LABORATORY RESEARCH ABOUT THE FORCES FOR THE STERILE ROCKS CUTTING PERFORMED AT ROSIUȚA OPEN PIT

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Abstract*: This paper shows the main laws that govern the variation of the cutting forces during the cutting operations in relation to the cutting depth, tooth undercut, laws which have been determined after laboratory tests.*
Key words*: forces, cutting, rocks*

1. GENERAL CONSIDERATIONS

One of the most important aspects involved in increasing the efficiency of the mechanized operations performed in lignite open pits and for improving the technical and economic indices is represented by an efficient increase of the mechanized cutting operations in general and of the mechanized cutting and loading with the use of drag-line excavators in Motru coal field in particular.

Several aspects should be considered when speaking about an suitable efficiency of the excavators at work: the largest possible mining capacity, the lowest possible costs for the excavated mass, the highest possible output of the excavator working face, a high extraction ratio, the lowest possible power consumption, a high level of labour safety, suitable working conditions, a high reliability of the machine, etc.

Accordingly, a correct selection and an efficient and an intensive use of the drag-line excavators involve the use of certain typodimensions that meet the given conditions and where the cutting –loading system plays the most important part.

A simple analysis of the said factors and of the experience gained during the selection and use of drag-line excavators allows taking a suitable decision on the excavator as a whole (from a constructive point of view and with respect to the basic characteristics), but the design or selection of the cutting –loading system that corresponds best to the existing conditions means that one should know certain laws and correlations between the sizes that characterize the cutting process and the constructive and functional parameters, between the machine power parameters and the conditions of the deposit in situ, both in general and for each case apart, from a quantitative and a qualitative point of view.

All these aspects rely either on laboratory researches on the behavior to cutting of coals and rocks from the covering bed, or on tests performed in real working conditions for a certain types of excavator. Generally, all theses studies performed abroad intend to determine some laws of interdependence between the characteristics of the excavators and those of the coals or of the sterile rocks from the covering bed in their coal fields and the types of excavators made and used in their own working conditions.

Consequently, the University in Petrosani has also performed laboratory tests on samples of sterile rocks sampled from Rosiuta open pit.

2. LAW OF VARIATION OF THE CUTTING FORCES

Based on the experimental tests carried out on a blackish-grey clay sample, as representative sterile rock of Rosiuța open pit, there have resulted certain laws of variation of the cutting forces in relation to the cutting depth and to the tooth undercut. Accordingly, Fig. 1 shows the relation between the average cutting forces F_{xm} and the cutting depth h_0. One can notice that this dependence is parabolic; the increase of F_{xm} goes with the increase of h_0, according to the equation said in the figure. For a practical use, the variation F_{xm} = f (h_0) may also be given by a linear function, see Fig. 1, which provides the corresponding equation.

Fig. 2 shows the dependence of the forces F_{xm} in relation to the tooth undercut; thus, it displays a decreasing curvilinear variation with the increase of the undercut, according to a power function given in this figure.

Fig. 3 shows the dependence of the cutting forces as average values of the peaks F_{xmv} as function of the cutting depth h_0 for different values of the tooth undercut α. The same as for the previous situation, the variation F_{xmv} = f(h_0) is linear and the values decrease with the increase of α.

