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KABINA, P. and HUSKA, D., Vysoká škola poľnohospodárska Nitra, CSSR

INFLUENCE OF LOADING ON THE VALUE OF THE COEFFICIENT OF PERMEABILITY OF GEOTEXTILES
EINFLUSS DER BELASTUNG AUF DEN DURCHLÄSSIGKEITSBEIWERT VON GEOTEXTILIEN
L'INFLUENCE DU CHARGEMENT SUR LA VALEUR DU COEFFICIENT DE PERMEABILITE DES GEOTEXTILES

The value of the coefficient of permeability is very important characteristic of the geotextiles, of their hydrofyzical properties, needed for jugding the construction soil-geotextiles.Its value is influenced, besides of own construction of the geotextile, by a different factors, main of which is the loading acting on the geotextiles.In the presented contribution the influance of the loading on the value of k_n of geotextile is documented. The measurements were conducted on the 7 sorts of geotextiles aimed as a filter enveloping of drainage pipes.

INTRODUCTION

In the application of geotextiles as construction materials in hydrotechnical engineering, so far as these possess properties of porous materials, it is necessary, in addition to other characteristics, to assess also their value of the coefficient of permeability $\underline{k}$.

In earths and other porous traditional building materials, the value of $\underline{k}$ is usually assessed in situ; if it is not possible, it is assessed in laboratory with undisturbed or disturbed samples and the designer himself has to draw the conclusion from the results. But it is possible to assess the value of $\underline{k}$ either as one characteristic value of the given material, or in case of anisotropy as two values giving the characteristics of the examined material in two mutually perpendicular planes (k_n, k_p).

In introducing geotextiles into building production there was an attempt to characterize geotextiles like earths with one value of $\underline{k}$ only, in the better case with two values, i.e. perpendicularly to the plane of the geotextiles and in the plane of the geotextiles.But it has been shown with increasing knowledge on the use of geotextiles in various applications of hydrotechnics that the above values k_n and k_p are not sufficient for their characterization in the future designing. Thus it is needed to give the designer also possible changes of these values evoked by the influence of loading, to which the geotextile will be subject and then by the influence of displacement of single soil particles in the kontact zone under the respective hydraulic and earth pressure.Further it mus be clear to the designer whether the construction and its single components which the geotextile is incorporated in cause changes of the original $\underline{k}$ values in the geotextiles immediately or this change will manifest itself gradually during the service life of the construction. Information is also of importance to the designer, whether some changes of $\underline{k}$ values are reversible or not.

The direct measuring of $\underline{k}$ values in situ meets with a series of difficulties in geotextiles owing to their small thickness. That is why we give in the paper presented some pieces of knowledge from our laboratory measuring of $\underline{k}$ values and their changes caused by loading.

MATERIAL AND METHOD

For the assessment of the value of $\underline{k}$ there was used the apparatus LAHYV-150, that had been designed in cooperation of two workplaces: Department of Soil Reclamation of the University of Agriculture in Nitra and the Research Institute of Textile Chemistry in Žilina. It is possible to measure in geotextiles with the abobe apparatus the values of k_n and k_p at different pressures exerted on the surface of the geotextile.

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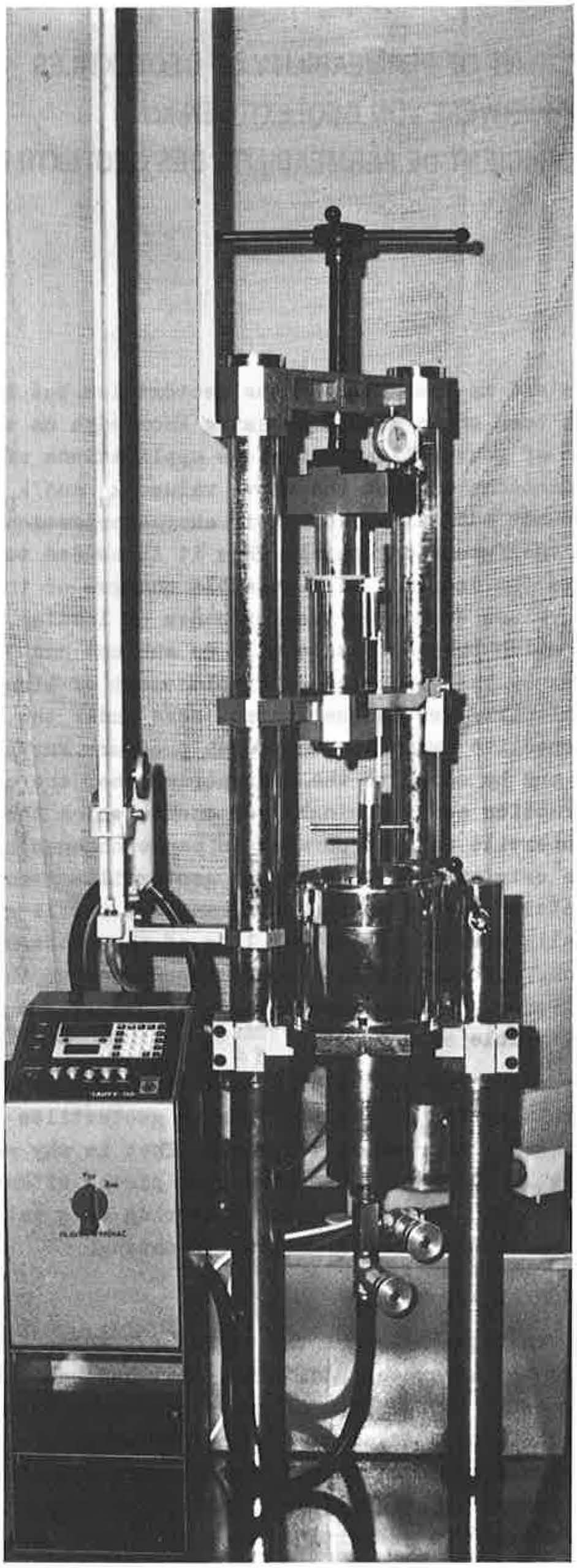

