Considerations Concerning the Characteristics of Permeability of the Podzolic soil in Voinesti Catchment

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Abstract: The nature of the soil and the substratum is important for the determination of the proportions between the drainage of surface and the underground drainage. The substratum of the catchment of Voinesti is constituted by brown podzolic soil. We are interested here in the description of the soil concerning it's hydrological functioning knowing that the passage or not of the water in various compartments of the soil determine hydrological answer of the catchment.

Keywords: hydraulic conductivity, suction, drainage

1. Introduction

The nature of the soil and the substratum is important for the determination of the proportions between the drainage of surface and the underground drainage. The substratum of the catchment of Voinesti (situated in west extremity of the Under - Carpathian of Curvature) is constituted by brown podzolic soil.

We are interested here in the description of the soil concerning it's hydrological functioning knowing that the passage or not of the water in various compartments of the soil determine hydrological answer of the catchment.

It was executed two soil profiles, one in experimental station and another one at 400 m distance from the station.

Because the demarcation on the soil in horizons is difficult, we took samples for the following depths: 0-30 cm, 30-60 cm and 60-100. We sample three samples for every depth.

The purpose of this site investigation is to obtain data as regards the physical and hydraulic characteristics of the soil (the hydraulic conductivity in saturated soil, the grain size analysis, specific gravity, etc.).

The determination was made in the Physical Soil Laboratory of the Ovidius University of Constantza and the results can be seen in the following paragraphs.

2. Laboratory tests

The quantity of the soil used to make the grain size analysis is between 100 to 200 g.

The grain size analysis was made by the hydrometer analysis method. The results of this test for one sample took from station profile by horizon 0 -30 cm depth is presented in Fig.1.

Using the ternary diagram we determined the type of soil. For this example we obtained the following fraction: 28 % clay, silt 21 % and 51 % sand. The type of this soil is sandy clayey loess (Stefan P., 86). More interesting is to study the variation of the grain-size distribution on the soil profile. The Fig. 2 and the Fig. 3 present the grain-size distribution variation for both pedological profiles. In the grain-size distribution the clay and the sand have the greatest percentage. For the pedological profile opened in the zone of the experimental station (Fig.2) we observe an important variation of fractions percentage.

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The upper layer of the profile, up to the 60-cm depth, the contents of clay is 28 - 29 %, but in the bottom of the profile we observe an accumulation of clay. The content of clay has here the value of 57 %. The content of silt varies between 9 % and 34 % and the content of sand is from 9 % to 62 %.

Moreover the soil which is up to the 30 cm can be situated (according to the textural classification used in Romania) in the category of the soil (LAS) sandy clayey loess. The soil found between 30 and 60 cm is a loam clayey loess (LAL) and the soil from 60 to 100 cm enters the in the category clay soil (A).

