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Theoretical Substantiation Of The Parameters Of The Track Softening Flat Cutting Claw

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Annotation: The article describes the parameters of the flat cutting claw of a comprehensive break-smoothing track softener (flat cutting claw scanner and grinding sink angles of the blades, mounting relative to the direction of movement of the flat cutting blade blades and their opening angles, analytical expressions and the results of calculations performed on them, which allow to determine the rational values of the width of the flat-cutting jaw scan and the coverage width of the flat-cutting jaw).

Keywords: Gravel leveler, track softener, flat cutting claw, flat cutting claw scanner, flat cutting claw blades, flat cutting claw scanner and blades entry angles, the installation of the flat cutting claws relative to the direction of movement and their opening angles, the width of the flat cutting claw shank, the coverage width of the flat cutting claw.

Аннотация: В статье описаны параметры плоскорежущего захвата комплексного разглаживающего путеукладчика (сканер плоскорежущего захвата и углы заточки лопаток, установка относительно направления движения плоских режущих лезвий и углов их раскрытия, аналитические выражения и результаты выполненных по ним расчетов, которые позволяют определить рациональные значения ширины развертки плоскорезной челюсти и ширины охвата плоскорезной челюсти).

Ключевые слова: выравниватель гравия, смягчитель гусениц, плоскорежущие захваты, плоскорежущие захваты, плоскорежущие лапы, плоскорежущие лапы, сканер плоскорезов и углы входа ножей, установка плоскорежущих захватов относительно направления движения и углы их раскрытия, ширина хвостовика плоскорежущих захватов, ширина охвата плоскорежущих захватов.

Introduction

It is known that the main task in preparing the soil for planting is to level the surface of the fields, compact them to the required level and crush large lumps in it to form a fine soil layer [1]. At present, MV-6.0, MV-6.5 and other mowers are widely used in our country for this purpose [2, 3]. But because they are trailers, they are energy-intensive, inconvenient to use, have low maneuverability and work efficiency, and require a large turning area. In addition, when the existing molasses are used with drive tractors (aggregates), the traces created by their wheels on the field surface are not softened. This negatively affects the quality of sowing, germination of seeds, as well as plant development and crop yields.

Based on the above, the design and experimental version of a comprehensive suspension trowel equipped with trace softeners in the mechanization of agriculture was developed [4, 5], and research was conducted to substantiate its parameters.

This paper presents the results of a comprehensive theoretical study to substantiate the parameters of the flat cutting claw of the suspension trowel-smoothing trace softener.

The trail softener of the developed molass-leveler consists of a parallelogram mechanism 1, a rod 2, a flat cutting claw, levelers 7 mounted on its front transverse beam (Fig. 1). The flat cutting blade consists of a column 3 and a chisel 2 mounted on it, as well as 3 right and 4 left blades. During the operation of the trowel, the flat cutting blade softens the trail created by the tractor wheel to the specified depth, while the flatteners 7 flatten the surface of the area softened by the flat cutting blade. As a result, favorable and uniform conditions are created for high-quality sowing and harvesting of seeds throughout the field, uniform growth and maturation of plants, as well as high yields.

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Research method

The research was conducted using the theory of pona of agricultural mechanics and the fundamental laws and rules of theoretical mechanics and higher mathematics.

Results of the study

The following are the main parameters of the track softener flat cutting claw that affect its agrotechnical and energy performance.

