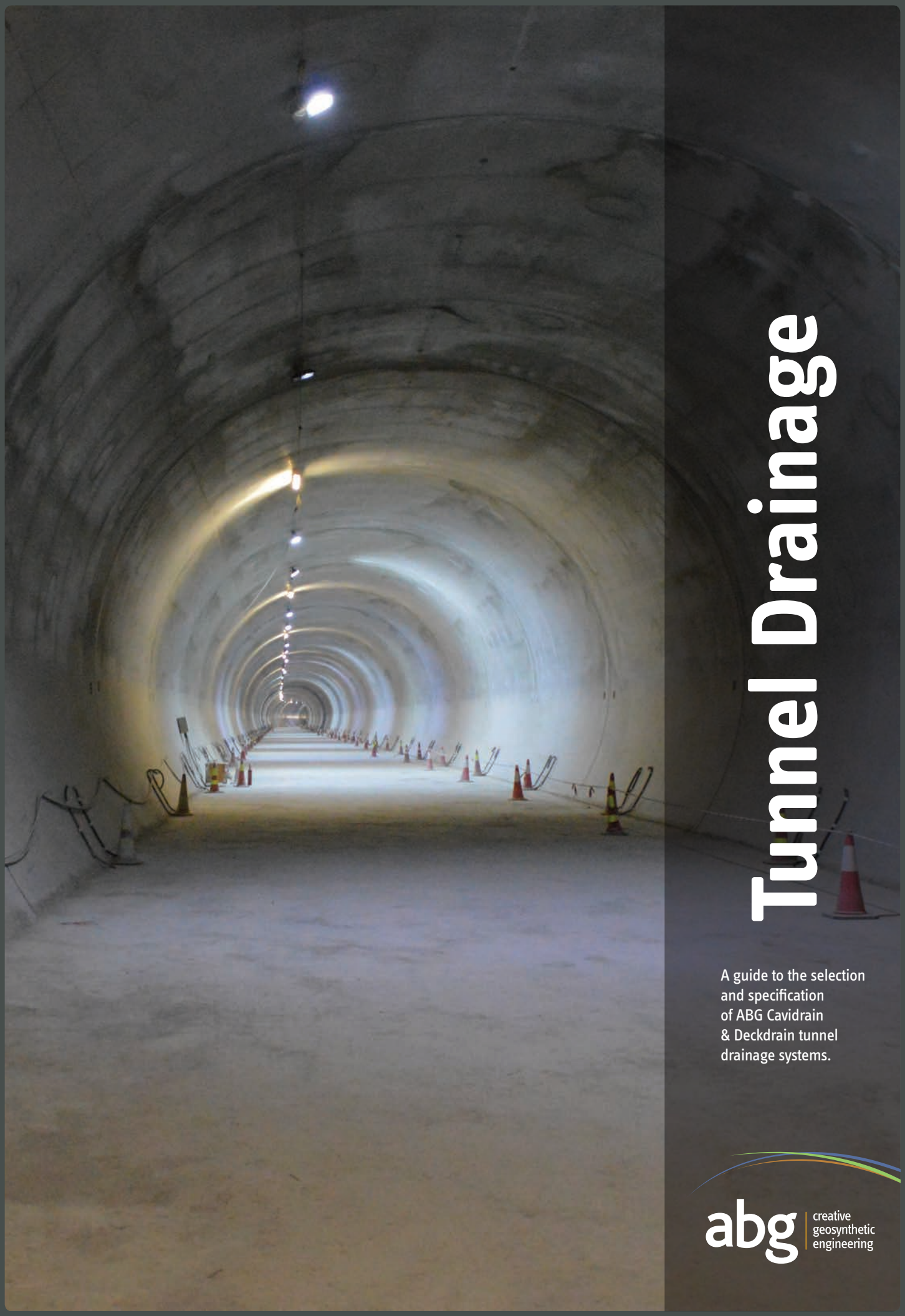


Tunnel Drainage

A guide to the selection and specification of ABG Cavidrain & Deckdrain tunnel drainage systems.

abg creative geosynthetic engineering

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.

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 specifically 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.

