EXPERIMENTAL RESEARCH ON DETERMINATION OF DEFORMATIONS IN THE CUTTING PROCESS IN WET SANDY SOILS

VLADUTOIU L. [1]*, PERSU C.* [1]*, GRIGORE A. I.* [1]*, SORICĂ E.* [1]*, PETRE A. A.* [1]*, CRISTEA M.* [1]*, CRISTEA O.D.* [1]*, GRIGORE I.* [1]

[1] ***INMA Bucharest;***
Tel: 0749281500; E-mail: laurentiuvladutoiu82@gmail.com

Keywords: soil, wear, active parts

ABSTRACT

The active parts of tillage equipment must be checked for wear resistance, under different conditions working with the soil, so that the average life span should be determined wear resistance, to ensure timely changes of parts. Research in the field has shown that there are at least two main forces acting on the active parts: impact and friction, the action of these forces causes wear.

In order to test the tillage knives in laboratory conditions, was used a stand made by INMA Bucharest. With the help of this stand, the deformations in the cutting process were determined in different working conditions: at a certain working speed and at a certain humidity of the sandy soil.

INTRODUCTION

Soil information is needed in precision agriculture to drive and understand plant growth and the behavior of the land at repeated passages of agricultural machinery. Soil penetration resistance and shear strength are among the soil parameters that affect plant production by limiting productive potential and affect machine mobility by limiting traction potential. Soil quality must be determined and analyzed to increase crop productivity (Iznaga et al, 2018; Voicu et al, 2019).

The implementation of intensive agricultural production systems has led to the use of heavy machinery with high working capacity requiring high traction forces. The traffic of these machines causes soil compaction and general structural degradation, reducing porosity and creating obstacles to air, water, nutrient movement and root penetration (Carrara et al., 2003; Febo and Pessina, 2002).

The coefficient of friction increases with increasing soil moisture. It increases to the maximum and then decreases with increasing humidity. The increase of the coefficient of friction with the increase of the soil moisture is explained by the increase of the molecular attraction forces of the soil particles by the metallic surface. The decrease of the coefficient of friction with the further increase of the humidity, is due this time to the lubricating property of the water that is between the metal surface and the soil.

The coefficient of friction between a sandy soil and a metal surface is less than the coefficient of friction between a clay-sandy or clay soil and the same metal surface

The texture of the soil also influences the process of abrasive wear, by texture is meant the way in which the size, shape and proportion of the different elementary particles of which it is composed are presented in the soil.

Humidity strongly influences the intensity and character of abrasive wear. The variation of soil moisture leads to the variation of a series of factors such as: density, shear force, coefficient of friction, pressure on the metal surface, etc. Along with the variation of these factors, the abrasion property of the soil also changes. Experiments to date have shown that changing soil moisture leads to wide variation in abrasive wear (Matache et al ,2008).

A soil is all the more abrasive because it contains particles with high hardness, often higher than the materials from which the knives are made to work the soil. This fact causes premature wear of the tillage knives, the change of its geometry, especially of the cutting part, which leads to large increases in the working resistance and fuel consumption, including the increase of environmental pollution.

The tensile strength of tillage equipment is dependent on several factors, which can be grouped into three categories: factors dependent on the type and physical-mechanical properties of the soil (composition, texture, structure, etc.); soil condition (moisture, degree of compaction, degree of weeding, etc.); the tread conditions of the tread; constructive factors: shape and type of chisel knives for working the soil; the quality of the chisel type knife surfaces (material, roughness, coefficient of friction, etc.); the degree of wear of the chisel knife edge; exploitation factors: furrow dimensions (depth, width); the number of chisel knives; working speed.

Meeting a low resistance during work gives a lower fuel consumption and a lower degree of environmental pollution.

Various studies have shown that the intensity of wear increases in proportion to the increase in pressure and the size of the abrasive particle size. Speed does not have a decisive influence on the intensity of wear. Also, the intensity of the wear of the chisel type knives is influenced by the wear resistance of the materials from which they are made.

