DETERMINATION OF THE TRACTION RESISTANCE OF THE HOUSING OF A MODULAR PLOW

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Annotation.
The article presents the results of studies to determine the traction resistance of the modular plow body, taking into account the width and depth of plowing at a unit speed of 6-8 km/h. According to the results, the traction resistance of the modular plow body should be in the range of 9.69-10.41 kN.

Key words. soil, soil layer, plow, body, traction resistance, plowshare, blade, field board, support wheel, speed.
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Introduction.

In the conditions of our republic, the most common method of basic tillage is plowing, ie tillage. Its main function is to bring the top layer of soil down and the bottom layer up. This includes weed residues, their roots and seeds, pests and pathogens, as well as mineral and local fertilizers applied before plowing. Also, the cultivated soil is deformed, crushed and crushed. As a result, weeds, diseases and pests are reduced in the field, mineral and local fertilizers are well mixed into the soil, and the soil is softened, creating favorable conditions for plant growth and development.

In addition to two-tier plugs, modular plugs for general work are widely used in our country. However, these plows are imported from abroad and do not fully meet the requirements for tillage in the Republic. In addition, their prices are high, which leads to an increase in the cost of agricultural crops. Therefore, the development of modular plows for general work for high-powered wheeled tractors, widely used in the Republic, is a topical issue.

The traction resistance of the plug body used consists of its lemexi, overturner, and field board resistances;

$$R \ = R \ + R_o + R_n \ , \qquad (1)$$

$R_к$— the overall tensile strength of the housing;
$R_л$— gravity resistance of the body lemex;
R_o— body gravity resistance to overturning;
$R_п$— the tensile resistance of the body field board.

The gravitational resistance of Lemex as a three-sided bevel can generally be determined by the following expression.

$$R = R_1 + R_2 + R_3 + R_4, \quad (2)$$

R_1— resistance of the soil to the penetration of the lemex blade;

R_2— resistance of soil to deformation (shear);

R_3— resistance associated with the sliding and lifting of the soil slab along the lemex;

R_4 — resistance associated with the inertia of the ground plate.

The resistance of a Lemex blade to soil penetration depends on its shape, thickness, length, and soil hardness. It can be determined by the following formula.

$$R_1 = \quad _1 \quad b \,, \quad (3)$$

K_1— coefficient taking into account the shape of the lemex blade (K1 = 1 for a straight-line blade);

T — the hardness of the soil;

$t_л$, $b_л$ — the thickness and length of the lemex blade accordingly.

$$b \;= b \;/ \sin\beta$$

For a straight line blade. With this in mind, expression (3) has the following appearance

$$R_1 = \quad b \;/ \sin\beta \;. \quad (4)$$

The resistance associated with the deformation of the soil slab is determined by projecting the shear resistance of the slab and the frictional force generated by this force in the direction of movement of the aggregate.

$$R_2 = S\left[\cos\psi + f\sin(a \;+\psi)\cos a \;\right]\sin\beta \;, \quad (5)$$

S — the shear strength of the slab;

— the angle between the plane of disintegration and the directions of motion;

f— coefficient of friction of soil to metal.

Given that $S=TF$(T— where is the specific resistance of the soil to displacement; F is the surface area on which the soil is displaced), we write (5) in the following form

$$R_2 = \tau F\left[\cos\psi + f\sin(a \;+\psi)\cos a \;\right]\sin\beta \;. \quad (6)$$

From the diagram shown in Figure 1, taking into account that the plane of displacement extends to the surface of the wall of the slope and is $\delta = \frac{\pi}{2} - \beta$ we obtain;

$$F = b^2 / \left(\sin 2\beta \;\cdot \cos\psi \;\right). \quad (7)$$

$\psi \;= \frac{\pi}{2} - \frac{1}{2}(a + \varphi_1 + \varphi_2)$ Given that and putting the value of F on (7.) to (6.) we obtain the following;

$$R_2 = \gamma b^2\left[\sin\frac{1}{2}(a \ \ +\varphi_1+\varphi_2)+f\cos\frac{1}{2}(a \ \ -\varphi_1-\varphi_2)\cdot\cos a \ \ \right]\times$$

$$\times\frac{1}{2\cos\beta \ \ \sin\frac{1}{2}(a \ \ +\varphi_1+\varphi_2)}. \quad (8)$$

j_1, j_2 — the internal and external friction angles of the soil, respectively.

We determine the resistance associated with the lifting and sliding of the soil slab along the lemex according to the following formula.

$$R_3 = \rho gab \ \ \frac{\cos^2 a \ \ \sin(a+\varphi_1)}{\sin\beta \ \ \cos\varphi_1}, \quad (9)$$

C— the width of the lemex;

$\alpha=arctg(tg\alpha_\kappa\sin\beta_\kappa)$ (where the angle of the α_κ—plug body lemex is crushed (mounted on the bottom of the row)).

We determine the resistance generated by the inertial force of the ground plate according to the following formula.

$$R_4 = 2\rho ab \ V^2\frac{\sin a_1\sin\beta \ \ \sin(a_1+\varphi_1)}{\cos\varphi_1}, \quad (10)$$

V— the speed of movement of the drive unit.

