Consultancy and Partnership

Maccaferri’s motto is ‘Engineering a Better Solution’; not merely supplying products, but working in partnership with clients, offering technical expertise to deliver versatile, cost effective and environmentally sound solutions. Maccaferri aims to build mutually beneficial relationships with clients through the quality of its service and solutions.

Organisational Structure

Maccaferri’s 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. With over 2000 employees, 30 manufacturing facilities and local operations in 100 countries around the world, Maccaferri can truly claim to have a global presence with local focus.

Officine Maccaferri

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 offers solutions at a global level for a wide range of civil, geotechnical and environmental engineering applications, from coastal protection to reinforced soil structures and from rockfall mitigation to tunnelling systems.
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 office and website.

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Maccaferri offers clients a wide range of solutions for retaining walls and slope reinforcement problems. Whether this is a small retaining wall in a housing development, or massive reinforced soil structures on major highways, Maccaferri offers cost-effective, value engineered, scalable solutions. Maccaferri’s technical approach is that one system cannot solve all problems. Accordingly, Maccaferri offers a range of engineered solutions and can select the most appropriate to the client’s specific project needs. Maccaferri develops solutions and uses design tools in accordance with the latest generation of technical standards and design approaches. Consequently, Maccaferri manufactures and supplies high quality durable materials which enhance the service life of the works, reduce environmental impact and provide client reassurance.
Gravity retaining walls

The stability of mass gravity retaining walls relies upon the structural integrity of the units and their filled mass, to support or contain unstable earth slopes. In order to select the optimum Maccaferri retaining wall solution, key considerations include:

- The geotechnical parameters of the retained and foundation soils
- The presence of water and hydrostatic loads
- External loads from structures and live or seismic loads
- The simplicity and speed of construction

Certified by many authorities worldwide, Maccaferri double-twist woven gabions offer strength and high drainage capacity. Long-term stability and client reassurance is provided as these structures are capable of absorbing differential settlement and deformations.

Maccaferri gabions are available with a range of corrosion protection coatings to suit the expected exposure conditions and design life requirements.

Segmental walls

MacWall™ is a segmental retaining wall system combining the aesthetics of masonry walls with the engineered reassurance of reinforced earth. Segmental block retaining walls are increasing in popularity due to their ease of construction, cost-effectiveness and versatility.

The two components of the MacWall™ system are:

- Split face concrete modular block in a range of colours to suit adjacent structures and environments
- Reinforcement polymer geogrids locked between the courses of block

The geogrids are placed horizontally within the compacted structural backfill to the wall, providing tensile strength and reinforcing the soil mass. The grids also tie the fascia blocks to the reinforced soil.

MacWall™ easily incorporates curves, corners and steps and being dry-built (without mortar), it is simple and rapid to construct in all climates.
Reinforced soil walls & slopes

Modifying soil slope profiles beyond their natural angle of repose, can lead to slope instability. This situation can arise when reducing the footprint of a new highway embankment, or to gain development area on a sloping site.

Maccaferri geogrid reinforcements used in conjunction with the soil, enable that soil to perform better than it would in its unreinforced state. Maccaferri geogrids enable soils to accommodate greater loads and stand at steeper angles. The geogrids are laid horizontally within the compacted soil mass during construction, reinforcing it due to their high tensile strength, low strain and good interaction with the soil.

Maccaferri reinforced soil slopes and structures are ideal with soils which have poor bearing capacity; the structure accommodates differential settlement far better than more rigid solutions. This is also a great benefit in seismic zones.

Maccaferri’s unsurpassed range of geogrid reinforcements, including MacGrid® WG, Paragrid® and Paralink® with strengths up to 1350kN/m, maximises the opportunity to reuse site won materials as backfill to a reinforced slope. This saves on the export and import of materials from site, embracing sustainability and reducing polluting truck movements. With over 30 years’ continuous use around the world, Paralink® is one of the most tried-and-tested geogrids in existence.

Cost savings through the reuse of site won material with geogrids can be substantial on a project. Furthermore, combinations of geogrid types, to create ‘hybrid structures’, often create more efficient designs and faster construction compared to traditional techniques.

