Rail Infrastructure

Geosynthetic systems for railway infrastructure applications

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Rail infrastructure challenges

Adverse weather conditions are subjecting rail infrastructure to intense and frequent storm events. In the face of a more erratic climate, it is more important than ever that civil engineers and national operators take effective steps to manage drainage and erosion across rail networks.

Without appropriate measures in place, heavy rainfall and storm events can give rise to a host of issues. As well as landslips and sea defence damage, surface water can cause considerable flooding and damage to the trackbed.

It is with these problems in mind that rail engineers must look to implement high-performance drainage systems, in order to ensure network resilience and passenger safety.

Key considerations include implementing systems to protect against erosion, controlling the quantity and quality of stormwater run-off and ensuring the stability of sea defences and rail embankments.

For trackside drainage, subsurface drainage options were previously limited to crushed stone filter drains.

However, with sustainability increasingly high on the agenda this requires engineers to look again at the tonnage of clean crushed stone consumed by traditional designs and for more modern, carbon saving alternatives to be adopted.

The advantages of geosynthetics in railway engineering

ABG has been designing, manufacturing and supplying geosynthetics for transport drainage applications for over 35 years. Our systems include a series of channel and embankment drainage options to meet Network Rail standards.

This winter's record rainfall and widespread flooding brought the issue of trackside drainage into sharp focus. Large sections of the network were inundated, flooding tracks and causing numerous embankment slips. The scale of disruption highlights the importance of effective drainage systems. They must be able to resist high static and dynamic loads and be fully maintainable over a design life in excess of 60 years to provide the best whole-life cost. As most drainage systems are installed during remediation, where time is limited, speed of installation is also a very significant factor.

Traditional cess drains

Current trackside drainage is reliant on cess drains, consisting of cut trenches filled with crushed stone below the sleeper level, either side of the track. Excavating traditional cess trenches for drainage pipes and lining the sides of the trench with geotextile, prior to backfilling with crushed stone, is a relatively expensive and laborious process.

Trenches deeper than 1.5 metres must be shored for support, prolonging the installation time. Then there is the cost of disposing of the arisings and procuring new stone. In addition, crushed stone is not a particularly efficient drainage material, since it interlocks when compacted, leaving very little void space for water flow.

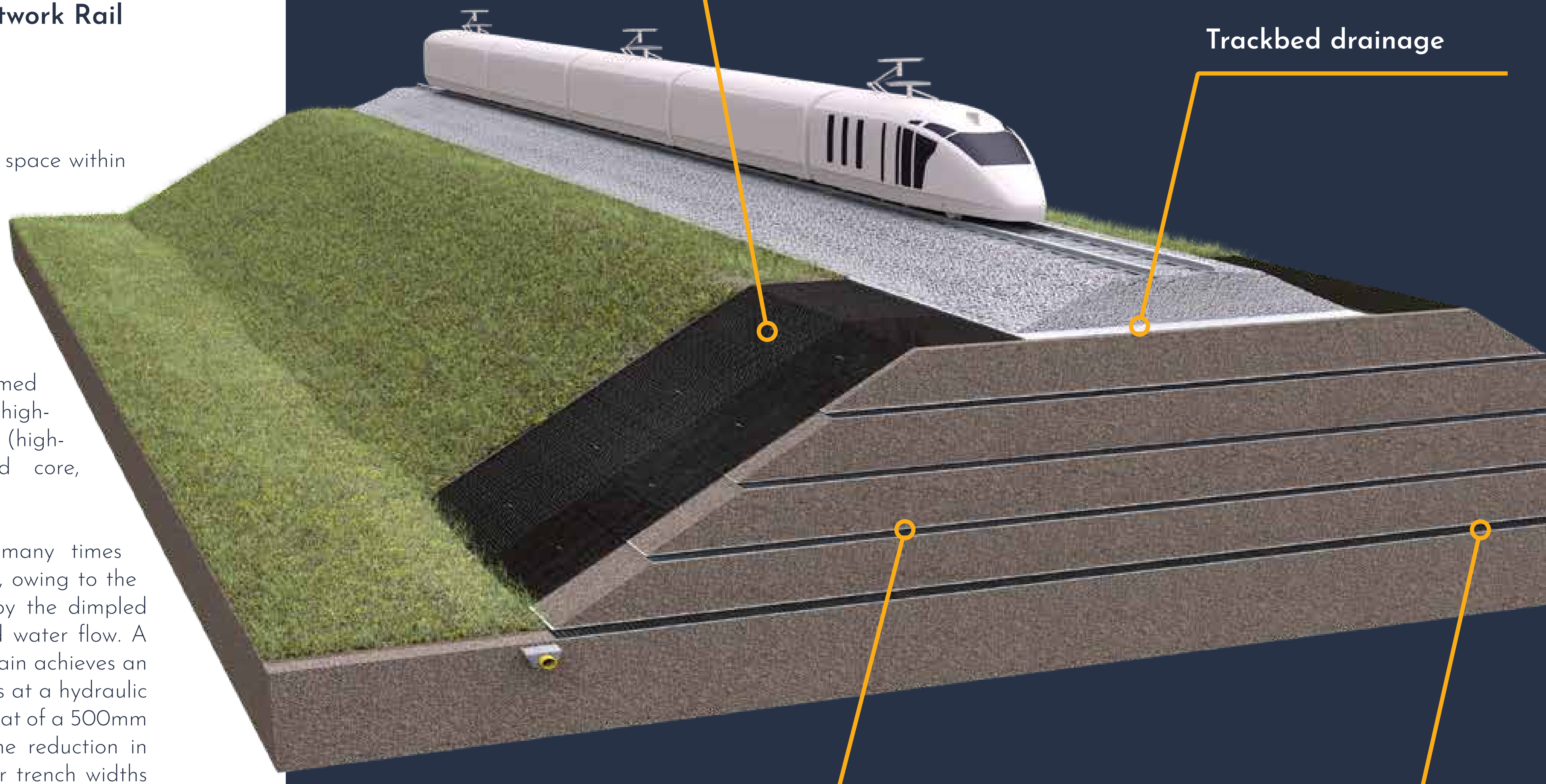
Alternative solution

The realisation that it is the void space within a layer of crushed stone that achieves the drainage flow led to the development and specification of Fin drains or Fildrains, polymeric cores that have a high void ratio.

ABG Fildrains are a preformed drainage layer comprising a high-strength, lightweight HDPE (high-density polyethylene) cuspated core, laminated with geotextile.

Fildrain has a flow capacity many times that of traditional crushed stone, owing to the unique open structure created by the dimpled core profile, allowing unhindered water flow. A 7mm thick cuspated core of Fildrain achieves an in-plane flow capacity of 1.0 l/m/s at a hydraulic gradient of 1. This is eight times that of a 500mm layer of drainage stone. It is the reduction in layer thickness, and the narrower trench widths required, that enables the geocomposite drain to achieve project time and cost savings, reducing closure times and the number of trackside deliveries required.

Fildrain has many applications in railway cuttings, cess and embankment drainage and is BBA approved, meeting requirements for load resistance, maintenance and fast installation. It is simply installed into narrow trenches, with the excavated soil replaced as the backfill and then topped with a thin layer of crushed stone.



