavy duty ParaLink® geogrids are also used in piggybacking works to reduce differential settlements when an existing waste facility is re-engineered to accept more waste.

Dewatering

The dewatering and drying of sludge is a technology with low environmental impact and cost. MacTube® geosynthetic tubes are filled in-situ with natural or contaminated fluid sludges. The fluid drains through the specifically designed fabric walls, leaving the solid residue within the tube which is easier and more cost effective to dispose of.

COASTAL PROTECTION, MARINE STRUCTURES & PIPELINE PROTECTION

We offer engineered solutions to protect and ballast submerged pipelines, to reduce coastal erosion and reduce inland flooding.

Pipeline Protection

Our Sarmac® bituminous mattresses and our ACBM (Articulated Concrete Block Mattresses) ballast and protect underwater pipelines and cables. They are flexible, deformable and impact resistant.

Breakwaters & Groynes

Replacing the traditional rubble mound core material with MacTubes® filled with dredged material (sand or silt) can be an effective alternative to speed up construction activity and reduce breakwater overall costs. The range also includes unique Ballasted Filtering Mattresses for use beneath marine structures.

Dune Reconstruction

Our solutions to reconstruct and preserve existing dunes combine landscape and environmental requirements with material availability and ease of implementation. MacTubes® and MacBags® are ideal where there is a readily available supply of sand whilst gabions and Reno or Marine mattresses are alternatives where rocks or other material is available.

Quays, piers and Jetties

Free-draining gabions and Reno Mattresses® with tough and durable PoliMac™ coatings provide flexible solutions in port areas. They can even be prefilled and lifted into position to offer scour protection from eddies, propeller wash or beneath open piers.

Seawalls and Shoreline Structures

MacTube®, MacBag®, gabions and Reno Mattresses® provide longitudinal shoreline protection and rehabilitation. They are often used in sympathy with each other.

Seagrass Meadows and Reef Reconstruction

Our reinforced MacMat® geomats provide root anchorage for vulnerable seagrasses as they attempt to colonise sea beds. A similar approach, often in combination with MacBags® and MacTubes® is used in the reconstruction of reef zones, damaged by storms.

Ballasted Filtering Mattress

MacTube® and MacBag® breakwaters and groynes

Coastal Protection, Marine Structures & Pipeline Protection solutions

DRAINAGE OF STRUCTURES

Without adequate drainage, the soils in contact with structures can become saturated and weakened potentially causing numerous problems.

MacDrain® drainage geocomposites (with a geomat or geonet core) are the modern solution to replace traditional gravel drains which reduces:

- the cost of the drainage system
- the quantity of quarried materials
- the polluting truck movements needed to deliver the gravels

Vertical Drainage Works

Effective drainage of the soils behind retaining structures, piled walls and within slopes is important to ensure the long-term performance of that asset. Lab-tested MacDrain® geocomposites offer reliable and long-term drainage capacity unlike gravel drains which can become clogged by fines in suspension within the ground water.

Consolidation by Drainage Systems

Slope and ground instability can be caused by ineffective management of the water within them. Removing that water stabilises and consolidates the soils. MacDrain® within drainage trenches, linked to collection systems rapidly removes unwanted ground water.

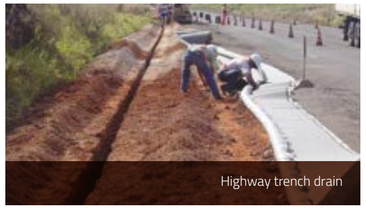
Planar and Horizontal Drainage

Providing a reliable drainage path beneath structures and sports pitches removes water which could affect the performance or lifespan of the structure above. Even when placed near-horizontally, MacDrain® provides good drainage function.

Railway track drainage

Sports pitch drainage

Our MacFLOW software resolves water-management challenges by enabling the design of the optimal MacDrain® drainage solution. The best value solution should not only address technical and economic issues, but also the environmental benefits and the speed and efficiency of installation.



Highway trench drain

Drainage of structures

LANDSCAPE & ARCHITECTURE

Both functional and eye-catching, gabions have a rich history world-wide for their use as architectural features.

The only limit is the imagination and landscape architect's creativity in the use of the mesh or gabion. We have seen gabions, geogrids, Terramesh® and Green Terramesh® used as the core in many landscape architecture projects to provide an intimate and reflective area offering sound proofing, privacy and beauty.

There are many design options available to the landscape architect from retaining to free standing landscaping walls; low with trailing plants, or built with curves, sharp angles or coloured rock fill. Rock filled gabion units are also popular as cladding on buildings and other structures, to provide a natural-looking aesthetic statement.

SAFETY & NOISE BARRIERS

Increasing urbanisation brings people and infrastructure into closer proximity. We provide solutions to this, addressing potential conflicts and providing solutions to mitigate the risks of safety and noise. Simple to construct reinforced soil bunds or gabion walls can provide acoustic and visual screening.

Vehicles accidentally leaving highways or railways, can be stopped before they threaten people or property. The impact knowledge is founded in our experience of rockfall and debris flow embankments.

Defence and Security; today's hostile threats are as likely to affect civilians as well as service personnel. Our force protection bastions were first used in WW1 and the original philosophy remains true today with our Defencell MAC™; to provide rapid-to-deploy effective troop protection from blast, ballistic or vehicular attack. In addition, our MacSafe™ fence can prevent hostile vehicle intrusion.

Acoustic barriers along highways

MacSafe™ on Promenade des Anglais, Nice, France
Images© Robert Palomba Photographe

Defencell MAC™ force protection