

# INNOVATIVE TUNNEL DRAINAGE

Alan Bamforth looks at the benefits of Cavidrain, an innovative tunnel drainage system from ABG.

**Tunnels are constructed for transport, hydro, sewers and cables by methods such as TBM (bored), drill and blast, road header or cut and cover with linings of concrete, segments or sprayed concrete (SCL/NATM). Most tunnels are intended to be waterproof in that the construction prevents seepage of water into or out of the tunnel. Often the design also includes pressure relief of ground water behind the waterproofing.**

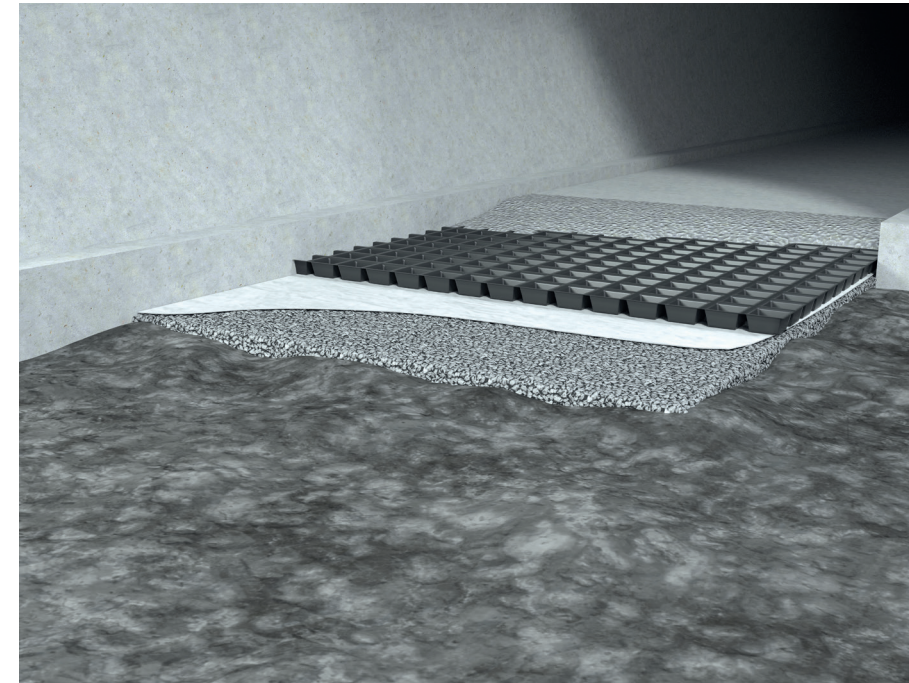
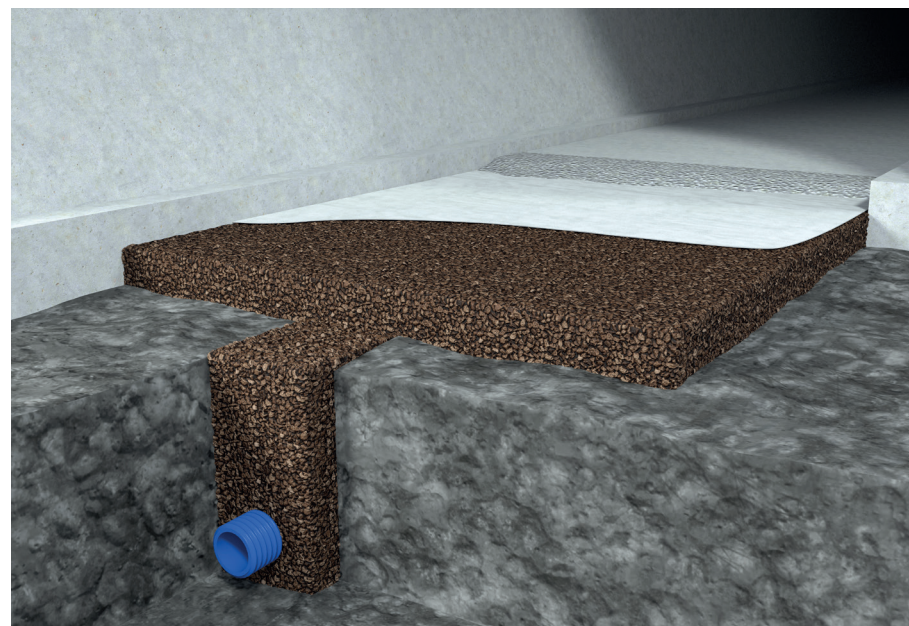
Conventionally, the required waterproofing and pressure relief of the arch is achieved by a 700gsm non-woven geotextile layer behind a welded waterproof membrane. From there, the water is normally led into a crushed stone

drainage layer and a longitudinal pipe trench to pump sumps at tunnel low points. There are known problems with this arrangement:

- The geotextile and perforated pipe are known to clog with precipitates in iron and calcium carbonate rich groundwater.
- The 700gsm geotextile's in-plane flow capacity is woefully inadequate at around 0.015l/m/s at 20kPa confining pressure (even less at higher confining pressures).
- The crushed stone drainage layer is typically 300mm thick and requires a larger tunnel cross section.
- Construction of the pipe trench is often a second operation on the critical path before waterproof lining can commence.

Innovation since 2000 has led to several alternative methods of tunnel drainage by making use of geosynthetics. For example, ABG/ Halcrow/ Dumez pioneered a novel invert drainage layer, first used on the Black Hills Tunnel for the MTRC in Hong Kong and subsequently in several tunnels around the world. Cavidrain Invert is a deep profile HDPE cuspated core that forms a drainage layer across the whole tunnel invert, replacing the crushed stone and the pipe trench. With a typical thickness of 40mm or 60mm, Cavidrain Invert reduces excavation and can be installed in conjunction with the waterproofing installation, leading to a quicker construction program. The concrete slab is cast into the Cavidrain Invert which then transfers the design pressure onto the formation. ABG manufactures a range of Cavidrain Invert products and will input to the technical design/detailing and also tailor the product to suit the project.

Tunnel wall water pressure relief is also innovating away from the conventional 700gsm geotextile with the BTS/ICE specification indicating that the drainage function must be designed and that geosynthetic drainage layers may be considered. ABG manufactures Cavidrain Protector for this application. This is a thin cuspated geosynthetic in 400, 500 or 700gsm HDPE that has in-plane flow capacity of up to 2 l/m/s at 250kPa long term confining pressure. Cavidrain Protector is installed in the same way as a geotextile, however, it provides greater than 100 times more in-plane flow capacity. This is achieved as a result of the network of open flow channels in the cuspated core which are resistant to clogging by deposits in the ground water. One side of the Cavidrain Protector is open and the other side is virtually impermeable which means that the water is actually flowing on the Cavidrain before it can reach the waterproofing. The greater factor of safety this gives means



that LLDPE is difficult to ignite, resists flame spread and does not produce toxic fumes. The first use of Cavidrain Liner was developed and approved for a cable tunnel project being constructed by Dragages JV. On that project, the Cavidrain Liner was fixed to the tunnel walls using a proprietary rondel and the individual sheets were welded together with a Leister Twinny. A sprayed concrete lining was applied to the Cavidrain and this revealed another benefit, in that the rebound loss was significantly reduced by virtue of the textured nature of the Cavidrain core compared to a smooth waterproof liner.

Where cut and cover tunnels are constructed, the waterproofing is usually applied externally and here, ABG Deckdrain provides a robust drainage and protection layer. Deckdrain has a HDPE cuspated core bonded to a geotextile filter compatible with the soil backfill. Accordingly the in-plane flow is tested with Soft Platens to EN ISO 12958 and ABG has pioneered the application of the Stepped Isothermal Method (SIM) to the determination of the compressive creep of geocomposite drainage so as to demonstrate long term performance over a 120 year design life. ABG Deckdrain has been granted a BBA Certificate for this application.

Though successfully and advantageously used in numerous prestigious projects, not all of these innovations are widely known or understood. There are also further innovations that have yet to be developed. Our technical team of engineers is eager to assist you to maximise the benefits within your potential new projects.

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that there is reassurance that the, all important, pressure relief of the waterproof lining is maintained for the whole lifetime of the tunnel.

Temporary Works is also an area in which Cavidrain Protector has been utilised as an expedient and convenient method to deal with water ingress during tunnel construction. In this situation, the Cavidrain is simply laid over the fissure and fixed in position with shot fired nails. Unlike corrugated sheeting used in a similar way, the Cavidrain will fold in more than one direction which means that it is easier to apply to curved surfaces.

Even more innovative is ABG Cavidrain Liner which combines the waterproofing and







# CAVIDRAIN for quick and effective tunnel drainage

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