Design Considerations

The importance of achieving good earthworks drainage - to reduce groundwater levels, control pore water pressure and to increase bearing capacity - has long been established. Traditional methods use mineral filter layers, which is still the default position, but there is now a wider range of techniques available.

Surface Water or Groundwater

Geocomposite drainage is suitable for dealing with groundwater and groundwater plus surface water, but not ideal for purely surface water. Surface water carries silt and detritus and this is best dealt with by pipes and channels. For situations with combined surface water and groundwater, e.g. Cess / French Drains, the surface water must pass through a layer of filter stone before reaching the geocomposite drain. This filter stone, typically 300mm deep, will trap the silt and detritus and can be periodically excavated and replaced. Designing a geocomposite for filtered surface water or groundwater to achieve a 120 year life is therefore very simple.

Traditional Crushed Stone Drainage

Crushed stone or gravel is relatively abundant but not always of the correct quality to be used as drainage. It is expensive and has high carbon emissions associated with processing and transport. Graded crushed stone is often used to perform both as the filter and drainage, but this limits its drainage performance. Single sized crushed stone or gravel is more effective for drainage applications when specified with a geotextile filter. Crushed stone drainage is not often designed, but is utilised based on standard specification e.g. Permeability 1 x 10-3 m/s and minimum thickness, e.g. 500mm. This leads to stone drainage layers being over or under capacity. Neither situation is ideal. To move from crushed stone drainage to geocomposite drainage, engineers first have to be able to calculate either the required flow or equivalence of the specified crushed stone drainage. In-plane flow in a drainage layer is governed by Darcy's Law (**Q = k i t**) where **k** is permeability (m/s), **i** is hydraulic gradient (no unit), **t** is layer thickness (mm) and **Q** is in plane flow capacity (l/m/s). So a 500mm layer of 1 x 10-3 m/s at hydraulic gradient of 1/100 has a capacity of 0.005 l/m/s.

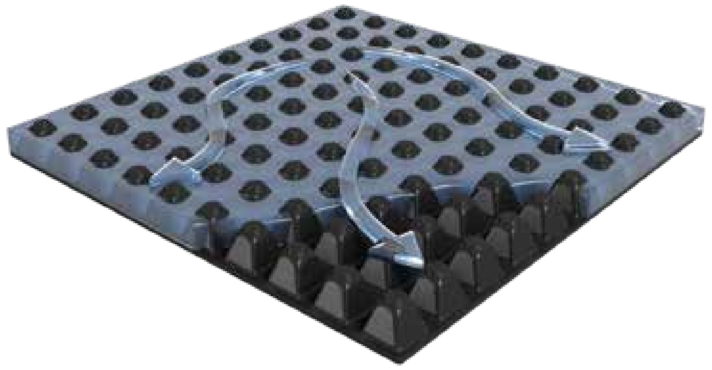
Geocomposite Drainage

The realisation that it is the void space within a layer of crushed stone that achieves the drainage flow led to the development of polymeric cores that have a high void ratio. The cores must also be flexible and have sufficient compressive strength. The cuspated void combined with a geotextile together forms the geocomposite drainage layer.

The reduction in layer thickness enables the geocomposite drain to achieve project time and cost savings. To be equivalent to drainage stone, the geocomposite must be able to demonstrate equivalent in-plane flow capacity under confining pressure in machine direction (MD) and cross machine direction (CMD). Having this true equivalence enables the geocomposite to be used at any orientation and allows flow to continue past any localised obstruction. Just like stone drainage, geocomposite drainage has a large surface area to collect water from the ground and guide this to the network of collection pipes.

In-plane Flow Capacity

The in-plane flow capacity of the geocomposite in MD and CMD when subjected to the confining pressure is a key design criteria. This is tested to EN ISO 12958 or ASTM D4716 using SOFT boundary platens to simulate soil backfill.



Prefabricated drainage has evolved into geocomposite drainage and this continues to meet today's needs for off site construction, sustainability, carbon saving, cost saving and speed of installation.

The test places a specimen of geocomposite and a Neoprene soft foam in a transmissivity rig, jacked up to a confining pressure between 20 and 1,000 kPa, whilst water at the required hydraulic gradient flows through the specimen to give the inplane flow capacity in (l/m/s).

The limitations of some types of geocomposite drain include a weak core, a geotextile that intrudes into the core, or both. Fildrain with its unique cuspated core and laminated stiffened non-woven geotextile has been developed and manufactured to achieve minimal loss of performance even at pressures of 1,000 kPa.

Weaker cuspated products and poor geonet products resort to using EN ISO 12958 with HARD or RIGID platens. As can be imagined, these metal platens fail to replicate the soil backfill, resulting in no geotextile intrusion, giving these products an artificially high in-plane flow value on the datasheet that cannot be achieved on site. Therefore all datasheets that give HARD or RIGID platen test results should be disregarded (unless the geocomposite is to be placed on concrete or something similarly rigid).

Chemical Exposure

The polypropylene geotextile and polyethylene core of Fildrain have excellent resistance to a wide range of chemicals including acids, alkalis, salts, sulphates and petroleum. The Reduction Factors for Chemical Clogging (RFCC) and Biological Clogging (RFBC) for Fildrain are typically 1.

Long-Term Creep

The water flow capacity test to EN ISO 12958 or ASTM D4716 is a short term test that takes only minutes to perform. In use however, the geocomposite will be subjected to pressures for the whole design life of up to 120 years. All materials are subject to creep (including crushed stone), but plastics can be especially prone. Creep is defined as the continued reduction in thickness under a constant pressure over time. To assess the creep performance of Fildrain, ABG pioneered the application of the Stepped Isothermal Method (SIM) to measure the compressive creep of geocomposites. The method is now published as ASTM D7361 and ABG has an extensive library of creep data for Fildrain. The creep performance of Fildrain is excellent and provides the relevant in-plane flow reduction factors (RFCR) for 120 year design life.

Compressive Strength, Mass and Thickness

These values are meaningless to design and performance specifications. They are short-term tests and completely irrelevant in determining performance. For example, a 5mm product could be so full of plastic that it has almost no void ratio / flow. Likewise compressive strength is measured at the point when a product is crushed flat. The only purpose in this value is for CQA to determine that the correct grade of product has been supplied against the datasheet value.

Trackside Drainage

Fildrain installed vertically for trackside edges only requires a narrow trench for installation. This is especially beneficial when services are required to run along the railway line, reducing land take.

Multi-directional Flow

Crushed stone drainage has equal flow in all directions. For true equivalency, any geosynthetic selected must also have multi-directional flow in order to meet the requirements of the application.

Multi-directional flow means that in the event of a localised obstruction, the liquid within the core simply flows around the affected area. In some applications, the predominant flow is in the Machine Direction (MD) but in most applications the predominant flow is in the CMD (Cross Machine Direction). Fildrain has true multi-directional flow. Many other geocomposite drainage systems, including those based on geonets and random fibre cores, do not.

