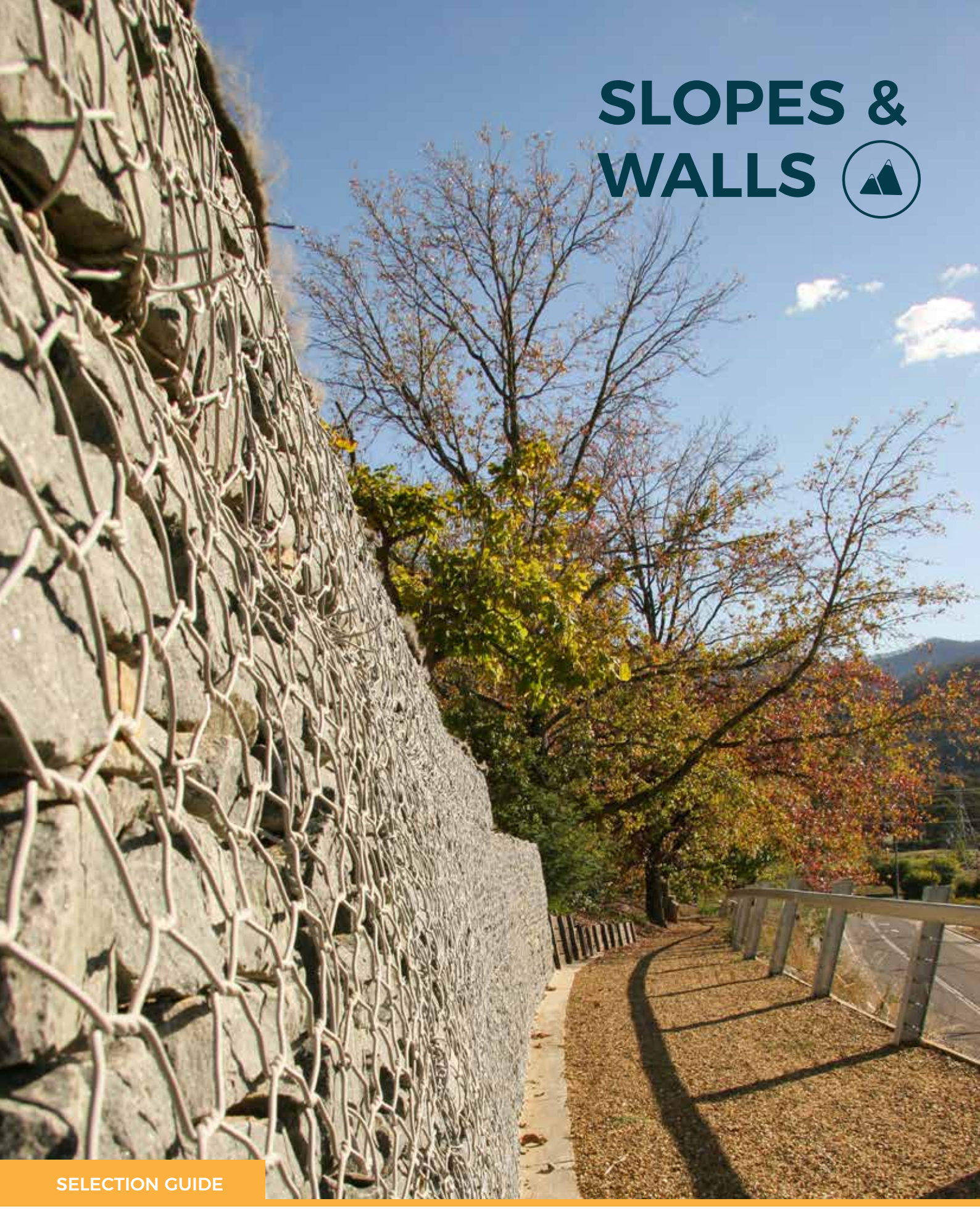
SLOPES & WALLS



SELECTION GUIDE

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GEOFABRICS®
Sustainable solutions

Today, Geofabrics is committed to providing product solutions that are more efficient, longer lasting and readily integrate with the surroundings while at the same time have less detrimental impact on the environment compared to solutions using more carbon intensive construction materials. We work to protect, contain and secure the physical environment by using innovative and efficient solutions. We help our clients mitigate environmental risk through world-leading research and innovative product design and development.

