Original research article

MODELS DESIGNED TO INCREASE THE WORK OF REVERSIBLE DISC PLOW

Abstract

In this paper, we study the models designed to increase the work of reversible disc plow. Results of research on the use of design-engineering methods of a heightening of serviceability are reduced and it is offered to use an improved disk of digging out device root of the tillage machines. Results of a study on the application of design and technological methods revealed that one of the promising areas of increased efficiency and durability are strengthening blades durable material of variable thickness.

Keywords: *system tillage, fertilisers, manure, crop residues, reversible disc plow.*

Introduction

The term "tillage" embraces a range of operations applied prior to sowing, to prepare the soil for crop growth. These operations are using various types of implements and machinery to loosen, invert, and mix the soil, modify the surface configuration, change aggregate size, incorporate materials (fertilizers, manure, crop residues, etc.), eradicate weeds, and form openings for seed placement. Using advanced machines and technologies agricultural production can reduce its cost and increase competitiveness. The primary means of cost savings living and materialized labour is increasing durability wear parts and components of machines strengthening methods [1]. Flux durable alloys are the most versatile, economical and widely used in methods of restoring the economy and manufacturing of machine parts, providing the working surface of the special properties that contribute increase the duration of their time between failures [2]. In the agricultural machinery used almost all known methods and types of surfacing. Improved and implemented into production progressive types: arc powder wires and ribbons, electroslag, induction, plasma, gas ardent and others. Application surfacing operations allow creating new bimetallic structures with the necessary technological and performance properties, thus increasing the durability products significantly reduce the costs of construction and alloy steels [3]. A promising direction of strengthening sustainable technologies and materials should be considered to strengthen the use of as a way to control the formation of the working surfaces of agricultural machines. This line of research found its development in the work [4]. Reversible disk plow is a kind of disk implement that reverses horizontally to provide two-way plowing. This device includes advantages of both disk and reversible implements simultaneously. By simplifying and improving the current device, a new type of reversible disk plow was designed. The structure of this design was a five-bar linkage which obtained from the optimization of Daniel straight line four-bar linkage [5]. William et. Al. [6] designed a reversible disk plow, in which a particular mechanism made it possible all working elements to reach a symmetric position, i.e. a primary linkage displaced movable (disk carrying) chassis in a transitional manner, a secondary one adjusted the disk angles by rotating them separately about their original position, and a final one rotated rear wheel about a selected normal axis. Reversible disk plows, in addition to all disk implements, have further benefits such as leaving the field unfurrowed, saving time and expenses, maintaining soil structure, improving the total efficiency, and so on [5].

Achieving the effect of the controlled operation is determined by applying the local wear resistant coating so that the selected scheme application and value durability of the material basis and provide the necessary strengthening (set) surfaces forming working groups. The second area is hard facing layer of variable thickness, with the parameters which include the maximum and minimum thickness and length of layer determining step placement sites blades with different parameters [7]. In contrast to the strengthening of the homogeneous layer of durability is achieved by only more wear-resistant properties of the built-up layers, the controlled capacity is reached the much greater effect of increasing the operating time required by building profiles of the trips.

So in the study [8] saw tooth blade is achieved using point arc welding as separate points strengthening. Value durability materials base and surfacing at the selected location diagram plots the strengthening achieved self-sharpening blades at its wavy shape, which reduces the energy process increases durability and plowing blade. Controlled operation obtained for other working bodies of agricultural machinery such as paws cultivators, shovels, hammers, knives to cut the tops and others.

Noteworthy method of strengthening durable material variable thickness [9], which is used in the manufacture sector repair disk beet machine. Blade digger in service acquired gear shape by varying the intensity of wear parts blades with different thickness of wear resistant layer. The process forming teeth contributes self-aggravation blade and reduce resistance entering the blade drive device digging up the soil. However, the disadvantage this method had the opportunity to strengthen the parts are small, and development of technology to strengthen large parts such as disk archaeologists, had difficulties related to the development and implementation of complex technological equipment. As a result of the research, a new design and technological methods to strengthen the working surface of the blade Disk digger durable material [9]. The essence of the method is shaping performances and depressions mostly metal layer method run-up, followed by the strengthening of existing technology (Fig. 1).

