MACCAFERRI

TerraMesh™

Rise to the challenge

WE WERE FOUNDED ON INNOVATION

In 1893 we started a journey towards it, striving to balance the demands of our societies and the environmental equilibrium. Today, we are a leading international provider of advanced solutions to the civil, geotechnical, and environmental construction markets. All of our solutions are designed and developed with an eye on the quality of life and on preserving the environment and our communities for future generations. Rigorously tested and certified, our nature inclusive systems ensure long-term performance and sustainable blend with the environment.

GLOBAL PRESENCE LOCAL KNOWLEDGE

- Sales in +130 countries
- +3,000 employees
- 23 factories
- +60 subsidiaries

TOGETHER, WE RISE TO THE CHALLENGE!

Today, the design criteria behind the development of civil engineering structures are not only based on economic considerations but also on the environmental and social impacts of the structure.
In the late 70s, we designed and manufactured the first prototype of TerraMesh™ with that broad concept of sustainability in mind. We aimed at creating reinforced slope systems and mechanically stabilised earth walls that could meet the needs of the present with an eye on the future.

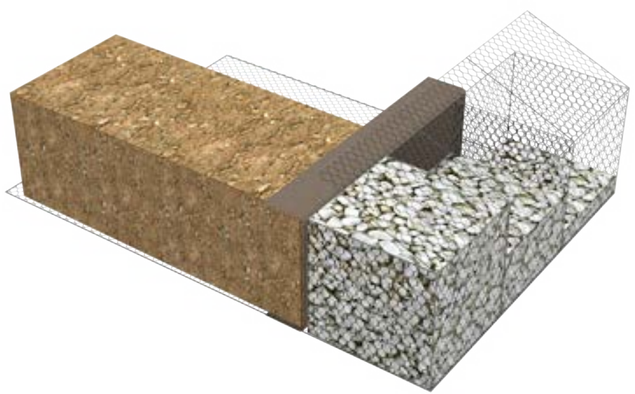
Over the years, our modular, versatile, eco-friendly prototype has turned into a renowned civil engineering structure and has been used in thousands of projects across the world. Thanks to our experience today we can proudly say that TerraMesh™ is a synonymous of reliability, durability, material saving and environmental integration.

This is what we proudly present in this success stories collection.

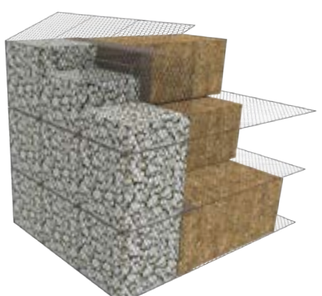
Antoine Gagliardi
Head of DT BU at Maccaferri

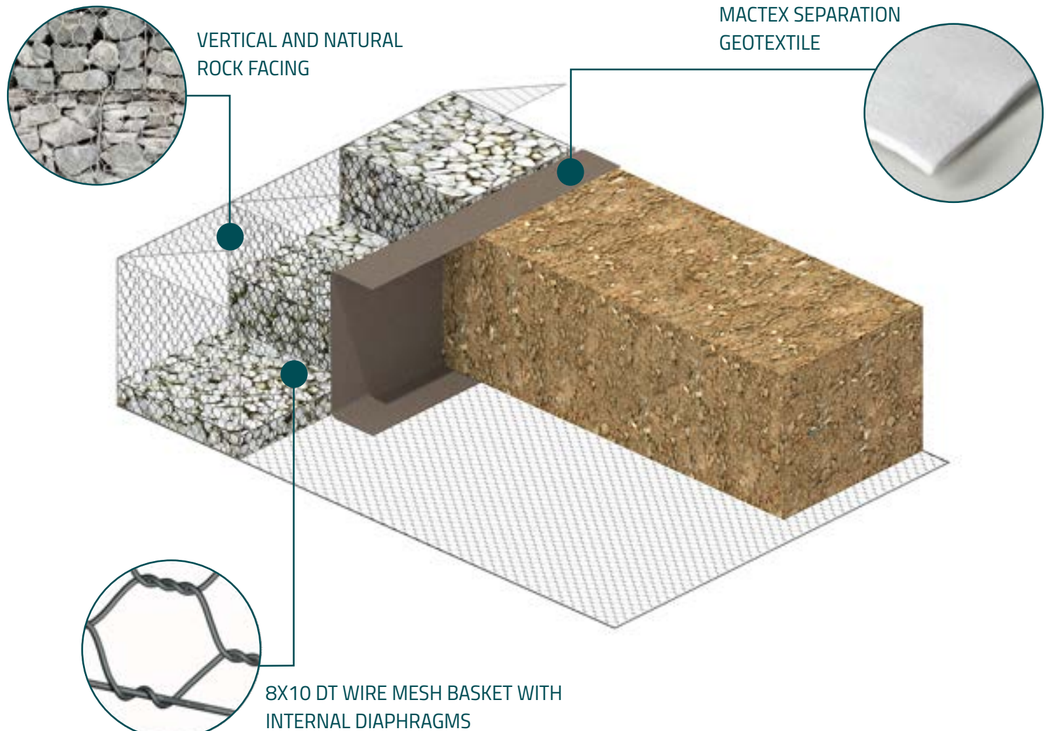
TerraMesh System

Rise to the challenge



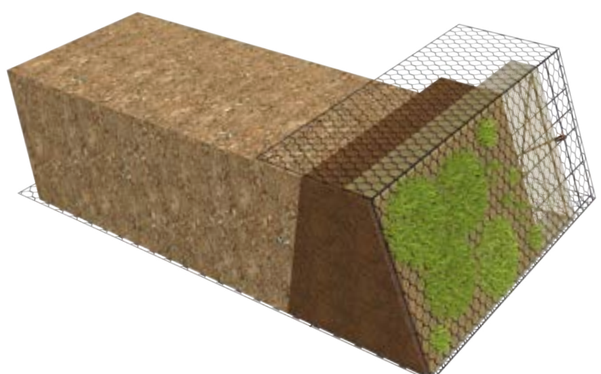
Maccaferri's renowned TerraMesh™ System is a modular system used to form rock-faced reinforced soil walls and embankments. It has been used globally on some of the most significant infrastructure schemes, including what is believed to be the tallest reinforced soil structure in the world at 74 m high.



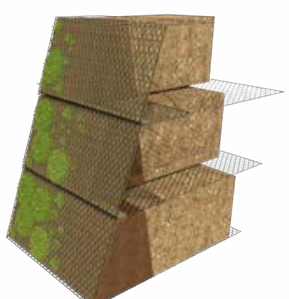


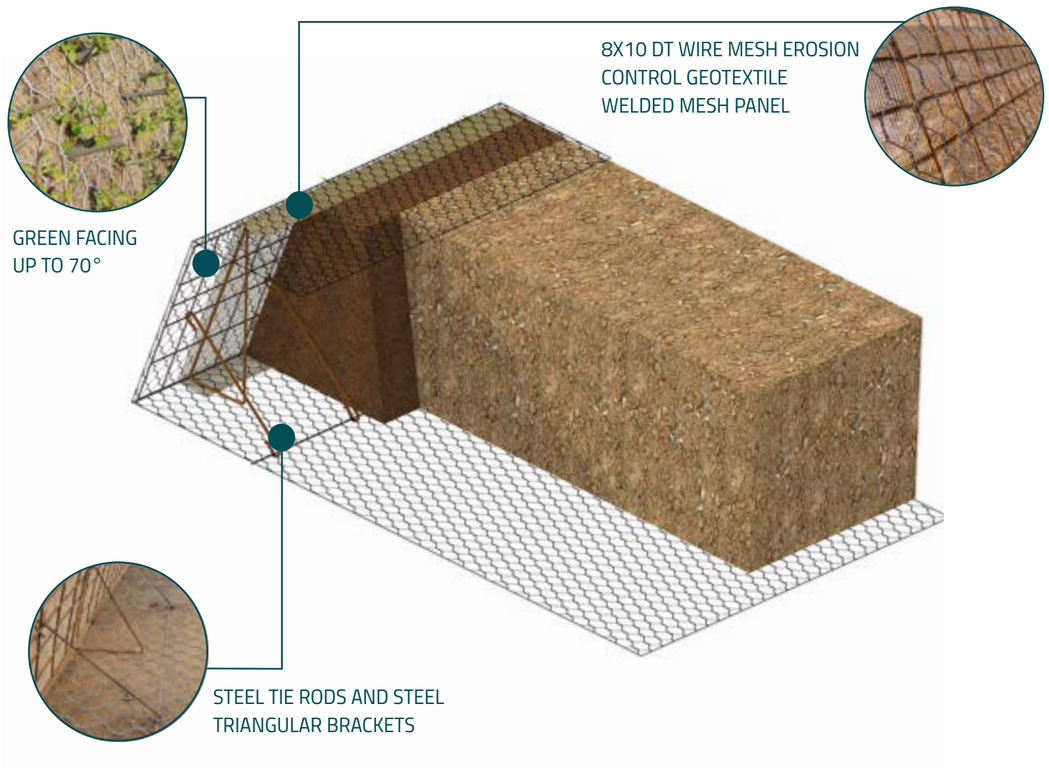
TerraMesh Green

Rise to the challenge



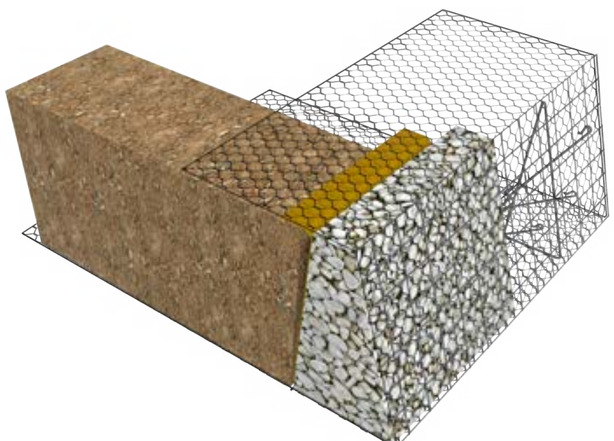
TerraMesh™ Green is an environmentally friendly modular system used to form vegetated (green) faced soil reinforced structures. As all components are factory fitted, TerraMesh™ Green is the most rapid to install reinforced soil system.



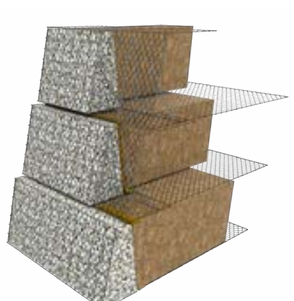


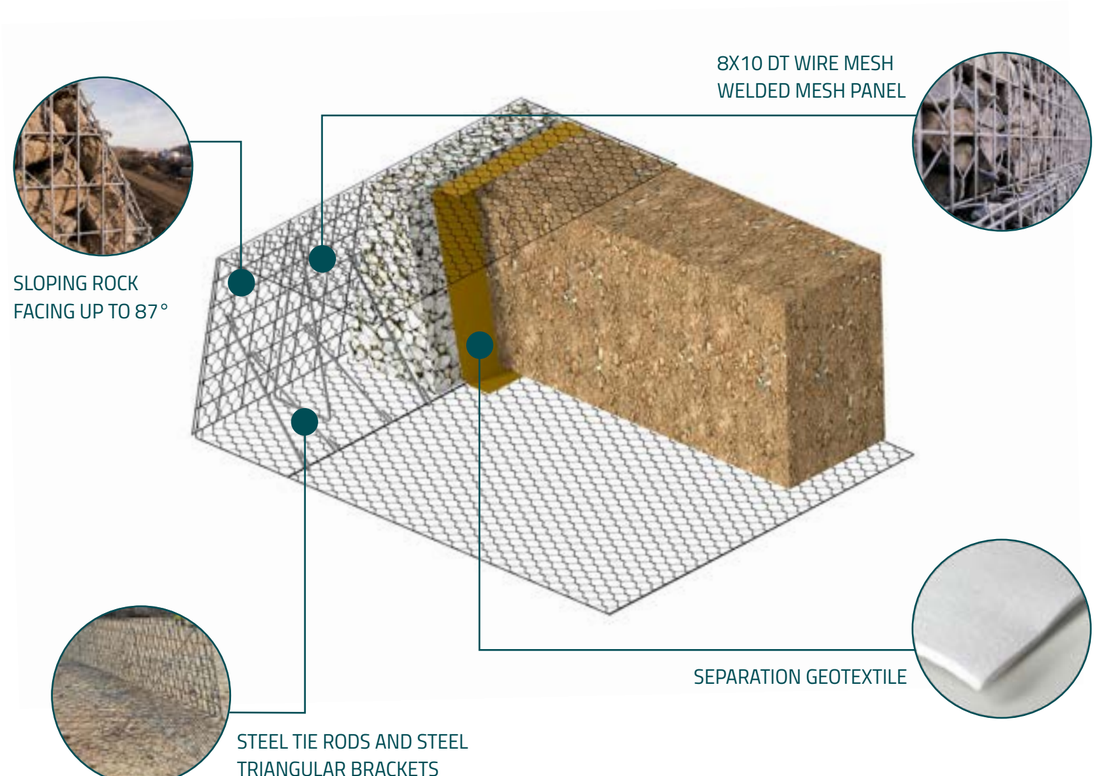
TerraMesh Mineral

Rise to the challenge



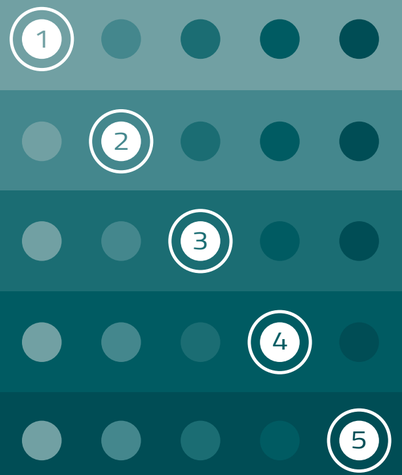
If a rock-faced reinforced soil slope is required, TerraMesh™ Mineral is the ideal solution. TerraMesh™ Mineral features an external welded mesh panel. The result is a functional and aesthetically pleasant retaining wall.





ENGINEERING CHALLENGE

The TerraMesh™, also thanks to its versatility, lends itself to be used in any type and size of project. Nevertheless, every single project is curated and tailored to rise to all kind of challenges! Within the following collection, 5 levels of engineering challenge stood out:

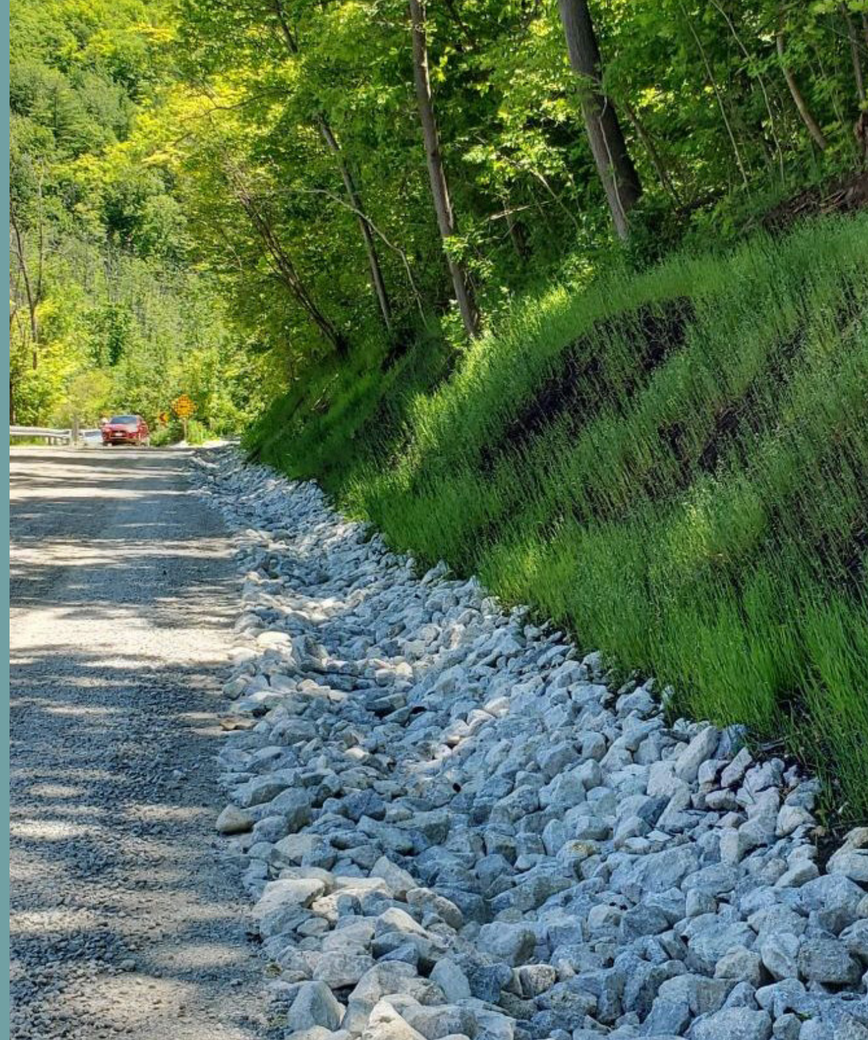


1. Small project under standard working conditions, with overall dimensions of approximately around 1,000 m² of surface and heights of the TerraMesh™ wall in between 2 and 5 meters.
2. Small/ medium-sized projects, between 2,000 and 5,000 m² and with a TerraMesh™ wall that can reach up to 5-10 meters in height. Standard working conditions
3. Medium-sized projects, about 5,000 m² and TerraMesh™ wall heights around 10 meters. The project, also usually presented some difficulties in terms of either construction or design, which were then resolved thanks to the TerraMesh™ solutions and our technical support.
4. Big projects, with dimensions between 5,000 and 10,000 m² of surface and heights up to 20 meters. During the design and execution phase further geotechnical and / or stability analyses were necessary; some projects also required particular attention in the drainage capacity of the structure.
5. Mega projects and / or projects of national interest, such as large road embankments, airports or railways. The dimensions are generally over 10,000 m² of surface, with TerraMesh™ walls with heights of over 20 meters. Projects may require in-depth geotechnical and stability investigations.

ENGINEERING CHALLENGE

1 2 3 4 5

Small project under standard working conditions, with overall dimensions of approximately around 1,000 m^2 of surface and heights of the TerraMesh™ wall in between 2 and 5 meters



2018
Vaughan, Ontario, Canada

DISTINCTIVE LANDFORM USING MARGINAL FILL FROM MAN MADE STORM POND

Create a green sustainable environment around the Cortelluci Vaughan Hospital

Client:	**MACKENZIE HEALTH**
Designer / Consultant:	**HOC ARCHITECTS CORPORATION**
Contractor:	**ROCKY RIVER CONSTRUCTION**
Products used (Qty.):	**TERRAMESH™ GREEN 860 pcs**
Date of construction:	**08/2018 - 12/2018**

1

Engineering challenge

"The Cortelluci Vaughan Hospital will be the first Smart Hospital in Canada featuring fuly integrated smart technology systems and dedicated devices that can speak directly to one another, and improve patient care." - Mackenzie Health In keeping with the concept of Smart Solutions and the need for improved construction methodologies. The goal of the site works portion of the project was to minimize e carbon footprint of the earthworks and create a green sustainable environment around the hospital. The goal to reduce the carbon footprint was compounded with the need to construct a large storm pond to handle all the runoff from the site. In order to do so a large pit had to be dug out. Inevitably creating a large amount of surplus material. With the hospital, parking lots and other amenities taking up the majority of the space. How does one maximize the use of all this surplus marginal soil without trucking and dumping off site?

Our Solution

HOC Architects solution was twofold. The terrain where the hospital is situated was relatively flat. In order to create a pleasing area which was free of height and to provide a berm that would blend with the green scape, a vegetated landform was devised. The small footprint of the available space and the low friction angle for the marginal soils was maximized by creating a TerraMesh™ Green landform, in combination with the Maccaferri Paradrain™ geogrids. The TerraMesh™ Green, a proven vegetated reinforced soil system using PVC coated and galvanized double twist wire was able to create and support a 60' angle face slope, while the Paradrain™ geogrid attended to the marginal fill. The Paradrain™ composite construction allowed for drainage to dissipate water pore pressure in cohesive silty clay soils while providing reinforcement yet simplifying and accelerating the construction process. In the end providing stability for the Landform once constructed. The construction of the landform went as planned. An efficient reuse of soil, a maximization of space, with an overall reduction in carbon footprint. The sum of the parts working together in the creation of a living architectural land mass.

2020
Halton Hills, Ontario, Canada

TENTH LINE LOT 29/30 ROADWAY AND SLOPE REPAIR

An ideal and robust solution

Client: **THE TOWN OF HALTON HILLS**
Designer / Consultant: **CHUNG & VANDER DOELEN ENGINEERING LTD.**
Contractor: **GREENSPACE CONSTRUCTION INC.**
Products used (Qty.): **MACGRID™ EG 1,975 m² - MACDRAIN™ W 1,705 m²**
TERRAMESH™ GREEN 269 m² - MACMAT R STEEL 900 m²
Date of construction: **02/2020 - 08/2020**

1

Engineering challenge

Tenth line is a gravel road at the Town of Halton Hills between 27 Side Road and 32 Side Road. Land use in the area is primarily rural, residential or farmland. The topography of the site is undulating, with a moderately steep slope. Based on two geotechnical investigations, it was noted that approximately 110 meters of the adjacent slope was in distress. Historically, guardrails had sunk into the slope, until three rows of guardrails had been installed on the slope. The reason for the slope distress was not clear. One theory was that upper slope collected a large amount of water that was not properly diverted, and that ground water had no other option but to move beneath the road and lower portions of the slope. Each spring the town had to add road gravel to continually resurface and regrade the road which necessitated the need for future remedial works.

Our Solution

The town approached Maccaferri in 2016 to seek an engineered solution to this challenge. The engineering team proposed the following four solutions:

- Full road reconstruction reinforcing the road subbase with Macgrid™ EG. This is a high modulus high density polyethylene (HDPE) grid characterized by a tensile resistance in both longitudinal and transverse directions.
- Installation of a layer of Macdrain™ below the road subbase and behind the reinforced slope. This allows water moving from the upper slope to be diverted beneath the road and directed away from the lower slope. Macdrain™ geocomposites are made from a plastic drainage core that is thermally bonded to a geotextile on both sides.
- Full slope reconstruction with a Maccaferri TerraMesh™ Green. This is an environmentally friendly modular system used to form a vegetated (green) faced reinforced soil slope.
- Upper side slope protection with the use of MacMat® R. To collect water from the upper slope, the slope needed to be regraded, and the slope protected from erosion. The MacMat® R provided an ideal robust solution as it is a reinforced polymer geomat which has a three-dimensional matrix extruded onto a double twist steel mesh. The steel mesh allows it to be installed as one continuous sheet of erosion protection.

2020
Kanosh, Utah, U.S.A.

UDOT I-15, MP 135 TO MP 142.5 CLIMBING L

A solution with an over 75 year service life expectancy

Client: **HARWARD & REES**
Designer / Consultant: **TERRANE ENGINEERING**
Contractor: **HAYWARD AND REES**
Products used (Qty.): **TERRAMESH™ 260 pcs**
Date of construction: **06/2020 - 10/2020**

1

Engineering challenge

The Utah Department of transportation Project on I-15 required a permanent wire Face MSE retaining wall for the bridge at the climbing Passing Lanes. The Steel product needed to comply with the Buy America Act requirements, provide a minimum of 75 year service life expectancy, feature a free draining element fascia, and provide an aesthetical rockery wall look.

Our Solution

Hayward & Rees Construction approached Maccaferri Thru Hanes Geocomponents, we submitted a TerraMesh™ MSE Retaining Wall solution which is a single elemet Gabion™ Type face unit that has a metal reinforcement element that works in conjunction with Macgrid™ WG Geogrids for wall stability. The solution provided savings on installation time, utilizing the face rock available on site. Maccaferri TerraMesh™ is included in the Utah DOT Approved list of materials. The wall consisted of about 5,000 SF of Face surface.

ENGINEERING CHALLENGE

1 **2** 3 4 5

Small/ medium-sized projects, between 2,000 and 5,000 m^2 and with a TerraMesh™ wall that can reach up to 5-10 meters in height. Standard working conditions

2016
Lanslebourg Mont Cenis, 73, France

TSD DES ARCELLINS

A perfectly integrated structure for a beautiful landscape

Client: **SE2MC**
Designer / Consultant: **DCSA / SAGE INGENIERIE**
Contractor: **GRAVIER TP**
Products used (Qty.): **TERRAMESH™ GREEN 700 m² - PARAGRID™ 8,000 m²**
Date of construction: **06/2016 - 08/2016**

2

Engineering challenge

The ski resort Val Cenis is located in Haute-Moriana Vanoise,France. For skiing and snowboarding, there are 125 km of slopes available and up to 29 lifts transport skiers, it's family friendly and considered one the best location for beginners in Europe.
This work concerns the development of a platforms of reinforcement necessary for the construction of the six places chairlift des Arcellins and the family track, at the ski station of Val Cenis in Savoy. The focus of the project and it's challenge was on integration of the structure with the beautiful landscape surrounding it.

Our solution

Maccaferri dimensioned the supports of the embankments in TerraMesh™ Green, a solution with a facing plant combined with a reinforcement layer of double mesh twist. For this particular project, it was also added a certified Paragrid™® type 100 reinforcement geogrid Asqual, of variable length depending on the height. The total work has a length of 67 m for a height between 8.3 and 12 m. This solution can sustain great heights and pick up very strong loads, as in the case of this project, where it was necessary to take into account the overloads linked to the weight of the snow and groomers. Furthermore, the structure also has a great response with respect to seismic stresses.