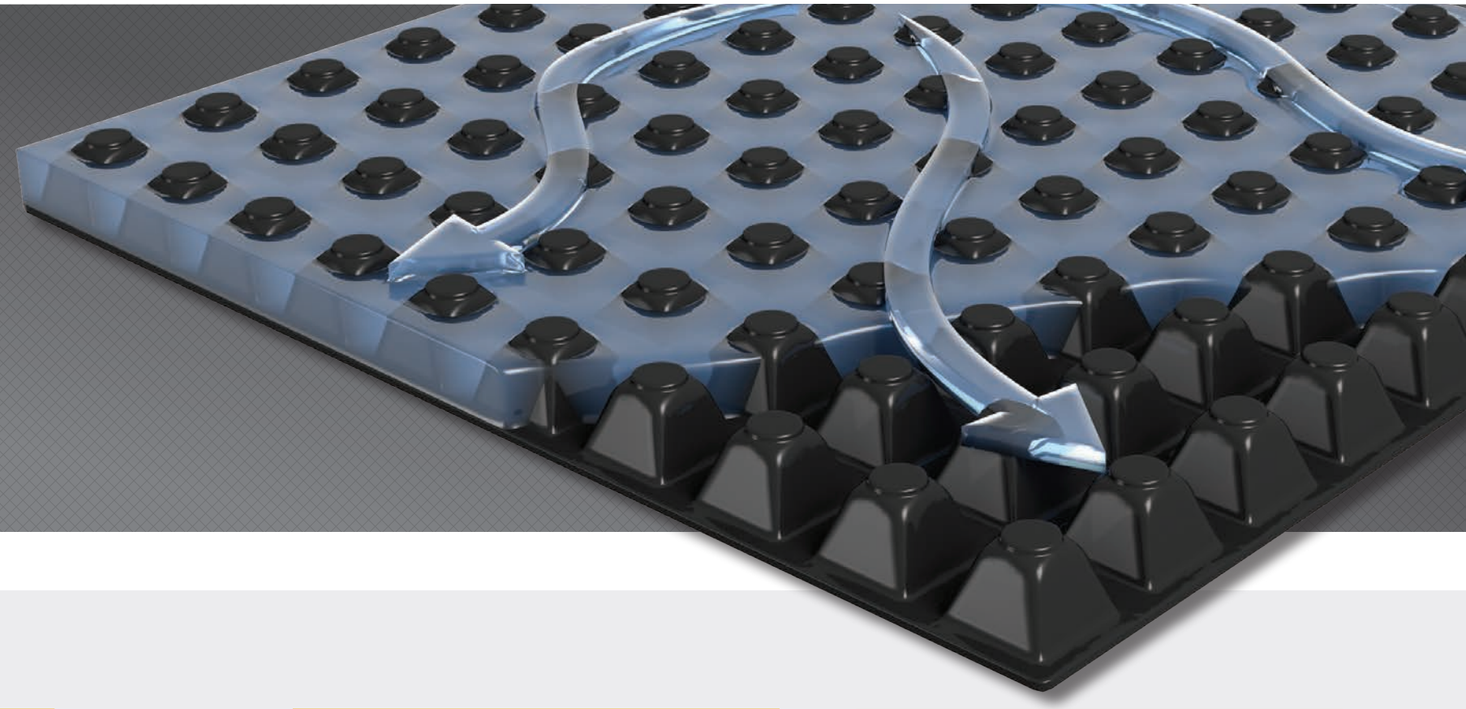
The ABG Deckdrain range is a geocomposite drainage system comprising a high-strength cuspated core thermally bonded to a filtration geotextile. ABG Deckdrain is designed to relieve the effects of water penetration from particulate or soil interfaces, and can be used for internal and external tunnel walls.

Contents

Tunnel Drainage Solutions

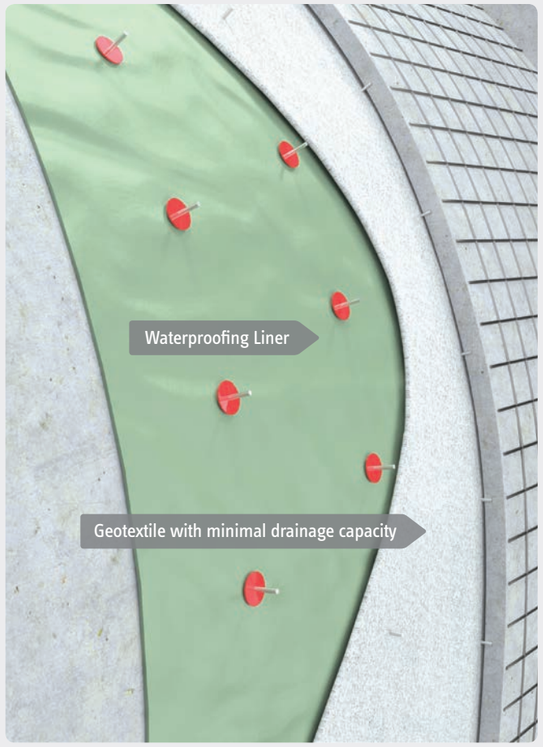
ABG has developed and proven a range of geosynthetic solutions to the known problems associated with traditional tunnel drainage methods:

- the clogging of perforated collection pipes and thick geotextiles with precipitates from calcium carbonate and iron oxide-rich groundwater.
- the time and space consumed by using crushed stone and a pipe in the tunnel invert.



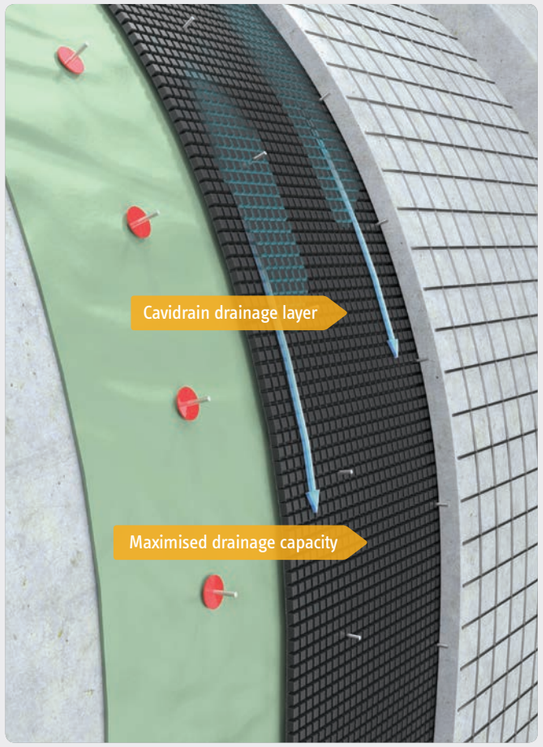
Traditional Wall Drainage

Tunnel wall drainage is traditionally provided by a layer of geotextile held in place by rondels. This inadequate drainage capacity is further impeded by the compressive forces and the clogging of the geotextile due to calcification.



