

Decrease of draught resistance of the rebuilt and reinforced end-effectors during Exploitation

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The purpose. To probe change of draught resistance of shovels with volumetric and surface reinforcement while in service. **Methods.** Mathematical-statistical, inferential and inductive analysis. **Results.** Correlation between radius of curvature of active face and aging aggression of a blade on width with multiplicity of change of the square of contact is determined. That hypothetically influences change of draught resistance of shovels with volumetric and surface reinforcement while in service. **Conclusions.** Mathematical model of assessment of change of square of contact of end-effectors during exploitation for prediction of relative draught resistance and expression of assessment of limiting state of altitude of aging aggression of shovel is gained.

Key words: *shovel, self-sharpening, reinforcement, active face, abrasive wear, draught resistance.*

Formulation of the problem. The process is energy intensive tillage and requires major cost in the production of agricultural products. [8] According to the source [9] tillage costs are 30% of all costs in agriculture. Abrasive wear of working tillage machines depends on the physical and mechanical properties of the soil and the material properties of which the made working bodies. The intensive abrasive wear considerably decreases the reliability tillage machines and results in high energy costs in the process of cultivation. [4]

The state of the cutting edge of the blade working body depends on the quality of cutting weeds, tillage depth, stability paws go in depth, resistance tillage machines and fuel consumption. [11]

The problem of increased resistance to wear of working body, ensuring self-sharpening and magnification their resource is relevant. [13]

Therefore, it is important to research parameters to ensure cutting edge of the blade working that will provide qualitative and economic performance of tillage machines.

Analysis of recent research. Improving resource working bodies tillage machines and reduce energy consumption achieved by self-sharpening blade or cutting edge due to the application of wear resistant materials by various methods. [6]

Blunt blade increases the cost of working farm operations with tillage by increasing the cost of fuel and lubricants, as well as reduces the quality indicators cultivation. [5]

According to the research [3] found that with increasing radius cutting edge of the blade to 0.6 -0.7 mm cutting weeds reduced by 15-20%, and at 0.8 mm happening reducing the depth of processing of soil, that does not meet the established agro-technical requirements.

The study authors [1] also confirm that in achieving radius cutting edge of the blade paws to 0.4 - 0.5 mm on the field surface is observed 20% not clipped weeds.

Enhancing of operational characteristics of working bodies, including the clutches of cultivators is an actual problem in agricultural production. This can be achieved through the creation of new manufacturing technologies and strengthening working bodies, and through the use of new materials at the same time. Particularly promising is the development of technologies with application to strengthen the cutting edge of powder materials with nanoparticles which are components of the particle size of about 0.1 microns, which improves the physical and mechanical properties of the deposited layers, namely, tensile strength of 1.5 - 2.5 times while maintaining sufficient plasticity [7, 10].

Objective research – Managing change traction resistance cultivators paws with volume and surface hardening in service.

Research results. In the period of exploitation of as a result the abrasive action and pressure of soil primarily worn cutting edge working bodies tillage machines.

Is observed her blunting and further change geometry, namely increasing the radius of curvature. Especially it is typical for working bodies with volumetric hardening of individual sections of working bodies, including the wings lancet paws cultivators. [2]

The scheme of distribution of the load on work surface paws and look of cutting edge on i wear stages shown in Figure 1.