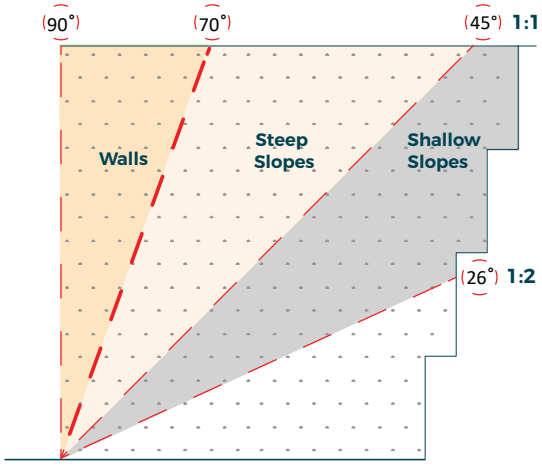
Retaining Walls and Reinforced Soil Structure Selection Guide

To determine the most appropriate solution to meet your project requirements, there are several factors that should be considered. These include:

- The geometry and overall aesthetics of the structure
- Construction access and long-term maintenance requirements
- The height of the structure and the loading imposed on the structure
- The quality and availability of fill materials
- Whether the structure is permanent or temporary
- Budget constraints

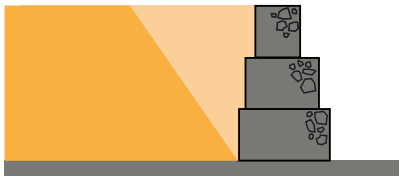
There is a slopes and wall solution for every project, whether it be for a small domestic retaining wall or a large-scale reinforced soil structure for a major highway. The objective is the same, regardless of the project size – to win back space and provide safe soil retention.

As a general guide, if the face angle ≤ 70° the structure is considered a slope and if the face angle > 70° the structure is considered a wall.



Gabion mass gravity

45° to 90°

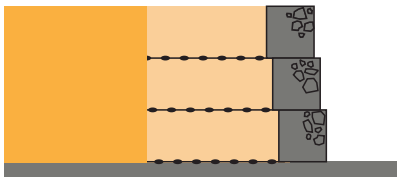


- Stability provided by self-weight
- Typically low height <5m but can be in excess of 10m high
- Can be vertical or stepped front or rear
- Suitable for cut or fill scenarios

Page 4

Terramesh (Gabion rock face)

63° to 90°

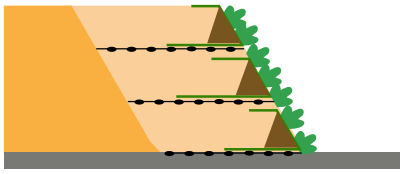


- Integral tail provides required connection capacity
- Geogrids can be included to augment the strength of the integral woven mesh soil reinforcement
- Can be vertical or stepped
- Less rock fill required than a mass gravity gabion structure

Page 6

Green Terramesh (vegetated face)

45° to 70°

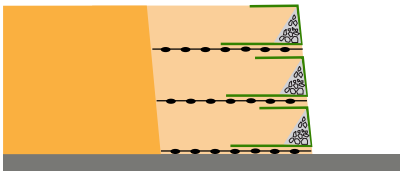


- Topsoil veneer to promote vegetation growth
- No external formwork required when installing
- Integral tail provides connection capacity
- Geogrids can be included to augment the strength of the integral woven mesh soil reinforcement
- A customised unit can also be used for temporary applications

Page 7

Mineral Terramesh (rock face)

70° to 90°

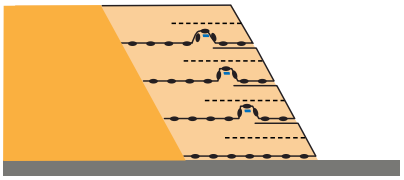


- Rock fill veneer front face
- No external formwork required when installing
- Permanent facing unit
- Save on rock fill
- Geogrid is terminated at the front face

Page 8

Wraparound (vegetated / non-vegetated)