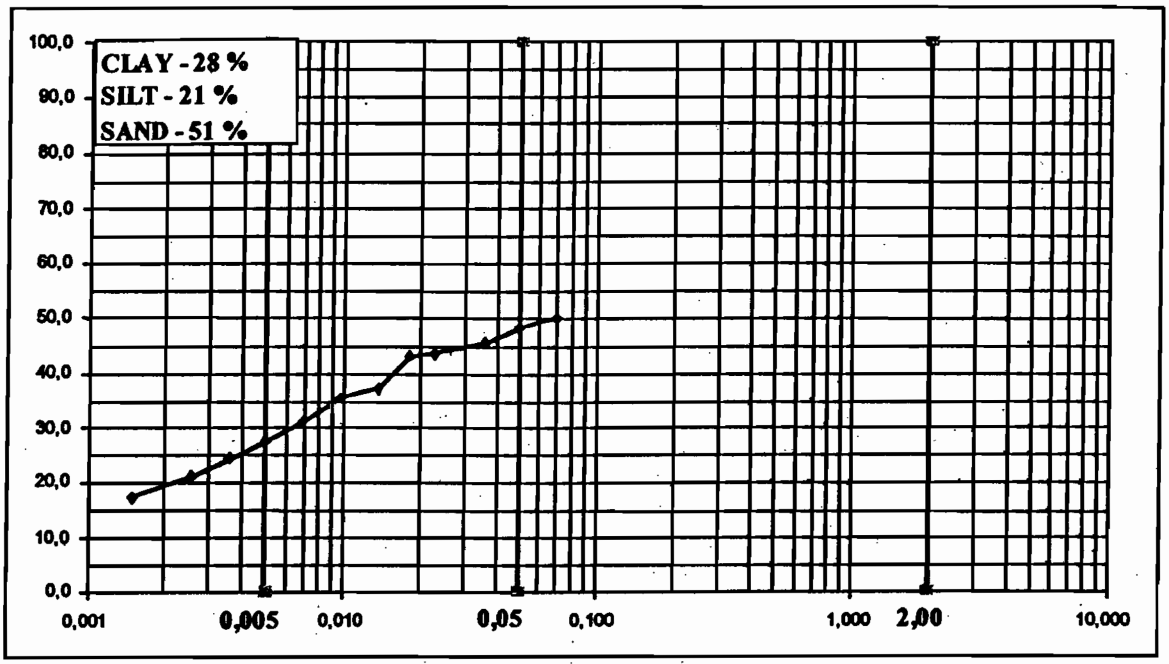

Fig.1

The textural characteristic factor is superior to two what means one abrupt passage between both last horizons, specific for the passage enters the horizon E (deluvial) and Bt (alluvial or textural horizon).

The horizon Bt presents a less permeability what provokes a temporary stagnation of the water in the profile and determines the phenomenon of pseudo-gleyied.

Over against, the profile realized at the South-Est of the experimental station presents homogeneity of the composition grain-size distribution (Fig. 3). The contents of clay vary between 23 % and 28 % and that of silt is about 21%. Dominating in this profile, is the sand that has value comprising between 51 and 57 %.

The soil of all profile depth is in category of the sandy clayey loess (LAS) and it is very difficult to identify the major pedological horizons.

Apparently this situation is due to the landscape phenomena which were it produces in last ten years. The clay is from 2-3m of depth, but we did not make boring until this depth.

The specificity of the solid phase of a soil ensues from its composition mineralogical and expresses them by the specific gravity ρ_s.

The values of the real gravity vary between 2,65 and 2,70 g/cm3 (for the profile 1) and from 2,59 to 2,61 g/cm3 for the second profile (Figure 4).

The dry density varies between 1,39 and 1,53 g/cm3 for the profile 1 and for the second profile this greatness is about 1,57 g/cm3. In that case, the porosity of the soil vary between 42 % and 48 % by following the type of the soil for the first profile and ii is constant of 39 % for the second profile.

The natural density varies between 1,70 and 1,80 g/cm3 for the profile 1 and for the second profile this greatness varies from 1,74 to 1,85 g/cm3.

