

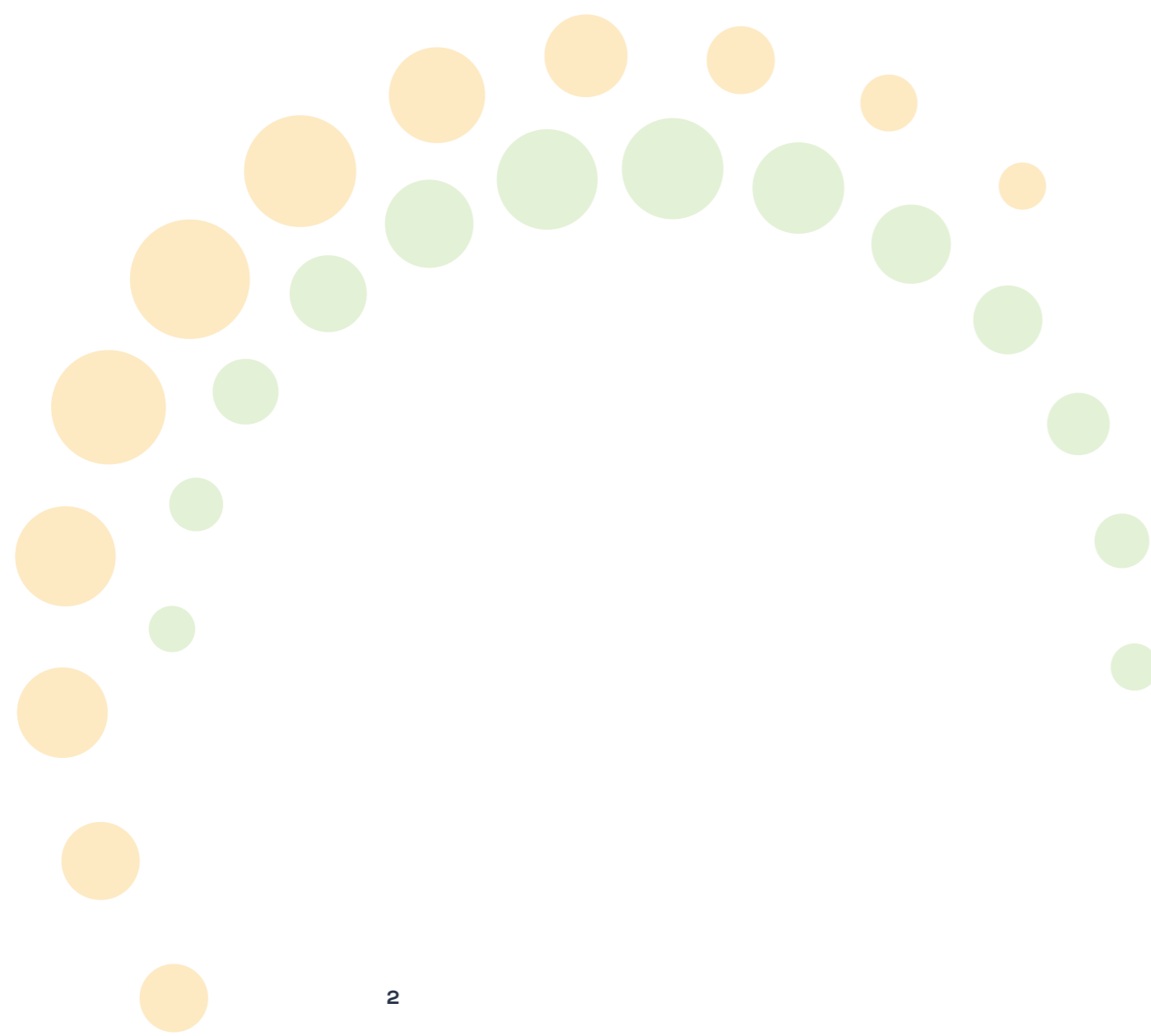


Tunnel Drainage

Geosynthetic systems for tunnelling
infrastructure applications

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• Tunnel drainage challenges

Pressure relieved tunnel design anticipates drainage needs by managing the build up of hydrostatic pressure on the waterproofing layer and by transporting water away in the tunnel invert.

Many traditional tunnel invert constructions favour the extensive use of crushed stone together with a longitudinal collection pipe. However the drainage capacity of crushed stone is limited and reliant on depositing relatively thick layers of aggregate that are prone to clogging.

There is also a significant cost in time and money associated with excavating the trench and then crushing and grading of the stone before installation.

Tunnel wall drainage is traditionally provided by a layer of geotextile. However the drainage capacity of the geotextile becomes impeded by the compressive forces and the clogging of the geotextile due to calcification.

ABG has developed and proven a range of geosynthetic solutions to prevent some of the problems associated with traditional tunnel drainage methods.

By utilising drainage geocomposites the problems of perforated collection pipes and thick geotextiles becoming clogged with precipitates, and the additional time and space required to construct the tunnel invert can be avoided.

