Pore structure and long term performance of nonwoven geotextile filters
Structure des pores et performance à long terme des filtres de géotextile non-tissé

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ABSTRACT: This paper analyzes and compares the behavior of two nonwoven geotextile groups when tested with gap graded soils and Ottawa sand. The analysis showed that long term behavior of the soil geotextile systems is influenced most by the geotextile structure. Pore structural properties for the geotextile were measured using mercury intrusion porosimetry and image analysis techniques. Stable and unstable soils showed similar trends for their long term behavior. Decrease of flow was attributed to densification of Ottawa sand and to the cake build up for gap graded soils. Cake build up was enhanced by the high flow rates and influenced by the retention ability of the geotextile and its pore structural properties.

RESUME: Cet article fait l'analyse et compare le comportement de deux groupes de geotextile non-tissés quand elles ont été essayées aux sols gradés à interstice et le sable d'Ottawa. L'analyse a montré que le comportement à long terme du systéme sol-geotextile est largement affecté par la structure de geotextile. Les propriétés de la structure du pore pour les geotextiles ont été mesurées grace au porosimétrie à intrusion de mercure et la technique de l'analyse des images. Des sols stables en non-stable ont montré une tendance semblable concernant leur comportement à long terme. La diminution de débit a été attribuée et la formation de cake dans des sols gradés à interstice. La formation de cake a été augmentée par les taux de grand débit et influencée par la capacité de retention de geotextile et les proprietes structurelles de son pore.

1 INTRODUCTION

Geotextiles installed in earth structures can be altered with time by many phenomena such as clogging, blocking and piping. These phenomena are a function of the pore structure of the geotextile and the soil adjacent to it.

This paper attempts to analyze and compare the behavior of two geotextile groups when tested with gap graded soils and Ottawa sand. Each geotextile group is from the same manufacturer, but geotextiles in the same group differ mainly in thickness.

Qualitative assessment will be made for the long term behavior of different geotextiles when tested with gap graded soils. The objective is to study the effect of fabric structure on the long term performance of soil geotextile systems.

2 CURRENT APPROACHES

There are three major approaches used to evaluate long term performance of geotextiles: the gradient ratio test; long term filtration tests; and morphological evaluation of field and laboratory samples.

A quantitative parameter, the gradient ratio, is obtained from the gradient ratio test. A gradient ratio greater than 3 will indicate clogging. The limitations of the gradient ratio test were given, in detail, in (Williams and Luettich, 1990).

Long term filtration tests are continued until no significant change in the flow rate of the system is observed, i.e., the system stabilizes. Koerner and Ko, (1982) suggested that a system stabilizes when the final slope of the filtration curve becomes very small. Mlynarek et al, (1991) used the shape of the long term filtration curve to evaluate long term filtration tests. They found that a geotextile will satisfy long term performance requirements as long as its filtration behavior curve is of a certain type.

Mlynarek et al, (1991) defined a long term property termed flux decay, defined by the ratio of seepage velocity at 20 hours to seepage velocity at 2 hours after the start of the test. The flux decay measures the rate of decrease of flow during the initial stages of the test. A good relationship between flux decay and d10 of the soils was reported by Mlynarek et al.

The morphological approach involves analysis of magnified images (microscopic photographs) of geotextile samples, after being subjected to prototype usage, or obtained from laboratory simulation tests, using direct observations or image analysis techniques.

3 MATERIALS AND METHODS

Six geotextiles (Ph4, Ph8, Ph12, TR114, TR1125 and TR1145) were studied by the authors for their pore structure using mercury intrusion porosimetry (MIP) and image analysis (IA).

Table (1) shows summary of the pore structural parameters of the studied fabrics. The Ph? geotextiles are from the same manufacturer, while TR? geotextiles are from different manufacturer. The same geotextiles were tested by Qureshi, (1990), for their long term filtration behavior with gap graded soils. The data to be analyzed are filtration tests in which the aforementioned geotextiles were tested with Ottawa sand, and mixtures of three cohesionless silts (SIL CO SIL 75, SIL CO SIL 106 and SIL CO SIL 250) with Ottawa sand (20% silt). A hydraulic gradient of 10 was applied during the test.

The apparatus and procedure of the filtration tests were described by Qureshi. The results of the long term tests of Ottawa sand and the 20% mixtures of SIL CO SIL soils with Ottawa sand, were extracted from plots given in Qureshi (1990).
<table>
<thead>
<tr>
<th>geotextile type</th>
<th>thickness (mm)</th>
<th>porosity</th>
<th>surface porosity</th>
<th>$D_{95}$ (μm)</th>
<th>$D_{15}$ (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph4</td>
<td>0.81</td>
<td>0.79</td>
<td>-</td>
<td>278</td>
<td>124</td>
</tr>
<tr>
<td>Ph8</td>
<td>2.3</td>
<td>0.84</td>
<td>0.29</td>
<td>250</td>
<td>158</td>
</tr>
<tr>
<td>Ph12</td>
<td>2.67</td>
<td>0.84</td>
<td></td>
<td>237</td>
<td>159</td>
</tr>
</tbody>
</table>
soil/geotextile systems is influenced most by the geotextile structure. Stable and unstable soils showed similar trends for their long term behavior. For Ottawa sand the decrease in flow was attributed to the densification of the sand. The rate of densification and therefore decrease in flow rate was controlled by the fabric structure. Cake build up is enhanced by high flow rates and is influenced by the retention ability of the fabric and its pore structural parameters.

REFERENCES

Elsharief, A. M. 1992. Effects of the structural properties of nonwoven geotextiles on their filtration behavior. Ph.D. thesis, School of Civil Engineering, Purdue University, USA