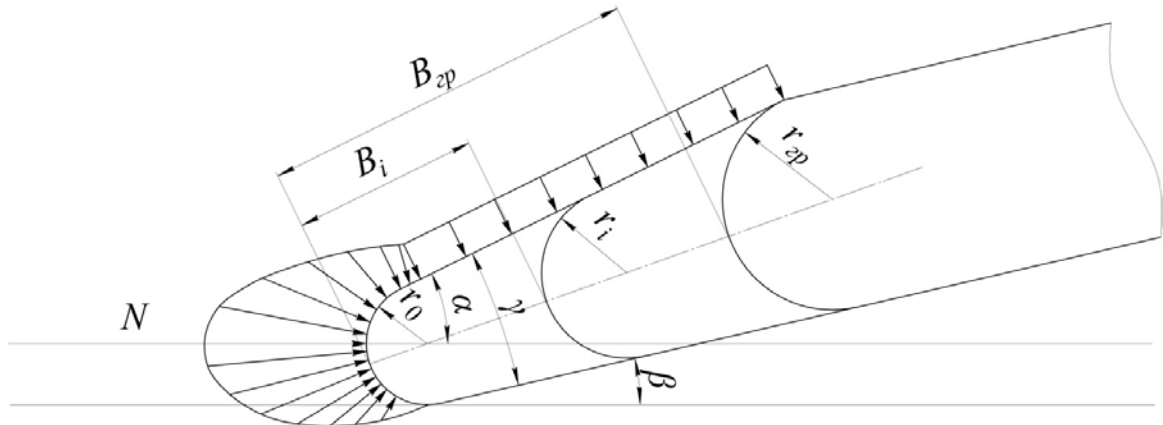


Fig. 1. Scheme load distribution N on the cutting edge cultivators paws and change the radius edge during the operation r_i – i value of wear; B_{lim} – the limit value of wear; r_0 – the initial value of of radius edge; r_{lim} – wear and tear limit radius edge; $r_0 < r_i < r_{lim}$; α – angle of attack, cutting, lifting; β – rear corner; γ – sharpening angle; $2B_i$ – reducing the width paws cultivator at i stage wear

Sharp edge new paws characterized by a primary radius r_0 and angle aggravation γ . Depending on the purpose paws changing the angle of attack α and rear angle β .

In this case the relationship between the angle of sharpening, lift and rear such a [12]:

$$\gamma = \alpha - \beta. \quad (1)$$

Wear parts accompanied by changes in the radius r_i of the cutting edge, from r_0 to r_{lim} , where r_i – and any intermediate value radius edge; r_{lim} – limit value of radius, after reaching which he does not change and is half the thickness of the sheet, whose manufactured paw. With increasing magnitude wear B_i increases r_i .

All centers of the radii are on the angle bisector of the aggravation. Intercommunication of between these values such a:

$$r_i - r_0 = B_i \cdot \sin \frac{\gamma}{2}, \quad (2)$$

from here:

$$r_i = B_i \cdot \sin \frac{\gamma}{2} + r_0. \quad (3)$$

This expression is suitable for predicting the radius of curvature of the cutting edge and analysis of resistance of the working body depending on magnitude of wear paws. Contact area of the cutting edge with soil which determines resistance force of the working body is determined by the calculation expression:

$$S = \frac{2\pi r}{2} \cdot L = \pi r L, \quad (4)$$

where πr – arc length of the cutting edge, characterized semicircle, mm; L – the length of the cutting edge working body, mm.

For value r_i , expression (4) becomes:

$$S_i = \pi r_i \cdot L_i. \quad (5)$$

Thus relation of S_0 to S_i will have the form:

$$\frac{S_0}{S_i} = \frac{\pi r_0 \cdot L}{\pi r_i \cdot L_i} = \frac{r_0 \cdot L}{r_i \cdot L_i}. \quad (6)$$

Then for the paws with the same length of the cutting edge, ratio the area of the cutting edge provided volumetric hardening, for example hardening, is defined as the ratio of the radii at certain fixed their meanings:

$$\frac{S_0}{S_i} = \frac{r_0}{r_i}. \quad (7)$$

And this means that by calculating the value r_i can be estimated magnification contact area, that enables predict resistance when performing soil cultivation and influence the fuel consumption by reducing r_i .

Reduction r_i , and in ideal case bringing it to its original value r_0 and ensure its constant value during operation, possible by strengthening the surface of the working body agricultural machines by the application of coatings, including a nanocomponents.

Unlike the kind of cutting edge on i stages of wear with surround hardening, which is shown in fig. 1, scheme of distribution of forces on the work surface and form hardened cutting edge on i stages of wear with surface hardening has the form shown in figure 2.