2021
Metz, la Moselle (57), France

WIDENING TO 2X3 LANES OF THE A4 ON THE NE METZ BYPASS

Mineral facing reinforced embankments

Client: **SANEF**
Designer / Consultant: **GROUPEMENT SETEC INTERNATIONAL / SETEC TPI**
Contractor: **NGE**
Products used (Qty.): **TERRAMESH™ MINERAL 4,712 m²**
Date of construction: **01/2021 - 05/2021**

2

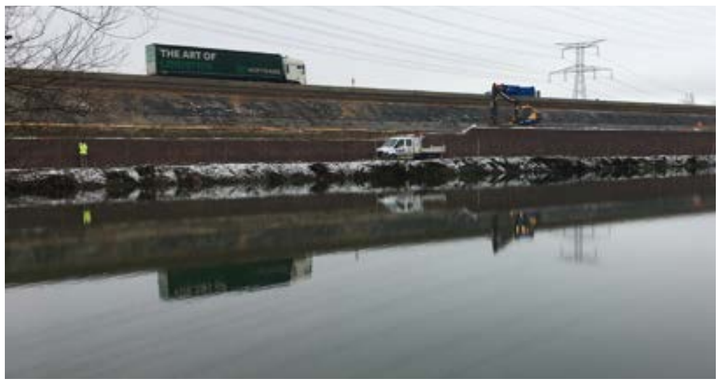
Engineering challenge

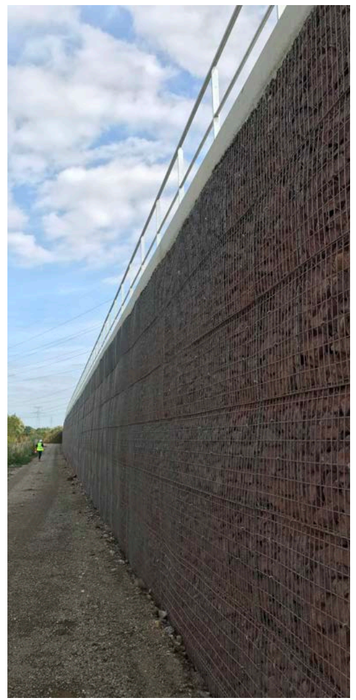
Metz is a french city of around 120 thousand people in the north-est of France. The city has a rich and old history, funded as in the late Bronze Age, it was the capital of the Gallic population of the Mediomatrici during the III century DC. As part of the development of the Northern Bypass East of Metz and the upgrading to 2x3 lanes of the A4 motorway, Maccaferri carried out work to supply and implement the retaining structures in the embankments reinforced with mineral facing (TerraMesh™ Mineral). The three work areas concern reinforced embankment retaining walls were:

- The walls MS1 (316_4 direction 1) and MS2 (316_7 direction 1).
- The MS3 wall (317_4 sens1).
- The MS4 wall (316_9 direction 2).

Our solution

The reinforced soil structures are located at the foot of the embankment highway. They are used to retain the backfill caused by the widening of the highway. The walls of support in TerraMesh™ Mineral present a variable height up to 5.7 meters in height. They are surmounted by a slope at 2H:1V of variable height. Above the TerraMesh™ mineral wall, a concrete gutter of 20cm thick and 1.4 meter wide was achieved; The channel was shaped along the longitudinal profile and filled locally with a more closed material (GNT 0/31.5) to ensure a level seat to lay the gutter. TerraMesh™ Mineral modules are made up of a mineral facing 30 cm thick at the top and 50 cm of medium thickness, which is extended by a layer of rear wire mesh of variable length next the profiles, 3.5 and 4.5 meters. The double twist fence constituting the facing and the layers is coated with polymer for better durability. Mineral TerraMesh™ structures are manufactured in the framework of an ISO 9001 quality system and are CE certified according to EU Construction Products Regulation 305/201. The structure was implemented by the Maccaferri teams, under Asqual ROG certification (Production of Works in Gabion™s).





2020
Valenciennes, Nord, France

R375-VALENCIENNES TRÉMIE JEAN-JAURÈS NORTH BYPASS

The crossing of rue Jean Jaurès in Bruaysur-Escaut

Client: **NORTH DEPARTMENT**
Designer / Consultant: **SETEC INTERNATIONAL**
Contractor: **GUINTOLI**
Products used (Qty.): **TERRAMESH™ MINERAL 1,300 m² - GABION™ 160 m²**
Date of construction: **11/2019 - 03/2020**

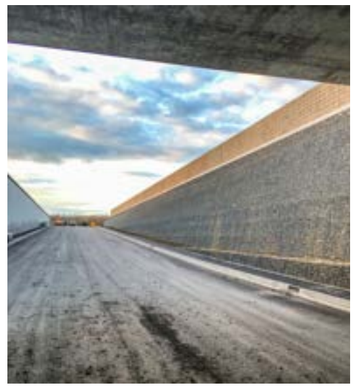
2

Engineering challenge

Valenciennes is a town in the Nord department, Hauts-de-France, famous due to the Battle of Valenciennes in 1918 during the World War 1 , during which seven British divisions attacked eleven German divisions and won.
The challenge of this case study consisted of the construction of infrastructure allowing the crossing of rue Jean Jaurès in Bruaysur-Escaut, in particular where the T2 tram line runs. The bypass road network is relatively developed around Valenciennes (A23 to the west, A2 to the south, RD 75 to the east and northeast), even though it did not allow an effective bypass of the agglomeration from the north. The northern bypass project of Valenciennes met several objectives, including restructuring of the departmental road network in the northern part of the agglomeration.

Our solution

The development consists of the realization of a work of the north side of the hopper. The wall is arranged in terraces and has a variable height between 1.58 and 6.32 m depending on the profiles. The work was carried out in reinforced embankment with Mineral TerraMesh™, with an inclined mineral facing of 10° from the vertical, having a thickness of 0.3 m top and 0.5 m average thickness. The facing was extended by a sheet of metal mesh behind the 2.5m in length. In terraces, the interaction between tree pits and the netting layers required an adaptation of the system. We therefore proposed the cutting of the fences constituents of the mineral TerraMesh™ around these structures. The upper part of the concrete wall behind the reinforced embankment, serving as a railing for the road behind the hopper, was "dressed" using Gabion™s of thickness 0.3 m. Mineral TerraMesh™ is a product developed by Maccaferri combining a double twist mesh and an electro-welded facade panel. The double twist fence, coated with Zinc/Aluminium and a polymer sheath (for better durability), provides horizontal reinforcement in the backfill and returns to the facing to ensure the local stability of the massif. The welded mesh, with a 50x100 mesh ensures continuity aesthetic with the Gabion™s.



2019
Montagnac, 34, France

DEVIATION OF MONTAGNAC RD613

Our solution to save materials and reduce the carbon footprint of the project

Client: **CONSEIL DÉPARTEMENTAL DE L'HÉRAUL**
Designer / Consultant: **EGIS/TASSERA**
Contractor: **GROUPEMENT GUINTOLI-RAZEL BEC-COLAS**
Products used (Qty.): **TERRAMESH™ SYSTEM 2,200 m² - GABION™ 85 m² - PARAGRID™ 13,500 m²**
Date of construction: **09/2018 - 12/2019**

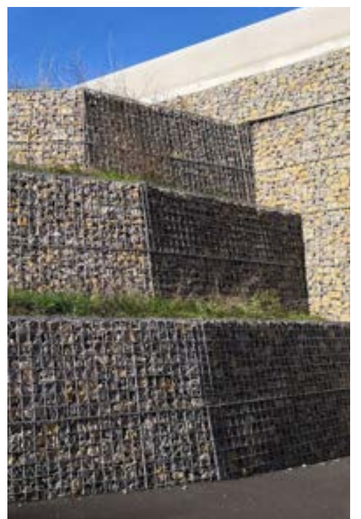
2

Engineering challenge

To reconcile the challenges of road safety, the framework of life and local development, the Department of de l'héraul has initiated the construction of the Montagnac deviation on the RD 613 located on the territory of the communes of Aumes and Montagnac. Aumes and Montagnac are two small French town in the Occitanie regione in the southern France. This work required retaining structures with mineral facing to be able to obtain an infrastructure with an arc configuration made of terraces.

Our solution

The solution adopted was Maccaferri's TerraMesh™ mineral, which consists of a mineral facing 50 cm thick on average, extended by a sheet of wire mesh behind 3m in length. TerraMesh™ Mineral structures were combined with reinforcement geogrids of the Paragrid™ 50 and Paragrid™ 100 type variable length and vertical spacing depending on the Works. This technique benefits from the advantages of resistance, flexibility and durability of plastic-coated double twist mesh while providing the desired aesthetics on this site with the 100x100 mesh welded mesh to the facing. In addition, the TerraMesh™ solution has enabled the reuse of materials from the treated site for backfill and has limited the thickness of facing stones. This technique has therefore generated a significant saving of materials and their transport, resulting in a smaller carbon footprint.



2017
Žilina, Žilina, Slovensko

D1 HRIČOVSKÉ PODHRAIDE - LIETAVSKÁ LÚČKA, SO 206-00

A project capable of ensuring overall stability of the structure and sufficient bearing capacity of the subsoi

Client: **NÁRODNÁ DIAĽNIČNÁ SPOLOČNOSŤ**
Designer / Consultant: **DOPRAVOPROJEKT A.S**
Contractor: **STRABAG S.R.O**
Products used (Qty.): **TERRAMESH™ SYSTEM 885 m²**
Date of construction: **07/2015 - 08/2017**

2

Engineering challenge

The D1 Hričovské Podhradie - Lietavská Lúčka highway is part of the state road from Bratislava to the state border with Ukraine. The stretch of motorway in question is also part of the international line E-50: Paris - Nuremberg - Prague - Brno - Trenčín - Žilina - Košice - Uzhhorod with continuation through Ukraine and Romania to the south or through Eastern Russia.
The retaining wall of considered in this case history serves to secure the slope cone of support numbero 17 and 18 and the body of the D1 highway from the 31.936 to 32.042 kms. Considering the geological environment formed by the positions of unconsolidated compressible clays, the support system needed to be able to carry high loads and absorb expected vertical and horizontal deformations. The wall is 246 m long and reaches a maximum height of 7.5 m, is graduated bench of variable width, maximum height degree is 4.5 m and two-tiered with an 80-degree slope steps with modification of the embankment under the bridge.

Our solution

The wall construction is designed from a prefabricated system of the TerraMesh™ modular structure formed by facing wire stone elements with an integrated reinforcement network. The face elements of the prefabricated TerraMesh™ modular construction have dimensions of 2.0 × 0.5 × 0.8 m and are reinforced in the form of a horizontal panel with a length of 3.0 m z double-twisted steel mesh with long-term tension. The external stability of the reinforced wall is secured using Paragrid™ uniaxial geogrids 100/05 with a length of 6-12 m. The face of the wall has a graded slope 5:1.
The goal of the project was to ensure overall stability of the structure and sufficient bearing capacity of the subsoil and create the conditions for an accelerated consolidation subsoil. Remedial measures consisted of subsoil replacement with a thickness of 1.5 m and supplemented by a system of gravel ribs with 1.0 m wide and 1.5 m deep. To ensure the total stability, a geoplate was implemented on the replacement of the subsoil formed by two layers of uniaxial Paragrid™ geogrids 200/05 with a length of 16.5 – 32 m and with a long-term tensile with a strength of 126.5 kN/m.

2017
Dirtpot Corner, Peebles, Scotland

A72 ROAD WIDENING

A technically challenging TerraMesh™ System project in one of the most scenic locations in Scotland

Client: **PT CIPUTRA DEVELOPMENT TBK**
Designer / Consultant: **PT MACCAFERRI INDONESIA**
Contractor: **PT. WIJAYA KARYA TBK**
Products used (Qty.): **TERRAMESH™ GREEN 4,000 pcs - MACGRID™ WG 8,000 m²**
MACDRAIN™ W 15,936 m²
Date of construction: **06/2017 - 09/2017**

2

Engineering challenge

A technically challenging TerraMesh™ System project in one of the most scenic locations in Scotland, Peebles, alongside the River Tweed.
The A72 in the Scottish borders connects to the River Tweed as it passes Dirtpot Corner, at Peebles. The highway was very narrow which was a problem for road users causing congestion and car accidents. Large vehicles had to stop to pass each other, which subsequently damaged the existing walls that bordered the highway.
The 3 m widening, with associated road safety parapet upgrades, required a retention solution due to the presence of the River Tweed immediately adjacent to the highway approximately 7 m below road level. A fast-flowing river, the Tweed is also one of the foremost salmon migration rivers in the UK, so any solution had to be sympathetic to the environment.

Our Solution

The Scottish Borders Council decided to widen the highway by approx. 3 metres and started a 10 month contract to start the work in August 2018. The low height retaining wall and revetment slope to the river needed to be replaced, plus the construction of a new barrier would improve safety in line with current standards.
Steep slopes and the river being below the road caused project challenges in that there was a lack of space to construct a new wall, and there were no verges either.
A hybrid reinforced soil structure was designed by MHB Consultants to retain the highway yet minimise the impact on the surroundings. The structures height would be 6m and would run 150 m along the River Tweed.
Maccaferri's technical support was used alongside Albion Drilling which enabled MHB to design a tied-back Gabion™ and TerraMesh™ reinforced soil structure. Maccaferri supplied and constructed the TerraMesh™ System.
Scottish Borders Council also placed an environmental clerk of works on the project who monitored and minimised the impact of construction works on the local environment.

2021
Wolverhampton, South Staffordshire, Uk

I54 DEVELOPMENT

Constructing a new business park without negatively impacting the view

Client: **STAFFORDSHIRE COUNCIL**
Designer / Consultant: **AMEY CONSULTING**
Contractor: **AFS EARTHMOVING & AGGREGATES**
Date of construction: **07/2020 - 04/2021**

2

Engineering challenge

The i54 development on the outskirts of Wolverhampton in South Staffordshire is a 239 acre UK technology-based business park and is located at junction 2 of the M54 motorway. The £67 million regeneration and development of the site commenced in 2011 as part of a joint venture between City of Wolverhampton Council, Staffordshire Council and South Staffordshire Council and notably saw the construction of a new Jaguar Land Rover engine plant in 2014. In January 2019, planning permission was granted for a 60 acre expansion to the west of the existing business park in the direction of Pendeford Hall Lane, where the Pendeford Nature Reserve and Pendeford Hall Residential Park are located. A key condition of the planning permission was to ensure the new business park extension would not negatively impact on the view from the residential park.
In order to maximise the industrial space available within the new development and therefore increase revenues, the proposed 6m high bund needed to be constructed within a relatively narrow footprint so it was immediately clear that a traditional bund with shallow unreinforced slopes would not fit within such tight constraints.

Our solution

Throughout 2019, Staffordshire Council and their engineering consultants Amey, engaged with Maccaferri to develop proposals for a double-sided reinforced soil bund to meet the requirements of the planning and geometric constraints.Maccaferri proposed the use of its Mineral TerraMesh™ reinforced soil retaining wall system, to create two retaining structures either side of a central core in order to drastically steepen the sides of the proposed bund. The proposal consisted of a low height Mineral TerraMesh™ wall of 1.5m retained height with an 80° slope angle on the western side of the bund and a taller 6m retained height Mineral TerraMesh™ wall with a 70° slope face on the eastern side. The crest slopes of the bund core could then be graded at 1:3 and 1:3.5 respectively and still produce a bund with a footprint to fit comfortably within the available 23 m footprint.

The ground investigation report revealed that in the southwest corner of the site there was a large amount of sandstone rock that would need to be excavated to reach the required level for the development platform. Maccaferri proposed that this material could be crushed to suit a class 1A grading and used as structural fill to the Mineral TerraMesh™ reinforced soil structures.This enabled the use of mostly site won materials to build the new bund which allowed the client to meet environmental, sustainability and budget targets with ease. This typifies the approach of Maccaferri by trying to re-use site won fills wherever possible. Paragrid™® polymer, Macdrain™ drainage geocomposite a basal reinforcement layer of Paralink™® 300 were also used in the project to enhance the structural and drainage characteristics of the structure.

2005
Arequipa, Peru

CERRO VERDE FLOAT AREA

Contributing to the expansion of the Cerro verde mine

Client: **SOCIEDAD MINERA CERRO VERDE**
Designer / Consultant: **VECTOR PERÚ SAC**
Contractor: **GRAÑA Y MONTERO CONTRATISTAS GENERALES**
Products used (Qty.): **TERRAMESH™ 60 TONS**
Date of construction: **08/2005 - 12/2005**

Engineering challenge

Sociedad Minera Cerro Verde, one of the mining companies leaders in copper production, carried out an expansion of 850 million dollars that allows to explore a primary sulfide body. This project process approximately 1 billion tons of sulphides. The Sociedad Minera Cerro Verde hired Fluor Daniel to undertake a major expansion project. Fluor Daniel, in partnership with Vector Peru, had the need to build a wall in reinforced soil with heights of 6 to 12 m.

Our Solution

Vector Peru, a company known worldwide for quality of its engineering works, proposed and designed the reinforced soil structure with the System TerraMesh™. The Terraesh™ System wall was adapted perfectly to the characteristics of the place, highlighting as main advantages the flexibility and monolithicity of the system. The project was carried out with the help of software MACSTARS® 2000, a program created by Maccaferri to facilitate the correct use of its products, the wall was supported on soil with good resistance parameters and the backfill structure was rigorously selected and compacted. On-site quality control was strictly monitored. The structure is about 200 m long.

2019
Balikpapan, East Kalimantan, Indonesia

MSE WALL FOR SLOPE PROTECTION AT KARIANGAU OFFSHORE

A retaining structure for slope protection

Client: **PT. PETROSEA, TBK**
Designer / Consultant: **PT. ZEKON INDONESIA**
Contractor: **PT. PETROSEA, TBK**
Products used (Qty.): **TERRAMESH™ 3,825 m²**
Date of construction: **01/2019 - 09/2019**

2

Engineering challenge

Kariangau Offshore Supply Base (KOSB) Fuel Terminal is a fuel terminal located in Balikpapan, East Borneo; it serves as fuel storage for various industries. The Client needed a retaining structure for slope protection of the access road that connects the port and the fuel terminal. Few slope failures and erosion occurred from 2015 and some slope remediation already been done in 2016. While the area has a low seismicity level, there is a presence of coal and clay shale at the project location which could be the cause of the problem if appropriate measures are undertaken. Certain substances of coal, typically the iron sulfide (FeS2) can be oxidized after being exposed to air and water, therefore they have the potential to damage the retaining structure if the adequate coating of the system is not applied. The clay shale, while hard with high shear strength when dry, can lose its shear strength when exposed to air and water. The slope to be protected has various height, ranging from 20 – 30 meters. The initial solution was mass gravity retaining structure with Gabion™ and woven geotextile.

Our Solution

Maccaferri proposed the hybrid MSE Wall structure called TerraMesh™ System as an alternative to mass gravity retaining structure with Gabion™. Mainly, the TerraMesh™ System consists of anchored Gabion™ made from double twisted steel wire hexagonal mesh called TerraMesh™ and woven polyester geogrid called Macgrid™ WG. The TerraMesh™ units, considering the presence of the coal layer at the project location, were coated with Zinc 95% - Aluminium 5% and a polymeric formula. Furthermore, to prevent water infiltration to the system, a drainage geocomposite called Macdrain™ was installed behind. The erosion control mattress called MacMat EM was installed to protect the slope above the TerraMesh™ System from water runoff, wind and all factors that can cause erosion. The structure was designed using limit equilibrium method software. Both static and seismic analysis had been performed. Finally, the hybrid MSE Wall solution called TerraMesh™ System proposed lead to savings of the material cost of nearly 38% comparing to mass gravity structure with Gabion™ and woven geotextile.

2021
Burlington, Ontario, Canada

HAGAR CREEK SLOPE-A SELF WATERING VEGETATED SLOPE USING PARADRAIN™

An environmentally sound solution

Client: **CITY OF BURLINGTON**
Designer / Consultant: **SOIL ENGINEERS LTD.**
Contractor: **ANTHONY'S EXCAVATING CENTRAL INC.**
Products used (Qty.): **TERRAMESH™ GREEN 294 m² - PARADRAIN™ 3,510 m²**
MACMAT 126 m² - MACDRAIN™ W 430 m²
Date of construction: **04/2019 - 05/2021**

2

Engineering challenge

Vegetated reinforced slopes have become a familiar retaining system in place of traditional reinforced systems. These systems use tiebacks interacting with engineered backfill to create a stable mass to stabilize the retained soil over time. The natural appearance of vegetation growing in the front of a reinforced slope provides an environmentally sound solution. The design of vegetated reinforced slope systems requires an organic soil pocket within the front face and directly behind that, free draining granular backfill. Due to this configuration an inherent problem arises. Wherein any water within this structure drains downwards away from the front face. This lack of water results in stunted growth. For the Hager slope project. A slope failure occurred during the widening of a trail within a ravine setting. To stabilize the failing slope which was adjacent to an existing residence. A natural looking solution was the prerequisite. It needed to be constructed within a forested area, with limited space. Further, due to the slope location, there needed to be zero maintenance once built.

Our Solution

Team, Soil Engineers Ltd., the geotechnical engineers along with Maccaferri's Technical Department, designed a TerraMesh™ Green Slope 5.6m high using Paradrain™ 100 as the geogrid reinforcement, with a 3m high 3:1 slope above it. Though typically used with marginal fills to accelerate the dissipation of pore pressures,the Paradrain™ in this application do not only act as a reinforcement but also act as a drainage channel. Due to gravity, any water draining through the engineered fill flows downwards, but with Paradrain™ partial amounts of water would also is directed horizontally, thus acting as a self-watering irrigation system. This would ensure the structure vegetation. The work was performed by Anthony's Excavating Central Inc. It was their first time installing the TerraMesh™ Green with Paradrain™. They found the installation straightforward. The project was completed on time and on budget and was a big "W" (win) for all involved.

2020
London, Ontario, Canada

VAUXHALL WWTP EFFLUENT PUMPING STATION & BERM

A solution to minimized the foundation footprint with steeper side slopes

Client: **THE CITY OF LONDON**
Designer / Consultant: **DILLON CONSULTING**
Contractor: **CLASSIC EXCAVATING**
Products used (Qty.): **TERRAMESH™ GREEN 1,558 m² - PARADRAIN™ 7,800 m²**
MACMAT 2,766 m²
Date of construction: **02/2020 - 08/2020**

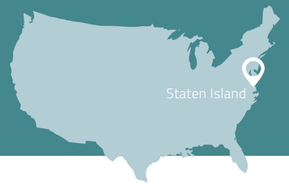
2

Engineering challenge

The Vauxhall wastewater treatment plant and effluent pumping station is located beside the Thames River at the City of London, Ontario. The pumping station continuously receives treated effluent downstream of the existing UV Disinfection. The Vauxhall WWTP EPS discharges into an elevated channel which provides the necessary head to push the plant's effluent into the river during high river levels. In the past, the WWTP was flooded due to major rainstorm events. After evaluation of alternatives, the consulting firm recommended the construction of a double sided protection berm with clayey soils to make it impervious.

Our Solution

In order to optimize the construction footprint of the berm, a Maccaferri TerraMesh™ Green MSE wall with Paradrain™ soil reinforcement was proposed. The original solution proposed flatter side slopes at 27° which created a larger footprint. The Maccaferri solution minimized the foundation footprint with steeper side slopes oriented at 60° to the horizontal. TerraMesh™ Green is an environmentally friendly modular system used to form a vegetated (green) soil reinforced slope or embankment. It consists of pre-fabricated units of double twisted wire mesh (8×10 type) lined with an erosion control blanket and stiffened with a welded wire mesh panel. The Paradrain™ Geogrid is a high tenacity multifilament polyester yarn that is placed in tension and co-extruded with a polyethylene sheath into strips. The polyethylene sheath is profiled to provide a shaped drainage channel. The profiled element has a thermally bonded nonwoven geotextile strip bonded on the shoulders of the drainage channel. The Paradrain™ advantage is that it allows dissipation of excess pore water pressure while using cohesive soils, and also ensures soil reinforcement strength in a uniaxial direction which is necessary for design. The completed structure was an impervious clay reinforced berm fully vegetated that will protect the facility against future flooding events. The ends of the berm transitioned from 60°slopes to a 2:1 slope which was constructed and protected with Maccaferri MacMat N10 turf reinforcement mat to prevent surficial erosion and promote vegetation.



2019
Staten Island, New York, U.S.A.

NORTHPARK AT FRESH KILLS

The reclamation from the decommissioned Fresh Kills Landfill

Client: **ACF ENVIRONMENTAL**
Designer / Consultant: **NYC DEPARTMENT OF PARKS & RECREATION**
Contractor: **LOMMA CONSTRUCTION**
Products used (Qty.): **TERRAMESH™ GREEN 405 pcs**
Date of construction: **12/2019 - 12/2019**

2

Engineering challenge

The Fresh Kills Landfill in Staten Island, New York was in operation from 1948 – 2001, and was once one of the largest landfills in the world. It stretched over 2,200 acres, and at its peak, received 29,000 tons of waste per day. Over time, pollution damages, pests, and destruction of the land began to take a toll on the surrounding community. As a result of community pressure, a law was passed in 1996 requiring the landfill to cease operation by the end of 2001.The New York City Department of Parks & Recreation is responsible for creating park land from the decommissioned Fresh Kills Landfill. In October 2008, reclamation of the site began for a multi-phase, 30-year site development. The Fresh Kills Landfill was to be transformed into Fresh Kills Park, to include reclaimed wetlands, recreational facilities, and landscaped public parkland. As a part of this reclamation, the New York City Department of Parks & Recreation needed to create a roadway and pedestrian walkway leading up to a lookout area and comfort station. They needed a system that would be able to be vegetated in order to blend into the park like surroundings, so they contacted Maccaferri for a retaining wall system.

Our Solution

TerraMesh™ Green was chosen as the best solution because it can be live staked in order to provide the green wall that the New York City Department of Parks & Recreation was looking to achieve. The contractor was able to bury sonotubes in the top of the wall during installation as locations for a necessary guard rail to be installed later on in the project. They were also able to prepare the locations during installation where trees will be planted along the top of the wall. They achieved this by marking the location of each tree and placing a round steel form in that area and filling with the appropriate soil. Then they would backfill the form with the wall fill material then remove the form.