MATERIAL AND METHOD

In order to test in laboratory conditions the chisel knife for working the soil in a conservative system, a stand made by INMA Bucharest was used (figure 1).

The chisel knife test stand consists of the following main subassemblies:

- Sand basin;
- Worm wheel reducer worm for training;
- Assembly of working support arms;
- Force transducer arm;
- Command and control installation;
- Force transducer;
- Laptop;
- Acquisition system with amplifier.

The main technical characteristics of the stand are:

- Type of gear motor worm gear wheel MRV 100 U02A
- Electric motor HB2 132M B5
- power, 7.5 kW
- frequency, 50 Hz
- voltage, V 400
- IP55 protection
- speed, rpm 1460
- mounting position V5
- transmission ratio 10
- output speed, rpm 146
- Maximum adjustment depth 300
- Overall dimensions, mm
- the outer diameter of the basin 2000
- height of the pool 1000

In order to reduce the influence of various physical parameters that characterize agricultural soil and to maximize its effect on the wear of chisel knives, it was decided to conduct experiments in an environment that promotes basic observations on the chisel-soil knife interaction.

Thus, fine quartz sand was obtained as a test medium, obtained by washing and mechanical grading which falls into the particle size class coarse sand and fine sand (according to the Attenberg scale) with a particle diameter between 0 and 0.3 mm.

Figure 1 Chisel type knife test stand

Sand moisture is characterized by the water content (q_a) in each unit of dry matter (q_{su}) and is determined by the ratio:

$$W = \frac{q_a}{q_{su}} 100\%, \qquad (1)$$

RESULTS AND DISCUSSIONS

Results and discussions. The humidity of the sand in which the tests were performed was determined using a Theta Probe type ML2x sensor (figure 2), this device is a sensor to estimate volumetric soil moisture whit ± 1% accuaracy and the device Data logger HH2, this device is used to store information from the theta probe.

Figure 2 Theta Probe type ML2x

The working speed was determined using a Mitsubishi F700 FR-F740-00310-EC inverter (figure 3).

Figure 3 Invertor Mitsubishi F700

To determine the deformations, a portable data acquisition system was used, consisting of:

▪ QuantumX 1615 data acquisition and conditioning modules, 2 modules, with 32 measurement channels each module (figure 3);

▪ laptop (figure 4);

• KYOWA tensometric marks model KFSG-6-120-C1-11N15C2, 120 Ω, type, Total size 10.00mm x 3.40mm, (grid size: 6.00mm x 1.70mm), Temperature coefficient: 11 ppm /° C, Attached with: 1 x 0.15-meter cable with 2 wires each (figure 4);

Figure 4 QuantumX 1615 data acquisition and conditioning modules

a) b)

Figure 4 Determination of the deformations

a) data acquisition system; b) placing tensiometric marks on the chisel knife holder

The tests took place under the following conditions:

- Working depth 220 mm;
- Humidity of the test environment, wet sandy soil 16%;
- Working speed 15 Hz.

In figure 5 we graphically represented the evolution of the deformations at the surface, measured on the support of the chisel knife for working the soil at a frequency of 15 Hz of the motor on the simulation stand, for dry sand.