Maccaferri Terramesh® and Green Terramesh® combine the flexibility of soil reinforcement with the benefit of a modular system. With factory fitted face elements, geogrid reinforcement and with pre-determined dimensions, these systems significantly reduce on-site installation times.

On ‘green-slopes’, vegetation of the finished reinforced slope is important. Maccaferri can also assist in the selection of appropriate seed mixes, topsoil and erosion protection products.
Where there is not enough space on a project to construct a reinforced soil slope, it may be possible to use Soil Nailing. With soil nailing providing the overall slope stability, Macmat® R offers flexible surface reinforcement and protection options for use between soil nails.

In collaboration with leading technical Universities, Maccaferri has developed software to assist in the stability analysis of reinforced soil projects. The MacSTARS software incorporates the latest design methodologies to check both local and overall stability of complex structures.

Maccaferri’s reinforced soil slopes and structures are trusted to support motorways, railway embankments and property around the globe.

**Vertical walls with concrete facings**

When it is necessary to construct reinforced soil structures with a vertical concrete face, for projects in urban areas, or when there is not enough space to create a reinforced soil slope, Maccaferri MacRES® can provide the answer. MacRES® is also used to construct crusher and hopper walls in mines, supporting massive loads.

Steel or Paraweb® polymeric soil reinforcement strips are placed horizontally within the compacted backfill during construction, reinforcing it. Maccaferri Paraweb®, can be supplied with an ‘all-polymer’ connection to the concrete fascia panel. This corrosion-free connection is ideal for use in aggressive conditions, for example, where highway de-icing salts are used, or a recycled aggregate backfill is used.

Used worldwide, the MacRES® vertical faced concrete panel system can have a wide range of face finishes to suit aesthetic requirements.
Rockfall and avalanche protection are key elements in the security and safety of infrastructure networks. Even small rockfalls, or debris flows can block infrastructure, damage buildings or other installations, having far-reaching economic effects beyond the immediate disruption.

With over 50 years’ experience in rockfall protection systems and rockfall hazard mitigation, Maccaferri offers a wide range of solutions that stabilise rock faces and snow slopes, reducing risk to people, buildings and infrastructure. These interventions often consist of a number of structural components which act together, either to prevent the triggering of the rockfall or avalanche, or to contain it once it has occurred. Solutions include high strength meshes used in conjunction with anchors to provide surficial stabilisation and also dynamic barriers to contain rockfalls and avalanches. Hybrid, attenuator and debris flow barriers have also been developed to counteract specific problems found on sites. Using advanced design software, Maccaferri assists designers with selecting the intervention which is most appropriate for the prevailing site conditions and the client’s requirements.
Drapery

Rockfall drapery systems are installed on rock slopes to contain loose and falling rock debris and allow it to fall to the foot of the rock slope in a controlled manner.

Steel wire double twist mesh is ideal as it is flexible in all directions and it conforms easily to the rock slope. Also, it does not unravel in the event of accidental breakage of the wires, unlike single twist meshes, irrespective of the strength and type of wire used.

Maccaferri Steelgrid® and Steelgrid® HR high strength drapery is used when increased loads are expected on the drapery; high slopes and debris quantities, snow/ice loads. This features high tensile steel cables woven into the double twist mesh during the production stage. Steelgrid® and Steelgrid® HR have the advantage that two different products can be installed simultaneously (mesh and steel cables), reducing overall project costs and saving installation time.

Ring Net panels offer the highest strength mesh available in the Maccaferri range. Panel characteristics can be configured to suit the project technical requirements.

Secured drapery & surface stabilisation

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

HEA Steel cable panels or Steelgrid® HR are more suited to surface stabilisation applications than simple woven mesh as they possess greater stiffness. They provide high resistance with minimal deflection in order to limit the displacement of the unstable surface rock mass.

Preventing rock masses from detaching reduces the deterioration of the slope, increasing the level of security. These robust systems are available with a variety of protective coatings for an enhanced design life.
Rockfall barriers

In certain rockfall hazard situations, due to technical, topographic or access issues, flexible rockfall catch fences are an ideal solution. These barriers are positioned to intercept and stop falling rocks. The fences consist of a complete kit of components, for a specific height and length, capable of absorbing impacts of kinetic energy normally in the range 500-5000kJ.

