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ANALYSES OF THE GEOMETRIC CHARACTERISTICS OF SOIL- CUTTING CULTIVATING WORK ORGAN

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ABSTRACT:
Cutting of the soil in order to prevent erosion and retain moisture is done with a special work organ which structure has not been well analyzed yet. The article studies the geometric characteristics of this work organ.
KEY WORDS:
cutting of the soil, soil-cutting work organ, geometric characteristics

1. INTRODUCTION

Cutting of the soil, according to P. D. Dimitrov (1994) [1], is a technological operation in which a cut that absorbs the surface water flow formed by the erosive rains is executed in a tilt as well as on the surface of the terrain in order to prevent erosion and retain the moisture of the land. In the procedure of the cutting the force impact on the land and the corresponding reactions are considerable [2, 3].

For analyzing that procedure and also for measuring the specific operating work machines, a theoretical analysis of the geometric characteristics of the cutting work organ have been described in the article.

2. EXPOSITION

As a result of a longstanding research of the cutting anti-erosive soil-cultivating procedure [1,4], the technological parameters of the process have been defined; that are the depth, width, direction and space of the cuts.

The width-parameter of the cutting work organ, its cross-section and its position towards the horizon specify its construction. This work organ can be described as a body whose cross-section is a pointed triangle along its whole length. For determining the relations between all elements a simplified version with the same cross-section and position towards the horizon, have been analyzed in this article.

Taking into account the construction mode, as well as the respective changes of the resistance of the work organ an interesting relation between the changes of the top angle and the cross-section according to the position towards the horizon can be outlined. Figure 1 shows two versions of the position of the cutting work organ, one drawn vertically (1a), and the other drawn at a slant (1b), whereas in both cases the parameters of the width and the respective cross-section remain the same.

The correlation between the parameters in the vertical position can be described with the following equation:

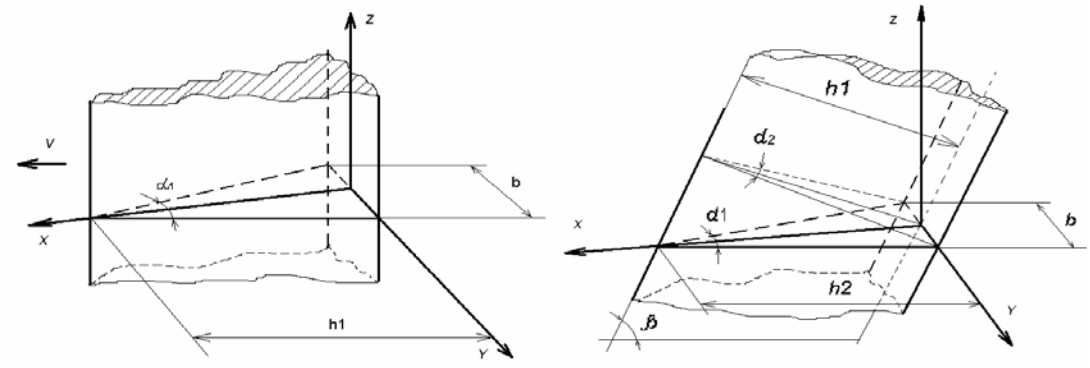
$$\frac{b}{2} = h_1 tg\frac{\alpha_1}{2}; \qquad (1)$$

Where:

b - is the width;

h_1 - the height of the cross-section;

α_1 - an angle at the top of the cross-section



a) b)

Figure 1. A cutting work organ is drawn:
a) in a vertical position; b) at a slant

In the slanted position the following equation is used:

$$\frac{b}{2} = h_2 tg\frac{\alpha_2}{2}, \tag{2}$$

Where: h_2 и α_2 are respectively the height and the angle at the top of the cross-section in the direction of the movement.