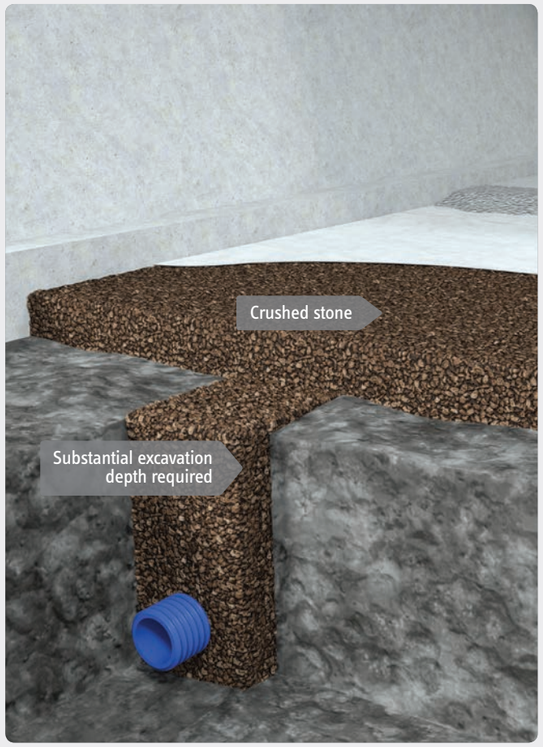
Cavidrain Wall Drainage

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.



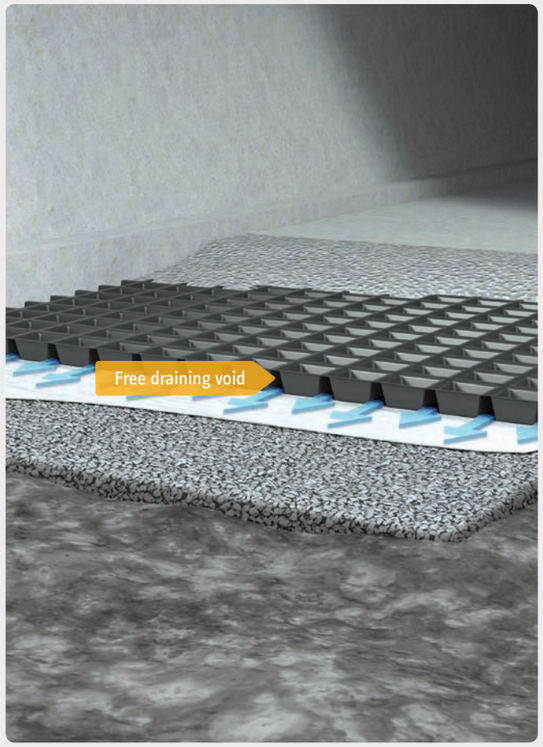
Traditional Invert Drainage

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 optimized for maximum bearing area and flow and is strong enough to withstand normal installation loadings.



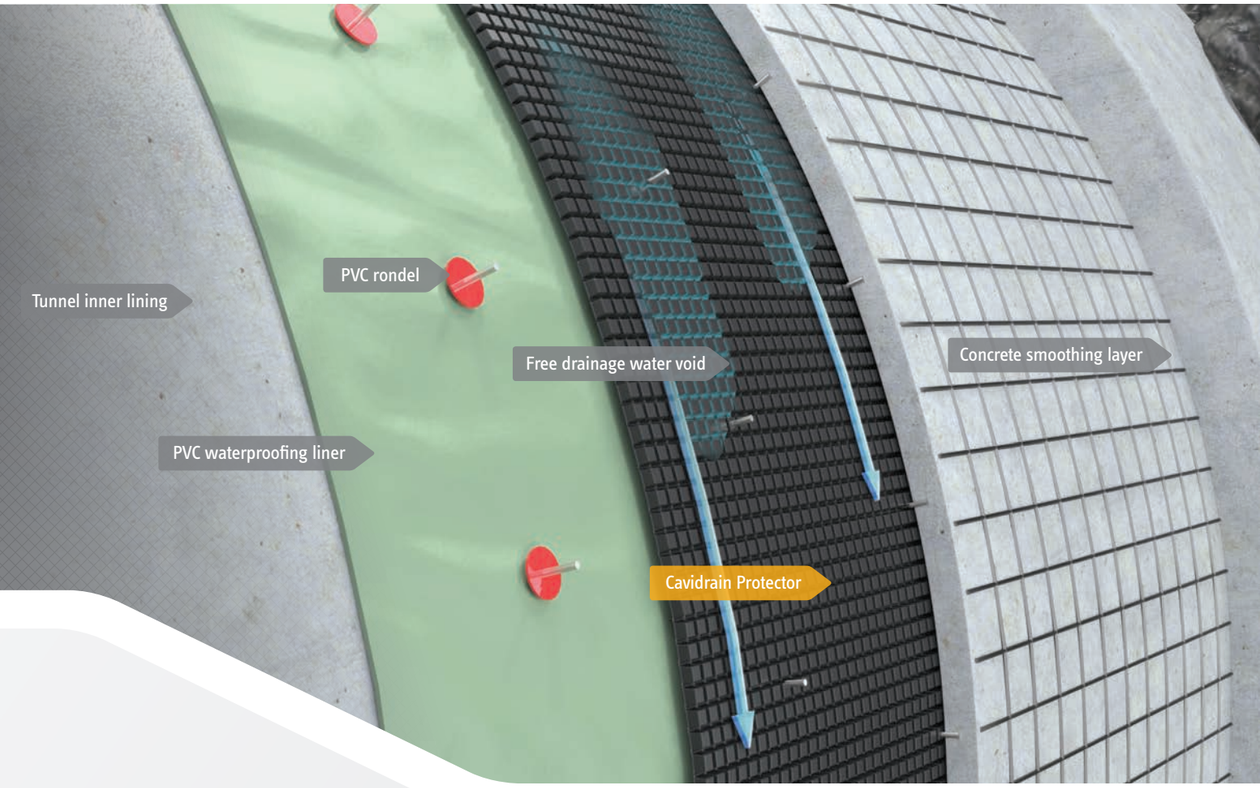
Cavidrain® Protector

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.