Maccanerri’s range of rockfall barriers have been tested in accordance with the requirements of the European guideline ETAG 027 and provided with CE marking.

Specialist hybrid, attenuator and debris flow barriers have also been developed to counteract specific problems. Hybrids and attenuators have been in use for over 10 years and a Maccanerri attenuator performed best in independent comparative tests. Debris flow barriers are typically installed in natural or artificial channels in order to protect infrastructure from the debris flow.

Rockfall embankments

Rockfall embankments are designed to protect infrastructure and buildings at risk of rock falls, debris slides or mud-flows, in situations where it is not practicable to install other systems directly on the slope face.

Maccanerri rockfall embankments are built using reinforced soil, enabling the reuse of locally available, suitable site-won materials. A variety of face finishes are available, including a vegetated embankment facing, which reduces the environmental and aesthetic impact of the system.

Being constructed from reinforced soil, Maccanerri rockfall embankments are scalable to accommodate extreme rockfall impacts of almost unlimited volume, velocity and energy limit. Unlike rockfall catch fences, rockfall embankments can sustain multiple impacts and rockfall events, without repair. Rockfall embankments are also used for avalanche protection as well.
Soil nailing

Soil nailing is a consolidation technique used on natural or excavated slopes, where the ground is reinforced by the insertion of tendons. The 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 mobilize between the anchorages, potentially destabilising the overall slope.

To design such facing systems, Maccaferri has developed BIOS; a new software and calculation methodology used for these projects.

Snow fences

Snow fences and snow nets are designed to stabilise the layer of snow at the potential avalanche initiation zone, thereby preventing triggering of the avalanche.

The snow-pack exerts a force which is resisted by the fence and transmitted to the ground by means of a system of snow fence posts and anchors. The flexibility of Maccaferri’s snow fence system results in a reduction of the loads exerted on the structure, enabling a more efficient installation.

It may be necessary to install various rows of structures, on the upslope and downslope sides of a potential failure point. This limits the propagation of the shear failure and the resulting movement of the mass of snow.

The entire range of Maccaferri’s snow barriers has been approved by the FOEN (Federal Office for the Environment) and the SLF WSL (Swiss Federal Institute for Snow and Avalanche) in Davos in Switzerland in accordance with the "Technical Guideline 2007".
Whether constructing a gravel forestry track over soft soil, or resurfacing a multi-lane highway carrying many thousands of vehicles per day, Maccaferri has the technical knowledge and wide range of solutions for the rigorous demands of today’s roads. Roads can fail prematurely due to excessive deflections under cyclical loads, causing cracking. Maccaferri uses state of the art design software, featuring various design methodologies, to optimise the reinforcement and the required thickness of the pavement layers. By reducing construction materials whilst simultaneously increasing the fatigue life, Maccaferri’s leading range of pavement and ground stabilisation and drainage products can help achieve the goal of reducing whole-life costs. As reinforced pavements require less maintenance and less materials, whole life costs are lower making them a more sustainable solution than unreinforced pavements.
Asphalt pavement reinforcement

The reinforcement of asphalt pavements increases the service life of highways by reducing fatigue, reflective, thermal and settlement cracking.

Reinforcement relieves and redistributes stress concentrations in the asphalt;

• Reducing reflective cracking into overlays
• Improving load distribution
• Improving the bearing capacity of the pavement structure
• Increasing resistance to rutting and shoving

The capability of the reinforcement to withstand loads will depend both on the type of reinforcement, its location within the structure and the interaction between the reinforcement and the surrounding bituminous material. Discontinuities will inevitably lead to cracks in the asphalt.

Maccaferri offers a wide range of asphalt pavement reinforcement products from Road Mesh® double twist steel wire mesh, used to structurally reinforce pavements, to MacGrid® AR polyester or glass fibre geogrids used to reduce reflective cracking.

