APARATUS FOR DETERMINATION SOIL PENETRATION REZISTANCE, FOR ESTABLISHING WORK INDEX PARAMETERS OF AGRICULTURAL MACHINES

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The experimental studies have underliend the benaviour of the soil at challenges in horizontal and vertical plane, as a result of the rolling system of the agricultural machines on the soil.

The way of transmitting the pressure in the soil and the result of this transmission influence the physical and machanical properties od the soil.

The resistance at the penetration of the soil influences the work parameters of the agricultural machines, but also consuption of energy for each agricultural work. The intensity of the treading of the soil is influenced by the internal and the factors external the internal ones being characterized by the resistance at the penetration of the soil.

Key words: *agricultural machines, pressure sensor, penetration resistance*

Determinarea rezistenţei la penetrare a solului în plan vertical şi în plan orizontal, se determină în scopul observării rezistenţei cu care solul s-ar opune deplasării rădăcinilor plantelor în timpul dezvoltării, dar şi pentru a determina parametrii de exploatare ai agregatelor agricole, când prin organele active acestea acţionează asupra solului prin forţa de tracţiune sau prin organe active acţionate de la priza de putere.

Orice modificare a rezistenţei la penetrare ne indică gradul de compactare (tasare) al solului la un moment dat şi de aici necesarul de lucrări agricole pentru mărirea sau micşorarea gradului de compactare a solului. În condiţiile realizării tehnologiilor agricole cu un număr minim de lucrări cel mai adesea se constată modificarea gradului de compactare prin determinarea rezistenţei la penetrare a acestuia în plan vertical. În plan orizontal situaţia se schimbă datorită faptului că se poate considera că în timpul deplasării organelor active ale maşinilor agricole sau chiar a rădăcinilor plantelor, acestea conduc la modoficarea poziţiei particulelor solide ale solului, uneori tăierea acestora şi modificarea spaţiilor aerate afectând deseori structura şi textura solului.

MATERIAL AND METHOD

Under the action of the external forces, in the soil appear reactions which acts on the soil, mainly at compression in the vertical plane, and at tangent forces in the horizontal plane. The result of these actions could bea movement of the soil on a limited section, leading to a break up of the soil (*figure 1*).

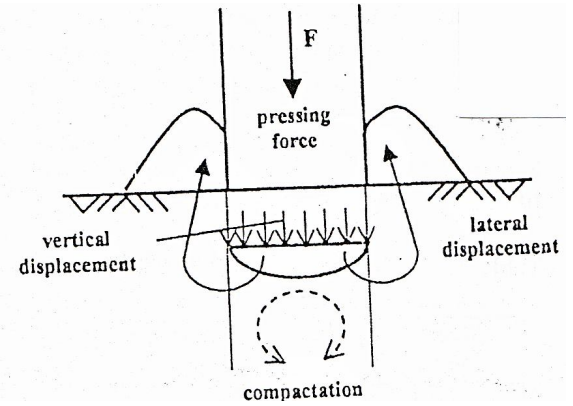

Figure 1 **The effect of the pressure on the soil**

The intensity of the treading of the soil is influenced by the internal and the factors external the internal ones being characterized by the resistance at the penetration of the soil. The interdependance between the parameters which characterize the structure of the soil, and the ground conditions, and the experimental conditions, is shown by the equation between pressure-deformation.

$$P=\left(\frac{Kc}{b}\cdot Ky\right)h^{n} \qquad (1)$$

In which: n the exponent of the deformation, it is always greater 2.
b- the width of the strip of the soil upon which the compacting occurs.
Kc, Ky- the parameters which depend on the pressure in the soil, s deformation, it is determined after at least 2 experiments.
h- the deformation depth of the soil.

In order to determine these parameters, a mobile installation is used, mounted on a tractor, formed by:

- a loading cylinder (load);
- rolling hydraulical motor (engine);
- torsional movement sensors;
- penetration plates with calculated surface;
- signal amplifiers;

a) equipment for processing the data.