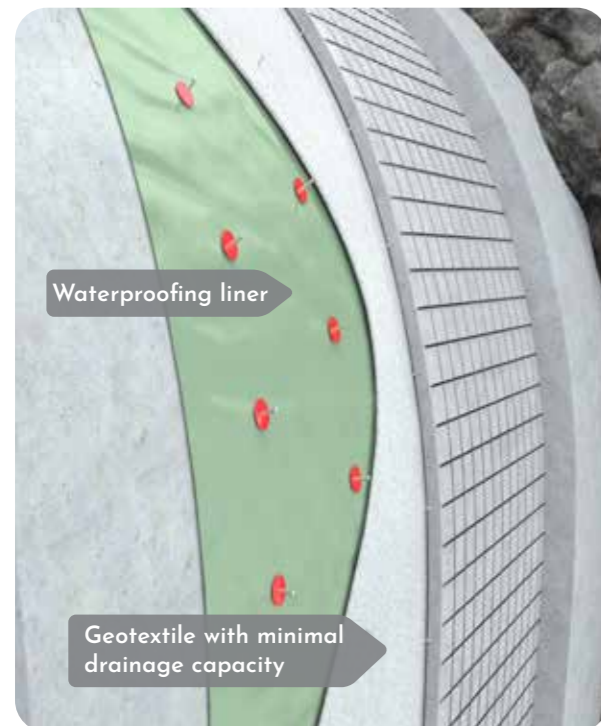
• Tunnel Drainage Solutions

ABG Geosynthetics have developed a range of geosynthetic and geocomposite drainage products specifically for tunnel drainage.

The Cavidrain range is a pre-formed cavity drainage system designed to relieve the effects of water penetration from tunnels and is suitable for both remediation and new build. Cavidrain can be used in internal and external tunnel walls and tunnel invert drainage.

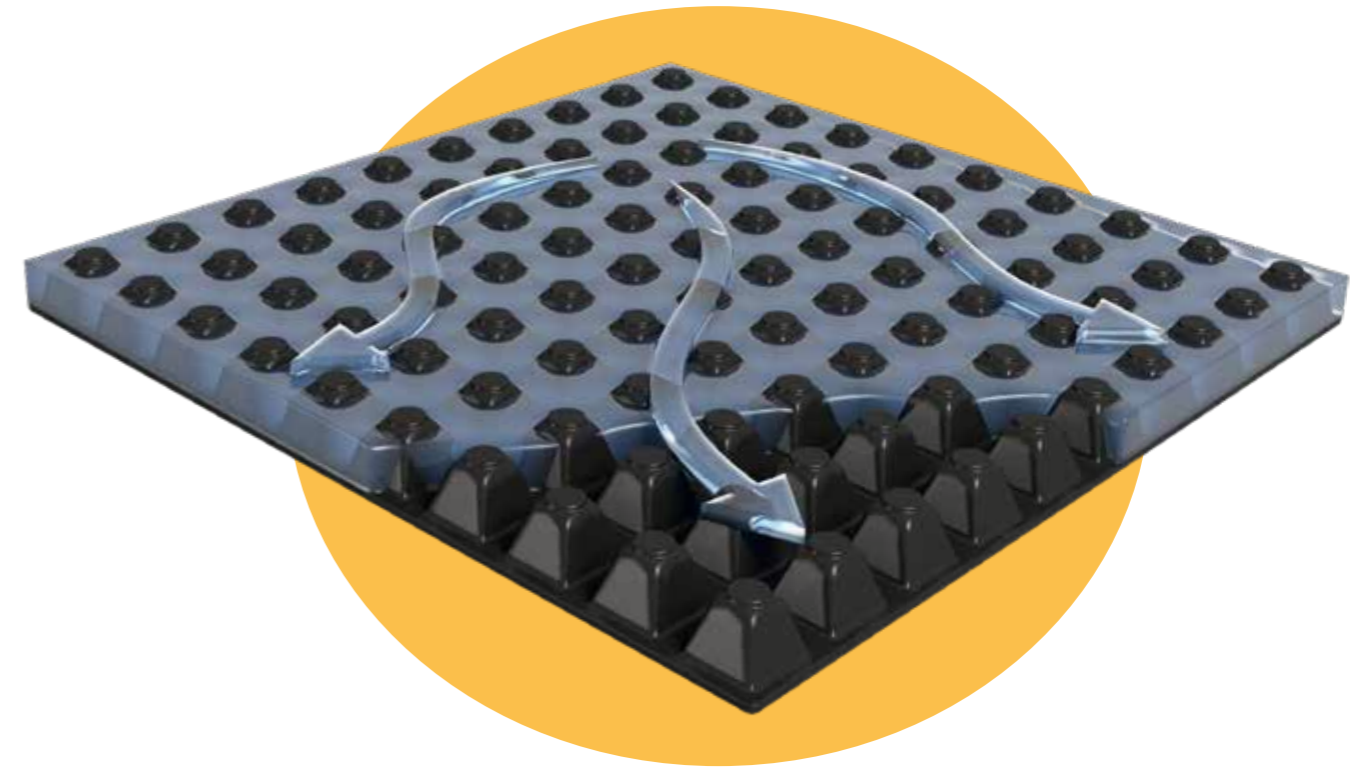
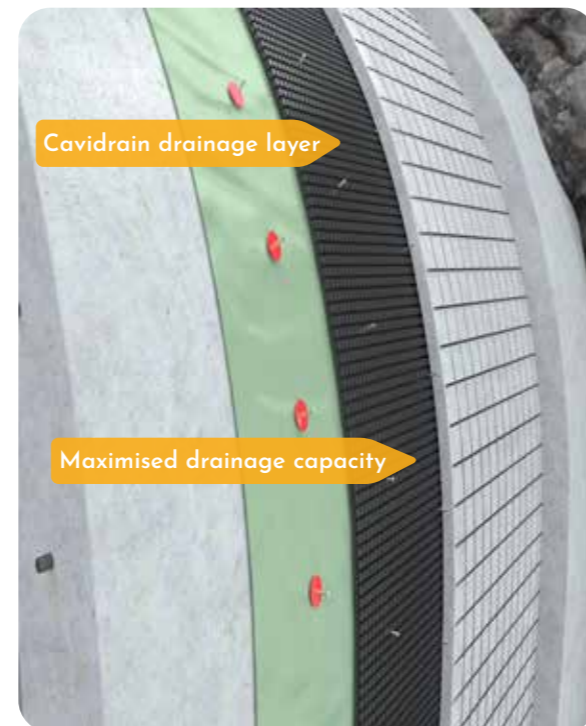
Traditional Wall Drainage

Tunnel wall drainage is traditionally provided by a layer of geotextile held in place by rondels. The limited drainage capacity is further impeded by the compressive forces and the clogging of the geotextile due to calcification from calcium carbonate and iron oxide-rich groundwater.



