МАШИНОЗНАВСТВО

UDC 339.138

Lukianchuk O. P., Candidate of Engineering, Associate Professor, Zahurskyi A., Master's-degree Student (National University of Water and Environmental Engineering, Rivne)

EXPERIMENTAL RESERCH OF THE EFFECINCY OF THE WORKING BODY OF THE SINGLE–BUCKET BACKHOE EXCAVATOR

Experimental study of soil cutting process at work single-bucket excavator in the four radius of tine blunt was performed, the power consumption, comparison of energy efficiency were investigated.
***Keywords*: performance, digging, blunt, tine, cutting, efficiency, soil.**

Purpose. The importance of improving the efficiency of construction equipment is due to significantly reduced cost of manual labor.

The experience of excavators operation proves excessive wear of the tines and cutting edges of the bucket, improves soil cutting power capacity by 1.4-3.0 times, reduces productivity by 10-40%, resulting in economically advantageous further operation. In metal structure of the equipment the loads arise that increase tension in 1.1-1.8 times. Timely replacement of times when reaching the limit of wear reduces the development cost price of 1 m^3 of soil by 18-20% [1].

Findings. The most rational way to determine the effort while cutting the ground with different angles of excavator tines sharpening is expressed by Vetrov theory is based on the process of space and manifests itself in the destruction of soil as trapezoidal apertures, which has the greater width than the width of the blade [2; 3].

Methodology. Objectives of the study – the eventual establishment of the ways that would reduce the power consumption of the excavator with different diameters cutting elements blunting and determination of the optimal angle of tines blunting for the reduced power consumption of the workspace, while determining the blunting angle of the working body at which the most effective process of chip breaking takes place. To increase the performance assessment it is necessary to analyze the efforts and dependence of tines blunting [4].

The purpose of the work is: the study of the effect of the cutting angle blunting on the soil.

To achieve this goal the following tasks were carried out –

experimental studying of soil cutting process in the operation of single-bucket excavator.

During the experiment the following tasks were set: studying the physical nature of the soil cutting by a single-bucket excavator; comparing of efforts of excavator tines passing at different radii of blunting, identifying the areas of the developed surface, volume of prisms; comparing of chip scrap volumes with different radius of the excavator tines blunting; determining the amount of loosened soil; identifying of key characteristics of the soil (moisture content, type, category, flexibility, consistency, density, power and angle of internal friction).

The value of the experimental research. The obtained results confirmed the experimental theories of soil destruction, blunting and wearing of the cutting tool increase the resistance to soil destruction, blunting causes an increase in resistance of the excavator tine. Also for the results of the study there were selected the most suitable range tine blunting in which power capacity will be the highest.

Originality. Also much attention is paid to cutting elements blunting and its impact on the process of digging the soil. The experience of the operation of excavators, excessive wear of the tines and cutting edges of the bucket improves power capacity of the cutting soil by 1.4-3.0 times, reduces productivity by 10-40%, resulting in not economical advantages in further operation.

Displacement occurs when the effort necessary for soil compaction before using tines, as compared with the effort, required to shift the soil.

Performance excavator, m^3/t:

$$P_e = q \cdot k_n / k_p \cdot t_c = B \cdot S_b \cdot k_n / k_p \cdot t_c, \quad (1)$$

where k_n – bucket filling ratio; k_p – rate of loosening the soil; t_c – cycle, t; B – bucket width, m; S_b – lateral area of the bucket, m^2.

The research indicates that the most productive mode of operation is digging the soil in which the cutting path and the filling of the bucket will be the lowest.

It considers the experimental design, methodology and results of experiments to determine the conditions of the experiment, the characteristics of the working body, the passage rate, determines the number of repetition, the characteristics of the soil environment, description of the experiment and the experimental setup, the study made also possible to determine the volume of prisms, which values allow to determine the volume of loosened soil for four experiments. It also determines loosening soil density, volume of soil on the surface and four research and loosening factor. The calculations were carried out to compare the values obtained with different radiuses of working bodies blunting.