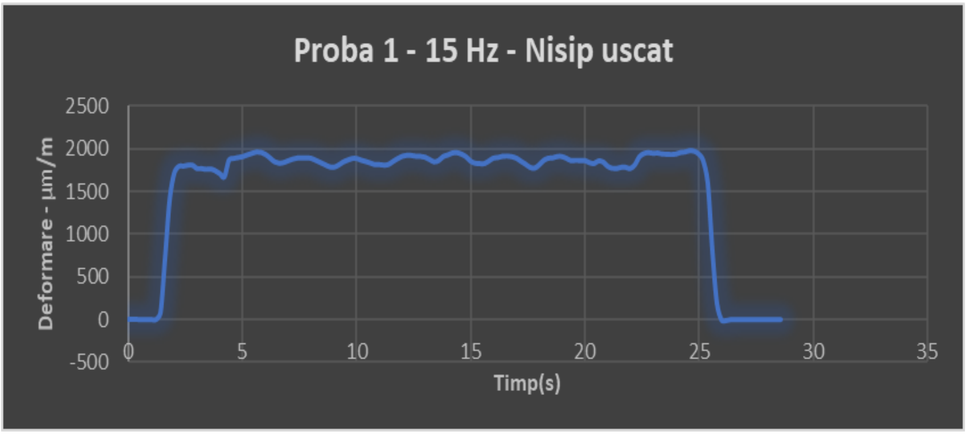

Figure 5 Deformations at a frequency of 15 Hz for wet sand

The average value calculated in the bearing area was 1708,9 µm/

In figure 6 we graphically represented the evolution of the deformations at the surface, measured on the support of the chisel knife for working the soil at a frequency of 15 Hz of the motor on the simulation stand, for wet sand.

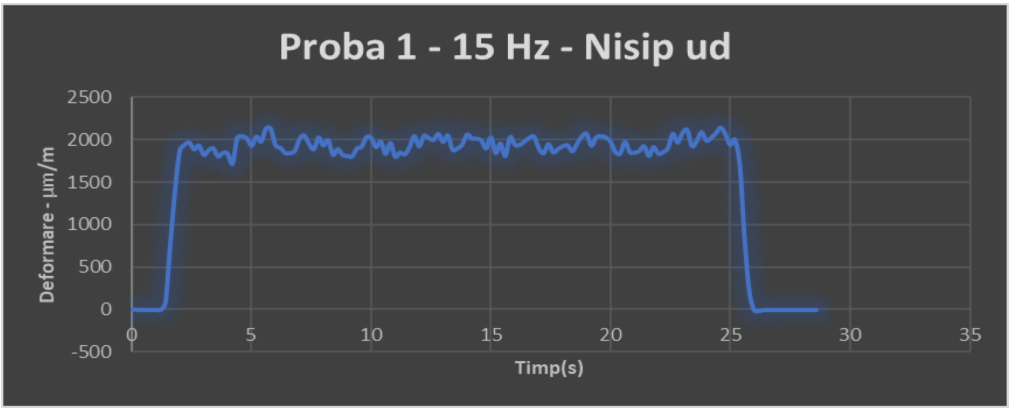

Figura 6 Deformatiile la o frecventa de 15 Hz pentru nisip ud

The average value calculated in the bearing area was 1962,4 µm/m.

In figure 7 we graphically represented the evolution of the deformations at the surface, measured on the support of the chisel knife for working the soil at a frequency of 13 Hz of the motor on the simulation stand, for dry sand.

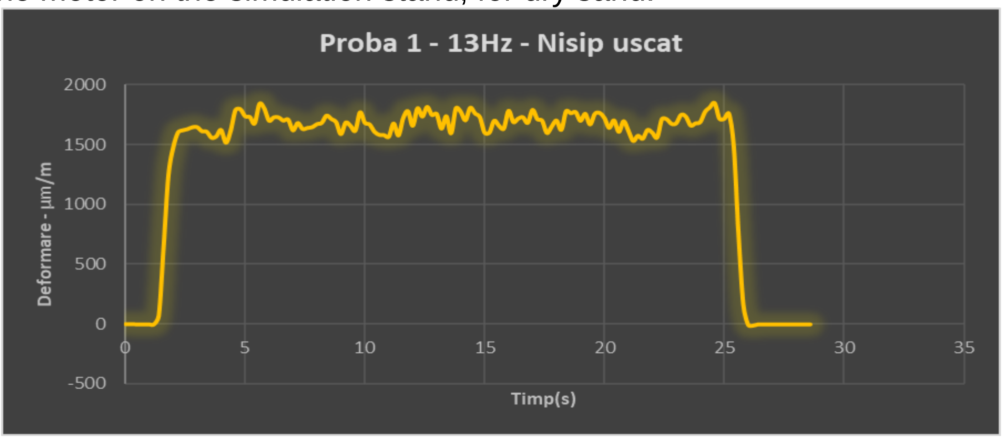

Figura 7 Deformations at a frequency of 13 Hz for dry sand

The average value calculated in the bearing area was 1681,1µm/m.

