Filtration Function of Unwoven Geotextiles Evaluated using Oedopermeameter

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ABSTRACT: Due to the fact that the existing criteria for evaluating the filtering function of geotextiles in contact with cohesive soils are not entirely satisfactory, this paper presents one new approache to the problem. This new method con - sist in the direct modelling of filtration phenomenon in an oedopermeameter by moving water through a soil sample in close contact with unwoven geotextile, submitted to the pressure undergone by the material inserted in the earth work. The results of the experiments showed that this method give good results.

1 INTRODUCTION

The existing criteria for evaluating the filtering fuction of unwoven geotextiles are usually based upon the assumption that void size distribution of the synthetic material is previously known; some conditions for O_{90} or O_{95} void diameters (corresponding to 90 %, respectively 95% on the integral void distribution curve) are thus imposed [Giroud, 1984; John, 1987]. Void size distribution is usually determined by sieving (pas - sing) through the textile sheet some small spherical glass balls, whose diameters are known.

The main drawback of this procedure lies in the fact that during the entire test the geotextile is not subjected to any pressure, i.e. testing conditions are substantially different from the actually occuring.

2 SUCTION TESTS AND VOID SIZE DISTRIBUTION

In order to remove the above mentioned incongruity it was elaborated another method for evaluating the void size distribution based on water retention curve by unwoven geotextiles, when they are submitted to very small pressures (p = = 0 to 4 kPa) as compared to those occuring in construction works [Andrei,et al,1982].

This method is based on the relation between the diameter of pores d_p (cm) and the suction h (cm H_2O) needed to remove water from geotextile [Andrei,1967]

$$d_p = (0.3/h) \cos \theta_u$$

where θ_u is contact angle.

3 TESTS WITH OEDOPERMEAMETER

The oedopermeameter is an apparatus elaborated some years ago for measuring the permeability of geotextiles [Andrei et. al,1982]. Its essential advantage is the self-desaeration of circulating water,avoiding in this way the formation of occluded air bubbles in geotextile samples and the spreading of measured values of permeability. The removing of air was obtained by the set-up sketched in fig.1 the top water is passed through a vacuum funnel (1) where a release of dissolute air from water occurs and air bubbles so separated are eliminated through the connection tube (2) and a constant-lever jar (3). From time to time the suction due to the relax of the water stream in the lower part of vacuum funnel may be transmitted by a connection tube (4) to the upper cavity of oedometric cell (5) and in this way the accumulated air is aspirated and eliminated also in the constant-lever jar.

When the oedopermeameter is used for normal permeability tests, the porous stones of oedometric cell are replaced by perforated discs (6) and the piston (7) is also perforated. In this manner the hydraulic head loss for empty cell, measured by the difference of level in two piezometers is reduced to few millimetres.

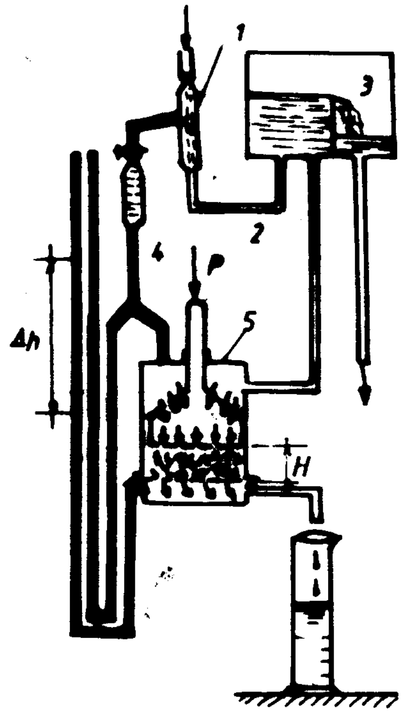

Figure 1

The oedopermeameter allows pressure application by piston (7) in the range 0 - 1,000 kPa. After air removing permeability repeated measurements gave almost identical results.

The drawback due to the limitation of applied pressures in the case of use of glass suction plate apparatus could be expelled if a modified oedopermeameter cell is utilized, which may be called oedosuctiometer. In this case the glass funnel is replaced by an oedopermeameter cell, whose lower perforated plate (6) (Fig.2) is replaced by a clean ceramic plate (8) with very fine pores; the maximum pore size d_p of this ceramic plate is function of suction h to be applied and may be deduced from relation, taking into account that contact angle $\Theta_u \doteq 0$ ($\cos \Theta_u = 1$).

On the other side it is to note that all soil particle retention criteria related to geotextiles ignore the possible cohesion of the considered soil, as well as limit gradient inducing water seepage - factors obviously affecting the filtration process.

