Coastal Protection

High quality geosynthetic solutions for
Coastal Protection and Erosion Control

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Coastal Erosion

Coastal areas are home to major cities around the globe, as well as roughly 40% of the world's population. Rising sea levels and flooding as a result of climate change is increasingly threatening these coastal areas and causing the loss of tens of thousands of acres of land each year.

Coastal erosion is the process by which rising sea levels, storms and other phenomena wear down or carry away the rocks, land and sand making up a coastline.

Coastal areas face relentless challenges from natural forces like waves, tides and currents, leading to erosion and threatening both infrastructure and ecosystems.

Whilst all coastal areas are subject to storms and natural events causing erosion, these factors have accelerated as sea levels rise and human activity such as unsustainable development is also contributing to erosion processes.

Coastal erosion has a significant impact on tourism, shipping, fishing, agriculture and other industries dependent upon coastlines. From lost land and destroyed assets to reduced revenue potential, coastal erosion is a growing concern for nations all around the world.

Erosion as a result of corrosion, abrasion and hydraulic processes, can jeopardise the stability of shoreline structures and exacerbate environmental degradation.

Conventional methods, such as the use of armour stone, although effective, can be prohibitively expensive and environmentally damaging.

Moreover, aging infrastructure and narrowing beaches increase the urgency of coastal rehabilitation measures and highlight the need for sustainable solutions.

Geotextiles & Coastal Protection

Geotextiles are a versatile type of synthetic fabric widely utilised in various engineering applications, including coastal protection. They play a crucial role in stabilising shorelines and preventing erosion in coastal areas. Geotextiles find applications in beach nourishment, dune stabilisation and seawall construction, each contributing to the overall protection of coastal regions.

The degradation of coastal areas due to erosion poses significant challenges, particularly concerning the stability of hydraulic defense structures. In beach nourishment projects, geotextiles help secure newly added sand, safeguarding it against the erosive forces of waves and currents.

In dune stabilisation initiatives, geotextiles are instrumental in fortifying dunes, providing protection against storm surges and wave damage that benefits both the beach and nearby properties.

When incorporated into seawall construction, geotextiles are positioned between the seawall and the water, serving as a barrier against erosion and scouring at the seawall's base, thereby prolonging its lifespan.

A significant advantage of employing geotextiles alongside rip-rap or armour stone is the creation of a more resilient coastal protection system. Geotextiles anchor the soil, guarding against erosion, while rip-rap fortifies the defense against wave action and storm surges. This combination effectively dissipates wave energy, reducing the impact of storm surges and lowering the risk of damage to the beach, dunes, and nearby properties.

Coastal protection structures like rock revetments rely on granular filters to prevent sand from washing away and ensure stability. Geotextiles can replace a significant portion of this granular filter, offering a more economical and ecologically friendly alternative.

Traditional defense mechanisms rely on costly and ecologically harmful solutions, underscoring the need for innovative approaches to coastal protection. What makes geotextiles particularly appealing in coastal protection is their cost-effectiveness and ease of installation. Moreover, geotextiles demonstrate durability in the challenging environmental conditions prevalent in coastal areas.

ABG has a full range of geotextiles and geosynthetics designed especially for coastal applications, catering to specific project requirements and taking into account the needs of the project site. This includes high durability, high energy absorption and excellent filtration properties.

Features and benefits

Durable construction materials are essential for long-lasting projects. They must endure for at least a century and offer high performance at reasonable costs.

