Filtration behaviour of soil-nonwoven geotextile combinations subjected to various loads

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Abstract

Geotextiles are often subject to different load types in their filtration applications. The load action can cause changes in soil density, geotextile stretching and flow interaction at the soil-geotextile interface. All of these load-induced changes to a geotextile may affect the filtration behaviour of the soil-geotextile system. The impact of load type on the filtration behaviour of soil-nonwoven geotextile combinations has been studied through a series of tests using an experimental apparatus designed specially for the laboratory tests. In these tests, the soil-geotextile combination was fabricated by inserting a piece of nonwoven geotextile between a 50 mm thick soil layer and a layer of steel beads. Two chemical-bonded nonwoven geotextiles were employed in this study. One of the three load types, namely sustained, pulsatory and a combination of both was applied to the combination prior to each filtration test. The frequency of the pulsatory load was 0.1 Hz and a total of 5000 cycles of repeated load applied to the combination for each load type test. After applying this specific type of load on a soil-geotextile combination, water was allowed to flow down through the combination from the soil into a drainage layer set at various hydraulic gradients. The flow rates corresponding to elapsed times were measured and the average hydraulic conductivity value was extracted by using Darcy’s law to characterize the filtration performance of the entire soil-geotextile combination. Variations in the average hydraulic conductivity value with respect to the soil void ratio, magnitude and type of normal load were examined.

The experimental results revealed that the void ratio of soil decreased with the increase of total load. Although two parent geotextiles under study, namely GT1 and GT2, have similar filtration characteristics, soil-geotextile combinations composed of these two geotextiles exhibited different filtration responses to the normal load. Soil-GT1 combinations exhibited a normal relationship between the average hydraulic conductivity and the normal load applied; the average hydraulic conductivity increased with an increase in the total load. Soil-GT2 combinations exhibited different load-dependent responses to a normal load with the average hydraulic conductivity depending on the magnitude and type of load. Such load-dependent hydraulic conductivity changes are attributed mainly to the geotextile in-plane strain and the pumping action in the combination.

1. Introduction

Geotextiles have been widely used as a substitute for mineral materials to provide separation and filtration functions in roadway systems. Geotextiles placed horizontally between subgrade fine soils and subbase aggregates can perform the separation function by preventing them from mixing together. A geotextile lining the inside of a trench filled with coarse mineral particles that form an edge drainage system can also perform a filtration function. Furthermore, the drainage system formed by mineral materials and a lining geotextile can be replaced by a geocomposite made of a core of quasi-rigid plastic sheet protected by a geotextile on one or both sides.

In filtration applications the wrapping geotextile is used as a filter to prevent the undue migration of fine particles and allow adequate seepage to flow through the geotextile plane. The primary concerns of a geotextile used for filtration applications are its seepage and particle retention capabilities.

A geotextile serving as a filter or separator in roadway applications is subject to earth pressure and dynamic or impact load caused by highway vehicles, railroad trains or landing aircraft.