Cost effective

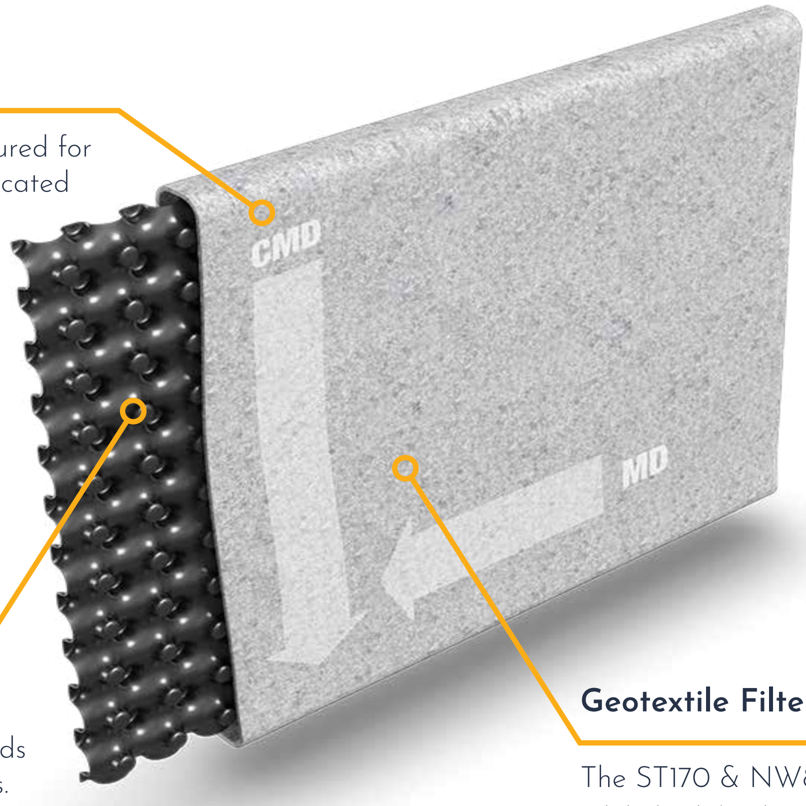
Using Fildrain can significantly reduce the volume of drainage stone required on site. This offers a number of financial benefits through reduced material handling, transport costs, material re-use and reduced disposal costs.

Minimises Environmental Impact

One vehicle load of Fildrain provides equivalent drainage to approximately 200 tonnes of crushed stone, greatly reducing the environmental impact associated with both quarrying the stone and the site vehicle movements required during installation. All these benefits combined assist smoother site logistics and help clients to deliver a more sustainable development.

Speed of Installation

Fildrain is efficiently and rapidly installed when compared with traditional systems, ensuring schemes are completed within the required time scale.



Off Site Construction

Fildrain is factory manufactured for delivery to site as a prefabricated unit.

Cuspated Core

High strength HDPE core is capable of withstanding loads applied by backfill materials. Cuspated core profile forms a void through which collected water can flow freely. Double cuspated structure allows flow both sides whilst forming an impermeable central barrier.

Geotextile Filter Fabric

The ST170 & NW8 geotextiles minimise intrusion into the core to ensure high performance. Pore size O_{90} and permeability create a filter zone within the soil backfill adjacent to the geotextile that enables long-term drainage performance.

Surface & Sub-Surface Drainage

Fildrain provides an ideal alternative for 'traditional' stone constructions in the formation of surface and sub-surface drainage systems, saving time and money on construction projects.

Cess Drains

On a large rail project there could be as many as four cess drains running the length of a railway in order to collect both ground and surface water from the verges, slopes and landscaped areas. These cess / French drains have traditionally been specified with and constructed using crushed stone. Using Fildrain not only saves the stone, but also requires less excavation width and so helps to accommodate a reduced land take.

Groundwater Drains

Control of groundwater is critical to achieving a stable formation. As a groundwater drain, Fildrain is installed either upright in narrow trenches or in large horizontal sheets to form a complete blanket across the formation.

Gas Venting

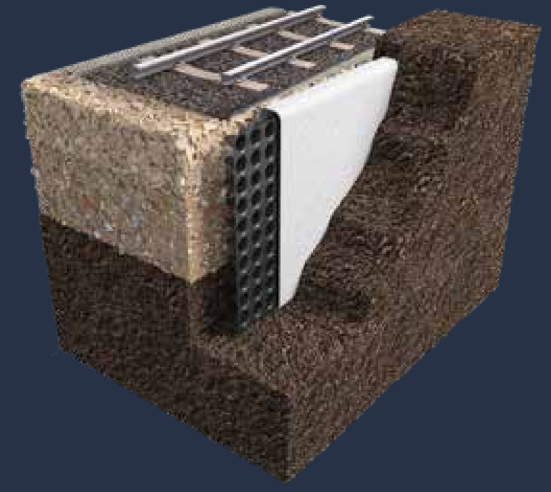
Fildrain is also used to intercept and collect ground gas.

Cut-off Drains

Cut-off drains are a special form of groundwater drain intended to intercept the groundwater flow and prevent it from passing into another zone. The use of geocomposites with a central impermeable barrier (such as the cuspated cores of Fildrain) makes a highly effective cut-off drain. The geocomposite's central impermeable barrier means that lateral flow can be intercepted within a much narrower trench than required by 'traditional' solutions.

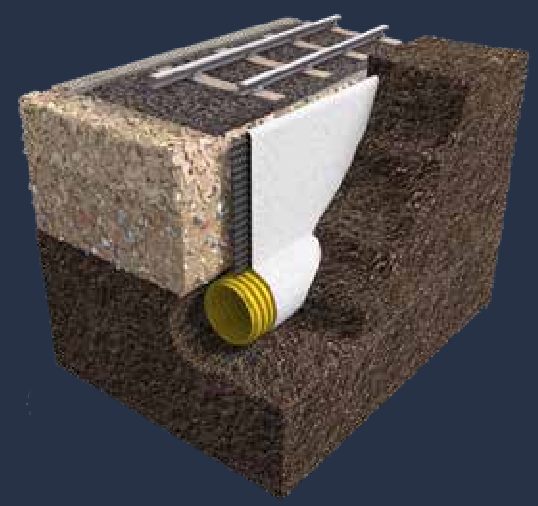
Traditional construction

Consists of an excavated trench, infilled with free-draining aggregate. This type of construction may require off-site material import and the removal of excavated materials. Trench width is typically 300mm to 500mm, a high cost option with a large carbon footprint.



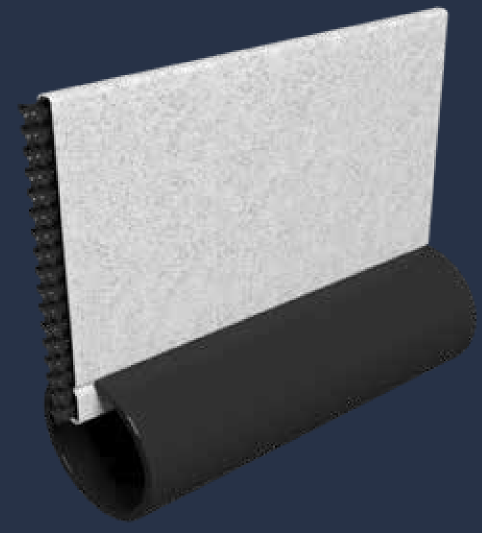
Fildrain Type 5

ABG Fildrain Type 5 is a BBA certified edge drain that allows excavated material to be simply backfilled into the trench and requires no import of clean aggregate. At the end of each run, a fitting is used to connect to the outfall pipe. Type 5 fin drain drainage system is a low cost system, with low embedded carbon which is suitable for manual or mechanical installation.