Sub-base stabilisation

In the construction of unbound roads, including forestry tracks, mine haul roads, construction sites and parking areas, the use of appropriate geosynthetics within the unbound layers;

• Increases the load bearing capacity of the structure
• Increases the life of the structure
• Reduces the thickness of the granular layer
• Reduces rutting

MacREAD (MACcaferri Road Equivalent Assistant for Design) software is used to select appropriate Maccaferri geogrids and geotextiles to meet the project demands, optimising the structure and cost efficiency.
When embankments (for a road, railway, airport or simply a parking or storage area) are to be constructed on weak foundation soils, there is a risk of settlement due to poor bearing capacity, subterranean voids or "sink holes". Although, design approaches can be different, geosynthetics are proven to strengthen foundations, reduce differential settlement and accelerate the consolidation of cohesive soils. If necessary, high strength geogrids can be used in conjunction with foundation piling, enabling greater pile spacing and construction efficiency.

**Piled embankments**

There are many situations where it is necessary to limit the vertical settlement of an embankment, due to the consolidation of a soft foundation. In these situations, the embankment is typically built on a piled foundation.

High strength-low strain, Paralink® or MacGrid® WG geogrids, sometimes in combination with the family of MacTex® W or C geotextiles, can take the place of the embankment foundation slab. These geosynthetics absorb the embankment loads, transmitting them into the supporting piles.

Numerous projects around the world have been designed using MACBARS (MACcaferri BAsal Reinforcement Software). Maccaferri qualifies as a true expert and leader in this application area with a team of experts ready to help clients identify and optimise technical solutions.
Construction over voids

Some areas are subject to the sudden formation of cavities or natural depressions caused by mining subsidence, or where natural voids and solution features can occur. In these circumstances, it is necessary to introduce reinforcement, typically at the base of the embankment, to prevent the sudden failure of the foundation.

Maccaferri’s Paralink® high strength-low strain geogrids meet the most stringent design criteria and have been used for many years in these applications, in conjunction with the expertise and support of Maccaferri technical teams.

Construction over soft soils

Embankments constructed on a cohesive or alluvial soil may be subject to settlement due to the nature of the foundation soil.

MacDrain® vertical drains can be used to accelerate the consolidation of the soil and are often used in conjunction with reinforcement elements at the base of the embankment to control differential settlement.

High strength-low strain geogrids Paralink® or MacGrid® WG, or the geotextiles MacTex® W and C are used for this purpose.

Maccaferri’s engineers, with the use of specific design software, are able to provide an invaluable contribution towards solving these problems.
Tunnelling

Depending on the tunnel dimensions and the physical and geotechnical conditions, tunnel excavation is carried out using traditional or mechanized TBM methods. Maccaferri’s tunnelling expertise has recently been enhanced through the acquisition of the tunnelling specialist, ELAS Geotechnica, offering solutions for both traditional and TBM excavated tunnels.

Traditional Excavation

Reinforcement and consolidation are techniques used to stabilise the face and tunnel excavation, enabling the safe and rapid advance of even large diameter tunnels. Fiberglass profiles are inserted throughout the tunnel section, to form an array of reinforcing elements, resisting loads generated during excavation and preventing collapse (ADECO-RS approach). Steel and fiberglass anchors are also available.

In problematic ground where achieving reinforcement or anchorage performance is difficult, the P.e.r. Ground™ system can be used; a sheath contains the injected mortars which compact soils surrounding the reinforcing element and also reduces grout-loss and washout. To rapidly reduce groundwater pressures at depth, drainage pipes can also be inserted. Accidental or sudden water ingress can be blocked with polyurethane resins which create expanding closed-cell foams.

Poor soils can be improved by the injection of Groutmaster™, a multi-function high performance grout.

It is used to; reduce the permeability of soils, control settlements, mitigate liquefaction, improve cohesion of granular soils, reduce the expansivity of cohesive soils and is used in compensation grouting and void filling.

During the Primary Lining phase, B Zero Tondo™, is used to support the tunnel. These unique tubular steel-arch ribs are filled with concrete and perform better than traditional steel-arch supports; fewer B Zero Tondo™ arches are needed, reducing costs and increasing tunnel productivity.

Wirand® steel fibre reinforced shotcrete (including the additives Rocksil or Apral as required) is then applied as a primary lining, limiting initial deformation of the gallery.