A way to cope with this drawback would be an experimental study by oedopermeameter (Fig.2,b) of the filtering effect

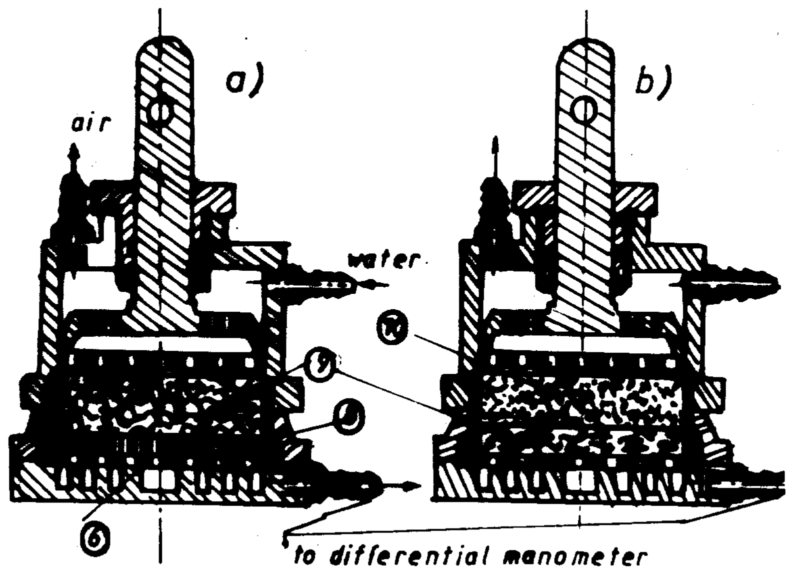

Figure 2

of geotextile (9) in close contact with the soil (10) where is has to be introduced.

In this Paper the results of some tests performed by the Authors are firstly presented, aiming to study the retention of soil particle (10) by a three layer geotextile (9) strip, manufactured by MINET Company at Ramnicu-Valcea (Romania). The strip was put into contact with a compacted loess sample (10) ($\rho_d = 1.417$ g/cm^3; $V = 1/\rho_d = 0.7058$ cm^{3}g^{-1}.

Testing programme included: (a) determination of head loss when water crosses the empty oedopermeameter ($\Delta h = 0.5$ cm); (b) evaluation of geotextile compressibility in both dry and wet state ($\log p; \Delta h/h$); (c) plotting the correlation between pressure P (kPa), specific volume V (cm^3 /100 g) and permeability coefficient k (cm.s^{-1})(Fig.3)

The results for these tests showed that the settlement (thinning) of the geotextile strip is practically independent of moisture state and has a semilogarithmic course for pressures exceeding 100 kPa.

A previous finding was also confirmed [Andrei et.al,1982]: it has been observed that between the square root of permeability $\sqrt{k}$ and the specific volume V or void ratio e exists a linear correlation, which is the more obvious as the geotextile is thicker (two layers compared to one layer) (Fig.3, left).

In the second phase of tests the construction system was modelled as well by laying on the bottom of the oedopermeameter box a small round sheet 0.7 cm

