

INVESTIGATION OF WEAR IN REJECTED REVERSIBLE CHISEL SHANKS

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The article presents the results of studying worn and rejected reversible chisel points. It was found that their rejection is caused by excessive wear of the tip (48.29 mm). The use of monometallic reversible chisel points leads to a decrease in their service life due to the formation of wide back bevels (up to 5.4 mm) and an increase in blade edge thickness to critical values. On non-saline soils, when excessive compaction occurs, chiseling with chisel-cultivators ChKU-4 and ChKU-4M is used instead of harrowing. To preserve moisture and prevent harmful salts from rising to the soil surface, in saline-prone areas where leaching irrigation is applied, harrowing is carried out when the soil reaches the proper maturity. After this, the soil is loosened with the ChKU-4 chisel-cultivator to a depth of 16–18 cm or more [1,2]. Studying the wear of chisel working tools makes it possible to obtain initial data for determining the permissible degree of blunting and for establishing the nature and dynamics of wear.

The nature and magnitude of wear on reversible chisel points, without considering their operating hours, were studied in the Syrdarya region on farms named after A. Navoi and U. Yusupov in the Bayaut district, as well as in the “Khawast” farm in the Yangiabad district of Jizzakh region.

The delivered reversible chisel points had operated under various conditions covering approximately three-quarters of the soil types and variants in Uzbekistan. Based on the conducted statistical studies, five characteristic defects were identified: lengthwise wear of the point, thickness wear, changes in the sharpening angle, formation of a back bevel, and changes in blade edge thickness. The repeatability coefficients of these defects were respectively 1.0, 0.9, 1.0, 1.0, and 1.0. The presence of the first, fourth, and fifth defects in the chisel points leads to deterioration of agrotechnical performance regarding working depth. Thickness wear and changes in the self-sharpening angle affect the strength and self-sharpening ability of the blade. The nature of wear and the most wear-intensive locations were determined by micrometric measurement of dimensions, drawing their contour, and overlaying it onto the contour of a new point. To carry out statistical research, the sample size was determined according to well-known methodologies [3,4]. The analysis showed that the distribution of dimensions of worn chisel points follows a normal distribution (table).

Reversible chisel points wear unevenly along the length of the tip. The nature and contours of the wear are shown in Fig. 1. As can be seen from these materials, more intensive wear is observed at the tip, while slower wear occurs on the lateral parts. Gradually, the tip of the point changes from a spear-shaped form to a rounded (blunt) one.

Significant wear of reversible chisel points is observed in their average length dimension (along L). In more than 50% of the points, the entire metal reserve intended for wear has been completely worn out.

The amount of wear was determined by the difference between the parameters of the worn points and the weighted average values of new ones.

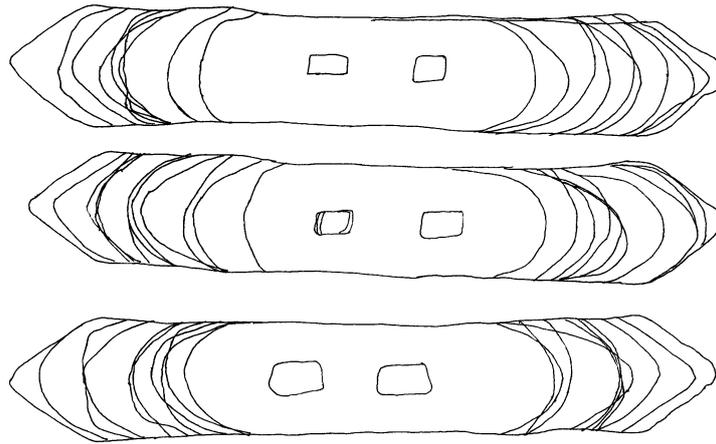


Fig. 1. Contours and extent of wear of the cutting parts of rejected reversible chisel points.

Table. Results of data processing obtained from micrometric measurements of reversible chisel points.