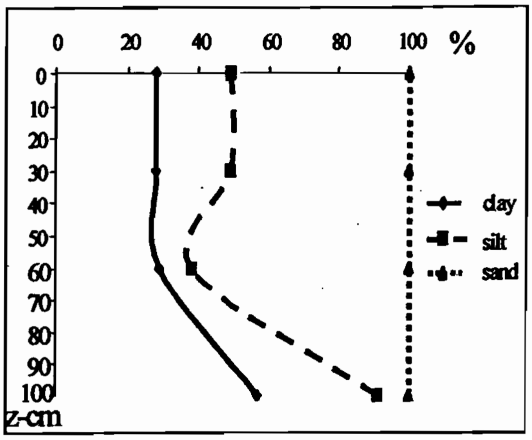

Fig. 2

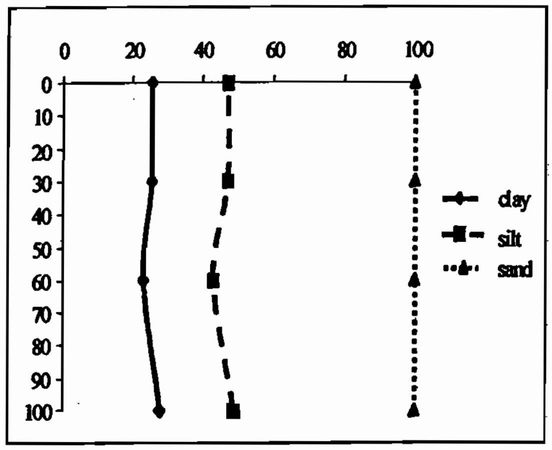

Fig. 3

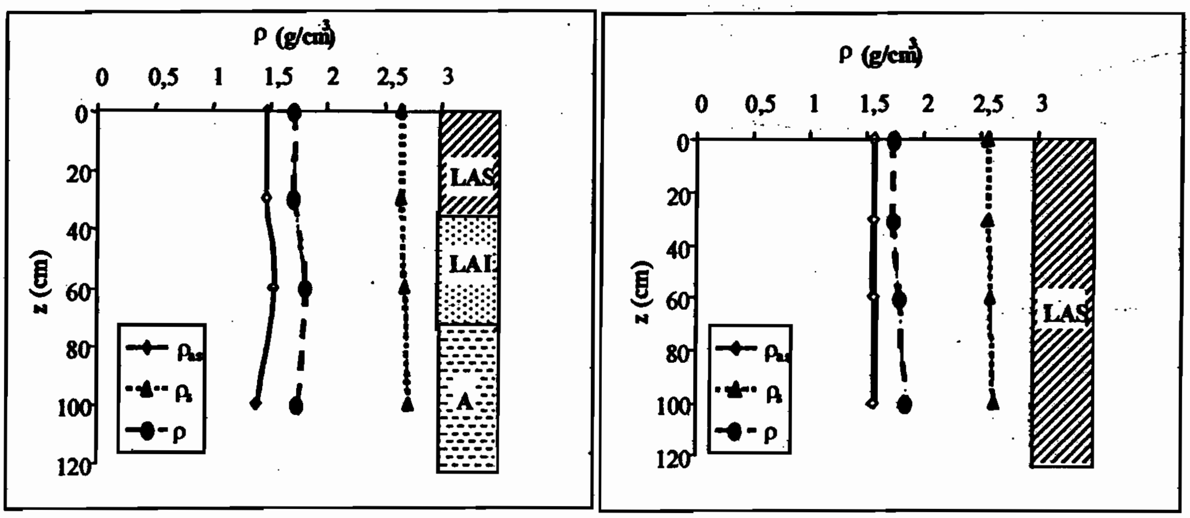

Fig. 4

Determination of the hydraulic conductivity of saturation was made for every type of horizon of soil for undisturbed cylindrical samples, with 2 cm high and 5,6 cm in diameter. For this test we used a permeameter with constant head without suction. The sketch of this permeameter is presented in Fig.5. The sample is introduced into the permeameter by assuring the waterproofs. The air is removed of the soil using a flux of the water from bottom to the top. The presence of the water in the piezometer means the end of evacuation of the air of the soil. Once the air of the soil evacuated we measure the volume of the water evacuated by the surplus of the reservoir, the time in seconds and the difference between both piezometers with a precision of a millimeter. We repeat the measurements to us let us obtain constant relative values for the value of the infiltrated volume (the difference between two successive values should be under 10 %). The specific conductivity with k_{sat} saturation is calculated with the following equation:

$$k_{sat} = \frac{v}{i}, \quad v = \frac{V}{A \cdot T}, \quad i = \frac{h}{l}$$

where: V represent the volume of the water (cm^3) evacuated meanwhile of time T (s) k_{sat} is the hydraulic conductivity of saturation (cm/s), A is the cross section of sample (cm^2), h is the difference between both piezometer tubes (cm), l (cm) represents the height of sample

