ASSESSING THE MECHANICAL CUTTING BEHAVIOUR OF BARREN ROCKS WITH HIGH DISLOCATION RESISTANCE FROM HUSNICIOARA MINE PERIMETER

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ABSTRACT: The paper brings forward the experimental cutting trials of a series of dead rocks found in Husnicioara quarry belonging to The National Company of Lignite "Oltenia". These experimental trials were carried out on significant sterile rocks of the aforementioned quarry on a bench conceived and realised in the "Mining Machines and Equipment" Laboratory of the Department of Mechanical and Industrial Engineering and Transports. The experimental trials were carried out on sterile samples taken from the topsoil stripping of the layers of lignite which is surface mined in the aforementioned quarry.

Key-words: mechanical cutting, increased cutting resistance rocks, Husnicioara quarry, tensometry

1. GENERAL CONSIDERATIONS

Sterile sampling in the quarry of "Oltenia" National Company of Lignite in Târgu-Jiu in order to carry out the experimental laboratory trials, have raised new problems, as such researches on sterile rocks have never been carried out in our country.

Therefore in order to carry out the experimental researches sterile samples were taken from Husnicioara quarry.

The sampling place for each quarry was appointed according to a documentation made in collaboration with the management and the geologic department.

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- Husnicioara quarry, the cover of the 1st layer, two samples of low coal content greenish clay marked 1H and 2H;
- Husnicioara quarry, the cover of the 4th layer, the samples market with 3H and 4H of sand silicified through diagenesys (between sandstone and sand) which the paper shall conventionally call "sandstone".

From the greenish clays of Husnicioara quarry presented in Figures 1 and 2, the block of "sandstone" undergoing deformation under the action of the drilling machine, the resulted sample preserved and introduced in the crate, respectively the sample fixed in the crate.

Fig. 1. The deformation of the „sandstone" sample

Fig. 2. "Sandstone" Sample

2. PRESENTATION OF THE BENCH

In order to determine the cutting resistance of rocks and coal, through the determination of the cutting forces (on samples coming from different mining fields), a dynamometer was designed and realised, successively equipped during the cutting process using teeth with different geometrical characteristics (rake angle, bottom rake, tool angle, lateral angle, etc.)

During the research, it has been observed that while cutting coal from different mine fields, forces larger than the ones estimated were created, and the dynamometer presents a series of constructional and operational deficiencies, being required therefore its redesign and the development of a modern one.

The modern dynamometer allowed for a certain number of grooves to be cut in the coal and rock samples, with different depths and different directions related to the layering, simultaneously recording the tangential, normal and lateral components (Fx, Fy and Fz) of the resulting force on three rectangular directions in relation to the cut surface.

Images regarding different experimental sampling phases on Husnicioara Quarry "sanstone" are presented in Figures 3 and 4.

Fig. 3. Dynamometer sampling bench

Fig. 4 Last cut on the surface of a "sandstone" sample

3. MECHANICAL CUTTING CHARACTERISTICS

The variation of force F_{xm} in relation to the cutting depth h_o, respectively with the rake angle α is presented in figures 5 and 6. It is observed that F_{xm} increases in relation to h_o and it is relatively constant in relation to α.

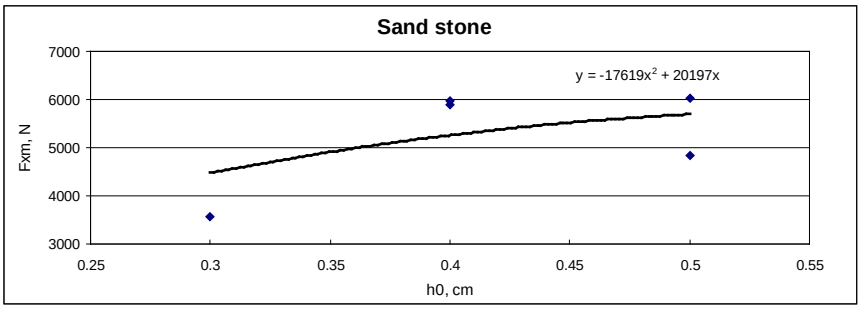

Fig. 5. Medium effective cutting force F_{xm} in relation to the cutting depth h_0