The resistance at penetration the soil depends upon the physical and mechanical properties of this – one, which are mainly influenced by the contet of the clasy in the soil, by its humidity. From the experimentalresearch, it has been show that the cohesion component of the resistance at penetration is directly proportional, to the contet of clay and conversely proportional to the humidity coefficient of the soil *(figure 2*).

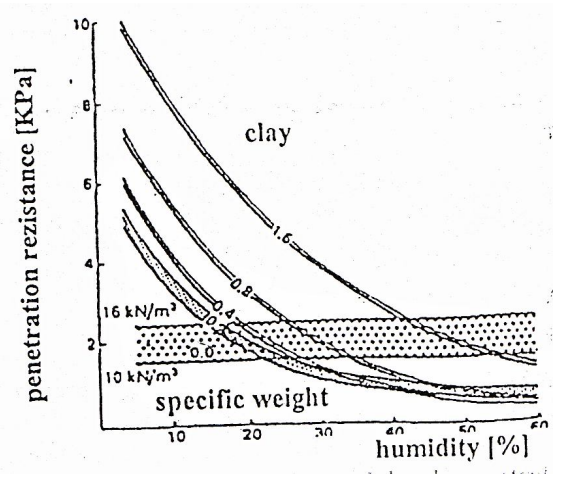

Figure 2 **The humidity effect and the clay content upon the resistance at penetration of the cone for soils with p 10-16 KN/m^3**

RESULTS AND DISCUSIONS

In order to determine the resistance at penetration of the soil in horizontal plane, a deformation of the soil takes place, in the vertical plane, till a certain depth. And this deformation is considered to be almost equal to the deformation of the soil, in the process of compacting of this-one, with a force equal to the resistance at penetration of the soil, applied to a penetration cone surface, used during the determination of the resistance at penetration, in horizontal plane. For the determination of the resistance at penetration of the soil, in horizontal plane, an installation was used, which was mounted on the soil deep breaking up machine MAS-60.

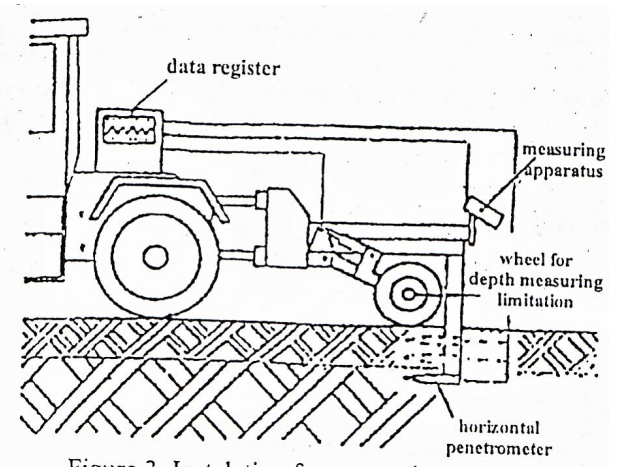

Figure 3 **Installation for measuring penetration resistance, in horizontal plane**

During the penetration of the soil, in horizontal plane, the top of the cone transmits through a calibrated spring. Pressure sensor (figure 4) is type of piezoelectric. It is known that the crystals of some materials who's are subjugate at mechanical deformations of compilation or extending has the propriety to produce an electrical load on one of the part of the crystal.

Pressure sensor who's equipped the electrometer is type of quartz crystal, and is subjugate at compilation on the neutral mechanic axis by the boot of penetration cone.

