THE INFLUENCE OF THE COMPACTION PROCESS ON THE OSCILATION OF SOIL HYDROPHYSICAL PROPERTIES FROM TATARASI AREA

Viorel FILER[1], Florian STĂTESCU[1]

e-mail: stef_vio2000@yahoo.com

Abstract

The present work wants to highlight the influence it has compacting process on the variation of hydrophysical.properties of three types of soil.
In resolving this hostile soil phenomenon this paper tries to noting the main effects exerted by the compaction process on the hydrophysical.properties distribution in time and space by applying laboratory methods for determining the physical and hydraulic properties of soils from Tatarasi study area. Principal physical characteristics were determined: soil density, soil bulk density, texture and soil porosity.
Hydraulic properties analyzed in order to mark the variation of water regime were: hydraulic conductivity (saturated and unsaturated) and soil suction.
All these basic aspects of soil were analyzed using laboratory methods widely applied all around the world.

Key words: compaction process, soil physical aspects, soil hydraulic properties

In general the soil compaction is one of the main causes of the phenomenon of negative character entitled destruction from degradation.

From the multitude of effects due to the emergence and further development of the compaction process reduced the hydraulic conductivity and soil water but should not be neglected increasing the water retention (soil suction).

In terms of hydraulic soil is a porous medium which is reflected in complex structure its rather complicated system of canals and trails variable called soil pores that support the movement of fluids through them. In this regard it was found that for the transport of water and chemical compounds in the soil is necessary to have two environments: solid medium (soil matrix) and a stream of water moving through the pores of the soil (Stătescu and Pavel, 2011).

During the process pierce soil by fluid, his permeability is altered. Thus, based on dry ground, in the first instance, the permeability is high and then decreases rapidly, until the soil is saturated with water. Since then, the amount of water that enters the soil becomes constant. Water entering for unsaturated soil is made by infiltration (I.C.P.A., 1980).

MATERIAL AND METHOD

All research was conducted on soil samples disturbed one for each depth (stored in labeled bags) and undisturbed harvested one for each depth from Tatarasi study area (*figure 1 b*) (collected by the method of metallic cylinders with a volume of 100 cm^3) shown in *figure 1 a*

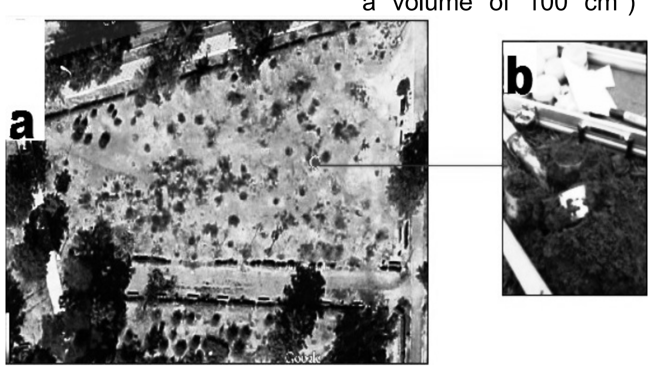

Figure 1 **Presentation of the Breazu location study a) zone of sampling soil, b) samples harvested**

[1] „Gh. Asachi“ University, Faculty of Hydrotechnics, Geodesy and Environmental Engineering, Iasi

Physical properties were analyzed in the laboratory with the following methods: soil density and soil bulk density (oven drying method and pycnometer method *figure* 1. c), texture (pipetting method performed using Eijkelkamp Pipette Apparatus *figure* 1 b) and size distribution (*figure* 1. a)

The analysis of hydraulic characteristics of soil samples was achieved by the laboratory methods, for hydraulic conductivity was the constant-head method (K_s) (Lungu., 2013) give us in *figure* 2. 2 d) and the falling head method (K_θ) (Stanciu & Lungu, 2006) presented in *figure* 2. 2 e.

Suction was determined on a value range between pF 0 and pF 4.2 using experimental plant comprising: sandbox (pF 0 – pF 1.8) remarked in *figure* 2. 2 a), sand/kaolin box pF 2 – pF 2.7) shown in *figure* 2 2 b), and the pressure membrane apparatus (pF 3 –pF 4.2) noticed in *figure* 2. 2 c) (Dumitru., 2009)