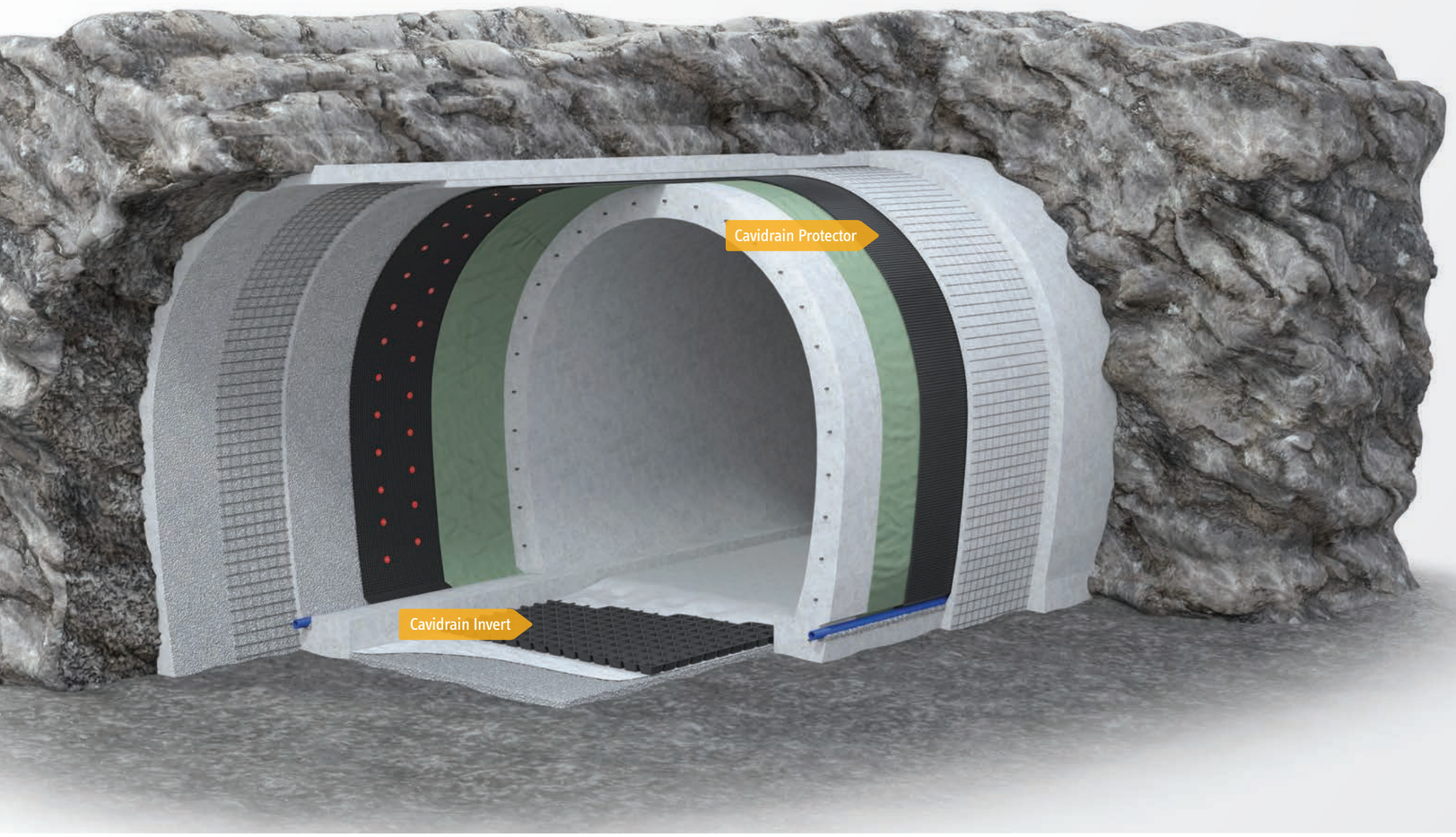
Cavidrain Protector is a cuspated HDPE wall drainage system, easily fixed to tunnel walls with drill and fix or shotfired pins. Cavidrain Protector provides a free draining layer to collect infiltration water from behind tunnel linings as well as providing protection from physical damage. The network of open flow channels in the cuspated 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