2019
Digos City, Philippines

DIGOS-MAKAR ROAD

Our contribution to the "Build, Build, Build" Philippines administration's program

Client:	**DEPARTMENT OF PUBLIC WORKS & HIGHWAYS - DAVAO DEL SUR DISTRICT ENGINEERING OFFICE**
Designer / Consultant:	**DPWH - DAVAO DEL SUR DEO**
Contractor:	**TSQUARE CONSTRUCTION CORPORATION**
Products used (Qty.):	**TERRAMESH™ 4,717 CUM - PARAGRID™ 33,345 m² - MACTEX™ NON-WOVEN GEOTEXTILE 20,720 m² MACDRAIN™ W 4,368 m²**
Date of construction:	**10/2018 - 11/2019**

2

Engineering challenge

The Department of Public Works and Highways implemented various infrastructure projects since the start of the new administration in 2016. The projects formed part of the administration's program called, "Build, Build, Build"; out of all proposal bridge construction and road widening works had been prioritized. In Mindanao, the DPWH Davao del Sur District Engineering Office allocated portion of its infrastructure budget to one of its most challenging projects to date - the rehabilitation and reconstruction of roads with slips and landslides along the Digos-Makar Road, a two-lane national highway in the mountainous portions of the city. The road is part of the Asian Highway, a network of highway routes of international importance within Asia and covers a total of 3,517 kilometres of roads in the Philippines. In order to achieve the rehabilitation and to upgrade the existing road to a four-lane highway as a minimum requirement for all Asian Highway-classified roads, the only viable solution at that time was to build a retaining structure in the cliff side of the Digos-Makar Road.

Our solution

With close coordination among DPWH personnel, Maccaferri engineers recommended a mechanically stabilized earth (MSE) wall using Paramesh - a combination of high tenacity polyester geogrids (Paragrid™) as primary soil reinforcements and TerraMesh™ system units for the facing of the wall. The designed total wall heights ranged from 5 up to 21 meters; due to space constraints, majority of the walls were required to have a vertical facing. Upon submission of detailed analysis and design of the ParaMesh MSE wall system, DPWH engineers approved the recommendation and proceeded with the construction. Backfill materials were qualified and tested, and frequent compaction tests were required. During the construction, a series of heavy rainfall and moderate earthquakes (up to magnitude 5) have tested the wall system and to date, the wall has stood still without any dangerous signs.

2018
Kuningan, Jawa Barat, Indonesia

RETAINING WALL AT KUNINGAN DAM

The wall reinforcement for the 25.9 million cubic meters Kuningan Dam

Client: **PT. WIJAYA KARYA (PERSERO) TBK**
Designer / Consultant: **PT. IKA ADYA PERKASA**
Contractor: **PT. WIJAYA KARYA TBK**
Products used (Qty.): **TERRAMESH™ 1,600 m² - MACGRID™ WG1,900 m²**
Date of construction: **03/2018 - 10/2018**

2

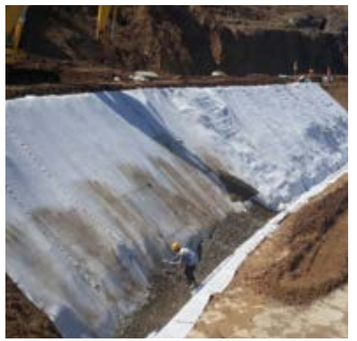
Engineering challenge

The Kuningan Dam is located in the west Java province, in the district/city of Kuningan. The dam has a capacity of 25.9 million cubic meters and is planned to irrigate 3,000 hectares of community rice fields in Kuningan, Cirebon, and Brebes districts. The dam is also useful for water security, controlling floods, providing 0.530 cubic meters of raw water per second, and being able to conduct 0.5 megawatts of electricity.
A cut slope at Kuningan Dam Project (Kuningan Jawa Barat) needed to be reinforced to avoid stability failure. The original slope was cut to create space for the access road of the Dam. The selection of the right solution was necessary in order to build a cost-effective structure with prompt construction methods while fulfilling the standard of safety. TerraMesh™ System by Maccaferri was selected in accordance with its easy installation method and capability to work together with available soil on site.

Our Solution

A combination of TerraMesh™ System and geogrid combined with an additional structure of wrapped around geogrid were built with 10.0 m - 13.0 m height. Macgrid™ WG was installed as primary reinforcement and then integrated with TerraMesh™ system as secondary reinforcement or facia. The retaining wall structure was constructed on a concrete capping with bored-piles underneath. A well-compacted soil as structural fill along with the system fulfilled the safety design criteria for the retaining structure. A drainage composite called Macdrain™ was added as a subdrain system inside the retaining wall structure to control any potential development of pore water pressure which might become a problem in the future. Maccaferri TerraMesh™ System granted many advantages such as:

- Easy and Quick construction;
- Allowing drainage on the facia of retaining wall;
- Earthquake resistant thanks to its flexibility;
- Cost-effective;
- Environmentally friendly.



2007
San Rafael, Rodriguez, Rizal, Region IV-A, Philippines

MWCI RESERVOIR

The protection of the Manila Water's facility

Client: **MANILA WATER COMPANY, INC.**
Designer / Consultant: **BC CUERPO CONSTRUCTION CORPORATION**
Contractor: **BC CUERPO CONSTRUCTION CORPORATION**
Products used (Qty.): **GABION™ 1,930 pcs - TERRAMESH™ 356 m² - MACGRID™ 2,800 m² - MACTEX™ 4,000 m²**
Date of construction: **03/2007 - 04/2007**

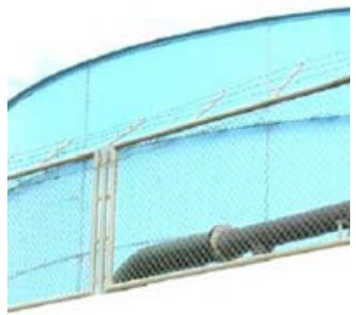
2

Engineering challenge

In line with the Manila Water Company Inc.'s extensive water supply infrastructure improvement, a 250,000 gallon-capacity water reservoir was designed. BC Cuerpo Construction Corporation, the general contractor of the project, initially planned to build a concrete gravity wall as a retaining structure on portions immediate to the location of the new water reservoir. The facility is adjacent to a river, which floodwaters could directly damage the facility if not protected.

Our solution

Maccaferri engineers recommended two wall systems due to project requirements and space limitations. One of the systems involved a Gabion™ gavity wall placed along the upstream of the reservoir's intake to hold curing tanks, machine room, and other equipment. The other wall system featured Maccaferri's TerraMesh™ System with Macgrid™ woven polyester geogrid as components for a mechanically-stabilized earth (MSE) wall system. The MSE wall was located along the downstream area to secure the 250,000 gallon capacity water reservoir. Gabion™ mattresses, 0.5 meter in thickness, were placed at the base of the intake structure for additional resistance against scouring due to the possible impact of floodwaters from the adjacent river. The proposed solution was found to be more advantageous than other wall systems for its flexibility, drainage capability, and structural soundness. Moreover, the wall systems were further proven to be more economical and were constructed just on time as scheduled.



2018
Vadodara, Gujarat, India

RETENTION AND BOX CULVERT PROTECTION WORKS

A flexible, permeable and environmental friendly reinforced earth structure

Client: **BALASORE ALLOYS LTD**
Designer / Consultant: **DGMS**
Contractor: **Z-TECH INDIA**
Products used (Qty.): **TERRAMESH™ 2,415 pcs - TERRAMESH™ GREEN 4,325 pcs - PARALINK™ 63,900 m² MACDRAIN™ 16,500 m² - BIOMAC™ NATURAL 1,000 m²**
Date of construction: **04/2015 - 07/2018**

2

Engineering challenge

The Vadodara-Gotri-Sewasi-Singrot road is a state highway across river Mahi. The HFL of the river is 104.645. As per survey carried out; this section (Km 6/415 to 8/124) used to submerge during high floods. To prevent this, authorities proposed to raise the embankment level to R.L. 105.2. In addition, cross drainage works were required to carry the excess water. Culverts at chainages 6/453, 6/705 and 7/450 Km. were part of the cross drainage work. The maximum height of retention was 6.7m and the culvert width was 12m. Heavy traffic load was expected on the road.Considering the height to be retained and expected loads on the structure, it was advisable to adopt flexible reinforced earth structure.

Our Solution

Maccaferri's TerraMesh™ system with Gabion™ facia and Paralink™ as primary reinforcement and mesh as a secondary reinforcement was selected as the best solutions. The client, was convinced about the system due to the following merits of TerraMesh™ walls:

1. Permeability: As it is made up of Gabion™s, the permeability of the front face ensures the drainage of the backfill resulting in less hydrostatic pressure which may develop during heavy rainfalls.
2. Flexibility: System being the flexible soil reinforcing system helps the structure to stand stable during seismic activity.
3. Structural Safety: This system offers safety against corrosion, fire, attack by earthworms, insects, rats, etc.
4. Environmental Impact: System gets covered with lush green vegetation enhancing the urban landscape.
5. Versatility: They can either be built manually or mechanically and in any climate.
6. Economy: Being simple, the system does not require skilled labor or special equipment.

TerraMesh™ is a soil reinforcement system which consists of panels of double twist hexagonal woven heavy zinc and polimeric coated wire mesh used for stabilizing steep slopes and vertical walls. It comprises of a continuous horizontal panel of mechanically woven steel wire mesh or geogrid with an integral Gabion™ fascia unit. The fascia unit is filled with hard durable rock-fill, identical to a Gabion™, and the wire mesh/ geogrid tail is then sandwiched between the compacted landfill.

2019
Mouding - Yao'an - Dayao, China

CHUXIONG - DAYAO HIGH-SPEED ZHONGTUN BRIDGE TERRAMESH™ RETAINING WALL PROJECT

Connecting the three counties of Mouding, Yao'an and Dayao

Client: **YUNNAN TRANSPORTATION INVESTMENT AND CONSTRUCTION GROUP CO. LTD**
Designer / Consultant: **GUIZHOU PROVINCIAL TRANSPORTATION SURVEY AND DESIGN INSTITUTE**
Contractor: **YUNLING CONSTRUCTION CO. LTD**
Products used (Qty.): **TERRAMESH™ SYSTEM 962 pcs**
Date of construction: **06/2019 - 09/2019**

Engineering challenge

The Chu-Yao Expressway is the second section of the new connecting line planned for the expressway network of the Central Yunnan Urban Economic Circle. The line starts from Daba Village, Donggua Town, Chuxiong City, and connects the Yu-Chu Expressway under construction, passing through Mouding County and Yao'an County ending at Zengjiawan in the south of Dayao County, and connecting to the Dayao-Yongren Expressway currently under construction.
The project is located in the road section between Zhongtun No. 1 Tunnel and Zhongtun No. 2 Tunnel. It was originally designed as Zhongtun Bridge, passing near Sanfeng Mountain Nature Reserve. The main problems in this section were the following:

- A large number of abandoned materials caused by tunnel excavation needed to be transported to a distance of 22 kilometers. During the transportation of abandoned materials, roads could have been damaged, which seriously affected the production and life of residents along the line, causing greater road traffic and increasing safety hazards;
- The seismic intensity in the area is 7 degrees, and the peak horizontal acceleration of ground motion is 0.15 g;
- The project had complex geological conditions, and the traditional scheme was expensive and difficult to implement;
- The opening of the Chu-Yao Expressway connected the three counties of Mouding, Yao'an and Dayao. In order to reach the goal of an expressway, the construction period was short, and a technically feasible, safe, economical, and efficient construction scheme was urgently needed.

Our solution

In order to consume the tunnel discard side and reduce the road traffic pressure, the headquarters decided to change the Zhongtun Bridge with a fill embankment scheme. The use of the TerraMesh™ wall technology, in the premise of ensuring the safety and stability of the high fill slope, increased the fill side slope rate and reduced the scope of land.

1. The slope foot was set with 3~9 m high weight retaining wall and the reinforcement behind the wall was designed to enhance the overall stability of the subgrade (reinforcement spacing of 1m and fold back). The maximum height of the upper slope is 21 m.
2. The product used were reinforced Gabion™ by TerraMesh™ system wall, geogrid, polyester long fiber non-woven fabric. The wall wires were galvanized with high wear-resisting organic coating double-stranded hexagonal metal mesh, the cage was filled with stone, polyester long fiber non-woven fabric for filtration behind the wall, the reinforcement material is 100 KN/m, 200 KN/m high strength fiber grille and finally the structure was filled with the tunnel excavation redundant discarded side.
3. The maximum height of the completed reinforced gabbing design is 21 m, the reinforcement spacing is 1m, from top to bottom, the first level of slope height is 9m, with a slope ratio of 1:0.75 and the second level of slope height is 12 m with a slope ratio of 1:1.

2021
Zalantun, Inner Mongolia

INNER MONGOLIA GUOSEN MINING ERDAOHE SILVER LEAD ZINC MINE RAW MINE TERRAMESH™ PROJECT

A flexible structure to allow structural deformation

Client: **INNER MONGOLIA GUOSEN MINING CO. LTD**
Designer / Consultant: **CHANGSHA NONFERROUS METALLURGICAL DESIGN AND RESEARCH INSTITUTE CO. LTD**
Contractor: **CHINA RAILWAY 18TH BUREAU GROUP CO. LTD**
Products used (Qty.): **TERRAMESH™ 2,038 pcs - PARALINK™ 22,000 m² - PARAGRID™ 28,000 m²**
Date of construction: **2020 - 2021**

2

Engineering challenge

The project is located 49 Km northwest of Chaihe Town, Zalantun City. The site is mainly composed of mining industrial zone, mineral processing industrial zone, living auxiliary area, tailings reservoir, discharge site, explosive depot, water source and substation. According to the capacity of the raw ore yard, the altitude of the top of the raw ore yard was determined to be 880 m, while the ground elevation of the north side was about 859 m. From the north side to the south side there is an external road, with a road elevation from 859 m to 873 m.
Therefore, the height difference varied between 7 m up to 21 m between the original surface line and the raw ore yard.

Our Solution

According to the topography and geological conditions of the site and after a comparison between the buttressed retaining wall and the TerraMesh™ system structure scheme provided by Maccaferri; the client and the design unit selected the 1:0.1 TerraMesh™ retaining wall scheme. Maccafferri's solution was considered the most convenient, considering the overall force of the retaining wall, the costs and the ability to resist fatigue deformation.

The TerraMesh™ system adopted in this scheme is a reinforced Gabion™ combined with the geogrid structure, which uses the flexible face wall of the reinforced Gabion™ and the high tensile strength characteristics of the geogrid to effectively distribute the load stress and reduce the force on the wall. Based on its flexible structure, it allows a certain degree of structural deformation, which can effectively alleviate the frequent effects of heavy loads and prevents local damage or overall fracture of the retaining wall caused by stress concentration or excessive deformation. After the reinforcement Gabion™ construction was completed, the ore processing of the original mine yard was also backfilled synchronously, which further saved the construction time of the retaining wall. It also avoided backfilling and rolling the raw ore yard after the construction of large volumes of concrete. The finished structure was highly appreciated by the client.

2019
Wenzhou - Fuzhou, China

WENZHOU-FUZHOU HIGH-SPEED RAILWAY PROJECT

The recovering from a landslide caused by Typhoon Sinlaku

Client: **NANCHANG RAILWAY BUREAU GROUP CO. LTD.**
Designer / Consultant: **CHINA RAILWAY FOURTH SURVEY AND DESIGN GROUP CO. LTD**
Contractor: **CHINA RAILWAY 18TH BUREAU GROUP CO. LTD**
Products used (Qty.): **TERRAMESH™ 1,131 pcs - PARALINK™ 18,175 m²**
Date of construction: **09/2019**

2

Engineering challenge

Typhoon Sinlaku was a typhoon that affected the Philippines, Taiwan, China and Japan. Sinlaku brought torrential and almost endless rain over most of Luzon from September 8 to the 11th, causing floods and victims. On the right side of the mountain slope of DK246+182 ~ +420 section of the Wenzhou and Fuzhou passenger line, the stratum is composed of two long granite rocks, gray and brown, with 50% total weathering and uneven weathering rock blocks (weak weathering). The particle size of the rock blocks is 1.2m to 3.5 m. The slope has been cut to a 1:1.25 slope rate during the typhoon on the 18th of July 2008. The water-rich weathering layer softened, and a large area collapsed. After the landslide toppled the barrier stone wall, it flowed to the road outside the slope on the left side of the line and the farmland outside the road. Additionally, a debris flow formed, seriously affecting railway safety.
Due to the debris flow caused by the landslide, the original design of stone wall and stone trough couldn't meet the needs of railway safety.

Our Solution

Because of the landslide, the construction of a retaining wall of 15 m high was needed. The wall had to be relatively tall and had to take into consideration that the slope instability was mainly caused by poor drainage. Because of these requests, the owner and design institute eventually decided to adopt a flexible ecological protection and well drained retaining wall solution.

The project was adapted to the uneven settlement of foundation. The TerraMesh™ solution has good water permeability and can reduce pore water pressure, which is critical to ensure the retaining wall stability and to mitigate the chances of landslides. Lastly, the TerraMesh™ system perfectly met the requirements of the construction period.

2015
Yiwu, China

YIWU SHUGANG EXPRESSWAY TERRAMESH™ PROJECT

A solution to shrink the subgrade slope foot, save earthwork and reduce land occupation

Client: **YIWU TRANSPORTATION BUREAU**
Designer / Consultant: **ZHEJIANG PROVINCIAL TRANSPORTATION PLANNING AND DESIGN INSTITUTE**
Contractor: **ZHEJIANG TRANSPORTATION ENGINEERING GROUP**
Products used (Qty.): **TERRAMESH™ 1,521 pcs - PARAGRID™® 18,000 m²**
Date of construction: **2015**

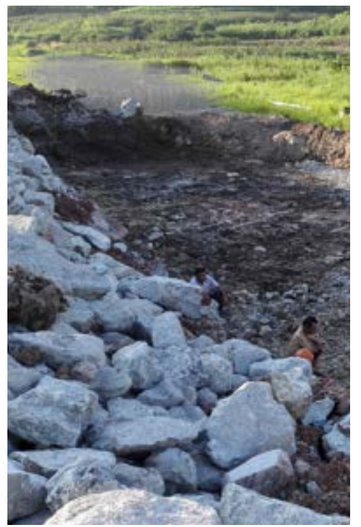
Engineering challenge

Yiwu has 1,859,390 inhabitants and its metro area, joined with that of the neighboring Dongyang, is home to 2,947,340 inhabitants. The city is famous for its light industry commodity trade and vibrant market and as a regional tourist destination. The project is located on the right side embankment of the YK3+362-YK3+690 section of Yiwu Shugang Expressway, Jiande City, Zhejiang Province. The retaining wall is located in a wide valley with a flat terrain. The ground contains a small amount of gravel, with a thickness of less than 5.0m, the underlying bedrock is gray-green, purple-red and gray-purple tuffaceous sandstone; the medium-thick layers are intercalated with thin layers.

Our Solution

According to the engineering geological conditions and requirements of the project, it was decided to adopt TerraMesh™ as a solution; which can greatly shrink the subgrade slope foot, save earthwork, reduce land occupation, and avoid occupying too much land on the outside.

The TerraMesh™ adopts galvanized plastic-coated double-stranded hexagonal metal mesh as the face wall, the main reinforcement of the reinforced soil adopts the high-strength grid with high tenacity polyester yarn cluster grid of 150 KN/m, and the inner wall is filled with stone. The stones are sourced from the local quarries that meet the requirements, and the materials are obtained locally. The structural filling is made of crushed stone after excavation, etc., which greatly saves the project cost.



2021
Xining, Qinghai, Cina

QINGHAI XINING TERRAMESH™ PROJECT

A solution for a high requirement on landscape, safety, and land use restrictions project

Client: **QINGHAI JIAHAOSHENG LEXUS AUTOMOBILE SALES SERVICE CO. LTD**
Designer / Consultant: **QINGHAI GEOTECHNICAL ENGINEERING SURVEY CONSULTING CO. LTD.**
Contractor: **QINGHAI GEOTECHNICAL ENGINEERING SURVEY CONSULTING CO. LTD.**
Products used (Qty.): **TERRAMESH™ SYSTEM 672 pcs - PARAGRID™ 29,871 m²**
Date of construction: **04/2021 - 06/2021**

2

Engineering challenge

The project had to face many challenges in order to be probably designed and built, such as:

- The project had high requirements on landscape, safety, and land use restrictions. The slope protection had to go from the northeast to the southwest of the newly built 4S store site, with an average height of 16m, in addition under the slope the newly built residential area is located.
- The northeast side of the slope is an existing building, and the building foundation is in the form of a column structure. In the later stage, the retaining wall needed to be connected with the original building structure, furthermore the drainage requirements were high.
- The southwest side is an embankment-type buttress-type retaining wall.
- Part of the retaining wall construction area is 4m deep miscellaneous fill, the original foundation bearing capacity is low, and the foundation treatment had a small budget;
- The retaining wall had high seismic requirements and a short construction period

Our Solution

Thanks to the TerraMesh™ system solution it was possible to support the structure and to increase the strength while reducing the length of the rib. Furthermore, for the project it was also reduced the slope ratio of the retaining wall, shrank the foot of the slope, reduced the construction land, removed the surface miscellaneous fill and treated the foundation to ensure the safety of the structure, which connects with the existing buildings and adjacent retaining walls.

ENGINEERING CHALLENGE

1 2 **3** 4 5

Medium-sized projects, about 5,000 m² and TerraMesh™ wall heights around 10 meters. The project, also usually presented some difficulties in terms of either construction or design, which were then resolved thanks to the TerraMesh™ solutions and our technical support.

2008
Dakar, Sénégal

CORNICHE ROAD

A more accessible Dakar

Client: **MINISTRY OF EQUIPMENT SENEGAL**
Designer / Consultant: **APAVE SENEGAL**
Contractor: **EIFFAGE SENEGAL**
Products used (Qty.): **TERRAMESH™ 8,000 m²**
Date of construction: **03/2007 - 03/2008**

3

Engineering challenge

The mosque of divinity it' a must-see in the Senegalese capital of Dakar, not only for the beautiful panorama, with a picture perfect ocean view, but also for it's unique architecture that melds elements of modernism with traditional Islamic design. Senegal, in charge of organizing the conference of Islamic States (OIC), needed a series of infrastructure roads to make the city of Dakar more accessible. The construction of the ring road linking the tip of Almadies to the cornice of Dakar required the construction of a structure original architectural support above the mosque of the divinity while preserving the access to the monument. For this reason two flights of stairshad to be integrated into the structure.

Our solution

The company EIFFAGE SENEGAL proposed the solution of TerraMesh™ System, in order to integrate the structure into the site protected from the Pointe des Almadies. The design of the structure, carried out by Maccaferri, has been validated by the Apave Senegal Control office. The structure with a length of 480 m and a maximum height of 17 m has a structure on the front mineral in Gabion™s stabilized by anchor layers of geosynthetic reinforcement incorporated in the embankment's techniques. It incorporates a service underpass, to site fishermen, and two flights of stairs that frame the rounding of the upper roundabout.

2021
Saint Martin De Vesubie, France

ACCESS ROAD TO BORÉON-STORM ALEX OCTOBER 2020: LANDSLIDE 6

The recovering after storm Alex

Client: **NICE COTE D'AZUR METROPOLIS**
Designer / Consultant: **NICE COTE D'AZUR METROPOLIS**
Contractor: **SLBTP, CACHAT TP, VENTURI**
Products used (Qty.): **TERRAMESH™ GREEN MINERAL 800 m² - PARAGRID™ 8,100 m²**
Date of construction: **04/2021 - 07/2021**

3

Engineering challenge

Between the 2 and the 7 of October storm Alex produced strong winds, heavy rain and thunderstorms; the heavy weather led to landslides and floods in south-eastern France, northern Italy and central Europe, causing at least 15 fatalities. Hundreds of homes, along with bridges and roads, were destroyed; outages of power, telecommunication and water supplies occurred due to fallen trees; rail services were cut off and dozens of people had to be rescued.
The passage of storm Alex caused significant damage in the Vésubie valley. The Roquebillière road subdivision has then had to take emergency measures to restore the axis road linking the Vésubie valley to the Var plain. The subdivision chose to rely on local businesses and the expertise of Maccaferri to design and implement the embankment retaining structures. The Boréon valley, upstream of Saint Martin de Vésubie, has been particularly badly affected by the storm on the 6km of road M89 leading to Lac du Boréon. Several shifts of terrain downstream of the roadway took place, requiring the construction of reinforcement and retaining structures, associated with hydraulic protections allowing resist the solicitations of the torrent. A major challenge for companies, both by technical constraints (only possible access by the bed of the torrent) than by the constraints planning (the reopening of the road was scheduled for the start July 2021).

Our solution

Large material resources have been implemented by the companies to complete the project in a timely manner record. Screening and crushing workshops have been set up in place to recover technical backfill used the construction of road platforms and structures in reinforced floors. Stones were sifted to best optimise the Gabion™ structures. Landslide 6 was Located at an altitude of more than 1300m, about 120 m long and 15 m high; furthermore, this part of the road was particularly exposed to the flow which hit against the riverbank. For this reason, it was decided to use hydraulic protection rather than rockfill concreted. However, to support the road embankment, a structure in reinforced TerraMesh™ Green embankment of 9m in height, combined with Paragrid™ HF 100 reinforcement layers of 7 and 8m in length, was executed and surmounted by an embankment at 3H2V 6 m high.

2019
Montauban, tarn et garonne (82), France

WEST URBAN BOULEVARD

A combination of aesthetics and technicality

Client: **GREATER MONTAUBAN AGGLOMERATION COMMUNITY**
Designer / Consultant: **EGIS/TASSERA**
Contractor: **GUINTOLI-RAZEL BEC-COLAS CONSORTIUM**
Products used (Qty.): **TERRAMESH™ 2,200 m² - PARAGRID™ 13,500 m² - GABION™ 85 m²**
Date of construction: **09/2018 - 12/2019**

3

Engineering challenge

The railway from Orléans to Montauban is an important and historical French 544 kilometre long railway line, that links Orléans and northern France to Montauban and southern France via Limoges. The railway was opened in several stages between 1847 and 1893, when the last section from Limoges to Brive-la-Gaillarde was completed. The project consisted of carrying out the most important infrastructure intended for the crossing of the Paris-Orléans-Limoges-Toulouse railway line by the BUO, " West Urban Boulevard". The operation to link the RD 820 - RD 959 is part of the framework of the development of the new " BUO of Montauban. These developments aimed to reduce traffic in its historical centre and create more convenient routes to towns to the west of the city. Section 1C included 3 crossing structures and 2 retaining walls. The structure has a total length of 91 m. The BUO platform is an embankment support of approximately 5 m in height and reinforced with facing mineral. The backfill materials used to build the massif are of the treated A2 Clay type (from the site).

