ABG Deckdrain vs. Filter Stone
Comparing vertical drainage performance

Introduction
A drainage zone is provided to the rear of bridge abutments, basement walls and retaining walls to prevent the build-up of hydrostatic forces against the structure. Traditionally, this consists of a 300-600mm layer of no fines crushed stone and ideally a geotextile filter to prevent fines migrating into the stone. This note addresses the drainage performance of this traditional method and makes comparison with the performance of ABG Deckdrain.

Background
The practical difficulties and environmental and monetary costs of obtaining and placing granular filter/drainage material behind walls and abutments are well known. Recognition of the inadequacies of the traditional methods and the increasing use of geotextiles as filters in road drainage, led to the development of drainage geocomposites. These consist of a cuspated HDPE core bonded to a geotextile filter. They have been developed specifically for drainage of structures and possess the necessary technical properties - compressive strength, permeability, and pore size - for long term performance. In most cases geocomposites outperform all granular solutions and specialised manufacturers such as ABG, with well-established experience, will certify the durability of the product for the 120 year life of the structure.

ABG Deckdrain
ABG Deckdrain is a geocomposite consisting of a polyethylene (HDPE) core which is cuspated on one side with a geotextile thermally bonded to the cuspatas. The cuspated side faces the soil where the geotextile acts as a filter to prevent fine particles migrating into the core. The HDPE core allows for optimum water flow and high resistance to chemicals, especially petrol and diesel which is associated with typical surface water runoff from road surfaces. ABG Deckdrain is optimised for performance, stable in all regular soil conditions, rot proof with a long life, and has a wide working temperature. The spacing between the dimples on the cuspated side is matched to the strength of the geotextile to ensure that, under backfill
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pressures, the geotextile cannot intrude into the core and block the water flow. The non-cuspatated side is relatively flat to protect structural waterproofing, where present. ABG Deckdrain is CE Marked and is easy to install on all structures including arched and curved surfaces. It can also be cut and fitted to suit angular changes and protrusions.

The geotextile can be matched to the soil particle size grading and permeability. The standard geotextile has a pore size of 120 microns and permeability of 100 l/m².s. This is compatible with all regular soil conditions. ABG Deckdrain is also available with special textiles of very small pore size for use with Pulverised Fuel Ash (PFA aka fly ash) and other challenging soils, and in a range of higher strengths and flow capacities for exceptionally demanding situations. Our technical department would be pleased to advise on appropriate geotextile selection.

Granular Filter Flow Capacity Assessment

Using Darcy’s Law for the movement of water, the flow capacity through a granular material is given by:

\[ Q = k \cdot i \cdot A \]

Where

- \( Q \) = Water flow (l/s)
- \( k \) = Permeability (m/s)
- \( i \) = Hydraulic gradient (decimal)
- \( A \) = Cross sectional area of flow (mm x m)

Considering a one metre strip of filter stone, of thickness \( t \), at a hydraulic gradient of 1 (vertical flow):

\[ Q = k \cdot 1 \cdot (t \cdot 1) \]
\[ = k \cdot t \text{ l/m\textperiodcentered}s \text{ (l/s per m width)} \]

The specified permeability of filter stone can vary from \( 10^{-2}\text{m/s} \) to \( 10^{-4}\text{m/s} \). So the drainage capacity for a typical 600mm wide granular filter is in the range 6.00 l/m².s to 0.06 l/m².s.

Geocomposite Flow Capacity Measurement

ABG Deckdrain comes in several different sized cores in order to provide a range of different drainage rates. From ‘in-plane’ flow testing in accordance with BS EN ISO 12958, the Minimum Average Roll Value (MARV) vertical tested flow capacity at various compressive stresses is shown in Table 1. The grades of ABG Deckdrain in Table 1 are standard sizes and strengths with many other variations available. The HDPE cores of each grade are a nominal thickness of 4mm (400S) to 25mm (2500S).