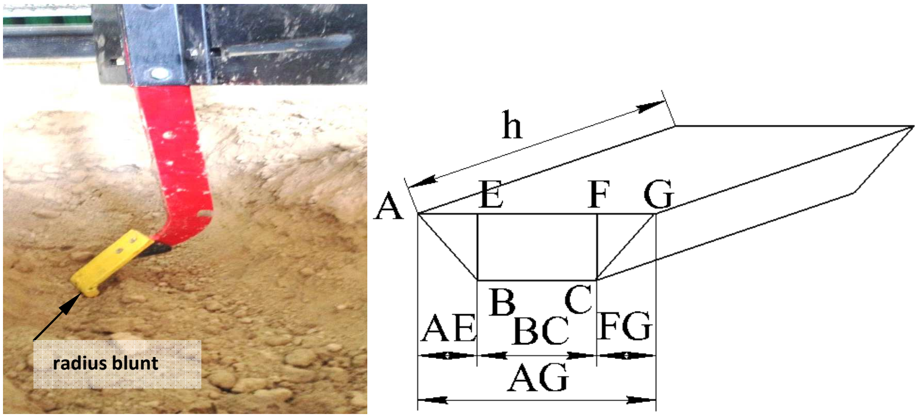

Fig. 1. Radius blunt and prism scheme of soil cleavage

According to the calculations we get the results and present them in the table.

Table 1

The volume of prisms soil

No of prism	So, sm^2	2So, sm^2	AB, sm	Po, N	Sb, sm^2	S, sm^2	V, m^3
1.	212,5	425	19,5	64	9600	1025	0,031875
2.	252	504	20,12	68,249	10237,35	10741,35	0,037800
3.	234	468	22,20	80,40	12060	12528	0,035100
4.	279	558	20,83	72,677	1090,59	11459,59	0,041850

On the basis of the results we compare the volumes *V* of soil.

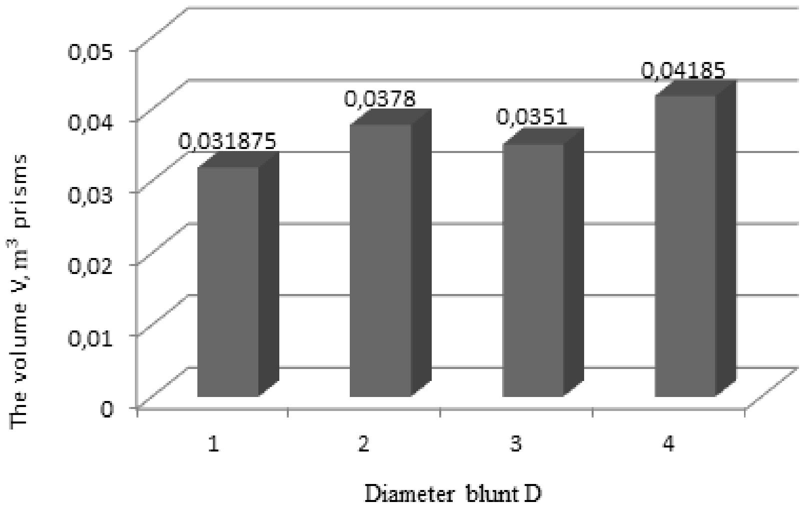

Fig. 2. Comparison of volume prisms

The calculation of the loosened soil volume.

Table 2

Volumes of the loosened soil V_{loos}.

№	$V_{loos,}$ m^3
1.	1,4649
2.	1,6163
3.	1,7844
4.	1,607

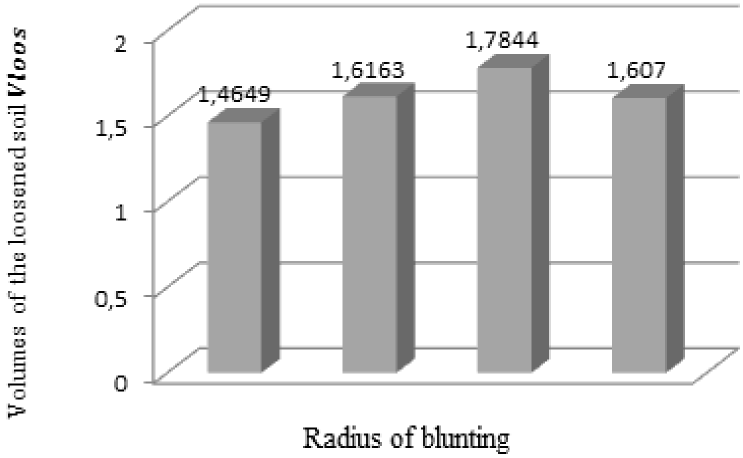

Fig. 3. Comparing volumes of the loosened soil

Calculation of loosening coefficient

Table 3

Coeficient of loosening

№ experiment	Coeficient of loosening. Kp
1	1,05
2	1,17
3	1,28
4	1,15

Analysis of average effort P, H for four experiments.

Table 4

Secondary analysis of middle efforts P, N.