Our solution

Maccaferri proposed her principle of backfill reinforced with a mineral facing, TerraMesh™ Mineral, which combines aesthetics and technicality. It is perfectly adapted to carry out this type of work of a significant height by accepting strong solicitations. Mineral TerraMesh™ structures consist of a reinforcing layer of double-twisted wire mesh placed horizontally in the backfill and returned to the facing. The facade is lined with a 50x100 mm welded mesh panel identical to those used for the Gabion™s, thus allowing visual homogeneity with the Gabion™ cladding conducted at the head of the concrete abutments. The double twist mesh is coated with a polymer enabling it to resist the chemical aggressiveness of treated soils. Paragrid™ 50, 100 and 200 high-performance reinforcement geogrids were inserted into the backfill in addition to the double twist mesh layers. The use of materials from the site to constitute the backfill during construction has enabled savings and a limited carbon footprint. The work was implemented by the Maccaferri team, under Asqual ROG certification (Realisation of Structures in Gabion™s).

2016
Siena - Grosseto, Italy

RETAINING WORKS E78 SIENA – GROSSETO

One of the italian largest infrastructures built during the last few years

Client: **ANAS**
Designer / Consultant: **NUOVO FARMA SCARL**
Contractor: **GRAVIER TP**
Products used (Qty.): **TERRAMESH™ GREEN 30,000 m²**
Date of construction: **03/2013 - 03/2016**

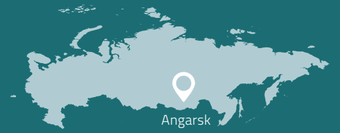
3

Engineering challenge

The Great Communication Road (SGC) E78 was one of the largest infrastructures built in Italy in the last few years, it connects the Tyrrhenian coast to the Adriatic one. The structures of this case history where all located on the Tyrrhenian side in the provinces of Siena and Grosseto. The enlargement of the embankments, or their construction from scratch, since they are situated in areas prized from a naturalistic point of view and highly frequented by tourists, required the use of a system that was effective, quick to implement and environmentally compatible.

Our solution

About 30,000 square meters of exposed façade were created using TerraMesh™ Green combined with high geogrids Paralink™ resistance used to support road embankments. The green facing of the TerraMesh™ system has given an excellent insertion from the point of view environmental and effective masking of the work. There combination of TerraMesh™ Green with geogrids Paralink™ allowed the construction of very high embankments with a high structural strength.



2018
Angarsk, Russia

EMBANKMENT IN ANGARSK

The bank protection for frequent floods

Client: **ADMINISTRATION OF THE ANGARSK CITY DISTRICT**
Designer / Consultant: **LLC "SPEKTR"**
Contractor: **SIBNA LLC**
Products used (Qty.): **TERRAMESH™ SYSTEM 6,822 pcs**
Date of construction: **06/2017 - 12/2018**

3

Engineering challenge

Kitoi is a river flowing in the Irkutsk region and Buryatia, 316 km long. The largest settlement in Kitoi is the city of Angarsk, located at the mouth of the river. According to the nature of the current, Kitoy is often affected by summer, and sometimes spring, floods. Particularly in 2001 one of the most sever flood affetcted the Angarsk municipality for a total damage of more than 251 milion rubles with hundreds of buildings flooded.

With each flood, Kitoy took tens and hundreds of meters of land from Angarsk. Due to the heavily crumbling coast, some houses in the microdistricts of Staritsa and Kirova stood a few meters from the cliff. In order to protect the city from the negative impact of the river during the floods, the administration of the Angarsk urban district decided to strengthen the eroded coast and build a protective dam on it.

Our solution

To strengthen the crumbling coast the designers of Spektr LLC chose the installation of a reinforced earth retaining wall with the TerraMesh™ system. The bank protection of the river was carried out at two sites: the village Kirov with a lengh of 400 m and the oxbow lakes with a lengh of 800 m.
The TerraMesh™ system turned out to be the most optimal solution for strengthening the eroded coast. The flexibility, permeability of the structure and the use of geotextiles in the backfill allows the system to operate as efficiently as possible in the aquatic environment, which is especially important in areas of periodic flooding. As a channel control structure, the TerraMesh™ system limits the impact of the river's flow and thus prevents bank erosion and washout.
The protective dam part of the project was also built with Maccaferri's products with two Gabion™ tiers of 6 m height and separated by an intermediate berm for the future pedestrian zone of 10 m wide.
In addition to the immediate task of bank protection, the dam will make it possible to equip a place of rest for the townspeople. An observation deck, family recreation areas, children's playgrounds, and paths for cyclists will be created on the embankment.

2011
Istanbul, Marmara, Turkey

ATAŞEHİR MİMAR SİNAN MOSQUE

An easy access to one of the largest mosques in Istanbul

Client: **EMLAK KONUT**
Designer / Consultant: **MACCAFERRI TURKEY**
Contractor: **GÜRYAPI İNŞAAT**
Products used (Qty.): **TERRAMESH™ GREEN 1,400 m²**
Date of construction: **03/2011 - 05/2011**

3

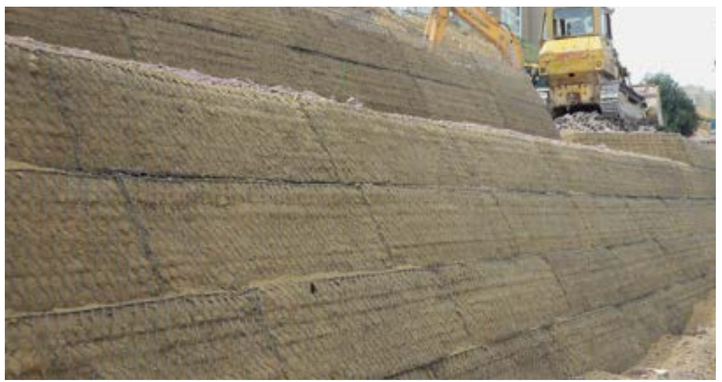
Engineering challenge

The Mimar Sinan Mosque is one of the largest mosques in Istanbul, located in the Ataşehir district of Istanbul province; it was commissioned by the Turkish government and designed by architect Hilmi Şenalp to honor of the famous Ottoman architect, Mimar Sinan. Within the scope of the Mimar Sinan Mosque project the need for a retaining wall on the TEM highway side of the mosque arose. The aim was to control the slope and to create a platform for the road by building a retaining wall in the sloped area where the mosque's parking road and access road to the mosque are located. However, in the landscaping works within the project, the concrete surface did not fit the concept, if a reinforced concrete retaining wall was to be built, it would have negatively affected the architectural appearance of the mosque. The reinforced concrete retaining wall couldn't give the desired image, and the reinforced concrete retaining wall needed additional ground improvements due to the weakness of the ground.

Credit: www.gursoyrestorasyon.com

Our solution

In the first meeting with the contractor, considering the problem and the requests of the employer, it was revealed that among the Maccaferri solutions, the most suitable choice was the TerraMesh™ Green retaining wall with geosynthetic reinforcement. Architectural details were prepared in line with the demands of the employer, and static and seismic calculations were made by following to this architectural concept. In addition, a drainage project had been prepared due to the high groundwater level. Although the total wall height is 15.00 m, a wall analysis had been made in 3 stages with variable cross-sections. Each stage was 5.00 m high for a total length of the wall of 250.00 m. TerraMesh™ Green modules were used on the front of the wall, while the Paragrid™ 80 geogrid was placed at every 0.76 m as the main carrier. As for the material used in the structural filling, upon the request of the employer , it was used graywacke material from the foundation excavation of another construction site nearby. The material was deemed appropriate in the calculation after positive results of the laboratory tests. Finally, after the TerraMesh™ Green retaining wall application was completed, spray grass was applied to the front surface of the wall.



2011
Sásová, Banská Bystrica, Slovensko

R1 BANSKÁ BYSTRICA-NORTHERN BYPASS, SO 262-00 RETAINING WALL AT THE CIRCULAR INTERSECTION

A reinforced retaining wall to sustain a road embankment

Client: **GRANVIA, A.S.**
Designer / Consultant: **GRANVIA CONSTRUCTION S.R.O**
Contractor: **DOPRAVOPROJEKT A.S.**
Products used (Qty.): **TERRAMESH™ GREEN 1,200 m²**
Date of construction: **05/2010 - 07/2011**

3

Engineering challenge

Banská Bystrica is a city in central Slovakia located on the Hron River in a long and wide valley encircled by the mountain chains of the Low Tatras, the Veľká Fatra, and the Kremnica Mountains. Banská Bystrica is a popular winter and summer tourist destination. Due to the need to build a roundabout on the road to the city hospital, it was necessary to build an embankment. Since there were large differences in height the realization of a classic embankment body was not the most suitable; for this reason it was proposed to build a reinforced retaining wall under the embankment. The retaining wall in the roundabout is designed as a reinforced wall with TerraMesh™ Green and geosynthetics.

Our solution

The reinforced wall is made of face prefabs, uniaxial flexible geogrids and backfill soil. The face prefabs are inclined at 60°. The prefabs are formed by a double-twisted hexagonal mesh of the 8x10 type, wire diameter 2.7/3.7 mm, surface treatment Galmac+PVC, with a height of 0.58 m. The face of the wall in its final state is green. The width of the prefabs is identical to the anchor length and is 3.0 m. The maximum height of the wall is 9.92 m. The wall is designed as a two-step, copying the route of the road to the hospital and a circular intersection with a 2.0 m wide slat at a 3% slope. The maximum height of the first level is 5.22 m, the second is 5.8 m. The reinforced wall protrudes on both sides and cuts into the original terrain. The length of the wall is 168.0 m. Uniaxial flexible Paragrid™ geogrids are used to ensure overall stability. The geogrids are connected to the face prefab using an overlap of a minimum length of 3.0 m.

2010
Pasco, Pasco, Peru

TERRAMESH™ SYSTEM STACKER ZONE – EL BROCAL

A 16 m high wall in soil reinforced with TerraMesh™ System

Client: **SOCIEDAD MINERA EL BROCAL S.A.A.**
Designer / Consultant: **BISA**
Contractor: **JJC - SCHRADER CAMARGO SAC**
Products used (Qty.): **TERRAMESH™ 32,280 KG - MACTEX™ 4,600 m² - MACGRID™ WG 7,725 m²**
MACDRAIN™ 1,320 m²
Date of construction: **06/2010 - 10/2010**

3

Engineering challenge

Sociedad Minera El Brocal S.A.A. carries out its operations at the Colquijirca mining units and at the Usina Huaraucaca Concentrator, located in the District of Tinyahuarco, Province of Pasco (4300msnm). Due to the increased of exploration activities the company decided to build a Stacker zone, which was executed by JJC – Schrader Camargo SAC. Even if the slope resulting from the cut was in a critical condition of stability, the results significantly reduced a stacking area of a high-density mineral.

Our Solution

Faced with the problems presented, the mining company needed a solution that would protect the Stacker surface and, at the same time, generate a larger area to stack minerals above containment. To control slope instability, it was proposed to construct a 16 m high wall in soil reinforced with TerraMesh™ System. This wall generated a gain of area at the top of the slope of 2,100 m², which is manly used for storage of material with a density of 3 ton/m³; the project considered a stacking height up to 8 m. Macgrid™ WG Geogrids were used in conjunction with the reinforcement of the TerraMesh™ elements, forming the containment. As the wall in reinforced soil is a flexible structure, it is suitable to withstand possible accommodations that may occur in the foundation.

2016
Chilpancingo, Guerrero, México

ROAD STABILIZATION FRACC. BLUE RIVER

An environmental friendly, economically advantageous and stable solution

Client: **EDIFICADORA Y PROMOTORA PATRIMONIO SEGURO S.A. DE C.V.**
Designer / Consultant: **MACCAFERRI**
Contractor: **EDIFICADORA Y PROMOTORA PATRIMONIO SEGURO S.A. DE C.V.**
Products used (Qty.): **TERRAMESH™ 616 m³ - MACGRID™ 10,530 m² - MACTEX™ 1,600 m² MACDRAIN™ W 120 m²**
Date of construction: **05/2016 - 10/2016**

3

Engineering challenge

During the construction of social housing, the director responsible for the work detected the need to protect the main road of the Río Azul Second Stage subdivision with a containment structure to guarantee vehicular traffic and avoid any risk. Therefore, different containment options were evaluated, among which two stand out a reinforced concrete structure and the construction of a mechanically stabilized wall.

Our solution

The challenge was of a high level due to the uneven topography of the site, which had very steep slopes (pronounced 16% near the cliff). Thanks to its flexibility, easy construction and use of natural material from the area, it was decided to build an MME with a stone face, TerraMesh™ System.

The main reason for the choice were the fulfilling of the technical stability requirements, the environmentally friendliness as well as the economic advantages. In this way, a wall 11.2 m high was projected and built in the critical part with a length of 93 m.

2008
Concepción, Junin, Peru

GROWTH OF SINAYCOCHA TAILING PRESSES

A fast and safe solution

Client: **COMPAÑÍA MINERA SINAYCOCHA**
Designer / Consultant: **GEOSERVICE INGENIERIA**
Contractor: **COMPAÑÍA MINERA SINAYOCHA**
Date of construction: **10/2007 - 01/2008**

3

Engineering challenge

The Sinaycocha Mining Company decided to carry out the regrowth of the tailings dam located within its production facilities. The mine is located in the department of Junín 4,2000 m.a.s.l, which despite being small in size (5,000 inhab.), it is of great historical importance, since it was the place where Simón Bolívar obtained the decisive victory that put an end to the Spanish domination over Peru. The original dam was designed and built under the conventional system using an earthen dam reaching a height of almost 20 m in its highest section and with slopes of 1.5H:1.0V. The mining unit required a growth system built safely and in the shortest possible time due to the increase in its production capacity.

Our solution

The Geoservice company, responsible for the design and supervision of the project, with the support of Maccaferri, proposed a growth system through a structure reinforced soil with TerraMesh™ System. A 6.00 m high wall was designed which closes the entire dam perimeter. Additionally, the dam vessel was waterproofed with an HDPE geomembrane in order to prevent seepage into the body of the dam.

2018
Fraser Canyon, B.C., Canada

SLIDE 5 EMBANKMENT, TRANS CANADA HIGHWAY #1

An ambarkment able to withstand a maximum rockfall impact energy of 10,000kJ

Client:	**BRITISH COLUMBIA MINISTRY OF TRANSPORTATION**
Designer / Consultant:	**MACCAFERRI CANADA LTD.**
Contractor:	**GABLE CONSTRUCTION / GABION™ WALL SYSTEMS**
Products used (Qty.):	**TERRAMESH™ 96 m**
Date of construction:	**07/2018 - 08/2018**

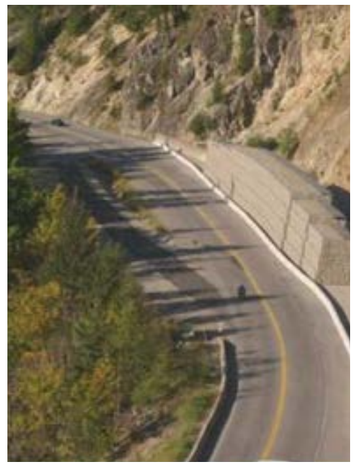
3

Engineering challenge

Initially constructed in 1958, this section of the Trans-Canada Highway #1 through the Fraser Canyon, located approximately 53km east of Hope, BC, began displaying signs of instability shortly after completion. Over 40 years, the slide scarp has regressed approximately 200 m. In 1961, a low height (2.4 m H x 255 m L) concrete barrier wall was constructed for rockfall protection (referred to as the Ferrabee Wall). In 1976, the highway was relocated in order to provide an additional 10m of rockfall catchment area. Since 1966, there have been over 60 rockfall events. The catchment area behind the existing wall varies in width from 8m to 22 m. In 2005, the British Columbia Ministry of Transportation (BC MoT) determined that a new rockfall protection structure was required at the narrowest point along the length of the concrete wall.

Our Solution

In January 2006, BC MoT approached Maccaferri in order to discuss the feasibility of designing a rockfall embankment for this site. Simulations and rolling rock tests conducted by BC MoT resulted in a series of design parameters that required that the structure must start at 6m in height and increase to 8m, have a maximum base width of 7 m, and be able to withstand a maximum rockfall impact energy of 10,000 kJ. Previous design concepts considered for this site included rockfall catch fences, but currently no catch fence systems are rated for 10,000kJ design impacts. The length of the structure was a set at 96 m. Maccaferri proposed using a TerraMesh™ System reinforced earth embankment for the basic structure on the site. The TerraMesh™ System was then modified to have a single unit, double side woven wire Gabion™ facing and to be a free standing structure. The width of the structure was partially dependent upon the impact conditions resulting from a 10,000 kJ impact on the structure. The custom TerraMesh™ System Units were ordered by BC MoT in late 2007. The installation contract was tendered and awarded to Gable Construction. Specialist constructor Gabion™ Wall Systems was sub-contracted to handle the installation of the TerraMesh™ System.



2021
Cayey, Puerto Rico

ACCESS ROAD DOPPLER RADAR CAYEY PUERTO RICO

Recovering after hurricane Maria

Client: **FEDERAL AVIATION ADMINISTRATION**
Designer / Consultant: **MACCAFERRI IN HOUSE DESIGN SERVICES**
Contractor: **MELENDEZ CONTRACTORS**
Products used (Qty.): **TERRAMESH™ 290 m²**
Date of construction: **08/2021 - 09/2021**

3

Engineering challenge

Just before 6 a.m. on September 20th, 2017 Hurricane Maria a Category 5 with violent winds slammed into the island demolishing the FAA Doppler Radar Dome and ripping it from its mountings. Hurricane Maria and its 190 km/h winds demolished this radar that forecasters and mariners used to monitor storms and navigate the Caribbean Sea. The radar was critical to determining rain intensity and path, which was vital to residents of the island, especially during hurricane season. A huge void had been left between Antigua and Cuba with no available radar in the eastern Caribbean Sea. The access road to the radar location experienced a landslide failure due to the mountainous terrain and extreme precipitation of up to 963mm that accompanied the hurricane. Impassable roads and bridges across the island would make the initial access to site and damage assessment difficult.

Our Solution

It was determined that a Mechanically Stabilized Earth(MSE) Rock Faced TerraMesh™ wall system was an ideal solution for this cut slope construction. This system of retaining wall has successful historical use in similar slope failures all across the island.It consists of a rock filled wire facing unit with dimensions of 2.4 m high by 0.8m deep, and a length along the front face of 2.7 m. Rockfill is comprised of size ranges of 100 mm to 200 mm. The coarser facing rockfill is separated from the structural backfill by use of a nonwoven geotextile(Mactex™ N47.1).The facing mesh is comprised of a double twist(DT) wire mesh, along with PoliMac coating for durability and longevity of the structure. The depth of burial in front of the wall is approximately 1.5 m, which is important when founding a wall on a sloping toe.All units are connected during installation to achieve the design intent of a monolithic mass retaining wall facing. The primary soil reinforcement noted at the base of the wall overlaps with the DT mesh on the lower return.The soil reinforcement is comprised of a WG11 uniaxial geogrid with an ultimate tensile strength of 110 kN/m. Geogrid lengths of 7 m are noted to extend to the cut slope face to ensure continuous soil reinforcement to the stable bank excavation.

2011
Calicut, Kerala, India

RETENTION WORKS FOR HAJJ HOUSECALICUT, KERALA, INDIA

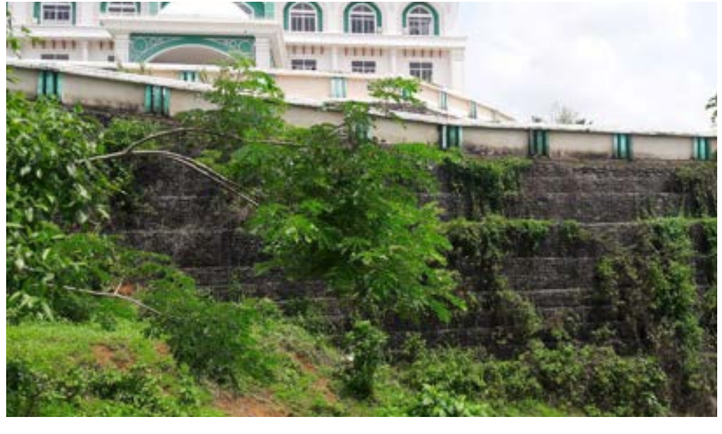
A Flexible structure with enough permeability to dissipate the excess pore water pressure

Client: **HAJJ COMMITTEE, KERALA**
Designer / Consultant: **MACCAFERRI ENVIRONMENTAL SOLUTIONS PVT. LTD**
Contractor: **NIRMAAN CONSTRUCTION PVT. LTD**
Products used (Qty.): **TERRAMESH™ 1,000 m²**
Date of construction: **02/2011 - 05/2011**

3

Engineering challenge

Hajj Committee constructed a Hajj house in Calicut, Kerala; near the building, there was high level difference between finished levels and the existing ground levels, varying from 8 to 13 meters along with an exposed rock at the existing ground level. As a temporary arrangement, soil was dumped on it. The dumped soil started to slide at various locations. Therefore, in order to protect the slope, a suitable retention measure was essential. The soil in the surroundings is lateritic in nature. In a place like Kerala where monsoons have heavy rains for continuous 3-4 months, there were many chances of reduction of strength (especially cohesion) for lateritic deposits. Lateritic soil has a complex characteristic of high shear strength in dry conditions which reduces drastically when in contact with water. Flexible structure with enough permeability to dissipate the excess pore water pressure, that may develop in retained fill, were the ideal solution.



Our Solution

Considering the heights to be retained, expected loads, site constraints and client requirements, Maccaferri proposed a Paramesh System which is very quick and easy to construct. Paramesh system consists of TerraMesh™ (Gabion™ facia units with an integrated double twist mesh) as secondary reinforcement and Paralink™ (geogrid) as a reinforcing element. Mactex™ N (Non-woven geotextiles) were used behind the Gabion™ facia units in order to act as a separator and filter, which allowed free movement of water and prevented backfill soil from entering in the voids between stone filling with TerraMesh™ facia. With Maccaferri's solution, client had to spend only half the costs when compared to a conventional alternative like a RCC wall. Simple drainage arrangements were provided on top of the slope and within the structure to cater to anticipated heavy pore water pressure.

2017
Runruno, Nueva Vizcaya, Philippines

FCF MINERALS SPILLWAY

A solution to support the residual storage impoundment (RSI) earth dam of the FCF mining company

Client: **FCF MINERALS CORPORATION**
Designer / Consultant: **GHD PHILIPPINES**
Contractor: **FCF MINERALS CORPORATION**
Date of construction: **06/2016 - 03/2017**

3

Engineering challenge

FCF Minerals Corporation, is a mining company, engaged in the exploration, development, and commercial operation of mineral claims. FCF Minerals Corporation operates gold and molybdenum minerals exploration in Runruno, Quezon, Nueva Vizcaya, Philippines. In 2016, in the mine a 40 meters-wide emergency spillway had to be designed to support the residual storage impoundment (RSI) earth dam of the mining company. For the project, a practical and economical design of the raised spillway was required. The design had to be able to maximize the use of existing soils in the project site.

Our Solution

The Project Consultant, GHD Philippines, designed a raised spillway for the customer. The said spillway was composed of a series of weirs to retard the flow velocity of the water in the hydraulic structure; for this reason, Maccaferri's TerraMesh™ System combined with Gabion™s were designed. TerraMesh™ units were mainly used for the construction of weirs, while Gabion™s were used to support both sides of the spillway structure as well as for the lining of the bottom width of the spillway.

The cascading steps and landing portions of weirs were capped with concrete for abrasion protection. Some portions on the sides of the spillway were reinforced with Maccaferri's Macgrid™ woven polyester geogrids to maintain stability. All backfill materials behind the TerraMesh™ units (along the main line of the channel) and those for the reinforced soil walls have been required to be compacted to a minimum 95% of MDD by Standard Proctor.

2017
Atimonan - Mauban, Philippines

ATIMONAN-MAUBAN PROVINCIAL ROAD

A longitudinal protection revetment structure with TerraMesh™ System

Client: **MERALCO POWERGEN CORPORATION (MGEN)**
Designer / Consultant: **GHD PTY. LTD.**
Contractor: **WAYCON BUILDERS & CONSTRUCTION SUPPLY**
Date of construction: **03/2017 - 11/2017**

3

Engineering challenge

An extension of the existing provincial road has been planned by Atimonan One Energy, Inc. (A1E) - a wholly owned subsidiary of Meralco PowerGen Corporation. AIE is the developer of an environment-friendly and state-of-the-art 1,200-megawatt supercritical coal-fired power plant in Atimonan, Quezon Province. The plant is expected to augment the power supply in the Luzon grid when it starts commercial operations. To provide access to the power plant, as well as to improve the road network in the town of Atimonan, the existing provincial road needed extension. As challenges are inevitable to every project, A1E engineers required cutting of rock outcrop and backfilling on the shoreline to construct the access road with its required elevation and geometry. Due to space constraint, a 160 meters long section of the shoreline required a revetment wall from STA 0+980 to STA 1+140, with average total height of nine meters.