During the Final Lining, Maccaferri’s Wirand® steel fibres are used to structurally reinforce the concrete final lining which is poured or pumped directly into formwork. As traditional steel reinforcement can be reduced or even eliminated, productivity is increased and lining thickness may be reduced. Steel fibre reinforced concrete (SFRC) is more ductile, tougher and
TBM tunnels and precast elements

less permeable than traditional concrete. FibroMac™ polymer fibres significantly increase fire resistance by reducing spalling phenomena. Finally, ceramic linings can provide an aesthetic finish to the tunnel.

**TBM Excavation**

The excavation of the ground by the TBM is immediately followed by the assembly of the tunnel lining, using interlocking precast concrete segments. Wirand® steel fibre reinforcement can replace some, or in certain cases all, of the traditional steel reinforcement within the precast segments. FibroMac™ polymer fibres offer increased fire resistance by reducing spalling phenomena.

TBM tunnels require the construction of access portals and shafts. Problems with groundwater ingress and poor quality ground can be overcome with the range of Maccaferri/ELAS products used to improve the ground and/or reduce permeability, including; Groutmaster™, drainage tubes and expanding polyurethane resins.

Furthermore, reinforcing concrete with fibreglass bars, simplifies future access through that concrete; useful in tunnel junctions.

**Precast Concrete**

Many products can benefit from the use of Wirand® SFRC to reduce or remove traditional steel reinforcement, especially for complex shaped elements; concrete pipes, slender structures or panels, curbs, gutters, manhole components and tanks. Customising the Wirand® fibre types and blend within the concrete mix to suit the concrete end-product, brings earlier demoulding, increases in durability, ductility, shear, impact resistance and fire resistance of the pre-cast product.
Flooring

Steel fibre reinforcement enhances the performance of concrete slabs and industrial floors in a multitude of uses: warehouses, container terminals, composite metal decks, airport slabs and runways, concrete roads and floors exposed to high thermal ranges.

Wirand® fibres within the concrete act once cracks initiate, redistributing tension, bridging the cracks and controlling their width. The fibres are distributed in three-dimensions throughout the concrete, providing performance precisely where it is needed. Maccaferri Wirand® SFRC enhances the performance of concrete; making it more ductile, with greater impact resistance and enhanced structural performance.

Compared to traditional steel reinforcement, Wirand® steel fibre reinforced concrete (SFRC) can:

- Reduce weak points in the slab
- Increase panel sizes by eliminating saw-cuts (up to 2500m²)
- Reduce slab thickness
- Be quicker, safer and cheaper to install
- Replace traditional reinforcement
- Increase construction output

FibroMac™ polypropylene fibres offer non-structural benefits of reducing shrinkage cracking.

In addition to providing a reliable and quality product, Maccaferri offers flooring contractors DOSO fibre dosage equipment and state-of-the-art software for the design of industrial floors. Assistance is available to integrate DOSO machinery into the concrete production process.
Since the company was founded, protection of the land and stabilising soils has always been within Maccaferri’s corporate mission.

By selecting from a graded, logical range of erosion protection and drainage techniques from a wide range of geomats, fabrics and materials, the level of intervention is tailored to the erosion risk encountered: Biomac® biodegradable biomats, MacMat® reinforced and unreinforced geomats, MacTex® EC, MacWeb geocells and traditional double twist steel wire-based products gabions and Reno Mattress®.

The range of MacDrain® drainage geocomposites (with geonet or geomat cores), constitute a fundamental tool in the design of erosion control and slope stabilisation systems; efficient water drainage has always been one of the most powerful tools and efficient means for soil stabilisation.
Slope protection

Soil slopes are subject to continuous erosion forces, whether natural or caused by man and some form of erosion protection may be required. Surface erosion protection systems can be short term (using Biomac® biodegradable mats, or anti-erosion geotextiles MacTex®) or long-term (using MacMat® geomats, MacWeb® geocells, Reno Mattress® and gabions). These products are also designed to facilitate the re-establishment of vegetation on the slope.

