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Determination of the traction resistance of a working body with an inclined rack

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ABSTRACT: The existing rippers used in agriculture do not provide high-quality loosening of the soil between rows of vineyards. A V -shaped volumetric ripper is proposed for strip loosening of the soil and intra-soil application of liquid fertilizers near the root system of the vineyard. The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study. Analytical dependences have been obtained to determine the traction resistance of a V-shaped volumetric ripper for strip loosening of soil and intra-soil application of liquid fertilizers near the roots of the vineyard. It is established that the traction resistance of a V-shaped volumetric ripper depends on the parameters of the ripper and the physico-mechanical properties of the soil.

KEY WORDS: Soil, traction resistance, fertilizer, ripper, chisels, rack.

I.INTRODUCTION

In agricultural engineering, various types of working bodies are being developed for loosening the soil and intra-soil application of liquid fertilizers, which have significant design differences. A large number of rippers of various types are known, existing in the form of experimental models and design developments. The most widespread design is in which the working body of the unit for the intra-soil application of liquid ameliorants has a feeding tube installed along the rear rack of a pointed or loosening paw, through which the liquid flows directly into the cavity formed between the working body and the soil layer.

The purpose of this work is to determine the traction resistance of a V-shaped volumetric ripper tool for strip loosening of soil and intra-soil application of liquid fertilizers near the roots of the vineyard.

II. SIGNIFICANCE OF THE SYSTEM

The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. LITERATURE SURVEY

As a result of the analysis of scientific research, a number of different designs of volumetric rippers have been identified [1]. Volumetric rippers have common elements - a ploughshare, side racks, and a frame. The differences are in the geometric parameters of these elements [2-5]. Despite the fact that bulk rippers have a simple design and low cost of manufacture, most of these technical solutions are not implemented in the form of industrial designs. It is known from literary sources that the V-shaped working body with side racks was produced in various versions and tested in the field [6]. The body of the V -shaped ripper has a small grip width, when installing two or three housings, the weight increases and the energy consumption of the machine increases [7-12].

The working body with U-shaped side posts connected by welding in the lower part with a ploughshare also has a simple design, but, as experimental studies have shown, the energy consumption of the loosening process is quite high. During

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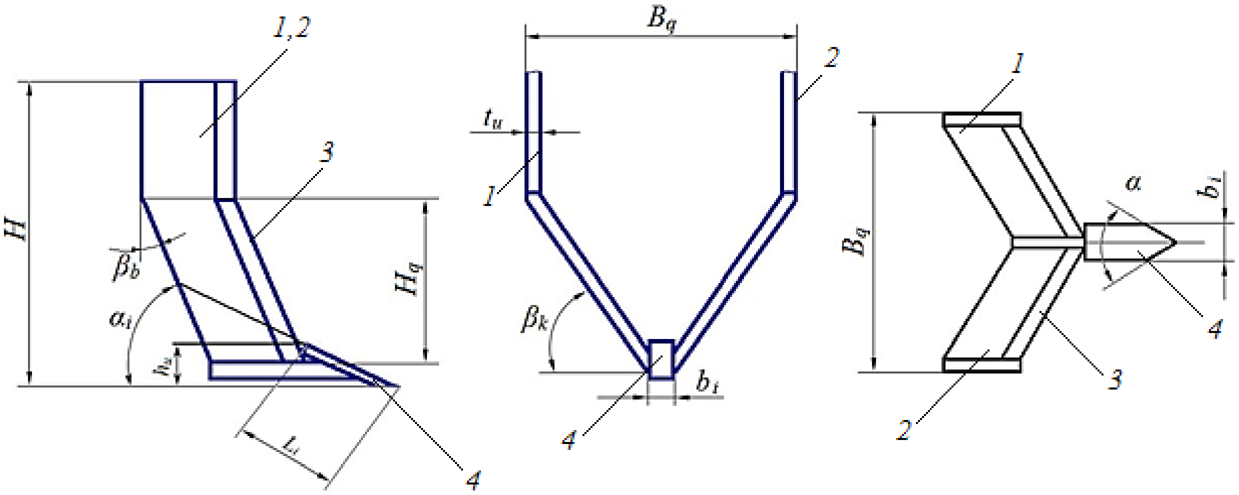
its operation, the soil is compacted in the middle part [13]. It is also known that the working body of the ripper also has two V-shaped straight-line knife racks inclined relative to each other, the difference of this working body lies in the fact that the racks are connected at the bottom by a V-shaped ploughshare with an upward-pointing top.