45° to 90°

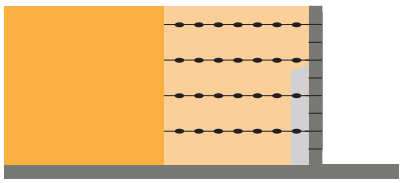


- Suited for both temporary or permanent structures
- Requires temporary formwork or sand bags for construction
- Exposed geogrids on the wrapped face require protection
- Can be used as permanent thrust relief behind an existing structure

Page 8

Segmental block wall

84° to 90°

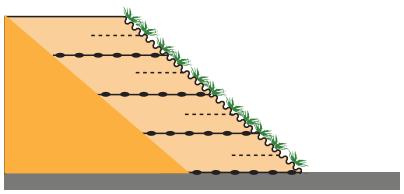


- Hand stacked precast concrete blocks
- Wide choices of textures and colours
- Positive or frictional connection

Page 9 & 10

≤ 45° slope

26° to 45°

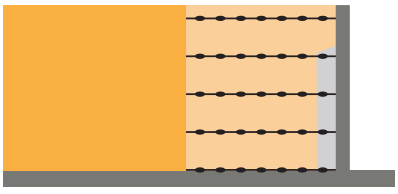


- May consider site won fill
- Geogrid is terminated at the front face
- Erosion control mat installed on the slope face
- Typically vegetated front face
- Economical and environmentally friendly

Page 9

Precast concrete panel

90°



- Geogrid starter is cast into the concrete panel
- Full height panels allow for rapid installation
- Primary geogrid reinforcements connected using polymeric bodkin connectors
- Different textures and patterns can be created

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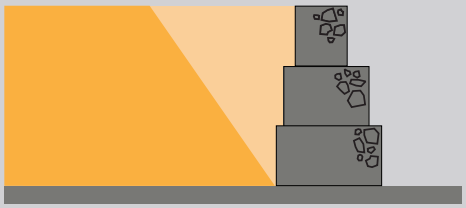


- Stability provided by self-weight
- Typically low height <5m but can be in excess of 10m high
- Can be vertical or stepped front or rear
- Suitable for cut or fill scenarios

Gabion Mass Gravity

Engineered from double twist steel wire mesh, our Maccaferri Gabion baskets are site assembled and packed with locally quarried or imported rock to form flexible, permeable and monolithic structures such as retaining walls, channel linings, hydraulic control structures and erosion protection.

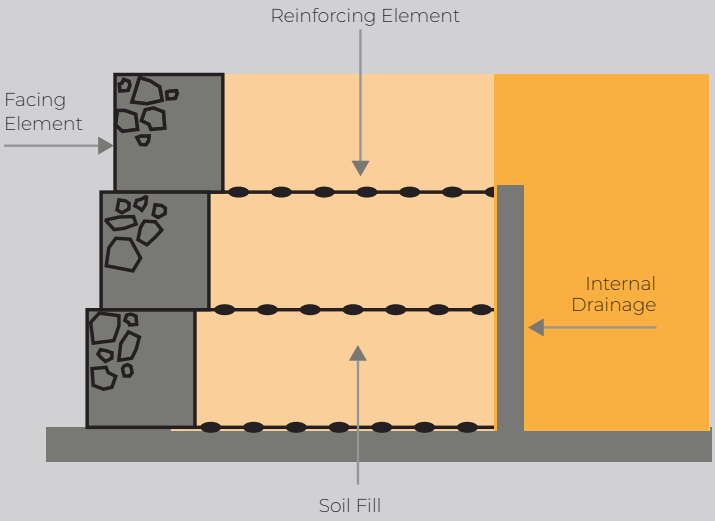
Rock is carefully hand-placed along all exposed faces of the baskets to ensure the best aesthetic appearance. Our Gabion retaining structures can be constructed with flush or stepped faces and offer:

- **Increased durability** with our GalMac® and GalMac G10 corrosion resistant metallic coatings proven to outperform standard galvanized mesh by up to five times
- **Flexibility and reliability** by accommodating large differential settlements without affecting structural integrity
- **Cost savings** when compared to other systems such as mass gravity boulder walls, grouted rock walls and mass concrete block walls
- **Greater abrasion**, chemical and UV resistance by incorporating Maccaferri's revolutionary PoliMac® polymer coating which provides significantly enhanced performance compared to traditional PVC coated wire mesh products
- **High permeability**, due to the open aggregate structure and Bidim Green geotextile interface. This allows efficient pore water pressures dissipation which removes the need for complex drainage systems
- **Independently verified and tested** with BBA-HAPAS certification

Reinforced soil structures

There are many factors to consider when modifying a soil slope beyond its natural angle of repose and it is recommended that a thorough geotechnical investigation be undertaken before design work commences.