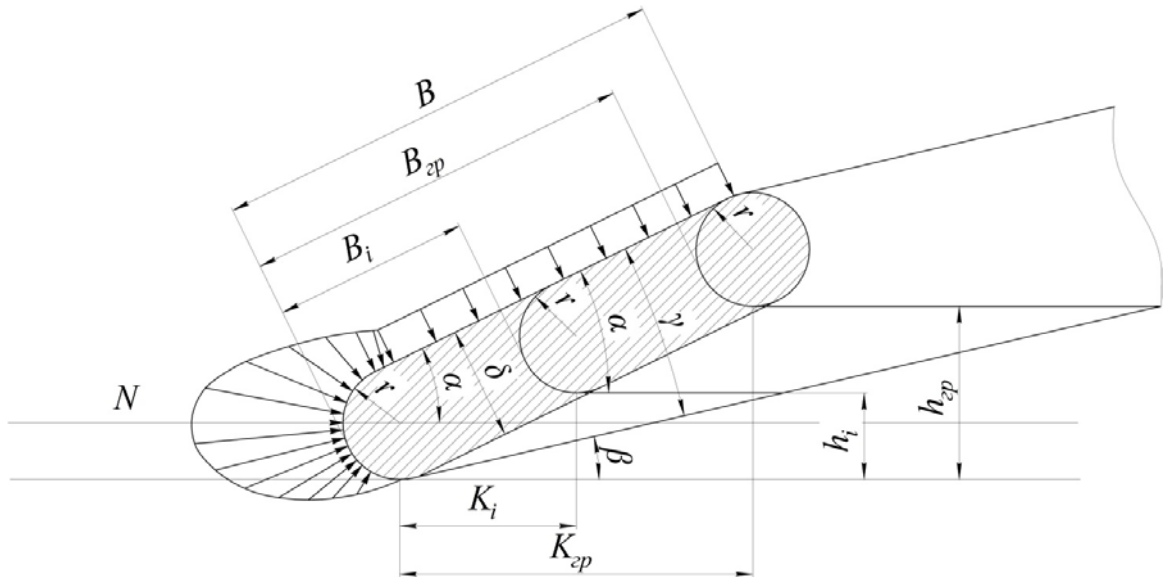


Fig. 2. The scheme of distribution of forces on the work surface and shape cutting edge on i stages of wear: a – angle of attack, cutting, recovery; β – rear angle; γ – sharpening angle; δ – the thickness of the strengthening layer, $\delta=2r$; B – size surface strengthening by width; h – lift height lower plane paws (soles) due to wear.

During the hardening the working body electroerosion processing of materials with nanocomponents at the beginning of the exploitation angle a , which is the cutting angle (angle of attack, lifting) equals the sum of angles β (rear angle) and γ (sharpening angle).

As the wear of the cutting edge is formed sole-the lower plane paws, parallel to direction of movement of the working body length B and at the height h_i of the initial value formed soles. This is a constant angle $a=Const$.

The thickness of the hardening layer δ thus will be equal $2r$ where r – radius curvature of the cutting edge.

Conditions self-sharpening occurs when $r=Const$.

Considering that the strengthening layer wears out less intensive than base metal, forecasted, that in the exploitation process will be formed plane on the working body, located parallel movement of the working body with the size of the by width K_i :

$$K_i = B_i \cdot \cos \alpha, \quad (8)$$

where B_i – wear value strengthening surface by width.

Thus the lower plane of the working body adjusted to a depth of tillage, rises to a height h_i , which equals:

$$h_i = B_i \cdot \sin \alpha. \quad (9)$$

This means that in process exploitation, operator by measuring the wear paws by width, may adjust depth of tillage accordingly previous adjustment

In addition, by controlling the length of hardened layer L determined by threshold quantity value of wear B_{ep} , that equals:

$$B_{ep} = B - r. \quad (10)$$

Thus h_{ep} will be equal:

$$h_{ep} = B_{ep} \cdot \sin \alpha. \quad (11)$$

Substituting into expression (11) value of (10), we get:

$$h_{ep} = (B - r) \cdot \sin \alpha. \quad (12)$$

This expression characterizes the height limit value wear paws cultivator, which provides its self-sharpening during exploitation, which is the basis for a decision to suspend operation of the working body and restore in case of absence defect.

Conclusions

An expression is obtained $r_i = B_i \cdot \sin \frac{\gamma}{2} + r_0$, by which determining magnitude of r_i by which to assess the frequency of increasing the contact area, that will predict resistance when performing cultivation process and influence the fuel consumption by reducing r_i .