Our Solution

Based on the data provided by the A1E engineers and in cooperation with Project Consultant (GHD Pty. Ltd.), Maccaferri recommended a longitudinal protection revetment structure following the concept of mechanically stabilized earth (MSE) and with the patented TerraMesh™ System product. The design has been proven to be structurally sound and economical and has met the tight construction schedule for the project. The reinforced structural backfill of the MSE wall was required to be compacted to minimum 95% of MDD by Standard Proctor. A buttress and scour protection using large-sized boulders was required at the toe as primary defence against waves.
The base of MSE wall was laid with Reno mattress for stabilization. Due to the sandy nature of the fill materials, the sub-surface drainage system in between the reinforced structural backfill and that of the cut soil surface was not required by the Consultant. The combined polymeric coating and Zinc+5%Aluminum provides optimum corrosion and abrasion-resistant protection to wires of TerraMesh™ System units. During construction, the MSE wall was tested by a local typhoon that flooded the town of Atimonan, Quezon, but the MSE wall remained still and without any damage.

2018
Obi Island, North Maluku, Indonesia

PARAMESH WALL (MSE WALL) AT NICKEL LATERITE SMELTER

A base foundation able to withstand the load of the new Smelter construction

Client: **JINCHUAN GROUP INTERNATIONAL RESOURCES Co. Ltd**
Designer / Consultant: **JINCHUAN GROUP INTERNATIONAL RESOURCES Co. Ltd**
Contractor: **JINCHUAN GROUP INTERNATIONAL RESOURCES Co. Ltd**
Products used (Qty.): **TERRAMESH™ 6,200 m²**
Date of construction: **06/2017 - 01/2018**

3

Engineering challenge

Nickel Laterite Project is a Nickel Smelter that located in Obi Island, North Maluku, Indonesia. New Smelter is planned to be built to increase the capacity of Nickel production. The client's purpose of this retaining wall structure is as a base foundation able to withstand the load for new Smelter construction.

Soil Retaining structures are varied from 5 m to 20 m in height. The area is characterized by a high seismic level and a horizontal seismic acceleration, equal to 0.25 g, had to be considered during the design process.

Our Solution

As the Client needed a solution that not as expensive as the traditional concrete retaining structure, Maccaferri proposed Paramesh System as a solution . Paramesh system is a retaining wall structure which is flexible, environmentally friendly, and cost-effective; especially if compared to traditional concrete structure. Paramesh system is a mechanically stabilized earth type soil retaining structure; it consist of a Primary reinforcement using Geogrid, followed by a secondary reinforcement of a TerraMesh™ made of double twisted wire mesh 8x10 with a coating of Galvanized and polymer steel wire, Mactex™ non-woven geotextile behind TerraMesh™ facia unit as separator, and a Macdrain™ as Geocomposite drainage to drain water from soil embankment.

Finally, all Stability checks of the structures in static and seismic conditions were performed using Macstar, an internally developed software by Maccaferri. Our solution does not require specialist contractor or labourer for construction and quality control on site is also always strictly monitored by Maccaferri Product assistance.

2017
Bekasi, West Java, Indonesia

RIVER BANK PROTECTION AT CITRAGRAN CIBUBUR

An environmental friendly solution to guarantee the safety of the Ciputra housing

Client: **PT CIPUTRA DEVELOPMENT TBK**
Designer / Consultant: **PT MACCAFERRI INDONESIA**
Date of construction: **06/2017 - 09/2017**

3

Engineering challenge

Ciputra, one of the biggest property developers in Indonesia, faced erosion issues for one of their new projects in Cibubur, West Java. Located not so far from the river, Ciputra needed to protect the access road from erosion and build the slope protection before a landslide came off and harmed the area. The high chances of a landslide were due to the combined action of the water flow and the heavy rainfalls saturating the clay soil of the slope. Rapid countermeasures to guarantee the safety of the housing area were mandatory.

Our Solution

Maccaferri as slope protection specialist provided a cost-effective, environmentally friendly, and tailored solutions for the client's problems. A 3.5 m high Gabion™-made retaining wall was used; the stability of mass gravity retaining walls relies upon the structural integrity of the units and their filled mass supports unstable earth slopes. In addition, as scour protection of the Gabion™ wall, Reno Mattresses® were placed at the toe of the gravity structure. A 7 m high of TerraMesh™ on the top of the structure was used as a reinforced slope to make the slope more stable. Maccaferri suggested TerraMesh™ because it combines the flexibility of soil reinforcement with the benefit of a modular system. Completed with Macgrid™® WG 15 as the primary reinforcement, it enables the soil to perform better than it would in its reinforced state and accommodate greater loads as well as stand at steeper angles. Soil slopes are subject to continuous erosion forces, whether natural or caused by man. For that reason, some form of erosion control was required. Maccaferri used MacMat® for the long-term erosion control to facilitate the reestablishment of vegetation on the slope. MacMat® is very helpful to decelerate the water flow during rainfall. All the stability checks were performed using the internally developed Maccaferri software (MacStars® W). The retaining structure stability was checked under both static and seismic conditions. Furthermore, the stability during soil excavation and construction phases had been verified. The construction works of the retaining wall lasted around 4 months.

2017
Bekasi, West Java, Indonesia

SAMPOERNA ACADEMY TERRAMESH™ GREEN

An environmentally friendly modular system solution for soil reinforcement

Client: **PT CIPUTRA DEVELOPMENT TBK**
Designer / Consultant: **PT MACCAFERRI INDONESIA**
Contractor: **PT. WIJAYA KARYA TBK**
Products used (Qty.): **TERRAMESH™ GREEN 4,000 pcs - MACGRID™ WG 8,000 m²**
MACDRAIN™ W 15,936 m²
Date of construction: **06/2017 - 09/2017**

3

Engineering challenge

Sampoerna Academy is an international school located at Sentul City, West Java, Indonesia. Sentul has a hilly topography, so the sport field of the school was constructed on a flat land as a result of slope cutting. Thus, the need of slope protection near the facility was required. The surrounding slopes around the field needed to be protected from the potential landslide and erosion. The slope which has sandy clay type of soil required protection from landslide and future erosion created by rain and surface water flow. The selection of the right solution is necessary to prevent failure by the presence of water. MSE Wall (TerraMesh™ Green) by Maccaferri was selected considering its flexibility and its ability of free drainage, allowing water to flow through the facing, and mitigating the excess pore water pressure of the structural fill. Furthermore, TerraMesh™ Green was chosen to be the facing / secondary reinforcement of MSE Wall considering its ability to grow vegetation (LCC – Legume Cover Crop).

Our Solution

MSE Wall structure by Maccaferri consists of TerraMesh™ Green and Macgrid™ WG 15 (Geogrid) as the main reinforcement. TerraMesh™ Green , that is fabricated from Galvanized (Zn) and PoliMac coated steel wire, acts as the secondary reinforcement or facia and Macgrid™ WG 15 (Geogrid) as the primary reinforcement, both works systematically along with the Well-Compacted Structural Fill to create a stable retaining wall structure. There is also Geotextile Non-Woven that works as a filtration layer between TerraMesh™ Green and Structural Fill, allowing water to flow out without carrying any soil particles. Macdrain™ W 1061 (Drainage Composite) works as subdrain layer between Structural Fill and Existing Backfill, providing a drainage for any incoming water from the rear of the structure. TerraMesh™ Green is chosen to be the facing due to its resistance to corrosion with the presence of PoliMac coated wire mesh that provides additional protection to the structure. TerraMesh™ Green is also considered to be the best solution because it is an environmentally friendly modular system used for soil reinforcement that permits a vegetative cover to be established rapidly.

2010
Antipolo City, Rizal, Region IV-A, Philippines

SUN VALLEY SUBDIVISION

The recovery of sun valley subdivision after storm ketsana

Client: **PIEDRAS NEGRAS CONSTRUCTION AND DEVELOPMENT CORPORATION**
Designer / Consultant: **PIEDRAS NEGRAS CONSTRUCTION AND DEVELOPMENT CORPORATION**
Contractor: **BC CUERPO CONSTRUCTION CORPORATION**
Products used (Qty.): **TERRAMESH™ 3,750 pcs - GABION™ 630 pcs - MACTEX™ 4,170 m²**
Date of construction: **01/2010 - 02/2010**

3

Engineering challenge

On September 26, 2009, the Philippines were devastated by a tropical storm Ondoy (or Ketsana, international name), with a record-breaking amount of rainfall that left damages on agriculture, lives, and properties in affected regions. One of the hardest hit areas was the province of Rizal; in the area the Sun Valley Subdivision, a residential community located in the mountainous landscapes of Antipolo City, Rizal was seriously affected. Typhoon Ondoy caused a landslide of about 15 meters in height below a portion of its major service road.

Our solution

After soil investigation and analysis, Maccaferri engineers designed a mechanically-stabilized earth (MSE) wall system composed of TerraMesh™ System units and Gabion™s. The structural integrity of the MSE wall was verified using Maccaferri's internal design software and was approved by the contractor's (Piedras Negras) engineers. TerraMesh™ units and Gabion™s provided a porous facing, and naturally blends with the green landscape of Sun Valley.

2005
Santiago de Chuco, La Libertad, Peru

PRIMARY CRUSHER, LAGUNAS NORTE PROJECT

A flexible system capable of withstanding higher loads

Client: **GRAÑA Y MONTERO CONTRATISTAS GENERALES**
Designer / Consultant: **ING. GERMAN VIVAR**
Contractor: **GRAÑA Y MONTERO CONTRATISTAS GENERALES**
Products used (Qty.): **TERRAMESH™ 25.5 TON - PARAGRID™ 7,605 m²**
Date of construction: **10/2004 - 02/2005**

3

Engineering challenge

Minera Barrick Misquichilca, one of the leading companies in gold exploration and exploitation, with the Lagunas Norte project, located in Alto Chicama, department of La Libertad, had the need to build a wall of soil reinforced 22.5 m high to generate an access platform for mining trucks. The problems that a wall of this height could generate required the use of a resistant and flexible system capable of withstanding the thrusts generated by themselves, by the loads imposed by the mining trucks and by the high seismic acceleration of the area. The company Graña y Montero, executors of the project, contacted Maccaferri to propose a design for the structure.

Our Solution

A soil wall reinforced with TerraMesh™ System was proposed, since the flexibility of the system was ideal for this project. The design was made by Maccaferri . The design was carried out with the help of the program MACSTARS 2000; for the proposed solution it was necessary to use of TerraMesh™ units with additional reinforcement of high resistance polyester geogrids Paragrid™ 200/15, reinforcement density was designed with the program mentioned. The wall was founded on a fill with compaction controlled; the structural fill material was rigorously selected and compacted up to 95% of Modified Proctor. On-site quality control was strictly monitored by the technical team of Maccaferri. The construction lasted 4 months with the work of the not high qualified labor from the adjacent communities in the area of influence of the mining project.

2018
Kaliapani, Jajapur, Odisha, India

PARAMESH WALL AT KALIAPANI CHROMITE MINES

A Paramesh wall designed to support the live load of heavy trucks

Client:	**BALASORE ALLOYS LTD**
Designer / Consultant:	**DGMS**
Contractor:	**Z-TECH INDIA**
Products used (Qty.):	**TERRAMESH™ 2,415 pcs - TERRAMESH™ GREEN 4,325 pcs**
	PARALINK™ 63,900 m² - MACDRAIN™ 16,500 m² - BIOMAC™ NATURAL 1,000 m²
Date of construction:	**04/2015 - 07/2018**

3

Engineering challenge

Kaliapni Chromite mines of Balasore Alloys Ltd. is situated in the state of Odisha and performs extraction of chromite. At present it has two plants with a total capacity of 160,000 MTPA. In open cast mines, the excavated waste material is dumped on the slopes. Hence, slope stability of overburden dumps is integral to the mine operations. Waste dumps have steep slopes due the waste being tipped over from the top of the dump. These unstable slopes along the roads to the mines are prone to subsidence, which can become a safety hazard and affect accessibility to mines. The heavy machinery and dumping trucks implanted for the extraction and transportation of materials add to the slope instability. Client was looking for innovative solutions for stabilizing the OB dump with suitable slope protection/retention system.

Our Solution

Reinforced soil wall was considered as an ideal solution. Paramesh wall system consisting of TerraMesh™ (Gabion™ facia units with an integrated double twist mesh) fascia and Paralink™ (geogrid) as a reinforcing element was installed. The Paramesh wall is built around the OB dumps for the stabilization purpose. The maximum height of the wall is 31m. The wall is designed to support the live load of the heavy trucks used at the facility. The truck's payload exceeds 22kPa. The main advantages for selecting the above solution were:

1. Flexibility: Flexibility of system helps the structure to accommodate differential settlement without any compromise in structural integrity.
2. Simplicity in construction: The construction is simple and fast. It does not involve deep excavation, dewatering of trenches and erection of formwork.
3. Cost-effectiveness: The total cost of Gabion™ fascia solution is less than rubble wall and R.C.C. wall. Also, minimum foundation is required.
4. Permeability: The ability to combine drainage and retention functions makes it an ideal structure.
5. Environmentally friendly: The system allows vegetation to grow through it. This further stabilizes the slope.

2010
Shaoxing, Zhejiang Province, China

ZHEJIANG SHAOZHU HIGH-SPEED GREEN REINFORCED GABION™ RETAINING WALL PROJECT

An environmental friendly and economic solution for a limited space area

Client: **SHAO ZHU HIGH-SPEED CONSTRUCTION HEADQUARTERS**
Designer / Consultant: **ZJIC (ZHEJIANG PROVINCIAL TRANSPORTATION PLANNING AND DESIGN INSTITUTE)**
Contractor: **ZHEJIANG COMMUNICATIONS CONSTRUCTION GROUP**
Products used (Qty.): **TERRAMESH™ GREEN 998 m² - MAC DRAIN® 500 m²**
Date of construction: **08/2010 - 10/2010**

3

Engineering challenge

The project is located on the right of section K38+325~K38+485 of the expressway from Shaoxing to Zhuji. Because of the limited space, the right side of the provincial road is close to the Shaoda highway. This solution also provided slope protection, saved land acquisition, and avoided the reconstruction of the old road. The project required a steep slope scheme with a slope as high as 9.88m. The project is located in a hilly area, with slightly undulating terrain. The ground is formed by shallow accumulation of thick layer of alluvial soil, with brecciated silty clay and clay containing gravel, between 9.8~15.1 m thick; with a bearing capacity of the foundation of 180-220kpa. The underlying bedrock lithology is grey-green, cyan gray sandstone and tuff, and the buried bedrock depth is shallow. The local structural development of this section is seriously affected by the structure, and the rock mass fractures are densely developed, all in addition to a strong weathering. According to the engineering geological conditions and engineering requirements of the project, it was decided to use TerraMesh™ Green steep slope. The reinforced steep slope shrunk the foot of the subgrade slope, saved earthwork, reduced land occupation, and avoided the reconstruction of the old road provincial road Shaoda line. At the same time, the safety and stability of the structure and the roadbed were increased.

Our Solution

The project was implemented in August 2010. The main construction process of reinforced soil steep slope was as follows: installation of foundation construction components, which consisted of earth filling and rolling.
After the reinforcement was laid, the soil filling started from the middle of the tensile reinforcement along the parallel wall gradually to the two ends of the filling, in order to ensure the uniformity of the tensile stress and to not squeeze the deformation of the tensile reinforcement to the wall, causing the wall tensile relaxation. Completed the soil filling, the soil was laminated by rolling, to ensure that the ground filling surface was flat. For the filler near the surface slope, light compaction machinery was used to ensure its compacting degree because the large roller couldn't be within 1m of the wall.
In the construction process of slope, the control of compaction degree is very important and it's tested according to the relevant standards to ensure the quality of the project. During the construction process, the green reinforced Gabion™ structure on the right embankment of K38+353 and K38+396 was also monitored. The monitoring content included horizontal earth pressure, vertical earth pressure, strain of reinforcement material and average strain of reinforcement body. The monitoring results showed that the horizontal earth pressure after unloading of the slope was very small, with maximum value of 4kPa. Due to the restriction of reinforcement, the lateral deformation of this structure is small, with a maximum value of 17mm, and occurs at 1/3H (H is the slope height). Moreover, structural deformation mainly occurs at the construction stage, and the deformation basically stops after the construction.

2014
Jianhe County, China

GUIZHOU QINGSHUI RIVER REVETMENT PROJECT

Creating a more ecological and livable environment

Client: **JIANHE COUNTY WATER CONSERVANCY BUREAU**
Designer / Consultant: **VTHOU QIANDONGNAN PREFECTURE WATER CONSERVANCY AND ELECTRIC POWER SURVEY AND DESIGN INSTITUTE**
Contractor: **HUNAN HENGCHU CONSTRUCTION CO,LTD**
Products used (Qty.): **TERRAMESH™ SYSTEM 6,000 pcs, RENO MATTRESS 10,000 m²**
Date of construction: **01/2013 - 12/2014**

3

Engineering challenge

The Qingshui River Flood Control Dike Project is one of key construction projects in Jianhe County to create an ecological and livable environment. The flood control embankment stretches for 7.5 kilometers from both sides of the river in Chuandong Village to Zhanjiajiang Village.
The river has a width of 200-450 m, the river valley is a symmetrical "U"-shaped valley on both sides, has a gradient of less than 1.1%, and a relatively slow water flow. The concave side (right side) eroded and formed deep grooves, while the convex side (left side) had a large amount of flood retention, and a seriously silted river channel.

The flood control infrastructure in this section of the river was weak and the flood control capacity was poor.
Every year a heavy rainfall produced rapid rise in water levels and washed the riverbank with sand and pressure, which damaged fertile fields, flooded residential areas, and suffered disaster every year.
However, in the economically developed and densely populated areas of Jianhe County, where the river passes, its geographical location and socioeconomic status are very important.
The existing flood control capacity couldn't meet the needs of social and economic development.

Our Solution

The left bank of the Qingshui River Flood Control Dike (Gedong Section) and the section from the highway intersection to the exhibition stand was mainly filled with embankments. Following the principle of "no damage and less damage is the greatest protection", the land occupation was reduced. After comparison and inspection of multiple schemes, the final decision ended up being the TerraMesh™ system combined with MacMat as slope protection and Reno Mattress as foot protection. The elevation of the top of the wall was set at the 2-year flood level, and a hydrophilic platform was set here. The slope ratio of the retaining wall was 1:0.25. The TerraMesh™ wall from the top of the slope adopts the ecological slope protection of MacMat R, and the slope ratio is 1:2. A 30 cm thick Reno mattress was laid in front of the steps in the middle of the TerraMesh™ wall and in front of the wall to prevent erosion. A Polyester long-fiber non-woven filter was laid behind the TerraMesh™ wall and at the bottom of the Reno Mattress.
The part of river section on the right bank of the Qingshui River Flood Control Dike (Gedong Section) eroded and with deep troughs was directly supported by TerraMesh™ system wall, and the upper slope was protected with MacMat R and Reno Mattress for ecological slope protection.

2021
Yueyang, China

YUEYANG 550KV POWER STATION TERRAMESH™ PROJECT

A stronger power grid structure for the whole province

Client: **STATE GRID HUNAN ELECTRIC POWER CO., LTD.**
Designer / Consultant: **CHINA ENERGY CONSTRUCTION GROUP HUNAN ELECTRIC POWER DESIGN INSTITUTE CO., LTD.**
Contractor: **CHINA ENERGY CONSTRUCTION GROUP HUNAN ELECTRIC POWER DESIGN INSTITUTE CO., LTD.**
Products used (Qty.): **TERRAMESH™ GREEN 170 pcs, PARAGRID™ 87,525 m²**
Date of construction: **11/2021 - 12/2021**

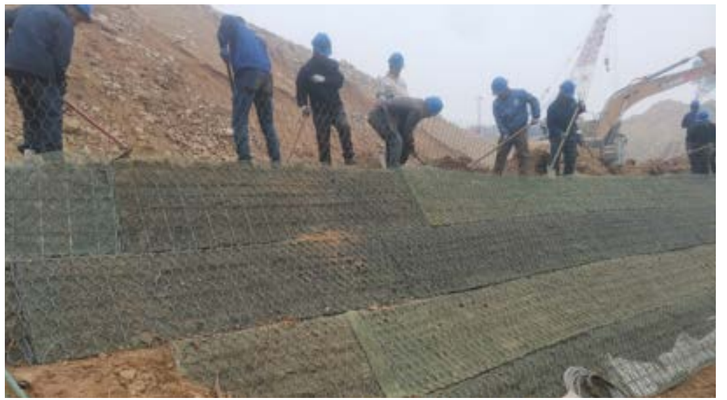
3

Engineering challenge

In the past, the Yueyang region faced the risk of power shortage. With the development of economy, the power load of the whole province kept increasing. The goal of the project was not only to make the electricity consumption of Yueyang region more reliable but also to make the power grid structure of the whole province stronger, even by providing strong power support for the economic take-off for the whole province. After the site of the proposed station site was leveled, higher artificial fill slopes were formed on the northeast side of the site and in the valley section of the west central part, with a maximum fill height of 30 cm. Due to the requirements of the layout of the general plan, there was not enough space for grading treatment at high slopes, and greening treatment was also required, and traditional concrete retaining walls were not suitable for such high fill slopes. The slope couldn't be supported in a timely and effective manner, and there was a risk of uneven settlement and slump. The customer unit needed to find a technically feasible, economical and reasonable solution.

Our Solution

According to the engineering geological conditions and engineering requirements of the project, the owner and the design unit comprehensively considered the economy, ecology and the overall force of the retaining wall and finally decided to adopt the TerraMesh™ retaining wall solution.
The retaining wall is composed of TerraMesh™ Green , TerraMesh™ system and Paragrid™. The main reinforcement of the reinforced soil adopts a high-strength fiber-plastic grid of 150~200 KN/m. The TerraMesh™ Green panel is composed of steel mesh panel, steel skeleton and geotechnical pad. The TerraMesh™ system adopts galvanized and high wear-resistant organic coating double-stranded hexagonal metal mesh as the face wall, which is set at the bottom of the structure to resist erosion. The interior of the reinforced Gabion™ wall is filled with stones, and the stones come from the waste stones after excavation of the slope (to meet the corresponding requirements); the structural fill is also made of weathered rocks and gravel slag after excavation (to meet the corresponding requirements). The material is used to save the project cost to a large extent. The maximum design height of the retaining wall is 22.65 m, and the slope form: from top to bottom, step by step, with a 2m wide horse track set at each level. The TerraMesh™ Green wall can be planted and greened by spraying and the slope ratio is 1:0.4. The slope body is reinforced with fiber-plastic grating, and the length of reinforcement is 11 m, 15 m, 18 m and 16m in sequence. The foundation of the reinforced soil slope is strongly weathered sandy slate. The drainage in the slope body is carried out by using the Macmat drainage pad after a reinforced soil combined with the gravel drainage layer at the bottom.



ENGINEERING CHALLENGE

1 2 3 **4** 5

Big projects, with dimensions between 5,000 and 10,000 m² of surface and heights up to 20 meters. During the design and execution phase further geotechnical and / or stability analyses were necessary; some projects also required particular attention in the drainage capacity of the structure.

2018
Prishtine, Kosovo

KOSOVO MOTORWAY PROJECT

Local key connection to Europe

Client: **REPUBLIC OF KOSOVO, MINISTRY OF INFRASTRUCTURE**
Designer / Consultant: **TEMPUS PROJECT LTD.**
Contractor: **BECHTEL ENKA GENERAL PARTNERSHIP**
Products used (Qty.): **TERRAMESH™ 7,133 pcs - PARALINK™ 43,980 m² - PARAGRID™ 77,695 m²**
MACTEX™ H 37,045 m²
Date of construction: **08/2017 - 10/2018**

4

Engineering challenge

This project has implied reinforced soil wall design, material supply and installation. The main contractor was Bechtel Enka general partnership. Bechtel Enka joint-venture completed Kosovo's first two motorways – Route 6 and Route 7. Route 6 Prishtine – Hani i Elezit is an integral part of road corridor which connects capital cities, Prishtine and Skopje (FYR Macedonia). The aim was to create a transport corridor from Kosovo's border with Albania, via its capital, to its border with North Macedonia. The four lane motorways are an essential part of Kosovo's national roads network. Other than the local key connection the motorways link also joins in with a major pan-European transport corridor, Corridor X, that connects Salzburg in Austria with Thessaloniki in Greece, crossing Slovenia, Croatia and Serbia, unleashing trade opportunities with the rest of Europe. The improved connectivity that the motorways bring to the Western Balkans and Western Europe is decisive for growth and jobs and will bring clear benefits for the region's economies and citizens. Furthermore to make the challenge harder the walls have been built in a seismic and mountainous area for a total of more than 13,800 sqm of reinforced soil facing.

Our solution

Mainly, seven Paramesh system walls have been built: WL 015, WL 024, WL 060, WR 131, WR 134, WR 139, WR 406. The main products used are TerraMesh™ System 3x2x0.5 and 3x2x1, Mactex™ H35.1, Paralink™ 500, Paralink™ 300 and Paragrid™ 150. The project also included Gabion™s walls, soil nailing with MacMat and rockfall protection. Most of the walls comprises of box culverts at the bottom for the runoff of water. The maximum height of the reinforced soil walls is nearly 25 meters.

2006
Egnatia-Odos, Anthohori, Greece

REINFORCED SOIL SUPPORTS NEW A2 MOTORWAY

One of the largest and most ambitious civil engineering projects of Greece

Client: **MINISTRY OF INFRASTRUCTURE TRANSPORT & NETWORKS**
Designer / Consultant: **MACCAFERRI**
Contractor: **J&P/AVAX**
Products used (Qty.): **TERRAMESH™ 8,000 m² - PARALINK™ 120,000 m² - GABION™ 990 m²**
Date of construction: **06/2003 - 10/2006**

4

Engineering challenge

The 670 km Egnatia Odos motorway is one of the largest and most ambitious civil engineering projects in Greece. The motorway runs across Northern Greece from east to west. It starts at Igoumenitsa and travels across the Prefectures of Thesprotia and Evros, to the village of Kipi on the Turkish border. On the Anthohori-Metsovo section of the new motorway, the alignment passes through some challenging topography. The mountainous territory required numerous tunnels, viaducts and embankments to be constructed. On this particular section a 50 m high structure was required to carry the highway into a tunnel section. The solution also had to have a minimal environmental impact with as small as possible land take. This section of the construction was awarded to contractor J&P Avax.