Fildrain Type 6

ABG Fildrain Type 6 provides vertical drainage on both sides, whilst acting as a barrier to protect the sub-base from inundation. Fildrain Type 6 is double cuspated and fully wrapped with a filter geotextile and an integral pipe sleeve. For larger diameter pipes Fildrain 7DW[P] or 7DW[F] are applicable.



Fildrain Type 7 & 7DW

The ABG Fildrain Type 7 fin drain is a BBA certified edge system that incorporates a slit solid pipe with a sealed invert. Fildrain 7DW is a findrain with a similar configuration that can be used with pipes of differing configurations, or without a pipe depending on the application.

Fildrain Configurations

Without Pipe 'W'

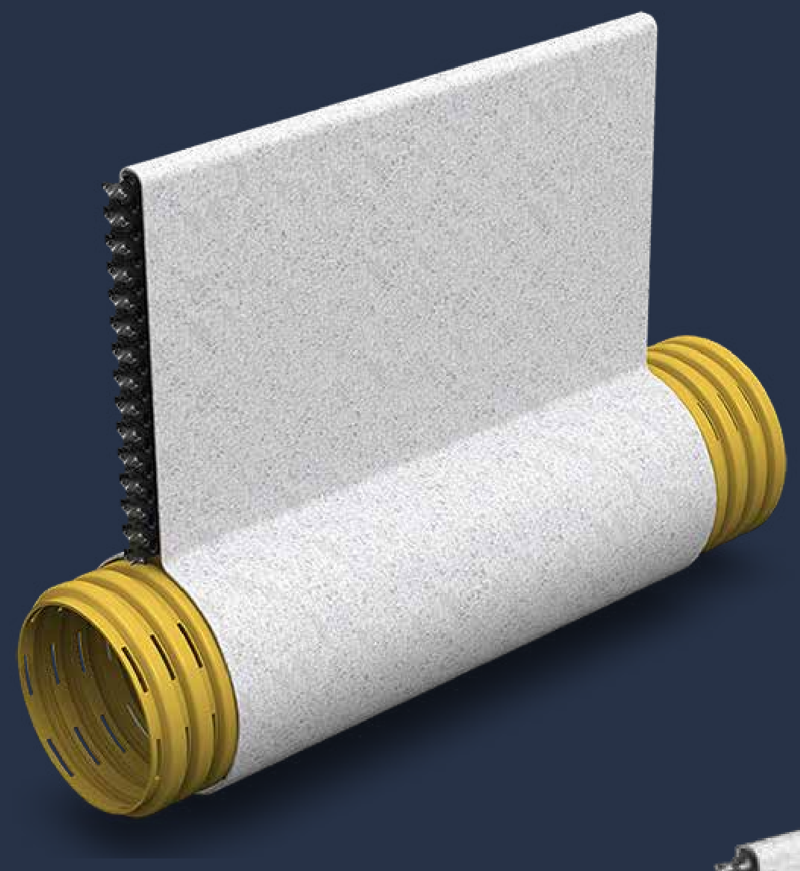
Used in applications where lower quantities of water are required to be transported. In this instance the Fildrain itself acts as the carrier, negating the requirement for a carrier pipe. Also used as a variable height extension with Fildrain W[P] & W[F]

Wide Width 'D'

Fildrain 4.4 or 5.5m wide is particularly useful for blanket drainage of large areas.

Slit Pipe

Fildrain W fully wrapped in geotextile is inserted through the gap in a de-stressed slit pipe. Water collected is drained vertically through the Fildrain and then transported within the pipe. The sealed invert is useful for drains that take a large amount of surface water.

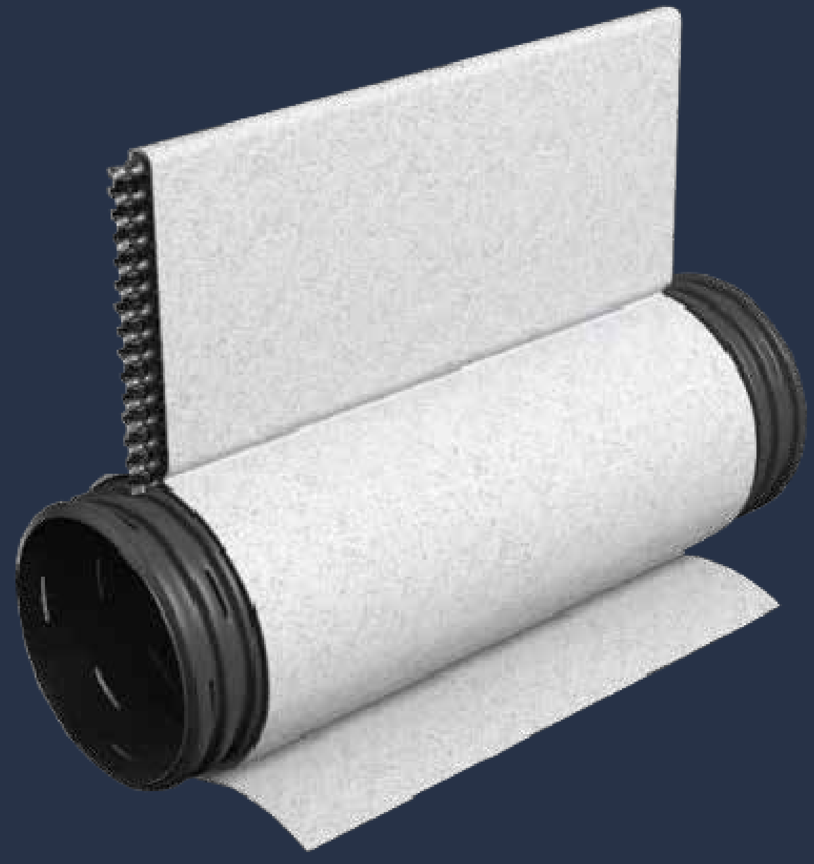


Pipe Sleeve W[P]

The Fildrain is constructed with an integral geotextile pipe sleeve to take a perforated drainage pipe up to 200mm diameter. Once on site the pipe is pulled through the sock before being placed into the trench.

Pipe flaps W[F]

Fildrain can be manufactured with geotextile flaps that encapsulate the pipe where a drainage pipe with a diameter greater than 200mm is required. This allows the pipe to be positioned in the trench and then the Fildrain to be attached afterwards.



Available Cores

Property	Unit	4S	7S	7D	12S	25S
Core thickness	mm	4	7	7	12	25
Cuspate Configuration	Single	Single	Single	Double	Single	Single
Material	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE

Fildrain

Fildrain is a geocomposite drainage system designed to collect and channel water to a suitable discharge point. It is usually specified as a direct replacement to crushed stone drainage.

Crushed stone is not an efficient drainage material since it interlocks when compacted, leaving very little void space for water flow.