Fig. 1 Testing equipment LAHYV-150

In the apparatus LAHYV-150 (Fig. 1) the measuring is fully automatized which accelerates this process, mainly if repeated measurings are required up to the stationary state which is necessary in such cases when the geotextile consolidates intrinsically only gradually in consequence of the loading exerted. The apparatus is equiped whith: a mechanism for inducing pressure of the test specimen within a range of 10 to 600 kPa, a dynamometer for measuring the value of the pressure force, a mechanism for measuring the thickness of textile samples at the given pressure whit an accuracy of 0,02 mm, a nonius for exact reading of the pressure head of the piezometer, a motion divice for changing the position of the overflow vessel, and an automatic equipment for measuring the flow of the liquid through the samples tested by means of sensing electrodes and a digital stop watch. It is at the same time possible in measuring the flow to choose constant quantities of the flow within a range of 100, 500 and 1000 cm^3.

In measuring the value of k_n, the arrangement of the samples in the measuring cylinder of the apparatus is made according to the scheme in Fig. 2.

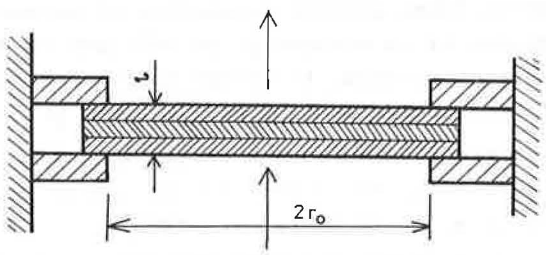

Fig. 2 Scheme for measuring the value of k_n

The relation for calculating the value of k_n will have the form:

$$k_n = \frac{V.l}{\Delta H.t.\pi.r_o} \quad (m.s^{-1}) \qquad (1)$$

where V = water volume passed through the geotextile (m^3)

l = thickness of the sample (or some of its layers, respectively) at the pressure exerted (m)

r_o = radius of the circular sample (m)

Parametre \ Material	A	B	C	D	E	F	G
Weight ($g.m^{-2}$)	1100	1200	1200	250	400	300	250
Thickness (mm)	7,70	7,60	10,80	3,20	2,40	4,10	3,30
Volume weight ($g.cm^{-3}$)	0,14	0,16	0,11	0,08	0,16	0,07	0,07
Specific weight ($g.cm^{-3}$)	0,80	0,92	0,92	0,92	0,95	0,72	0,72
Porosity (%)	82	82	88	91	83	90	90
Poren size O_{50} (μm)	720	380	540	145	165	170	250

Tab. 1 Technical parametres of draining filter materials

ΔH = difference of the piezzometric pressures of water (m)
t = time, for which the volume V flows through (s)

In measuring the value of k_p, the arrangement of the samples of the geotextiles in the measuring cylinder of the apparatus is used according to the scheme in Fig.3.

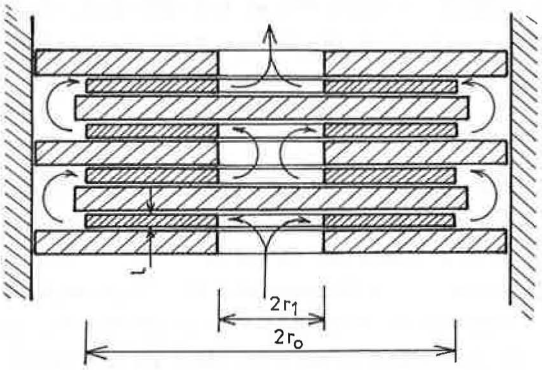

Fig.3 Scheme for measuring the value of k_p

The single samples have the shape of an annulus and the relation for the calculation of the k_p value is as follows:

$$k_p = \frac{V.n}{\Delta H.t.1.2\pi} . \ln \frac{r_o}{r_1} \quad (m.s^{-1}) \qquad (2)$$

where r_o = long radius of the sample (m)
r_1 = short radius of the sample (m)
n = number of simultaneously measured samples (-)

The apparatus is constructionally so arranged that the effect of the internal resistances of the apparatus on the accuracy of measuring is negligible. The temperature of water is followed during measuring and the results of the measuring are calculated to a uniform temperature of 10^o or 18^o C (according to the requirement of the respective standards).