IV. METHODOLOGY

In the studies applied methods of theoretical mechanics and agricultural mechanics. The authors proposed a V - shaped volumetric ripper for strip loosening of the soil and intra-soil application of liquid fertilizers near the root system of the vineyard. According to the feasibility of soil work organ constructions and work processes volumetric work organs into the soil are widely used in perspective. [14]. The proposal consists of elements on the floor of the softener, which soil novice processing: side posts 1, knife 2 and chizel 3 (Figure 1).



1 and 2 –left and right columns; 3 – knife; 4 – chizel
Fig 1. The main parameters of the weapon

V. EXPERIMENTAL RESULTS

The work in the form of a bracket consists of the resistance of the body to general traction of chizel 4, 3 left and right columns with blades 1, 2

$$R_x = R_{ix} + R_{chx} + R_{ux}, \tag{1}$$

in this R_{ix} – chisel drag resistance, kN;
R_{chx} and R_{ux}– the drag resistance of the left and right column, respectively, kN.

Since the resistance to dragging the left and right columns is equal to each other (1) the expression will have a view in the sheep

$$R_x = R_{ix} + 2R_{chx}. \tag{2}$$

The left and right columns work under closed cutting conditions. Working in the form of a skoba working under closed cutting conditions, we determine the resistance of the body's spark to traction by the formula in sheep [14]

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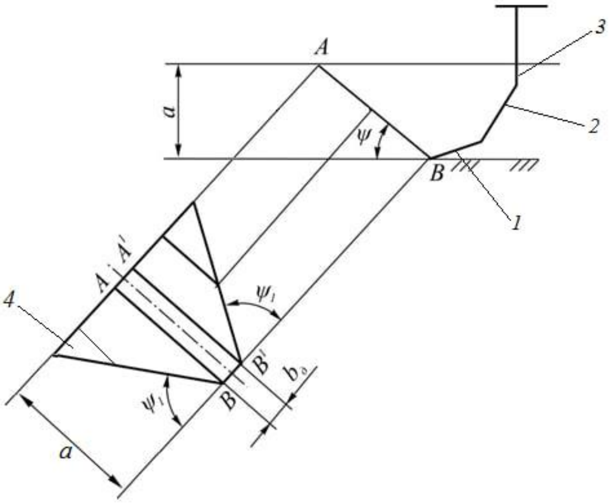
$$R_{ix} = \sigma_o \delta b_i + \frac{q b_i t_i^2 \sin(\alpha_i + i_i)\sin(\alpha_d + i_i + \varphi)}{2\sin^2 i_i cos\varphi} + \tau \frac{a}{\sin\psi_1} \times$$
$$\times (b_i + K\frac{actg\psi_2}{\sin\psi_1})[\cos\psi_1 + f\sin(\alpha_i + \psi_1)\cos\alpha_i] +$$
$$+ \gamma a[b_i V^2 \sin\alpha_i tg(\alpha_i + \varphi) + g l_i (b_i + actg\psi_2)(\frac{1}{2}\sin\alpha_i +$$
$$+ f\cos^2\alpha_i)](1 + \frac{W}{100}). \quad (3)$$

where σ_0 – is the comparative resistance to soil crushing with a scaffold beam, Pa;
δ – is the thickness of the cruciate ligament, m;
b_i – chisel width, m;
i_i – chisel sharpening angle, grad;
f – friction coefficient;
τ – is the pure displacement coefficient, Pa;
γ – soil density, g / cm^3;
W – soil moisture, %;
K – breaking the upper part of the layer deformed with K - chisel the coefficient to take into account.



1 – chizel; 2 – the oblique name of column; 3 – the steep part of column; 4 – the broken part of layer
Fig 2. Deformation of the soil under the influence of a gun bite

The general resistance of the column of the gun work organ consists in the sum of its oblique part $R_{ук}$ and the correct part of its resistance to pull $R_{ут}$, that is

$$R_{ux} = R_{ugx} + R_{utx}. \quad (4)$$

The resistance of the oblique part of the weapon to pull is equal to the sum of the pichoi knife, which is attached to it, and the forces acting on the side edge of the $R_{уп}$ and $R_{уё}$, which we define according to the expression in the sheep [14]

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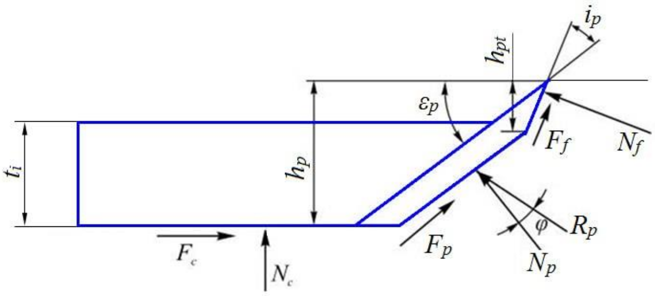

