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Justification Of The Angle Of Installation Of The Upper Edge Of The Dump To The Direction Of Movement And The Law Of Variation Of The Angles Of The Horizontal Generatrices Of The Dump To The Direction Of Movement

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ABSTRACT

The wing mounting angles are the angles of its installation to the bottom of the furrow ε_KP and to the direction of motion γ_{ED} in the plane touching the ploughshare-moldboard surface in the area of the upper edge of the wing. To reduce the traction resistance of the canal digger, when choosing the installation angles of the wing, one should proceed from the condition of reducing the angle of capture of the seam by the moldboard γ_{ED}. It is known from the theory of the share-moldboard surface that the angle γ_{ED} has a very significant effect on the traction resistance of the tool.

KEYWORDS

Canal digger, formation jamming, dump, intervals, variations, regression equations, two-dimensional sections.

INTRODUCTION

The work of the dumps of the canal digger is characterized mainly by the fact that they raise the cut layer to the day surface of the field and move towards the berm. In this case, in the depth of the excavation, there should be no seam jamming between the working body and

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the channel slope. This can be ensured if the lower part of the digging organ (share) is made in the form of a simple straight wedge, i.e.

$$\gamma_{\wedge}=90^{\circ}.$$

Behind the flat part, the value (γ_i) should decrease (decrease) to γ_{ED}.

Let us represent the law of variation of the angles of the horizontal generatrices of the canal digger dump by the following expression:

$$\gamma_i=\gamma_{\wedge}-(\gamma_{\wedge}-\gamma_{ED})\left(\frac{z_1}{h_{b.o-h_1}}\right)^{h},$$

(1)

where $\gamma_{\wedge}$ – is the angle of installation of the share to the direction of movement, degrees;

γ_{ED} – angle of installation of the upper edge of the blade to the direction of movement, deg;

z_1 –is the height of the corresponding horizontal generatrix, measured from the height h_1, m;

$h_{b.o}$ –depth of temporary sprinkler excavation, m;

h_1– is the height of the share in the vertical projection, m;

n– is an exponent.

MATERIALS AND METHODS

For research at the UzAMRI (Agricultural Mechanization Research Institute) experimental works, 4 pieces of the working body of the canal digger were made.

In the experiments, the angle γ_{ED} of the installation of the upper edge of the blade to the direction of movement was changed from 20 ° to 50 °. The experiment was carried out in a soil canal, in 3 replicates. Before and after the passage of the canal digger, the cross-section of a temporary sprinkler was measured using a known technique with a profilometer [8,9].

The rational values of the angle γ_{ED} of the installation of the upper edge of the blade to the direction of movement and the exponent n were determined using the methods of mathematical planning of the experiment

RESEARCH RESULTS AND THEIR ANALYSIS

In addition, the width of the dam base (L′) and its height ($\mathbf{h}_{\partial}$). were measured. The results of experiments carried out at a speed of movement ϑ_H=1, m / s, m / resistance, which corresponds according to the formula ϑ_M=0,9 m / s, are presented in (Fig-1).

Figure 1 shows that with an increase in the angle of installation of the upper edge of the dump to the direction of movement, the width of the dam base increases, and its height decreases.

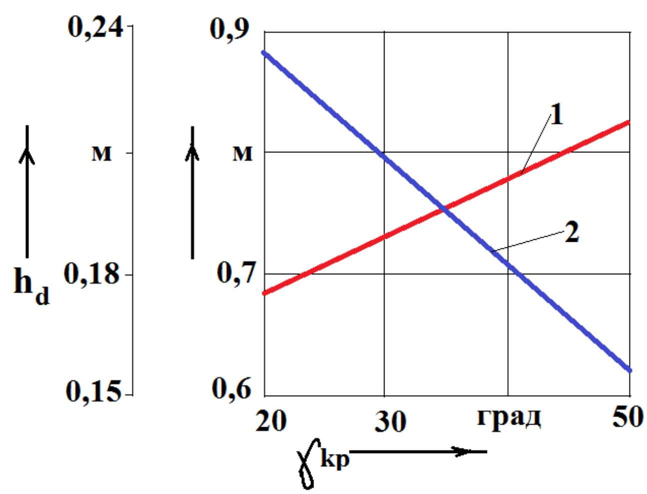

Figure 1. Dependence of the width L′ of the dam base and its height **h**∂ on the angle (γ_{ED}) of the installation of the upper edge of the dump to the direction of movement:

1- $L'=f(\gamma_{ED})$; 2- $h_\partial = f(\gamma_{ED})$;

This is explained by the fact that an increase in (γ_{ED}) causes a significant increase in the absolute speed of movement of soil particles and the speed of their descent from the dump.

