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Movement of the soil bar along the working surface of the double body

Ravshanov N.Q., Badalov S.M., Safarov A.A.

Doctoral candidate, Karshi State Technical University (KSTU), Karshi, Uzbekistan
Candidate of Technical Sciences, PhD, Karshi State Technical University (KSTU), Karshi, Uzbekistan
Doctoral candidate, Karshi State Technical University (KSTU), Karshi, Uzbekistan

ABSTRACT: For the successful implementation of rational technologies and means of mechanization of primary soil cultivation, it is of great importance to improve soil tillage machines and their working bodies. In order to reduce the resistance to soil traction and ensure the stability of its movement, it is important to design the shape of the working bodies of primary soil tillage machines based on operating conditions and soil properties. The trajectories of the soil blade along the furrow, the conditions determining the possibility of slipping on the surface of the soil mixture, can be determined both analytically and graphically. The movement of the blade along the furrow surface is expressed in the equation as follows. It is found that with a significant increase in the speed of the aggregate and an increase in the viscosity of the blade, its relative trajectory approaches the upper limit trajectory.

KEY WORDS: double-body soil, lime mortar, soil resistance, trajectory, layer, movement.

I. INTRODUCTION

Research work is being carried out all over the world to develop resource-saving technologies for primary tillage of land for planting agricultural crops and new scientific and technical solutions for the machines that implement them. V.P. Goryachkin., V.A. Zheligovsky., L.V. Gyachev., L.D. Turaev., V.I. Balovnev., V.M. Matsepuro., V.A. Sakun., J. P. Lobachevsky and other scientists have conducted research on the interaction of the working surface of general-purpose reversible plows with the soil and the trajectories of the soil blade along the furrow [1; 2; 3; 4; 5; 6; 7]. According to the results of analytical studies, there are no clear theoretical results on the interaction of the working surface of the double-hulled plow with the soil. The movement of the soil clod along the working surface of the double-hulled plowshare and the harrow has been studied the least. The movement of the harrow in a closed furrow has a number of technological features, in particular, a large amount of energy is required to separate and turn the soil clod. In this case, the layer is separated along the furrow edge due to intensive deformation of the soil and with the help of the side edges of the harrow. Therefore, it is of great importance to study the process of movement of the harrow along the surface of the plowshare and harrow in the framework of plowing work, both theoretically and practically.

II. SIGNIFICANCE OF THE SYSTEM

The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. LITERATURE SURVEY

The relative velocity of the incompressible layer remains constant in magnitude and its tangential acceleration is zero. In this case, the forces of resistance to motion are completely balanced by the forces of resistance to compression of the layer. [3; 7]. The differential equation of motion (relative to the inertial reference frame - the plug body) takes the form of the equation of relative equilibrium. [2]:

According to the theory of L.V. Gyachev, as the convergence of the particle increases ($Eab \dashrightarrow \infty$), its relative trajectory approaches the upper limit trajectory - the geodesic line of the surface [4].

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IV. METHODOLOGY

Considering the relative movement of the layer along the working surface of the double-body, we assume that the cut layer is divided into two equal parts, each of which acts on its own ram at an angle. In this case, the movement of each of the parts of the layer (when turning to the left or right) is free, that is, they do not exert pressure on each other along a straight line. This is absolutely legal, since when the trench is opened, the reaction from any part of the layer to the second part (in the plane of symmetry of the rams) acts only during the ramming. It is assumed that the soil forming the layer is not compacted and moves along the trajectory of the working surface of the ram. The dimensions of the layer are assumed to be known.

$$m = \frac{d^2S}{dt^2} = R - T = 0, \tag{1}$$

or

$$R = T; \qquad m = \frac{d^2S}{dt^2} = 0, \tag{2}$$

R- compressive strength of the layer;

T – force of resistance to an equally effective motion, for a part;

The forces of friction and gravity do not impart negative tangential acceleration to the parts, but are entirely spent on creating the static compressive force of the layer.

Thus, the previously accepted assumption is related to the relative velocity force of the layer, and all resistance forces act on the cross section of the layer [3; 4; 7].

V. EXPERIMENTAL RESULTS

We extract from the layer an element ABCD of the layer, which is separated from it by two infinitesimally close planes called AB and CD and is radially related to the relative motion of the parts (Fig. 1). We associate a moving coordinate system with the selected layer element. The axes p and n of this system are directed, respectively, along the normal and tangential relative trajectory of motion s, to the center of gravity of the layer. Fig. 1 shows the forces acting on the layer element. The following forces are under the influence of the cut element of the ABCD layer: the elementary force of gravity dG, directed downwards.

Since the soil layer moves along the trajectory s (with relative speed) located on the working surface of the body, it causes inertia forces dJ on the p axis, friction force dF^{mp} between the layer and the working surface, and adhesion force $dF^{\text{сц}}$ between the layer and the edge of the trench.

On the lateral side, the second soil layers also act on the layer element with compressive forces T and T_1, which intersect each other along the trajectory s at an angle d_η creating an elementary lifting force dP. When the double body operates in a closed trench, the layer element is affected by the normal pressure forces N from the lateral side, the reaction of the soil monolith dR" from the lateral side, and the elementary elastic force dQ that arises when the layer bends in the tangential plane.