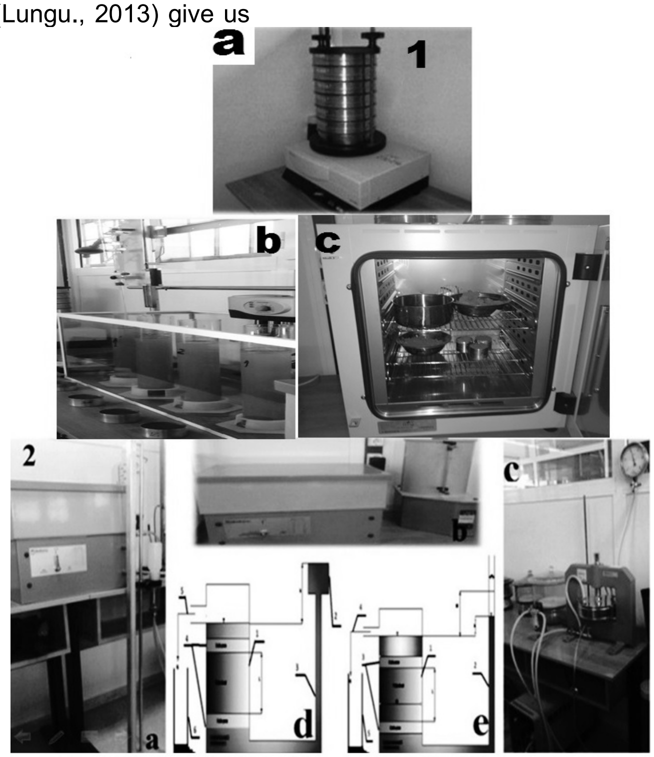

Figure 2. The techniques used in research: 1: equipment used to analyze the physical properties: a) shaker electromagnetic; b) Eijkelkamp Pipette Apparatus c) drying machine 2: all equipment used in the study of hydraulic properties a) sandbox; b) sand/ kaolin box; c) pressure membrane apparatus; d) constant-head method; e) falling head method

CALCULATION PROCESS

Soil density. is calculated with eq. 1 (Filipov & Lupaşcu., 2003)

$$D = \frac{m_2 - m_0}{m_1 + m_2 - m_0 - m_3} \cdot \rho_1 \qquad (1)$$

where:
D - soil density, [g/cm^3];
m_0 – mass of empty pycnometer;
[g], m_1 – mass of pycnometer with liquid;
[g], m_2 – mass of pycnometer with soil, [g];
m_3 – mass of pycnometer with soil and liquid, [g];
ρ_1 – liquid density, [g/cm^3].

Soil bulk density is calculated from the relationship (2) (Rogobete., 1993)

$$\mathrm{D\,A} = \frac{\mathrm{m_2 - m_1}}{\mathrm{V_t}} \ (\mathrm{g/cm^3}) \qquad (2)$$

where:
m_1 is the mass of empty cylinder gol [g];
m_2 – mass of cylinder with dry soil at 105°C [g];
V_t – the total volume of the soil sample from cylinder [cm^3].

Soil porosity is calculated with (King., 1965):

$$\mathrm{PT} = \left(\frac{\mathrm{V_p}}{\mathrm{V_t}}\right) \cdot 100 = \left(1 - \frac{\mathrm{DA}}{\mathrm{D}}\right) \cdot 100 \qquad (3)$$

where:
PT is the total porosity [%];
V_p – pore volume [cm^3];
V_s – the volume of the solid part of the soil [cm^3];
D – soil density [g/cm^3];
DA- the bulk density of the soil [g/cm^3].

Hydraulic conductivity K_s on vertical direction of the water flow is calculated from the relationship *(4)* (King., 1965):

$$\mathrm{K_S} = \frac{\mathrm{V*L}}{\mathrm{T*A*h}} \qquad (4)$$

where:

V- volume of water collected;
L - length of the soil sample;
T - time for the collection volume of water (the excess);
A –cross sectional area of the sample.

Unsaturated hydraulic conductivity values $K_{(\theta)}$ were determined with (King., 1965):

$$K_{(\theta)} = \frac{a * L}{T * A} \cdot \ln\left(\frac{h_1}{h_2}\right) \quad (5)$$

where:
a - the cross section of graduated tube;
L - length of the soil sample;
T - time for the collection volume of water (the excess);
A –cross sectional area of the sample;
h_1 and h_2 -height of water column after a time T.

The dates of water retention curve in the soil were obtained using the relation 8 (Ahuja., 1998):

$$W = \frac{\text{Weight of soil water} \times 100\%}{\text{Weight of soil}} \quad (6)$$

$$\rho_d = \frac{\text{dry soil weight (without ring.canvas)}}{\text{weight of soil}} \quad (7)$$

$$\theta = W \cdot \rho_d \quad (8)$$

where:
θ is the volumetric water content [%];
W – soil humidity [%];
ρ_d – soil bulk density[g/cm^3].

RESULTS AND DISCUSSIONS

In Table 1 and 2 are presents the results obtained after applying the research methods of the physical properties of soils harvested on the four depth from area studied.

