COMPACTION PHENOMENA WITH NEGATIVE IMPACT ON CONSTRUCTION

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Abstract *Soil compaction can be discussed in light of the farmer, in which case include the same process of land degradation due to natural or anthropogenic and secondly in terms of the civil engineer, in which case it is a technological operation, of building foundations, dams, embankments. In soil mechanics for construction, compaction is a process of converting of a soil into a material or rock hard to achieve stable construction. Some authors consider compacting synonymous, partly with compression or consolidation. The paper is based on soil studies conducted by OSPA Timisoara, in the land mapping of Dudeştii Vechi and Sânnicolau Mare, with the effective participation of authors and the experimental tests on the effect of ground compaction by machinery and land reclamation technologies applied. Density measurements have been processed, the apparent density and the porosity calculated and the degree of compaction over the entire thickness of the soil profile. The paper presents the results obtained in only 41 profiles on two representative depths. Compaction is one of the limiting factors of agricultural production, which includes factors ranging from land degradation and affect large areas of agricultural land and cause serious damage to the building.*

Key words: *compaction, soil profile, factor, degradation*

INTRODUCTION

Soil compaction represent the process includes that of land degradation due to natural or anthropogenic and secondly in terms of the civil engineer, in which case the operation is a technological building of foundations, dams, embankments. When used for agriculture or forestry land for cultivation, compaction is a negative process that yields a result of this process will be diminished.

Soil compaction can be discussed from soil study and the farmer point of view, in which case the process includes land degradation due to natural or anthropogenic causes and secondly in terms of the civil engineer, in which case is a technological operation of building of foundations, dams, embankments.

When land is used for agriculture or forestry, for plant cultivation, compaction is a negative process that the yields will be diminished.

Compacted layer from the base of the horizon processed as a compact layer of the basement, requires plant roots [6] increased energy consumption to entering into areas wetter, appear the phenomenon of decreasing the movement of water vertically and even stagnant water and as a consequently phenomena triggering a lack of oxygen and reduction of organic matter and iron and manganese compounds. The compacting pressure is caused by vehicles crossing the land, use of agricultural machinery, the hooves of animals.

Naturally, compaction can occur due to ice and snow loading field and the iluvial with clay and Bt horizon formation [9]. The natural compaction is produced in longer time, so that compaction process is cumulative.

Compactness [3] is a complex property of the soil and is expressed by the bulk density and total porosity and soil texture.

The compactness may be determined by the ratio multiplied by 100, between the apparent density of a given ground reference, and the apparent density of the same genetic type of soil. Romanian specialized literature, compactness index can be calculated using the formula:

$$GC = \frac{Pmn - PT}{Pmn} \times 100 \qquad (1)$$

where GC is the degree of compaction, Pmn is required minimum porosity and the total porosity PT expressed in% .

Negative values describe the soil without compaction and positive values the compact soils.

The problem of compact soils occurs primarily in the soils with coarse texture and fragile structure worked with heavy agricultural machinery, from temperate and tropical areas. Compaction is included with the phenomena of soil degradation by erosion, aridity, water stagnation, salinization, pollution, crusting, acidification, lack of humus and nutrients, etc. It affects 33 million ha in Europe. It is believed that, worldwide, 25 million ha are poorly compact and 36 million ha are moderately compacted [9].

In soil mechanics for construction, compaction is a process of converting a soil without compaction into a material or hard rock to achieve stable construction. Some authors consider synonymous compaction, compression or consolidation. The compression term refers to decreasing the volume of the soil (high bulk density and decrease in porosity) under a force or load applied perpendicular to the body. Soil or body which decreases volume has compressibility, expressed by a curve and a result of the logarithmic ratio indicating pressure / pore space. In various tests of compression, or uniaxial stress (applied to soil samples limited space or free) or triaxial stress, there is variation in sample volume, wet or dry. In this test can determine and shear strength. For if wet or saturated soil sample is assessed and that consolidation with pore water transfer from solid particles [6].

Soil deformation under loads transmitted by construction due to elastic deformation of solid particles, ie decrease of the volume of voids between granules. For each applied pressure there is a state of consolidation. If a clay layer under some pressure strengthened an increase of pressure occurs, it will further strengthen the corresponding additional pressure.

The sand with coated small water, below 2%, suffer deformations. Determination of compression curve is done edometric on samples with unmodified or modified structure.

$$e = \frac{\Delta h}{h_s} \qquad (2)$$

where Δh is the deformation, hs is the height of the solid volume Vs.

With e values is constructed the compression curve - porosity and compression - deformation, that allows determining the deformation M.

Determination of expected settlements under load transmitted by construction foundations to soil is one of the basic problems of soil mechanics, uneven subsidence could cause dangerous applications. Deformations must be within the permissible values for different structures and materials.

