



Highway Edge Drainage

A guide to the selection
and specification of ABG
Fildrain geocomposite
drainage systems





Drainage is a major consideration in all civil engineering projects. When designing surface water drainage, there are many modern materials engineers utilise to achieve an optimum design in terms of performance and economy. The same cannot presently be said about sub-surface drainage, although attitudes are changing.

Sub-surface drainage options have been limited to traditional crushed stone filter drains even though modern materials are available.

Sustainability is increasingly high on the agenda and this emphasis requires engineers to look again at the tonnage of clean crushed stone consumed by traditional sub-surface drainage requirements.

This change is being driven by clients who are asking for their projects to be designed to meet sustainability criteria and geocomposites enable significantly reduced volumes of crushed stone, whilst giving enhanced performance at lower cost.

The modern option of geocomposite drainage enables greater use of site won as-dug materials and this in turn minimises the number of vehicle journeys, both delivering and removing materials from site.

Contents

Fildrain	4-5
Design Considerations	6-7
Clause 514 / SHW	8-9
About ABG	10-11

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

Fildrain has attained BBA certificate number 14/H220.

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 cusped HDPE core which is wrapped in, and thermally bonded to, a non-woven 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.

The Fildrain range of drainage products has many applications within Civil Engineering schemes; encompassing Highways, Sports, Mining, Rail and Building, amongst others.

Fildrain specifically has applications in the drainage of embankments, reinforced soil structures and cut off drains. Fildrain can be manufactured in bespoke configurations to suit project specific requirements, including widths, lengths, geotextile specifications and pipe fixing detail.

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

Fildrain is one product in an extensive range of ABG geocomposites tailored to specific markets.

Off Site Construction

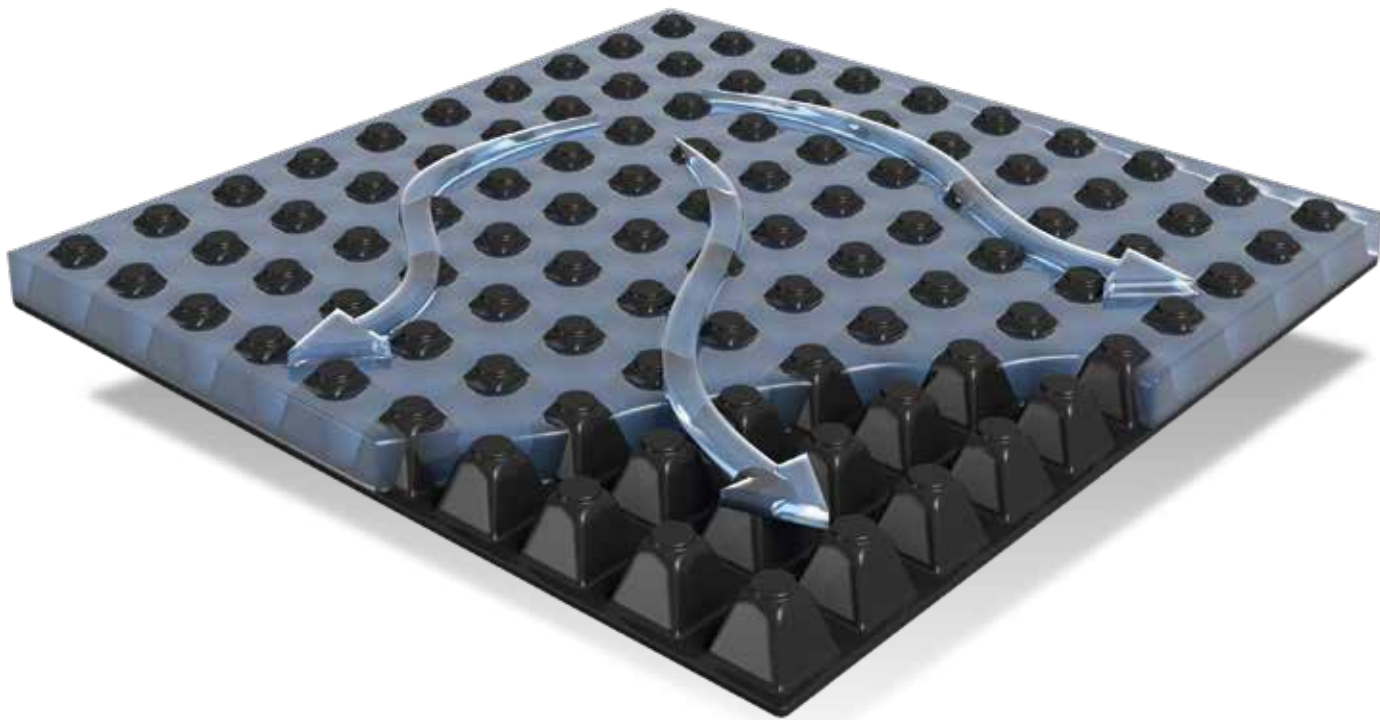
Fildrain is factory manufactured for delivery to site as a prefabricated unit.