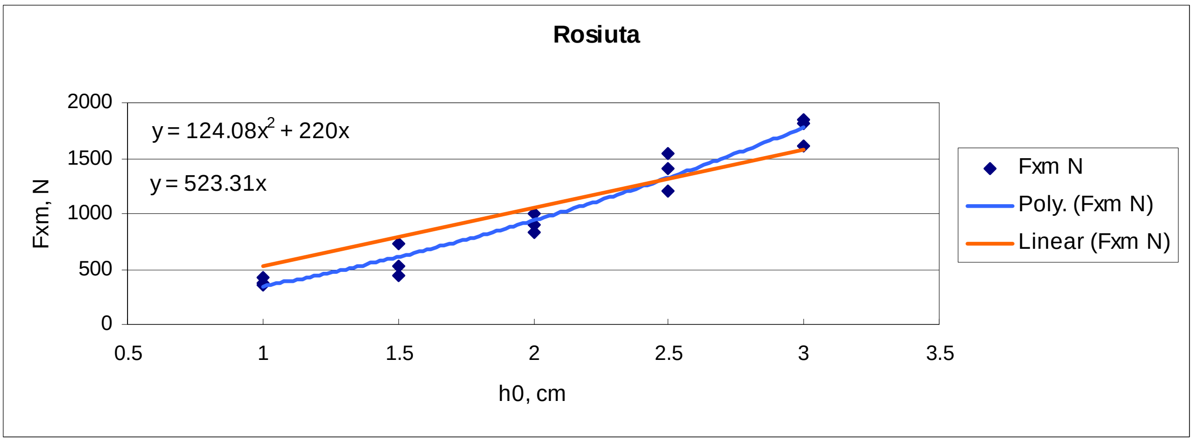

Fig. 1. *Real average cutting force F_{xm} depending on the cutting depth h_0*

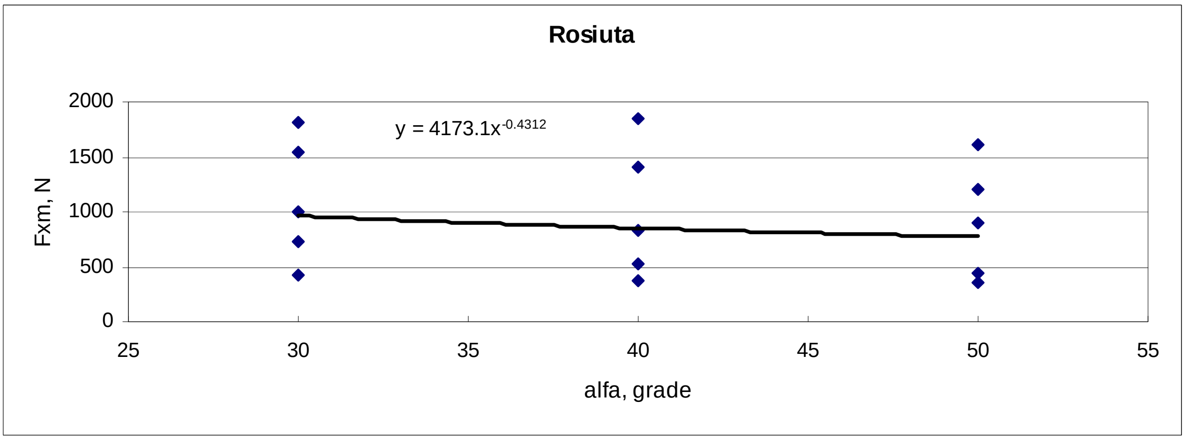

Fig. 2. *Real average cutting force F_{xm} depending on the tooth undercut α*

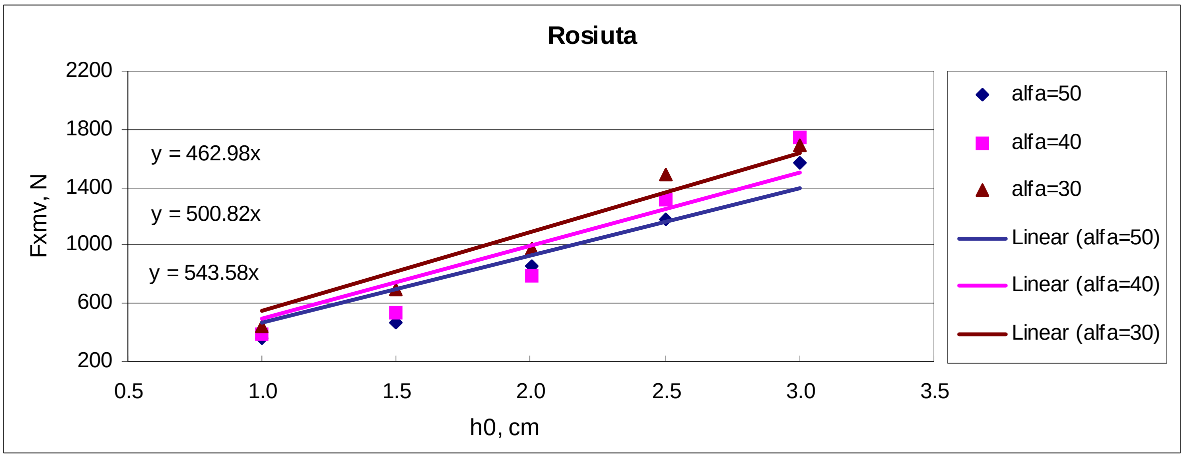

Fig. 3. *Average cutting force of the peaks F_{xmv} in relation to the cutting depth h_0 for different values taken by the tooth undercut α*

