Filtration and drainage: a technical note

Some ‘helpful hints’ to complement proper geotextile filter design of referenced procedures

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This technical note focuses on the use of geotextiles in filtration applications. Geotextiles most commonly used are either nonwoven (needlepunched or heatbonded) or woven geotextiles manufactured with monofilament yarns.

Woven monofilament geotextiles are 2-dimensional products with a distinct orientation of fibers, uniform opening size, and a high percent open area (POA). These products typically have an apparent opening size (AOS) larger than or equal to 0.21 mm and a POA of at least 4%. Nonwoven geotextiles have a relatively low tensile modulus, a random orientation of fibers, and a random opening size. These products typically have an AOS less than or equal to 0.30 mm, which decreases with increasing mass per unit area. Both woven monofilament and nonwoven geotextiles have very high in-isolation flow rates and are therefore suitable for filtration applications.

Quite often, engineers blindly specify geotextiles for filtration applications without having performed any soil analysis and determined the appropriate geotextile properties for their application. Manufacturers are often asked for recommendations when no soils information is available. Because soils are extremely variable, and applications may differ in terms of boundary and hydraulic conditions, blindly specifying a geotextile filter can be dangerous. In some circumstances a woven monofilament would be better suited for the application; while in other cases a nonwoven geotextile would be better suited. In many applications, either type of geotextile will perform equally well, yet there are times when neither type of geotextile will perform very well. TC Mirafi, a manufacturer of both woven and nonwoven geotextiles, promotes the proper design of the geotextile filter based on the application, soil, boundary and hydraulic conditions.

There are many design procedures available for determining geotextile properties in filtration applications (Geosyntec 1991, Holtz et. al. 1995). However, experience, judgment and knowledge of past research can be vitally important and help guide your decisions. The following are some “helpful hints” with respect to filtration and drainage applications. These “helpful hints” are provided in an effort to complement, not replace, proper geotextile filter design.

In high gradient coastal shoreline applications, the quick release of hydrostatic pressure through the geotextile is critical to long-term performance. Therefore, long-term permeability should be the designer’s favored criteria for selecting a geotextile filter. In favoring long-term permeability and in minimizing the potential for geotextile clogging, the designer should choose a geotextile with the greatest POA and the largest available AOS while adhering to the retention criteria. If highly silty soils are present, consider using a layer of fine-grained bedding sand between the geotextile and the silty soils, and design the geotextile as a filter for the bedding sand (Geosyntec 1991).
In leachate collection-system applications, research has shown that a woven monofilament geotextile with an AOS of 0.42 mm and 14 - 32% open area provides the best resistance to microbiological clogging (Koerner and Koerner 1995).

Woven geotextiles made with slit-film yarns are generally not suited for filtration applications because of their low POA and flow rates. Although woven slit-film geotextiles typically have a large AOS, these products have only 1% to 2% open area and may be considered a clogged filter before even entering a soil environment. To minimize the potential for clogging, the geotextile should have a POA of at least 4% (Geosyntec Consultants 1991).

For gap-graded silty sands with less than 20% silt, research has shown that a woven monofilament geotextile with a POA of at least 10% should be favored (Fluet and Luettich 1993). Check the retention criteria to determine AOS requirements.

For soils with a high silt content (>20%) and a low plasticity index (PI < 5), research has shown that non-woven geotextiles, woven slit-film geotextiles, and woven monofilament geotextiles with a low POA may experience clogging or blinding. This same research shows that woven monofilament geotextiles with a POA of at least 10% are much less susceptible to long-term clogging or blinding (Haliburton and Wood 1982).

Silts are troublesome. Nonwoven geotextiles may clog or blind (Haliburton and Wood 1982), and woven geotextiles, which generally have a large AOS relative to the silt particles, may allow piping. One possible solution is to choose a geotextile with a relatively large pore structure, expecting that some piping may occur, and increase the size of the downstream drain to accommodate the influx of some soil particles. Alternatively, for critical applications, place six inches of fine sand between the silt soils and the geotextile, and adjust the AOS of the geotextile to filter the adjacent fine sand (Geosyntec 1991).

Under high overburden pressures, a nonwoven geotextile may intrude into the drainage area, causing a restricted flow path. Possible solutions include increasing the size of the downstream drain to account for geotextile intrusion, or favor a woven monofilament geotextile, provided the retention criterion is satisfied (Geosyntec 1991).

Wrapping a pipe with a geotextile, in general, is poor practice unless the soil adjacent to the geotextile is a clean sand. In this application, to avoid geotextile clogging, the best design is to place the geotextile filter around the perimeter of a drainage trench, with the pipe encapsulated in stone.

For critical applications, consider conducting a laboratory test to assess the performance of the geotextile filter subjected to the actual soil and hydraulic conditions. There are two tests available: the Gradient Ratio test (ASTM D5101) and the Hydraulic Conductivity Ratio (HCR) test (ASTM D5567). Use the Gradient Ratio test for coarse-grained soils (permeability greater than 5 x 102 cm/s) and the HCR test for fine-grained soils. Note that neither test can assess the performance of the geotextile in dynamic, reverse directional, or turbid flow conditions. For concerns relating to microbiological clogging of the geotextile for leachate collection systems, perform ASTM D1987: Biological Clogging of Geotextile or Soil/Geotextile Filters.
For all applications, make sure the geotextile is strong enough to withstand the installation stresses. Refer to the AASHTO M288-96 standard specifications for minimum strength requirements for geotextiles in various applications.

References


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