Cusped Core

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

Geotextile Filter Fabric

The specifically manufactured ST170 & NW8 geotextile minimises intrusion into the core to ensure high performance. Geotextile pore size O_{90} and permeability create a filter zone within the soil backfill adjacent to the geotextile that enables long term drainage performance.



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 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, 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 HGV movements during installation.

Reducing HGV movements results in less exhaust emissions, reduced wear and tear on local infrastructure, reduced disturbance to local residents and less congestion and disruption to other road users.

All these benefits combined assist smoother site logistics and helps clients to achieve their stated environmental policies and corporate social responsibility for sustainable development.

Space Saving

Fildrain requires a narrow trench for installation. This is especially beneficial when services are required to run along the verge of a highway since this reduces land take requirements.

Speed of Installation

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

Design Considerations

The importance of achieving good earthworks drainage to reduce groundwater levels and control pore water pressure 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.

Keeping the focus on good drainage, it was the US Corp of Engineers who in the 20th Century pioneered prefabricated drainage as an alternative to crushed stone drainage. 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. ABG pioneered the development of wide width geocomposite drainage in the 1990s for applications in large area earthworks, and have supplied millions of square metres, saving billions of tonnes of crushed stone.

Surface Water or Ground Water

Geocomposite drainage is suitable for dealing with ground water and ground water 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 ground water, e.g. 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 ground water to achieve a 120 year life is 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 as drainage and is used with a geotextile filter. Crushed stone drainage is not often designed but is utilised based on standard specification e.g. Permeability 1×10^{-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 1×10^{-3} m/s at hydraulic gradient of 1/100 has a capacity of 0.005l/m/s.

Geocomposite Drainage

The simple 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. Such cores combined with a geotextile form a geocomposite drainage layer. The first generation polymer cores such as bi-planar geonets or random fibre were not very efficient, but latest generation modern cusped cores are highly effective.

The cusped core of Fildrain at just 4mm thick, when tested under simulated site conditions achieves an in-plane flow capacity of 0.04 l/m/s at hydraulic gradient of 1/100. This is 8 times that of a 500mm layer of drainage stone, at only 4mm thickness compared to 500mm! It is this reduction in layer thickness that 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.

Gas Flow

Whilst geocomposite drainage is most frequently used to drain water, it is also capable of venting gases. The flow capacity of gas is at a lower rate than the flow capacity of water due to the lower density of gas.