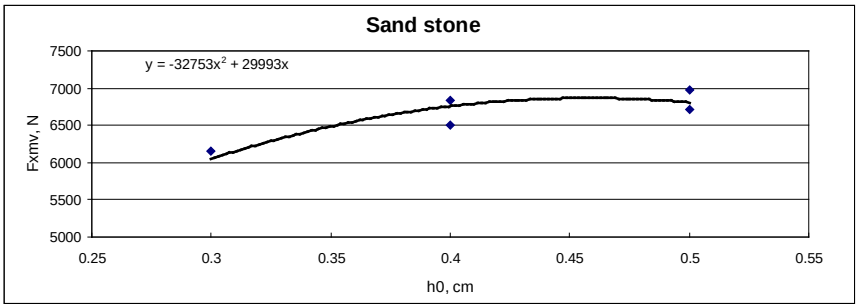

Fig. 6. Medium cutting force for peak F_{xmv} in relation to the cutting depth h_0

The specific resistance to cutting A in relation to h_0 and α presents an almost linear variation slightly decreasing, as it results from the representations in Figures 7 and 8. The values are quite large, comprised between 10,000 and 15,000 N/cm.

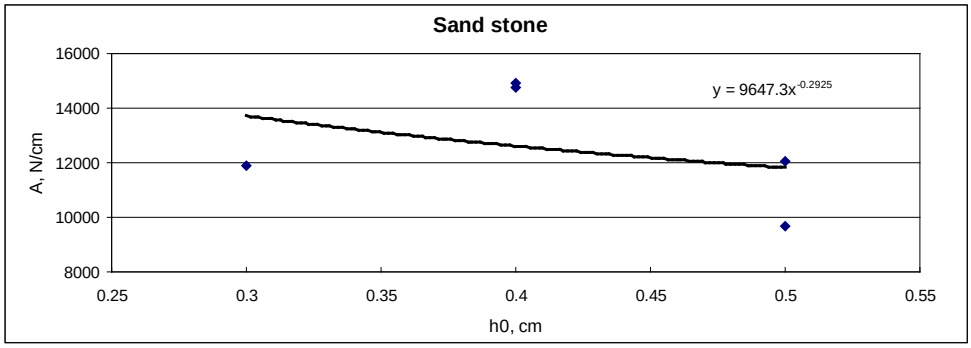

Fig. 7. The dependence of the specific resistance to cutting *A*, in relation to the cutting depth h_0

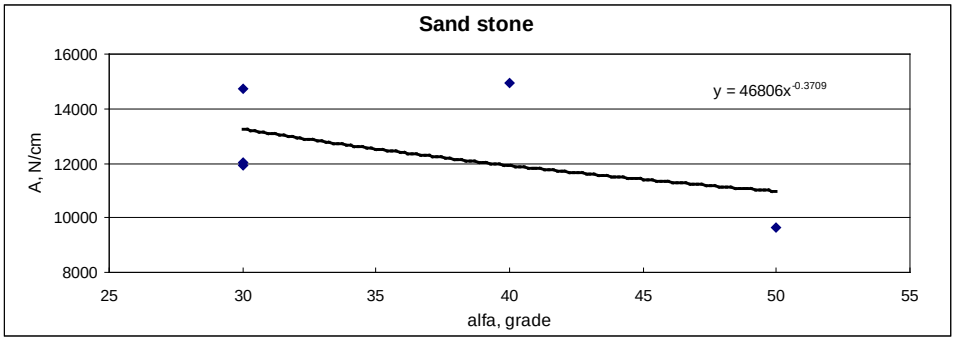

Fig. 8. The dependence of the specific resistance to cutting *A*, in relation to the rake angle α of the tooth

Figures 9 and 10 bring forward the dependence laws of the specific resistance to cutting A_1 in relation to h_o and α, where it may also be observed that it increases in relation to h_o and it is almost constant in relation to α. The values are comprised within the range 900 ... 1500 N/cm.

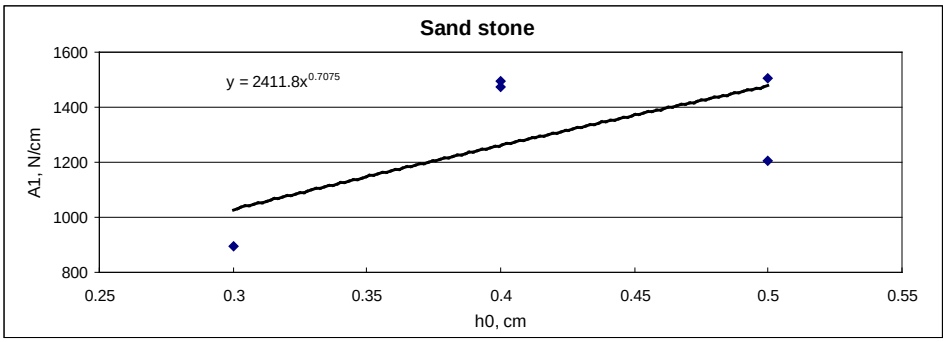

Fig. 9. The dependence of the specific cutting resistance A_1, in relation to the cutting depth h_0