Following the relation:

$$\frac{h_1}{h_2} = \sin\beta, \tag{3}$$

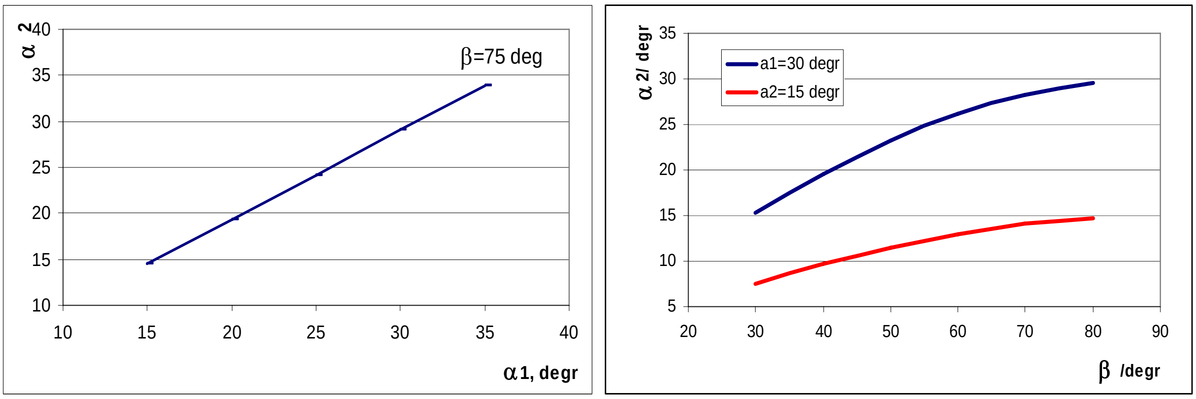
where β is the angle of the position of the work organ and after some calculations have been done the following equation is achieved:

$$h_1 tg\frac{\alpha_1}{2} = \frac{h_1}{\sin\beta} tg\frac{\alpha_2}{2}. \tag{4}$$

The next equation shows the correlation among the angles α_1, α_2 and β :

$$\alpha_2 = 2arctg\left(\sin\beta . tg\frac{\alpha_1}{2}\right) \tag{5}$$

The result in (5) can be described with the following graphs (fig.2 a, b).



a) b)

Fig. 2.A graphic dependence of the top angles α_1, α_2 on the slanted angle β

a) dependence of the top angles α_1 и α_2 at a constant value of the slanted angle β = 75°;

b) at a slanted top angle α_2 = 30° and 15°.

Choosing a desired value of the cross-sectional angle of the work organ α_1, the change of the slanted angle of the cutting work organ leads to a decrease of the angle of the direction of movement α_2 with the decrease in the slanted position of the work organ towards the horizon. This means that at a comparatively high value of the top angle α_1 (the aim of which is to lessen wear of the cutting edge), and an increase in the slanted position of the work organ towards the horizon, a relatively lower value of the angle α_2 has been realized. This result, in its turn, indicates a less extent of resistance of movement in the soil, because it is reasonable to suggest that with the movement of the cutting work organ in the soil, the efforts will be directed primarily in the horizontal way.

Studying the best characteristics of the cutting work organ from the position of its strength, construction and technology, it is suitable to have a work organ with a cross-section a combination of a triangle at the top and a form of a rectangle afterwards. (fig.3). It is desirable to determine the relation between the surface of the cross-section and respectively the angle of the slant of the work organ towards the horizon (angle β).