In-Plane Flow Capacity

The in-plane flow capacity of the geocomposite in MD and CMD when subjected to the design confining pressure is the key performance criterion. This is tested to EN ISO 12958 or ASTM D4716 using SOFT boundary platens to simulate soil backfill. 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 in-plane flow capacity in (l/m/s). The Achilles heel of a geocomposite drain is a weak core or a geotextile that intrudes into the core or both. Fildrain with its unique cusped core and laminated stiffened non-woven geotextile has been developed and manufactured to achieve minimal loss of performance even at pressures of 1,000kPa. Poor cusped products, poor geonet products and poor products in general 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 will not be achieved on site. Reject all data sheets that give HARD or RIGID platen test results (unless the geocomposite is to be placed on concrete or something similarly rigid).

$$Q = (FoS) \times Q_{SOFT} \times \frac{1}{RF_{CR}} \times \frac{1}{RF_{BC}} \times \frac{1}{RF_{CC}}$$

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 (RF_{CC}) and Biological Clogging (RF_{BC}) for Fildrain are typically 1.

So why is geocomposite drainage not the default position? Maybe it is that crushed stone has been used for 4,000 years compared to only 40 years for geocomposite drainage. Maybe it's that crushed stone is now generic and geocomposite drainage is still proprietary. Maybe there is insufficient geocomposite information and what information there is, is confusing. In the markets that have embraced geocomposite drainage, engineer's initial concern has moved from contentment with high quality geocomposites designed well, into contempt that any geocomposite will do.

Geocomposite drainage must be designed and specified to achieve the desired performance or like any other material (steel, concrete, timber, etc.) they will fail.

Here we present sound technical advice based on ABG's 30 years of experience to confidently guide the new user and the experienced user.



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 (RF_{cr}) for 120 year design life.

Compressive Strength, Mass and Thickness

These values that appear on data sheets must NOT be used in specifications as they are meaningless to design and performance. They are short term tests and completely irrelevant in determining performance. For example a 5mm product could be so full of plastic that it achieves almost no flow. Ditto a 900 gsm product. Compressive strength is measured at the point when a product is crushed flat. The only purpose in this value is for CQA to quickly determine that the correct grade of product has been supplied against its own datasheet.

Geotextile Filter Criterion - Filter Stability

The geotextile creates a stable filter zone in the soil adjacent to it by having a pore size that is compatible with the soil, a permeability that is many times higher than the soil and by allowing water to flow without a water head.

Geotextile

The geotextile is an integral part of the Fildrain geocomposite. In its standard forms Fildrain has either an NW8 or ST170 non-woven geotextile. These geotextiles have been selected, based on ABG's extensive knowledge, to be suitable for the majority of soils. Special geotextiles are available for specific situations and ABG's technical team are always pleased to confirm the suitability of the geotextile when the soil PSD has been provided. There are some soils that are particularly difficult, such as peat and ochre and these require special consideration.

Geotextile Filter Criterion - Pore Size

The geotextile creates a filter in the soil adjacent to the geocomposite. It does this by allowing some small/medium sized soil particles to pass through the geotextile but does not allow larger particles to pass. The geotextile pore size must be compatible with the soil particle size (PSD). The standard geotextile has a whole range of pores of sizes from 5 micron to 1,000 micron and is characterised by the O_{90} value. This is the value of which 90% of the pores are smaller. Typically the O_{90} will be 70 -120 microns. The geotextile pore size is tested to EN ISO 12956.

Geotextile Filter Criterion - Permeability / Perpendicular Water Flow

The geotextile must allow water (or gas) to flow freely from the soil into the core of the geocomposite. The rate of flow is expressed as the perpendicular water flow ($l/m^2/s$) and permeability (m/s). This is tested to EN ISO 11058 at 50mm water head. Typical values for a non-woven geotextile are 109 $l/m^2/s$ and 67 m/s. This is 100 to 10,000 times higher than most soils; hence there is a large factor of safety!

Geotextile Filter Criterion - Break Through Head

It is imperative that water starts to flow as soon it comes into contact with the geotextile. This is termed the break through head. Fildrain geotextiles have zero break through head but this is not the case for all geotextiles, some will only allow water to flow once the head is at 100mm for instance. For deep drainage applications, the water head in the soil will be greater than 100mm and all geotextiles will function, but for shallow applications and situations of high soil suction, no flow will occur through the geotextile unless the geotextile has zero break through head.