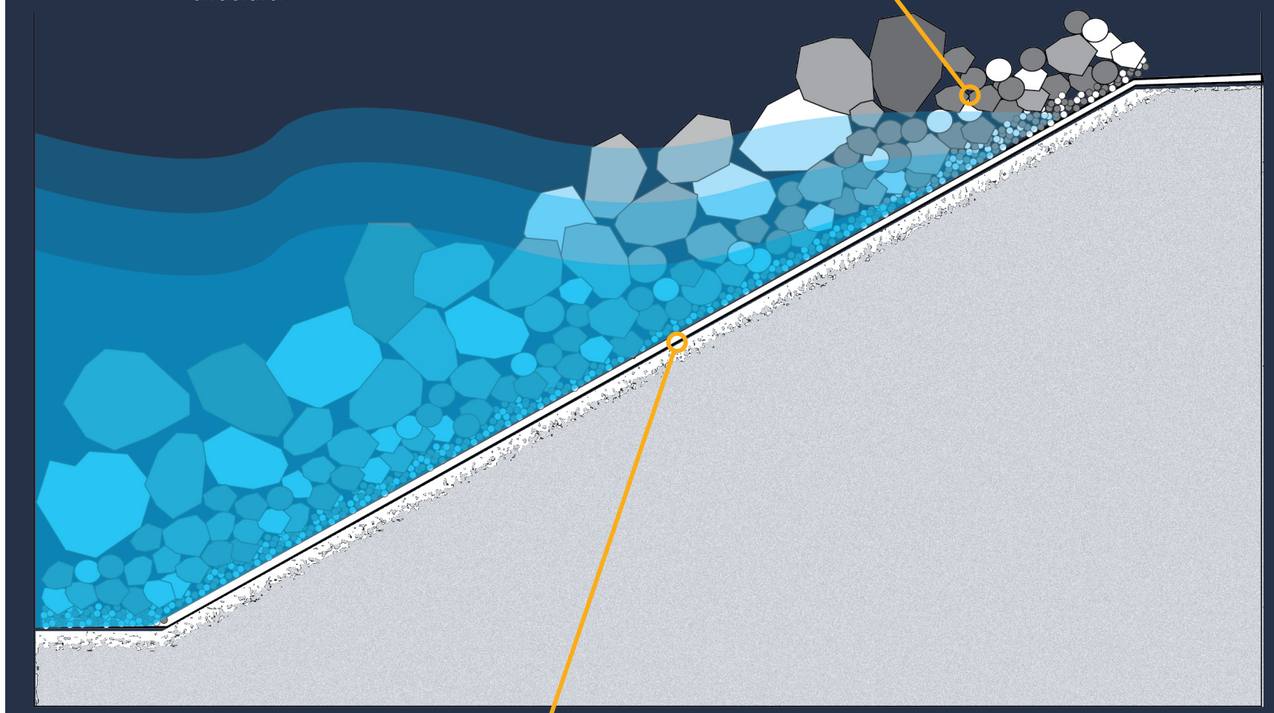
These materials should resist damage, even in demanding fill applications and be able to withstand corrosive elements like acids, alkalis and UV radiation.

Additionally, they need to be biologically resistant, puncture-resistant and provide superior protection for membranes and liners.

Finally, high permeability, fine pore size and a reduced carbon footprint are vital considerations, ensuring both functionality and sustainability in construction projects.

Rock armour

A typical application of heavy duty nonwoven geotextiles is beneath rock armour. In this case, the nonwoven geotextile acts as a separation and filtration layer between the sand and the placed rock armour. Overall, a geotextile filter can replace up to 1m of conventional granular filter buildup. In such a configuration, the geotextile filter prevents washing out of sand particles through wave action, which improves the long-term stability of the structure.



Geotextile layer

The geotextile provides a layer of protection against erosion by holding the soil in its place, while the rip-rap provides a layer of protection against wave action and storm surge.

Geotextiles & Coastal Protection

Seawall construction
When used in seawall construction, geotextiles are placed between the seawall and the water to help prevent erosion and scouring at the base of the structure.

This can help prolong the life of the wall and geotextiles are often used in combination with rip-rap (also known as armour stone) to provide an additional layer of protection to the structure.

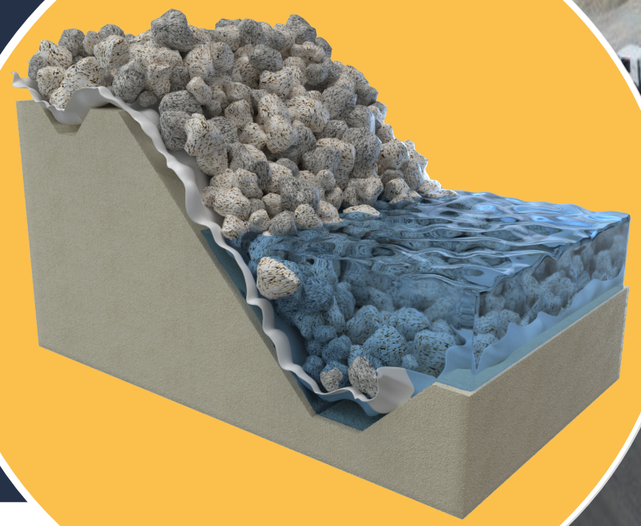
Wake and wave protection
One of the main advantages of using geotextiles in combination with rip-rap is that it creates a more stable and durable coastal protection structure.

