

A question of know-how!

Can Enkadrain® replace drainage sand layers?

by Henny Berkhout

To consolidate soft soil prefabricated vertical drains (PVD's) are used throughout the world instead of sand columns. Sand columns are made by drilling holes and filling them with good drainage sand. This method is being rapidly replaced because PVD's are more reliable, being manufactured industrially, and are easier to install. In addition, drainage sand is often expensive.

Drainage sand is generally unavailable in delta areas where PVD's are used and has to be transported long distances. In addition, transport of sand on soft soil is a problem. One sand column 30 meters long by 20 centimeters in diameter, represents a transport volume of 1 cubic meter and a weight of 1,600 kg. In contrast, the volume of a vertical plastic drain has a volume of 0.01 cubic meter and weighs only about 2 kg.

Top loads

When PVD's are placed, a top load is applied to speed up drainage. At the very least, part of this top load also consists of good drainage sand, so water flowing out of the drainage strips can be discharged through this flat drainage layer. The transport problems for this drainage layer are the same, of course, as for the drainage sand for the sand columns.

Accordingly, it is not really strange that several times a year the question arises, "*Can't we replace the drainage sand layer in the embankment with a geocomposite drainage mat like Enkadrain?*"

In principle, this should of course be possible, because Enkadrain was developed to replace mineral drains. However, I do not believe that replacement will ever be possible for this application.

Working surface

A disadvantageous property of the soft soil to be consolidated is that it can barely support vehicles. Consequently, a

working platform of reasonable good quality granular material has to be first laid down so that the cranes for placing the drains can drive on it. This layer of granular material with a minimum thickness of 0.3 - 0.5 meter has to be installed always. At the same time this layer can act as a drainage layer. In case of the use of a flat drain mat, uninterrupted flow from the stripdrains to the flat drain mats must be secured.

I do not know of a single commercial project where drainage sand has been replaced by flat drains. However, a pilot project is being carried out in Korea by the Korean Highway Corporation (KHC), which is still in progress.

Research

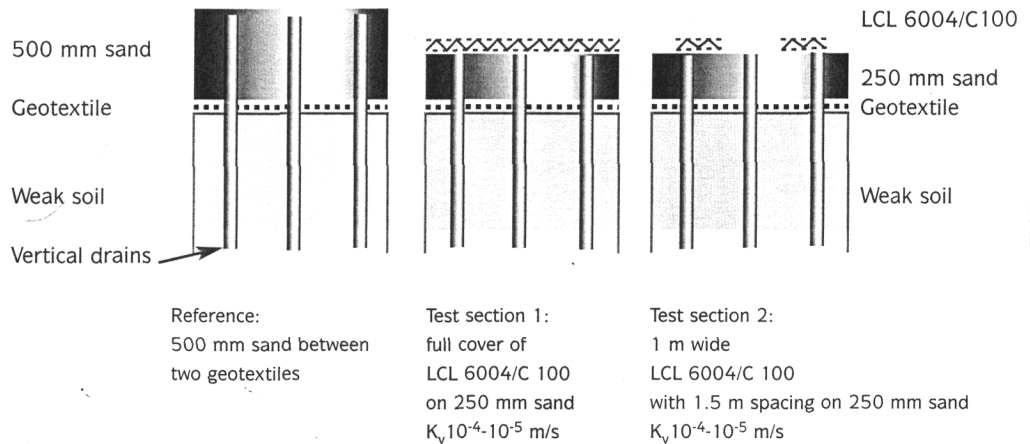
KHC is studying whether drainage sand can be replaced by Enkadrain 6004/C100 that entirely or partially covers the surface. Under a load of a 2 meter embankment of lesser quality, consolidation of the test areas with both 100% and 40% Enkadrain was measured for settlement and water pressure and found to be equal to the reference area with

cover



Second temporary loading

First temporary 2 m soil loading



50 cm of sand. Apparently, discharge capacity for all 3 designs is more than adequate. The test will continue with a heavier top load, but no findings are available yet. As is known, the 4 mm Enkadrain 6004 is being replaced by Enkadrain 8004 of the same thickness, and with the same discharge capacity. There is also a 6 mm variant of this type available, Enkadrain 8006, with much greater discharge capacity under the loads being applied here.

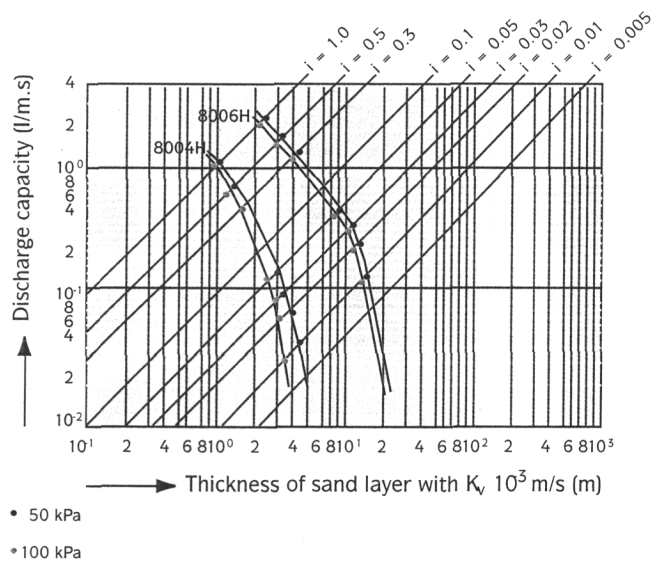
The diagram shows the layer thickness in meters of sand with a water permeability factor of 10^{-3} m/s that can be replaced by Enkadrain 8004 and 8006 under various hydraulic gradients and top loads of 50 and 100 kPa. Given a mass weight of 18 kN/m^3 , 50 kPa and 100 kPa correspond respectively to 2.7 meters and 5.5 meters of soil layer as top load.

Hydraulic gradient

Hydraulically, Enkadrain can definitely replace a substantial amount of drainage sand layer. The fact that it rarely if ever occurs probably has a great

deal to do with the required hydraulic gradient to transport the water. A drainage layer can only function properly if an adequate hydraulic gradient can be built in so that the water can run off.

Due to setting of the soil, which will often be in the order of 0.5 to 1.5 meters, the drainage layer may become uneven. On the side of the rise, settlement is next to nothing. It is maximum in the middle, and differential settlements are possible, too. In order for the water to run off normally, there must be an outwards hydraulic gradient. Since settlement is such that an inverse gradient is to be expected, the excess water will have to be removed mechanically or the mat will have to be installed at a slight incline. These problems occur even when sand is used as a level drainage layer, but the thick shape of the sand layer can bring about the gradient in this layer. The use of geocomposite drain mats will not simplify the configuration any.



Discharge capacity of Enkadrain 8004H and 8006H in comparison with sand layers with $K_v 10^{-3}$ m/s