Drain Envelopes: To Use or Not to Use

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Tile systems have been known to fail when sediment enters the pipe through the crack between abutting clay tile or through the slots in the more common corrugated plastic tube. Many architects design a system which has a geotextile cloth envelope or covering on the tile to prevent the infiltration of sediment into the tile. In many cases, the use of the envelope not only increases the cost of the system, but may lead to the very clogging of the system for which it was intended to prevent.

In most soils, the wide distribution of particle sizes from clay through sands and small gravel form natural bridges of particles over the entry points of water into the tile. Soils, however, which are of a relatively uniform particle size, are unable to form these natural bridges and are considered to be unstable when saturated with water; the condition which exists when water is about to flow into the tile line. These soils have been identified as very fine sands, loamy fine sands, fine sands, and silts. Clays would be expected to cause even greater problems, however, because of the plate-like nature of clay particles. Due to strong cohesive forces between the particles, clays react similar to bridging soils.

Certainly an envelope should never be used in a drainage system for USGA design of a sports field. The fine material that will wash out of the sand root zone will, with time, clog the pores in the envelope. It is wiser to ensure that the tile lines have sufficient grade so that they are self-flushing, which will ensure the fines are washed out of the system when a flush of water runs through the line after a heavy rain. A grade of greater that 0.5% on a four inch tube should ensure self-flushing.

The use of an envelope in conditions where it is not required, particularly in clay soils, will result in the clay forming a film over the geotextile material and clogging the pores in the envelope. The film of clay over the envelope in turn reduces the drainage efficiency of the pipe. If the envelope were not used, the clay particles not trapped in the bridging effect would move the slits in the tube and be flushed out during the next full flow period.

How does one determine whether an envelope is required? The recommended procedure is to have a uniformity analysis done on the soil materials which are to overlay the tile system. A uniformity analysis requires a particle size analysis for the various sand sizes, silt, and clay. The results are plotted as a graph of percent particles equal to or less than the sieve size versus the particle diameter. From this graph, the size of particles above which 60% of the particles lie and the particle size below which 10% of the particles lie is determined. The uniformity ratio or coefficient is calculated as D_{60}/D_{10}. Where the ratio is less than five, an envelope should be considered. If the ratio is greater than five, there is no need for an envelope.

Figure 1 is an illustration of the particle size distribution curve for several soils. Soil 1 represents a silt soil where the particles fall primarily in the silt and very fine sand categories resulting in a uniformity index of 3.9. The drain pipe used in this soil *should* have an envelope. Soil 2 is a sandy loam which has a wide distribution of sand, silt, and clay size particles to give a uniformity index of 12. The wide spectrum of particle sizes will provide the natural bridging effect and *will not* require an envelope. Soil 3, with a uniformity index of 9.3, is a sand used for the sand root zone of a soccer field and *will not* require an envelope.

There is a rough approximation test which can be performed on site to determine whether a soil is unstable and requires an envelope. The test requires three 105 x 175 mm juice cans. The tops are removed from all three cans. The bottom is removed from one. The second can has only the centre of the bottom removed to leave a 10 mm wide retaining ring at the edge. These two cans are soldered together to form a tube. A 95 mm diameter piece of wire screen which has 2 to 3 mm openings is placed on the retaining lip in the tube. The third can is marked at the 165 mm depth and used for a measuring device.

The moist soil in question is placed on the screen and packed to a 25 mm depth by tamping to give a compaction similar to that in the native condition. The third can is filled to the 165 mm depth with water and it is gently poured on the soil surface. Placing a long drinking straw across the mouth of the can and pouring the water down the side of the straw will introduce the water onto the soil with minimal disturbance.

If the soil does not wash out the bottom after standing undisturbed for 15 minutes, the drained pipe probably does not require a filter envelope. It must be realized, however, that the procedure is a quick test and highly subject to how the soil is packed on the screen. A uniformity coefficient derived from a particle size distribution analysis is the preferred procedure.

When drains are initially installed, the discharge water may be seen to carry a significant amount of sediment. Do not panic. With time, the amount of sediment will decline because the natural bridging of soil particles across the slits in the drain is taking place and within a year or so the water, should run clear.

A few dollars spent on a soil analysis, followed by the interpretation of the results, will save you money for an unnecessary cost addition to the tile system and the potential for reduced performance in the future. ♦

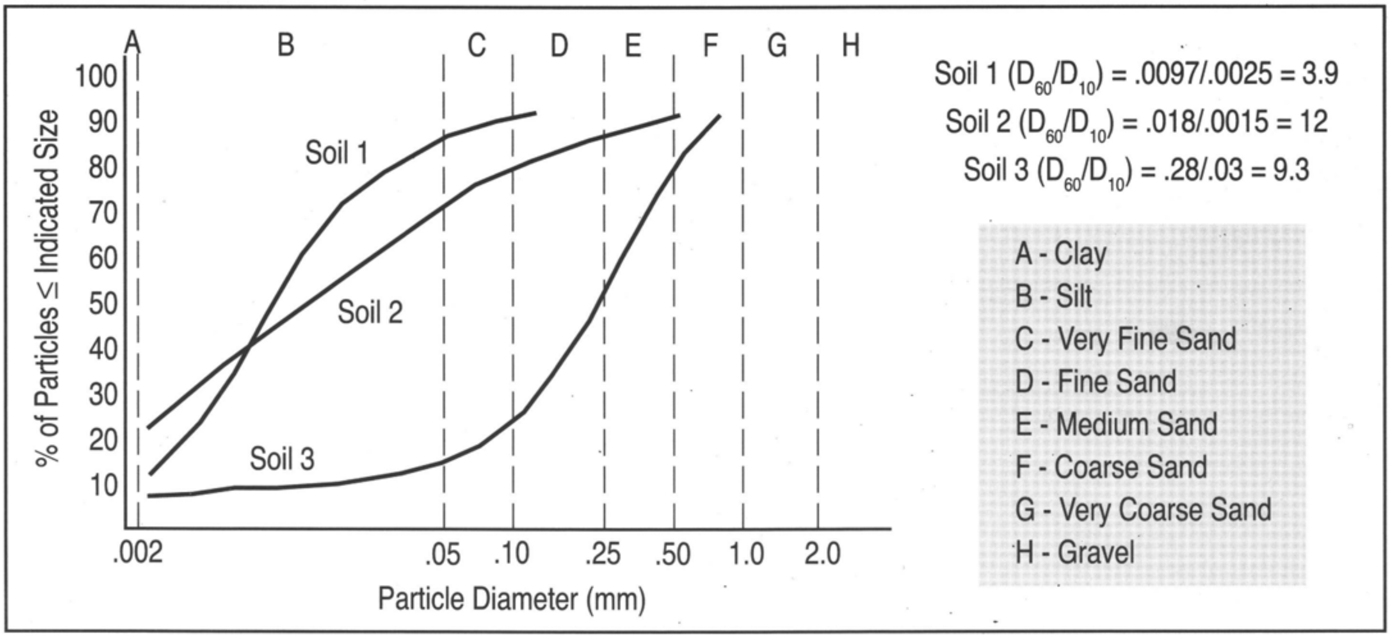

Figure 1: The particle size distribution curves for three soil samples having different uniformity indexes and envelope requirements. Please note that for interpretative purposes, the data must be plotted on a logarithmic scale.

"People of character don't allow the environment to dictate their style." — Lucille Kallen