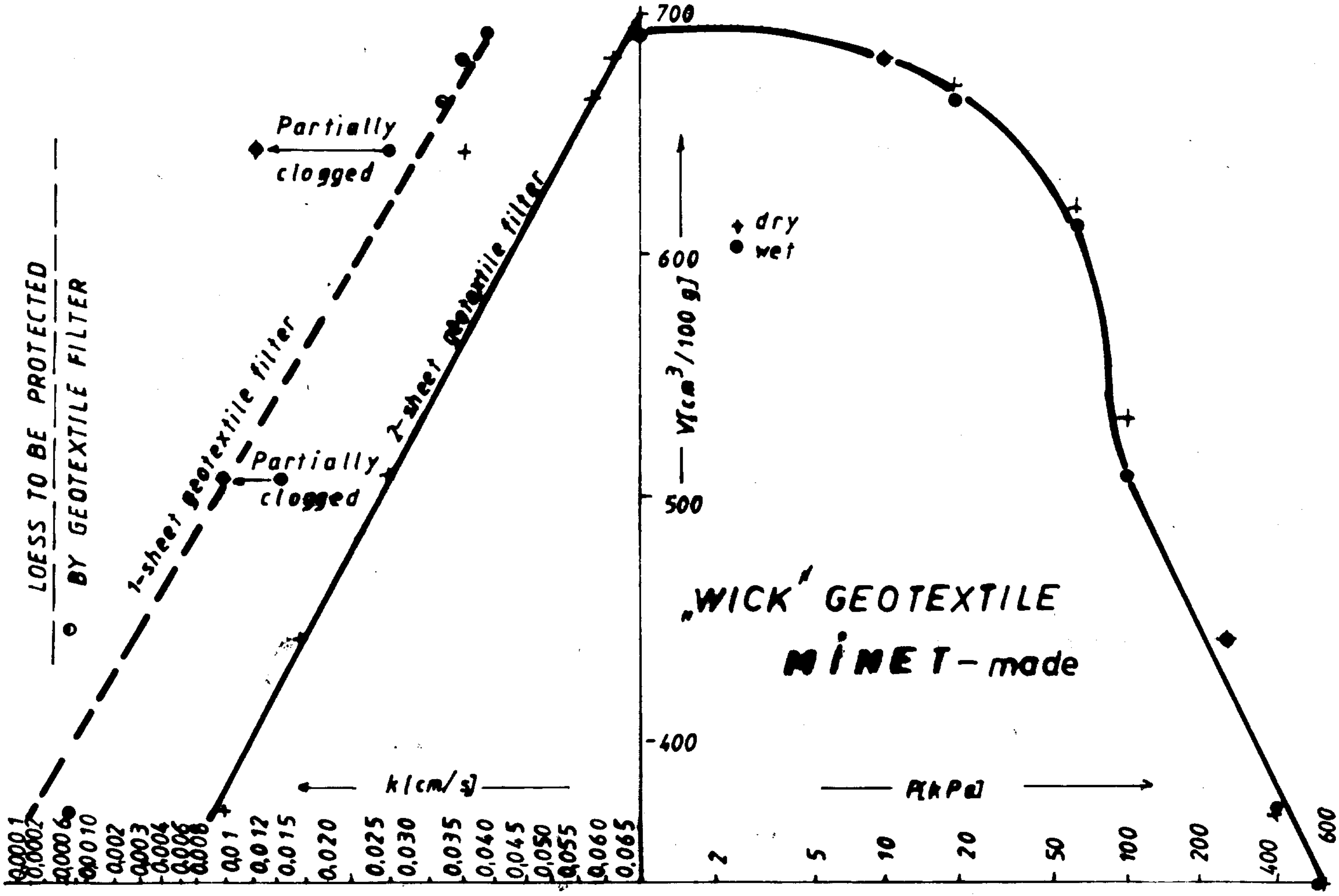

Figure 3

thick unwoven "wick" geotextile. Upon this sheet a 2.2 cm layer of dry loess was compacted, so that the whole thickness of the sample reached 2.9 cm.

Through this compound sample, submitted to a pressure of 50 kPa a water flow was percolated under various hydraulic gradients (17, 22, 26 and 31) each of them being maintained over 3 hours intervals; in every case the permeability coefficient of soil was measured (4.5 x 10^{-4}cm.s^{-1}) and it remained practically constant, irrespective of hydraulic gradient. In the same time it was studied if and to what extent the fine particles are dragged by water through the geotextile. It was thus observed that for a gradient equal to 17, the percolated water was turbid within 3 hours, and later on, after 3 hours under a gradient of 22 it was slightly turbid, then under 26 and 30 the water was clear.

On the and of the test the small geotextile roud sheet was partially clogged by soil particles, its weight increasing from 4.1 g to 6.3 g; in the same time, its permeability decreased to 1.1 x 10^{-2} cm.s^{-1}, viz.2.3 times lower than the permeability of intact material, under the same pressure of 50 kPa. In conclusion, after partial clogging, the permeability of the geotextile was reduced by approx. 2.3 times (2.4 x 10^{-2}/1.07 x 10^{-2}) but remaining however 24 times higher (1.1 x 10^{-2})/ 4.5 x 10^{-4}) than the permeability of compacted loess.

It is also to note that the sample has been submitted to hydraulic gradients which are much higher than usually occuring in engineering works, where unwoven geotextile filters are utilized.

By repeating the test with a similar sample, but subjected to a pressure of 100 kPa, and water being percolated under 16, 21, 16 and 30 gradients for durations of 2 hours each, the following results were obtained: the filtering ef fect was more efficient, as the emer - gent water wall slightly turbid only for two hours and there after clear, the weight increase of the sample by clog - ging was no more than 1.4 g (33 %) and the permeability decreased only by 1.6 times (0.0126/0.0079) as compared to in tact material subjected to the same pre ssure, however remaining 18 times higher ($7.9 \times 10^{-3}/4.5 \times 10^{-4}$) than for com - pacted loess.

4 CONCLUSIONS

We may conclude that the oedopermeame tric modelling of the filtration pro - cess through unwoven geotextile in con- tact with the same soil as in field con ditions represents the best method for evaluating the ability of geotextile in order to be used in similar conditions to those encountered in engineering works.

5 REFERENCES

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