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BASIS OF THE PARAMETERS OF THE MODULAR PLUG WITH HIGH POWER WHEEL TRACTOR

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INTRODUCTION

Research work is being carried out in the country aimed at developing new scientific and technical bases of resource-saving technologies for the main cultivation of crops and technical means for their implementation. In this regard, it is important to develop quality plows with low energy consumption of arable lands and study their technological work process, to ensure resource efficiency in the process of interaction of working parts with the soil.

At present, in addition to two-tier plows, general-purpose plows 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. Based on this, a design scheme of a modular plow for general work for high-powered wheeled tractors, widely used in the Republic, was developed and research was conducted to substantiate its parameters. The main parameters of the developed modular plug are as follows (picture 1) *B*- the coverage width of the plug, $b_к$ -the coverage width of the case

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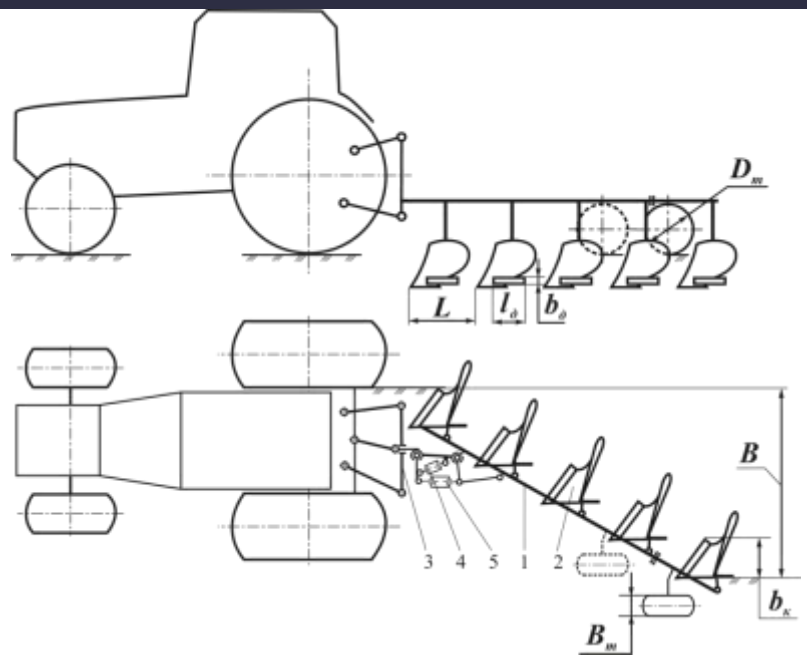

Picture 1. Design scheme and basic parameters of the modular plug aggregated with high-powered wheeled tractors.

$b_{ə}$-the height of the field board,

$l_{ə}$-the length of the field board,

L- longitudinal distance between housings

B_m-the width of the base wheel knot,

D_m-the diameter of the base wheel

The results of theoretical research conducted to substantiate the parameters of the modular plug developed in this article

Taken results. The modular plow and body coverage widths *B* and $b_к$, the building distance *L* between the housings, and the height $b_ə$ and length $l_ə$ of the field boards produced in this paper were developed and controlled

We determine the coverage width of the modular plug by the following expression [2]

n- tractor traction utilization factor;

$$B = \eta P / (\kappa a_{\max}), \quad (1)$$

P-rated traction power of the tractor;

k-relative resistance of soil to plowing; a_{max} - maximum processing depth.

At present, high-powered tractors of 4-5 classes with a nominal traction of 40-50 kN are used in our Republic. [3].

Given this, and n = 0.9; Assuming k = 65 kPa and amax = 35 cm, we determine that the coverage width of the plug must be 1.6-2.0 m in order to use them.

We determine the coverage width of the plug body. To do this, we look at it as a sloping (three-sided) pile, and consider how it interacts with an open ground pile on one side. Picture2 shows the scheme of exposure of the media to the soil silt. Here it is assumed that the decomposition of the soil occurs along the plane formed at an angle y_n to the horizontal [5].