Substituting the values of R_1, R_2, R_3andR_4into (2), we obtain:

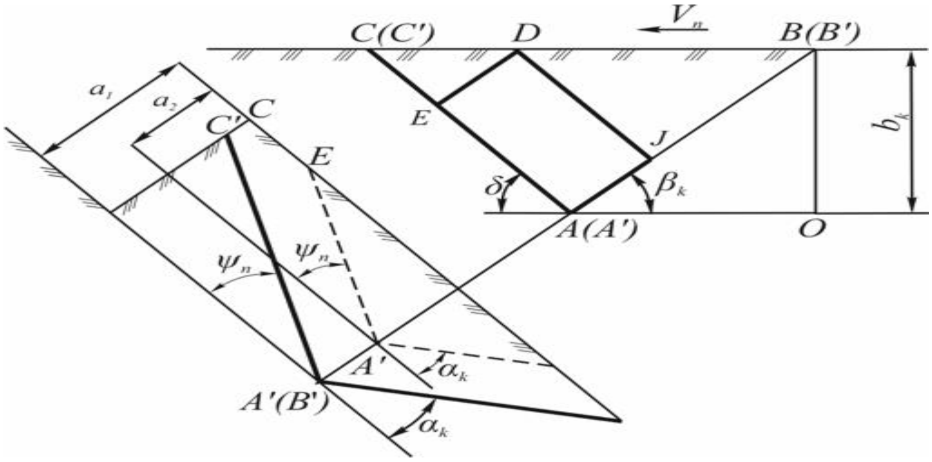

Figure 1 Scheme of the effect of the media on the soil slope

$$R = b\left\{ K_1 Tt \frac{1}{\sin\beta} + \right.$$

$$+ \tau b \cdot \left[\sin\frac{1}{2}(a + \varphi_1 + \varphi_2) + f\cos\frac{1}{2}(a - \varphi_1 - \varphi_2) \cdot \cos a \right] \times$$

$$\times \frac{1}{2\cos\beta \sin\frac{1}{2}(a + \varphi_1 + \varphi_2)} +$$

$$\left. + \rho a \frac{\sin(a_1 + \varphi_1)}{\cos\varphi_1}\left(cg\frac{\cos^2 a}{\sin\beta} + 2V^2 \sin a_1 \sin\beta \right) \right\}. \quad (11)$$

The inverter lemex performs the lateral rotation and sliding of the cut stalk. The resulting resistance can be determined by the following formula.

$$R_o = \varepsilon ab V^2, \quad (12)$$

where *e*is the coefficient depending on the shape of the working surface of the overturner and the physical and mechanical properties of the soil.

The tensile strength of the body field board can be determined by the following formula

$$R = F\cos\rho = fN_n \cos\rho \quad (13)$$

or, given the expressions (11) and (12), we obtain the following.

$$R = f\left\{ b\left\{ K_1 Tt \frac{1}{\sin\beta} + \right.\right.$$

$$+ \tau b \cdot \left[\sin\frac{1}{2}(a + \varphi_1 + \varphi_2) + f\cos\frac{1}{2}(a - \varphi_1 - \varphi_2) \cdot \cos a \right] \times$$

$$\times \frac{1}{2\cos\beta \sin\frac{1}{2}(a + \varphi_1 + \varphi_2)} +$$

$$+\rho a\frac{\sin(a_1+\varphi_1)}{\cos\varphi_1}\left(cg\frac{\cos^2 a}{\sin\beta}+2V^2\sin a_1\sin\beta\right)\Bigg\}+\varepsilon ab\,V^2\Bigg\}\times$$

$$\times\frac{\sin(\beta\pm a)\cos\rho}{\sqrt{1+f^2}\cos(\rho\pm a+\varphi_1)\cos\beta}\quad. \qquad (14)$$

From the expressions (11), (12) and (14) we obtain the following by substituting the values of $R_л$, $R_o$and$R_п$into (1), respectively.

$$R=b\Bigg\{\Bigg\{K_1Tt\frac{1}{\sin\beta}+$$

$$+\tau b\cdot\left[\sin\frac{1}{2}(a+\varphi_1+\varphi_2)+f\cos\frac{1}{2}(a-\varphi_1-\varphi_2)\cdot\cos a\right]\times$$

$$\times\frac{1}{2\cos\beta\ \sin\frac{1}{2}(a+\varphi_1+\varphi_2)}+$$

$$+\rho a\frac{\sin(a_1+\varphi_1)}{\cos\varphi_1}\left(cg\frac{\cos^2 a}{\sin\beta}+2V^2\sin a_1\sin\beta\right)\Bigg\}+\varepsilon ab\,V^2\Bigg\}\cdot$$

$$\cdot\left[1+\frac{\sin(\beta\pm a)\cos\rho}{\sqrt{1+f^2}\cos(\rho\pm a+\varphi_1)\cos\beta}\right]. \qquad (15)$$

According to this expression, the calculations performed when $b_к$=0,4 м, K_1=1,0,T=2×10^{6}Па,$t_л$=0,001м,$b_к$=40°,t= 35,0×10^3 Па, $a_к$= 30º, j_1= 30º, j_2= 40º,r=1400кг/м^3,a=0,35 м, c=0,14 м, f=0,5, e=1500 Н×с^2/м^{4}indicate that the pull resistance of the modular plug housing is 9,69-10,41 kН

This means that the total traction resistance of its housing should be in the range of 9.69-10.41 kН at a speed of 6-8 km / h in order to ensure high performance and quality with low energy consumption of the modular plug.

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