Fig 3. Scheme of forces acting on the weapon column Blade

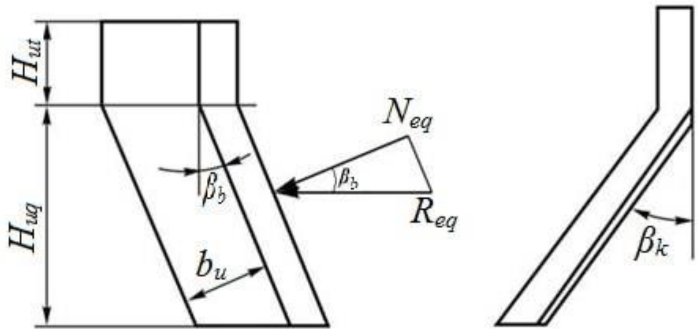

Fig 4. Parameters of the weapon column

$$R_{ugx} = \frac{\sigma_0 \delta H_{uk}}{\cos^2 \beta_б} + \frac{qH_{чк} t_n^2 \sin(\varepsilon_n + i_n)\sin(\varepsilon_н + i_n + \varphi)}{2\sin^2 i_n \cos\varphi} + \\ + p_n b_n H_н \sin(\varepsilon_н + \varphi)/\cos i_n \cos\varphi. \quad (5)$$

The tensile resistance of the upright part of the column consists of the sum of the resistances of its base, fascia and side edge, which we define by the expression on it

$$R_{cn} = \sigma_0 \delta H_n + p_c(2b_c - t_c ctg\beta_c)H_н tg\varphi + \frac{1}{2} q t_c^2 H_n(\sin\beta_c + tg\varphi\cos\beta_c). \quad (6)$$

Let's put the values of the $R_{ук}$ and $R_{ут}$ in terms of (5) and (6) expressions in terms of (7)

$$R_{chx} = \frac{\sigma_0 \delta H_{uq}}{\cos^2 \beta_b} + \frac{qH_{uq} t_u^2 \sin(\varepsilon_p + i_u)\sin(\varepsilon_p + i_u + \varphi)}{2\sin^2 i_u \cos\varphi} + \\ + p_p b_u H_{uq} \sin(\varepsilon_p + \varphi)/\cos i_u \cos\varphi + \sigma_0 \delta H_{ut} + p_s(2b_u - t_u ctg\beta_b)H_{ut} tg\varphi + \\ + \frac{1}{2} q t_u^2 H_{ut}(\sin i_u + tg\varphi\cos i_u). \quad (7)$$

Putting the values of R_{ux} and R_{chx} in terms of (3) and (7) expressions in terms of (2), we determine the tensile resistance of a recirculator operating in a closed shear sharite by the formula

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$$R_x = \sigma_o \delta b_i + \frac{q b_i t_i^2 \sin(\alpha_i + i_i)\sin(\alpha_i + i_i + \varphi)}{2\sin^2 i_i cos\varphi} + \tau \frac{a}{\sin\psi_1} \times$$
$$\times (b_i + K \frac{actg\psi_2}{\sin\psi_1})[\cos\psi_1 + f\sin(\alpha_i + \psi_1)\cos\alpha_i] +$$
$$+ \gamma a[b_i V^2 \sin\alpha_i tg(\alpha_i + \varphi) + g l_i (b_i + actg\psi_2)(\frac{1}{2}\sin\alpha_i +$$
$$+ f\cos^2\alpha_i)](1 + \frac{W}{100}) + 2[\frac{\sigma_0 \delta H_{uq}}{\cos^2\beta_b} + \frac{q H_{uq} t_u^2 \sin(\varepsilon_p + i_u)\sin(\varepsilon_p + i_u + \varphi)}{2\sin^2 i_u \cos\varphi} + \quad (8)$$
$$+ p_p b_i H_{uq} \sin(\varepsilon_p + \varphi)/\cos i_u \cos\varphi + \sigma_0 \delta H_{ut} + p_s (2b_u - t_u ctg\beta_b) H_{ut} tg\varphi +$$
$$+ \frac{1}{2} q t_u^2 H_{ut} (\sin i_u + tg\varphi \cos i_u)].$$

As can be seen from the obtained expressions (8), the general tensile resistance of a working organ with a sloping handle depends on its structure, column, limestone and softener structural and technological parameters, speed of movement and and physical and mechanical properties of the soil.

IV. CONCLUSION

Analytical dependences have been obtained to determine the traction resistance of a V-shaped volumetric ripper for strip loosening of soil and intra-soil application of liquid fertilizers near the roots of the vineyard.

It is established that the traction resistance of a V-shaped volumetric ripper depends on the parameters of the ripper and the physico-mechanical properties of the soil.

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