An expression is obtained $h_{ep} = (B - r) \cdot \sin \alpha$, which characterizes the height limit value wear paws cultivator, which provides its self-sharpening during exploitation, which is the basis for a decision to suspend operation of the working body and restore in case of absence defect.

Bibliography

1. Achkasov K. A. Povyshenie dolgovechnosti lap sejalok-kul'tivatorov SZS2.1 v uslovijah MNR/K. A. Achkasov, Ch. Nanzhaa//Sb. nauch. trudov MIISP. - Moskva, 1987. - S. 61 - 65.
2. Balabuha A. V. Povyshenie dolgovechnosti i jeffektivnosti raboty rezhushhijh jelementov pochvoobrabatyvajushhijh mashin putem upravlenija iznashivaniem pri diskretnom uprochnenii: dis. kand. tehn. nauk: 05.05.11/Balabuha A. V. – Kirovograd, 2001. – 135 s.
3. Bahtin P. U. Fiziko-mehaničeskie i tehnologičeskie svojstva pochv/P. U. Bahtin//Spravočnik konstruktora sel'skohozjajstvennyh mashin. - T. 1. - M.: Mashinostroenie, 1967. — S. 693—710.
4. Bobrytskyi V. M. Pidvyshčennia znosostiikosti rizalnykh elementiv robočykh orhaniv gruntoobrobnykh mashyn: dys. kand. tekhn. nauk: 05.02.04/Bobrytskyi V. M. – Kirovohrad, 2007. – 168 s.
5. Bondariev S. I. Obgruntuvannia hranychnoho spratsiuvannia lez gruntoobrobnykh robočykh orhaniv/S. I. Bondariev//Tekhnolohyčeskyi audyt y rezervy proyzvodstva. - 2013. - № 5(2). - S. 8-10
6. Denysenko M. Znoshuvannia ta pidvyshčennia dovhovichnosti robočykh orhaniv silskohospodarskykh mashyn/Denysenko M., Opalchuk A.//Visnyk TNTU. - 2011. - Spetsvypusk — chastyna 2. — S.201-210.
7. Izmajlov A.Ju. Nauchnye principy povyshenija iznosostojkosti rabochih organov pochvoobrabatyvajushhej tehniki/A.Ju. Izmajlov, S.A. Sidorov, Ja.P. Lobachevskij, V.K. Horoshenkov,

P.A. Kuznecov, M.A. Jurkov, S.A. Golosienko//Sbornik nauchnyh dokladov VIM. – 2011. – T. 1. – S. 89-95.

8. Kozhuhova N. Ju. Naplavochnoe armirovanie rabochih organov pochvoobrabatyvajushhih mashin, jekspluatirujushhihsja na tjazhelyh pochvah (na primere pluzhnyh lemehov): dis. kand. tehn. nauk : 05.20.03/Kozhuhova N. Ju. – Brjansk, 2011. – 175 s.

9. Kormakov L.F. Rynok sel'skohozjajstvennoj tehniki: problemy i reshenija/L.F. Kormakov, L.S. Orsik, Ju.D. Bahteev. - M.: FGNU «Rosinformagroteh», 2007. - 192 s.

10. Sainsus A.D. Povyszenie dolgovechnosti lap kul'tivatorov kompozicionnymi pokrytijami peremennogo sostava: diss. kand. tehn. nauk/A.D. Sainsus.- K. 2008. – 159 s.

11. Fajurshin A. F. Povyszenie dolgovechnosti lap kul'tivatorov v sel'skohozjajstvennyh remontnyh predpriyatijah: dis. kand. tehn. nauk : 05.20.03/Fajurshin A. F. - Ufa, 2006. – 134 s.

12. Chernyshev Ju. V. Razrabotka tverdogo splava i tehnologii uprochnenija ploskih rezhushhih organov pochvoobrabatyvajushhih mashin: dis. kand. tehn. nauk: 05.16.01/Chernyshev Ju. V. – Kursk, 2002. – 139 s.

13. Aulin V. Increased Wear Resistance of the Cultivator Plowshares by Laser Technology of Consolidation/V. Aulin, W. Arifa, S. Lysenko.//International Journal of Agriculture and Forestry. – 2015. – №5(6). – C. 318–322.