Reinforced soil technology can be applied to a range of applications from vertical retaining walls, bridge abutments and steep slopes to landslide repairs. Reinforced soil structures are also proven to outperform conventional rigid type retaining structures, particularly under extreme dynamic and seismic conditions because they are significantly more resilient.



Major components of reinforced soil structures

Soil fill: Soil fill is the selected material placed and compacted within the reinforced zone behind the facing elements. The better the quality of this material, the more efficient the structural outcome. A well graded, granular, free draining material with limited fines is generally recommended although marginal type materials can be appropriately engineered if their properties are known and determined through geotechnical testing.

Facing element: Facing element options are many and varied, their purpose being to contain the soil fill, provide adequate structural connection capacity to the reinforcement and to offer protection from harsh environmental exposure; chemical weathering, erosion, ultra violet degradation and so forth. Common and highly durable facing elements include Gabion units, Terramesh units, full-height concrete panels and TW3 precast concrete retaining blocks.

Reinforcing element: There are many reinforcement types that can be incorporated into the structural design such as high strength polymer geogrids and Polimac coated double twist steel wire mesh. The most common types polymer geogrid includes TenCate's Miragrid GX, Maccaferri's Paragrid and Paralink and Tensar's RE500 series of geogrids. These reinforcing elements provide:

- Increased performance with class leading physical and mechanical properties which enable efficient and safe structural outcomes. Good soil and geogrid interaction is important
- Quick and easy installation as they are light weight, flexible and can be easily cut to the required lengths
- Greater reliability, offered through state-of-the-art manufacture and accredited quality control systems. Where applicable, BBA certification predicts a design life of up to 120 years
- Reduction of environmental impact by maximising the opportunity to re-use site-won material as soil fill

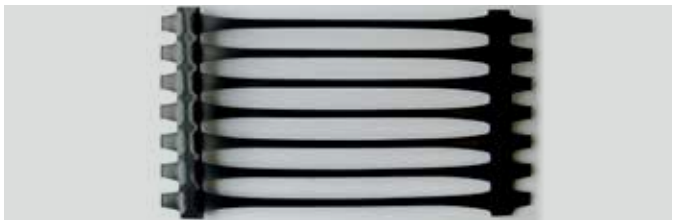
The Internal drainage: Internal drainage is generally recommended to prevent groundwater from entering the soil reinforced zone, weakening the soil's strength and compromising the internal stability of the structure as a whole; often with devastating results. Our geocomposite drainage products such as Megaflo® and Macdrain® are commonly used as an effective replacement to the traditional gravel and sand chimney drains. They can be laid at the interface between the natural ground and the reinforced soil fill to control groundwater movement.

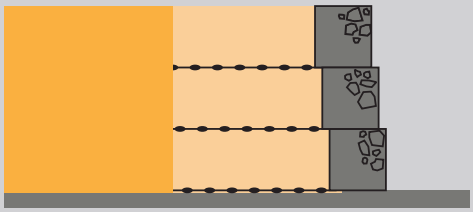
TENCATE GEOSYNTHETICS — MIRAGRID® GX GEOGRID

MACCAFERRI — PARAGRID® AND PARALINK®

MACCAFERRI — POLIMAC® WOVEN STEEL MESH

Tensar® — RE500 GEOGRID





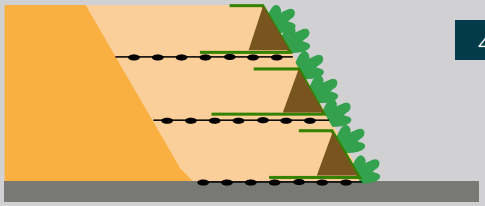
- Integral tail provides required connection capacity
- Geogrids can be included to augment the strength of the integral woven mesh soil reinforcement
- Can be vertical or stepped
- Less rock fill required than a mass gravity gabion structure