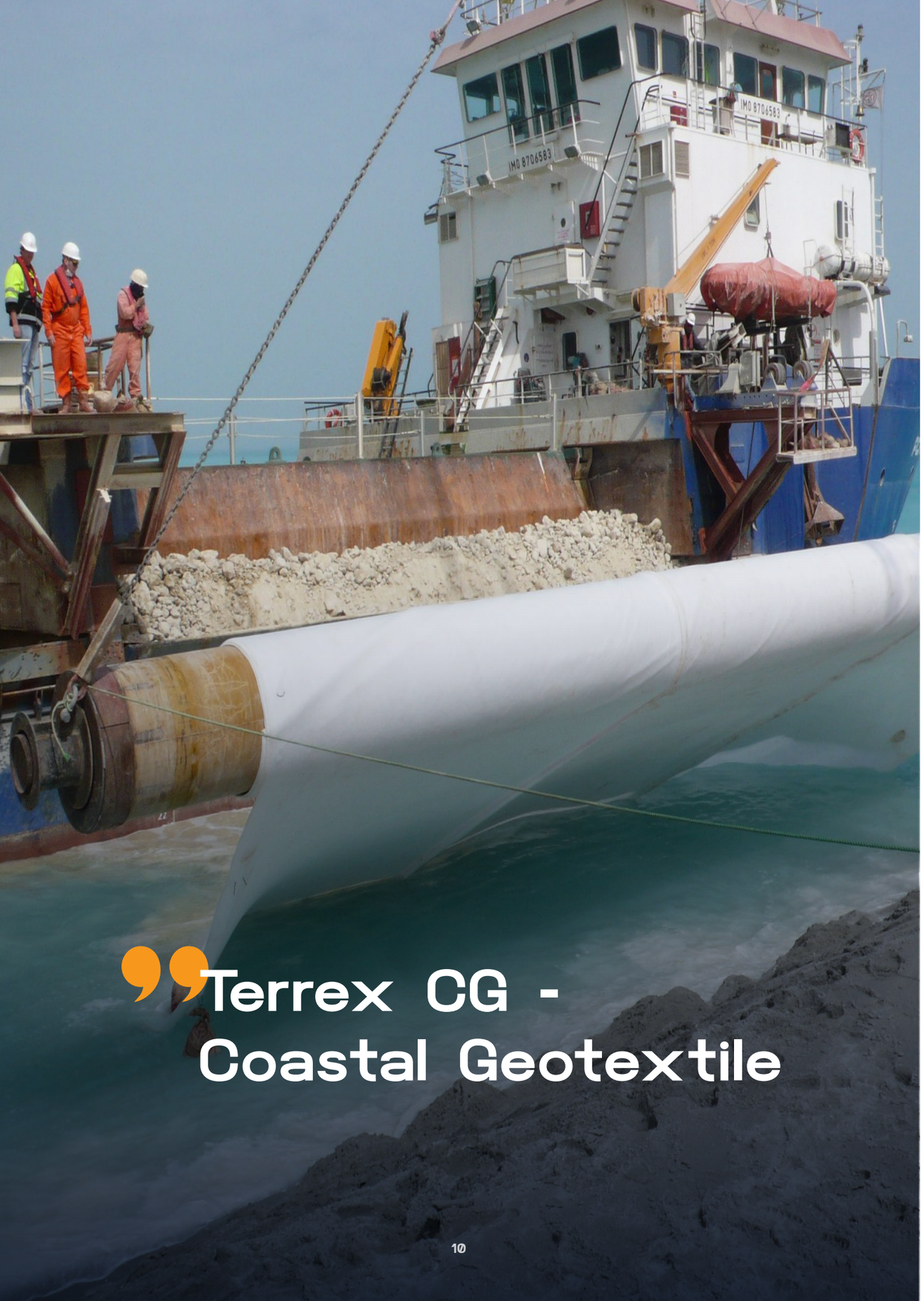
The geotextile provides a layer of protection against erosion by holding the soil in place, whilst the rip-rap provides a layer of protection against wave action and storm surges.

