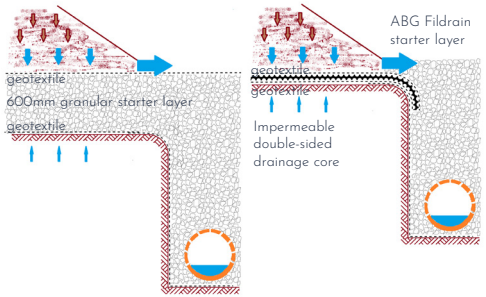
Tech Note: Embankment Starter Layers

Drainage Stone vs Drainage Geocomposites

Introduction

Starter layers are often specified in highway works to enable rapid construction of embankments over soft, semi-saturated soils. They usually consist of a 300mm-600mm thick drainage stone layer with the purpose of providing a stronger base to allow porewater pressure release and drainage of fill material. Other advantages include capillary breaks, artesian spring interception and the ability to work in wet conditions. Stone layers are heavy and hard to spread in wet conditions and often require a geotextile filter to be placed abave and below the layer to prevent pumping and silt contamination. Whilst the lower geotextile will provide a stabilising effect, this remains a challenge in wet weather. However, a factory made geosynthetic drainage geocomposite offers a more than equivalent alternative that is placed by hand in one operation. They have been used on major highways embankment projects over the last 20 years in the UK. This technical note compares the two methods, based on various criteria; including hydraulic performance, installation, durability, environmental impact and cost-effectiveness. Benefits include; cost savings, improved manual handling safety, quicker installation, and reduced environmental impact through minimising delivery vehicle journeys.

	Fildrain geocomposite (7mm thick)	Drainage stone (300-600mm thick)	
1 Hydraulic and Stability Performance	Fildrain consists of a double cuspated plastic core, bonded to a geotextile layer top and bottom. This provides multi-directional, high self-cleansing flow whilst filtering out fine particles to prevent clogging from below and above the impermeable central core. The hydraulic conductivity of the 7mm thick Fildrain exceeds 10^-3 m/s, allowing for efficient water drainage. The three bonded components combine to provide a robust separator that provides sufficient strength to establish a platform for the embankment. The simple addition of a geogrid can enhance this in particularly soft soil conditions.	Typically 6C stone has to be transported to and across the embankment site and compacted in position. Whilst 6C can attain 10^-2 m/s, when compacted it is 10^-3 m/s. The relatively thick layer causes a still further drop in quality during placement. The water path through the stone particles is designed based on relatively low permeability following compaction.	 Traditional 6C Starter Layer ABG Fildrain Starter Layer
2 Installation	Is simpler and >50% faster. Lightweight and easy to transport across site, Fildrain is rolled out just ahead of the backfill, conforming to the graded formation and requiring minimal labour and equipment. It is easily positioned and re-positioned / re-rolled by hand avoiding wastage. The impermeable core protects the formation, allowing continuous placement of suitable fill in all weather conditions to reduce construction time still further. Rolls are easily stacked close to install areas, with no delays awaiting material delivery. Covering is by end-tipping and spreading a minimum of 300mm before trafficking.	Three operations are required to achieve the same functions. Placement of the first geotextile takes the same time as a geocomposite. Then placement of stone by end tipping (min. cover 300mm); compaction and bringing upto formation with a bladed dozer to regrade to level; placement of the second geotextile and additional protective layer before trafficking. Access to install site for road transport has to be established and maintained for quarried stone with wheel wash facilities and safety control at a premium. Any adjustments, or where stone is incorrectly placed, will lead to a high percentage of wastage. Poor weather conditions will slow progress with possible resaturation of the formation.	

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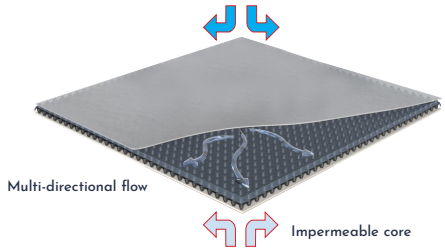
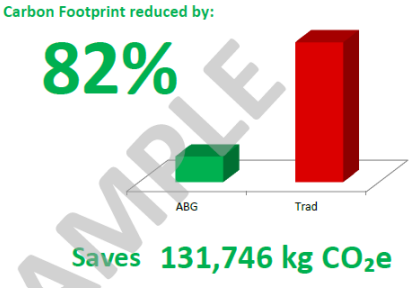
3 Durability & Longevity	Designed to resist environmental degradation, including UV exposure and chemical attack and freeze / thaw breakdown. Easily repairable before backfilling if damaged. The longevity of a geocomposite against environmental breakdown or crush collapse can be over 120 years. Its long-term function is to deal with unforeseen hydraulic events, spillage, or new artesian springs to prevent damage to the rest of the embankment. Fildrain is BBA / HAPAS certified for embankment starter layer applications.	Quality assurance is harder to maintain on delivery and during placement, susceptible to separation and pumping and piping of fines. Freeze / thaw effects breaking down stone in exposed or shallow embankment conditions and could reduce hydraulic properties and create long-term settlement. Spillages or springs are unconfined and can reach other parts of the embankment, causing possible weakening or contamination of the soil.	Diagram showing double cuspate and textile with arrows showing flow 
4 Cost Effectiveness	Although the initial cost of Fildrain may be higher, the ease of installation and reduced labour and plant costs, with no wastage, leads to significant overall project savings (>50% saving).	Can often have a lower upfront cost, but multiple placement of textiles and stone, along with install site deliveries poses an expensive challenge. The need for deeper excavations, heavy machinery and longer installation times leads to increased labour costs, off-setting the initial savings. Delays due to poor weather potentially add further costs.	
5 Environmental Impact	Carbon calculations show Fildrain saves 60-85% of embedded carbon, cradle to end of construction. As a robust separator, in this application the product is estimated as 75 - 80% recoverable, since it can be peeled back using an excavator bucket with a shallow (50mm) covering of soil and washed, re-rolled and recycled at the end-of-life. The time saved during installation reduces worker and public exposure to construction risk.	111 trucks of quarried stone mined, crushed and delivered to site for every 1 truck of geosynthetics has a considerable environmental impact. High carbon costs associated with the stone quarrying, delivery and placement, added to safety issues with exposure to the public and site personnel, especially with tipping operations on potentially unstable sloping ground.	 *(A carbon example, 5.88kg CO_2e/m^2 Fildrain stone starter layer)*

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Conclusion

In conclusion, both geosynthetic drainage geocomposites and stone drainage layers have their advantages and disadvantages for use as embankment starter layers. Geocomposites offer superior hydraulic performance, easier installation, and cost savings over time. They also provide additional functions, such as protection of the formation. In contrast, stone deliveries and placement on problematic soils requires more time and safety supervision.

For many modern applications where environmental criteria have come to the fore, the benefits of geocomposite materials make them an increasingly popular choice in starter layer applications.

Supporting documents for embankment starter layers

Fildrain Product Datasheet; BBA/HAPAS Certificate (14/H220); Reference lists spanning 20 years for Motorway and Trunkroads in UK; Detailed case studies; Comparison calculations for hydraulic performance and carbon saving; Durability declarations with supporting Technical Notes

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