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THEORETICAL STUDIES ON THE DESIGN OF TRENCHER WORK EQUIPMENT

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ABSTRACT

This article describes the research on the improvement of the temporary ditch digger device. In order to reduce the traction resistance of the ditch digger device and improve the quality of the trench, a straight disc is installed in front of the ditch digger device. During digging, the issue of resistance forces falling on the plough tooth of the working equipment was discussed.

Improvement of land reclamation conditions in our Republic today, Special attention is being paid to the development of the network of irrigation facilities, the wide introduction of intensive methods, first of all, modern techniques and technologies that save water and resources in the field of agricultural production.. In this regard, the use of modern water-saving technologies, maintenance of irrigation networks in constant technical condition, and the creation and application of energy-saving techniques and technologies to production are of great importance.

It is known that improving land reclamation, increasing crop productivity depends on self-irrigation. Irrigation networks are used to irrigate agricultural crops. Irrigation networks are divided into permanent and temporary networks according to the period of use Temporary irrigation networks are dug at the beginning of the irrigation season and leveled at the end of the irrigation season. Ditch digger-levellers are used to dig temporary networks.: they make the ditch 20 - 40 1/sec. from 100 - 200 1/sec. it is selected taking into account the ability to pass water up to.

Ditch diggers dig the soil, lifting excavated soil and placing it on the bank of the canal and in addition to pushing works, it is necessary to level and smooth its surface, as well as to ensure its slope. The analysis of these ditch diggers shows that, a lot of energy is required when digging ditches in hard areas, and the amount of large lumps increases in areas with low humidity and loss of geometric shape due to deformation of work equipment, in the process of digging a ditch, a large amount of energy is required to pull the work equipment, the size of the soil resistance.

In the process of creating temporary ditches, the lower part of the cutting organ should be flat, straight, and have a wedge like appearance. According to the scheme proposed by R.L. Tureski, it is necessary to raise the working equipment to a certain height h0 in order for the movement of the working equipment to move freely to the edge of the channel (ditch) (Fig. 1).

If the working device is considered as an object (body) that cannot be severely deformed, in this $AC_1 \le AB.$ its circulation may occur. It can be seen from the picture

$$AB = \frac{b}{2} + hctg\lambda \quad (1)$$

and

$$AC_1 = \sqrt{(AB)^2 + (BC_1)^2} = \sqrt{[(h-h_0)ctg\lambda + \frac{B}{2}]^2 + (h-h_0)^2} \quad (2)$$

(1) and (2) by equating the formulas and slopes into the pit $\lambda = 45^0$ at the angle of the slope h_0 calculated relatively, we get the following:

$$h_0 = h + \frac{b - \sqrt{(4h+b)^2 - 8h^2}}{4} \quad (3)$$

Relatively, the length of the plough is determined:

$$l = \frac{h_0}{\sin\alpha_\Lambda}$$

here α_Λ- angle of inclination of the ploughshare under the furrow (cutting angle).

The results of our research show that, such an optimal cutting angle in each type of soil There is a value of α_Λ, at which the traction resistance of the coulter has the smallest value ().Table 1

Table 1

The value of optimal installation angles of different trencher plough tooth

Types of soil	**Plough tooth installation angles, grad.**		**Explanation**
	Relative to the under the canal	**Relative to the canal wall**	
Peat	23………..26 25………..26 35………..40	90 90 90	W= 23………26 - h= 66………130
medium suglinok	33………..36	90	h≤60

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	25………..30	45	W= 19………20
Suglinok	37………..43	35………..40	h≤20
Quartz sand	35	90	W= 15………16
Mineral soil	20 32………..36 29………..32 28………..32 25 26………..30	90 90 90 90 90 90	- - - - - h≤50

It has a complex dependence on the physical and mechanical properties of the soil and the working conditions of the soil $P = f(\alpha_\Lambda)$ expression can be given. In the general case, the resistance of the wedge can be found:

$$P = P_1 + P_2 + P_3 \quad (4)$$

here P_1 – resistance of the soil when the blade of the plow is inserted into the soil;
P_2 - the force spent on plastic failure and deformation of the failure;
P_3 - the force used to shift (move) the plate (layer)..