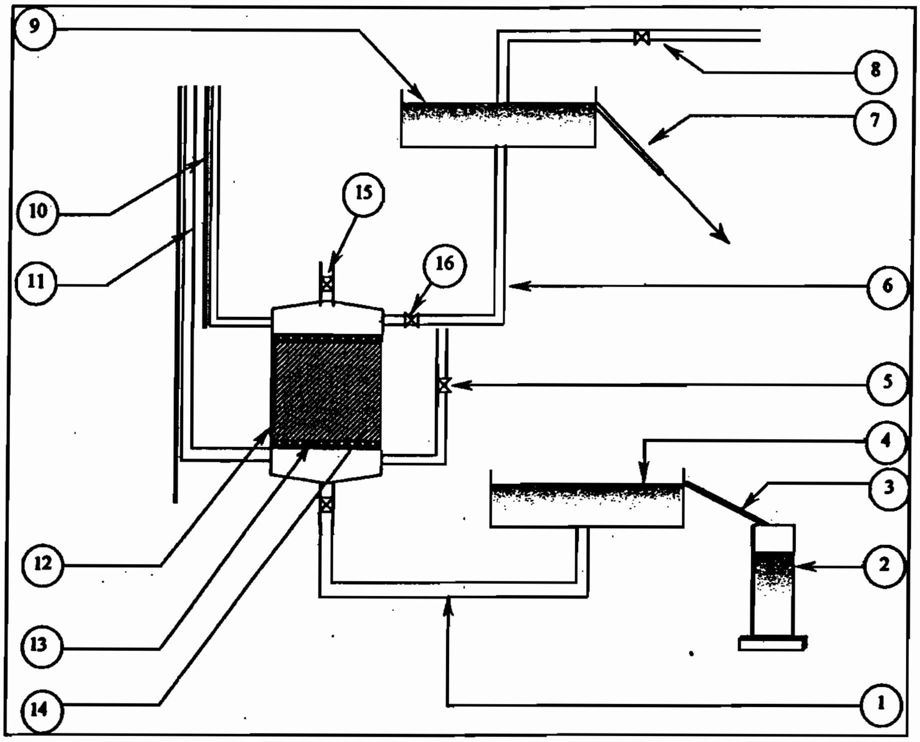

Fig. 5
1, 6 – tubes; 2 , 3, 7 – overflow; 4 – oulet reservoir; 5, 8, 15,16 - valves; 9 – inlet reservoir; 10, 11 – piezometer tubes; 12 –permeameter; 13 – porous plate; 14 – soil sample

The value of the specific conductivity calculated is corrected with a coefficient if the reference temperature does not take the value of 20°C.

The following curves of infiltration in the time shows that the infiltrated volumes grow in a linear way in time (Fig. 6). For the profile 1 we observe three curves different attached to three found horizons; the value of the lowering (going down) infiltrated volumes as the contents of clay increase in the profile. On the other hand, for the second profile, the values of the infiltrated volume are in the distance 10-20 cm^3 by the hour and the curves of infiltration are close one of the other one. The values of the specific conductivity in the saturation are carried in the Figure 7.

By following the relation specific conductivity of saturation - depth we observe two stages for the profile 1 (in the station): a fast diminution of the value of the specific conductivity of saturation what means a fast drainage followed of one flattening of the curve corresponding to a lent drainage.

For the second profile the value of the specific conductivity of saturation varies among 5,29e-06 and 2,76e-06 cm/s by following the depth. The values correspond to a soil with lent drainage.