Table 1

Size distribution of Tatarasi study area

µm	T 0-20 cm (%)	T 20-40 cm (%)	T 40-60 cm (%)	T 60-80 cm (%)
63	7	8	10	20,5
125	10	11	15	30,5
250	16,5	17	24	44,5
500	35,5	36	45	67,5
1000	100	100	100	100

Table 2

Physical and hydraulic properties of soils for Tatarasi

Sample	D.A. (g/cm3)	D (g/cm3)	P.T. (%)	Clay (%)	Silt (%)	Sand (%)	$K_{(\theta)}$ (cm/s)	K_s (cm/s)
T 0-20 cm	1.06	2.12	50	4	79	17	0.016085	0.02221
T 20-40 cm	1.13	2.2	48.7	9	60	31	0.020119	0.016124
T 40-60 cm	1.22	2.25	45.77	13	30	57	0.020171	0.016561
T 60-80 cm	1.31	2.35	44.3	14	57	29	0.016361	0.000133

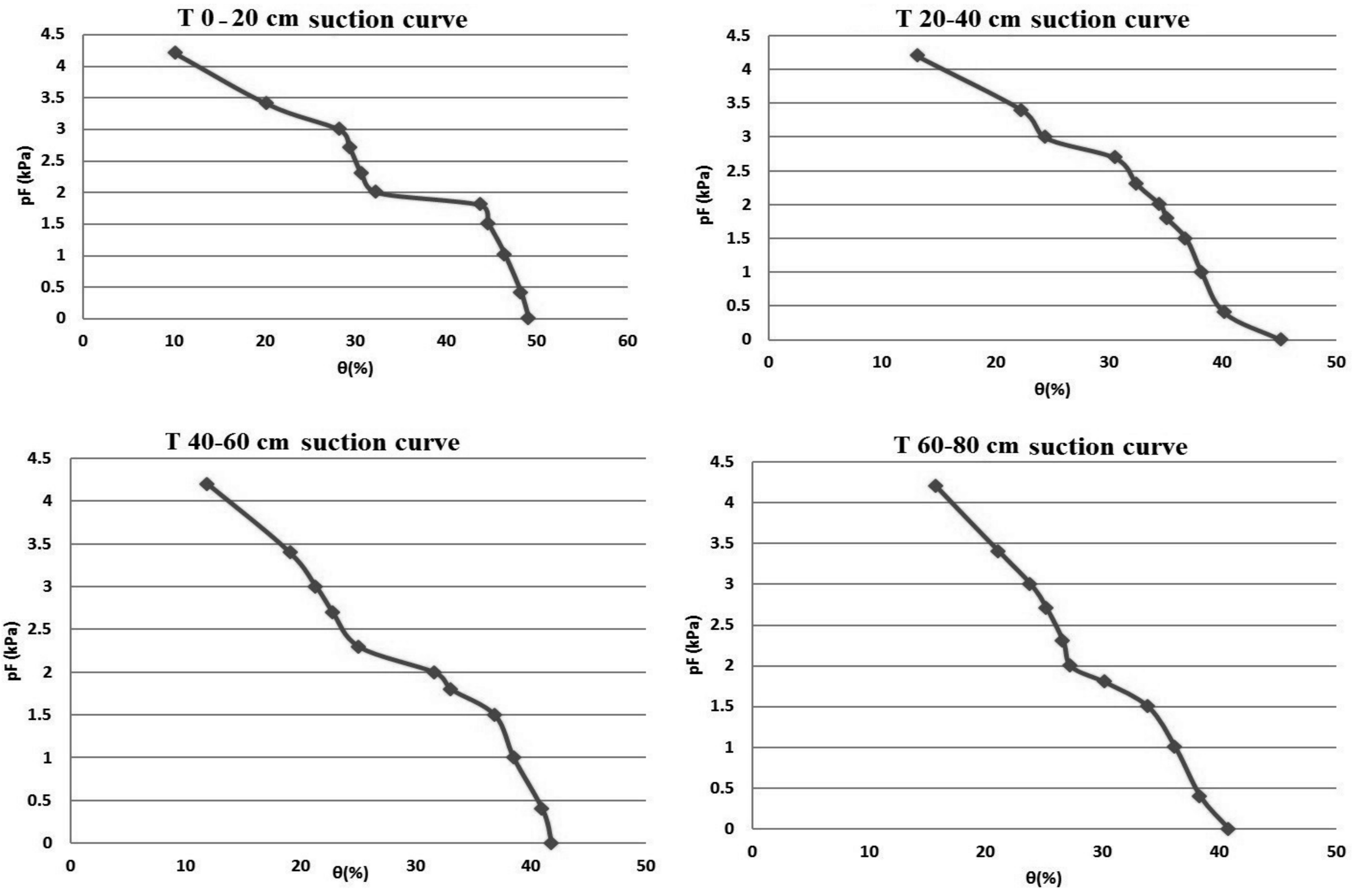

Figure 3 **The suction curves of Tatarasi study area**

For Tatarasi area we mention that aspect: soil density was generally lower than the other two areas because this type of soil presented a bit different mineralogical composition.