Fig. 4 shows the law of variation for the maximum cutting force as function of the cutting depth h_0 for the different values taken by α; there can be noticed that the effect of the undercut (for the maximum values considered) over the maximum cutting forces is insignificant.

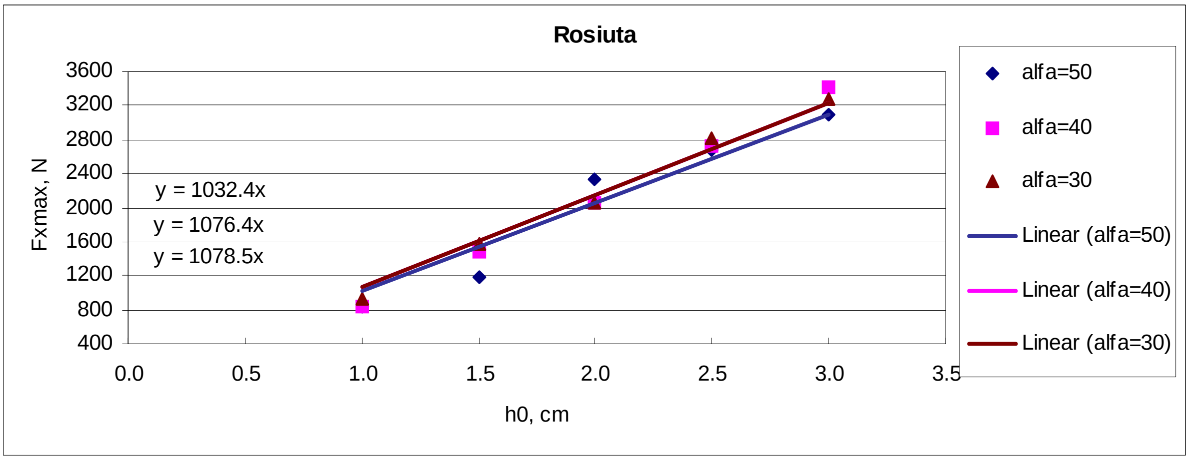

Fig. 4. *Maximum cutting force F_{xmax} depending on the cutting depth h_0 for different values of the tooth undercut α*

It is necessary to know the average values of F_{xm} of the cutting forces so as to be able to determine the energy parameters (power consumption, specific power consumption, power) of the average values of the peaks F_{xmv} for studying the cutting process from a dynamic point of view and the maximum values F_{xmax} for a suitable sizing of teeth, the tooth holder, of the scoop and the rotor.

The following synthetic parameters are being introduced to characterize the dynamics of the cutting process:

- the dynamic coefficient:

$$k_d = \frac{F_{x\max}}{F_{xm}} \tag{1}$$

This expresses the probable occurrence of certain extreme peaks of the cutting force during the dislocation

- the coefficient of variability of the average value:

$$k_v = \frac{F_{xmv}}{F_{xm}} \tag{2}$$

This expresses the force of the dynamic variation of the cutting forces in time.

Whether one knows these coefficients and the average values of the cutting forces, the values of F_{xmax} and F_{xmv} for certain existing conditions can be determined with the help of the equations (1) and (2).

Accordingly, Fig. 5 shows the relation between the dynamic coefficient k_d and the cutting depth h_0 for different values of the tooth undercut. There can be noticed that this coefficient is not affected significantly by the chip thickness, taking values between 1.8 and 2.8.