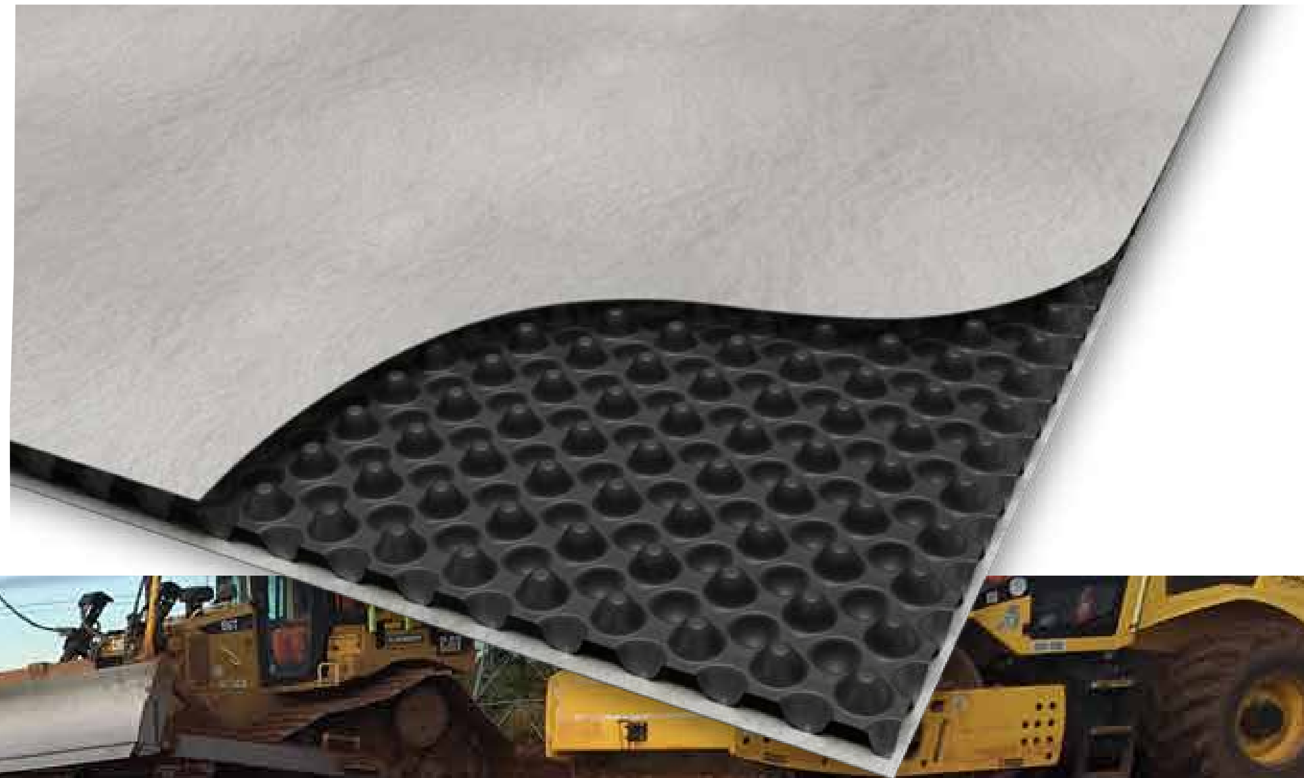
Fildrain geocomposite comprises a cuspated HDPE core which is wrapped in, and thermally bonded to, a nonwoven geotextile.

Fildrain has a flow capacity many times that of traditional crushed stone due to the unique open structure created by the dimpled core profile, allowing unhindered water flow.

Fildrain can be manufactured in bespoke configurations to suit project specific requirements; including widths, lengths, geotextile specifications and pipe fixing details.

Fildrain is used in every situation where crushed stone drainage can be used and also where stone drainage is impractical, such as vertically behind geomembrane liners.

Fildrain has attained BBA certificate number 14/H220.



Embankment Construction

Many civil engineering projects involve the construction of new embankments to achieve the required site levels. Accelerated drainage of embankments is key to their rapid construction, controlled settlement and long-term stability.

Embankment Starter Layers
A thick granular 6C drainage layer is often placed onto the prepared formation before construction of an embankment. This layer serves two functions, one of which is drainage and the other being to protect the formation from heavy construction machinery.

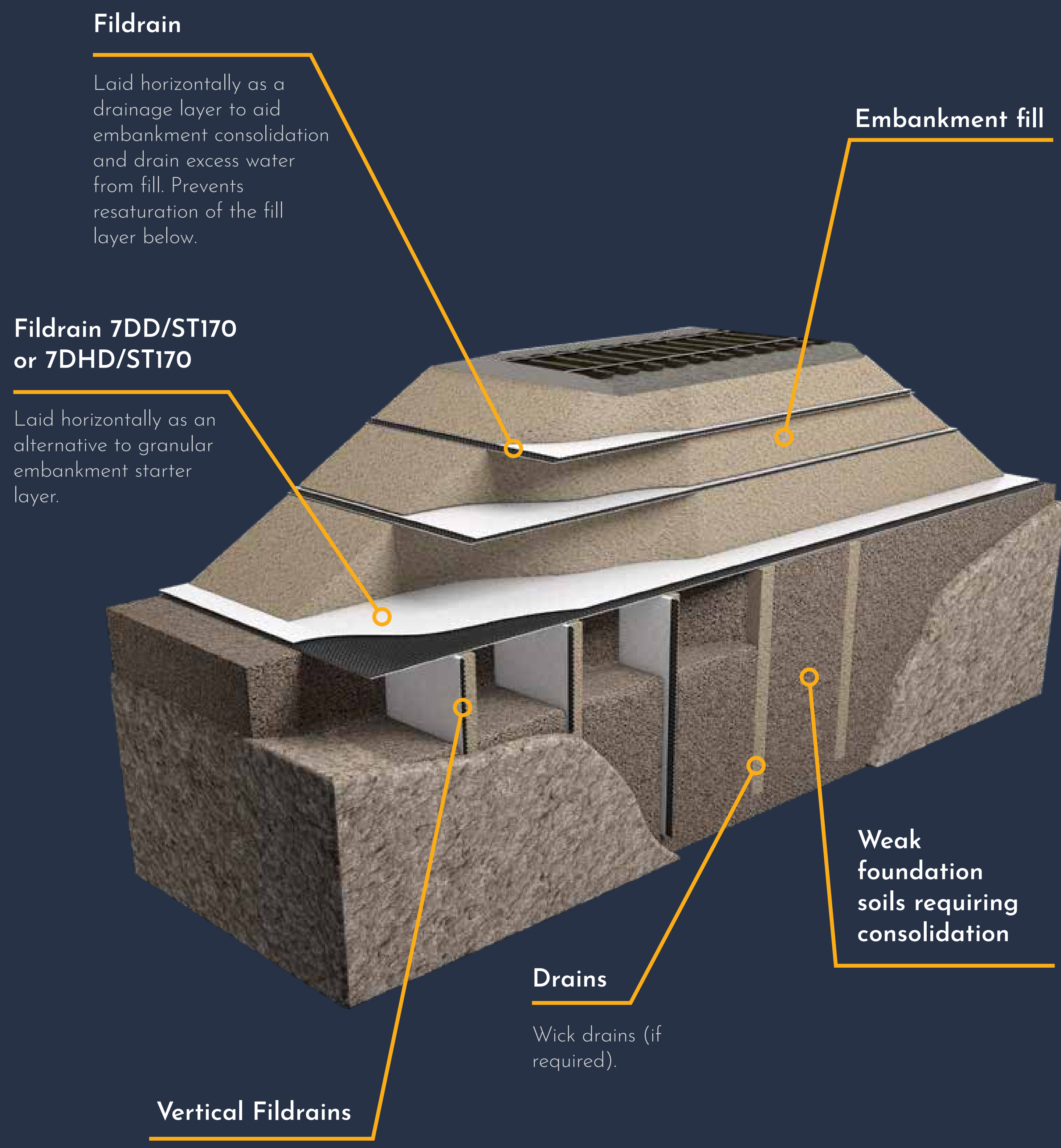
Fildrain 7DD/ST170 or 7DHD/ST170 provides an easy to install alternative that is laid across the width of the embankment with backfill placed on the advancing face. Fildrain is typically overlaid with at least 300mm of fill before it is tracked by construction plant. The geocomposite must have sufficient compressive strength for the forces under the full height of the embankment and ideally have a core with a central barrier that protects the formation from water ingress and re-hydration due to rainfall.