Additionally, the combination of the two materials can help to dissipate wave energy, thereby protecting the beach, its sand dunes and nearby properties.

Typical applications:

- Erosion Protection
- Seawall Construction
- Dune Stabilisation
- Beach Nourishment
- Rip-rap Structures





"Terrex CG - Coastal Geotextile

Terrex CG for Coastal Protection

Terrex CG is specially engineered to provide exceptional performance in separation, filtration, and protection - whilst maintaining reduced thickness compared to traditional geotextiles. These geotextiles offer benefits in coastal protection beneath concrete defences, and can also be used for the protection of impermeable membranes.

ABG Terrex CG coastal geotextiles are designed to be used as filtration and separation layers in hydraulic defence structures.

Placed onto lower permeability beach materials they prevent the migration of fine particles, while permitting the free passage of water. This creates a stable and consistent bedding layer, often replacing the need for more layers of armour stone and generating significant cost savings.

The advanced Terrex CG range is often used as a cost-effective alternative to traditional lining layers and provides benefits for toe design applications.

The range has been designed to resist damage during construction loading, with high strength and elongation properties that prevent tearing or puncture.

Advantages

- Terrex CG can be used as an effective replacement for starter layers, saving in materials, transport, carbon and installation costs
- The amount of material sinking into the coastal sand is minimised, with the textile preventing drainage stone being lost into the soft subsoils
- Differential settlement is reduced, helping with long-term alignment of revetments or breakwaters
- Available in five different textile weight / thicknesses to suit the loading conditions in widths of up to 6.5m
- The textile can often replace the need for a granular layer

Project Story

The new LNG terminal in Dunkirk represents an additional capacity of 13 billion m³ of natural gas per year and makes an important contribution to the supply and functioning of the natural gas market in northwest Europe.

In order to protect the inner port from wave erosion, rock armour was installed to provide coastal protection.

The design called for a geotextile filter underneath the rock armour that would withstand the harsh conditions and installation process.

In total, 250.000 m² of nonwoven geotextile was supplied. The Terrex CG nonwoven geotextile selected for this project offers an optimal combination of strength and elongation, as well as excellent hydraulic characteristics.

This results in a high energy index, allowing absorption of possible installation damage. The geotextile filter provides long-term stability to the rock armour layer, preventing fine sand particles from being washed away from behind / underneath and preventing shifts or subsidence.

In order to minimise the stand-in time of the pontoon during the installation, panels were produced in 15m widths. This was done by stitching together 5m wide rolls in the finishing department. In doing so, installation on the water could take place a lot faster compared to standard 5m wide nonwoven product and a big cost saving was realised.

Project
Dunkirk LNG Terminal

Quantity
250,000m²

Product
Terrex CG®

TERREX CG

Sandex for Coastal Protection

Sandex is a geocomposite consisting of a layer of quartz sand between a nonwoven geotextile and a nonwoven composite with scrim component, needle-punched together to provide internal reinforcement.

Sandex 5000 GSL provides a heavy-duty composite mat that is easy to sink and install underwater without the need for additional ballast / specialist equipment.

Designed to be placed over sediment, earthen or synthetic surfaces underwater, the mat provides protection from damage by erosion, scouring, wave action, heavy equipment or other forces.

Sandex provides high filtration performance, separation properties and construction stability.

Applications include revetment construction and rehabilitation of:

- Embankments
- Canals, waterways and reservoirs
- Marine and coastal structures including dams, dykes, seawalls etc.
- Other hydraulic engineering applications

Designed to provide a displacement-resistant filter, the Sandex composite comprises four-layers with encapsulated quartz sand in the centre that allows the installation of a geotextile filter in even the most challenging conditions.

SANDEX GSL

Sandex is recommended for application whenever the local hydraulic conditions make the installation of a standard filter impossible without incurring exceptional cost / effort.

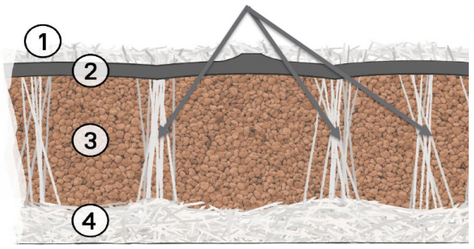
The heavy duty weight per unit area delivered by the quartz sand layer simplifies installation and offers enhanced protection against displacement.