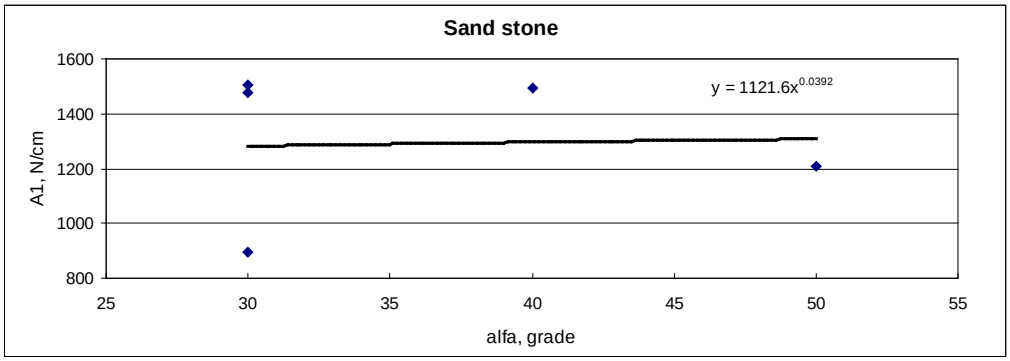

Fig. 10. The dependence of the specific cutting resistance A_1, in relation to the rake angle of the tooth

The piercing force F_{ym} in relation to h_o and α is presented in figures 11 and 12, where it may be observed that it has negative values, and the influence of h_o and α is relatively small. The values recorded are negative.

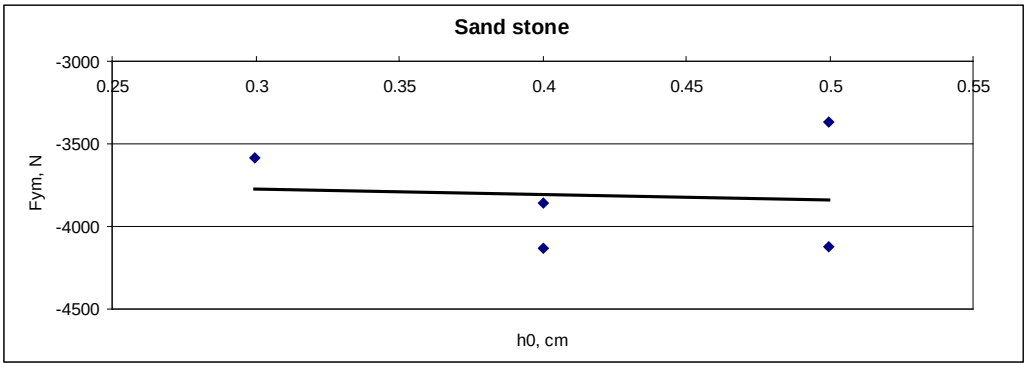

Fig. 11. The medium effective piercing force F_{ym} in relation to the cutting depth h_o

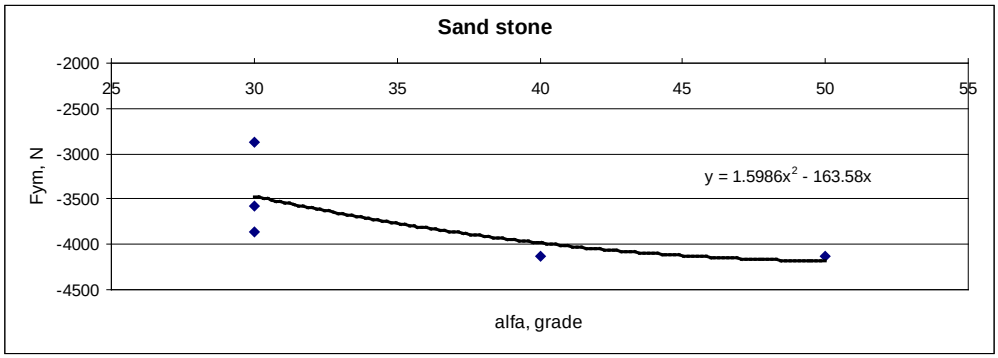

Fig. 12. The medium effective piercing force F_{ym} in relation to the rake angle α of the tooth

The medium lateral forces F_{zm} in relation to h_o and α are presented in figures

13 and 14, where the significant influence, of h_o, as well as of α may be observed. Force F_{zm} takes relatively small values, namely between 50 ... 200 N.