<table>
<thead>
<tr>
<th>Long Term Backfill Pressure</th>
<th>400S</th>
<th>600S</th>
<th>700S</th>
<th>1200S</th>
<th>2500S</th>
</tr>
</thead>
<tbody>
<tr>
<td>20kPa</td>
<td>0.67</td>
<td>1.31</td>
<td>2.20</td>
<td>3.77</td>
<td>9.99</td>
</tr>
<tr>
<td>100kPa</td>
<td>0.54</td>
<td>1.00</td>
<td>1.92</td>
<td>2.28</td>
<td>7.91</td>
</tr>
<tr>
<td>200kPa</td>
<td>0.44</td>
<td>0.80</td>
<td>1.56</td>
<td>1.96</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Notes:
1. The Minimum Average Roll Value (MARV) is calculated from a set of test results as the mean value minus two standard deviations. This means that 97.7% of tested samples will achieve the MARV or higher.
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These ‘in-plane’ flow values have been obtained with soft foam rubber platens to simulate real soil conditions. Other geocomposites, such as geonets, can have water flow impeded by soil intrusion, whereas ABG Deckdrain’s geotextile spans between the cuspates to resist soil intrusion. For more information ABG can provide a technical paper on this topic (Bamforth, 2008).

![Flow Test Rig](Image)

**Figure 4: In-plane flow testing simulating soil intrusion in geocomposite drainage products**

The horizontal soil pressure behind a wall varies with depth approximately as indicated below. Hence the ‘in-plane’ flow testing has been conducted at a range of pressures to determine the appropriate flow capacity.

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>2</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure (kPa)</td>
<td>20</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
</tr>
</tbody>
</table>

**Table 2: Approximate Horizontal Soil Pressures at Depth**

Geocomposite Flow Capacity Design

To assess an allowable flow capacity in a geocomposite several reduction factors should be considered as outlined below (Koerner, 2012).

\[
q_{allow} = \frac{q_{ult}}{RF_{IN}RF_{CR}RF_{CC}RF_{BC}}
\]

Where 
- \( q_{ult} \) = geocomposite flow rate as determined from ‘in-plane’ flow testing
- \( RF_{IN} \) = reduction factor to account for geotextile intrusion
- \( RF_{CR} \) = reduction factor to account for long term creep compression
- \( RF_{CC} \) = reduction factor to account for chemical clogging of the geotextile
- \( RF_{BC} \) = reduction factor to account for biological clogging of the geotextile

The reduction factor to account for geotextile intrusion (\( RF_{IN} \)) into the core from external pressures is used when ‘in-plane’ flow testing has been conducted with hard platens on either side. As flow testing of ABG Deckdrain accounts for this by using soft platens, the reduction factor can be taken as 1.0 (\( RF_{IN} = 1.0 \)). Without soft platen testing \( RF_{IN} \) can be as high as 2.5 to 5.0.

As with all plastics, HDPE undergoes creep compression under a long term constant load and hence a flow reduction factor (\( RF_{CR} \)) is incorporated to account for this. For standard grade ABG Deckdrain at the pressures in Table 2, the long term creep compression is less than 25%. This level of creep compression results in a maximum flow restriction equal to a flow reduction factor of 1.3 (\( RF_{CR} = 1.3 \)). Higher strength cores are available which can further limit long term creep compression up to pressures of 1,000kPa.

Further reduction factors should be applied to the flow values for biological and chemical clogging. For ABG Deckdrain in typical soil conditions there is little biological activity or detrimental chemical effects and so these...
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Factors should be taken as 1.0 (RF_{SC} = 1.0, RF_{CC} = 1.0). In atypical soil conditions where chemical or biological clogging is a concern ABG can provide further advice.