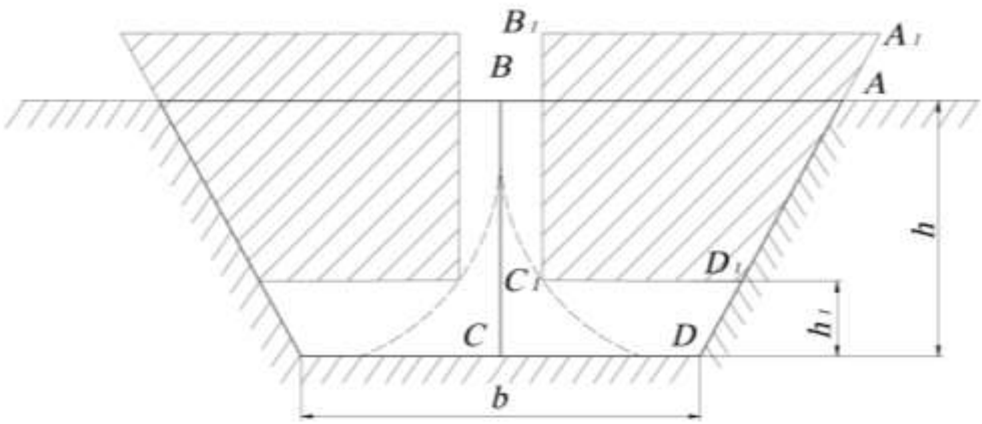


Fig. 1: plough blade height determination scheme

Currently, it is not possible to analytically determine the constituent values of this equality and hence the angle of cutting the total resistance of the trencher's blade from α_Λ dependence can only be established experimentally, and from it the cutting angle to $\alpha_{\Lambda onm}$ the optimal value is determined.
As a result of our research, it was found that the following considerations are useful when considering the operation scheme of the much simplified wedge.

We define the specific pressure of the soil on the working surface of the plow by q. Δl in length is equal to the normal (normative) pressure of the soil to the area of the pile.

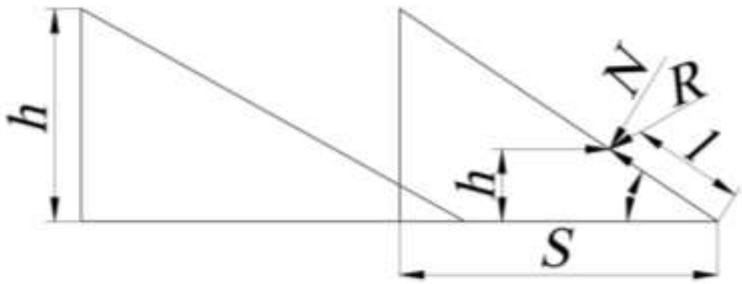
$$\Delta N = qb\frac{\Delta h}{\sin\alpha_\Lambda} \quad (5)$$

here *b* – the width of the wedge.
Projecting the vector of forces acting on the horizontal plane, we get the elemental resistance force of the beam.

$$\Delta P = \Delta N(\sin\alpha_\Lambda + f\cos\alpha_\Lambda) = qb\Delta h(1 + fctg\alpha_\Lambda) \quad (6)$$

ΔS which is spent on moving (moving) the object over a distance ΔP labor force, where soil particles move from point C to point M:

$$\Delta A = \Delta P\Delta S = qb(\Delta h)^2 \frac{\cos\varphi(1 + fctg\alpha_\Lambda)}{\sin\alpha_\Lambda \cdot \cos(\alpha_\Lambda + \varphi)} \quad (7)$$