If the slope is structurally unstable, more complex systems may also include soil reinforcement, (Terramesh®, geogrids Paragrid® / Paradrain®/ MacGrid® WG) or soil-nailing systems, in combination with more traditional technologies.
Vertical drainage

The importance of effective drainage behind structures (concrete retaining walls, contiguous piles, diaphragm walls and structures in contact with soil strata), and within slopes is well known, but is often overlooked. Traditional granular material drains are often installed, taking up unnecessary space and without a real understanding of their true long-term drainage capability.

The Maccaferri MacDrain® range of drainage geocomposites provides a cost effective and technically superior alternative to traditional granular drains.

MacDrain® geocomposites feature numerous geotextile filters (needlepunched, thermally-bonded or, for certain applications, geotextiles with specific weaves) and several types of drainage cores (geomats, geonets). This range enables the technical and economic optimisation of the solution.

Horizontal drainage

MacDrain® geocomposites are designed to replace traditional drainage materials such as gravels and sands. Left in place, water within a structure or the ground can weaken it. Geotextiles attached to the drainage core on one or both sides stop the materials or soils being drained, from clogging the drainage core or collection pipes.

The selection of an appropriate MacDrain® geocomposite (drainage core and textile type) for ‘horizontal’ or planar drainage, depends on a number of factors:

- The overburden expected
- The expected flow discharge required
- The type of material / soil to be drained (clean, contaminated etc)
- Hydraulic gradient
- Dimensions of the area to be drained

The best value solution should overcome technical and economic problems, and also installation speed and efficiency.
Maccaferri has over 100 years of expertise in hydraulic works and the protection and training of rivers and streams. For demanding, high energy flows, Reno Mattress® and gabions have always been the main component of any river works structure such as weirs, groynes, sills and energy dissipation basins.

With the development of geosynthetics (MacMat® geomat range) and biodegradable geomats (Biomac® C range) the variety of solutions has expanded greatly to offer a level of intervention appropriate to the erosion risk.

Maccaferri also provides solutions for lining and containment works for reservoirs, mine stilling basins, canals, attenuation and storage ponds as well as for golf courses and agriculture.

Longitudinal works

Longitudinal structures are hydraulic structures with their length parallel to the river flow. They are used for a variety of purposes, including:

- Channel bank erosion control
- Restoration of failed embankments
- Control of meandering
- Containment of the normal flow channel
- Flood defences

A trained water course reduces land-loss caused by erosion, yet the inherent strong currents can still erode the river banks destabilising them. Therefore the river bank protection solution must be commensurate with the level of hydraulic stress expected.

The inclusion of vegetation is important to integrate the structure into its natural environment. The use of materials and bioengineering techniques achieves this.

MAC.R.A. 1 software assists in the design of these solutions.
Transverse works

Gabion weir and drop structures are used to control high energy hydraulic flows carrying solids or sediments. Where required, lined stilling basins with counter-weirs are installed downstream of the weir. These structures alter the hydraulic profile of the flow, reducing its energy and capacity to erode and transport suspended materials, until a balanced condition is reached.

The type and configuration of the weir is dependent upon hydraulic and topographic conditions. MAC.R.A. 1 and MAC.R.A. 2 software is used to design channels, longitudinal and transverse structures. These enable the designer to rapidly perform preliminary hydraulic studies to evaluate the bank protection or the transverse weir required.

Waterproofing of reservoirs, lakes & channels

Lining works serve many functions, whether to provide storm water attenuation ponds, landfill capping, or to prevent contaminated water polluting the ground.

In some countries around the world, Maccaferri is not merely a supplier of these waterproofing products, but can provide a full service including: support during the design, materials supply, installation assistance or even the installation works itself.

In addition to this, Maccaferri can also protect these linings and ensure that they are inserted with sensitivity into the surrounding environment and in compliance with their operational requirements.
Bank protection

The channelization of a water course involves constructing a channel with a regular cross-section. This can be to control the meandering of a river through a built up area, or in the vicinity of infrastructure. Where channels transport clean water flow through polluted ground, or vice-versa, the channel may be lined to render it impermeable.

Reno Mattress®, gabions together with man-made or biodegradable erosion protection mats, are often applied to the banks and, if required, to the channel bed to maintain the channel function.