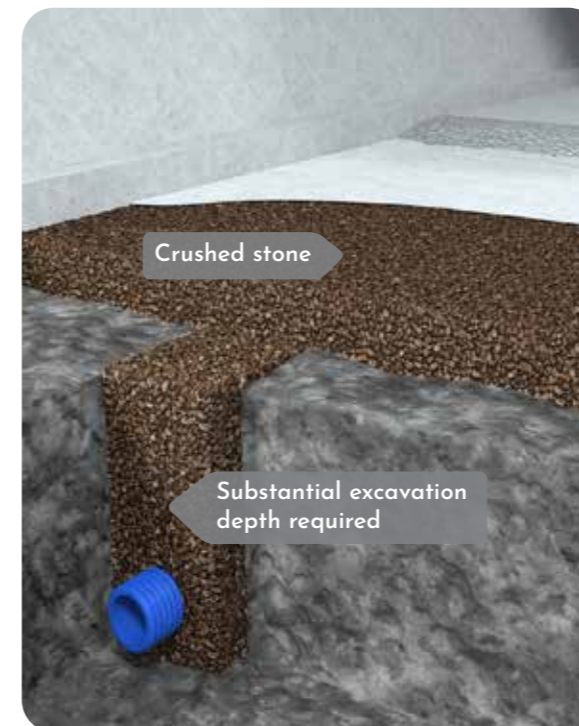
Cavidrain Wall Drainage

Cavidrain provides significantly more drainage capacity than geotextiles in traditional lining methods and in some cases also can replace the waterproofing. Cavidrain creates a free draining void to collect infiltration water from behind the tunnel waterproofing.



Traditional Invert Drainage

Many traditional tunnel invert constructions favour the extensive use of crushed stone together with a longitudinal collection pipe. There is a significant cost in time and money associated with excavating the trench and crushing and grading the stone before installation.



Cavidrain Invert

A pre-formed drainage layer into which the concrete floor slab may be cast, replacing crushed stone to collect infiltration water from the invert. Cavidrain is optimised for maximum bearing area and flow and is strong enough to withstand typical installation loadings.