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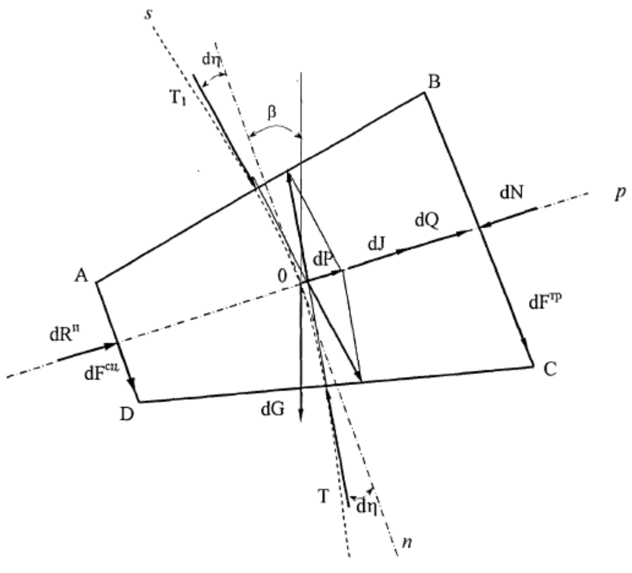

Figure 1. Diagram of forces acting on the ABCD layer element.

The selected layer element has three degrees of freedom. It can rotate about the n axis and move along the surface of the working element in two mutually perpendicular directions. Therefore, to study the relative motion of the blade, it is necessary to formulate three differential equations: the equation of the projections of all forces acting on the n and p axes and the equation of the moments of forces with respect to the surface.

The equation of the projections of the intersecting forces on the trajectory $(n - axis)$ does not provide anything to determine the motion, since, according to the previously accepted assumption of "incompressibility of the beam", inertial forces are not projected on the intersection of the trajectory [3; 4; 7].

Therefore, to describe the motion of the layer, only the equation of all the forces on the axis p is needed. and the equation of the moments. The sum of the projections of all the forces on the axis p is written as follows:

$$\sum \rho_i = dP + dQ + dJ + dR^{п} - dG \cdot sin\, \beta - dN = 0 \tag{3}$$

The equation of moments of force leads to the differential relationship between the bending moment and the shear force due to the action of stiffness forces [3; 4; 8]:

$$dQ = Eab \frac{d^3\eta}{ds^3} ds \tag{4}$$

where E is the modulus of elasticity of the soil, N/m^2;

a - depth of plowing m;

b - layer width, m.

The obtained expression is also acceptable for closed loop conditions, since it describes the internal connections of the beam. The moments of the reaction forces dF^{mp} and the coupling $dF^{cц}$are directed in opposite directions and do not significantly affect the equilibrium state.

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(3) The equation is defined by the following formulas:

$$dJ = \frac{ab\gamma}{g} \cdot V_r^2 \cdot \frac{d\eta}{ds} ds; \tag{5}$$

$$dP = T\frac{d\eta}{ds} ds; \tag{6}$$

$$dG = V^{пл} \cdot \gamma; \tag{7}$$

where: $a -$ is the depth of plowing, m;

b - width of the palm, m;

γ – specific gravity of the slag,N/m^2;

g – acceleration of free fall,m/s;

V_r - relative speed of the movement of the paddle,m/s;

$\frac{d\eta}{ds} = k$ - geodesic curvature of the layer element trajectory.

Given the initial conditions and assumptions, the normal pressure force kuchi N between the non-intermediate solids and the reaction force dR^{II} exerted by the soil monolith are equal and balance each other. Substituting expressions (4-7) into formula (3) and making appropriate changes, we obtain the differential equation for the relative trajectory of the layer movement in the closed trench conditions:

$$m = \frac{d^2s}{dt^2} = E \cdot a \cdot b\frac{d^3\eta}{ds^3} + \left(T + \frac{ab\gamma}{g} \cdot V_r^2\right) \cdot \frac{d\eta}{ds} - V^{пл} \cdot \gamma \cdot sin \cdot \beta \tag{8}$$

Equation (8) determines the shape of the relative trajectory of a layer depending on its mass and connectivity, the speed of movement, the pressure forces acting on it, and the parameters of the cut furrow.

IV. CONCLUSION

This study was carried out based on the theory of L.V. Gyachev. [4], It can be seen from this that as the convergence of the particle increases (Eab ⇢ ∞), its relative trajectory approaches the upper limit trajectory - the geodesic line of the surface, also a line on the working surface of the otval, whose geodesic curvature (stable curvature in the plane) is zero. (8) dividing the equation by the value of Eab and continuing it towards infinity, we get $d^3\eta/ds^3 = 0$ or, taking into account the initial conditions, dη/ds = 0, η=const. The result obtained ensures the constancy of the angle in the relative direction."

With a significant increase in the speed of the aggregate V_r, from equation (8)

$$\frac{d\eta}{ds} = 0, \quad \eta{=}const \text{ we accept}$$

Consequently, with an infinite increase in velocity, the relative trajectory also approaches the geodesic line.

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