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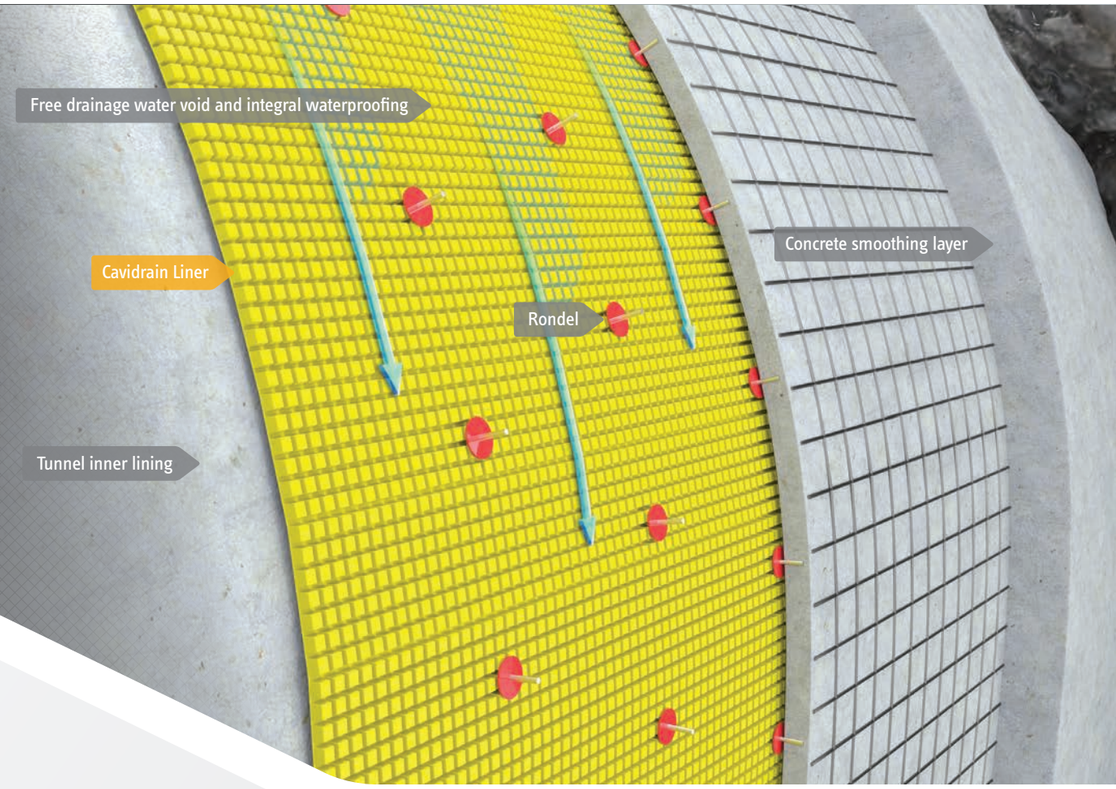
Cavidrain® Liner

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.

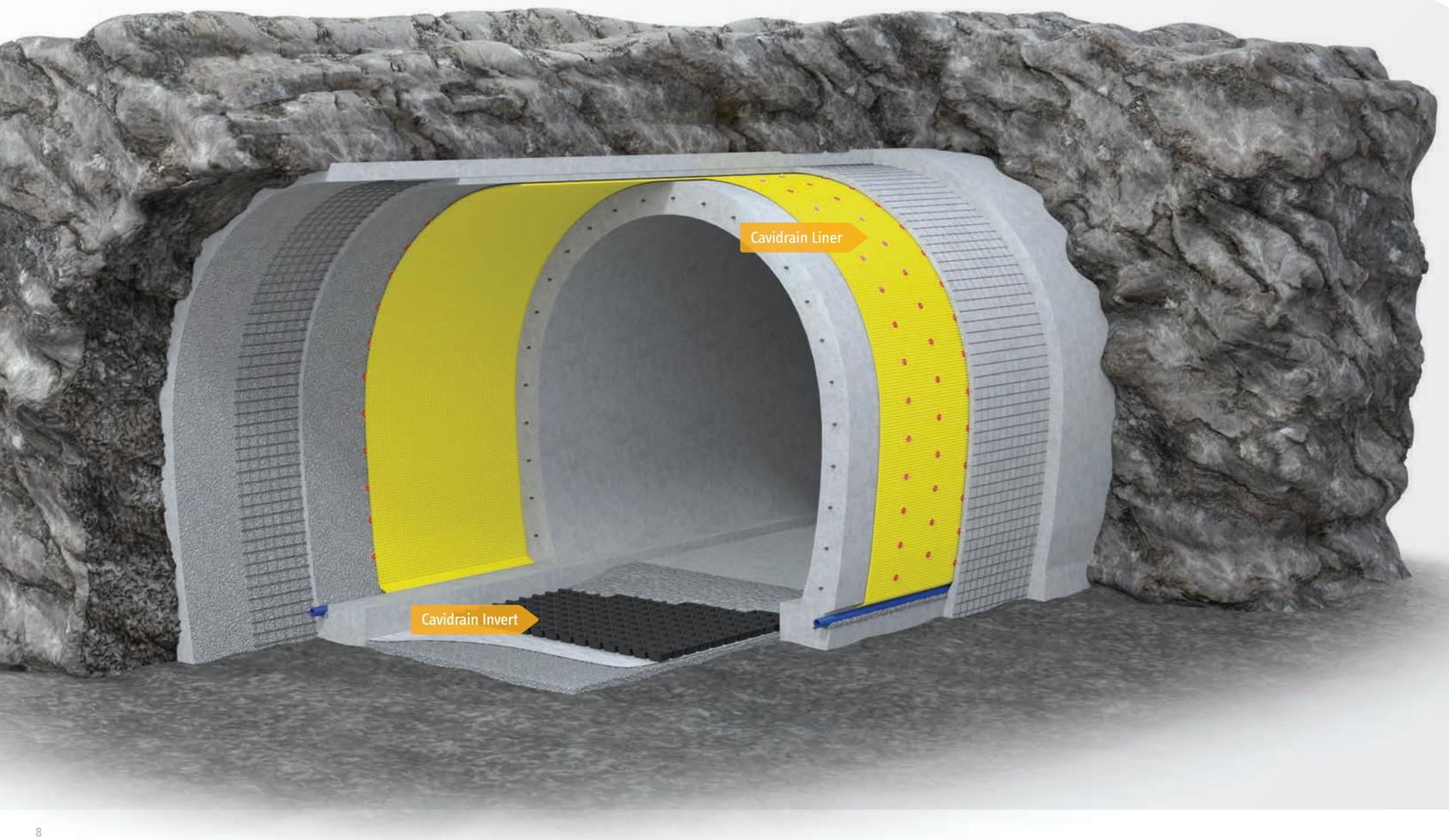
In typical installations, Cavidrain Liner is fixed to the excavated wall of the tunnel or onto a concrete smoothing layer. Sprayed concrete adheres directly to Cavidrain Liner to create the tunnel lining. The rebound loss is significantly reduced in comparison to smooth waterproof linings as concrete is retained in the cuspates. 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, cuspated 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	NATM constructed tunnels
Repair of existing tunnels	Drill and blast tunnels
Highway tunnels	Station boxes
Railway tunnels	Cable tunnels
SCL tunnels	TBM tunnels