To ensure higher and more stable dams of a temporary sprinkler, taking into account the results of laboratory studies, as well as in order to reduce the metal consumption of the canal digger, the angle γ_{ED} of the upper edge of the dump to the direction of movement can be selected for further research within 30 ... 50 °.

The rational values of the angle γ_{ED} of the installation of the upper edge of the blade to the direction of movement and the exponent n were determined using the methods of mathematical planning of the experiment. The angle γ_{ED} of the installation of the upper edge of the blade to the direction of movement varied 30 ... 50 °, the exponent was from 0.5 to 1.5 [12]. The principle of physical modeling was used for the experiment. Models of dumps with different horizontal generators in the amount of 9 pieces were made according to the patterns shown in Fig. 2.

For strain gauging of the models of the working body of the canal digger, an L-shaped strain protector with glued sensors was used to measure the longitudinal R_l and vertical R_v components of the soil resistance forces.

The levels of factors and the intervals of their variation, which are given in table -1, are selected based on the analysis of literature data.

The experiments were carried out in triplicate with appropriate randomization. The evaluation criterion was the total traction resistance of the working body of the canal digger and the width of the occupied strip of the temporary sprinkler being cut.

Table - 1.

Factor levels and variation intervals

The main factors	Designation code	Variation intervals	Levels		
			Bottom (-)	Plain (0)	top (+)
The angle of installation of the upper edge of the blade to the direction of travel γ_{ED} , degree.	x_1	10	30	40	50
Exponent, **n**	x_2	0,5	0,5	1	1,5
Movement speed $\vartheta_{м}$, m/s	x_3	0,3	0,6	0,9	1,2

The results of the experiments were processed on a computer in the experimental planning laboratory of the UzAMRI.

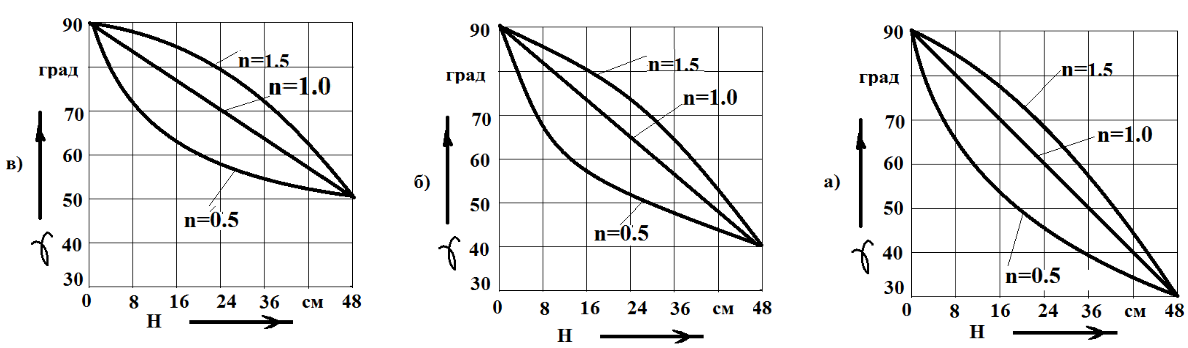

Fig.2. Regularities of changing the angles of the horizontal generatrices of the experimental dumps of the working body of the canal digger ***при γ_{ED}=30°; б) при γ_{ED}=40°; в) при γ_{ED}=50°; H- is the height of the body.***

To test the hypothesis of a priori variances of the experiments, the Student's t test was used at a significance level q = 0.05.

After processing the experimental results and assessing the significance of the coefficients, the following regression equations were obtained, which adequately describe:

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- traction resistance of the working body of the canal digger:

y_R=387,65 + 33,68x_1 + 21,44x_2 + 66,72x_3 + 93,62x_1^2 - 27,23 x_1x_2 –

-59,09x_2^2 - 45,56 x_2 x_3, H (2)

- the width of the occupied strip of the temporary sprinkler:

y_{B_2}=0,61+0,03x_1+0,015x_2+0,07x_3+0,072 x_2^1+0,016 x_1x_2-0,037 x_1x_3 +

+0,011x_2^2 + 0,011x_2x_3-0,012,x_3^2,m (3)

With the joint solution of the regression equations (2 and 3) at y_R→ min and 0,6≤ y_{B_2}≤ 0,7 m by the method of penalty functions, the optimal values of the factors were obtained.