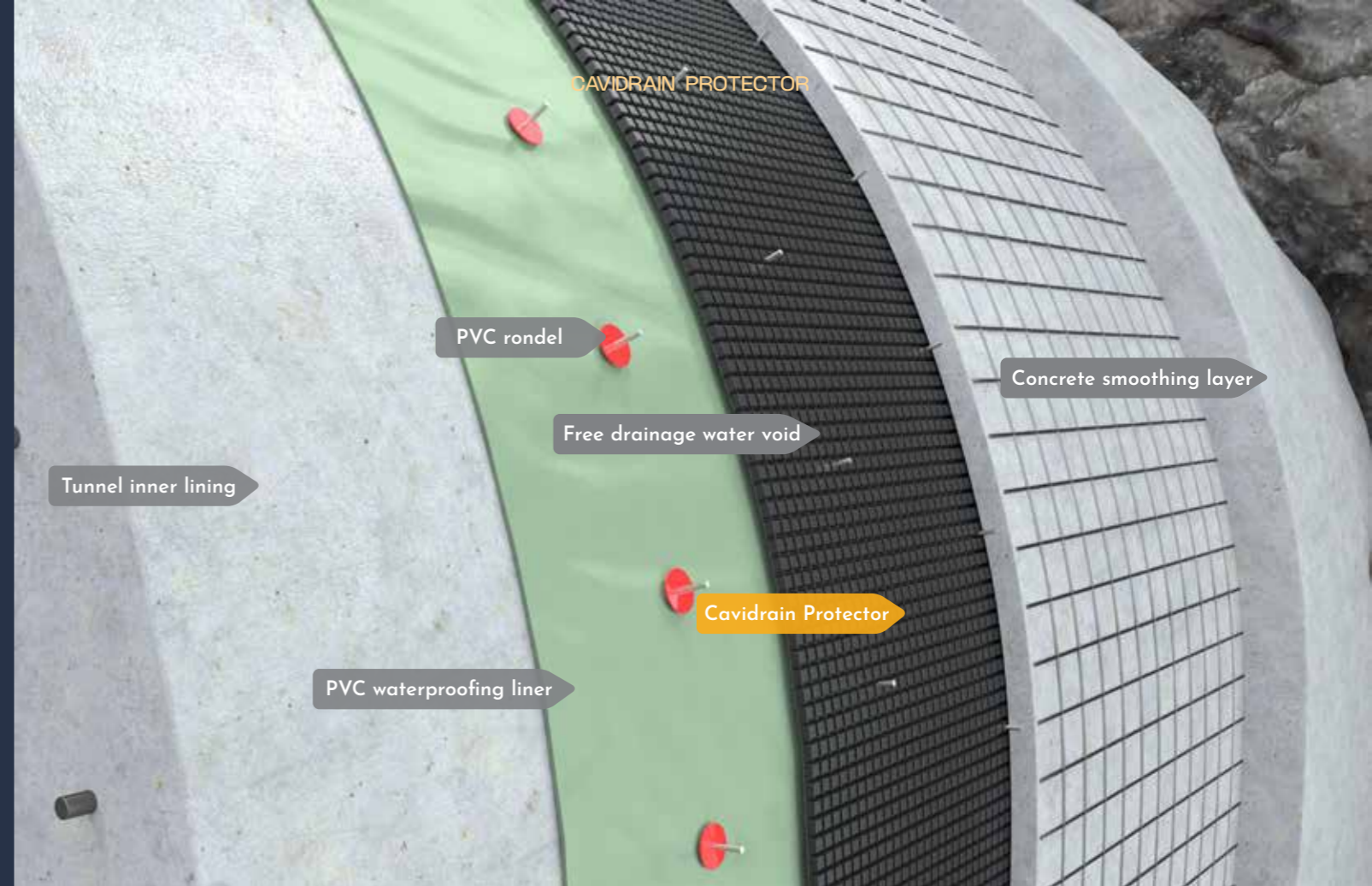
• Cavidrain® Protector

Cavidrain Protector provides significantly more drainage capacity than traditional geotextile fleece solutions and can often be used to replace the fleece itself. Cavidrain Protector creates a free draining void to collect infiltration water from behind the tunnel waterproofing. This minimises the build up of hydrostatic pressure, protecting and enhancing the effectiveness of the waterproofing.

Cavidrain Protector is a cusped HDPE wall drainage system, easily fixed to tunnel walls with drill and fix, or shotfired pins. Cavidrain Protector provides a free draining layer to collect infiltration water from behind tunnel linings, as well as providing protection from physical damage.

The network of open flow channels in the cusped core creates high flow velocities, which, together with the smooth surface, makes Cavidrain Protector extremely resistant to clogging by precipitates.

Cavidrain Protector acts to minimise the build-up of hydrostatic pressure, thus protecting and enhancing the effectiveness of the waterproofing layer. Cavidrain Protector has been used successfully in major tunnel projects around the world.



Cavidrain Protector combined with Cavidrain Invert



APPLICATIONS

New tunnel construction

Temporary tunnel works

NATM constructed tunnels

Lined sewers

Drill and blast tunnels

TBM tunnels

Station boxes

Cable tunnels

Highway tunnels

Railway tunnels

BENEFITS

Enhanced integrity of the tunnel lining system

Significantly improved drainage capacity

Ease of installation

For ABG product datasheets, CAD details, design guidance & other technical information call +44 (0)1484 852096 or email: enquiries@abgltd.com

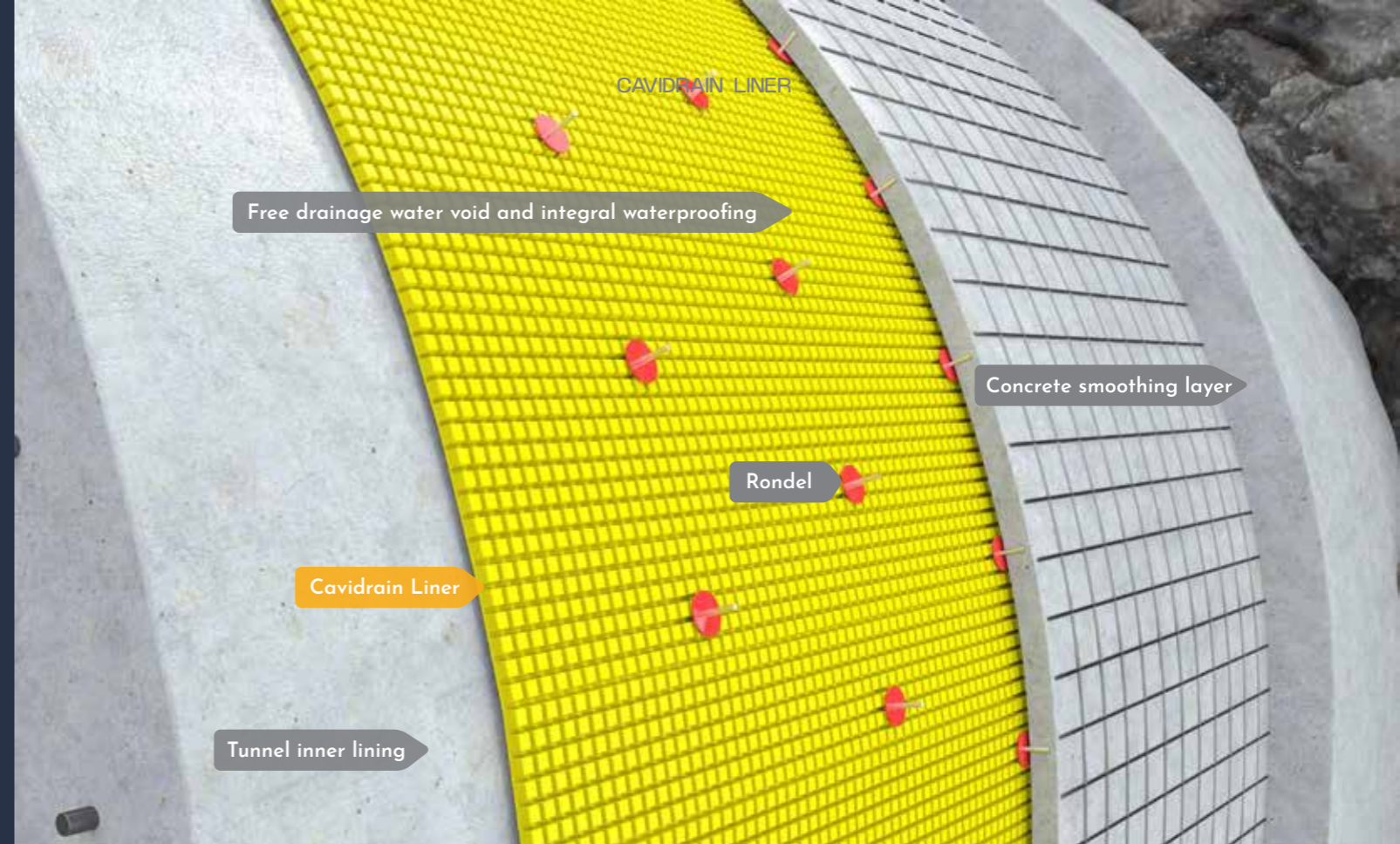
• Cavidrain® Liner

Cavidrain Liner is specifically designed to be highly flexible to accommodate the contours of the excavated tunnel walls. Cavidrain Liner provides a drainage layer that collects infiltration water from the tunnel wall while also acting as the tunnel waterproofing.