Average efforts 1 – 4 designs P, H	Blunts radius R, мм
832,025	4
1300,555	14
1391,669	24
1519,575	34

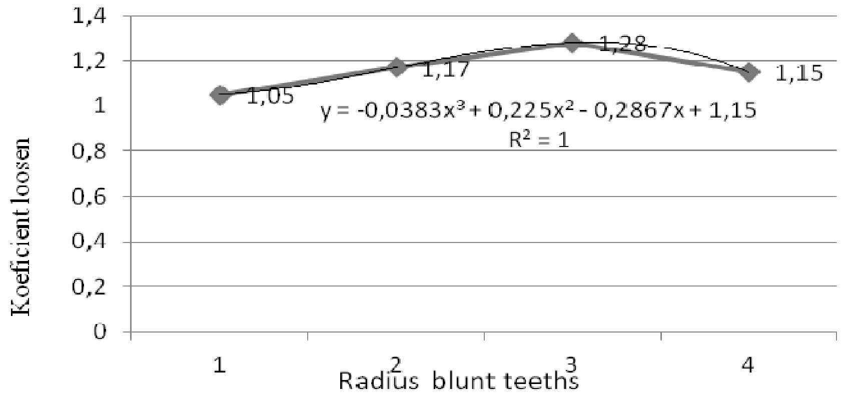

Fig. 4. Comprasion of loosening coeficient Kp

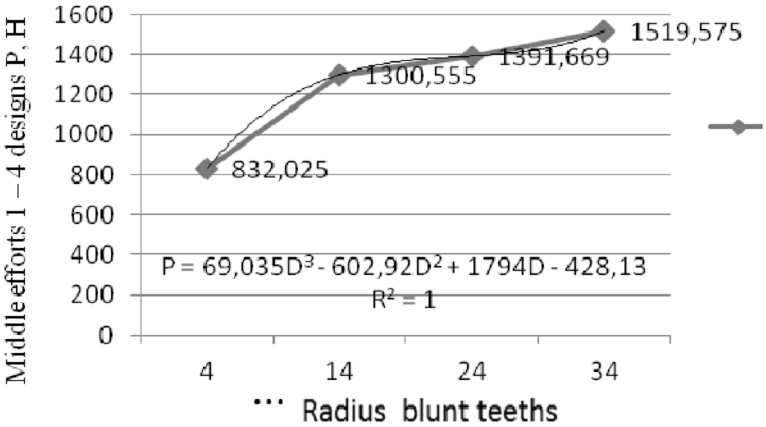

Fig. 5. Schedule medium efforts, P, H

So experiments confirmed the theory of experimental destruction of soil, blunt and cutting tool wear resistance increases soil destruction. Blunt causes an increase in resistance of the tine. After analyzing each experiment it can be seen in the graphs that the cutting force increases for each tine blunt with different diameters at different sites in different ways. For the analysis of average effort of four experiments, we can conclude that most efforts mean H, (kg) observed on the fourth blunt knives with radius 34 mm.

It considers the methods of calculation, feature performance calculation, determining the soil resistance to cutting work of digging the soil, digging process energy capacity.

As the results of the theoretical research, digging energy capacity decreases with increasing thickness of the chips. Although digging chip thickness of 55 cm cutting resistance is the greatest, but that is the way to complete the bucket is the smallest, and calculations show that the work it takes to develop such chips soil thickness is smaller. Therefore, the power consumption of that digging is the smallest.

Calcuation coefficient of digging performance η.

Table 5

Coefficient of digging perfomance η

№	light sandy loam	medium sandy loam	light loam
h_1	0,25	0,22	0,21
h_2	0,32	0,30	0,29
h_3	0,41	0,39	0,38

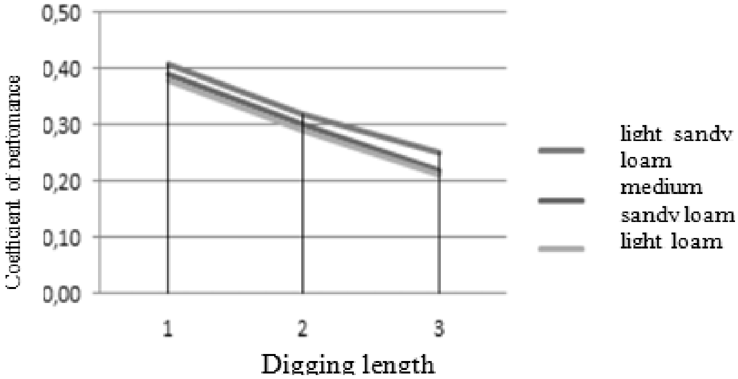

Fig. 6. Dependence of coeficient of perfomance to the length of digging

Calculation of digging power N, kW

Table 6

Power of digging N, kW

h, m	t, s	light sandy loam	medium sandy loam	light loam
0,2	9	43,648	59,520	68,022
0,3	7	36,216	49,197	56,427
0,55	5	31,411	44,507	51,282