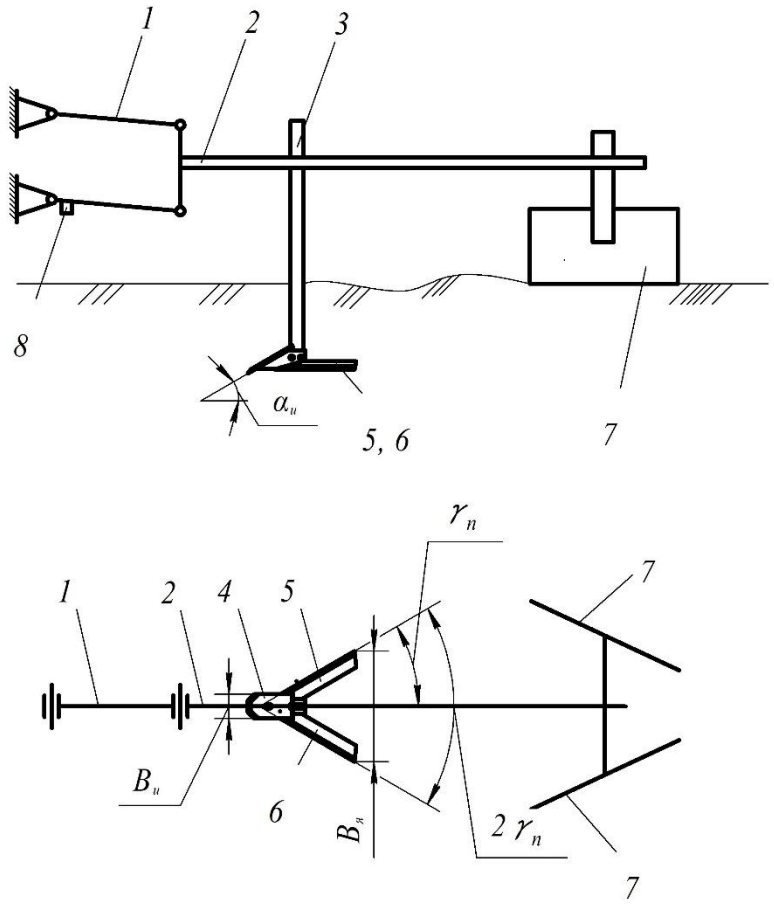

Figure 1. Schematic diagram of the device of the track softener

1 parallelogram mechanism; 2-barbell; 3-column; 4 flat cutting claw scan; 5, 6- right and left flat cutting blade blades, 7-straightener; 8 parallelogram pole.

α_u	-	the angle of crushing of the flat cutting blade, °;
B_u	-	the width of the flat cutting claw scan, m;
α_n	-	the grinding angle of the flat cutting blade blades, °;
γ_n	-	the mounting angle relative to the direction of movement of the flat cutting blade blades, °;
$2\gamma_n$	-	the opening angle of the flat cutting blade blades, °;
$B_я$	-	coverage width of flat cutting claw, m.

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We determine the grinding angles of flat cutting blades and blades by the following expression, provided that they provide high-quality grinding (grinding) of the soil with a low energy consumption [6]

$$\alpha_u = \alpha_n = \arcsin\left\{\left\{-\sin(\varphi_1+\varphi_2)+\sqrt{\sin^2(\varphi_1+\varphi_2)+\left[2+\frac{1}{2}\cos(\varphi_1+\varphi_2)\right]\left[1+\cos(\varphi_1+\varphi_2)\right]}\right\}:\right.$$
$$\left.:\left[2+\frac{1}{2}\cos(\varphi_1+\varphi_2)\right]\right\}, \qquad (1)$$

there φ_1, φ_2 - the friction angles of the soil to the metal (steel) and the soil to the ground, respectively, °;

φ_1=25-30° and φ_2=35-45° [7, 8] The angle of grinding of the flat-cutting blade and the blades for the fulfillment of the above-mentioned condition, as shown by the calculations made by the expression (2.1) 24°28′-31°11′ should be in the range of.

We determine the installation of the flat cutting blade relative to the direction of movement and their opening angles according to the following expressions**.** [9]

$$\gamma_n = 45° - 0{,}5\varphi_б \qquad (2) \text{ and } \qquad 2\gamma_n = 90° - \varphi_б, \qquad (3)$$

there $\varphi_б$ - the angle of friction of plant debris, weeds and their roots on the blades of flat-cutting claw blades, °.

When the conditions (2) and (3) are met, the blades of the flat-cutting blade blades ensure that the plant debris, weeds and their roots hanging on them slide freely and therefore work without clogging them.

$\varphi_б$=25-30° calculations performed on expressions [10], (2) and (3) γ_n corner 30-32°30′ range, $2\gamma_n$ while the corner 60-65° should be in the range.

Determine the width of the flat cutting blade using the following expression [12]

$$B_u \geq \frac{\left(m + ctg\alpha_u\right)H}{\left[0{,}1\frac{T_э}{k_c}\left(1+3tg\varepsilon\right)-k\right]}, \qquad (4)$$

there k, m - coefficients without units of measurement depending on the physical and mechanical properties of the soil;
H - depth of sinking of the flat cutting blade, m;
$T_э$ - specific resistance to soil compaction, Pa;
k_c - specific resistance to soil displacement, Pa;
ε - affecting the scanning of the flat cutting cla the angle of deflection of the impact force equal to the horizon of the soil reaction forces, °.

$\varepsilon = 90° - \left(\alpha_u + \varphi_1\right)$ given that [11], expression (4) has the following appearance

$$B_u \geq \frac{\left(m + ctg\alpha_u\right)H}{\left\{0{,}1\frac{T_э}{k_c}\left[1+3ctg\left(\alpha_u+\varphi_1\right)\right]-k\right\}}. \qquad (5)$$

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When this condition is met, no compacted wall is formed at the bottom of the treated layer, and complete and quality softening of the soil is ensured [12].