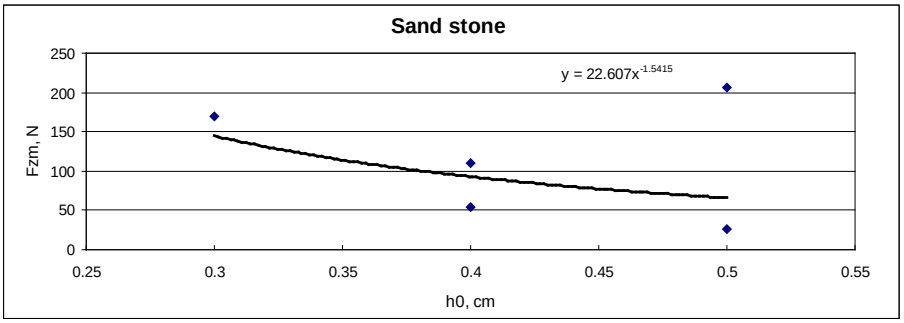

Fig. 13. The medium effective lateral force F_{zm} in relation to the cutting depth h_0

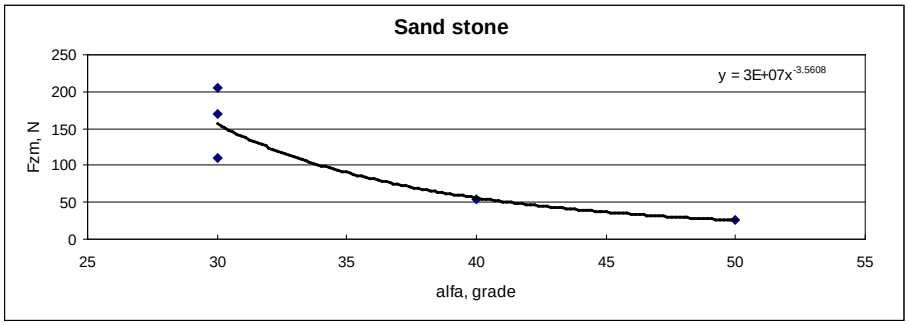

Fig. 14. The medium effective lateral force F_{zm} in relation to the rake angle α of the tooth

The breaking angle ψ of the chip from the massif, in relation to the cutting depth is presented in figure 15, while in relation to α is presented in figure 16. It may be observed that the value of ψ varies between 35^o and 55^o, with a most probable average value of 45^o.

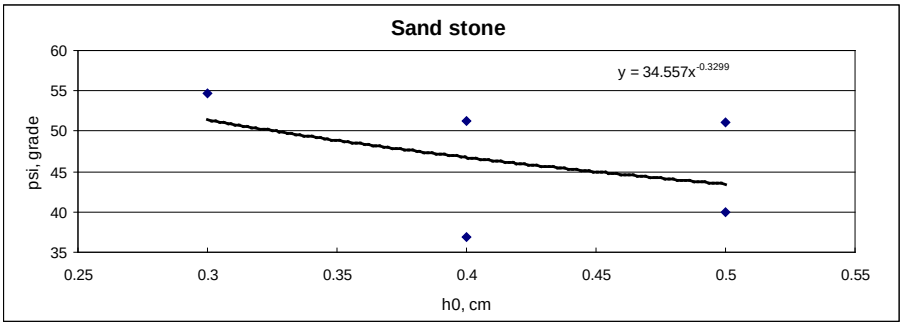

Fig. 15. The dependence of the angle of slope ψ, in relation to the cutting depth h_0