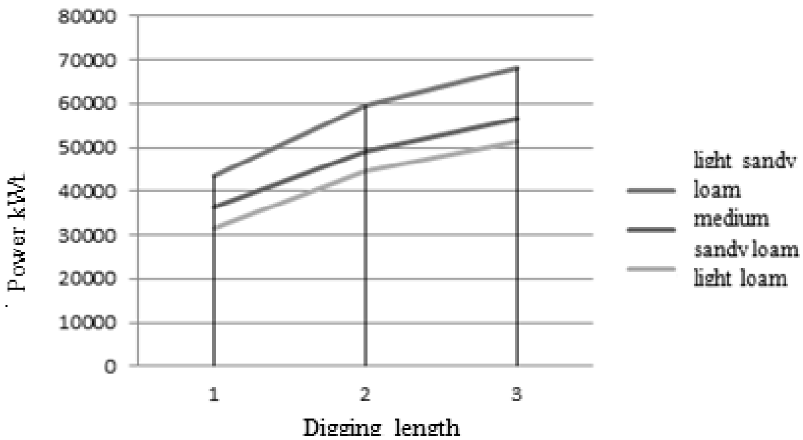

Fig. 7. Dependence of power N on the length of digging

In the work we regarded hour operational performance, the effect of tines wear on productivity of the excavator, investment calculation, calculation of labor costs, determined the annual savings of work, calculation of costs.

The cost of developing the soil chips thicker and therefore less by filling the bucket is about 20% less than in conventional digging. Also, the results can be concluded with the increased volume of developed soil excavator tine blunt the productivity decreases.

Practical value. A positive solution to this problem can be obtained only if it investigated the optimum cutting angle blunt of the body in the case of tines. For this comparison the efforts were carried out on cutting the soil at different diameters of the excavator tine blunt.

This suggests that when designing single-bucket excavator it is necessary to reduce the energy intensity of the process of digging, when you achieve such conditions, in which the soil cutting will be done with the least resistance. In our case the resistance was investigated according to the tine blunt radius of the excavator.

After comparing the proposed method of digging a greater thickness of the chip, it was determined that the cost of development of 1 m^3 is reduced by approximately 20% as compared to the cost of developing other soil thicknesses shavings.

Of course, the conclusions are experimental and require more in-depth study, but in this work the analysis effort was carried out based on cutting blunt.

1. Machines for earthworks: Textbook / Hmara L. A., Kravets S. V., Nichke V. V., Nazarov L. V., Skobluk M. P., Nikitin V. G. Under the editorship of prof. Hmara LA and prof. S.Kravets Rivne, Dnipropetrovsk, Kharkiv. – 2010. – 557 s. **2.** S. V. Kravets. Theory destruction workspaces. Tutorial. – Exactly : NUWMNRU, 2008. – 124 p. **3.** V. Y. Krikun. Soil resistance to cutting by turning the backhoe bucket. "Mechanization of Construction". – 2002. – № 12. from. – 19–21 s. **4.** I. L. Tsipursky. The resistivity of digging the soil. "Building and road machines." 2004. – № 8. from. – 37-39 s.

Рецензент: д.т.н., професор Налобіна О. О. (НУВГП)

Лук'янчук О. П., к.т.н., доцент, Загурський А., магістр (Національний університет водного господарства та природокористування, м. Рівне)

ЕКСПЕРИМЕНТАЛЬНІ ДОСЛІДЖЕННЯ ЕФЕКТИВНОСТІ РОБОЧОГО ОРГАНУ ОДНОКІВШЕВОГО ЕКСКАВАТОРА ЗВОРОТНА ЛОПАТА

Проведені експериментальні дослідження процесу різання ґрунту при роботі одноківшевого екскаватором при чотирьох радіусах затуплення зубів, дослідження енергоємності, здійснено порівняння

***Ключові слова*: продуктивність, копання, затуплення, зуб, різання, ефективність, грунт.**

Лукьянчук А. П., к.т.н., доцент, Загурский А., магистр
(Национальный университет водного хозяйства и природопользования, г. Ровно)

ЭКСПЕРИМЕНТАЛЬНЫЕ ИССЛЕДОВАНИЯ ЭФФЕКТИВНОСТИ РАБОЧЕГО ОРГАНА ОДНОКОВШОВОГО ЭКСКАВАТОРА ОБРАТНАЯ ЛОПАТА

Проведенные экспериментальные исследования процесса резания грунта при работе одноковшовых экскаваторов при четырех радиусах затупления зубов, исследования энергоемкости, проведено сравнение энергетической эффективности.
***Ключевые слова*: производительность, копание, затупления, зуб, резанье, эффективность, грунт.**