This ensures an efficient filtration performance for revetments, even when working underwater.

Installation for complex hydraulic conditions:

- Quartz sand layer enables installation underwater without the need for additional ballast / equipment
- Filter-stable construction allows water to pass through, but prevents fine soil migration
- Separation layer for granular soils with different grain sizes
- Simplified installation process
- Conforms to soil deformations and settlements
- Improved sustainability compared to alternative aggregate based revetment designs
- Standard product dimensions:
  7.5mm thickness x 5m wide x 40m length

Needle Punched Fibres



1. Nonwoven or

2. Nonwoven+Scrim component

3. Quartz Sand

4. Nonwoven

Coastal Geotextile Specification

The inclusion of an appropriately sized and weighted geotextile at the interface with the beach permits the free movement of water whilst retaining fine particles and preventing them from being washed away.

A geotextile filtration system must function throughout its deign life without clogging, this is vitally important since a coastal protection system cannot usually be easily re-installed.

Rather than stopping all particles from passing through the filter, a correctly sized textile will allow a percentage of smaller particles to pass through it. The overall coastal structure is then stabilised by the larger particles being held in place. Once in direct contact with the filter, the larger particles restrict the movement of the remaining particles to stabilise the entire soil layer.

The failure mechanisms that must be considered when specifying a filter for reverse flow applications include:

1) Soil retention - failure to retain soils in place may be due to an incorrectly specified pore size or inadequate contact between the soil and the filter. It could also be because of damage to the textile during installation or from abrasion in service.

2) Insufficient permeability - this can destabilise the entire coastal structure by creating excessive pore water build-up pressures. This could be due to the geotextile having a poor initial permeability at low head pressures, or excessive soil volumes being placed during installation causing localised blockages.

$$v = \frac{Flow\ rate}{Area_{geotextile}} = \frac{[l/s]}{[m^2]} = \frac{l}{m^2 \cdot s}$$

COASTAL GEOTEXTILE SPECIFICATION

The primary properties critical to the performance of any geotextile filter specification are:

1) Pore Opening Size - the opening size of a geotextile is measured using EN 12956, determined from the particle size distribution of a graded granular material being washed through the geotextile filter.

The size of the largest particle collected in the sieve is theoretically the maximum opening size, however this value cannot always be practically measured. The standard therefore defines an O_{90} value whereby 90% of the average diameter of soil particles are retained in the sieve. For example, an O_{90} of 100 microns (i.e. 0.10mm) means that 90% of the pores are 0.10mm or smaller. In silty sand conditions particle sizes range from 2mm to 2 micron in size and any soil particles that are smaller than the geotextile pore size will pass through the geotextile, whilst the larger particles are retained.

To function correctly a coastal geotextile must have an opening size that is smaller than d_{50} - defined as the median particle diameter size. The established design rules for granular soils in reverse flow coastal conditions state that the geotextile's O_{90} size should be less than the d_{50} of the soil being filtered and for a cohesive soil = $O_{90} < 10 \times d_{50}$.

2) Permeability - to ensure the free circulation of water and prevent an increase in internal pressure, basic filter principles govern that each layer of a filter system is more permeable than the layer beneath. The flow rate of water through the geotextile is therefore designed to be far greater than that of the flow rate through the soil so that the geotextile does not act as a barrier to the free drainage of water.

In coastal applications the permeability of sand is approximately 1 x 10-4 m/s and a typical nonwoven geotextile will have a perpendicular water flow of around 100 l/m2·s at a 50mm hydraulic head. This is at least 1,000 times greater than that of the granular soils.

In most applications the factor of safety for permeability is therefore very high, even allowing for some minor deterioration in the flow performance of the geotextile over time.

3) Extensibility - other properties which have a bearing on the geotextile's filtration performance relate to its ability to conform to the contours of the underlying surface without spanning and the material's elongation properties. Having a range of geotextile thicknesses available to suit the loading conditions is key to achieving this.