Terramesh® Reinforced Soil Structures

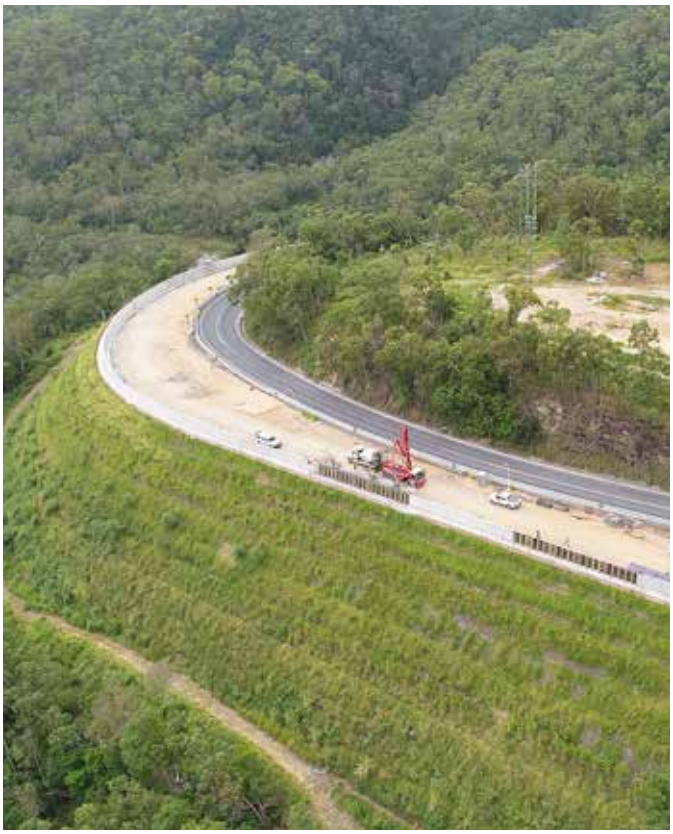
Terramesh is a modular system used to form rock faced reinforced soil walls and embankments. It has been used internationally on some of the most significant infrastructure projects, including one of the tallest reinforced soil structures at 74m high.

A Terramesh unit consists of a double twist steel wire mesh gabion fascia unit with a single length of mesh forming the lid, the front face and an extended integral underside of varying length referred to as the reinforced tail section. Gabion rock is similarly packed in the fascia unit and structural backfill placed and compacted in the reinforced zone behind. The Terramesh system offers:

- **Increased durability** compared to standard weld mesh systems due to the combined GalMac® and PoliMac® coating
- **Up to double the lifespan** compared to traditional polymer-coated wire mesh products. The PoliMac coating offers greater abrasion resistance, better performance at low temperatures and improved UV and chemical resistance
- **Improved performance** compared to welded mesh facings due the greater connection capacity provided by its integral mesh tail which avoids the need to provide a geogrid wrap to the facing unit
- **Cost savings** compared to other systems where additional geogrid lengths are required to achieve connection capacity and the associated time savings.
- **Independently verified and tested** with BBA-HAPAS certification



- Topsoil veneer to promote vegetation growth
- No external formwork required when installing
- Integral tail provides connection capacity
- Geogrids can be included to augment the strength of the integral woven mesh soil reinforcement
- A customised unit can also be used for temporary applications



Green Terramesh® Reinforced Soil Slopes

Green Terramesh is an environmentally friendly modular system used to form vegetated or green faced soil reinforced slopes and embankments.

A Green Terramesh unit consists of a prefabricated single length of double twist steel wire mesh forming a lid, an inclined front face and an extended integral base referred to as the reinforced tail section. The inclined face section is lined with an erosion control blanket and stiffened with a welded mesh panel which provide stability during filling and enhances the establishment of natural or introduced vegetation.

This system offers similar benefits to the standard Terramesh system but does not require the added cost of a rock facing:

- **Increased durability** compared to standard weld mesh systems due to the combined GalMac® and PoliMac® coating
- **Up to double the lifespan** compared to traditional polymer-coated wire mesh products. The PoliMac coating offers greater abrasion resistance, better performance at low temperatures and improved UV and chemical resistance
- **Improved performance** compared to welded mesh facings due the greater connection capacity provided by its integral mesh tail which avoids the need to provide a geogrid wrap to the facing unit
- **Cost savings** compared to other systems where additional geogrid lengths are required to achieve connection capacity, no need for a protective rock veneer facing and the very simple and efficient installation process
- **Independent verified and tested** with BBA-HAPAS certification

Mineral Terramesh® Reinforced Soil Slopes

Mineral Terramesh is a unique reinforced soil system providing a sloped rock veneer facing at angles of up to 87 degrees.