For clarity, two-dimensional sections were built using a well-known technique. When considering the two-dimensional sections of the response surfaces constructed with respect to the factors X_1 and X_3, the factor X_3 was fixed X_2 = + 1,0 which corresponds to the optimal value according to Table 2.

As a result of calculations, the following equations were obtained:

y_R=350+6,45x_1+21,16x_3+93,62x_1^2 4)

Table 2

Optimal values of factors

Factors	Optimal values	
	coded	natural
x_1	-0,06	40°
x_2	+1,0	1,5
x_3	-0,43	0,75 m/s

y_{B_2}=0,64+0,046x_1 +0,081x_3+0,072x_1^2 −0,037 x_1x_3-0,012 x_3^2 (5)

Here equation (4) is nothing but the equation of a parabola. Differentiating equation (5) with respect to factors X_1 and X_3, we obtain the following system of equations:

$$\frac{\partial y}{\partial x_1} = 0{,}046 + 0{,}144x_1 - 0{,}037x_3$$
$$\frac{\partial y}{\partial x_2} = 0{,}08 - 0{,}037x_1 - 0{,}024x_3$$
(6)

Solving the system of equations (6), we find the coordinates of the center of the response surface, i.e. $X_1^{'}$=0,38 and $X_3^{'}$ =2,75 at which the width of the occupied strip of the temporary sprinkler is $y_{B_{2s}}$= 0,76.

Next, we determine the angles of rotation of the new coordinates relative to the old ones

$$tg2\propto = \frac{b_{ij}}{b_{ii-}b_{jj}} = \frac{-0{,}037}{0{,}072+0{,}012} = -0{,}4405; \qquad \propto = -12^{o}.$$

After calculating the coefficients, the regression equation (5) will be written in the canonical form:

$$y_{B_2} - 0{,}79 = 0{,}073x_1^2 - 0{,}011x_3^2 \qquad (7)$$

Substituting different values of the optimization criterion into equation (7), we obtain equations of the second degree in the standard form, with the help of which a system of contour curves of equal width of the occupied strip of a temporary sprinkler is constructed, which is a minimax system (Figure 3.8). Substituting into equation (4) different values of the factors X_1 and X_3, we construct a family of parabolas (Fig. 3.).

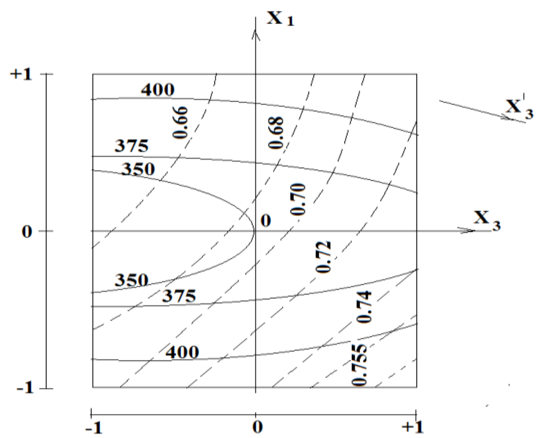

Figure - 3. Two-dimensional cross-section of the response surface, characterizing the traction resistance and the width of the occupied strip of the temporary sprinkler at X_2=+1,0

CONCLUSION

Analysis of two-dimensional sections (Fig. 3.) shows that with an increase or decrease in the values of the factor X_1 from its base value (X_1 = 0), the traction resistance of the working body of the canal digger increases.

With an increase in the value of the factor X_1 from 0 to +1.0, the width of the occupied strip of the temporary sprinkler decreases, and with a decrease in the value of the factor X_1 from 0 to -1.0, the width of the occupied strip of the temporary sprinkler increases.

With an increase in the value of the factor X_3 from -1.0 to +1.0, the traction resistance of the working body of the canal digger and the width of the occupied strip of the temporary sprinkler increase.

Jointly analyzing the response surfaces, taking into account that according to the initial requirements $B_2 \leq 0.7$ m, it can be noted that with a fixed value of X2 = +1.0, the most rational values of the factors under study are X_1 = -0.2 ... 0.1, X_3 = -0.5 ... -0.1.

With these values of the factors, the traction resistance of the working body of the canal digger is not more than 350 N, and the width of the occupied strip of the temporary sprinkler is not more than 0.70 m.

The values of the investigated factors are respectively equal: X_1 = 38 ... 410; X_2 = 1.5; X_3 = 1.29 ... 1.59 m / s.

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