Keeping the values of the width and cross-section constant, the following results illustrating the surfaces of the cross-section at a vertical position of the cutting work organ have been achieved:

$$S_1 = \frac{1}{2}bh_1 + b.h_1^{/}, \tag{6}$$

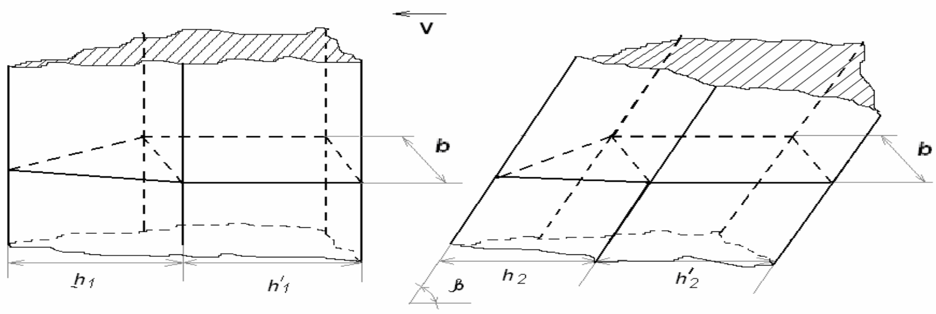
Where:

S_1 is the surface of the cross-section of the cutting work organ in a vertical position;

b - width of an acting work organ;

h_1 - height of the cross-section of the triangle of the cutting work organ in a vertical position;

$h_1^{/}$ - height of the cross-section of the rectangle of the cutting work organ in a vertical position



a) b)

Fig.3. A diagram of the cross-section of an acting work organ
a) in a vertical position; b) at a slant towards the horizon

When the cutting work organ is at a slanted position, the surface of its cross-section can be calculated by the following equation:

$$S_2 = \frac{1}{2}bh_1 + b.h_2^{/}, \tag{7}$$

Where:

S_2 is the surface of the cross-section of a slanted work organ;

b - the width of the work organ;

h_1 - the height of the cross-section of the triangle profile of a slanted work organ;

$h_2^{/}$ - the height of the cross-section of the rectangular profile of a slanted work organ;

Taking into consideration the fact that

$$h_1^I = \frac{h_1}{\sin\beta}, \quad h_2^I = \frac{h_2}{\sin\beta}, \tag{8}$$

The equation of the surface of the cross-section of a slanted work organ S_2 will be:

$$S_2 = \frac{b_1}{\sin\beta}\left(\frac{h_1}{2} + h_2^I\right), \tag{9}$$

The result has been illustrated by the following graph:

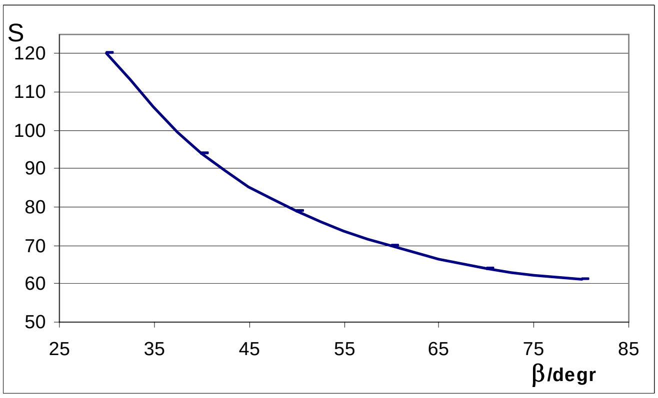


Fig. 4. A graphic dependence between the cross-section of the direction of the movement and the slanted angle β of the position of the work organ towards the horizon.

Analyzing the results on fig.4 we can see that at a constant cross-section and a top angle α_1, the surface of the cross-section along the direction of movement S_2 increases with the decrease of the slant of the cutting work organ towards the horizon.

3. CONCLUSIONS

As a result of the theoretical analyses of the geometric characteristics of a cutting work organ the following conclusions have been reached:

- At a constant cross-section of a cutting work organ with the decrease of the slant towards the horizon the top angle along the direction of movement also decreases, a result which is acceptable as far as the resistance of the soil during the working process and the wear of the cutting edge are concerned.
- The moment of resistance of the stem of the cutting work organ along the direction of movement increases progressively with the decrease of the slant angle towards the horizon, which is a satisfactory result as far as the construction of the cutting work organ is concerned.

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