This system is a modern derivative of the Green Terramesh system, ideal for use where a contemporary, aggregate-faced aesthetic finish is preferred. The inclusion of galvanised steel mesh frame delivers clean uniform lines with selected stone fill forming a thin layer as the façade:

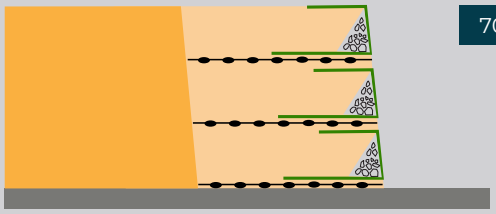
- **Save time** with quick and easy installation due to the heavily galvanized welded mesh panels and bracing struts which hold the face at the desired angle during construction, obviating the need for external framework and allowing easy filling with a small size stone aggregate
- **Reduce cost** by using a durable hard rock face that does not require ongoing maintenance
- **Independently verified and tested** with BBA-HAPAS certification

Geogrid Wrap-Around Structures

Reinforced soil structures can be built using only a geogrid which is conveniently wrapped around the fill material to form the front face, providing both confinement and the structural connection capacity requirements.

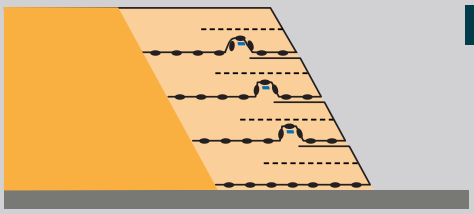
Wrap-around structures are typically used with vegetation cover for relatively shallow sloped permanent structures or with minimum protective cover such as a non-woven geotextile for temporary slopes or walls. They are relatively easy to build but consideration needs to be given to facing durability and long-term protection against the elements if vegetation cannot be sustained. This construction methodology is also often used in buried thrust wall applications:

- **Reduce environmental impact** with the option to have a vegetative facing in lieu of manufactured hard facing units
- **Save cost** by removing the need for separate facing elements although consideration must be given to the construction methodology which may require temporary formwork



70° to 87°

- Rock fill veneer front face
- No external formwork required when installing
- Permanent facing unit
- Save on rock fill
- Geogrid is terminated at the front face



55° to 90°

- Suited for both temporary or permanent structures
- Requires temporary formwork or sand bags for construction
- Exposed geogrids on the wrapped face require protection
- Can be used as permanent thrust relief behind an existing structure

Shallow Slope Structures ≤45°

Horizontal layers of geogrid reinforcement terminating at the front face will allow the slope angle to be maximized however, in lieu of a continuous geogrid wrap-around at the face the slope surface will need to be protected from erosion.

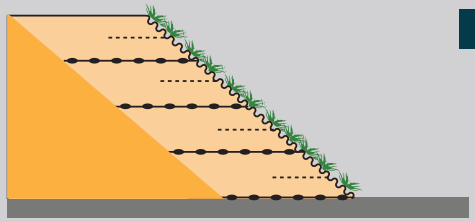
Consideration will need to be given to covering the slope with a biodegradable erosion control blanket or a polymeric option if the conditions are more severe. The design of these structures under heavy loading or where the embankment materials are marginal will need careful consideration in order to optimise the structure:

- **Save cost** with the ability to re-use site won material that can attract significant costs for removal
- **Save time** using conventional embankment construction techniques that do not require external formwork
- **Reduce environmental impact** by greening with endemic vegetation

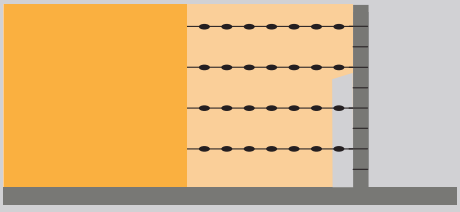
Segmental Block Retaining Walls

Segmental block retaining wall systems are a proven solution and a cost-effective alternative to conventional concrete retaining walls; significant savings are commonly reported. There are numerous types and shapes available and come in a variety of textures and colours. These wall systems are most often used in conjunction with high strength geogrids providing the necessary soil reinforcement.