The channel lining serves many purposes:

- Reduction of water loss by seepage if used with a geomembrane of bentonite clay geocomposite
- Improved bank stability
- Erosion protection of banks and channel bed
- Provision of a predetermined value of bank roughness, hence channel flow capacity.

MAC.R.A. 1 software assists in the design of these solutions.
Protection of submarine pipelines & cables

Submarine pipes and cables are surprisingly mobile due to the high current forces upon them; their immersed weight is insufficient to counteract these forces. They can also be damaged by the anchors of marine vessels.

For more than 30 years, Sarmac® bituminous marine mattresses, placed over the pipes to add ballast, have increased the mass of the pipe system, limiting movement. Depending on the expected current forces, the ballast can be continuous or at intervals along the pipe. Sarmac® mattresses are deformable, even in cold water and are also ideal as a separator between pipes at ‘cross-overs’ or junctions.

An alternative solution is Maccaferri Articulated Concrete Block Mattresses (ACBMs) which consist of a mattress of individual concrete blocks, of a specific shape, secured together with cables. The flexible mattress conforms to the shape of the pipeline or sea-bed. The major innovation introduced into this field is the ability to produce the ACBMs directly at the place of final delivery due to a patented mobile formwork. This results in a significant decrease in the time and cost of transport and which minimizes environmental impact.

Coastal protection & seabed stabilisation

The multidisciplinary experience and scope of the Maccaferri Group, enables it to propose and develop low environmental impact solutions for the protection and rehabilitation of coastlines.

MacTube® is a cylindrical container, constructed from high strength, durable geotextile and/or geocomposites, filled in situ with a sand/water slurry. They are used for the construction of coastal defence works, temporary works for beach alignment during nourishment works, dune reconstruction and to form the core of breakwaters.

MacBag®, was developed for emergency works and as a foundation for underwater works and embankments. Produced in various sizes from polypropylene or polyester geotextile, MacBag® can be filled with sand available on-site or a mix of sand and water or grout.

Maccaferri woven and nonwoven geotextiles (MacTex®) act as filtering and separation layers, preventing scour at the toe of structures. This ensures greater stability of the works and reduces the need for a regular replacement of materials. Maccaferri’s Ballasted Filter Mattress (BFM) is a unique geocomposite used as a foundation beneath rip-rap, breakwaters and other marine works. Pioneered on the world famous Venice MOSE project, it combines a filtration and separation function in one product and as it is denser than water it can be installed underwater!
Maccaferri has great experience in the development of integrated designs for landfills and the protection of polluted areas. This capability is leveraged from Maccaferri’s existing deep knowledge of geotechnical stability applications and experience in lining and waterproofing systems. Engagement with public works engineers and plant operators, have contributed to the development of a wide range of materials and technologies which respond to the technical and legislative requirements of the market.

In some regions of the world, Maccaferri offers site supervision and full turn-key solutions in this important sector, further adding to the expertise.

A combination of engineering know-how, the wide range of technological solutions and products offered, efficient logistics and the widespread presence of qualified personnel to service and assist in the installation of materials have made Maccaferri a leader in this sensitive market.

These solutions are used, not only in landfills, but in mining applications such as heap leach pads, or leachate lagoons.

**Barrier systems - Base**

The base barrier system is the most sensitive component of the landfill system since it must protect the underlying soil and groundwater from pollution. This barrier system is also a vital component in mining leachate lagoons, heap leach pads, and agricultural waste storage areas.

Maccaferri has designed various barrier systems depending on the hazardous nature of the contained material and the sensitivity of the surrounding environment. These solutions combine natural and synthetic materials to achieve the required safety levels and also to optimise construction efficiency.
Barrier system - Capping

The surface barrier system is an important part of the process when sealing and capping a landfill, contaminated mine or agricultural site. It is usually integrated within a more general project of rehabilitation into the existing landscape. The purpose of the capping is to: drain the methane gas which develops during degradation of the waste, prevent the infiltration of rainwater (and the subsequent generation of excess pollutant leachate within the cell) and to form a substrate suitable for the growth of natural vegetation.