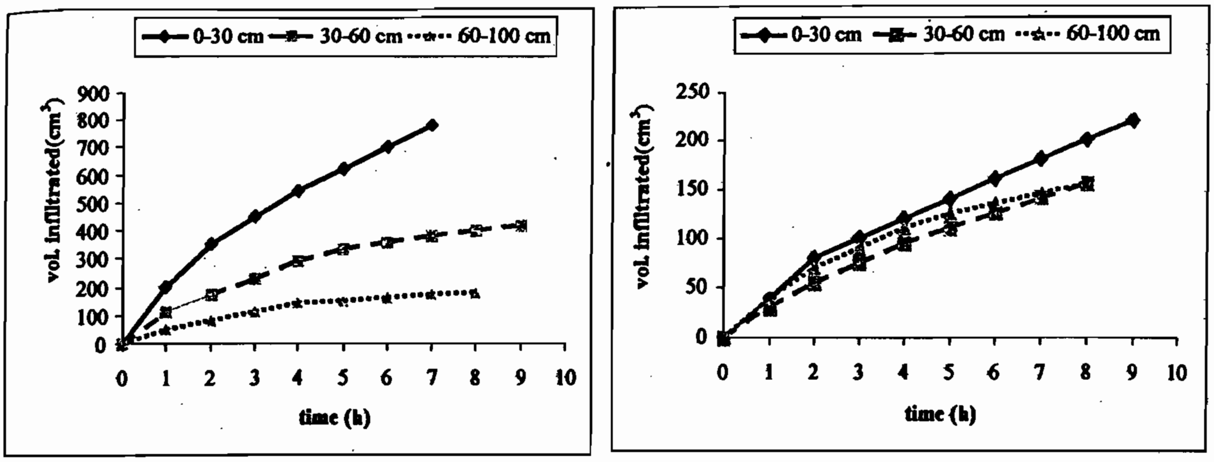

Fig. 6

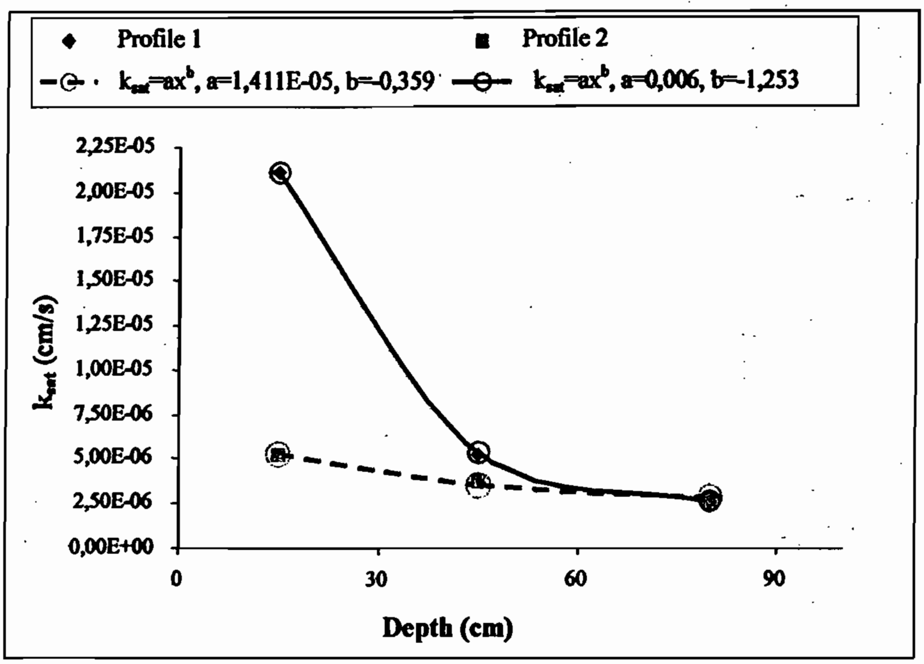

Fig. 7

We tried to find an analytical expression to express the relation between specific conductivity with saturation and depth for both profiles of the soil. Two types of equations are who can express this relation (*$y=k_{sat}$, x=depth*):

$$y=\frac{1}{a+b\cdot x+c\cdot x^2}$$

$$y=a\cdot x^b$$

The first equation is a model in three parameters, which offers a good correlation (coefficient of correlation equal to 1). The standard deviation is close in zero. The second equation is a model in two parameters. The coefficient of correlation varies 0,999 (for the profile 1) in 0,989 (for the profile 2) and the standard deviation is also close in zero (0,0000001). We retained for our example the second model by taking into account that the models in two parameters are stable.

The parameters are obtained by means of the square test Chi. Two iteration are necessary to obtain the parameters which takes the values following ones (Figure 13 the series in red respective blue circle)

- a=0,0006301 et b=-1,2532865 for the profile 1
- a=1,41057-05 et b=-0,359201 for the profile 2

3. Conclusions

Dynamic of the drainage in unsaturated zone will be different in two categories:

- the working of height part catchment is influenced by the Bt (alluvial) horizon which principal characteristic is water accumulation. These characteristic combinations with the stratum of clay confer at this soil type a interesting comportment: a rapid drainage follow by a lent drainage and the alimentation possibilities with water for height stratum.
- the working of lower part catchment is influenced by the landscape phenomena. Concerning of that, the horizons can't be different. The characteristics of soil are homogeneous on profile.

We suppose that the overland flow is more important like others component in the catchment dynamic.

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