UV Exposure Limits and Oxidisation

The polyethylene and polypropylene polymers used to manufacture Fildrain contain UV stabilisers and oxygen inhibitors. Geocomposites are always designed to be covered in use. The UV stabilisers enable exposure during installation and the oxygen inhibitors are active throughout the design life of the geocomposite at normal temperatures. For long time UV Exposure, ABG has XUV grades of Fildrain and for long term use at elevated temperatures, ABG has the UVAO grades of Fildrain.

Attenuation

Fildrain is a geocomposite that is optimised for high performance water flow and is superior to crushed stone in this application. Crushed stone, however, can be used for water storage or water attenuation. Crushed stone has a porosity of 30%, so 1m³ can store approximately 0.3m³ of water. ABG supplies geosynthetic crates that have a porosity of 95% for these applications.

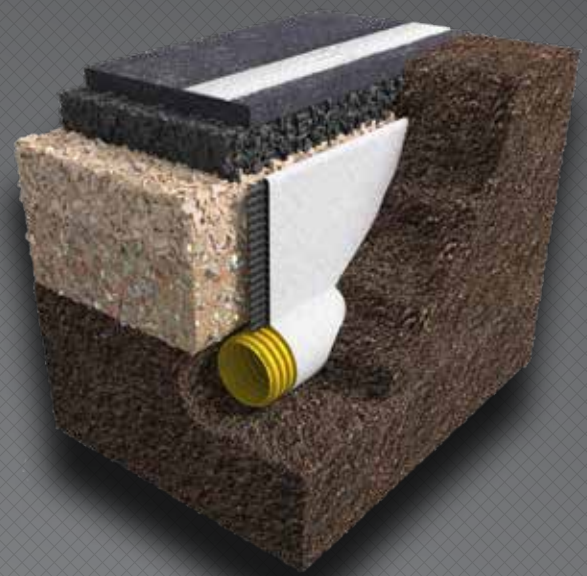
SHW Clause 514 Applications

Specification for Highway Works (SHW) clause 514 and the associated notes for guidance details the use of both traditional and geocomposite drains at the edge of carriageways to remove infiltration water from the construction layers, thereby preventing saturation of the highway formation.



Fildrain Type 5

Consists of a geocomposite with a thickness of 25mm used vertically in a narrow trench. There is no inclusion of a pipe since the geocomposite provides the conveyance mechanism. The trench can be backfilled with as-dug materials. The impermeable single-sided core means the geocomposite can be used as a cut-off barrier, preventing lateral migration of ground water into the highway structure.



Fildrain Type 6

Consists of a geocomposite with an integrated geotextile sock into which a perforated pipe is placed. Using this system allows a narrow (pipe diameter plus 50mm) trench to be excavated and then backfilled with as-dug materials, minimising material movements both to and from site.