For demonstrating the effect of loading on geotextiles, the material commonly used in the function of protective draining filters was chosen. They are mats of coconut fibres (A), fine PP-fibres (B), coarse PP-fibres (C), then geotextiles of the types of BIDIM (D), PETEX (E), MEPAS (F) and MELITEX (G). The technical parametres of the materials under examination are shown in Tab.1.

EVALUATION OF THE RESULTS OBTAINED

For the evaluation of filter materials used for the production of prefabricated draining filters (wrapped flexible drain tubes) of importance is their k_n-value, i.e. in the plane perpendicular to the surface of the geotextile, since the water from the soil flows in this direction through the geotextile into the drain tube. So that the input resistance of the drain construction tube + filter may be as small as possible, the value of k_n is required to at least a tenfold of the value of k of the soil being drained. The depth of the installation of drains in draining agricultural lands usually ranges from 1 to 1,5 m, at which depth the filter packing of the drain tube is subject to earth pressures of 20 to 40 kPa, under extreme conditions even to a higher one, the accidental and temporary loading having not been taken into account. In Fig.4 a graphically represented course of the changes of k_n-values is given as result of loading within a range of 10 to 150 kPa. The cross-hatched section of the Fig.4 shows the values of a possible loading in the drain trench. The course of the

Tab. 2 Fall of the k_n-value in % at various levels of loading

Loading \ Material	A	B	C	D	E	F	G
40 kPa	87	88	82	63	55	50	49
150 kPa	27	14	24	18	4	18	20

single curves distinctly separates from each other two types of filter materials, i.e. of the mat and the textile. Further, we can see that a possible loading in the value of 40 kPa does not cause in any of the materials such a fall of the k_n-value that whould threaten its function. But at this loading textile shows a relatively more pronounced fall of the k_n-value in contrast to mats due to their finer structure. At a loading of 150 kPa, the fall of the k_n-value reached 1/5 of the original value in almost all the materials examined. The fall of

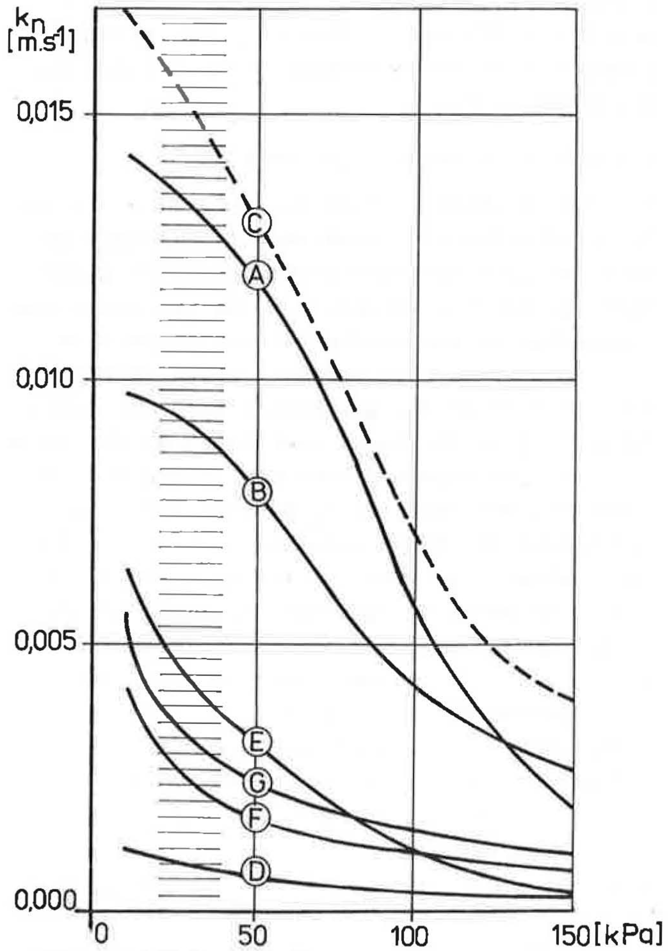

Fig.4 Chances k_n-values caused by loading

the k_n-value expressed in per cent is well arranged in Tab.2.

Moreover, it is necessary to mention that the values obtained of k_n with the apparatus LAHYV-150 are not final values, since these will be prononcedly influenced still by the tapy of the earth present at the contact zone with the geotextile. But the above values allow to find out, how the geotextiles examined retain one of the main characteristics owing to the loading evoked. In evaluating the changes of k values as a result of loading, it is further needed to take into account the fat, that paralelly to the change of this value the porosity as well as the pore size of the geotextile loaded will be changed.

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