Materials and Methods

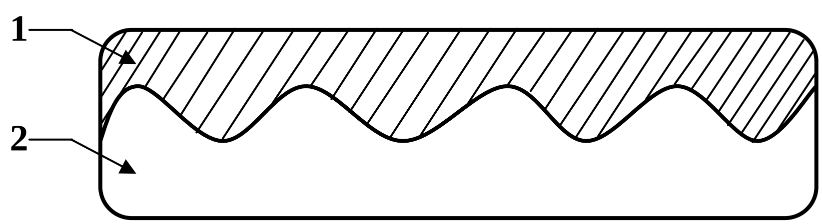

Figure 1 - Schematic profile blades hardened durable material

variable; thickness: 1 - wear-resistant layer, 2 - basic layer

Study of regulation durable properties labour surface determining the influence of deposition parameters on the intensity wear parts blades.

Equation wear parts blades with different thickness endurance layer have the form:

$$\gamma_{\circ} = \frac{C_{\circ} R_X \left(1 - \mu\xi / l_{\circ}\right)}{h_{\circ} l_{\circ}}; \; \gamma_H = \frac{C_H R_X \left(1 + \mu\xi / l_{\circ}\right)}{h_H l_H}$$

(1)

Where $\boldsymbol{\Upsilon_o}$, $\boldsymbol{\Upsilon_H}$ - the intensity of wear parts blades with minimum and maximum thickness of wear resistant layer $\boldsymbol{C_o}$, $\boldsymbol{C_H}$ – coefficients operation of the primary and wear resistant layers $\boldsymbol{R_x}$ - the resultant component forces that determine the operation of the blade in the radial direction; $\boldsymbol{\mu}$ – coefficient proportionality, which depends on the height of teeth $\boldsymbol{\xi}$; $\boldsymbol{h_o}$, $\boldsymbol{h_H}$ - total thickness blades at sites $\boldsymbol{l_o}$, $\boldsymbol{l_H}$.

As a result, changes and substitutions made set pattern parameters to influence the intensity of wear resistant layer formation toothed surface of the blade at its operation:

$$\xi = \frac{l\circ}{\mu}\left[\frac{\dfrac{\varepsilon_{\circ} h_{\circ\max}}{\varepsilon_H h_{H\min}} l_H - \dfrac{\varepsilon_{\circ} h_{\circ\min}}{\varepsilon_H h_{H\max}} l_{\circ}}{\dfrac{\varepsilon_{\circ} h_{\circ\max}}{\varepsilon_H h_{H\min}} l_H + \dfrac{\varepsilon_{\circ} h_{\circ\min}}{\varepsilon_H h_{H\max}} l_{\circ}}\right]$$

(2)

Where $\varepsilon_{\boldsymbol{o}}$, $\varepsilon_{\boldsymbol{H}}$ - durability and endurance core layers.

Based on the established pattern forming the surface of the blade the parameters of wear resistant layer, providing intensive forming teeth on the surface: the length of the blade are $\boldsymbol{l_o} = 15 \ldots 30$ *mm*; $\boldsymbol{l_H} = 15 \ldots 20$ *mm* maximum thickness endurance layer $\boldsymbol{h_{H\,max}} = 3.5 \ldots 5$ *mm*. To set the intensity triggering the thickness Blades, investigates triggering discs reinforced durable material of variable thickness. Given that the intensity of the triggering inversely proportional to its thickness, based on the processing of the experimental data would explode, improved archaeologists (Fig. 2) established an exponential dependence:

$$\gamma_l = ve^{-wh_l} \qquad (3)$$

Where ***v, w*** - steel ratios as determined by the method least squares.

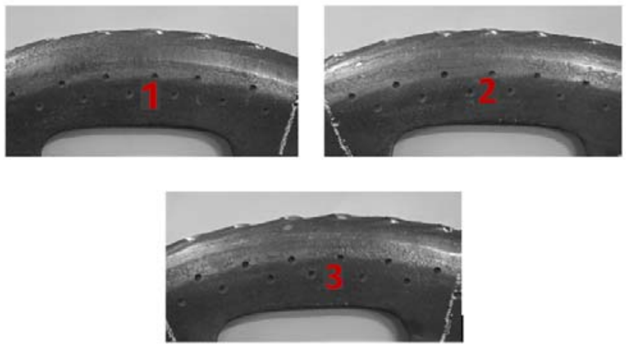

Figure 2 - General view of the disk sectors after working out 250 hectares of parameters: ***a)*** *–* $t_3 = 35mm$, $H_3 = 2$ *mm,* ***b)*** *–* $t_3 = 35mm$, $H_3 = 2.5$ *mm,* ***c)*** *–* $t_3 = 35mm$, $h_3 = 3$ *mm*