2 – picture. Determining the tensile strength of a simple pone

In expression (7) (α_Λ) according to from $f(\alpha_\Lambda)$ setting one to an arbitrary zero and M.A.Tusyatskiy offered to $\alpha_{\Lambda onm}$ it is difficult to define as in graphic style, we present it in the following form:

$$-\cos(2\alpha_\Lambda + \varphi)tg(\alpha_\Lambda + \varphi) = \sin\varphi \quad (8)$$

to α_Λ (8) to set the plough blade after solving the expression $\alpha_{\Lambda onm}$ we get the value of the angle, in which the work will be minimal. Because of this equation using the graphic method to α_Λ analytical calculation is much more difficult. By giving different values for it $f(\alpha_\Lambda)$ we see the change graph. (8) in the five values of the friction angle for the left part of the expression $\varphi -$25,30,35,40 and 45 we express in degrees (3-picture). Equal values of the right intersection of the abscissa points of the resulting curve with the corresponding ordinates $\sin\varphi$ is the core of this equation.

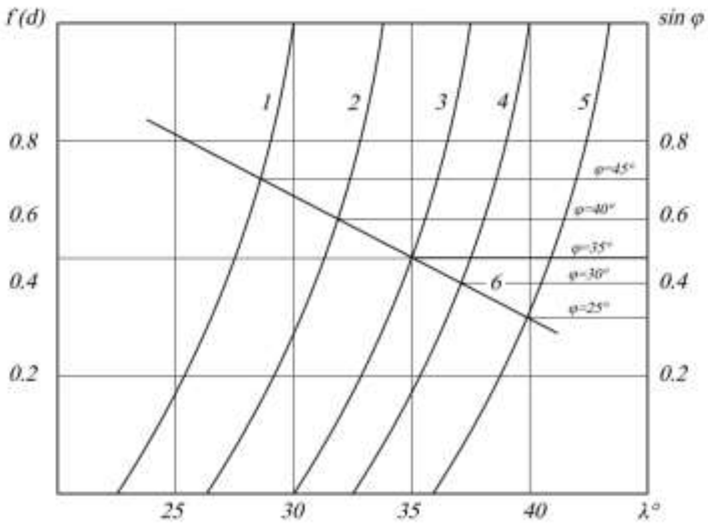


Figure 3. A graphical calculation of Eq

1 – $\varphi - 45^{\circ} da$; 2 – $\varphi - 40^{\circ} da$; 3 – $\varphi - 35^{\circ} da$; 4 – $\varphi - 30^{\circ} da$;

5 – $\varphi - 25^{\circ} da$;

It can be seen from the figure that these points lie on a straight line, which can be written using the empirical formula:

$$\alpha_{\Lambda_{opt}} = m - n\sin\varphi \qquad (9)$$

we determine the values of the coefficients by the method of least squares m and n:

$$\alpha_{\Lambda_{opt}} = \frac{\pi}{5}(1.5 - \sin\varphi) \qquad (10)$$

Using the obtained formula, knowing the angle of friction of steel, it is possible to calculate the optimal angle of installing the ploughshare under the furrow.

Guideline curvature When designing the surface of the plow shell (body) of the coulter, usually the intersecting curvature of the surface of the coulter with the vertical plane of the blade perpendicular to the coulter is accepted. For cultivated surfaces, this plane passes 2/3 of the length of the blade from the tip of the plow, and for half-screws it passes through the right end of the plow.

A circle (circle) or a parabola built on it is selected as a reference curve. For the last one, any protrusion can be selected, which allows to better adapt the surface of the wheel in different (various) working conditions.

The cutting line of the surface of the wheel located in the symmetrical plane of the working bodies is considered to be the most convenient guiding curvature for the channel diggers (Fig. 4). Also, the shape of the trencher shell casings, the shape of the surface of the trencher, which directs the surface of the trencher, affects the digging, resistance, and the quality of work.