Consolidation Layers
Earthworks are usually on the critical path in the programming of the project works and soft soil embankments are no exception. The speed of construction of the embankment depends on the rate at which the pore water pressure can dissipate as the embankment height progresses.

Fildrain is so effective at reducing pore pressures, that it significantly increases the range of soils that can be considered as suitable fill. Using Fildrain instead of crushed stone also utilises more site fill, which is cost saving and has a positive impact on the earthworks balance.

Prevents resaturation of fill
Fildrain has a central core that is impermeable to restrict vertical movement of water. This means that each layer of Fildrain acts as a roof to the fill below, preventing rainfall from slowing consolidation. Consequently the weather window for earthworks is extended.

Settlement
Control of settlement within specified limits is key. Fildrain has been assessed for 114 year loading conditions for full height embankment construction to ensure long term settlement is minimised.



Structural Drainage

Rail construction projects require structural drainage in a number of key application areas. Typical infrastructure applications include bridge abutments, buried concrete structures, retaining walls and sprayed concrete walls.

Geosynthetic drainage layers are designed to efficiently alleviate hydrostatic pressure, control groundwater and manage surface water, providing significant cost savings.

Traditional structural drainage solutions include drainage aggregates and hollow concrete blocks. High performance geosynthetic drainage systems provide an effective, more sustainable replacement to these techniques with factory consistent flow capacity for both vertical and horizontal drainage applications.

Furthermore, geocomposites provide a light-weight and easy to install alternative to granular drains and enable more site won spoil to be re-used.

Typical applications:

- Bridge abutments
- Green bridges
- Buried structures
- Back of wall drainage
- Cut & cover tunnels
- Horizontal & vertical drainage

ABG Roofdrain® geocomposite layers can be utilised for green bridge applications to provide a combined water reservoir and structural drainage function, supporting vegetation growth and protecting the bridge deck waterproofing respectively. Available with different core thicknesses and geotextile options to suit the specific loading conditions.

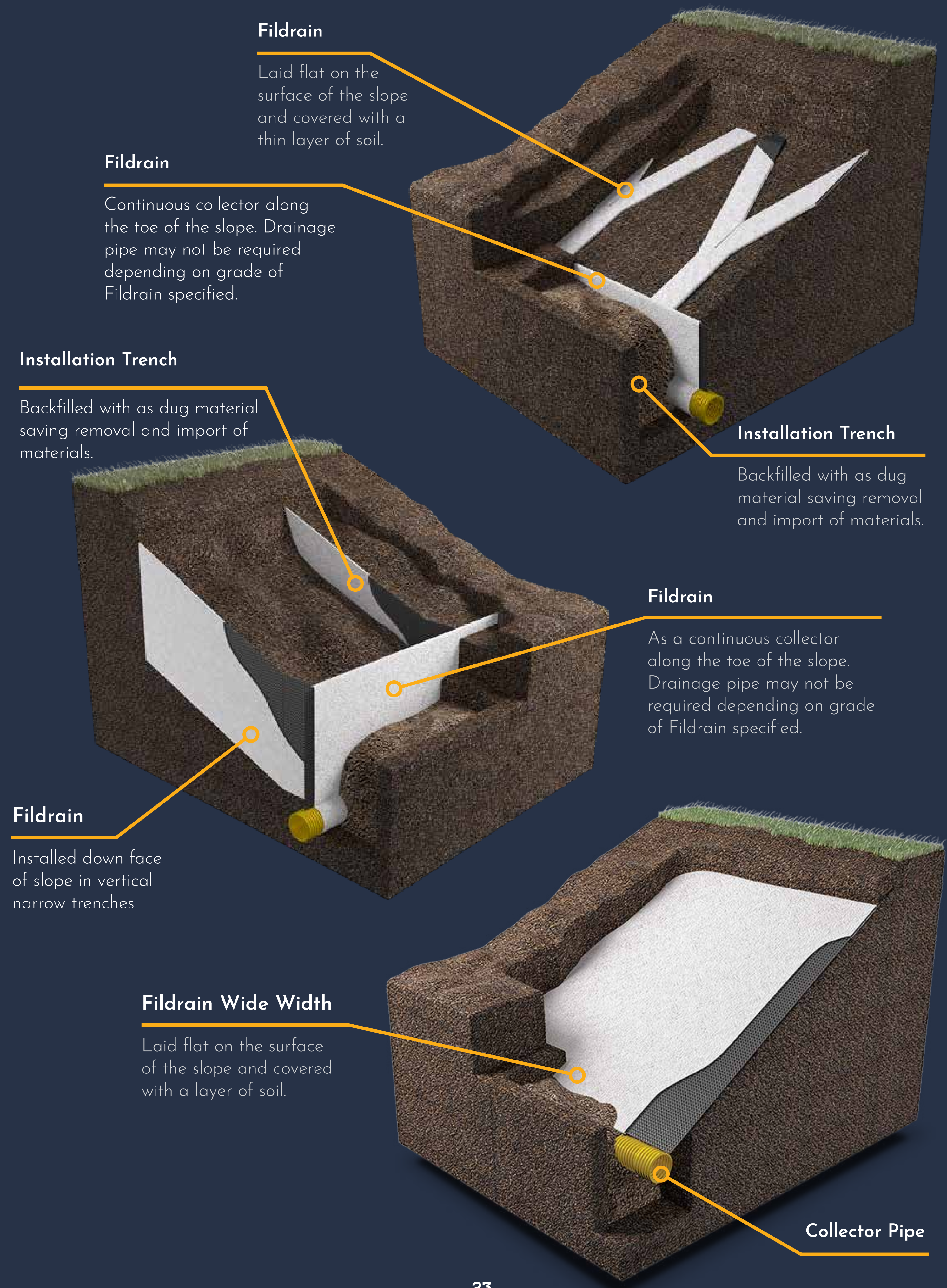
ABG Deckdrain geocomposite is used to enhance and protect the waterproofing and provide drainage to railway structures, removing the need for bulky porous blocks and the logistical challenge of importing granular fill.