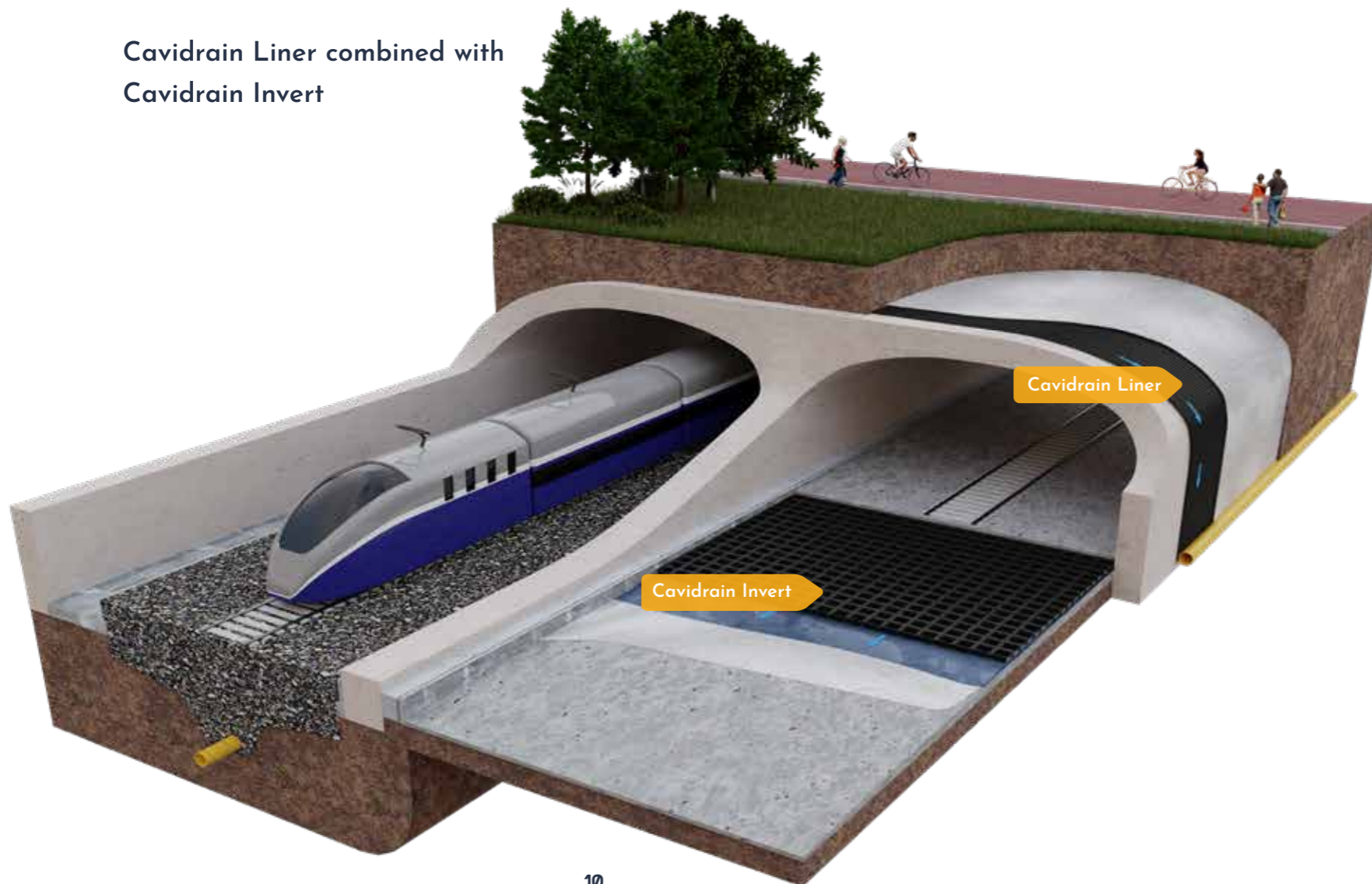
In typical installations, Cavidrain Liner is fixed to the excavated wall of the tunnel or onto a concrete smoothing layer. Sprayed concrete adheres directly to Cavidrain Liner to create the tunnel lining. The rebound loss is significantly reduced in comparison to smooth waterproof linings as concrete is retained in the cusps. Cavidrain Liner is fixed by rondels to avoid penetration of the waterproofing function.

Special fixings are also available to resist the suction effect caused by passing trains where Cavidrain Liner is not covered with concrete.

Cavidrain Liner is a highly flexible, cusped LLDPE, waterproof lining that also acts to minimise the build-up of hydrostatic pressure, thus protecting and enhancing the integrity of the tunnel. Cavidrain Liner has good fire resistance and is rated B2, with B1 available on request. Cavidrain Liner can be welded together to form a continuous waterproofing layer.