According to the data provided in the literature [13, 14, 15, 16] m=4,2; k=2,5; $T_э$=1,44·10^6 Pa; k_c=2·10^4 Pa; φ_1=30° and on the basis of research and data presented above H=0,2 m, α_u=30° accepted, and the calculations carried out under expression (5) showed that the width of the flat-cutting claw should be at least 6.91 cm.

We determine the coverage width of the flat cutting blade using the scheme shown in Figure 2, provided that the track formed by the tractor wheel is completely softened by it along its entire width. To do this, the following condition must be met

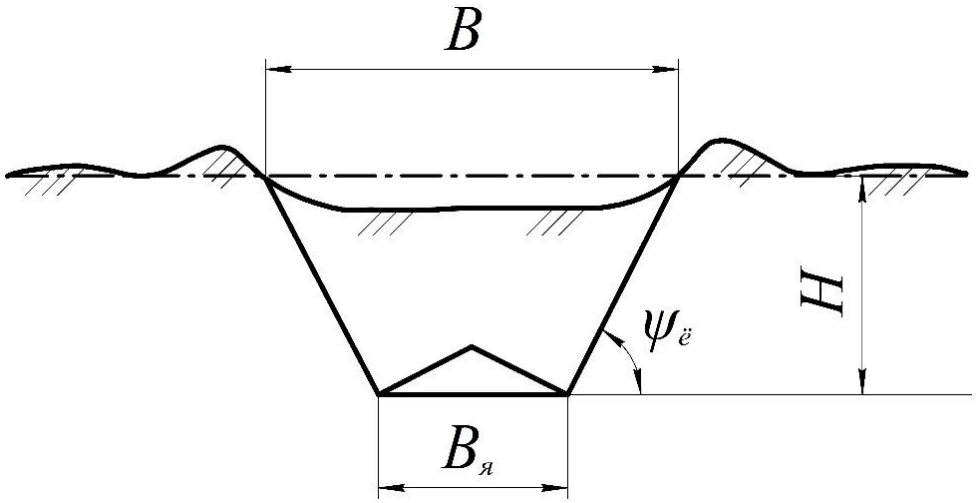

Figure 2. Scheme for substantiating the coverage width of a flat cutting blade

$$B_я + 2Hctg\psi_ë \geq B, \quad (6)$$

there $\psi_ë$ - the lateral fracture angle of the soil under the influence of a flat cutting claw, °;

B - the width of the trail formed by the tractor wheel, m.

(6) equation $B_я$ we have the following

$$B_я \geq B - 2Hctg\psi_ë. \quad (7)$$

In this expression $\psi_ë$ we find To do this, we consider the process of deformation of the soil under the influence of a knife located on the right side of the flat cutting blade (Fig. 3).

H When the right-hand blade of a flat-cutting blade moving at depth moves from position I to position II, the stresses in the soil reach a critical value, and it is relative to the soil horizon. $\psi_б$ placed at an angle $A_1'B_1'C'D'$ let it be displaced (broken) along the plane [12].

From the diagrams shown in Figure 3, we obtain the following:

$$tg\psi_ë = \frac{H}{B_1E}; \quad (8)$$

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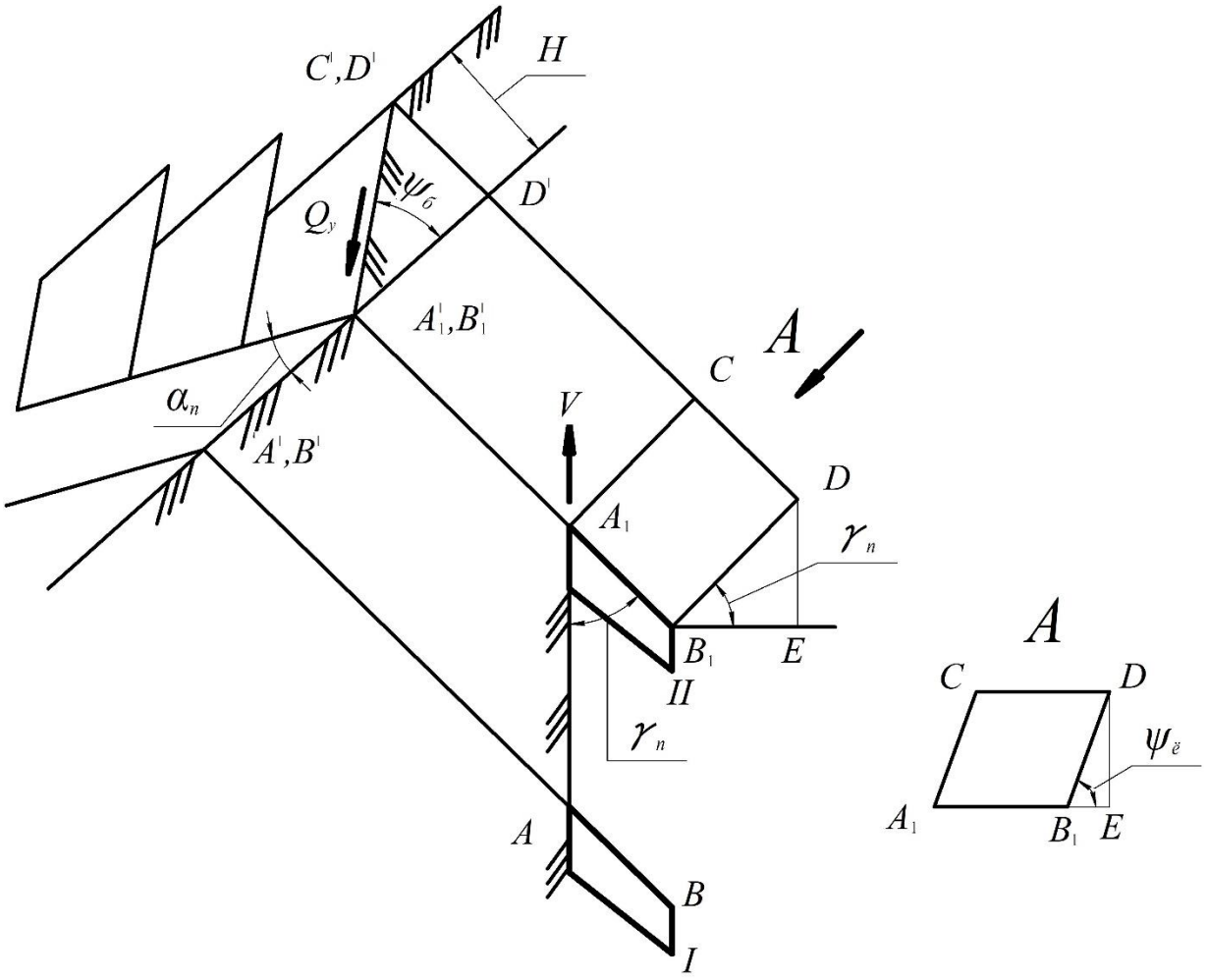

Figure 3. Scheme for determining the lateral fracture angle of the soil under the influence of a flat cutting blade

$$B_1E = B_1D\cos\gamma_n; \quad (9)$$

$$B_1D = Hctg\psi_б, \quad (10)$$

there $\psi_б$ - the angle of refraction of the soil in a direction perpendicular to the flat cutting claw blade, °;

(Considering the expressions 9) and (10), the expression (8) has the following form

$$tg\psi_ё = \frac{tg\psi_б}{\cos\gamma_n}. \quad (11)$$

$\psi_б = \frac{\pi}{2} - \frac{1}{2}(\alpha_n + \varphi_1 + \varphi_2)$ Given that [17, 18] (11), the expression has the following appearance

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$$tg\psi_{ё} = \frac{tg\left[\frac{\pi}{2} - \frac{1}{2}\left(\alpha_n + \varphi_1 + \varphi_2\right)\right]}{\cos\gamma_n} = \frac{ctg\frac{1}{2}\left(\alpha_n + \varphi_1 + \varphi_2\right)}{\cos\gamma_n}. \quad (12)$$

In this we have the following

$$\psi_{ё} = arctg\left[\frac{ctg\frac{1}{2}\left(\alpha_n + \varphi_1 + \varphi_2\right)}{\cos\gamma_n}\right]. \quad (13)$$

With this in mind, the expression (7) given to determine the coverage width of the flat cutting blade has the following final appearance

$$B_{я} \geq B - 2Hctg\left\{arctg\left[\frac{ctg\frac{1}{2}\left(\alpha_n + \varphi_1 + \varphi_2\right)}{\cos\gamma_n}\right]\right\}. \quad (14)$$

It can be seen from this expression that the total coverage width of the flat cutting blade depends on the width of the track formed by the tractor wheels, the physical and mechanical properties of the soil and the installation angle relative to the direction of movement of the blade blades.

Based on the results obtained above and, in the studies, conducted and the data presented B=0,7 m, H=0,2 m, α_n=30°, φ_1=30°, φ_2=40° ва γ_n=30° the calculations carried out on expression (14) showed that the coverage width of the track softener flat cutting claws should be at least 31.24 cm in order to completely soften the traces formed from the tractor wheels.

Conclusions

The flat cutting claw of the comprehensive molar-leveling track softener provides the required level of work with low energy consumption and the grinding angles of its blades and blades 24°28′-31°11′ in the range of 30-32 ° 30′ with respect to the direction of movement of the blades and their opening angles are in the range of 60-65 °, the width of the flat cutting blade should be at least 6.91 cm and the coverage width of the track smoothing flat cutting claws should be at least 31.24 cm.

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