№	Parameter Name	Designations	ед. изм.	Statistical Processing Indicators				Kolmogorov Goodness-of-Fit Test $P(\lambda)$
				\bar{x} , мм	σ , мм	V , %	P_t	
1	Tip Length	L	мм	91,708	17,1	18,6	1,71	0,1122
2	Length of the Right Edge of the Tip	l_1	мм	91,977	13,9	15,11	1,39	0,7920
3	Length of the Left Edge of the Tip	l_2	мм	79,85	5,8	7,26	0,58	0,2700
4	Sharpening Angle"	α	град	65,15	14,7	22,25	1,47	0,0681
5	Sharpening Angle of the Right Edge	α_1	град	64,88	13,7	20,19	1,3	0,9639
6	Sharpening Angle of the Left Edge	α_2	град	54,88	13,6	24,8	1,38	0,1777
7	Tip Thickness of the Point	H	мм	6,32	1,5	25,7	0,1	0,1122
8	Tip Thickness of the Point	h_1	мм	6,20	1,3	20,9	0,13	1

For example, with an average new chisel point length of 280 mm, wear along dimension L ranges from 10 mm to 72.3 mm, while along dimensions l_1 and l_2 it ranges from 5 mm to 50 mm. Out of the total sample, 36% of reversible chisel points have a remaining service life of 1 to 10 mm. The wide variation in tip-length wear of rejected points is explained by differences in operating hours of the worn reversible points and the abrasive properties of the soils on which they were used.

Thus, complete wear of the tip serves as an indicator of exhaustion of the technical resource. Tip wear reaches 48.29 mm, while wear at the edges ranges from 18.02 to 30.15 mm (see

Table). As can be seen, the wear exceeds the allowable limit by 1.6 times, which results in additional operational costs.

According to studies, in the size distribution, the agreement between experimental and theoretical curves, evaluated by the Kolmogorov criterion, ranges from $P(\lambda) = 0.1122$ to 0.7920 (see Table). In this case, the curves can be considered sufficiently consistent, since $P(\lambda) > 0.05$. Analysis of the sharpening angles of rejected points showed that at the tip, the angle increased 2.61 times compared to the initial value, while at the tip edges it increased 2.2 to 2.6 times. This indicates the absence of self-sharpening, which is associated with the formation of large back bevels, reaching up to 5.4 mm at the tip and 3.57 to 3.91 mm at the edges (see Table and Fig. 2). Of the total sample, 91.5% of monitored points have a back bevel width at the tip greater than 3 mm, while at the edges this figure is 79–84%. Comparing these data with similar reversible cultivator points shows that the proportion of chisel points with back bevels wider than 3 mm at the tip is 15% higher than that of cultivator points. This can be explained by the fact that chisel points operate at depths of 16–18 cm and more, up to 25 cm, whereas cultivator points operate at 12–14 cm. Consequently, under harsher working conditions, higher loads act on the tip portions, increasing wear. This is likely the reason why rejected chisel points exhibit higher sharpening angles and larger back bevels.

If we consider the blade edge thickness at the tip of rejected points, it can be noted that the changes in this parameter, compared to the corresponding parameter of cultivator points, are higher. For example, while thickness wear of reversible cultivator points amounts to 5–6% of the initial value, for chisel points it reaches 8.9–9.3%.

Analysis of the results shows that 39% of reversible chisel points have a blade edge thickness of 1 mm or more at the tip, while at the edges, blade dulling predominates, reaching 78–80%. These values indicate that the blade is sharper at the tip than at the edges. This can be explained by the fact that the lower surface of the blade at the tip experiences intensive wear due to the longitudinal flow of abrasive material (soil), which sharpens the edge, whereas at the edges, the abrasive moves in a transversely oblique direction, wearing the edge itself and causing dulling.

This likely explains why the blade edge thickness at the tip is 0.85 mm ($\sigma = 0.3$ mm; $V = 33\%$; $Pt = 0.03$), while at the right edge it is $t_1 = 1.25$ mm ($\sigma = 0.4$ mm; $V = 32\%$; $Pt = 0.04$), and at the left edge $t_2 = 1.17$ mm ($\sigma = 0.3$ mm; $V = 27.2\%$; $Pt = 0.03$). The probability density distribution of the blade edge thickness of a reversible chisel point is illustrated in Fig. 3.