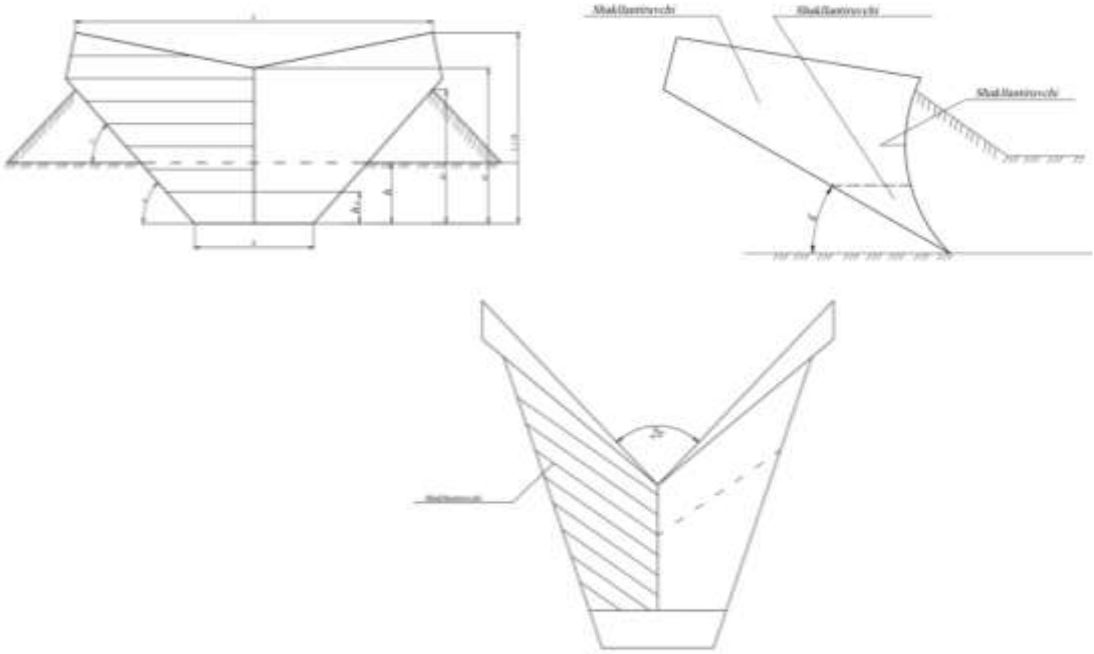


Figure 4. Diagram of the working body of the trencher

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In the right-angle coordinate system, we get the curve AB (Fig. 5) and its shape can be taken as a trace of it being pulled on the ground. In this curve, we divide the elements cross-section ds and put the forces acting on it. From the conditions of equality of forces:

$$\Sigma y = 0.$$

$$T_2 \sin(\omega + d\omega) - T_1 \sin\omega - dp = 0 \quad (11)$$

$$\Sigma x = 0.$$

$$T_2 \cos(\omega + d\omega) - T_1 \cos\omega = 0 \quad (12)$$

here: *dp* – *ds* compressive force applied to the soil in the section;

T_1, T_2 - the traction force at the corresponding points (power).

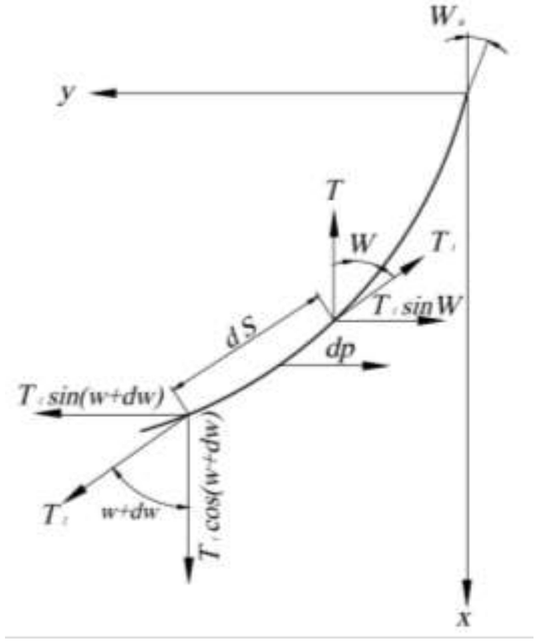

Figure 5. Determination of the shape of the curvature of the working device

It can be seen from the equation (12).

$$T_2 \cos(\omega + d\omega) = T_1 \cos\omega = T$$

from this

$$T_1 = \frac{T}{\cos\omega}$$

$$T_2 = \frac{T}{\cos(\omega + d\omega)}$$

here – T vertical projection of string tension.