To calculate deformations of foundation land it use results from the Boussinesz theory formulas [5] or simplified based on existing buildings.

In the case of rigid foundations, a central force P will cause subsidence equal in every points to the contact surface with uneven efforts. The final expression poaching will be like:

$$sm = 0{,}89\frac{P\sqrt{A(1-\gamma^2}}{E} \qquad (3)$$

where 0.89 is the σm coefficient expressing influence of the shape and stiffness of the foundation on average subsidence.

Calculation of compaction can be done using laboratory law, having determined the compression - porosity curve, respectively known the applied pressure p, index of compression Cc and deformation module M.

$$s = \frac{ph1}{M} \qquad (4)$$

identical expression with Hooke's law.

Long buildings present bigger settlements in their midst.

The construction side by side are inclined due to the compaction greater between them. An old building tilts to a new one as a result of increasing pressure.

Bingner and Wells [1,2] have developed a soil compacting model known as COMPACT to determine the bulk density of a soil compacted by vehicle. The model allows estimation of the effects of different operations in a landfill prepared by breeding ground for cultivation. The model simulates compaction caused by vehicles crossing a mine field improved.

MATERIAL AND METHODS

The paper is based on soil studies conducted by OSPA Timisoara, the land mapping of Dudeştii Vechi and Sânnicolau Mare, with the effective participation of authors and make experimental field tests on land by the effect of compaction by machines and reclamation technologies applied.

Density measurements have been processed, the apparent density and calculated porosity and the degree of compaction over the entire thickness of the soil profile. The paper presents 41 profiles with only two depths representative results.

RESULTS AND DISCUSSION

The results of the analyzes carried out on samples taken from soil profiles are presented in Tables 1 and 2.

Soil density, the mass per unit volume (D) consider only the volume of solid particles. In most soils, there are fluctuate low values frequently between 2.60 to 2.70 g / cm^3. Lower values even below 1.80 g / cm^3 occur in soils with high organic matter content. The densities greater than 2.80 g / cm^3 meet where there are many Fe oxides.

Some values in the tables, only a small fraction were determined directly in the lab (with pycnometer), most were assessed based humus content.

The bulk density, which expresses total mass per volume, including pores, determined on pedogenetical horizons with metallic cylinders on existing field moisture. In most soils DA varies from 1.20 - 1.60 g / cm^3. Values below 1.20 occur in soils with horizons rich in organic

matter and high values of 1.80 and beyond, appear in compact soils and in some soils with coarse sand. Determining DA at field moisture includes pore with water (wet DA) and dry DA after the drying of cylinders in the oven.

The total porosity was calculated by the relationship:

$$PT = 1 - \frac{DA}{D} \quad (5)$$

The degree of compaction, an complex indicator for soil compaction was calculated with the relation:

$$GT = \frac{PMN - PT}{PMN} \times 100 \quad (6)$$

$$PMN = 45 + 0{,}163 \times A \quad (7)$$

where: PT - total porosity (%), PMN - the minimum required porosity (%) A - the percentage of clay <0.002 mm.

It states that a GT> 18 means scarification on I urgency and a GT values between 11-18, means scarification on urgency II.

To determine the degree of compaction (DC),the measure of an soil is compacted, we are using the formula:

$$DC = \frac{\varepsilon a - \varepsilon i}{\varepsilon a - \varepsilon m} \quad (8)$$

where: DC - degree of compaction (dimensionless), εa - porosity (%) in the loose state, εm - porosity (%) in the most compact state, εi - actual porosity (%).

In the Sânnicolau Mare territory (Table 1), the dominant type of soil is cernozem, considered the best qualities soil. It is noted, however, that the presence of the phenomenon of gleyzation and sodization, as the depth of molic horizon, at 50 - 70 cm, there is a state of compaction (profile 1, 6, 8, 11, 12). If and texture is clayey (profile 7, 10, 13), the degree of compaction even reach 27,7.

Table 1

Sânnicolau Mare data base

Profile No.	Soil	Depth (cm)	Clay <0,002 mm (%)	D g/cm^3	DA g/cm^3	PT (%) v/v	GT (%) v/v
1	Cz gc 1	0-29 -58	28 29,5	2,54 2,54	1,38 1,46	45,7 42,5	7,9 14,6
2	Cz ac 2	0-21 -48	27,6 27,1	2,63 2,61	1,27 1,42	51,7 45,6	-4,5 7,7
3	Cz ac 3	0-16 -51	13,7 11,7	2,69 2,68	1,42 1,51	47,2 43,7	0,04 6,9
4	Cz ac 4	0-21 -67	23,8 23,7	2,59 2,53	1,32 1,24	49,0 50,1	0,3 -4,3
5	Cz ac-gc 5	0-25 -62	30,2 29,7	2,58 2,60	1,22 1,35	52,7 48,1	-5,6 3,5
6	Cz ss 6	0-30 -67	37,2 43,5	2,42 2,48	1,03 1,42	57,4 42,7	-12,5 18,0
7	Cz vs-gc-ss 7	0-25 -60	49,3 54,8	2,42 2,54	1,23 1,55	49,2 39,0	7,3 27,7
8	Cz ss 8	0-20 -55	41,3 38,8	2,43 2,49	1,07 1,35	56,0 45,8	-8,2 10,8