Slope Drainage

Slope drainage is primarily required to collect seepage water emerging from permeable layers in soil slopes or from open joints in rock slopes. It is essentially required to stop topsoil from slumping or being eroded by water from below.

When designing and constructing cuttings, the groundwater level needs to be reduced below the intended surface of the slope. Traditionally this is achieved with crushed stone counterfort drainage trenches. Installing any trench on a steep slope is not easy.

Fildrain helps to simplify the process through either installation within narrower trenches, laying in flat strips, or placing across the whole area before the topsoil layer is placed.



Erosion Control

Erosion control products are suitable for applications such as surface protection and protecting the structural stability of soils. Included in the range are biodegradable and non-biodegradable erosion mats and three dimensional geocells used for retaining soils on embankments.

- Comprehensive product range of environmentally friendly erosion control materials, including biodegradable as well as permanent turf reinforcement mats. Erosion control mats are designed to provide surface protection from the damaging effects of wind and rain, and enhance the structural stability of newly cut slopes
- Geocellular options available to protect the structural stability of soils, retaining earth onto slopes and promoting the growth of vegetation, whilst also allowing the free passage of water.

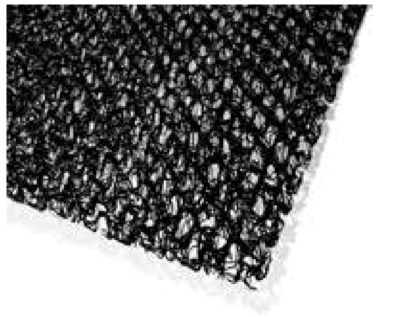
Typical applications:

- Erosion Protection
- Surface Control
- Soil Retention Systems
- Steep Slope Construction

Erosaweb® geocell is designed for the reinforcement of weak soils and has many applications, including the retention of soil onto steep profiled sections of railway embankments. The cells of the geocell retain the fill material whilst still permitting water to drain through.

Erosamat Types 1 and 2 product options are a range of biodegradable and intermediate life-span turf reinforcement matting options. The jute and coir materials provide a dense mesh of fibres to absorb the impact of rainfall and reduce run-off velocity. The matting protects the soil until the vegetation has germinated and a root system has established.

Erosamat Type 3 is a range of permanent turf reinforcement matting products for the protection of grass roots as they establish onto steep slopes and for specification in high flow velocity conditions. The sheet is made up of a thermally bonded matrix of polypropylene fibres that create a tough, flexible and long lasting erosion control mat.



Reinforced Soil Drainage

Reinforced soil is widely used as an economic solution for construction of steep slopes and walls. A drainage layer is also typically incorporated at the rear of the retaining structure to relieve water pressure.

New Walls

Reinforced soil is cost effective, but unlike concrete retaining structures drainage must be placed against the cut face. This is incredibly difficult to do with layers of crushed stone. Fildrain however, provides the required drainage and can be simply rolled into position up the cut face as construction of the reinforced soil progresses.

Slip Repairs

A rotational slip of a cutting is often repaired by excavation and replaced with reinforced soil. The slip will often have been mobilised by groundwater making the soil wet and weak, so Fildrain can be used in the repair to intercept the ground water and make the existing soil suitable for re-use.

Abslope EM

Abslope EM is an economical and structurally flexible, sustainable earth retaining slope system developed for road & rail embankments to meet the demands of Engineers, Architects and Developers. The system consists of proprietary ABG Geogrids and Erosamats deployed to construct slopes to a face angle of up to 45°.

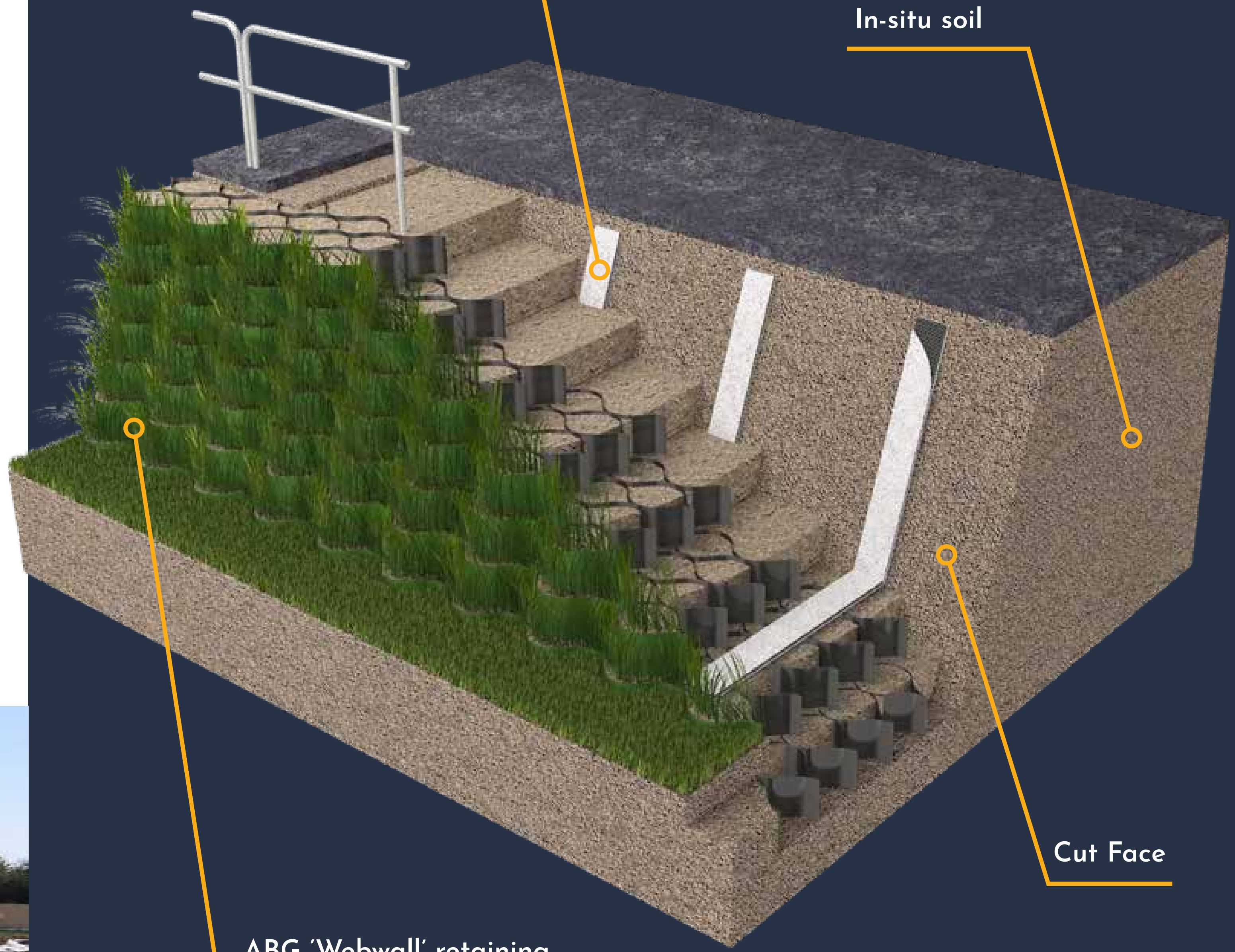
Abslope SM

ABG Abslope SM is an economical and structurally flexible sustainable earth retaining slope system developed to provide a neat solution for rail embankment projects.