T_1 and T_2 we put the values in equation (11).:

$$Ttg(\omega + d\omega) - Ttg\omega - dP = 0 \quad (13)$$

Because $tg\omega = \frac{dy}{dx}$ without taking into account the small values with appearance and higher order

$$tg(\omega + d\omega) \approx \frac{dy}{dx} + \frac{d^2 y}{dx^2} dx$$

while

$$dP = k \cdot \delta \cdot ds \cdot \cos\omega$$

here K= f(x) – specific pressure of the soil depending on the condition of the soil and the depth of the walk; δ - plot width

$$\cos\omega = \frac{dx}{ds}$$

After suitable modifications and reductions, expression (13) takes the following form:

$$\frac{d^2 y}{dx^2} = \frac{\delta}{T} f(x) \quad (14)$$

The above was determined through our experiments.

$$K = f(x) = Ax^3 + B \quad (15)$$

$$T = D(h - h_0) \quad (16)$$

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where A, B, D are empirical coefficients (15) and (16) depending on the speed of movement of the working bodies and the physical and mechanical properties of the soil, putting K = f (x) and T values in (14)

x=0 when *y=0* $\frac{dy}{dx} = tg\omega_h$, da *x=(h-h₀)* and when

$$\frac{dy}{dx} = tg\omega_o = tg(90^{\circ} - \alpha_{\Lambda}) = ctg\alpha_{\Lambda}$$

having the expressions , and after integration and the corresponding transformation, we obtain the final expression for the guide curvature:

$$y = \frac{\delta}{2D(h-h_0)}\{0.1Ax^5 + Bx^2 - [0.5A(h-h_0)^4 + 2B($$

(17)

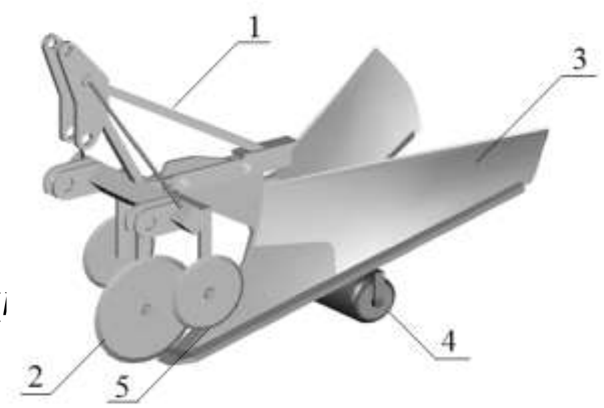
According to the formula (17), the directional curvature can be seen in the interval of equal depth of the temporary ditch. After that, it can be smoothly continued to other curves with the radius of the circle.

$$R = \frac{H-h}{\sin\alpha_h}$$

(18)

or you can build a ferry to it.

From the above research, it can be seen that in the formation of temporary ditches, a great force is exerted on the blade of the working equipment. As a result, it leads to the loss of the geometric shape of the working device, as well as the need for a lot of energy. Taking into account the above, in order to reduce the soil softening resistance, improve the quality of the soil fraction and slope, three straight discs were installed on the front part of the dumper (Fig. 6).



6 – picture. General view of an improved temporary ditch digger with discs.

1-frame, 2, 5-discs, 3-overturning, 4-densification equipment.

The energy-saving canal digger improved by our research and the discs recommended by us allows to reduce the fuel consumption by 12-15% and increase the productivity by 1.5 times compared to the existing device when digging a temporary ditch.

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