9	Cz vs-gc 9	0-25 -57	47,1 47,7	2,50 2,52	1,38 1,49	44,8 40,9	2,1 22,5
10	Ec vs-gc 10	0-22 -72	37,1 42,2	2,60 2,54	1,38 1,57	46,9 38,2	8,1 26,4
11	Vs ss-gc 11	0-30 -73	55,0 58,3	2,40 2,42	1,20 1,32	50,0 45,5	7,3 16,6
12	Vs ss-gc 12	0-37 -75	62,1 63,5	2,47 2,45	1,25 1,30	49,4 46,9	10,4 15,2
13	Vs ss-gc 13	0-30 -68	54,0 61,8	2,39 2,37	1,19 1,35	50,2 43,0	6,7 21,9

On the Dudeştii Vechi territory (Table 2) dominate the loamy type of soils like vertisols (total 53 profiles), which commonly occurs compaction even in surface horizont, Ay, compaction caused by the large amount of smectite clay.

Table 2

Dudeştii Vechi data base

Profile No.	Soil	Depth (cm)	Clay <0,002 mm (%)	D g/cm^3	DA g/cm^3	PT (%) v/v	GT (%) v/v
1	Cz vs-gc	0-27 -77	43,3 41,3	2,68 2,68	1,49 1,46	44,4 45,5	14,7 12,0
2	Cz ag	0-21 -100	41,8 37,7	2,68 2,70	1,13 1,32	57,8 51,1	-11,6 0,0
3	Cz vs-gc	0-14 -86	59,1 25,5	2,68 2,72	1,41 1,35	47,4 50,4	13,7 -2,5
4	Cz vs-ac	0-16 -48 -85	45,0 52,6 13,4	2,68 2,68 2,72	1,18 1,40 1,18	56,0 47,8 56,6	-7,0 10,25 -20,0
5	Cz vs-ss	0-25 -73	49,5 28,4	2,68 2,68	1,43 1,43	46,6 46,6	12,1 6,02
6	Cz vs-ss	0-25 -80	42,3 32,5	2,68 2,68	1,36 1,48	49,2 44,8	5,1 11,0
7	Vs gc	0-15 -71	57,3 45,0	2,68 2,70	1,54 1,46	48,1 45,9	11,4 12,2
8	Vs ag	0-23 -100	48,3 45,4	2,68 2,72	1,36 1,43	49,2 47,4	6,8 9,5
9	Vs ag	0-23 -104	68,3 66,1	2,68 2,70	1,44 1,51	46,3 44,1	17,6 21,0
10	Vs ag	0-27 -110	52,8 72,4	2,68 2,70	1,32 1,11	50,6 59,0	5,34 -3,7
11	Vs gc-sc	0-15 -92	66,7 70,0	2,68 2,70	1,28 1,34	52,2 50,4	6,5 10,7
12	Vs gc-sc	0-16 -85	50,5 40,8	2,68 2,72	1,41 1,46	47,4 46,3	11,0 10,3
13	Vs gc-sc	0-17 -95	61,0 50,8	2,68 2,70	1,39 1,45	48,1 46,3	12,4 13,1
14	Vs gc-sc	0-24 -100	65,1 56,0	2,68 2,72	1,39 1,48	48,1 45,6	13,4 15,8
15	Vs gc-sc	0-25 -101	45,9 36,2	2,68 2,70	1,38 1,31	48,5 51,5	7,6 -1,1
16	Vs gc-ac	0-20 -85	45,3 42,9	2,68 2,70	1,30 1,55	51,5 42,6	1,7 18,1
17	Vs gc-sc	0-25 -95	64,4 66,4	2,68 2,68	1,51 1,64	43,7 38,8	21,3* 30,5*
18	Vs gc-sc	0-17 -92	66,5 54,7	2,68 2,70	1,31 1,43	51,1 47,0	8,4 12,8
19	Vs gc-ss	0-14 -100	69,5 73,6	2,68 2,72	1,26 1,48	53,0 46,0	5,9 20,0