Reinforcement of waste & marginal fills

Increasing amounts of waste produced per capita and the difficulty in finding sites suitable for landfills, requires operators to maximise the storage volumes in their existing facilities. Maccaferri geogrid reinforced soil structures have been extensively used within landfill cells to successfully increase capacities by up to three times for the same landfill footprint, with environmental and cost benefits.

Piggybacking

Consideration is often given to re-open abandoned storage areas, in order to reduce the environmental impact resulting from the construction of new facilities. This technique enables the redevelopment of the site into a safe and reliable facility for the storage of new waste materials. Specific solutions and technical knowledge are a prerequisite because the existing capping/barrier system has been built upon areas with inhomogeneous geotechnical characteristics (waste). These are subject to considerable differential settlements and are characterised by considerable environmental hazards (potentially chemical and organic pollutants); important considerations in the design of suitable solutions.
Dewatering

The dewatering and drying of sludge is a technology with low environmental impact and cost. It enables the on-site treatment of a wide range of both natural and contaminated fluid sludges. Dewatering features MacTube® geosynthetic tubes which are filled in-situ with a pumped slurry; the fluid drains through the fabric walls, leaving the solid residues within the tube. Once the residue has dried it can be disposed of far more safely and cost effectively than wet, slurried material. The use of site-specific flocculants is common to accelerate the filtration process.

The system is simple and versatile; only minor adaptations are required to tailor the solution to each project site, enabling the treatment of both small and large volumes of material within a small work-area.

Fields of application
- Soil or contaminated sediments (harbours, rivers, lagoons)
- Derivatives of mining processes
- Residues from the production of electricity
- Waste and by-products from the production of pulp
- Wastewater treatment plants
- Derivatives of industrial processes
- Farms and agriculture waste
- Aquaculture by-products
- Waste and arisings from drilling operations

Low environmental impact
- Minimal risk of spillage
- Absence of odour
- Mobile (non-permanent) operation
- Reversible civil works
- Ease of environmental restoration
- Potential to incorporate the filled tubes into the permanent works for site topographical remodeling (provided the residue is not contaminated)

Cost-effective
- Ease of transportation of equipment
- Simple to prepare and reinstate the work area
- Can treat large volumes of slurries within a small area
- Short duration of operations
- Efficient concentration and consolidation of solids
- Reduces the final volume for disposal
Acoustic barriers

Acoustic barriers are used to reduce noise pollution. In addition, the barrier should have minimal environmental impact. Vegetating acoustic barriers meet this dual need and mitigate noise whilst inserting a decorative element into the urban landscape. Green Reef® and Greensonic® are a new concept of noise barrier which not only occupy a minimal footprint, but thanks to the characteristics of the specially developed artificial soil, promotes the growth of plants and shrubs on the face of the barrier. Constructed from modular elements, Green Reef® is durable and rapid to construct and compared to similar solutions it is low-maintenance and requires no formal foundation.

Greensonic® is used to form either single or double faced vertical barriers.
Both systems support numerous plant species, which can be selected to suit the particular environment in which the barrier is to be placed.

Safety barriers

The new Milan to Bologna and Milan to Turin high-speed railway lines lie partly alongside the motorways along the same routes. To prevent vehicles (even heavy goods trucks), from accidentally leaving the motorway and straying onto the high-speed rail tracks, Maccaferri designed a specific reinforced soil structure to act as a safety barrier. Also used in Rockfall Embankments to absorb extreme rockfall impacts, Maccaferri’s Dune system was installed for more than 100 km on this project alone.

Maccaferri’s solution combined the safety requirements with the need to minimise the construction time. Dune is rapid to install as it is fabricated from elements which are completely pre-assembled in the factory including the various types of facing and face angles required.
Maccaferri’s experience in fencing started 500 years ago with wrought iron fences and gates in Italy. Now, the company offers state-of-the-art fencing solutions embracing safety, security, protection and durability through the combination of modern materials and components. Maccaferri optimises solutions for clients not only in terms of service life and maintenance, but also cost-effectiveness and ease of construction. Modular construction and design standardisation are also key elements of the fences.

Maccaferri fences can meet the protection and security needs of many applications;• Roads and motorways• Ports and other service infrastructure• Railways and stations• Residential and industrial buildings