The system consists of a proprietary steel mesh facing panel and retained earth, reinforced with ABG geogrids. The slope can be constructed to a face angle of between 60° to 70° and the steel mesh facing is lined with a vegetation liner to assist establishment of a grassed slope face.

Webwall

Webwall® is a geocellular retaining wall system designed as a cost saving alternative to gabions and crib wall constructions. The Webwall structure is formed from horizontal layers of Webwall geocell panels, each panel being expanded and filled layer by layer until the required height is achieved. Using Webwall geocell for green faced walls enables near vertical faces to be built quickly and easily, with the added benefit of using site won materials as fill.



Reinforcement & Stabilisation

Geosynthetics provide many benefits over traditional construction techniques where soils, sub-bases, subgrades, foundations, slopes and trafficked surfaces are constructed.

By reducing the volume of traditional stone construction layers required; the use of geogrids, geocells and geotextiles have become the engineered, environmental and cost-effective solution for civil engineering projects.

Our biaxial geogrids are available in a range of strengths and our Design team utilise them in a diverse number of civil engineering applications; including ground reinforcement, sub-base aggregate reduction, basal reinforcement, paved and unpaved access road foundations, permeable paving construction, retaining walls and steep-sided soil embankments.

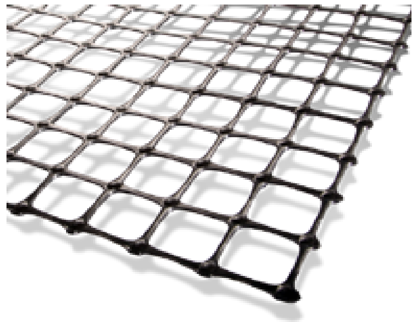
Stabilised foundation solutions compensate for low CBR strength values (i.e. less than 2.5%) and to ensure the relevant foundation class is achieved.

Typical applications:

- Soil Stabilisation
- Ground Stabilisation
- Basal Reinforcement
- Access road sub-base reinforcement
- Working Platforms

REINFORCEMENT & SEPARATION

ABG geogrid ranges solve a variety of geotechnical design challenges: from ground reinforcement, sub-base aggregate reduction, basal reinforcement and paved and unpaved road foundations; through to permeable paving construction, retaining walls and steep-sided soil embankments. Options include biaxial, triaxial and fibre reinforced grids.



Abweb geocellular panels for slope reinforcement and ground stabilisation applications. Abweb pockets are smooth and unperforated for use in car parking, tree root protection and access road containment applications.

Terrex NW is a range of high performance, thermally bonded needle-punched nonwoven geotextiles. Their main range of application is in separation and drainage of granular stone layers. Appropriate grades of Terrex NW may be used to provide a protection layer to geomembrane liners and other materials.

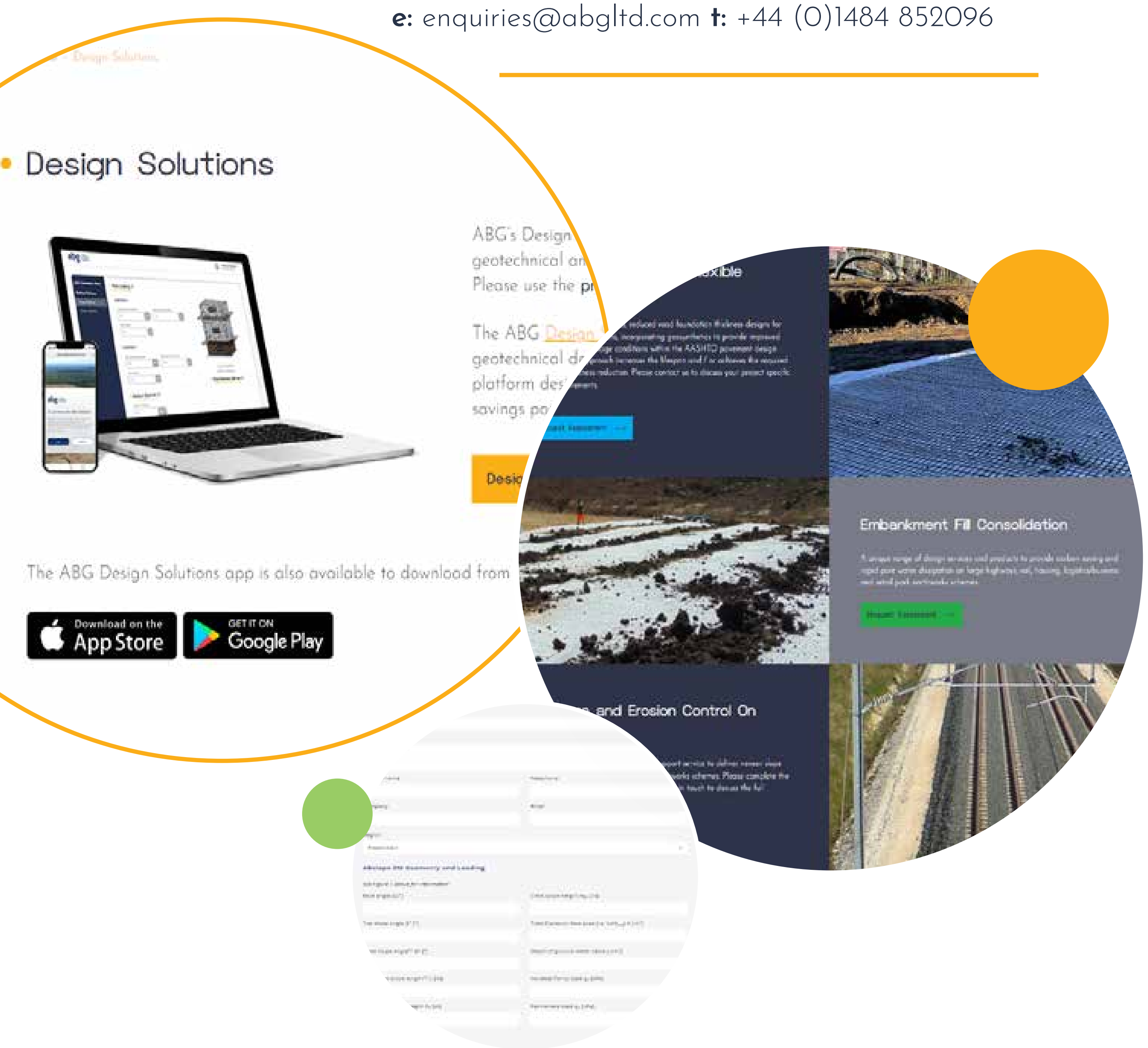
Design Solutions

Our experienced engineering department is on hand to assist with your rail 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



www.abgltd.com

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

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