Our Solution

Maccaferri assisted the project team by providing feasibility studies, geotechnical design and on-site support services for the 50 m high embankment. The embankment was divided in two parts: the Lower 30 m – with a 3 x 10 m high cut slopes with intermediate terraces and the Upper 20 m a reinforced soil embankment founded upon the cut slopes beneath. The lower terraced slopes were cut from the existing ground profile and were provided as foundation for the reinforced soil embankment above. These cut slopes were protected by MacMat® R to prevent erosion and promote the establishment of vegetation. The 20 m embankment above was constructed from a Maccaferri TerraMesh™ and Paralink™ soil reinforcement 'hybrid' system. Paralink™ geogrids with an ultimate tensile strength of 400 kN/m were used as primary soil reinforcement.

2018
Bartin, Karadeniz, Turkey

KOZCAĞIZ DAM RELOCATED ROAD PROJECT

A long-term stabilization for the Kozcagiz Water Dam

Client: **YAPIYOL ALTYAPI İNŞAAT SAN. VE TİC. A.Ş**
Designer / Consultant: **MACCAFERRI TURKEY**
Contractor: **YAPIYOL ALTYAPI İNŞAAT SAN. VE TİC. A.Ş**
Products used (Qty.): **TERRAMESH™ 7,104 m² - PARALINK™ 7,104 m²**
Date of construction: **09/2017 - 05/2018**

4

Engineering challenge

The Kozcagiz Water Dam project is one of the biggest water related investments by DSI in the Bartin province, providing water to a total of 24.600 decares of agricultural area. The dam construction consists of clayish sand-gravel backfill and ends up in a total height of 54 meters. The aim of the Kozcağız Dam is the constant water supply of the agricultural Bartin region and additionally the protection of the region from floods and resulting damages. In scope of the Kozcagiz Dam project an additional construction of berms was required. Since the bottom section had to be permanently located under water, the berm type and supporting geosythetic materials were crucial for the successful and long-term stabilization of the system. Furthermore, in the foresight of possible instabilities and settlements of the ground, the system needed to perform on a high level.

Our solution

To face these challenges a TerraMesh™ system had been designed. For the TerraMesh™ system of the Kozcagiz Dam project, planary reinforcement materials with a high tensile strength in one direction and composite geosynthetic stripes were used. Regarding the settlement problems, a piling platform was constructed as base of the berm to stabilize the system. TerraMesh™ System berms were used with Doubletwisted Wire Mesh to provide a long-term service life; they had been also filled with hard rocks and supported by geosynthetic reinforcements.
This elastic system responds to the latest architectural requirements for retaining walls and faces problems like settlement successfully.

2015
Artvin, Karadeniz, Turkey

ARTVİN DAM TERRAMESH™ SYSTEM WALL APPLICATION

Our design for the embankments of the Demirkent village road

Client: **DSİ GENEL MÜDÜRLÜK**
Designer / Consultant: **MACCAFERRI**
Contractor: **DOĞUŞ İNŞAAT A.Ş**
Products used (Qty.): **TERRAMESH™ 11,010 m² - PARAGRID™ 70,000 m²**
Date of construction: **05/2014 - 02/2015**

Engineering challenge

The Artvin Dam is a dam with an arch-gravity architecture on the Çoruh River in Artvin Province, Turkey. The dam was built to produce hydroelectric energy and its power station has an installed capacity of 340 MW.
The Artvin Dam was built 30 km from Yusufeli, under the contractor of Doğuş İnşaat A.Ş. Due to the construction of the dam the Demirkent village road, that was situated below the water level of the current Artvin Dam Lake, had to be flooded, which arose the need of the construction of a new road, above the level of the newly formed basin. On the slope, which is generally made up of slope rubble, walls with a height of up to 25 meters were needed. Alternative retaining systems had to be used in this geography since the classical retaining system solutions were not possible due to the flow of groundwater from the slope depending on the season.

Our solution

Geosynthetic reinforced TerraMesh™ System retaining walls were chosen in the design of the embankments of the Demirkent village road in the area between the T7 and T8 tunnels, due to its flexibility, its drain-allowing structure and its economic advantages. Due to the high performance of this hybrid structure, which consists of a combination of geogrids and double-twisted wires, against deformation and settlement, it has been frequently used in reinforced embankment structures exceeding 15 m. This TerraMesh™ system retaining walls, which is the first application of its kind on highways, were designed by Maccaferri. During the design, the tunnel mat was used during the construction of the walls designed on the assumption that the backfill will be made with borrow material. The ground where the walls sit is slope rubble, and the wall foundations were placed on solid ground by digging. In this project, a total of 8 walls were built and a total of 11,010 square meters of TerraMesh™ system wall, supported with Paragrid™, had been fabricated.

2003
Maslenica, Croatia

ZAGREB—SPLIT MOTORWAY

Client: **HRVATSKE AUTOCESTE D.O.O**
Designer / Consultant: **INSTITUT IGH, D.D.**
Contractor: **KONSTRUKTOR SPLIT**
Products used (Qty.): **TERRAMESH™ 10,000 m²**
Date of construction: **2002 - 2003**

Engineering challenge

Zagreb – Split - Dubrovnik Motorway will be part of the Adriatic - Ionian Motorway. The motorway will be combined with the continental and Adriatic corridor, and it joins the Adriatic and the Aegean Sea. Alternatively, the infrastructure also connects the west European regions to the southeast Europe and Middle East. Lastly, the motorway links all Adriatic coastal areas and ports of the Republic of Croatia.
The section Tunnel "Sveti Rok" - Maslenica on motorway Zagreb –Split in Croatia passes through difficult mountain topography. On this section, which is 15 km long, the motorway descends from the altitude of 510 m to 90 m and alsocontains 3 tunnels and 4 viaducts. The terrain very steep and on 3 locations the cuttings are up to 50 m at one side of the road while the opposite side is on the embankment. In particular,on two of the locations where embankments had to be builtthe inclination of the terrain was up to 32° (1:1.6) and it was not possible to build embankments with the usual inclination (1:1.5), which would normally ensure slope stability for stone fill material.

Our Solution

In order to solve the problem of building embankments on a steep ground base at these two segments of the route, it was decided to build embankments with reinforcement. The Maccaferri TerraMesh™ System (TMS) was used for the construction. The face of embankment is formed by Gabion™s, which form blocks of 6m in height and have 2:1 face inclination. Blocks are divided from each other by berms, to reduce global inclination of the structure and correct geometry during the construction. The lengths of reinforcements used in embankments were 5, 7 and 9 m, while the height of Gabion™s is 0.5 m at lower part of the embankments and 1 m in the upper part. Overall, this was the demand of reinforcement density from stability analysis.
The finished project ends up having a first embankment of 176 m long with maximum height of 29 m and a second bigger one of 208 m long with maximum height of 30 m.

2011
Bologna - Firenze, Italy

VARIANTE DI VALICO

Green facing mask for the entrances of the tunnels

Client: **AUTOSTRADE PER L'ITALIA SPA**
Designer / Consultant: **SPEA**
Contractor: **VARI**
Products used (Qty.): **TERRAMESH™ GREEN 10,000 m²**
Date of construction: **03/2010 - 01/2011**

4

Engineering challenge

The "Variante di Valico" highway is an important work strategic for the connection between the North and the South of the country, playing a fundamental role for the mobility of people and goods between Europe and the Mediterranean. The enhancement of this stretch, which in 2015 recorded an average daily of about 96,000 vehicles, of which about 23,000 heavy vehicles, therefore represented an intervention priority in the framework of the network expansion plan of Autostrade per l'Italia. Over the years, Maccaferri has collaborated in the design and supply of materials for the retaining works, hydraulic protection and protection works from the falling rocks made in the Variante di Valico. In this specific case we only focused over the work done toward the mitigation of the visual impact of the tunnels concrete entrances.

Our solution

In the section the highway between Aglio and Barberino - Lot 12 there are several Reinforced lands with green facing to mask the entrances to the tunnels of the lot. In this context, TerraMesh™ Green was used in the sloping portals of the galleries that made it possible to minimize the environmental impact. In some cases, the base was made with the TerraMesh™ System with Gabion™ facing and the part in elevation with green facing.

2007
Hualgayoc, Cajamarca, Peru

PRIMARY CRUSHER, CERRO CORONA PROJECT

An access platform for trucks miners

Client: **GOLD FIELDS LA CIMA S.A.**
Designer / Consultant: **MACCAFERRI**
Contractor: **MWH**
Products used (Qty.): **TERRAMESH™ 25.5 TONS - PARAGRID™ 7,605 m²**
Date of construction: **09/2007 - 12/2007**

Engineering challenge

Minera Gold Fields La Cima is one of the world leading companies in gold mining, with a gold equivalent production of 2.2Moz. The project was located in La Cima's Cerro Corona mine, in Hualgayoc (department of Cajamarca), which needed to build a reinforced soil wall 16.5 m high in order to generate an access platform for trucks miners. The height of the wall required the use of a robust and flexible system capable of withstanding the thrusts generated by the wall itself, the loads imposed by the mining trucks and the high seismic acceleration of the area. Hatch company, project consultants, contacted Maccaferri to propose a design for the structure.

Our Solution

A soil wall reinforced with TerraMesh™ System was proposed, since the flexibility of the system was ideal for this project. The design was made by Maccaferri. The design was carried out with the help of the program MACSTARS 2000; for the proposed solution it was necessary to use of TerraMesh™ units with additional reinforcement of high resistance polyester geogrids Paragrid™ 200/15, reinforcement density was designed with the program mentioned. The wall was founded on a fill with compaction controlled; the structural fill material was rigorously selected and compacted up to 95% of Modified Proctor. On-site quality control was strictly monitored by the technical team of Maccaferri. The construction lasted 4 months with the work of the not high qualified labor from the adjacent communities in the area of influence of the mining project.

2018
Huaraz, Áncash, Peru

CORREDOR VIAL: CASMA – HUARAZ

A quick solution to recover from a platform loss

Client: **CONSTRUCCION Y ADMINISTRACION S.A.**
Designer / Consultant: **CONSTRUCCION Y ADMINISTRACION S.A.**
Contractor: **CONSTRUCCION Y ADMINISTRACION S.A.**
Products used (Qty.): **TERRAMESH™ 26.6 TONS - DRAIN PIPES 85.87 ML - MACGRID™ WG 10,530 m²**
MACDRAIN™ 2,340 m² - MACTEX™ N 6,006 m²
Date of construction: **03/2018 - 09/2018**

4

Engineering challenge

At the beginning of March 2018, a slope located in the Corridor Road: "Casma – Huaraz – Huari – Huaycabamba – Jircan – Tingo Maria – Monzon – EMP. PE – 18A" came off due to a seismic effect, reducing the section of the road and putting the rest of the structure at risk of imminent collapse. As this road is the main access road between the different points of the road corridor and having a strong pressure from the residents of the affected area, Provias needed a solution to recover the platform loss.

Our solution

The CASA company contacted Maccaferri, betting on our solution for the design and construction of a reinforced soil wall of 18 m high. The wall was built using the TerraMesh™ System, since the flexibility of the system was ideal for this project, and with additional reinforcement of uniaxial geogrids of 120 kN. For the design, the software MACSTARS 2000 was used. The wall was founded on a concrete conglomerate with controlled compaction; the filling material structural was rigorously selected and compacted up to 95% modified proctor.

2003
Pcia. - Mendoza, Potrerillos, Argentina

PERILAGO PATH

Our contribution to the reconstruction of route 82

Client: **DIRECCIÓN PROVINCIAL DE VIALIDAD DE MENDOZA**
Contractor: **UTE HOMAQ - ROVELLA - PAEDILLE**
Products used (Qty.): **TERRAMESH™ 3,965 m² - GABION™ 94,5 m³ - RENO MATRESS 2,190 m²**
MACTEX™ N 26,600 m²
Date of construction: **02/2002 - 07/2003**

4

Engineering challenge

For the construction of the Potrerillos dam in the province of Mendoza. The dam was built between 1999 and 2003 by a consortium consisting of Industrias Metalúrgicas Pescarmona (IMPSA) to provide flood control, hydroelectricity and irrigation water. The main problem was that in order to build the dam it was necessary to interrupt route 82.

This route connected the cities of the region, like Potrerillos and Cacheuta. Once the construction of the dam was finished, work began on the reconstruction of route 82 in order to restore the connection between Potrerillos and Cacheuta. The trace of route 82 was also redesigned to generate a tourist path in the perimeter of the lake (reservoir).

Our solution

The most adequate solution for the needs of the work was the reinforced soil. The structure was designed with TerraMesh™ System, the built wall has a maximum height of 15m and a 22° inclined vertical face. It was also necessary to provide protection at the foot with Reno® mattresses, in order to protect the structure from the effect of erosion from rainwater.

2021
Sonora, Zona Norte, México

TERRAMESH™ WALL FOR QUEBRADORA

A 10 meters access ramp for trucks

Client: **SILVERCREST METALS**
Designer / Consultant: **AUSENICO**
Contractor: **CIHUACOATL CONSTRUCCIONES**
Products used (Qty.): **TERRAMESH™ 380 pcs - PARAGRID™ 6,750 m² - MACDRAIN™ 180 m² MACTEX™ N 1,200 m²**
Date of construction: **02/2021 - 03/2021**

4

Engineering challenge

Within the development of the primary metallurgical process that includes a mining project is the installation of a mechanically stabilized wall that, in this particular case, as a topography that made it difficult to reach the upper level of the crusher where the trucks are intended to deposit the ore extracted from the mine by turning.

Our solution

The solution required an access ramp for trucks with a final height of approx. 10 m, which is appropriate based on the type of crusher to be used. The TerraMesh™ system turned out to be the best option because it used local stone to fill the stabilized wall. The incorporation of Macdrain™ 2L favoured the release of hydrostatic pressure, avoiding additional thrusts. The retention of the compacted soil was achieved thanks to the N50.2 geotextile, while the Paragrid™ HF 200 provided the necessary resistance to guarantee the internal stability of the system.

2021
San Tiburcio, Zacatecas, México

SPECIAL TMS WALL FOR THE CAMINO ROJO BREAKER

A new ramp for the primary crusher of the largest silver mines in Mexico

Client: **ORAL MINING**
Designer / Consultant: **AUSENICO**
Contractor: **CIHUACOATL CONSTRUCCIONES**
Products used (Qty.): **TERRAMESH™ 825 pcs - PARAGRID™ 27,402 m² - MACNET 3,500 m² MACGRID™ 592 m² - MACDRAIN™ 189 m² - MACTEX™ N 6,980 m²**
Date of construction: **05/2021 - 08/2021**

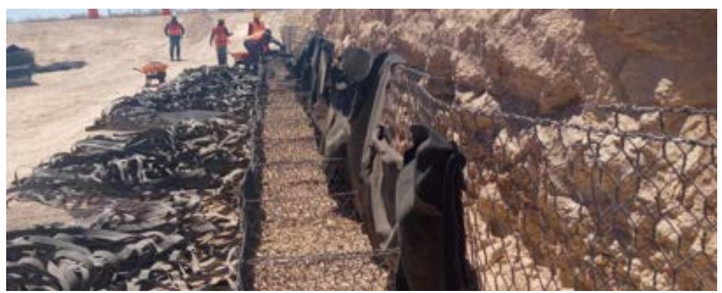
4

Engineering challenge

In the Camino Rojo mining project, there was a need to install a primary crusher as an initial step in its metallurgical process. The Camino Rojo mine, located in the center of the country in Zacatecas, is one of the largest silver mines in Mexico and in the world. For the installation of its crusher, it was necessary to design a wall for the cargo trucks to able to climb to the height of the crusher and deposit the ore to be broken by turning. The biggest challenge was the absence of material to fill the cells of the TerraMesh™ System due to its size of gravel with soil behavior.

Our solution

With the Geotechnical information provided by the consultant, a mechanically stabilized wall 62 m long and with a maximum height of 19.10 m was designed using the MacStars software. The lack of fill stone was addressed with EG rigid geogrids placed in the center of the TerraMesh™ cells, which were surrounded with MacNet to prevent gravel from leaking through the mesh diamond. The 80.1 geotextile wrapped the piece for retention of fine soil. High strength PG geogrids and 2L drainage were also installed.



2018
Guerrero, México

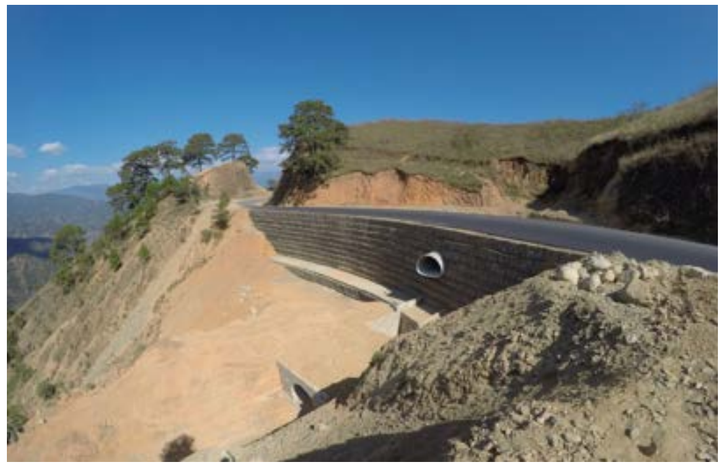
REHABILITATION WITH MME ON THE METLATÓNOC ROAD

A flexible and permeable solution able to withstand extraordinary hydrological events

Client: **SCT DELEGACION GUERRERO**
Designer / Consultant: **MACCAFERRI**
Contractor: **COMERCONSTRUYE DE MEXICO S.A. DE C.V.**
Products used (Qty.): **TERRAMESH™ 504 m³ - PARAGRID™ 7,326 m² - MACDRAIN™ 440 m² MACTEX™ N 1,200 m²**
Date of construction: **08/2018 - 12/2018**

Engineering challenge

Precipitation is extremely intense in the mountainous area of Tlacoachistlahuaca-Metlatónoc, in south-western Mexico. The area is characterised with uneven terrain and prone to continuous surface runoff of great magnitude, which triggers global failures. The metlatónoc road was directly affected due to the clogging of its storm sewer, which caused saturation of the ground and thus a partial rupture of the road body, disabling vehicular traffic in the region.



Our solution

Due to the topographic variation that favors extraordinary hydrological events, the best solution had to comply with being flexible to adapt to the possible deformations of the soil from landslides, as well as have a permeable side to favor the rapid evacuation of water. The TerraMesh™ reinforced soil system together with its complementary hydraulic works was the one indicated, with also its formation in berm walls that favored the safety factors. The final project has a length of 60m and total height of 10m, it is also reinforced with Paragrid™ 200 geogrid. Overall, it was the ideal configuration to guarantee the free transit.

2016
Sorel-Tracy, Quebec, Canada

SOREL SOUND WALL

A permanent, safe, efficient and cost effective solution to solve the noise and pollution issues for the residents of Sorel-Tracy

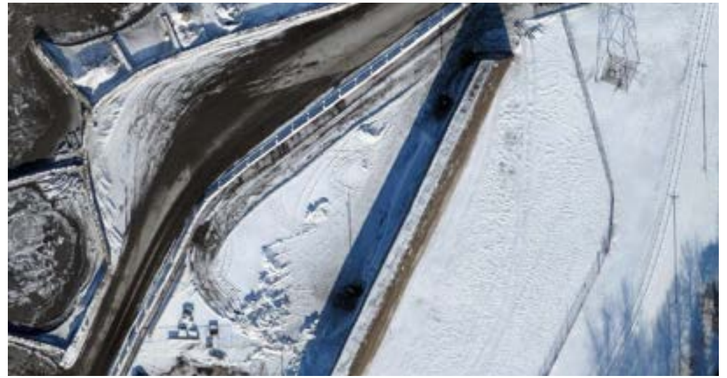
Client: **RIO TINTO, FER ET TITANE (RTFT)**
Designer / Consultant: **MACCAFERRI CANADA LTD.**
Contractor: **A. & J.L BOURGEOIS LTEE**
Date of construction: **11/2016 - 12/2016**

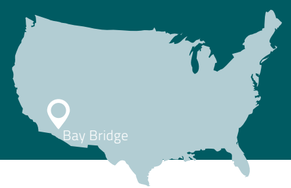
Engineering challenge

Sorel-Tracy is a small town located on the south shore of St. Lawrence River, roughly 75 km east of Montreal. The town has been home of Rio Tinto, Fer et Titane (RTFT) for many years. The RTFT is a big complex (with a capacity to produce more than one million tons of titanium ferrous slag annually), and is recognized around the world as the key supplier of titanium dioxide pigment; a compound used in paints, plastics, textiles and papers. Due to the nature of the facility, the residents of Sorel-Tracy have lived with noise and pollution issues. RTFT was looking for a permanent, safe, efficient and cost effective solution to solve the noise and pollution issues for the residents of Sorel-Tracy.

Our Solution

In order to facilitate RTFT's requirements, Maccaferri proposed TerraMesh™ Green (city side) and Terrawall System (plant side) as the most appropriate solution. In order to reduce the sound 7.5 m high and 64m long sound wall was required. TerraMesh™ Green was installed on the city side of the structure at 60° using Macgrid™ WG woven polyester geogrids as primary reinforcement within the slope. This proposal was selected as offering the optimal balance of value and function, meeting the clients objectives, including the vegetating slope face. The Terrawall System was installed on the plant side of the structure at 84° using Macgrid™ WG woven polyester geogrids as primary reinforcement. This proposal was selected for its ability to use the available recycled crushed concrete from the plant. Macgrid™ WG series geogrids are used predominately in Mechanically Stabilized Earth (MSE) and Reinforced Soil Slope (RSS) structures. Macgrid™ WG geogrids are made from high molecular weight, high tenacity polyester multifilament yarns. The yarns are woven under tension in the machine direction and finished with a polymeric coating. Macgrid™ is engineered to be mechanically and chemically durable, and resistant to biological degradation.





2017
Bay Bridge, California, U.S.A.

BAY BRIDGE, CALIFORNIA, 112-FOOT-TALL VEGETATED RSS

Our contribution to the Bay Bridge reconstruction

Client: **O.C. JONES & SONS, INC.**
Designer / Consultant: **MACCAFERRI, INC.**
Contractor: **O.C. JONES & SONS, INC.**
Products used (Qty.): **TERRAMESH™ 112 FOOT HIGH**
Date of construction: **02/2017 - 11/2017**

4

Engineering challenge

The Bay Bridge demolition and reconstruction required a reinforced soil slope in the final phases of the new bridge's construction. A reinforced slope was urgently needed behind the U.S. Coast Guard building that sits at water level on the southeast coast of Yerba Buena Island. The embankment confinement system (ECS) facing alignment was originally proposed to follow contours. However, the proposed slope of the contours varied from left to right and top to bottom, demanding custom manufacturing and complex construction.

Our Solution

Caltrans designed a 112-foot-high reinforced soil slope, sitting on top of a 21-foot-high TerraMesh™ system mechanically stabilized earth (MSE) wall at the bottom of the slope next to an existing Gabion™ gravity wall. Maccaferri manufactured all the ECS-related products as part of a $1.5 million contract with OC Jones. Maccaferri Inc.'s engineering team led the discussions with the contractor and Caltrans, and recommended alignment changes and a uniform slope to simplify the construction, saving the contractor time and money while maintaining the solution's quality and integrity. The project team reinforced the 112-foot-high slope with the TerraMesh™ Green ® system. The system's angled front face and erosion control blanket are designed to help establish natural vegetation. In addition to the slope's height and complex nature, the project team discovered underground obstructions that were remnants of the old bridge. The team had to figure out how to work around an existing drainage system, manhole drain inlets, and an electrical duct bank as well as numerous columns and foundations associated with the new bridge. Maccaferri's TerraMesh™ system and polymer-coated Gabion™s were used to form the TerraMesh™ system MSE wall at the slope's base. After the TerraMesh™ system and Gabion™s were installed at the bottom of the slope, the project team started reinforcing the slope using Maccaferri's TerraMesh™ Green system.

2012
Spurgeon, Indiana, U.S.A.

TRIAD MINING COAL MINE

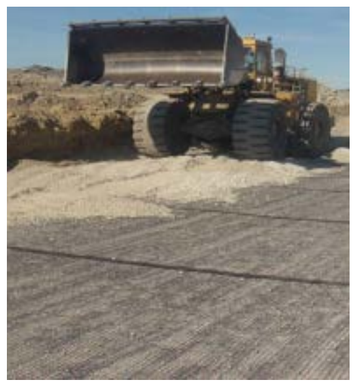
The expansion of the Triad Mining Indiana plant

Client: **TRIAD MINING, INC.**
Designer / Consultant: **MACCAFERRI, INC.**
Contractor: **TRIAD MINING, INC.**
Products used (Qty.): **TERRAMESH™ 17 m**
Date of construction: **08/2011 - 09/2012**

4

Engineering challenge

Triad Mining's growing coal mining field was expanding their plant in Indiana to include a Coal Mine Dual Hopper System. A wall was needed in order to support the loads of coal-filled trucks going up the hill to dump the coal into the hoppers. The trucks being used were Caterpillar 777D, an off-highway truck weighing 162,000 Kgs. A wall that could hold a truck of this weight with a full load of coal was needed.



Our Solution

Maccaferri designed a wall using the HITEC evaluated TerraMesh™ System because of its longevity and its ability to meet the design requirements of the project. The maximum height of the wall was 17 m. Triad was able to use on-site materials such as shale for the backfill, which eliminated the need to bring new material in, saving them time and money. With the on-site assistance of Maccaferri, Triad was able to utilize their own crew to construct the wall. Maccaferri provided training to the crew, which had no experience in this type of building application. The crew now has the experience and knowledge to construct future applications of this type. Construction of the wall started early in the morning and continued into the evening hours, using lights when it became dark. The crew consisted of approximately 5 workers and they were able to complete the construction in time to begin using the facility in May of 2012.

2014
Joda, Orissa, India

CRUSHER WALL AT SERAJUDDIN MINES (JODA), ORISSA

A flexible and stable 22 m high earth retaining structure.