Compared to the density and bulk density of the soil, porosity decreased concomitantly with the enhancement the density of the two types.

The lowest values were noted in the case of last depth, they ranged from 44,3%.

The mean values of total porosity on the three areas have been highlighted in the type of soil collected from second harvested level, the latter being in the range of 48.7%-37.5% compared to the maximum percentages found in soil samples taken from T 0-20 cm. All these variations in the values of total porosity is attributable to the content of sand, silt and clay varied according to depth and location.

Preliminary data obtained (table 2) from the $K_{(\theta)}$ and K s analysis showed a speed of transport which gradually varied from a depth to another depending on the physical properties (density, bulk density, texture etc) of the environment in which there is process of infiltration.

This change in flow regime can be justified by the increase of both types of density (density (ρ) and bulk density (DA)) which exerted a great influence on the total porosity (PT) limiting access of water in soil pores (routes drain).

Unsaturated hydraulic conductivity (*table 2*) research conducted on soil samples collected from the study site Tatarasi have revealed that in the first depths (T 0-20 cm) value K_s (0.0222 cm/s) was higher than the $K_{(\theta)}$ (0.0160 cm/s).

The $K_{(\theta)}$ values for soil samples collected from depths of T 20-40 cm, T 40-60 cm and T 60-80 cm fluctuated in line with the change in physical properties.

About saturated hydraulic conductivity (*table 2)* we can remarked as: the Tatarasi perimeter showed similar values but compared with other situations, the relationship between the physical and hydraulic properties variation was constant on all four depths

In *figure 3*, is presents the results obtained after applying the research methods of the hydraulic properties (soil suction) of soils in the three areas studied.

The soil of Tatarasi site is a special case because he merged the two situations described above.

In the pressure range pF 0- pF1,8 the percentage values have been fluctuated constantly on the soil surface to the 80 cm depth and generally taking into account the possible shrinkage of the porous mass arising from the rise of the compaction process.

Between pF 2 and pF 4.2 percentages have fluctuated over the four depths of study, we also highlight the next issue - where T 20-40 cm was observed the highest percentage (32.43%) compared to the other three steps whose values which are evidenced in the graph of *figure 3.*

At pF 4.2 the soil of Tataraşi site could retain a water content between 15.74% and 10.14%. In this case the highest value was observed at T 60-80 cm followed by T 20-40 cm 13.10%, T 40-60 cm had a water content of 11.9% and finally the lowest value was detected in T 0-20 cm soil sample.

CONCLUSIONS

Making an overall analysis we can mention the following:

The compaction process greatly influenced the distribution in time and space of hydrophysical properties in entire section study depending on the site geology and the action of natural and anthropogenic factors.

The physical properties varied from one area to another one - in the case of soil in the Tatarasi area can be discussed by a slump by natural origin which in the presence of a higher content of clay, silt and sand generated a number of effects worse.

Soil compaction in Tatarasi zone said the word when saturated hydraulic conductivity was determined at the 60-80 cm depth, mainly due to the rearrangement of particles of soil compaction caused by anthropogenic origin fed continuously usefully land of the studied site.

By point of view of the soils storage capacity analyzed can easily observe its variation that can be substantiated by the distribution of physical properties that changed simultaneously with migration percentages of clay, silt and sand on 0-80 cm section for each type of analyzed soil.

REFERENCES

Ahuja L.R., 1998 - *Changes in soil water retention curves due to tillage and natural reconsolidation* Soil Sci. Soc. Am. J., 62,1228-1233.

Dumitru E., 2009.- *Metode de analiză utilizate în laboratorul de fizică a solului*. Sitech. Craiova.

Filipov F., Lupașcu Gh. 2003 - *Pedologie.* Editura Terra Nostra. Iași.

I.C.P.A., 1980 - *Sistemul român de clasificare a solurilor.* București.

Irina Lungu, 2013 - *Geotehnică - Lucrări de laborator.* Politehnium. Iaşi.

King L.G., 1965 - *Description of soil characteristics for partially saturated flow.* Soil Science American Procedings 29:359-362.

Rogobete G., 1993 - *Știința solului.* Vol. 1. Editura Mirton.

Stanciu A., Lungu. I., 2006 - *Fundații şi mecanica pământurilor.* Editura tehnică. Bucureşti.

Stătescu F., Pavel L.-V., 2011 - *Știința solului.* Edit. Politehnium. Iaşi.