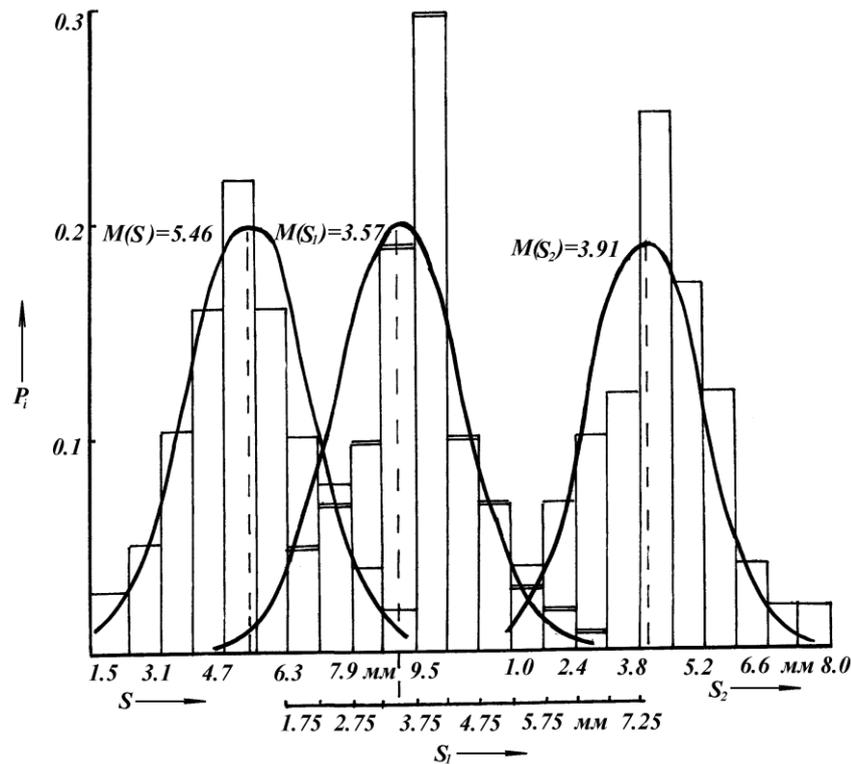


Fig. 2. Probability density distribution of the back bevel width of reversible chisel points.

The work carried out allows the following conclusions:

Rejection of reversible chisel points occurs due to excessive tip wear (48.29 mm), which inevitably leads to increased consumption of fuel, lubricants, and other resources.

The use of monometallic reversible points reduces their service life due to the absence of a self-sharpening effect on the blade.

The primary rejection criterion for wear of reversible chisel points is the formation of wide back bevels on the blade due to intensified wear on the rear side of the working surface, while tip length wear serves as a secondary criterion.

The increase in the sharpening angle during wear up to 2.6 times, the back bevel width up to 5.4 mm, and the blade edge thickness to critical values is caused by the use of monometallic rather than two-layer self-sharpening blades.

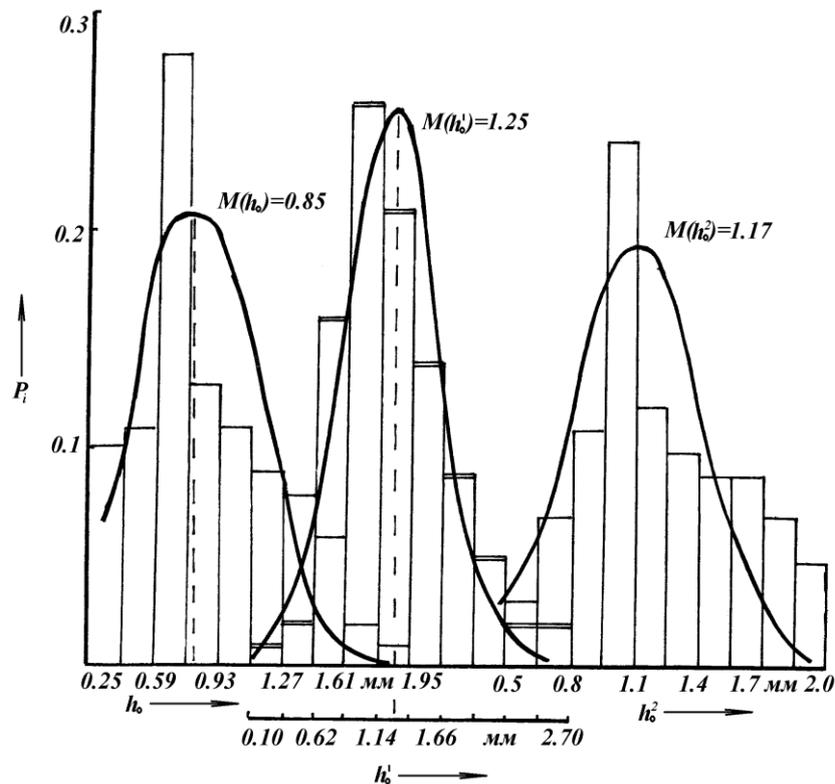


Fig. 3. Histogram and density curves of the blade edge thickness distribution of a reversible chisel point.

The identified defects, based on the conducted studies and revealing certain patterns of wear in reversible chisel points, provide important material for addressing the improvement of the durability of working tools operating under harsh conditions.

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