BENEFITS

- Simplified tunnel lining system
- Materials & labour cost reduction
- Reduced installation requirements
- Significantly improved drainage capacity
- Reduced sprayed concrete rebound

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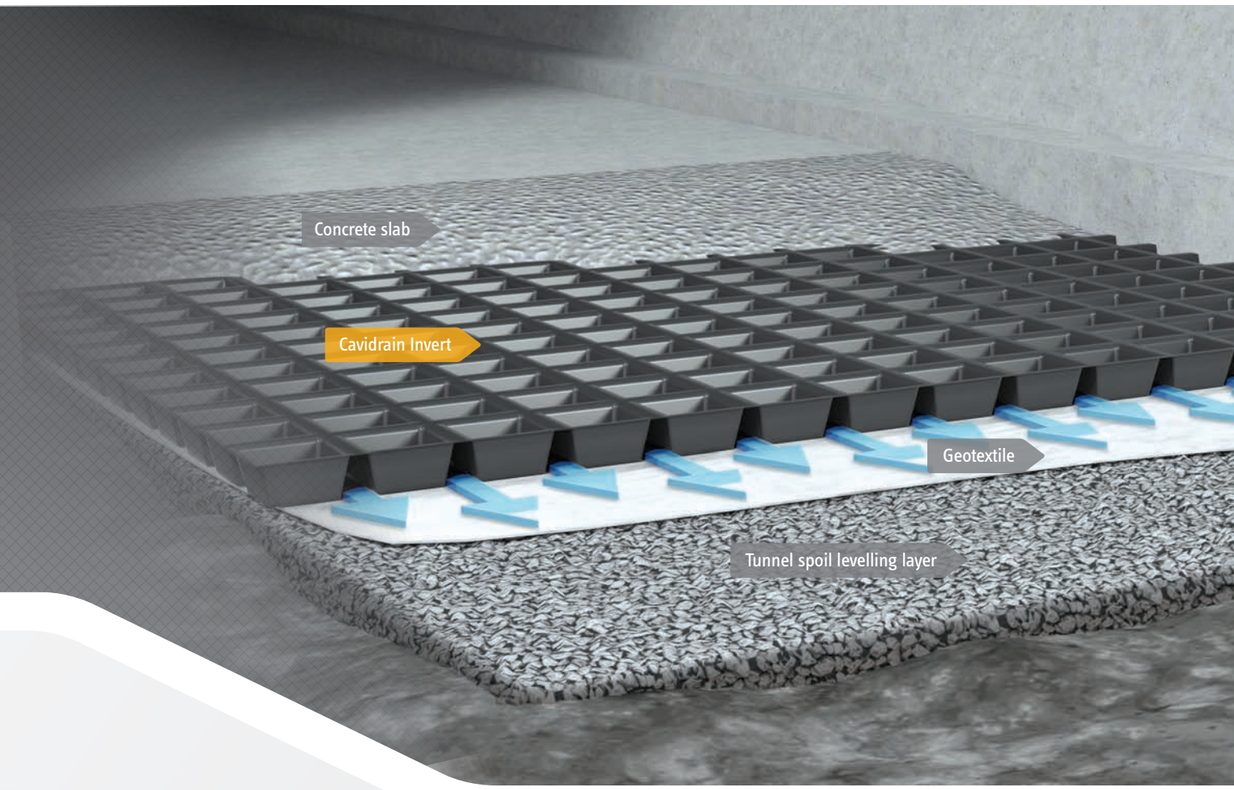
Cavidrain® Invert