20	Vs gc-ss	0-30 -75	52,6 53,6	2,68 2,70	1,46 1,51	45,5 44,1	15,0 18,0
21	Vs gc-ss	0-23 -80	44,8 62,2	2,68 2,70	1,46 1,57	45,5 41,8	13,0 24,2
22	Vs gc-ss	0-20 -91	54,9 55,4	2,68 2,70	1,17 1,36	56,3 49,6	-4,4 7,9
23	Vs gc-ss	0-14 -100	58,8 58,7	2,68 2,70	1,21 1,42	54,8 47,4	-0,5 13,12
24	Vs gc-ss	0-11 -78	60,9 62,5	2,68 2,70	1,38 1,49	48,5 44,8	11,7 18,8
25	Vs gc-ss	0-24 -69	61,5 63,0	2,68 2,68	1,44 1,52	46,3 43,3	15,9 21,7
26	Vs gc-ss	0-17 -55	73,7 72,9	2,68 2,68	1,48 1,60	44,8 40,3	21,5* 29,2*
27	Vs gc	0-11 -89	56,3 57,2	2,68 2,70	1,38 1,45	48,5 46,3	10,7 14,8
28	Vs gc	0-28 -75	56,3 54,1	2,68 2,70	1,29 1,42	51,9 47,4	4,3 12,0

Agricultural machines produce subsidence and compaction even on Chernozems (with more than 40% clay), such as profiles 1, 3, 5, due to the high content of salts.

The data from Table 2 reveals a more special effect that, however, although some vertisols have clay between 69.5 (0-14 cm) and 73.6 (75-100 cm), the profile 17 or 66.7 (0-15 cm) and 70.0 (50 - 92 cm) as the profile 11, the apparent density is "normal", only 1.28 - 1.34 (profile 11).

On Vertisol soil type, compaction phenomenon is more pronounced, reaching DA values of 1.60 to 1.64 and GT of 29.2 to 30.5.

Compaction increases resistance to penetration of roots crops. The penetration resistance (as measured by a cone with a diameter of 12.7 mm and the peak angle 30^{O}) of 1.5 MPa and 3.0 MPa, the rate of growth of the roots has dropped to 50% and 0% [10].

In dry soils increases resistance to penetration. By increasing soil moisture and increase soil compactibility.

The presence of significantly higher humus (chernozem) tends to decrease compactibility and increase the elasticity of soil.

To ascertain the effect of compaction on agricultural production and deep work of soil and plowing (a Topsoil) presented data experience [4].

In order to highlight the influence of compaction degree of farmland were carried out experimental tests by 6 variants works spread over a number of four crops: corn, wheat, beets and beans. The land where experiments were conducted was placed in the system Sânnicolau Mare (N. Ionescu, Gh. Rogobete [4]).

On the field were placed following works:

1 - scarified twice at a depth of 80 cm by moving the unit lengthwise and diagonally

2 - scarified by one pass at a depth of 80 cm

3 - plowing at 40 cm depth

4 – witness with the plowing depth of 25 cm

5 - plowed to a depth of 20 cm and tapped once with a tank of 1800 liters

6 - plowing at depth of 20 cm, tapped twice with a tank 3600 liters.

In each plot were cultured 4 cultures mentioned above.

Following harvest, we could determine the influence of soil compaction on crop production values obtained for each culture conducted in the conditions described above are shown in Table 3.

Table 3

Yields per hectare in different degrees of compaction at Sânnicolau Mare

Working Depth(cm)	Soil Work	Corn (kg/ha)	Wheat (kg/ha)	Beet (kg/ha)	Bean (kg/ha)
80	Scarified twice	6000	4200	36600	1450
80	Scarified once	5200	3600	31200	920
40	Plowed	5000	3400	30300	860
25	Plowed control	4000	3200	28000	800
20	Plowed and tapped once	3600	2900	27500	740
20	Plowed and tapped twice	2600	2200	16000	420

CONCLUSION

Compaction is one of the limiting factors of agricultural production, which is included under land degradation factors and affecting large areas of agricultural land and cause serious damage to the building.

The influence of plowed on the farmland compaction is determined by the appearance of compacted layer.

To reduce friction between the heel of plow and soil and the pressure that it exerts on the bottom of the furrow plow, is recommended to mount the plow under angles $\Delta\alpha = \Delta\gamma = 3 - 5^{O}$ to the base and furrow wall.

The yields per hectare of the 6 plots of field experiment prouv that they are directly affected by soil compactness. The highest production was achieved in the terrain that was performed by scarifying twice at a depth of 80 cm.

It is satisfactory the work obtained by plowing at the depth of 40 cm, where it was found disappearance of compacted layer, with beneficial effects on production per hectare.

So, it is recommended to periodically carry out, by ripping in two directions at a depth of 80 cm, obtaining a soil loosening, conducive to achieving maximum production.

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