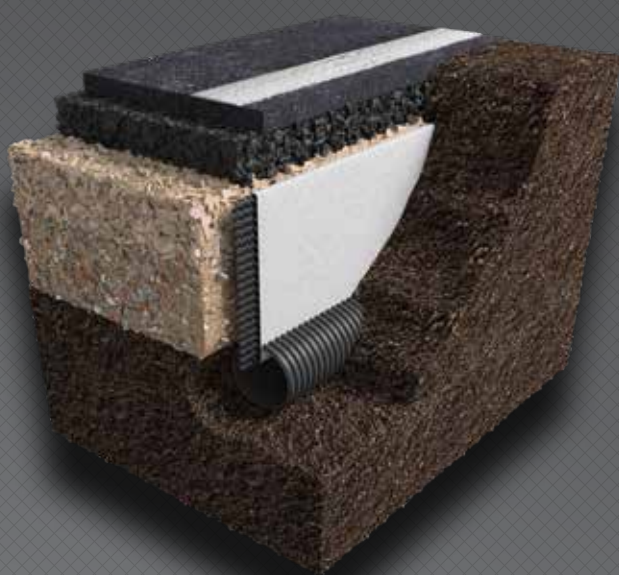
Edge of Highway Drainage

Fin and narrow filter drains form part of the specification for highway works and highway construction details (HCD) F18 through to F21. The main detail is HCD F18 which shows drains that are differentiated by 'Type' which run numerically from 5 to 9. In addition to drains 5 - 9 there is also a drain Type 10 shown on a separate HCD - F21 which is used in a specific under concrete channel application. The standard clause relating to all systems is clause 514 which should be accompanied by scheme specific appendix 514. For all drains there is a requirement for the system to hold a current BBA certificate.

ABG can supply all grades shown in the HCDs, all types vary considerably in their configuration and drainage capacities. Types 5 to 7 offer many advantages over Types 8 and 9 in that backfill material is normally as-dug material, negating the need for granular drainage stone which is required for Types 8 and 9. This gives financial advantages in that excavated material does not need to be sent to landfill and costly filter stone is not required.

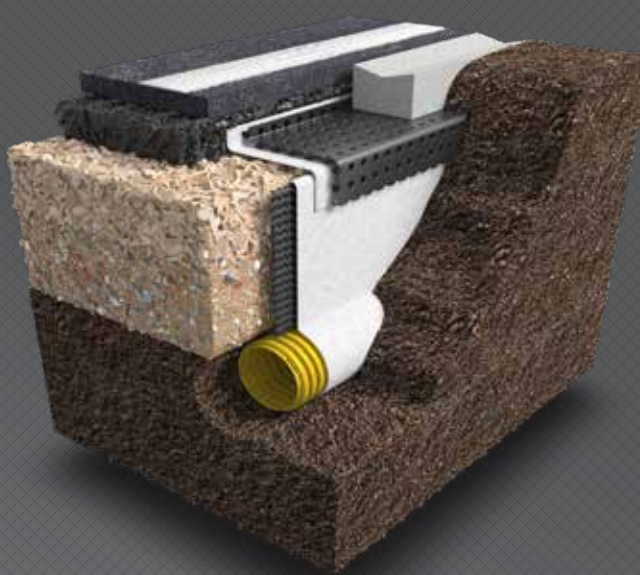
ABG Fildrain Type 6 and 7 have a unique double cusped drainage core which allows water to be collected from both sides of the core whilst the centre of the core is impermeable. This is considerably advantageous where cut off drains are required. The benefits of Fildrains can be summarised below:

- As dug material used as backfill
- BBA approved
- Fully meets the requirements of SHW clause 514
- CE marked
- Rapid installation in narrow restricted areas
- Acts as an impermeable barrier to protect sub-base



Fildrain Type 7

Consists of a geocomposite which is inserted into a destressed slotted pipe. Like with the Type 6 using this system allows a narrow trench to be excavated and then backfilled with as-dug materials minimising material movements both to and from site.



Type 10

Consists of a geocomposite installed horizontally beneath trapezoidal concrete channel sections to allow lateral conveyance of water from the carriageway to vertical findrain. They are usually used in combination with one of the other drainage types (5, 6 or 7) with Fildrain Type 5, 6 or 7 to convey water to a carrier pipe.

Associated Materials



Structural Drainage

ABG have vast experience in drainage solutions, used globally on major highway projects. Deckdrain is a geocomposite drainage system used to relieve external water pressure from behind retaining walls, bridge abutments, culverts and beneath block paved areas.



Verge Protection

Vehicle over-run onto soft verges presents a serious safety hazard, any vehicles which stray onto the verge can lose control with disastrous consequences.

Concertinaweb is a geocellular containment system which confines and strengthens infill materials and provides a cost effective solution for the reinforcement of roadside verges. The geocell provides a cost effective way to reduce stone scatter or to strengthen grass verges to protect from rutting when over-run.