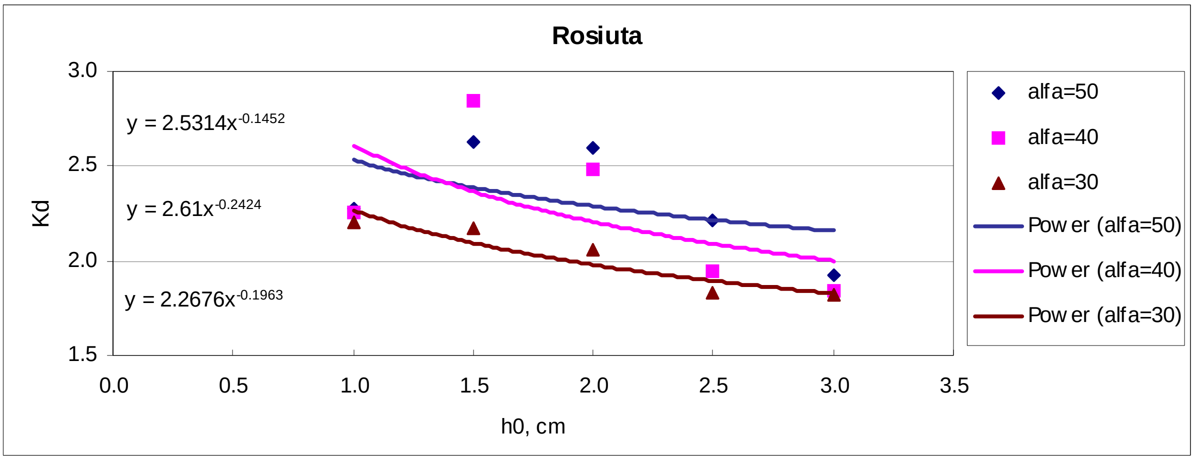

Fig. 5. *Relation between the dynamic coefficient k_d and the cutting depth h_0 for different values taken by the tooth undercut α*

Fig. 6 shows the relation between the variability average coefficient k_v and the cutting depth h_0 for the different values taken by α. There can be noticed that this coefficient decreases with the increment of h_0, taking values between 0.9 and 1.1.

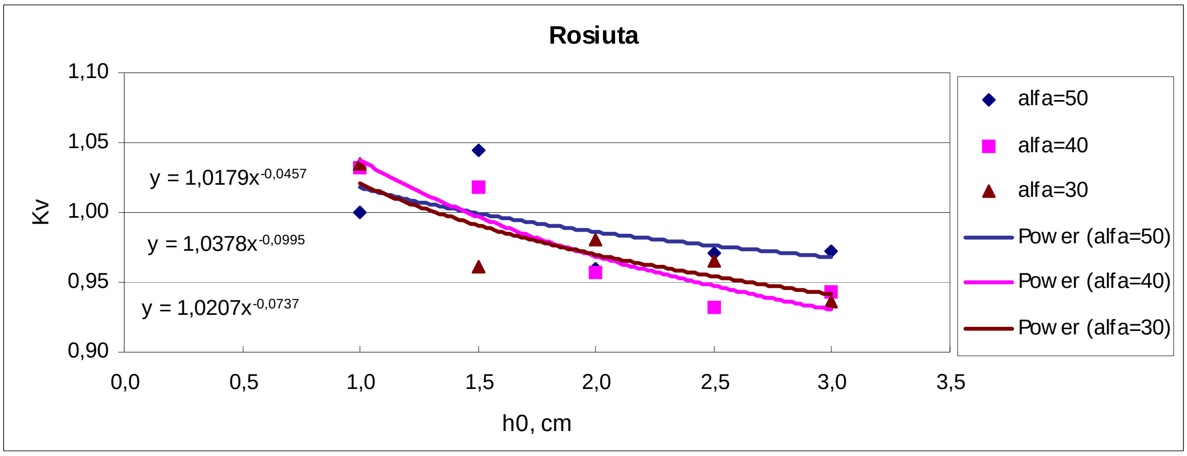

Fig. 6. *Relation between the coefficient of variability of the average value k_v and the cutting depth h_0, for different values of the tooth undercut α*

3. CONCLUSIONS

The results of the laboratory tests have materialized into curves and groups of curves which describe with sufficient accuracy the parameters of the cutting operation on sterile rocks, both from a qualitative and from a quantitative point of view. Each group of interdependences which have considered the studied parameters is being accompanied by explanations and comparative analyses under multiple aspects, aiming all the useful elements for the purpose of becoming more familiar with the cutting operation and the final target being the improvement of operation performances of the mining machines.

REFERENCES

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