In figure 8 we graphically represented the evolution of the deformations at the surface, measured on the support of the chisel knife for working the soil at a frequency of 13 Hz of the motor on the simulation stand, for wet sand.

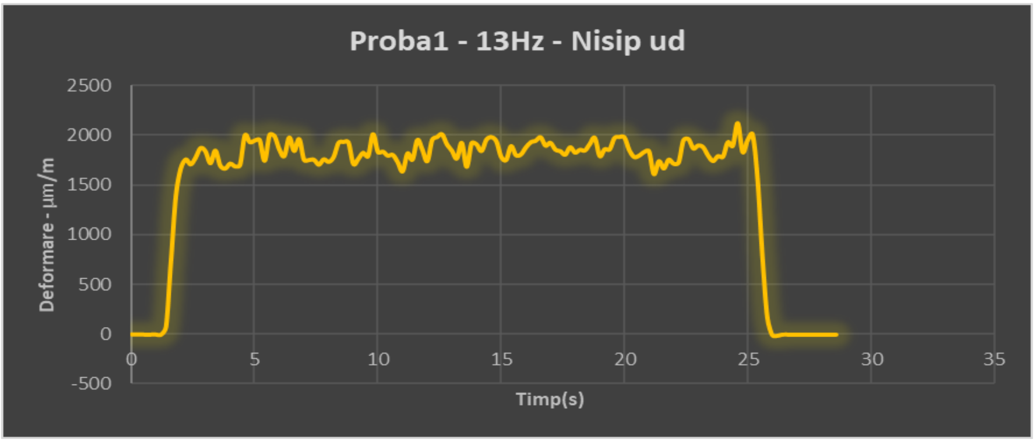

Figure 8 Deformations at a frequency of 13 Hz for wet sand

The average value calculated in the bearing area was 1839,1 µm/m.

CONCLUSIONS

Moisture as a physical factor can change quite significantly the mechanical properties of the soil: one and the same soil, depending on the water content can be hard or soft.

The intensity of wear increases in proportion to the increase in pressure and the size of the abrasive particle size. Speed does not have a decisive influence on the intensity of wear.

Meeting a low resistance during work gives a lower fuel consumption and a lower degree of environmental pollution.

The texture of the soil also influences the process of abrasive wear.

The frequency obviously does not influence the value of the deformations specific to the surface.

The significant influence of the deformations of approximately 10% is registered in the samples performed with wet sand.

ACKNOWLEDGEMENT:
This work was supported by a grant of the Ministry of Education and Research on the Programme 1 – Development of the national research-development system, subprogramme 1.2 – Institutional performance – Projects for financing excellence in RDI, contract no. 16 PFE

BIBLIOGRAPHY

1. **Carrara A., Crosta G., Frattini P.**, 2003 - *Geomorphological and historical data in assessing landslide hazard*, Earth Surface Proocesses and Landforms, Volume 28, Issue 10, p.p. 1043-1159.
2. **Febo P., Pessina D., Orlando S. et al.**, 2002 - *The ground pressure exerted by agricultural*, Rivista di Ingegneria Agraria, ISSN: 0304-0593, Italy.
3. **Matache M., Ganga M., Mihai M., Postelnicu E., Bajenaru S.**, (2008). *Researches regarding determination of mechanical and wear characteristics for fricţion materials*, Scientific Papers (INMATEH), vol. 28, pp. 120-123.
4. **Iznaga S., Lázaro A. et all,** (2018). *Efecto de la geometría y tipo de material en el desgaste de aperos de labranza. Rev Cie Téc Agr* [online - ISSN 2071-0054], vol.27, n.1 pp. 36-45.
5. **Voicu G., Olac B., Ilie, F., Tudor P.,** (2019), *Aspects regarding the wear of working organs of the Agricultural scarifiers*, Research People And Actual Tasks On Multidisciplinary Sciences, Lozenec, Bulgaria, pp. 139-144.