Cut and Cover Tunnels

Cut and cover tunnel design should anticipate drainage needs by managing the build up of hydrostatic pressure on the structure. ABG Deckdrain is a high-performance drainage geocomposite which provides an environmentally-friendly alternative to traditional structural drainage. ABG Deckdrain delivers factory-controlled high-flow capacity to the external faces of the tunnel. Quick and easy to install, the use of ABG Deckdrain eliminates the need for further protection of the waterproofing system.



Green Bridges

Green Bridges provide a haven for wildlife and create a safe passage to cross busy roads. ABG manufacture 'Roofdrain' which is a unique geocomposite system that provides attenuation and a water supply to sustain a strong root system for vegetation. Roofdrain also offers the additional benefit of providing protection to underlying bridge deck waterproofing. Roofdrain is available in differing sizes, is light-weight and easy to handle on site.



About ABG

ABG is a market leader in the design, development, manufacture and technical support of high performance geosynthetic systems for use in a wide range of civil engineering, environmental and building projects.

Formed in 1988, based in Meltham, in the heart of the Pennines, ABG have developed an excellent reputation for developing quality products and delivering outstanding service. The ability for rapid product development ensures that the most innovative, up to date and cost effective solution can be found for many engineering problems.

ABG's involvement in highway construction and maintenance goes back over twenty five years and we now have a complete range of products developed specifically for use in this technically demanding application.

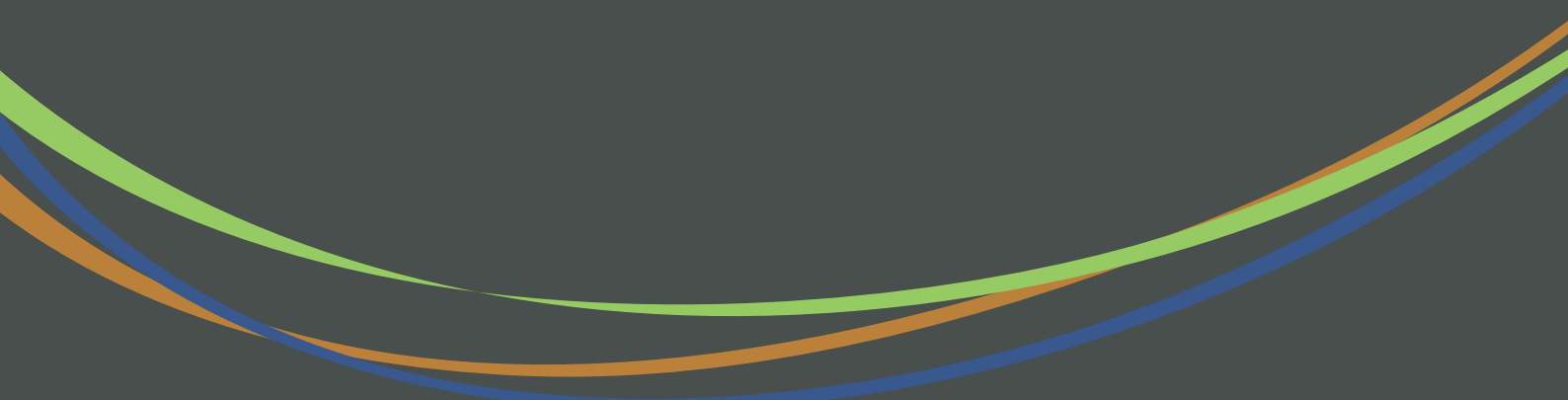
Technical support is provided by our trained and experienced staff, many of whom are Chartered Civil Engineers. This extensive support extends to full design, design validation, feasibility studies, cost advice and advice on meeting regulatory requirements.

Part of this technical support includes developing and driving knowledge within our active markets, including working with both international and local regulatory bodies on developing guidance and best practice in the use of innovative geosynthetics to solve complex engineering issues.

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