Results

The results of experimental studies of advanced drive confirmed the position of the possibility of the formation of jagged surface of the blade during its operation. Based on production tests disc identified rational design parameters of the blades in intensity forming toothed surface needless aggravation, the intensity of wear and time to failure: step location recesses $t_3 = 45 \ldots 47$ *mm* depth $h3 = 2.5 \ldots 2.7$ *mm*, length $l_H = 15 \ldots 20$ *mm*, which correspond intensity triggering hollow tooth $\gamma_{ht} = 0.0139$ *mm / ha* , teeth $\gamma_t = 0{,}008$*mm / ha*, elevation teeth by producing of 250 hectares - $\xi = 1{,}39$ *mm*, resource digger $T = 1441$ *ha*. As a result was confirmed the adequacy of mathematical process models wear and gear shaping surface improved player.

The effectiveness of the method developed to strengthen the working surface of the Xia confirms the data shown in Table 1.

Table 1 - Comparative evaluation of disk archaeologists reinforced format-1

Characterization archeologists			The intensity of the triggering γ_1 mm / ha	Relative self-sharpening
grade material	method of manufacture	method of strengthening		
L30H uniform	molten	even durable layer	0.43256	0.33
steel 65G	stamped (serial)	even durable layer	0.021243	9.58
Sector steel 65G	made (repair)	durable layer variable thickness	0.035667* 0.027845	0.94
steel 65G	pressed (improved)	durable layer variable thickness	0.023353* 0.007897	0.99

* In the numerator - the intensity of wear hollow, the denominator - intensity of wear of teeth

The average intensity of wear parts blades with rational parameters improved drive lower than in series. In this relative as exacerbation that determined with the time to failure, complies with the repair sectors.
Analysis of the data shows that the proposed method of strengthening disk archaeologists has an advantage over the existing consolidation that shown to increase longevity almost doubled and is characterised the more rational approach to the creation of technology to strengthen durable material of variable thickness in a production environment. Working drawings of the improved design of disk digger root crop machinery transferred to JSC "Ternopol combine factory "for introduction into production [6].
The advanced design of disk digger preferable serial diggers through reinforced blades with variable thickness durable material that

provides increased performance and durability by the formation of serrated blade profile when performing destination [5]. The economic effect of implementing disk archaeologists proposed structures were calculated on the basis of improving its efficiency and durability. In figure durability, disk archaeologists made time to regrinding. Lifetime disk archaeologists to regrinding according to data [10] are four seasons of fieldwork or 550 to 600 hectares per root crop machine KS-6B. According to the results production tests, life developed disk archaeologists equal to the life of CS-6B, the economic effect is 14334hrn one machine root crop that is economically viable.

Conclusions

1. Results of a study on the application of design and technological methods revealed that one of the promising areas of increased efficiency and durability are strengthening blades durable material of variable thickness. When the functional purpose it promotes self-aggravation blade and formation on working surface of teeth.

2. Based on the obtained mathematical model (2) forming the dentate surface of the blade, hardened durable material of variable thickness, established patterns of influence of parameters on the wear resistant layer intensity shaping of the technological process.

The parameters of wear resistant layer, providing intensive forming teeth on the surface: the length of the blade are $l_O = 15 \ldots 30\ mm; L_H = 15 \ldots 20\ mm$ maximum thickness endurance layer $hH\ max = 3.5 \ldots 5\ mm$.

3. Results of experimental studies triggering drives the blades the rational design parameters of the blades in intensity forming toothed surface s self-aggravation, intensity wear and time to failure: step location grooves $t_3 = 45 \ldots 47\ mm$, depth – $h_3 = 2.5 \ldots 2.7\ mm$, length - $L_H = 15 \ldots 20\ mm$, which 75 correspond to the intensity of wear hollow $\gamma_{VP} = 0.0139\ mm / ha$ teeth Tooth $\gamma_t = 0{,}008\ mm / ha$, elevation teeth for elaboration of 250 hectares - $\xi = 1{,}43\ mm$, resource digger $T = 1533\ ha$, regulatory developments KC-6B 990 hectares.

Confirmed the adequacy of mathematical models of processes and operation forming toothed surface developed disks.

4. The analysis developed working body root crop machinery introduced in the production of JSC «Ternopol Combine Plant". The economic effect from the introduction designed drive unit is digging up 12,557 USD per root crop machine.

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