Depending on the parameters of the plow (plug body) and the physical and mechanical properties of the soil, the cracking of the soil can be of two types:

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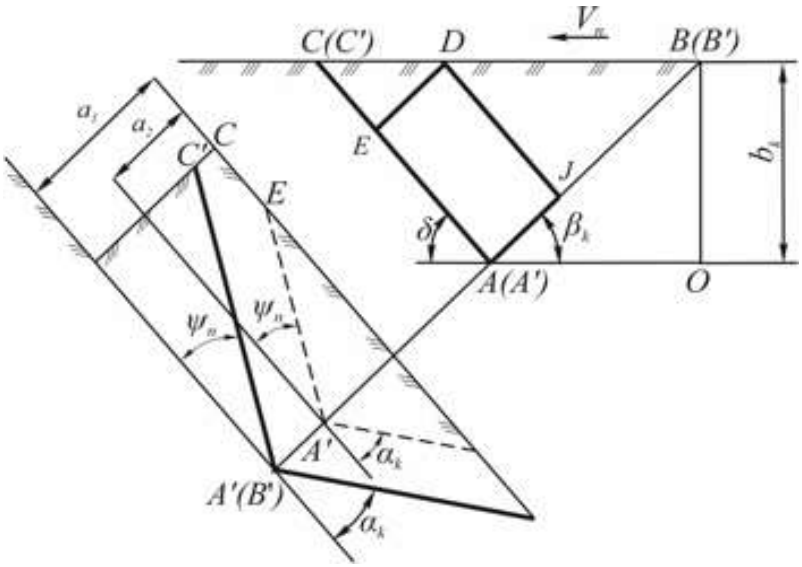
- The boundary line AC of the plane of disintegration of the ABC reaches the wall BC and rises to its surface;



Picture 2 Scheme of the impact of the media on the soil silt

- The AE boundary line of the ABDE fracture plane does not reach the egat wall BC and extends to the field surface.

The first case:

$$\frac{b_k}{a} \le \frac{\sin\delta}{\sin\psi_n} \quad (2)$$

Second:

$$\frac{b_k}{a} > \frac{\sin\delta}{\sin\psi_n} \quad (3)$$

where a is the driving depth; d - ABC (ABDE) is the angle between the projection of the boundary line AC (AE) in the horizontal plane and the
direction of movement of the plug.

decompose the expression in relation to b_k and $\psi_n = \frac{1}{2}[\pi - (\alpha_k + \varphi_1 + \varphi_2)]$ Considering and accepting the stain $\delta = \frac{\pi}{2} - \beta_k$ we obtain the following:

$$b_k \le \frac{a\cos\beta_k}{\cos\frac{1}{2}(\alpha_k + \varphi_1 + \varphi_2)} \quad , \quad (4)$$

b_k -the mounting angle of the body lemexi blade relative to the egat wall.
a_k -the mounting angle of the lemex relative to the bottom of the egat
j_1-the angle of friction of the soil with the metal
j_2-the angle of friction of the soil with the soil.

(4) The analysis of the expression shows that the width of the enclosure depends on the driving depth, the mounting angles of the lemex blade relative to the wall and bottom, and the friction angles of the soil to the ground and the lemex material when the enclosure interacts completely with the soil.

(4) To expression b_k, a_k, j_1, and j_2 known ($b_k = 40^o$, $a_k = 30^o$, $j_1 = 30^o$ and $j_2 = 40^o$) leaving the values, we get the following:

$$b_k \le 1{,}2a \quad (5)$$

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or assuming that a = 35 cm, we have the following:

$$b_k \le 42 \text{ см.}$$

From this result and the total coverage width of the plow found above, it is clear that the modular plug for general work with high-powered tractors available in the Republic has four to five housings, ie modular, and the cover width of each enclosure should be 40 cm.

We determine the longitudinal distance between the plow bodies on the condition that the plow to be machined does not change its size during the overturning process and that it does not reach the structural elements of the plow forward during the movement of the plow.

It is known that an unreasonable increase in the longitudinal distance between the bodies leads to an increase in the metal capacity of the plow and the torque that reverses the tractor in the transport mode of the unit. Therefore, when choosing this distance, one should try to keep it as low as possible.

From 3rd picture:

for the first kind of decomposition of the soil

$$L_1 \ge l_{nв} + l_{nд} + l_{д1} - l_л \quad (6)$$

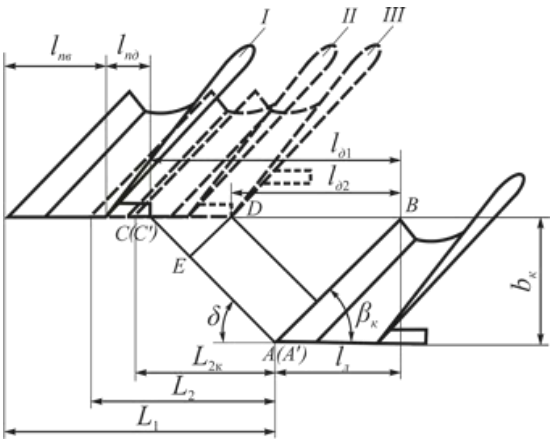
and for a second kind of decomposition of the soil

$$L_2 \ge l_{nв} + l_{nд} + l_{д2} - l_л \text{ ,} \quad (7)$$

$l_{nв}$ - the lemex-overturned surface of the hull protruding from the field section

$l_{nд}$ - the length of the part of the body field board protruding from the overturner

$l_{д1}$, $l_{д2}$ - longitudinal distances from the heel of the lemex to the point of exit from the lemex heel to the wall of the earthen wall, respectively, for the first and second cases, $l_л$ - lemex blade longitudinal axis projection.