When using **ABG Deckdrain** in typical soil conditions the assessment of the allowable flow rate can be reduced to:

\[
q_{\text{allow}} = \frac{q_{\text{ult,DD}}}{1.0 \cdot 1.0 \cdot 1.3 \cdot 1.0} = \frac{q_{\text{ult,DD}}}{1.3}
\]

Where \(q_{\text{ult,DD}}\) = flow rate in **ABG Deckdrain** as per Table 1.

In addition to the reduction factors outlined above, a global factor of safety should be applied to both the granular filter flows and geocomposite flows to give the final design flows (Koerner, 2012).

\[
FS = \frac{q_{\text{allow}}}{q_{\text{reqd}}}
\]

Where \(FS\) = global factor of safety (applied to both granular and geocomposite flows)
\(q_{\text{allow}}\) = allowable flow rate
\(q_{\text{reqd}}\) = required flow rate as obtained from the design of the overall system

**Flow Capacity Comparison**

As demonstrated above, the flow capacity of a granular filter depends on the thickness of the layer and the permeability of the stone used. For a geocomposite filter such as **ABG Deckdrain**, the dimensions, strength and stiffness of the geocomposite, and the horizontal soil pressure applied, are the governing properties. Shown in Figure 5 is a graph of granular filter thickness vs. flow for various granular filter permeability grades. Superimposed on this graph are the MARV flow capacity ranges for **ABG Deckdrain** in typical soil conditions and at different pressures after application of the reduction factors outlined above (i.e. \(q_{\text{ult,DD}} / 1.3\)).

**Conclusion**

**ABG Deckdrain** provides flow capacity equivalent to that of granular filters with just a fraction of the space required. This allows greater use of on-site materials and reduces the need to acquire and place suitable granular filter material. In addition, a geotextile filter does not need to be added as **ABG Deckdrain** is a geocomposite which incorporates a geotextile filter. On sites where suitable granular filter stone is not readily available this can lead to significant savings both in terms of monetary cost and CO₂ emissions associated with delivering stone over long distances.

**References**


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Figure 5: Vertical Flow Capacity Equivalence

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Permeability, k (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobble and boulders</td>
<td>10 to 10^{-1}</td>
</tr>
<tr>
<td>Coarse, clean gravel</td>
<td>10^{-1} to 10^{-3}</td>
</tr>
<tr>
<td>Well graded sandy gravel</td>
<td>10^{-3} to 10^{-5}</td>
</tr>
<tr>
<td>Well graded sand</td>
<td>10^{-4} to 10^{-6}</td>
</tr>
</tbody>
</table>

Deckdrain Drainage Capacity Compared with Filter Stone TECH NOTE Rev 1.00

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Worked Example A

Consider a retaining wall in typical soil conditions which is 2.0m tall and needs to be able to manage maximum groundwater flows \( (q_{allow}) \) of up to 0.4 l/m²s. It is proposed to use a 600mm thick granular filter.

1. Assess required permeability of granular filter as \( 6 \times 10^{-4} \) m/s.

2. As the retaining wall is 2.0m high the approximate horizontal soil pressure is 20kPa. So a suitable ABG Deckdrain must have an 'in-plane' flow capacity of \( \geq 0.4 \) l/m²s at 20kPa.

For this application all ABG Deckdrain options are suitable and the recommended grade is 400S.

Solution: ABG Deckdrain 400S ✓
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**Worked Example B**

Consider a 10m deep basement excavation where you have a nearby source of aggregate with a permeability of $3 \times 10^{-3}$ m/s. The required maximum flow ($q_{allow}$) is 1.30 l/m·s.

1. Assess the required thickness of granular filter as 425mm.

2. As the basement is 10m deep the approximate horizontal soil pressure will be 100kPa. So the suitable ABG Deckdrain must have an ‘in-plane’ flow capacity of ≥ 1.3 l/m·s at 100kPa.

For this application the suitable ABG Deckdrain options are 700S, 1200S or 2500S and the recommended grade is 700S.

**Solution:** ABG Deckdrain 700S ✔