A correctly specified & installed coastal geotextile will:

- Restrict particle movement and maintain the overall soil structure
- Allow loose, fine particles to pass through it to prevent clogging
- Maintain permeability in the short and long-term

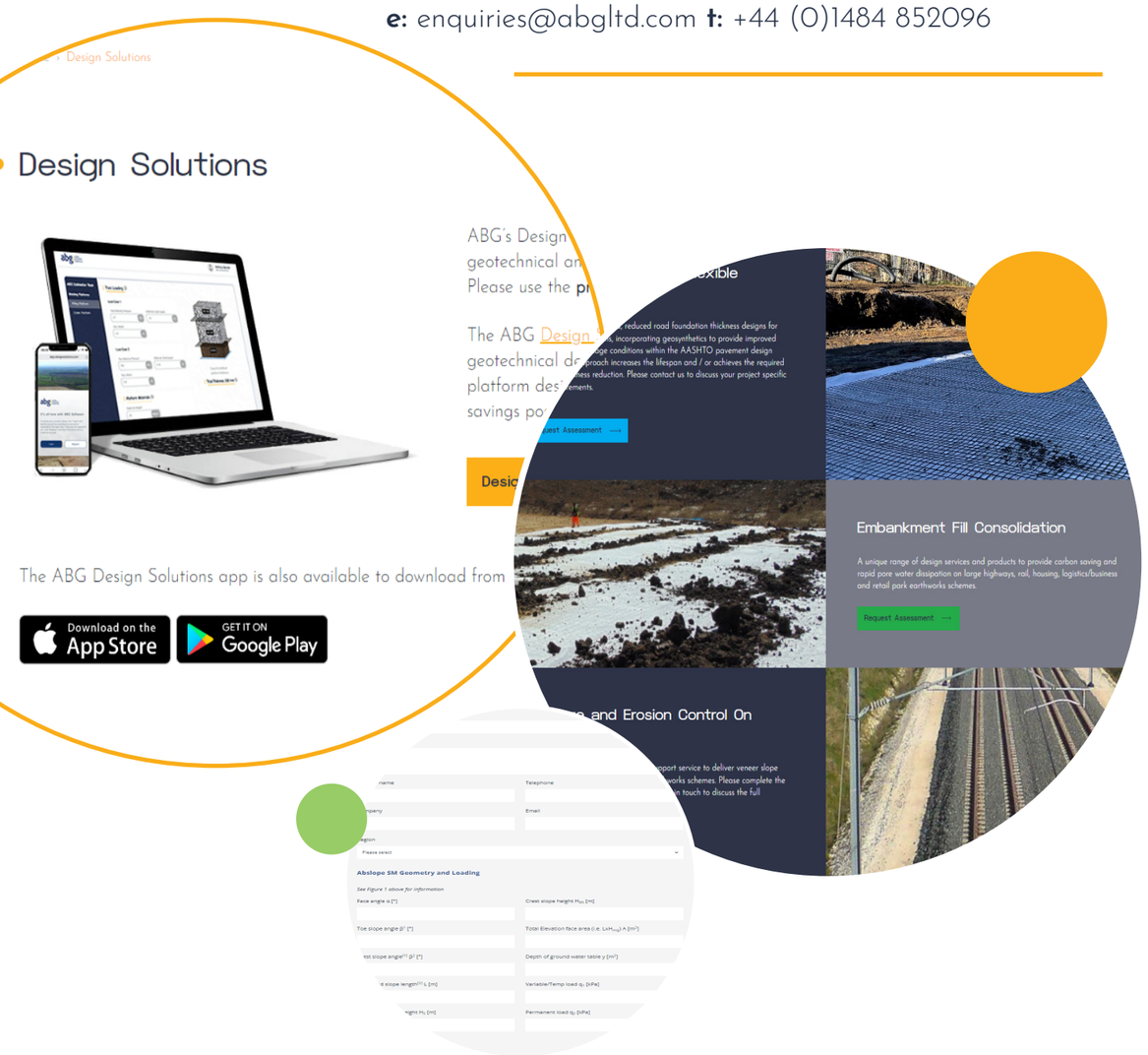
Design Solutions

Our experienced engineering department is on hand to assist with your coastal project requirements.

A range of project assessment forms are now also available on our website to assist with your project design @ www.abg-geosynthetics.com/design-solutions

Contact the ABG engineering team for design and application advice:

e: enquiries@abgltd.com **t:** +44 (0)1484 852096



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ABG Geosynthetics
E7 Meltham Mills Road, Holmfirth, HD9 4DS
T: +44 (0)1484 852096 **E:** enquiries@abgltd.com **W:** www.abgltd.com