Picture 3. Schematic for determining the longitudinal distance between the plug bodies.

From picture 3 we also have the following :

$$l_{д1} - l_л = b_к ctg\,\delta \text{ ;}$$

$$l_л = b_к ctg\,\beta_к$$

and:

$$l_{д2} = atg\,\frac{1}{2}(\alpha_к + \varphi_1 + \varphi_2)\sin(\beta_к + \delta)/\sin\beta_к \text{ .} \quad (8)$$

Given these expressions, and the expressions look as follows (6) and (7)

$$L_1 \ge l_{nв} + l_{nд} + b_к ctg\,\delta \quad (9)$$

and:

$$L_2 \ge l_{nв} + l_{nд} + b_к ctg\,\delta + atg\,\frac{1}{2}(\alpha_к + \varphi_1 + \varphi_2)\sin(\beta_к + \delta)/\sin\beta_к \text{ .} \quad (10)$$

Analysis of expressions (9) and (10) In the first case, an increase in the width of the body coverage increases the value of L1, while in the second case it decreases.

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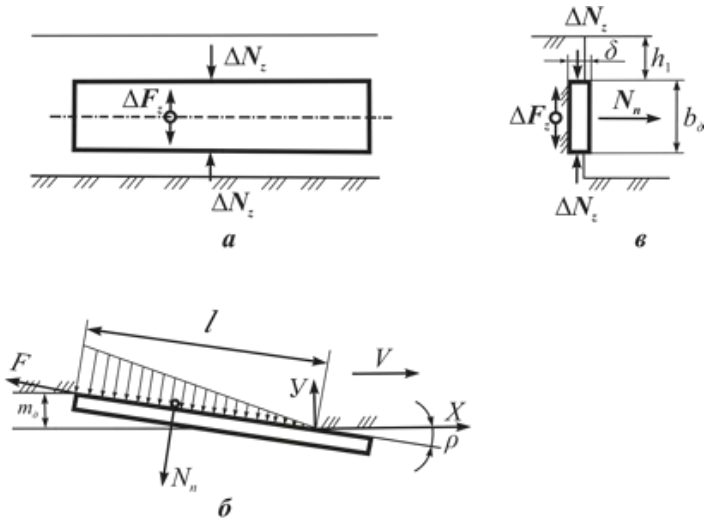
$l_{nв}$=35 см; $l_{nд}$=15 см; a=35 см; b_k=0,40 м; d=50°; a_k=30°; j_1=30°; j_2=40° and b_k=40° Calculations performed on expressions (9) and (10) showed that the longitudinal distance between the plug bodies for general work should not be less than 88 cm.

The field board is important in ensuring that the plow is balanced in the horizontal plane and therefore the drive unit moves in a straight line and that the plow's coverage width is uniform. During operation, the following forces are affected by the wall of the field board



(picture 4).

a) in the horizontal plane. N_n normal force and the resulting friction force F_n= fN_n(where f is the coefficient of friction of the soil on the field board)

a - in the longitudinal-vertical plane;

б is in the horizontal plane and; *в*- is in the transverse vertical plane

Picture 4. The forces acting on the field board by the Egat wall in vertical planes.

ΔF_z is the friction force and the normal Nz force formed by crushing the soil at the lower and upper edges of the field board. These forces occur only when the plug oscillates in a vertical plane and have a very small value relative to the other forces acting on the body and its field board. Therefore, they can be ignored in subsequent calculations. [2]

$$N_n = \frac{R_{xy}\sin(\beta \pm \alpha)}{\sqrt{1+f_д^{\,2}}\cos(\rho_1 \pm \alpha + \varphi_1)},$$

(11)

R_{xy}- an equal effect of the forces acting on the working surface of the plug body in the horizontal plane; b - aggregate movement speed R_{xy}- the angle between the direction of the force. α -the angle between the gravitational force of the plug and the direction of its movement. ρ_1–is the installation angle in the horizontal plane relative to the side wall of the field board.