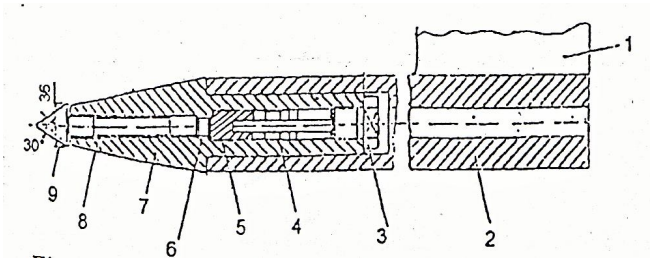

Figure 4 **Components of horizontal electrometer: 1-support, 2-body, 3-screw for adjusting pressing force, 4-spring, 5-piston, 6-pressure sensor, 7-support sensor, 8-hub, 9-penetration cone**

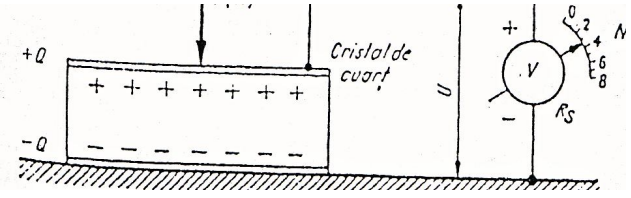

Figure 5 **Piezoelectric pressure sensor**

Electrical load Q who's appear in compilation time (load of polarization) is lead on the directional neutral axis, where is auctioning force F corresponding of soil penetration resistance and is proportional with her.

$$Q=K.F \qquad (2)$$

With here: K is a constant of proportionality named piezoelectric modulus.

$$F=\frac{Q}{K} \qquad (3)$$

With here: Q=UC

With here: U is the tension obtained in measuring circuit:

C-total electrical capacity of the circuit;

$C=C_a+C_c$

With here: C_a represent the proper electrical capacity of quartz circuit.

C_c capacity of connection circuit.

In the way to avoid accidental electrometer destruction at the appointment with obstacles, this/one is mounted in his support with two cutting screws calibrated is produced, the electrometer come back on the support.

Also, the support is mounted on the frame of the MAS 60 machine; with add of two screws who allowed the rotation in vertical plane, and go cut of soil.

The same electrometer can be used also for an static vertical electrometer, used for quickie and easy determination of soil resistance penetration in vertical plane. After the determinations achieved on an sandy clay soil with 0,4-2% clay and humidity 10-20%, are obtained the flowing results, presented (*table 1*).

Table 1

Average values of penetration resistance (KPa)

Measuring depth [m]	Penetrometer position	
	Vertical	Horizontal
0,1	50,30	2,10
0,2	10,20	4,02
0,3	12,50	5,00
0,4	17,60	7,10
0,5	25,00	9,98

On the et above data based it could be rise the graphic represented in (*fig. 6*).

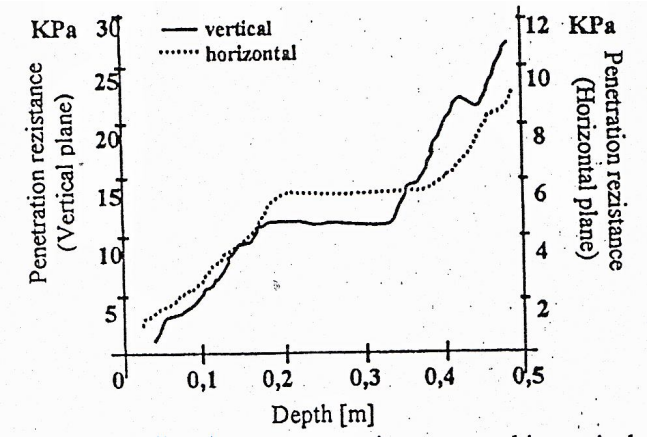

Figure 6 **Soil resistance penetration measured in vertical and horizontal plane**

CONCLUSIONS

1. Soil penetration resistance decrease with increasing of humidity and also increase with clay content.

2. A low firmness of soil and a low humidity lead at decreasing of penetration resistance.

3. Between the values of soil penetration resistance of electrometer cone in vertical and horizontal plane exist a ratio estimated of 1:2, 7.

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