Most dry stacked segmental block facing systems utilise a simple frictional connection between the blocks and the geogrid, and we strongly recommend using our Miragrid GX range of geogrids in these applications. They are strong, flexible, made from high tenacity polyester yarns covered with a protective black polymer coating perfect for achieving a good frictional connection.



- May consider site won fill
- Geogrid is terminated at the front face
- Erosion control mat installed on the slope face
- Typically vegetated front face
- Economical and environmentally friendly



- Hand stacked precast concrete blocks
- Wide choices of textures and colours
- Positive or frictional connection

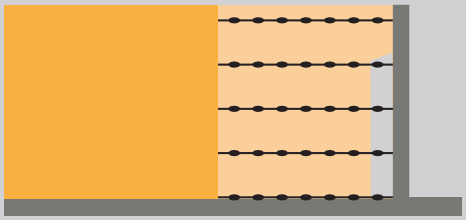
TW3® Concrete Block Retaining Walls

Tensartech TW3 Keystone wall system is a proven and practical engineered solution to segmental block retaining walls. The system's precast modular blocks are positively connected to Tensar's uniaxial geogrids which reinforce the soil backfill to create a retaining wall with a near vertical face angle. The system offers:

- **Increased strength and resilience** particularly in heavily loaded situations and in seismic areas due to the positive connection between the facing unit and geogrids; full scale shaking table testing conducted with up to 0.63g horizontal acceleration has shown minimal face deflection values
- **Efficient design** layouts by taking advantage of the positive connection facility and allowing less reinforcement overall
- **Cost and time savings** with relatively simple construction methodology utilising light weight dry stacked units
- **Independently verified and tested** with BBA-HAPAS certification

Full Height Concrete Panel Walls

Full height precast concrete panel walls offer great design flexibility and many different surface textures and patterns can be created. Short lengths of Tensar RE500 HDPE geogrids are cast into the rear of the concrete panel during production to allow for later connection of the main geogrid reinforcement. Once the panels are propped in position the geogrid reinforcement is connected to the cast in grid sections using high efficiency polymeric bodkin connectors. Independently verified and tested with BBA-HAPAS certification.



- Geogrid starter is cast into the concrete panel
- Full height panels allow for rapid installation
- Primary geogrid reinforcements connected using polymeric bodkin connectors
- Different textures and patterns can be created

Temporary Retaining Wall Structures

Geofabrics provides an innovative system when temporary elevated working platforms and grade separation structures are required. Using a customised form of our Green Terramesh system, we are able to provide project specific solutions meeting your design requirements; the lid, face element and tail length are all adjustable and the integral framework facilitates rapid wall construction.

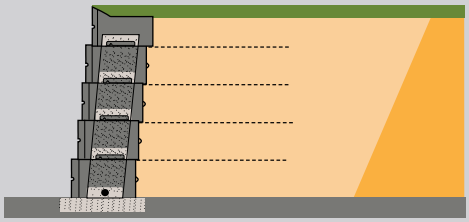
Where loads are significant, the double twist wire mesh tails can be augmented with Maccaferri's Paralink or Paragrid range of geogrids to significantly increase strength requirements. These types of geogrids are available in strengths of up to 1,600 kN/m and are protected with polyethylene sheathing able to withstand rigorous installation activities and large aggregate backfill.

VERTI-BLOCK® Concrete Block

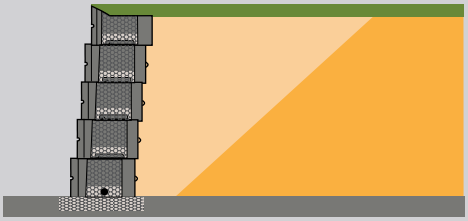
Verti-Block is perfectly proportioned for popular types of civil engineering & landscaping projects, including gravity walls up to 4.3m high — even higher when reinforced. Its hollow design makes it affordable and easier to handle than solid blocks. Plus, Verti-Block is less labor intensive than small, hand-laid blocks and offers a more practical solution than a cast-in-place retaining wall. The system offers:

- **Unique size and design** – a mass hollow block measuring 610mm (h) x 1200mm (l) x 910mm (w), Verti-Block is perfectly proportioned for soil reinforced and gravity walls. The range offers a variety of shapes, including corner blocks, to accommodate for all civil engineering & landscaping needs
- **Strong and versatile** thanks to its interlocking connection design, Verti-Block units ensure a secure fit. It also ensures that just the right amount of crushed stone is used as fill as it interlocks, creating a continuous mass for greater strength.
- **Easy installation** – blocks can be moved and put into place with smaller equipment; there's no need for heavy machines like a crane. The interlocking connection design increases placement accuracy, ensuring strength and an exact installation every time.
- **Engineered for strength** – the hollow nature of Verti-Block improves its ability to retain earth, even in poor soil conditions, it can be stacked higher than other blocks with or without the use of tiebacks or geogrids.
- **Cost effective** due to its hollow design, Verti-Block is lighter which lowers labour, equipment and transportation costs. It's quick to install and more cost effective than solid block options. Internal drainage through the block's infill means no over-or under-excavating because additional crushed stone backfill is not required
- **A look like no other** - Verti-Block is a popular favourite for its rockwork appearance. It makes a finished wall appear more like stacked stone. Plus, it is easily stained to complement its surroundings with a beautiful, weather and UV-resistant finish.

20' GEOGRID FRICTION CONNECTION



TYPICAL GRAVITY WALL WITH 36" VERTI-BLOCK



Technical support and service

For more than 30 years, Geofabrics Australasia has been providing technical support throughout Australia, New Zealand and the Pacific Islands. With our leading expertise in the field, we can assist you to save time, cost and improve efficiency which can be critical to your project.

Geofabrics, along with our global partners Maccaferri, TenCate and Tensar offers a full range of associated geotechnical product solutions including:

- Subgrade stabilisation in areas of soft ground for access roads and working platforms
- Erosion control and surficial stabilisation on vulnerable cut slopes
- Basal reinforcement of embankments constructed over soft ground, sub surface voids or old mine workings
- Stream and riverbank stabilisation and protection

We work with you to understand your project requirements and together, develop solutions with full support from our qualified civil engineering teams. Our wide range of products and systems combined with our many years of proven in-field experience in different regions with different climatic conditions, soil types and seismic conditions allows us to offer a specialised solution to your particular engineering challenge.

By engaging our team of experts at an early stage of your project, will allow us to develop and evolve design concepts to help you save time and money. We also offer project support with:

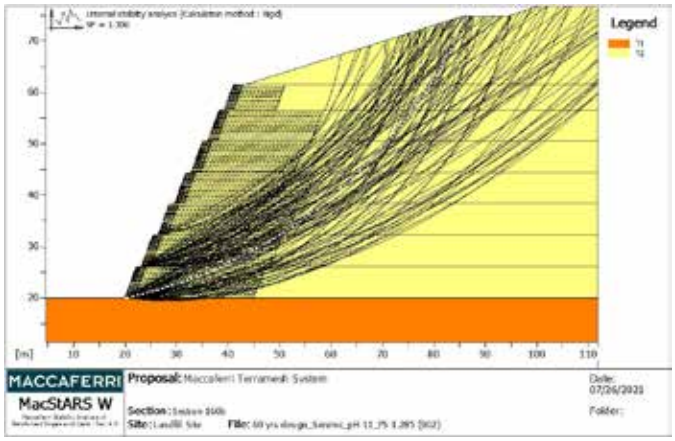
- Preliminary design proposals
- Construction and installation advice and guidelines including practical tips
- Quality control certification
- Product specifications and technical data
- Extensive case studies
- Typical standard drawing details
- In-depth technical papers on specific projects or subjects
- Design software tools

Design software services

We have a full suite of proven in-house design software developed over many years that we are able to share with you for the analysis and design of retaining walls and reinforced soil structures. Available at no additional cost, our engineers can provide software training or demonstrations on request. Software programs that are available include:

- **Gawac 3.0**; a Maccaferri package for designing mass gravity gabion retaining walls
- **MacStars 4.0**; a Maccaferri package for designing reinforced soil structures and retaining walls
- **TensarSoil**; a Tensar package for the design of reinforced soil structures and retaining walls
- **TensarSlope**; a Tensar package for assessing overall slope stability of reinforced soil structures

With Geofabrics, it's about working smarter together every step of the way.



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