If the gravitational force of the plug is tilted in the direction of the non-driven field relative to the direction of movement (11), the expression is preceded by a "+" sign, if it is tilted in the driven direction "-" 7].

$$R_{xy} = R_x / \cos\beta$$

(12)

And:

$$R_x = R_л + R_o$$

(13)

Given that the above expression (11) can be written as follows

$$N_n = \frac{(R_л + R_o)\sin(\beta \pm \alpha)}{\sqrt{1+f_д^{\,2}}\cos(\rho_1 \pm \alpha + \varphi_1)\cos\beta},$$

(14)

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Where $R_л$, R_o - the corrosion resistance of the body lemexi and the overturner, respectively.

в - Using the scheme shown in the figure, we express the force $N_п$ by the dimensions of the field board and the physical and mechanical properties of the soil.

$$N_n = \frac{1}{2} q_o mbl \,, \tag{15}$$

Where q_o - coefficient of volumetric compaction of soil; m is the depth of immersion of the field board in the arch wall; b-is the width of the field board;
l-is the length of the field board.

By aligning the right-hand sides of (14) and (15) and solving the resulting equation with respect to "m", we obtain: (16);

To ensure that the plow moves in a straight line in the horizontal plane and that

$$m = \frac{2(R_л + R_o)\sin(\beta \pm \alpha)}{qbl\sqrt{1+ f_д^{\,2}}\cos(\rho_1 \pm \alpha + \varphi_1)\cos\beta} \,. \tag{16}$$

its coverage width is uniform, the pressure on the field wall of the plow should not exceed the allowable pressure, i.e.

$$p < [p] \tag{17}$$

or:

$$p = mq = \frac{2(R_л + R_o)\sin(\beta \pm \alpha)}{bl\sqrt{1+ f_д^{\,2}}\cos(\rho_1 \pm \alpha + \varphi_1)\cos\beta} < [p] \,, \tag{18}$$

where p and $[p]$ - the actual and allowable pressure on the wall of the enclosure
(18) for a given working condition, i.e., when the values of q, f, and j_1 are known, is provided mainly by changing the length and width of the field board.

In most cases, the top of the egat wall is soft and therefore cannot withstand the pressure exerted by the field board. Therefore, the width of the field board

$$b \le \frac{2}{3} a \,. \tag{19}$$

should not exceed two-thirds of the driving depth [4], ie (19);

With this in mind, we find the length of the field board from expression

$$l = \frac{3(R_л + R_o)\cdot\sin(\beta \pm \alpha)}{a[p]\sqrt{1+ f_д^{\,2}}\cos(\rho_1 \pm \alpha + \varphi_1)\cos\beta} \,. \tag{20}$$

Considering the above, expression (20) has the following appearance

$$l \ge 3\Bigg\{\Bigg\{ K_1 T t_л \frac{1}{\sin\beta_к} + \pi b_к \Bigg[\sin\frac{1}{2}(\alpha_к + \varphi_1 + \varphi_2) + f\cos\frac{1}{2}(\alpha_к - \varphi_1 - \varphi_2)\cos\alpha_к \Bigg] \frac{1}{2\cos\beta_к \sin\frac{1}{2}(\alpha_к + \varphi_1 + \varphi_2)} + \rho a \frac{\sin(\alpha_1 + \varphi_1)}{\cos\varphi_1}\Bigg[cg\frac{\cos^2\alpha_к}{\sin\beta_к} + 2V^2\sin\alpha_1\cdot\sin\beta_к \Bigg]\Bigg\} + \varepsilon a V^2 \Bigg\} \times \frac{\sin(\beta \pm \alpha)}{a[p]\sqrt{1+ f_д^{\,2}}\cos(\rho_1 \pm \alpha + \varphi_1)\cos\beta} \,, \tag{21}$$

Where p - soil density; g - free fall acceleration; c - lemex working surface width; $a=arctg(tg\alpha_к \sin\beta_к)$

e - coefficient depending on the shape of the overturning working surface and the physical and mechanical properties of the soil (e=1500-2000 Нс^2/м^4); $f_д$ – coefficient of friction of the field board on the side wall; b - the angle between the speed and power of the plug; a - the angle between the force of gravity and the direction of motion.

Calculations from expressions (19) and (21) showed that the plow body with a coverage

width of 40 cm and a driving depth of 35 cm should not be less than 25 cm wide and 46 cm long.

Conclusion. Thus, according to the research, for high-quality plowing of aggregates with high-powered wheeled tractors, its coverage width is 1.6-2.0 m, body width 40 cm, longitudinal distance between bodies 88 cm and the width and length of the field board. should be 25 and 46 cm.

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