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

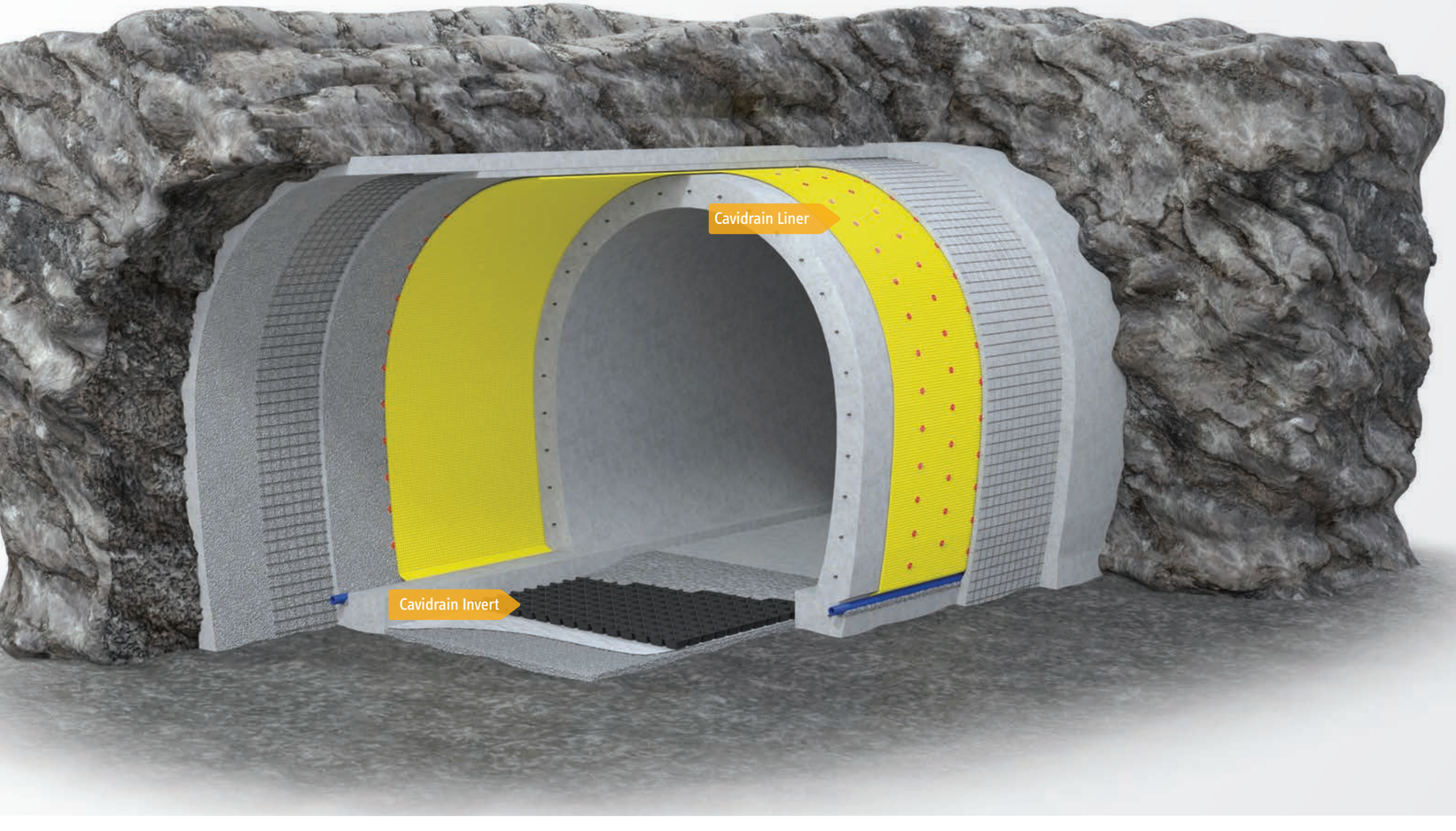
Traditional tunnel invert constructions favour the extensive use of crushed stone together with a longitudinal collection pipe. There is a significant cost in time and money associated with excavating the trench, and crushing and grading the stone before installation. Considerable stone thickness is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

With a typical thickness profile of 40 mm or 60 mm, 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 have the placement of wet concrete. The profiles are chosen to be compatible with the concrete aggregate size such that concrete completely fills the cuspates and once cured, the ultimate load capacity of Cavidrain Invert is that of the concrete fill.



Cavidrain Invert combined with Cavidrain Liner system



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 time scales
- Materials & labour cost reduction
- Reduced invert excavation depth
- Improved drainage capacity
- Highly resistant to calcification

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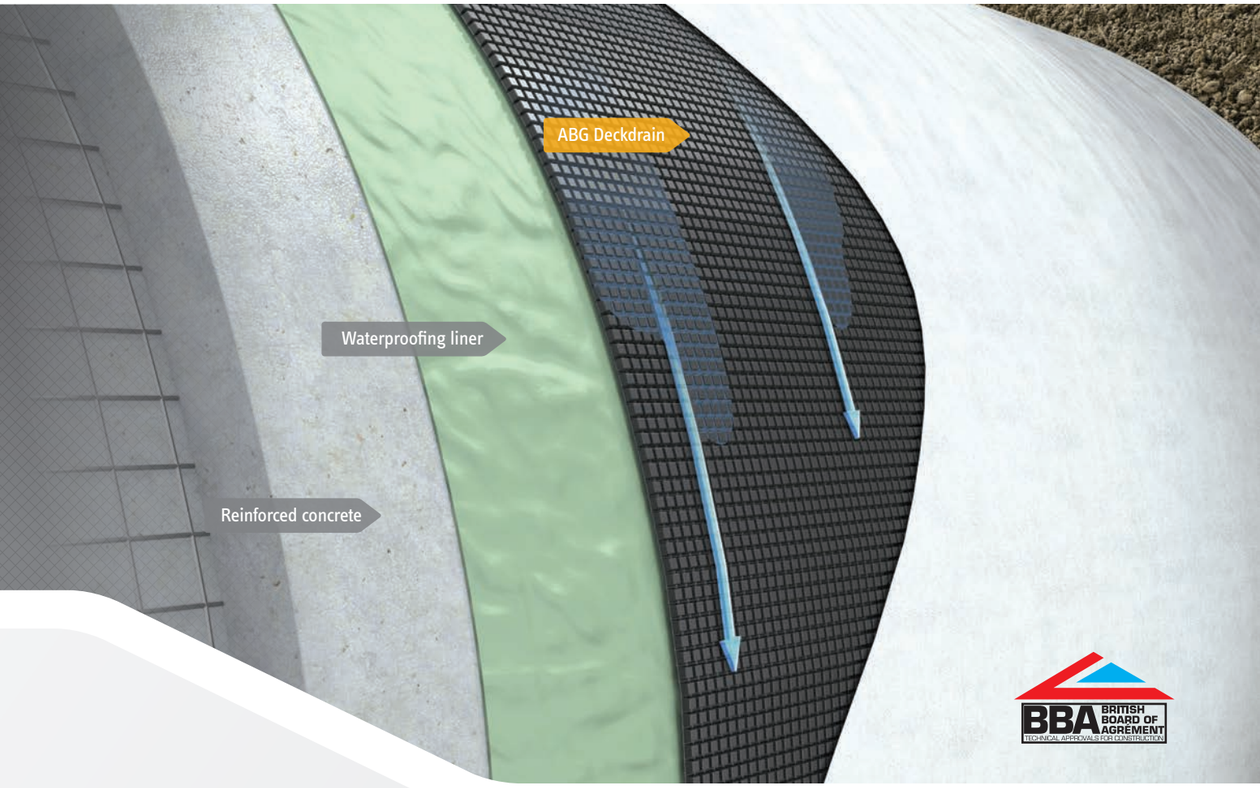
ABG Deckdrain® Cut & Cover