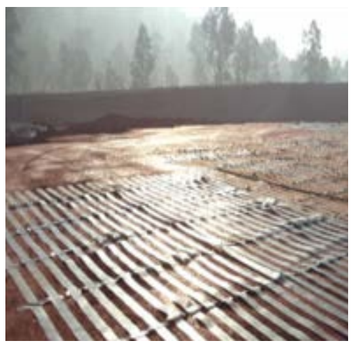
Client:	**SERAJUDDIN MINES**
Designer / Consultant:	**M/S THRIVENI EARTHMOVERS PVT. LTD**
Contractor:	**BC CUERPO CONSTRUCTION CORPORATION**
Products used (Qty.):	**TERRAMESH™ 1568 pcs - PARALINK™ 31,500 m²**
Date of construction:	**01/2014 - 03/2014**

Engineering challenge

The Serajuddin mines is a mining & metals company based out of Saheed Nagar, Bhubaneswar, Orissa in India. The mining company planned the construction of another central ore handling plant, consisting of screening, crushing and Grinding of iron. Part of the construction of the plant infrastructures at the Serajuddin Mines, at Joda, Orissa was entailed providing access to 22 m high loading bin at the primary crusher. The complications associated with such a high earth retaining structure required the wall to be flexible in nature since the wall had to accommodate excessive vertical and horizontal load (175 KPa and 900 KN respectively) imposed by heavy duty Caterpillar 785 mining dump trucks, as well as the presence of a layer of soil having low bearing capacity near base of the structure.

Our solution

A 22 m high vertical TerraMesh™ TM System wall was proposed. The inherent flexibility of the TerraMesh™ System TM made it an ideal choice. The design was carried out with in-house software MacStars W. High strength reinforcement was provided at every 1 m interval. Non-woven geotextile Terram 1000 was provided behind the Gabion™ facia units (TerraMesh™ TM) as separator. Reinforcement length at the main wall section about 16m. Once completed, the first TerraMesh™ TM wall (22 m high) in India as crusher wall had frontal face area 1771 m². A wing wall on each side of the main wall tapered off at a slope of 1V : 2H for an overall length of 82 m. The entire wall was founded on 1m thick replaced foundation soil strata. Only pre-approved selected soil was used as backfill operation and compacted to 95% (+/- 2%) proctor density. Quality control on site was strictly monitored.



2021
Lambagarh, Uttarakhand, India

MITIGATION OF LANDSLIDE ZONE AT NH-58, LAMBAGARH

Implementing slope stabilization solutions for landslide zone

Client: **NH-UTTARAKHAND PWD**
Designer / Consultant: **CASTA ENGINEERS AND BYUCKSAN INDIA PVT LTD JV**
Contractor: **MACCAFERRI AND BHARAT CONSTRUCTION JV**
Products used (Qty.): **TERRAMESH™ 16,825 pcs - PARALINK™ 2,90,520 m² - MACTEX™ N 45,080 m²**
Date of construction: **10/2016 - 02/2021**

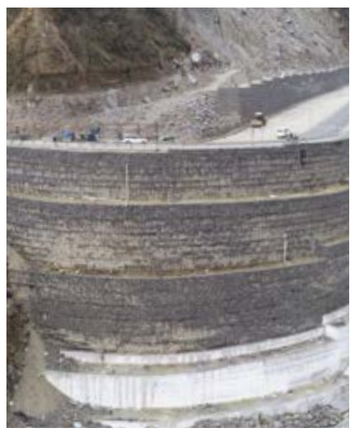
4

Engineering challenge

Lambagarh slide is located on NH-58, the road leading to the holy shrine of Badrinath which receives large number of visitors every year. The slide is very steep with an average inclination of 60°, near vertical at the crest and 34-38° below the road. Alaknanda river runs along the toe of the slide. Deep gullies can be seen on the face of the slide due to surface runoff, leading to erosion of fines, loosening of boulders, toe cutting and formation of overhangs. This area comes under chronic slip zone with slides hampering traffic every rainy season. In 2013, the road was badly damaged because of landslide caused by the flash floods. The main causative forces were:

- Toe erosion by river Alaknanda.
- Water seepage (glacier melting).
- Rainfall (triggers the surface erosion).
- Steep slope.
- Anthropogenic activities.

The site faced challenges of limited uninterrupted working period of only 5 months, clearances, maintenance of existing roads and slides on hill side. The client was looking for an effective and innovative solution to protect the road from landslides.



Our solution

Maccaferri worked in a JV to implement slope stabilization solutions for landslide zone between Km 504.00 to Km 505.00 on NH-58. It included shifting of the existing road from its current location through construction of a flexible reinforced soil wall (RS wall) with Gabion™s as facia (Maccaferri TerraMesh™ system- 3m*1m*1m and 0.5 m with 2 m long integrated tail) and high strength geogrid (Paralink™) as reinforcement towards the valley side. This counteracted the destabilizing forces due to heavy hill surcharge with seepage. The height of the wall varied from 27 m to 44 m for a total length of 500 m. The stones and backfill material for the wall were locally sourced hence making the solution economical and with a low carbon-footprint. Structure was protected from scour and boulder hit with RCC jacketing up to a depth 5 m below bed level. A rockfall embankment (using back to back TerraMesh™ and Paralink™ reinforcement) of 320 m length and 10m height was constructed at hill side toe to protect road from direct impact of falling debris and rocks. A new flexible pavement was also constructed as part of the project.

2015
Runruno, Nueva Vizcaya, Philippines

FCF MINERALS ROM PAD

A 29m-high reinforced soil slope with TerraMesh™ Green

Client: **FCF MINERALS CORPORATION**
Designer / Consultant: **PLANT & INFRASTRUCTURE ENGINEERING (PAIE)**
Contractor: **FCF MINERALS CORPORATION**
Date of construction: **03/2014 - 08/2015**

4

Engineering challenge

FCF Minerals Corporation operates gold and molybdenum minerals exploration in Runruno, Quezon, Nueva Vizcaya, Philippines. A 29 meters-high retaining structure was needed for the construction of the run of mine (ROM) pad. The structure was required to have a wide bench mid-height for servicing of heavy equipment.

Our Solution

Based on the data provided by FCF Minerals engineers and with the supervision of the Project Consultant (PAIE), Maccaferri engineers recommended a 29 m-high reinforced soil slope using TerraMesh™ Green as facing units and Macgrid™ woven polyester geogrids as main soil reinforcements. TerraMesh™ Green units promoted vegetation on the slope facing. The reinforced backfill of the structure was required to be compacted to minimum 95% of MDD by Standard Proctor. The height of the reinforced soil slope varied as it followed a safe angle for the ramp of heavy equipment located on its top. The design had been proven to be structurally sound and economical and met the tight construction schedule for the project. The remaining slopes immediate and terminal to the ROM pad had been built by compacting the backfill materials according to required density and relaxing the facing angle to less than 45 degrees. Maccaferri's biodegradable geoblanket made of coconut fibers (BioMac C) was used together with Vetiver and peanut grasses to control erosion and expedite vegetation.

2017
Tangerang, Banten, Indonesia

PARAMESH SYSTEM OF SOEKARNO HATTA RAILWAY PROJECT

An alternative transportation to reach Hatta International Airport

Client: **PT. KERETA API INDONESIA (PERSERO)**
Designer / Consultant: **PT. VIRAMA KARYA**
Contractor: **PT. WASKITA KARYA (PERSERO) TBK**
Products used (Qty.): **TERRAMESH™ 4-12 M HEIGHT, 2 KM LENGTH**
Date of construction: **01/2017 - 12/2017**

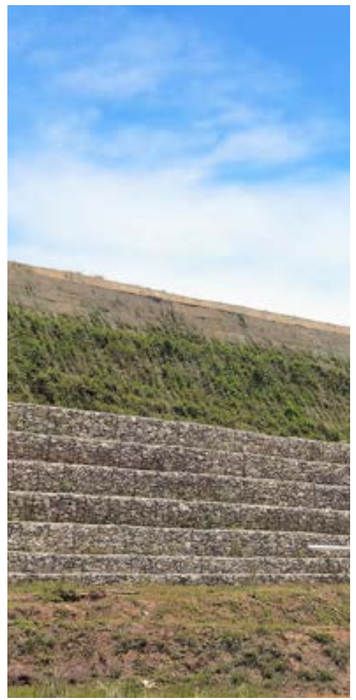
4

Engineering challenge

Soekarno Hatta Railway is an alternative transportation route to reach Soekarno Hatta International Airport (the most active airport in Indonesia). The railway is built at urban area with dense population and limited area of workspace; hence a steep slope of embankment had to be followed. The railway was also constructed on soft soil; therefore, a ground improvement solution had to be applied before the work of main embankment. Necessity of project completion under tight schedule and effective cost became an important aspect of using Paramesh – MSE Wall System (Retaining Wall) as the solution of the steep slope of embankment.

Our Solution

Following the described and identified problems, Paramesh – MSE Wall System was chosen compared to conventional method. Paramesh System by Maccaferri uses Paralink™ 300 (Geogrid 300 kN/m) as primary reinforcement, TerraMesh™ as facing and secondary reinforcement, Mactex™ MXS 250 as separator and filtration between the reinforced backfill soil and box of TerraMesh™. The designer has conducted the analysis using internally developed Maccaferri Software (Macstars W 4.0) and finite element software – Plaxis. The retaining wall stability was checked under both static and seismic condition along with the stability during soil excavation and construction phases had been verified. Maccaferri provided comprehensive services starting from design and planning stage with technical recommendation, manufacture and supply materials, and construction stage with Product Assistance. Most of the materials from Maccaferri are manufactured locally in Indonesia under International and National Standardization and verified by TKDN certificate.



2017
Batam, Kepulauan Riau, Indonesia

MSE WALL FOR ROAD REHABILITATION AT BUKIT KEMUNING

One of the favorite tourist attractions of the Batam community

Client: **MINISTRY OF PUBLIC WORKS**
Designer / Consultant: **PT BATAM STRUTTURALI ENGINEERS**
Contractor: **PT JATI RAJA KONTRAKTOR**
Products used (Qty.): **TERRAMESH™ 800 pcs - PARALINK™ 12,600 m²**
Date of construction: **07/2017 - 10/2017**

4

Engineering challenge

In 2016, there was a landslide at Jalan Bukit Kemuning, Batam caused by heavy rain that continued for two days in the hilly area. As a result, some houses adjacent to the road were severely damaged and several more houses were in danger should there be subsequent landslides. In addition, road access connecting the Tanjungpiayu area had also been cut off. The local government immediately took action to evacuate residents to safer areas and prevent further landslides from occurring. The slopes needed to be stabilized with retaining walls to provide safety for the road user and the surrounding community. Innovative solutions with fast installation were needed to optimize the soils from cut-slopes.

Our solution

Maccaferri proposed to use its innovative Paramesh system – an MSE (Mechanically Stabilized Earth) wall – as a solution to the landslide problem in Bukit Kemuning. Paramesh system consists of TerraMesh™ as a secondary reinforcement and high strength geogrid Paralink™ 300 as a primary reinforcement, with a tensile strength of 300 kN/m. The system has a Sub Drainage System using a 30cm thick rock layer wrapped with non-woven geotextile. Maccaferri provided comprehensive services starting from the design and planning stage with a technical recommendation, manufacturing and supply of materials, and construction stage with product assistance on the site. Most of the materials from Maccaferri are manufactured locally in Indonesia under national and international standardization. After the system's installation, the location of the previous landslide has become one of the favorite tourist attractions for the Batam community. People stop at the location to enjoy the view of the city of Batam in the afternoon and the number of visitors will much increase in the month of Ramadan. The local government also provides adequate culinary tourism facilities along with a safety fence on the roadside. Now people can safely enjoy the panorama at Bukit Kemuning.

2022
LanPing - Sanchongshan, China

LANPING LEAD-ZINC MINING SANCHONGSHAN DUMP RETAINING WALL PROJECT

The Pearl of the Plateau in the Northwest Yunnan

Client: **YUNNAN JINDING ZINC INDUSTRY CO. LTD**
Designer / Consultant: **KUNMING NONFERROUS METALLURGY DESIGN AND RESEARCH INSTITUTE**
Contractor: **YUNNAN JINDING ZINC INDUSTRY CO. LTD**
Products used (Qty.): **TERRAMESH™ AND PARAGRID™ 2,868 pcs**
Date of construction: **10/2021 - 12/2022**

4

Engineering challenge

LanPing County is very rich in mineral resources, mainly non-ferrous metal minerals. It enjoys the reputation of "Hometown of Non-ferrous Metals in Yunnan" and "Pearl of the Plateau in Northwest Yunnan". It is a key mining area on the "SanJiang Metallogenic Belt". The dump site is located in the sub-stable area of the crust and it's basically stable under the current situation. There are no unfavorable geological phenomena such as subsidence caused by tunnels left over from history and goafs in the mine, and it is suitable for capacity expansion. In order to ensure the smooth implementation of open-pit mining, various factors needed to bew taken into consideration such as waste rock transportation, land acquisition and relocation, safety measures, etc. After multi-level grading of the dump site with a height of more than 100 meters, it was necessary to set up a slag dam at the bottom to avoid occupying the ground of the boundary of the lower refractory ore storage yard and to further ensure the stability of the entire dump. The challenge consisted in the fact that if the slope of the high fill dump could not be supported in a timely and effective manner, a collapse was likely to happen. Therefore, the owner urgently needed to find a technically feasible, safe and economical blocking solution.

Our Solution

According to the geological conditions and engineering requirements of the project, the owner and the design unit comprehensively considered the economy and the overall force of the retaining wall, and finally decided to adopt the TerraMesh™ retaining wall scheme. The main characteristics of the project are:

1. The TerraMesh™ system slag dam is composed of reinforced Gabion™ and geogrid. The main reinforcement of the reinforced soil adopts a high-strength fiber-plastic grid of 150~200 KN/m. The reinforced Gabion™ adopts galvanized and high wear-resistant organic coating double-stranded hexagonal metal mesh as the face wall, and the inside of the face wall is filled with stone excavation. The structural fill is also made of waste soil, gravel and other materials, which are taken locally to save the project cost to a large extent.
2. The maximum design height of the retaining wall of the slag dam is 30 m. The sloped body is reinforced with fiber-plastic grilles. The length of the reinforcement in the dam body is determined by the top width of the reinforced Gabin slag dam of 5m, the bottom width of 53 m and the slope ratio of the inside and outside of the dam body.
3. Because the foundation trench is deep, the bank slope is high, the terrain is steep, and the physical and mechanical indicators of the stratum are low, the bank slopes on both sides needed to be excavated in steps.

2021
Yiyang City, Hunan Province, China

ANHUA ZIWEI MIDDLE SCHOOL PROJECT

A newly built public junior high school to accelerate the development of compulsory education

Client: **ZIWEI MIDDLE SCHOOL**
Designer / Consultant: **HUNAN PROVINCIAL SURVEY AND DESIGN INSTITUTE CO. LTD**
Contractor: **ANHUA DUOLING HUACHENG REAL ESTATE CO. LTD**
Products used (Qty.): **PARAGRID™ 100 68,850 m² - MACGRID™ WG15 19,575 m²**
TERRAMESH™ SYSTEM 1,137 pcs
Date of construction: **07/2021 - 09/2021**

4

Engineering challenge

A new public junior high school, Anhua Ziwei Middle School has been built in the Anhua country, Yijang city, Human Province. This school will not only solve the problem of large class sizes at the junior high school level in Anhua County once it is completed but will also make it much easier for junior high school students to enroll in the southern part of the county. It will also greatly improve the conditions of schools in the country and accelerate the balanced development of compulsory education.

The current situation of the project slope is the original mountain and the gully landform. Because of the requirements of the general map layout, it is necessary to landfill the southern gully of Ziwei Middle School, and the exit of the east side of the gully is the eastern road to the slope top comprehensive teaching building of Ziwei Middle School. This will form a high fill slope with a thickness of up to 60 m or more, and the slope length is about 100 m.

Our solution

According to the engineering geological conditions and requirements of the project, the client and the design unit comprehensively considered the economy, ecology and the overall force of the retaining wall and finally decided to adopt the composite reinforced Gabion™ retaining wall solution.
The ecological reinforced Gabion™ retaining wall is composed of Gabion™, reinforced Gabion™ and geogrid. The front of the retaining wall is a reinforced Gabion™ wall of one-meter-high. The lower 9m main reinforcement of the reinforced retaining wall adopts a two-way warp knit polyester geogrid of 150 KN/m; while a one-way fiber plastic geogrid of 100 KN/m is adopted above 9 m. The length of each main reinforcement is adjusted accordingly to the slope height and strength.
Based on the extremely high height of the fill, the vertical design of the structure adopts a segmented design, and according to the spatial distribution of each structure in the area, double to multiple rows of cantilevered anti-slip piles are adopted below the elevation of 130.0 m on the slope. The filled slope above 130.0 m elevation is supported by reinforced Gabion™ stone cage and geogrid.

2019
Beijing - Zhangjiakou, China

BEIJING-ZHANGJIAKOU HIGH-SPEED RAILWAY PROJECT

Our contribution to the world's first driverless high-speed railway

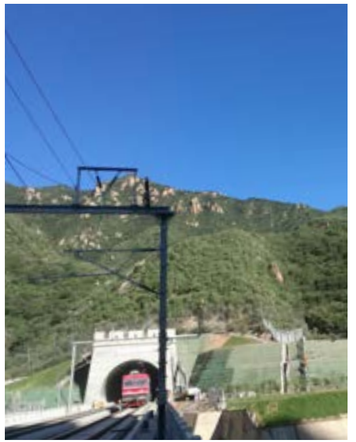
Client: **BEIJING RAILWAY BUREAU GROUP CO. LTD.**
Designer / Consultant: **CHINA RAILWAY ENGINEERING DESIGN CONSULTING GROUP CO. LTD.**
Contractor: **CHINA RAILWAY SIXTH AND FIFTH BUREAU GROUP CO. LTD. - CCCC SECOND NAVIGATION ENGINEERING BUREAU CO. LTD.**
Products used (Qty.): **TERRAMESH™ GREEN 3,429 pcs - MACTERRA 5,523 m²**
Date of construction: **07/2019 - 09/2019**

Engineering challenge

The Beijing-Zhangjiakou high-speed railway was opened on the 30th of December 2019, and is the world's first driverless high-speed railway, shortening the traveling time from Beijing to Zhangjiakou from 3 hours and 7 minutes to only 47 minutes. The project is located on the core of China ecological scenic spot, and because of that the landscape requirements are extremely high. Furthermore, the excavation within the tunnel entrance area is steep and the slope is rocky, so it is very difficult for the vegetation to survive. Moreover, the project is in the arid area of northern China, where the survival rate of green plants is low. Lastly, the terrain was steep and the construction site was narrow, which overall made the construction challenging.

Our Solution

Considering the engineering characteristics and landscape needs, Maccaferri recommended the TerraMesh™ Green wall and MacTerra greening solution. The slope ratio of the TerraMesh™ Green wall was built to be 1:0.466, each wall was divided into 3 to 4 levels according to the scene for a total level height of 3.65m. In some parts with steep terrain and insufficient land area, soil nailing and TerraMesh™ Green system solution were used to reduce the excavation of the original slope.



2014
Sanming, Fujian, China

FUJIAN SANMING AIRPORT TERRAMESH™ RETAINING WALL PROJECT

6-level reinforced TerraMesh™ slope

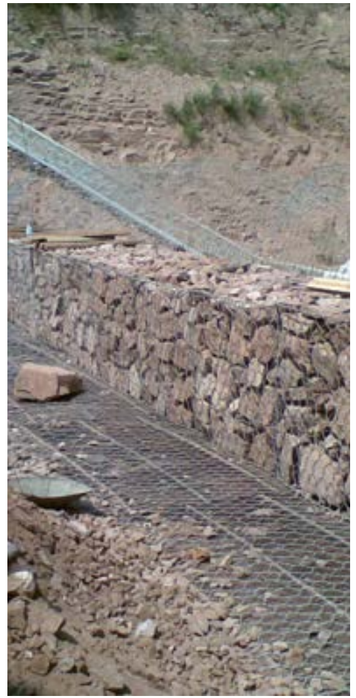
Client: **SHANGHAI HIGHWAY AND BRIDGE (GROUP) CO. LTD.**
Designer / Consultant: **CIVIL AVIATION NEW ERA AIRPORT DESIGN INSTITUTE GUANGZHOU BRANCH**
Contractor: **SANMING AIRPORT CONSTRUCTION HEADQUARTERS**
Products used (Qty.): **TERRAMESH™ SYSTEM 1,899 pcs - GREODRID 200,000 m²**
Date of construction: **03/2013 - 09/2014**

Engineering challenge

Sanming is an emerging tourist city with a beautiful landscape garden; for this reason, it's an important eco-tourism area for the whole province. Shaxian is an important transportation center in central Fujian in Shaxian, Sanming City. In the long-term, it has the conditions to expand into a 4D-level airport. The runway extends 2,800 meters to the northeast, and direct flights to major domestic routes. Sanming Airport involves a large number of high fill and protection works, involving 60 million cubic meters of earth and stone works. It is necessary to focus on the slope protection scheme. If the slope is too steep, the construction cost will be too high, and all natural grading treatment will lead to encroachment. A lot of land, so a balanced design consideration is required. In addition, the project is located in a subtropical marine monsoon climate, with heavy rainstorms in summer, and the adverse effects of rainstorm erosion need to be considered.

Our Solution

Relying on Maccaferri Group's rich experience in handling super high fill engineering walls and drawing on similar cases in China and abroad, after comparing and selecting design plans, a reinforced wall with TerraMesh™ system was adopted. The project consisted on setting 6-level reinforced TerraMesh™ slope, the rate of the slope was to be of 1:0.75, which greatly reduced the land occupation of the structure, the amount of filling of the project and the damage to the ecological environment by minimizing damage to forest area. For Sanming Airport, TerraMesh™ wall reinforced slope scheme was adopted. The porous structure of the Gabion™ panel has self-permeability and well-suited, to the subtropical marine monsoon climate in Fujian, and has excellent anti-scour performance. It solved the scouring problem of heavy rain, and the flexible reinforced Gabion™ structure also well adapted to the adverse effects such as settlement that often occurs in high fill engineering walls.



2016
Huaxi - Anshun, Guizhou, China

GUIZHOU HUAXI TO ANSHUN HIGH-SPEED TERRAMESH™ RETAINING WALL PROJECT

A solution capable of satisfying all the environmental and technical requirements

Client:	**GUIZHOU TRANSPORTATION GROUP**
Designer / Consultant:	**GUIZHOU TRANSPORTATION PLANNING SURVEY&DESIGN ACADEME CO.LTD**
Contractor:	**GUIZHOU BRIDGE ENGINEERING CO. LTD**
Products used (Qty.):	**TERRAMESH™ 1,200 pcs - MACDRAIN™ 28,000 m² - PARAGRID™ 25,000 m²**
Date of construction:	**03/2016 - 05/2016**

Engineering challenge

This project is located on the right side of the K11+600 ~ K11+760 section of the Huaxi to Anshun Expressway in Guizhou Province. Since it crosses farmland, a river and is close to a trunk highway, the land use is greatly limited. The maximum height of the retaining wall is 23 m. The project is located in a hilly and mountainous area. The lithology of the site consists of a silt clay containing breccia and clay containing gravel, the thickness is not big, the gravel is weathered strongly and the foundation bearing capacity is 180-220 kpa. The underlying bedrock lithology is gray sandstone, dolomite, etc., the buried depth of the bedrock is shallow and the rock mass fractures are densely developed. In addition, the weather is also very strong. According to the engineering geological conditions and requirements of the project, the TerraMesh™ retaining wall scheme was decided to be adopted. The TerraMesh™ retaining wall greatly shrinks the foot of the subgrade slope, saves the earth, reduces the area and avoids the reconstruction of the old road on the right side. At the same time, it also supports new retaining technology for high embankments in Guizhou Province.

Our Solution

The TerraMesh™ retaining wall was adopted, this type of solution can save the land and adapt to the uneven settlement of the foundation, which in this project has a very low bearing capacity. The structure consists of a TerraMesh™ system reinforced with Paragrid™; the side wall is filled with stone, which are derived from the tunnel after the excavation and from the slope beside the site (if met with the corresponding requirements). The maximum height of the retaining wall is 23 m, the spacing of the main reinforcement is 1m, and the length of the reinforcement is different from 6 m to 17 m in a normal trapezoidal arrangement, for a total of 23 layers.

ENGINEERING CHALLENGE

1 2 3 4 **5**

Mega projects and / or projects of national interest, such as large road embankments, airports or railways. The dimensions are generally over 10,000 m^2 of surface, with TerraMesh™ walls with heights of over 20 meters. Projects may require in-depth geotechnical and stability investigations.

2022 Ongoing
Antwerp Belgium

ANTWERP'S OOSTERWEEL LINK

Our contribution towards a sustainable mobility

Client: **LANTIS / TEXION GEOSYNTHETICS NV**
Designer / Consultant: **ARCADIS NV /LANTIS**
Contractor: **STADSBADER NV**
Products used (Qty.): **TERRAMESH™ (SYSTEM, GREEN AND MINERAL) 20,000 + pcs**
PARALINK™ 100,000 m² - PARAGRID™ 120,000 m²
Date of construction: **2018 - 2022 ONGOING**

5

Engineering challenge

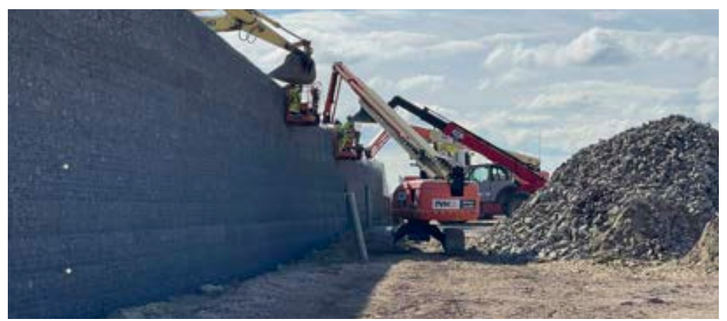
In February 2018, the city of Antwerp launched a major infrastructure project to develop the Oosterweel Link, in order to make it the best mobility solution for citizens. Maccaferri, with Texion as official partner, was involved in the project development, offering the city its proven technical experience and an innovative solution portfolio.