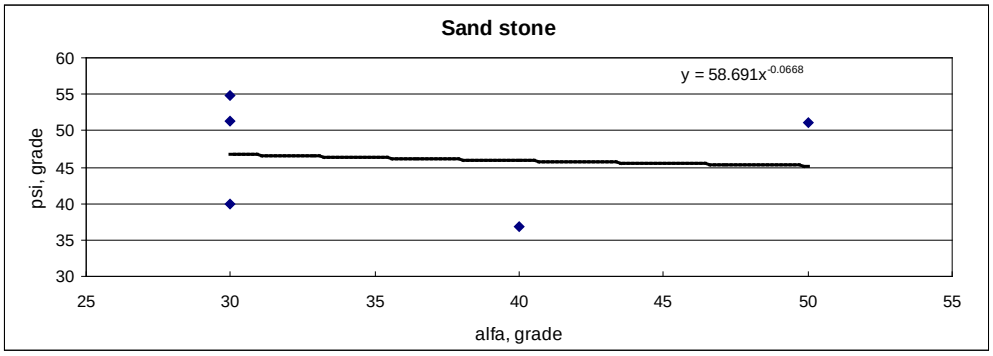

Fig. 16. the dependence of the angle of slope ψ, in relation to the rake angle α of the tooth

The specific energy consumption E_s in relation to h_o and α is presented in figures 17 and 18 resulting therefore that once the cutting depth is h_o and the rake angle α of the tooth are increased, the specific energy consumption decreases. In the case of "sandstone" the specific energy consumption varies between 6.5 and 9.5 kWh/m^3.

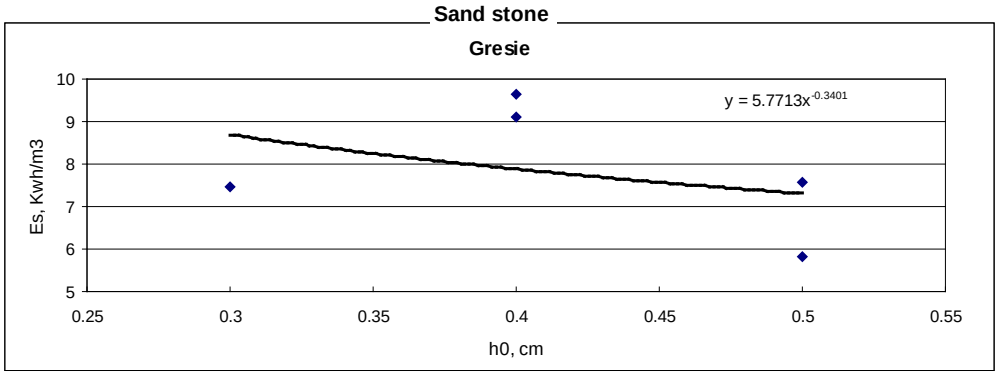

Fig. 17. The dependence of the specific energy consumption E_s, in relation to the cutting depth h_0

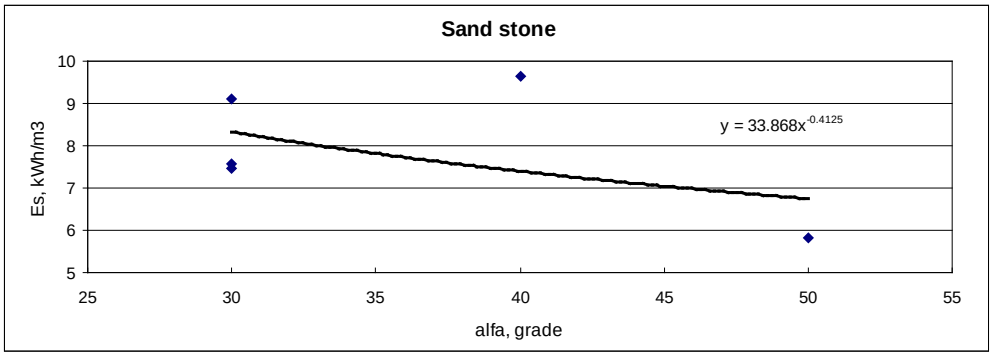

Fig. 18. The dependence of the specific energy consumption E_s, in relation to the rake angle α of the tooth

4. CONCLUSIONS

The parameters of the cutting operation of sterile rocks in Husniciora Quarry were determined through experimental laboratory trials, carrying out cutting samples on the sampling bench using specially designed and created machineries by the Mining Machines and Equipment Laboratory of the University of Petroşani.

Based on the experimental data the cutting characteristics of sterile rocks in Husnicioara Quarry were established.

The trials carried out on "sandstone" samples taken from Husnicioara Quarry have highlighted the fact that this type of rock cannot be rationally cut by bucket wheel excavators, firstly because of the high exaggerated specific resistance of the cutting and piercing forces, and secondly because of increased specific energy consumption during cutting.

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