Cavidrain Liner combined with Cavidrain Invert



APPLICATIONS

New tunnel construction

Repair of existing tunnels

Highway tunnels

Railway tunnels

SCL tunnels

NATM constructed tunnels

Drill and blast tunnels

Station boxes

Cable tunnels

TBM tunnels

BENEFITS

Simplified tunnel lining system

Materials & labour cost reduction

Reduced installation requirements

Significantly improved drainage capacity

Reduced sprayed concrete rebound

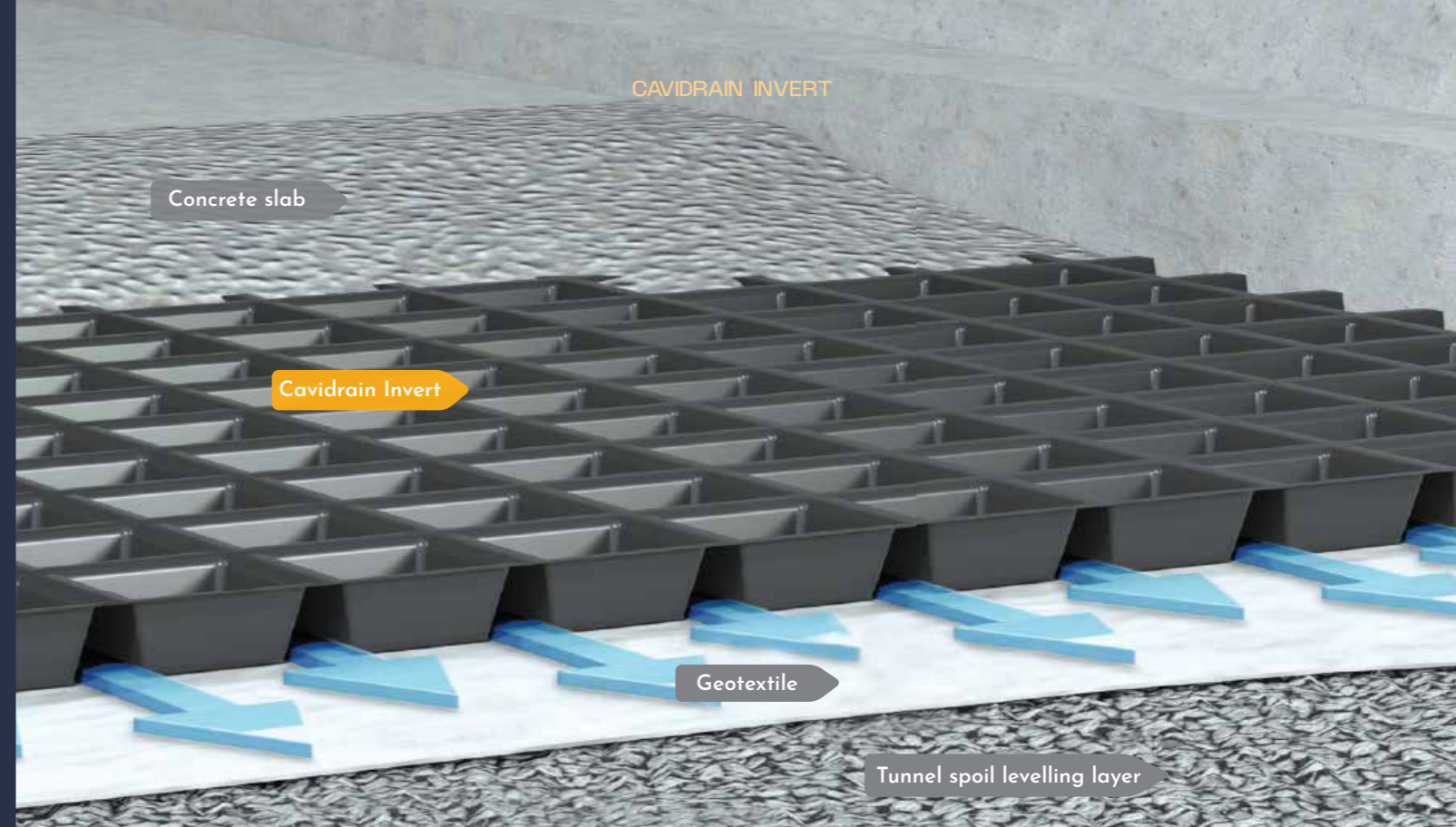
● Cavidrain® Invert

Cavidrain Invert is a pre-formed drainage layer into which the concrete floor slab can be easily cast, replacing the crushed stone and pipe method traditionally used to collect and transport away infiltration water. It is optimised for high in-plane flow to mitigate problems caused by calcareous deposits.

Traditional tunnel invert constructions favour the extensive use of crushed stone together with a longitudinal collection pipe. There is a significant cost associated with excavating the trench, and crushing and grading the stone before installation. Considerable stone thickness is also required to meet the drainage requirements.

With a typical thickness profile of 40 or 60mm, Cavidrain Invert reduces excavation requirements. It can be installed in conjunction with the waterproofing and leads to a significantly faster construction programme by removing the invert drainage construction from the critical path.

Cavidrain Invert provides a pre-formed drainage layer into which the concrete floor slab may be cast and replaces both the invert trench and pipe to transport water along the tunnel invert. It has an in-plane water flow capacity far in excess of crushed stone. The profiles are optimised for maximum bearing area and have been designed to withstand the compressive loads arising with the placement of wet concrete. The profiles are chosen to be compatible with the concrete aggregate size such that concrete completely fills the cusps and once cured, the ultimate load capacity of Cavidrain Invert is that of the concrete fill.