The Oosterweel Link project is a 15 km-long motorway connection developed by Lantis for completing the Antwerp ring road R1 (Belgium). Its design started in the 1990s to find a solution to the congestion problems in and around Antwerp. The total estimated cost of the project is approximately €4.5 bn.

Based on the "De Grote Verbinding" (the Great Link) project, Oosterweel will consist of five sub-projects to optimize local and freight congestion, for a total estimated cost of approximately €4.5bn. The whole project should be fully up and running by 2030.

Our solution

Maccaferri´s Corporate Technical Department has supported and is still supporting the main designers step by step from the first preliminary Global and Internal stability checks with Limit Equilibrium Method (LEM) analyses carried out with MacStars Software to Finite Element Method (FEM) deformation analyses due to the strict restrictions on displacements.
The use of inherently sustainable products, aimed at promoting easier integration between urban and natural landscapes, was among the key points of Maccaferri's involvement in the Oosterweel Link project. Maccaferri has used double twist wire mesh reinforcement together with Paralink™ and Paragrid™ geogrids, offering a significant cost effectiveness and performance leverage. A 3D-BIM model was also created to check and design all possible interferences on the reinforcements.
The project includes 23.000 facing sqm of "TerraMesh™ Green", 16.000 facing sqm of "TerraMesh™ Mineral and System, 275.000 sqm of Paragrid™ and Paralink™ geogrids, and 5.000 facing sqm of Gabion™ cladding. During 2020-2021 and 2022, 37.000 sqm of MSE walls have been already installed, with a maximum height of 13m for the structures erected so far.
Thanks to this project and a series of synergetic interventions, the city of Antwerp can now be considered a virtuous example of how urban spaces can adapt to the needs of citizens and the need to achieve standards of sustainability.



2022
Korca, Albania

TERRAMESH™ RETAINING WALL KORCA-ERSEKA-LOT2 PHASE1

Promoting the further development of tourism in the southeast of Albania

Client: **ANK SHPK**
Designer / Consultant: **A&E ENGINEERING SH.P.K.**
Contractor: **ANK SHPK**
Products used (Qty.): **TERRAMESH™ 10,500 pcs - PARALINK™ 75,600 m² - PARAGRID™ WG 197,400 m²**
MACTEX™ H 79,200 m²
Date of construction: **02/2021 - 01/2022**

5

Engineering challenge

The Korca - Erseka Road project is located in the southeast of Albania, the project construction started in March 2021 and finished the first part in January 2022. Currently, the road axis Korca Erseka has a length of 45 kilometers, while with the completion of the new segment the distance is reduced to 35 kilometers. The challenge was to build a construction able to promote the further development of tourism in the southeast of the country by bringing closer two areas with great development potential, such as Korca and Erseka. With its completion, the distance between Korca and Erseka will be reduced to 20 minutes. Being a unique design with back-to-back earthed filled structures, the contractor company ANK asked Maccaferri to support them for the project. After running the profiles in Macstars 4.0 we found out that the geogrid reinforcement lengths designed by ANK were not satisfying the stability checks.

Our solution

Firstly, we redesigned the solution using TerraMesh™ units with dimensions 3x3x1x1 m, to ensure stability the TerraMesh™ System was reinforced with Paralink™ 300 and Macgrid™ WG15 according to the software Macstars2000 calculations. This way we obtained the most cost-effective solution. The construction of the wall started in March 2021, and it was finished in January 2022. In total 4 TerraMesh™ back-to-back walls were built around 31'500 m² of façade.

The two biggest walls are the first one, with 325 meters of length and a maximum height of 32 meters; and the fourth one, the longest, with its 525 meters that reach a maximum height of 16 meters. While the second one and the third one are considerably smaller with respectively 130 and 50 meters of length for a maximum height of 12 and 16 meters.

2010
Durrës, Western Albania, Albania

MIXED RSS FOR THE RRESHEN-KALIMASH HIGHWAY

Part of Albania's largest public contract

Client: **MINISTRY OF PUBLIC WORKS & COMMUNICATIONS ALBANIA**
Designer / Consultant: **ALBANIA DRAHT / MACCAFERRI**
Contractor: **BECHTEL-ENKA JOINT VENTURE**
Date of construction: **03/2008 - 10/2010**

5

Engineering challenge

Rreshen Kalimash Motorway project is Albania's largest public contract ever signed, the 103 km long motorway is a key connection between Durres Port, Albania's primary harbor on the Adriatic Sea and Kosovo. The objective was to reduce the journey times and thanks to this project six and ten hours of cruise will be reduced to two and the new route will serve to stimulate the economy in Albania's North Eastern region. Furthermore, due to the mountainous topographic area, many sections of the motorway had to run alternately through large steep embankment fill sections and slope cuts, with soil reinforcement, rock-fall protection, erosion control and revegetation measures.

Our solution

Bechtel-Enka brought in geotechnical specialists, Maccaferri in a partnership arrangement to provide engineering design solutions for the walls. Maccaferri's responsibility encompassed the design assistance, structural calculations and construction drawings for the 30 walls. For 20 of the walls, Maccaferri also provided supervision and construction management through its local partner Albania Draht. The 30 composite reinforced soil structures have a total facing surface area of more than 35,000 m², with the maximum wall overall height of 40 m. The walls, where a steep (84°) facing was required, have been constructed using a hybrid reinforced soil system, combining two Maccaferri products; -TerraMesh™ System, a double-twisted steel wire mesh unit which forms structures with the aesthetics of Gabion™s but with the reassurance of soil reinforcement -Paralink™ 300, a high strength polyester geogrid (primary reinforcement). The Paralink™ was spaced at 1 or 2 m vertical centres depending upon the design requirement. These walls are among the highest of their type constructed anywhere

The availability of large quantities of rock fills generated by the slope excavations made the choice of embankment fills a more cost-effective alternative to the construction of viaducts. Of the 70 retaining walls required, those up to 15m high were constructed of concrete. However, the 30 walls over 15 m high were designed as reinforced soil structures to reuse site won fill and reduce the visual impact.

2018
Tasiast, Mauritania

ADRAR MASSIF TASIAST GOLD MINE

One of the highest TerraMesh™ wall system in the field of Mining applications

Client: **KINROSS**
Designer / Consultant: **AUSENCO**
Contractor: **TASIAST MAURITANIE LTD SA**
Products used (Qty.): **TERRAMESH™ 2,200 m² - PARALINK™ 45,000 m²**
Date of construction: **09/2017 - 03/2018**

5

Engineering challenge

Engineering challenge Tasiast mine in Mauritania is one of the largest gold mines in the world, only last year it produced more than 6 tonnes of gold equivalent. The mine is located about 300km north of Nouakchott and 162 km east-south-east of Nouâdhibou in the north-western Mauritania in the Adrar massif. As part of its operation the company KINROSS mining commissioned a primary crusher wall, requiring the construction of two side walls with a height of 32 and 50 meters. To satisfy the requirements it was selected Maccaferri's reinforcement technique floor with vertical TerraMesh™ System mineral facing. The AUSENCO company, in charge of the project management of work, was convinced by the mechanical performances of the TerraMesh™ system as well as the technical support provided by Maccaferri's experts.

This project end up being one of the highest TerraMesh™ wall system in the field of Mining applications!

Our solution

The TerraMesh™ system is a system combining a Gabion™ facade to a reinforcing ply of continuous mesh from the facing. The Gabion™ part ensures a neat facing while the mesh reinforcement allows a reinforcement of the rear embankment and the holding of the massif. In addition to netting, reinforcement geogrids of the Paralink™ 300 type and Paralink™ 400 have been added over a length of 20m in the backfill to provide the necessary reinforcement. The constituent mesh of the TerraMesh™ system is mesh hexagonal double torsion (run-proof) coated with polymers. The dimensioning of the structure was carried out by the Maccaferri technical department using the software internal MACSTARS slope stability in order to define the length, spacing and type of reinforcement. The construction of a retaining structure of such scale requires careful placement of structures and strict compliance with the work procedure. MACCAFERRI has transmitted a complete work procedure to assist the company in all the stages of carrying out the work. The cages were filled with stones extracted and crushed on site, therefore nearly 4000 t of stones were needed to fill the cages. In considering an average gold concentration of 5g/t of stones extracted, the wall is made up of about 20kg of gold!

2019
Attica - Corinzia - Acaia, Greece

CONSTRUCTION A/D OLYMPIA ROAD

A safe connection to western Greece

Client:	**J & P AVAX S.A. - TERNA SA - AKTOR A.T.E.**
Designer / Consultant:	**K/X OLYMPIA STREET**
Contractor:	**J & P AVAX S.A. - TERNA SA - AKTOR A.T.E.**
Products used (Qty.):	**TERRAMESH™ 3,360 pcs - TERRAMESH™ GREEN 3,175 pcs MACGRID™ 270,000 m² - PARALINK™ 29,000 m² - PARAGRID™ 7,000 m²**
Date of construction:	**02/2013 - 09/2019**

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Engineering challenge

The lack of A/D European specifications for the connection of the Peloponnese with the rest of Greece and Europe led to the construction of a new, advanced, and comfortable A/D, which safely connects the western part Greece with the rest of the country (from and to its port Patras, the archaeological and tourist attractions areas).
The construction on the 120 km section of OLYMPIA ROAD CORINTHOSPATRA was carried out simultaneously with traffic of vehicles and in a particular unstable geological ground. The whole project included 47 bridges, 13 junctions, 22 overpasses and 12 tunnels of a total length of 16 km. The many geotechnical difficulties during the construction phase required the use of approximately the entire range of Maccaferri's materials.

Our Solution

Our company collaborated with the study group during the design phase as well as with the technical companies during construction, offering specialized solutions with high quality products. Reinforced embankments were constructed using TerraMesh™ system and TerraMesh™ Green combined with Macgrid™ WG, Paralink™ and Paragrid™ geogrids.
During the project, a difficult case study involved the 14 meters high retaining wall built near the village of Elaionas. Statics data was entered to design permanent loads, as well as the expected cyclical loads of traffic vehicle and seismic analysis were conducted. As a result of the study, our engineers suggested the application of TerraMesh™ system for the reinforced embankment.
The results design imposed the use of geogrid type Macgrid™ WG for reinforcement and to increase the load capacity of TerraMesh™ pieces; moreover, the length of these polymers of geogrids was calculated to penetrate 15m into the slope.

2013
Ras Al Khaimah, United Arab Emirates

RETAINING WALL NO. 10 FOR MOUNTAIN ROAD TO JABEL JAIS

36 km long road to the highest peak of the UAE

Client: **PUBLIC SERVICE DEPARTMENT, RAS AL KHAIMAH**
Designer / Consultant: **HALCROW INTERNATIONAL PARTNERSHIP**
Contractor: **GENERAL MECHANIC COMPANY**
Products used (Qty.): **TERRAMESH™ 4,100 m² - PARALINK™ 32,500 m²**
Date of construction: **11/2012 - 08/2013**

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Engineering challenge

The highest peak in UAE, Al Jais, is located in the Northern Emirates of Ras Al-Khaimah, 25 Km away from the main town. As per the master planning, the mountain top is to be developed as a unique tourist destination with resorts, the world's longest zip line, golf course, etc. The proposed 36 km long road to the mountain peak site rises to a height of 700 meters; as it is the highest peak in UAE, construction ought to be challenging due to large quantity of earthworks, difficulty in access, moving up construction machinery, etc.
The existing site condition required a nearly vertical retaining structure of height 32m between chainages 20+350 to 20+575. Additionally, the site receives occasional rainfall & snowfall; during the rains, flash floods are quite common and they even wash away the entire road and underlying embankment. Consequently, the high retaining structure had also to be naturally free draining and stable against the potential effect of additional hydraulic forces behind the structure.

Our Solution

Maccaferri was subcontracted for design, supply, and construction assistance of the 32 m high retaining wall with Paramesh system, a widely used composite system by combining high strength Paralink™ geogrids along with TerraMesh™ facing units. This solution is a lot more cost-effective and easy-to-apply, particularly for such high structures. The constructed total facia area of retention is 4100 m², ranging in height between 5 m to 32 m. The site strata primarily consisted of sedimentary rock, which varied from weathered to hard rock conditions. The backfill material used between Paralink™ geogrid layers contain relatively larger particle sizes, thanks to the superior polyethylene coating on the geogrid material's polyester core. The possibility of using local materials like high graded backfill material and boulders for Gabion™ facia resulted in considerable cost savings in the project. The actual site conditions varied a lot from the design conditions that resulted in few design revisions, but due to the flexibility of the TerraMesh™ system; the units could be easily modified/deformed at the site to match the new site requests.

2021
Dubai, United Arab Emirates

MUSEUM OF THE FUTURE

A green contribution to a piece of art

Client: **MERAAS**
Designer / Consultant: **BURO HAPPOLD ENGINEERING**
Contractor: **BAM INTERNATION**
Products used (Qty.): **TERRAMESH™ GREEN 3,500 m² - MACWEB 3,000 m² - MACDRAIN™ W 12,500 m² MACMAT HS 6,000 m² - BIOMAC™ NATURAL 9,000 m² - DT MESH HS 3,000 m²**
Date of construction: **11/2018 - 04/2021**

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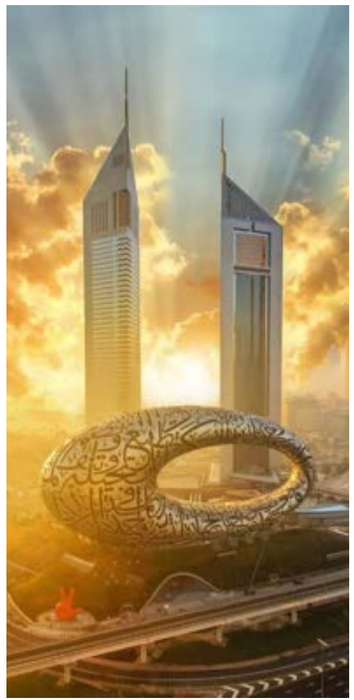
Engineering challenge

The Museum of the Future (MOTF) is a unique initiative by the Dubai government that explores the future of science, technology, and innovation and is located at a prime spot in Sheikh Zayed Road near the Burj Khalifa. The architect 'Kila' designed MOTF in three main parts: the lower green hill, the upper building, and the elliptical void, representing earth, mankind & innovation, respectively. The inspiration for the green hill was also to elevate the building calmly and unobtrusively above the metro line and create greenery in elevation where visitors can enjoy while engaging with the Museum. The green hillhad to be done through a smooth transition from the site as an earthen, vegetated mound with a minimal visible built intervention. A three story podium structure had be embedded inside the green hill, which houses the lobby, auditorium, cafés, restaurants, retail, car parking, etc. For the aforementioned reasons, the vegetated mount had to be done as a thin cladding of varying slopes rather than a solid earth hill.



Our solution

Maccaferri was chosen as the technology provider for the green cover system; thanks to the wide range of products in our portfolio we were able to achieve the varying slope requirements of the artificial green mount of the project. After studying the landscaping requirements, Maccaferri proposed to categorize the green cover system based on final slopes, and accordingly, the products were suitably chosen. The first choice was the Biomac cover for slopes up to 35- degree inclination; the second choice was Macweb geocell for slopes up to 45- degree inclination and lastly the TerraMesh™ Green reinforced soil system for slopes up to 70-degree inclination. For the first two cases, continuous veneer reinforcement was proposed below the thin soil fill by means of Maccaferri wire netting or Macmat HS, which were anchored on the concrete beams at the top. Additionally, Macdrain™ drainage composite was proposed below the entire surface area of the green cover system for the easy draining of continuous irrigation water. Maccaferri was therefore involved in the design, supply, and construction assistance of the project.

2018
Republic Of Sakha, Yakutia, Olekminsky Ulus, Russia

GROSS FIELD DEVELOPMENT

A wall construction in a harsh local climate

Client: **NORDGOLD COMPANY**
Designer / Consultant: **SPB - GIPROSHAHT LLC**
Contractor: **MACCAFERRI GABION™S CIS LLC**
Products used (Qty.): **TERRAMESH™ SYSTEM 1,360 pcs - GABION™S 56 pcs - RENO MATTRESSES 43 pcs PARALINK™ 35,775 m² - PARAGRID™ 27,066 m²**
Date of construction: **03/2018 - 10/2018**

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Engineering challenge

Gross Mining and Processing Plant (MPP) is the new main gold mining facility of Nordgold in Russia. The mine commissioning in 2018 confirmed the Nordgold status as the industry leading constructor of state-of-the-art gold mines.
One of the main stages of ore preparation is its processing at crushing and dresser facility. To ensure the access of heavy dump trucks to the ore discharge zone of Gross MPP coarse crushing facility, taking into account the site geomorphology, it was necessary to install high retaining walls adjacent to the crushing facility. The main issue complicating the wall construction was the harsh local climate, with a winter season of 7 moths and January temperatures that can drop up to -55° C, determining a short construction season. Furthermore, the infrastructure of the region is poorly developed, the facility is located in remote areas, which made it impossible to use reinforced concrete for this project. Low temperatures would negatively impact building materials, and poor transport accessibility and a short construction season would only increase construction costs and delay time.

Our solution

Specialists of the general design organization LLC SPb - Giproshakht in cooperation with the designers of MACCAFERRI, developed the retaining walls design using the TerraMesh™ soil reinforcement system. This system was selected basing on its following advantages:

- Economic efficiency of TerraMesh™ soil reinforcement system is 20% or higher versus the traditional reinforced concrete retaining walls and sheet piling, depending on the height and length of a structure;
- Local rock material was used for the construction;
- Installation of the system is simple and quick, because does not require skilled labor and heavy equipment;
- The wall can be constructed at low temperatures using dry masonry;
- The wall can be erected in confined area;
- The technology allows to reduce the construction time up to 3 times;
- Walls built using the TerraMesh™technology have high bearing capacity and are durable;
- The wall is able to accommodate local deformations without compromising its reliability and durability.
- The finished structure is twenty-eight-meter embankment with soil reinforcement consisting of three layers (lower layer – 10 m, middle one – 10 m and upper one – 8 m) and divided in height by two intermediate berms with 1.5 m width.

The local materials were used to construct the TerraMesh™ soil reinforcement system for coarse crushing facility access road. It triply accelerated the construction rate and reduced construction costs.
Other than the TerraMesh™system, the finished structure also includes the use of the following Maccaferri's products: the Reno mattresses®; Geosynthetic grids Paragrid™ and Paralink™; Rock material for Gabion™ structures filling.

2018
Pakyong, Sikkim, India

MACCAFERRI SOLUTIONS FOR CONSTRUCTION OF NEW AIRPORT AT PAKYONG, SIKKIM

The 2012 international ground engineering project of the year

Client: **AIRPORTS AUTHORITY OF INDIA (AAI)**
Designer / Consultant: **PUNJJ LIOYD LTD AND MACCAFERRI**
Contractor: **MOTT MCDONALD INDIA PVT LTD**
Date of construction: **2009 - 2018**

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Engineering challenge

Sikkim came into existence as a state of India in 1975. Due to its land locked scenario, the state of Sikkim was only approachable by road. By virtue of its lush green topography, with a wide variety of flora-fauna and presence of Himalayas, it had always been a place of tourist attraction.
The site of the proposed airport at Pakyong was on a hilly terrain having valleys and spurs with an acquired area of around 200 acres. Since a plane surface (min. 150 m wide) was required for the construction of structures, cutting of uphill portion had to be done and the same material had to be filled at downhill portion to get the required level of runway. The constraint that material from the cutting had to be used in filling was mandatory.
Furthermore, Sikkim receives a very high annual rainfall. Due to heavy rainfall intensity, storm water drain was one of the important aspects of this project.
Finally, it was also highly required by the client Airport Authority of India (AAI) to have an eco-friendly solution on cutting side, as this area is direct visibility from runway and terminal building and the construction couldn't have adverse impact on the environment and local habitat.

Aerial view of Pakyong Airport / Source: Airport Authority of India (AAI) - VDR

Our Solution

For the project the uphill portion of the slope was cut and used for the filling operation to get the required leveled platform of the airport runway.
To retain the fill within the Airport boundary on valley side, TerraMesh™ retaining structure of height varying from 4 to 80 m were planned. ParaMesh system was adopted for construction of retaining structures. Paralink™ as a primary reinforcement of grades varying from 200 to 800 were introduced in the soil mass to retain the soil vertically or at steep slope by virtue of interaction between soil and reinforcing elements. To prevent sloughing failure of the facia and to achieve improved compaction, TerraMesh™ Green , TerraMesh™ or a combination of both were used depending on space availability and need for taking a concrete culvert through.
At the end of the construction, these ParaMesh structures were the highest among the "Reinforced steep slope" structures in world.
Furthermore, on the 18th of Sep 2011, Sikkim was reached by high intensity earthquake during which most of other infrastructure got severely damaged, ParaMesh structures of this project performed excellent owing to their flexible nature, though the seismic event happened was theoretically more than the magnitude for which these structures were designed.
Owing to the environmentally friendly and sustainable reinforced fill structure, the airport authority of India won the prestigious Greentech CSR award in 2011. Also in 2012, the project won the prestigious international ground engineering award as project of the year.

2016
Tana Toraja, South Sulawesi, Indonesia

PARAMESH WALL OF TANA TORAJA AIRPORT

The construction of a new and bigger airport

Client: **MINISTRY OF PUBLIC WORKS**
Designer / Consultant: **PT. BREMA**
Contractor: **PT. BINTANG ARAFFA**
Date of construction: **10/2015 - 01/2016**

Engineering challenge

Toraja Airport, formerly Buntu Kunik Airport, is an airport at Mengkendek, Tana Toraja Regency, South Sulawesi, Indonesia. It was built to replace the Pongtiku Airport, which was closed due to lack of land for expansion to cope with increasing passenger demands.
The new airport runway is 2 km long and approximately 210 m wide, suitable for ATR type aircrafts. Since a plane surface is required for the construction of the runway, and due to the presence of hills and spurs clashing with the runway area, massive cut and fill heart works had to be undertaken in order to get the required level of runway. Thus, the filling soil had to be retained with technically suitable and economically feasible structures. It is worth to note that the maximum embankment height to be retained is almost 40m. The main technical constraints had been: the high seismicity of the area, the heavy rainfall encountered every year and the presence of clay shale foundation soils. Clay shales were originally dry and hard with high shear strength, but if they absorbed water during the unloading process, they could have rapidly turned to stiff or even to soft clay with extremely low shear strength. For this reason, excavation and construction operations required noteworthy care and adequate planning in order to minimize the exposure of the foundation soils to weathering agents.

Our Solution

Different types of retaining structures have been considered during the design stages: traditional concrete walls, bored piles and hybrid MSE walls (Paramesh). The evaluation criteria have been:

- permeability: the retaining structures had to have a very permeable facing in order to rapidly drain the rainfall waters and to dissipate the hydrostatic pressure developed in the backfilling soil;
- flexibility: the retaining structures had to have a flexible behavior in order to accommodate potential differential settlements and to absorb dynamic shocks;
- construction time/schedule;
- overall cost.

Based on all the above criteria, Maccaferri hybrid MSE structures (DT + Paralink™) have been selected as the best solution. In October 2015, the construction of the first Paramesh retaining structure using Maccaferri products started. It has a maximum retained height equal to 25 m, distributed in 5m high berms. The berms are realized using both TerraMesh™ System and TerraMesh™ Green elements (60 degrees). The primary reinforcements are Paralink™ geogrids having an ultimate tensile strength equal to 300 kN/m.

2012
ShenNongJia, Hubei China

HUBEI SHENNONGJIA AIRPORT TERRAMESH™ RETAINING WALL PROJECT

A fast access to the world's ecological treasure house

Client: **BEIJING JINGGANG AIRPORT CONSTRUCTION CO. LTD.**
Designer / Consultant: **CIVIL AVIATION NEW ERA AIRPORT DESIGN INSTITUTE GUANGZHOU BRANCH**
Contractor: **BEIJING CHINA AVIATION PORT CONSTRUCTION ENGINEERING CO., LTD.**
Products used (Qty.): **TERRAMESH™ SYSTEM 19,127 pcs**
Date of construction: **07/2011 - 09/2012**

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Engineering challenge

ShenNongJia is in northwest Hubei province, it has the only virgin forest in the middle latitudes of the world and is known as "the world's ecological treasure house". With the advancement of the construction of the eco-tourism circle in western Hubei, ShenNongjia Forest Area, one of its core sectors, urgently needed fast and convenient access and exit, which led to the construction of ShenNongjia Airport.

The challenge derived from the fact that the ShenNongjia Airport is located at a high-altitude ridge in the forest area, filled with super-high fill areas in the field, and the height difference of the highest fill area is nearly 50m. Due to the limitation of geomorphological conditions, natural grading would occupy a large amount of land and cause great damage to the forest ecosystem. However, using a traditional support structure, would not only make it difficult to design and construct, but would also need extremely high basic requirements, and a large amount of foundation treatment would have to be carried out.

Our solution

Relying on Maccaferri's rich experience in handling super-high fill engineering and drawing on similar cases of super-high fill engineering all over the world, a tall composite reinforced soil structure scheme was finally selected. By setting a face-to-wall slope ratio of 1:0.25, which is nearly vertical, the occupation of the retaining wall was greatly reduced, as the filling amount of the project, and the damage to the ecological environment of the forest area was minimized as much as possible.

In terms of foundation, the reinforced soil structure had relatively low requirements for the foundation, which were met by setting up a masonry base, eliminating the need for complex foundation treatment procedures and high treatment costs.

In terms of ecological greening, by making full use of the ecological characteristics of the TerraMesh™ system, and by setting greening measures such as geotextiles on the face walls, it was easy to restore vegetation and minimize the impact on the ecological environment of the forest area due to engineering construction, which fitted perfectly with the concept of green and environmentally friendly airports.

*TERRAMESH™, PARAGRID™, MACDRAIN™, MACTEX™, PARALINK™, STEELGRID™, GABION™, MACGRID™, PARADRAIN™ ARE A TRADE MARK OF OFFICINE MACCAFERRI SPA, REGISTERED IN SOME COUNTRIES, WHICH ARE PROTECTED UNDER THE APPLICABLE LAWS

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