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.

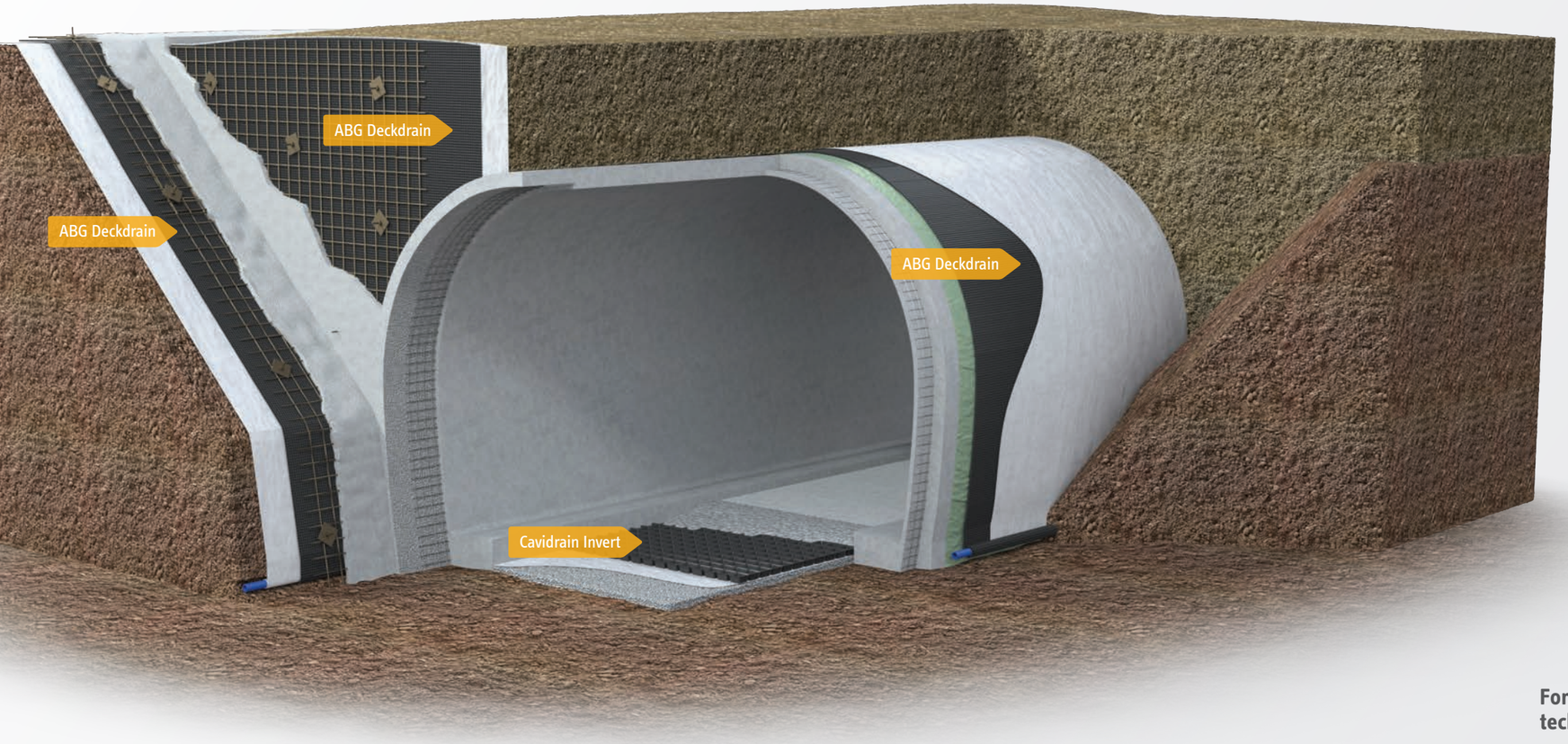
The HDPE cuspated core of the geocomposite provides a free flowing drainage void in all directions. The cuspates are designed to support the stiffened geotextile which is thermally bonded to the drainage core to ensure that it does not deform into the drainage passages under the pressure of the backfill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

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Reinforced Soil Walls

Limited space and time 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 Haul 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 and resulting 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 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 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.

abg creative geosynthetic engineering

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