Cavidrain Liner combined with Cavidrain Invert



APPLICATIONS

New tunnel construction

NATM constructed tunnels

Cut & cover tunnels

Drill and blast tunnels

TBM tunnels

Station boxes

Cable tunnels

Highway tunnels

Railway tunnels

Hydroelectric power caverns

Radioactive storage repositories

Retro-electrification

BENEFITS

Simplified invert drainage system

Reduced excavation requirements

Significantly reduced project timescales

Materials & labour cost reduction

Reduced invert excavation depth

Improved drainage capacity

Highly resistant to calcification

• ABG Deckdrain® Cut & Cover

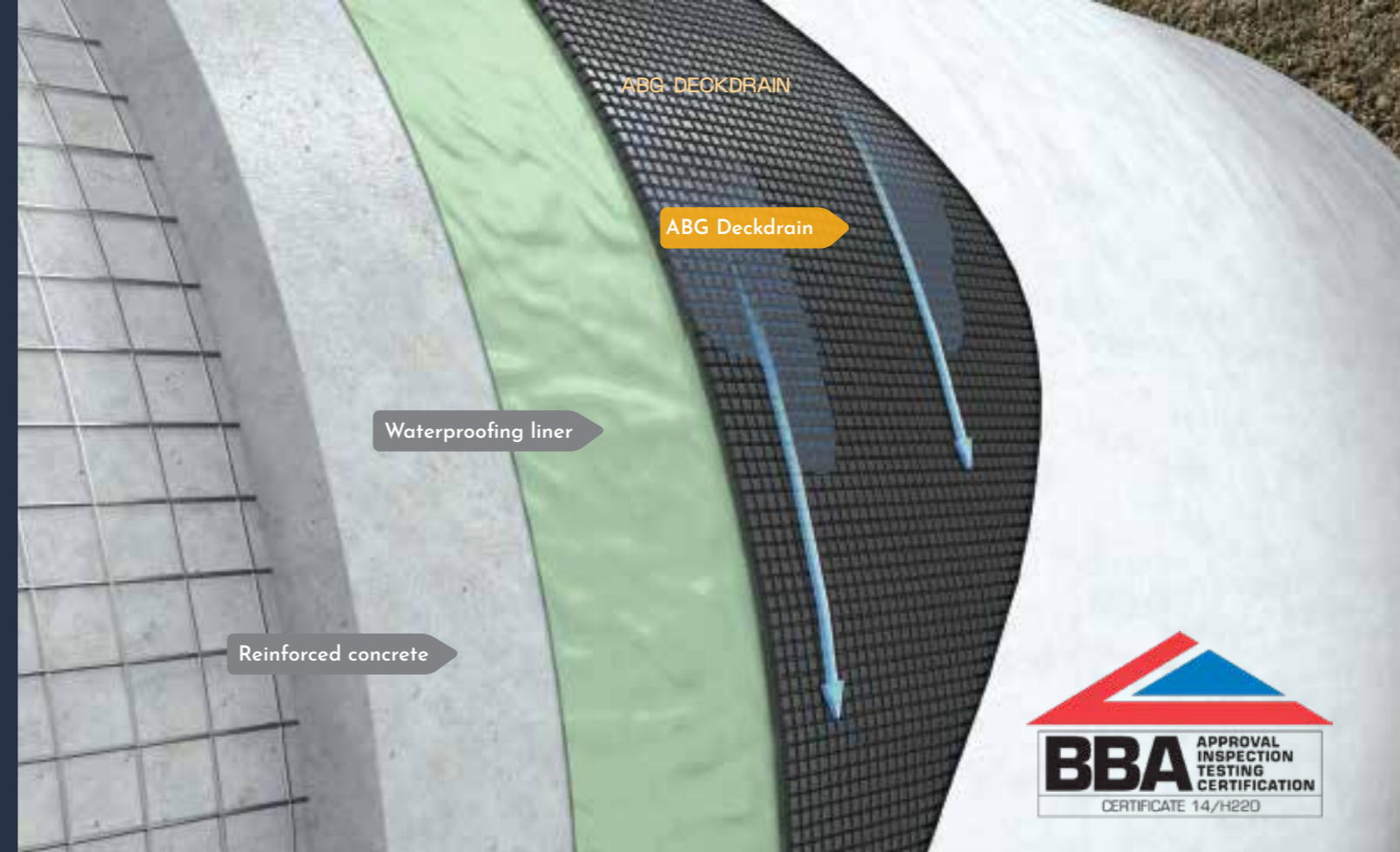
ABG Deckdrain is a high performance geocomposite drainage system, providing an environmentally friendly alternative to traditional structural drainage, with high flow capacity and added protection to the external walls of the tunnel.

The HDPE cusped core of the geocomposite provides a free flowing drainage void in all directions. The cusps are designed to support the stiffened geotextile which is thermally bonded to the drainage core to ensure that it does not deform into the drainage passages under the pressure of the backfill material.

ABG pioneered the application of the Stepped Isothermal Method (SIM) to determine the compressive creep of drainage geocomposites to guarantee long term performance over a 120 year design life.

ABG Deckdrain is durable and sufficiently robust to resist the mechanical stresses imposed during installation and continuously throughout its design life. It is suitable for long-term design pressures of 100 to 1,000 kPa. Use of ABG Deckdrain eliminates the need for further protection of the waterproofing system.

ABG Deckdrain incorporates a geotextile flap that is overlapped to ensure integrity of the drainage layer across the entire installation area.



ABG Deckdrain combined with Cavidrain Invert



APPLICATIONS

Buried structures

Cut & cover tunnels

Soft soil tunnels

Top-down constructions

Tunnel drainage

Lost shuttering

Relief of uplift pressure beneath tanks, slabs and culverts

Structural drainage

BENEFITS

Thinner drainage layers when compared to traditional crushed stone

Reduced dead loads means thinner slabs are possible

Factory controlled manufacture for consistent performance

Wide rolls for rapid installation

Enhanced performance of structural waterproofing

High CBR puncture resistance to provide protection

Allows use of lower specification backfill

Reduced construction traffic volumes when compared with crushed stone



Reinforced Soil Walls

Limited time and space often creates the need to build slopes and walls as steeply and quickly as possible. A geogrid reinforced wall or slope is often the most cost effective solution. ABG provides a design service to enable engineers and contractors to explore a range of solutions using hard or vegetated facing. Very often, site won excavated material can be used as the fill.



Stabilisation of Access Roads

Frequent trafficking by vehicles with heavy loads will result in ruts and constant regrading of the road. ABG offers a range of solutions for road base stabilisation that minimise the amount of stone and subsequent maintenance required. The solution could be based on a robust woven geotextile, a geogrid or a geocellular web, whichever is the most economical and practical for each design situation.



Erosion Control of Slopes

ABG has a complete range of products for erosion control of existing and newly formed steep slopes. Soil loss during heavy rainfall is a major concern for the stability of the slope, resulting in silt pollution of local rivers. ABG will help select the appropriate solution, whether a lightweight biodegradable mat, a permanent erosion control mat or a geocellular web which can provide veneer stability to thin soil layers.



Containment of Spoil

Spoil, especially slurry, can be regarded as a hazard and needs to be directed to an engineered containment. ABG can provide guidance and supply a range of geosynthetic materials that will ensure a robust containment. The barrier lining of a GCL or HDPE geomembrane is enhanced by the appropriate use of geocomposite drainage layers such as Pozidrain which will provide leak detection, protection and consolidation.

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. Our 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 tunnel construction spans more than thirty 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 design, design validation, feasibility studies, cost advice and advice on meeting regulatory requirements.

ABG is active in developing and driving knowledge within the industry 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.

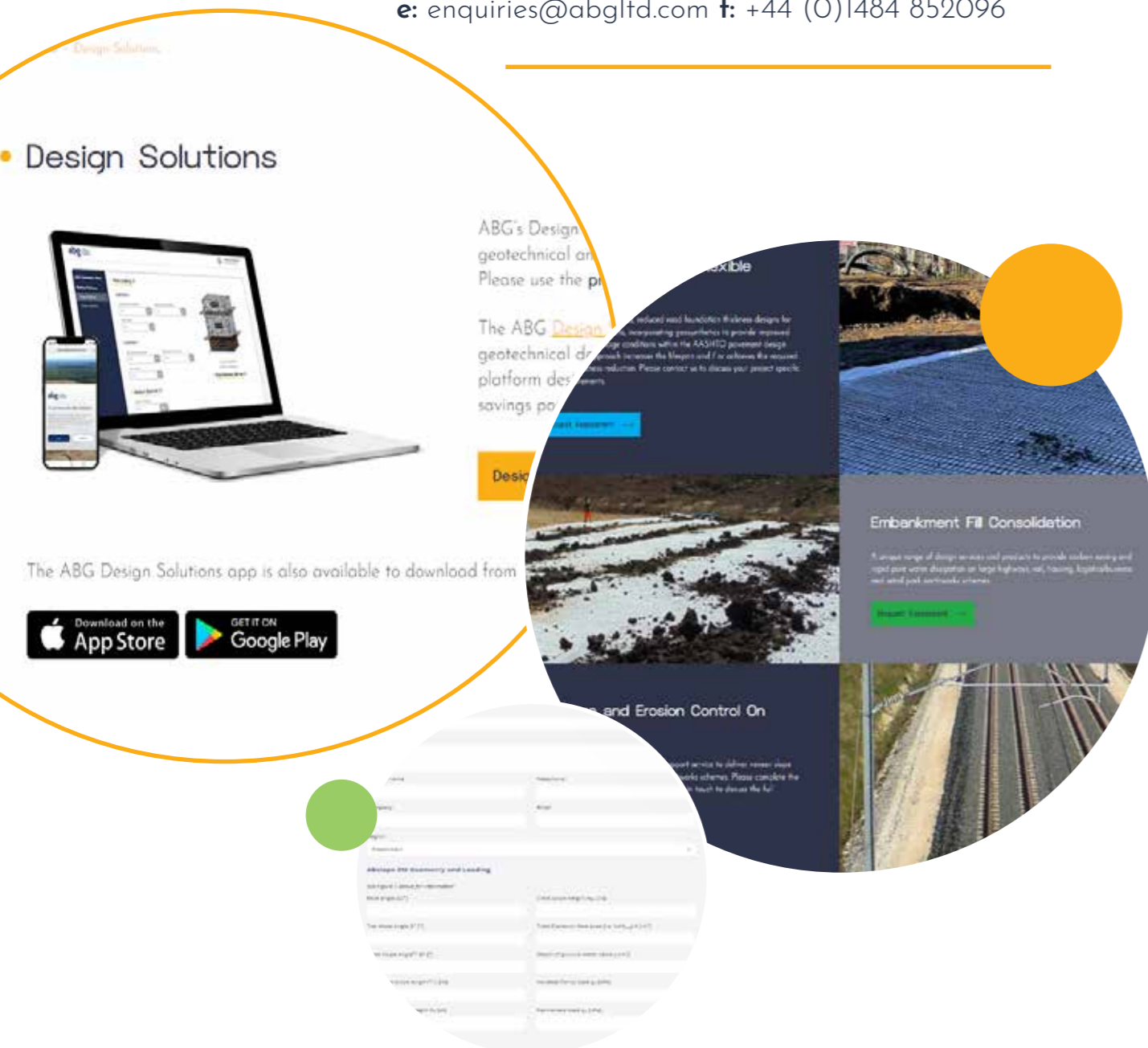
Design Solutions

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