RESULTS OF THE STUDY ON THE WEAR RESISTANCE OF STONE CRUSHER WORKING PARTS

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In our country, comprehensive measures are being implemented to increase the volume of road construction, building, excavation in mining, processing of rocks, and loading and transportation works. These measures aim to reduce material and energy costs of production and to effectively use widely applied technical means. Certain results are being achieved in these areas.

Notably, scientific works and research by Uzbek scientists such as U.A. Ikramov, T.I. Askarhodjaev and their students, and S.M. Kodirov, K.H. Makhkamov, K.Z. Kosimov, M.U. Turaev, R.J. Tojiev, R.U. Shukurov, A. Ruzibaev, Sh.H. Yuldashev, G.D. Ulugov, and others have explored issues related to increasing the durability, reliability, and wear resistance of working parts of road construction, building, and mining machinery. However, these studies have not sufficiently examined existing technologies for enhancing the service life of the working parts of machinery used to crush rocks for high-quality building materials. Additionally, they have not adequately addressed the use of promising materials with sufficient hardness and wear resistance, as well as local raw materials, to improve the resource of the working parts.

Taking the above into account laboratory studies were conducted to investigate the composition, structure, hardness, and wear resistance of materials that can improve the wear resistance of existing working parts of stone crushers.

Samples from the working parts of stone crushers used in our country were selected for the laboratory studies (Figure 1).

1) *2)* *3)* *4)*

Figure 1: Samples taken from the working parts of Stone Crushers

The main equipment used for preparing and studying the samples is listed below:

1. The working surfaces of the samples were ground using the MY1224 machine (Figure 2).
2. The chemical composition of the samples was studied using the SPECTROLAB optical emission spectrometer (Figure 3).
3. The microstructure of the metals was examined using the A13.0201-V2 metallographic microscope (Figure 4).
4. The hardness of the samples was determined using a Rockwell press in accordance with the GOST 23677-79 standard.
5. The wear resistance of the samples was tested using an abrasive wear testing device (Figure 5).

Figure 2: MY1224 machine for grinding samples.

Figure 3: Exquis T4 optical emission spectrometer.

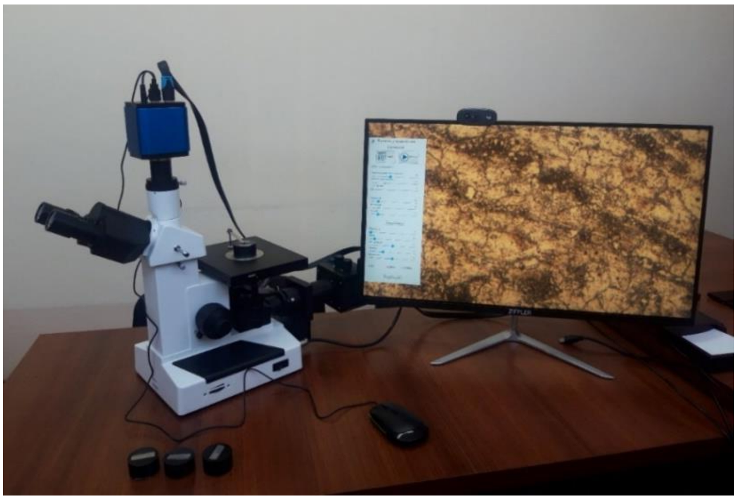

Figure 4: A13.0201-B2 metallographic microscope.

Figure 5: Device for testing samples for abrasive wear.

Results Obtained. Below are the results of the chemical composition study of samples taken from the materials used to manufacture the working parts of stone crushers in our country (Table 1).

Table 1

Chemical Composition of Samples

№	Намуна материали маркаси	Chemical element quantities, %										
		C	Si	Mn	Cr	Ni	Cu	B	Ti	W	Zn	Fe
1.	Sample 1	1.1	0.29	9.5	2.1	0.05	0.06	-	0.08	-	-	86.7
2.	Sample 2	0.94	1.05	12.1	1.6	0.51	0.16	-	0.01	-	-	83.2
3.	45Г	0.43	0.32	0.86	0.05	0.06	0.12	-	-	-	-	88.1
4.	110Г13Л Hadfield Steel	0.9-1.4	0.8-1.0	11.5-15	1.0	1.0	0.30	0	0.03	0	0	82
5	ЧХ22	3,56	1,89	1,86	18,09	0,19	0,19	-	-	-	-	74,5

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Results of Hardness Study of Samples

The determined hardness of the samples is presented in the following Table

Table 2

Average Hardness of Samples

Samples	110G13L Hadfield Steel	Sample 1 (China)	ChX22 Sample	45G Steel (Untempered)	45G Steel (Tempered)
Hardness HRA(HRC)	75 (49)	68 (37)	70 (41)	65 (31)	79 (56)

It is well-known that the primary cause of the rapid wear of stone crusher working parts is abrasive wear, which occurs due to friction against rocks. One of the main ways to combat the abrasive wear of machine parts is to ensure that the working surface has a hardness greater than the abrasive material while maintaining the surface's durability and toughness [4, 5, 6].

To determine the reasons behind the high hardness of the above-mentioned samples, their composition was studied. It was found that samples with high hardness contain larger amounts of carbide-forming elements such as carbon, chromium, silicon, and manganese compared to others. Literature indicates that the hardness of chromium carbides formed with carbon is significantly higher than the hardness of abrasive materials like stone and sand. Additionally, it is well-known that the presence of up to 15% manganese in the steel used for the working parts of machinery significantly increases the impact strength and toughness of the steel. This effect, known as Hadfield steel, occurs because the surface layer of the steel work-hardens when struck by hard rock during operation. As a result, the surface hardness increases from 60-62 HRA to 80-82 HRA, greatly enhancing its wear resistance. Based on these findings, it can be concluded that achieving the required hardness of the working parts of stone crushers will ensure their high resistance to abrasive wear.

Results of Wear Testing of Samples from Stone Crusher Working Parts

The wear testing program for the samples considered factors such as the applied pressure force, testing time, friction speed, and abrasive material consumption. Quartz sand was used as the abrasive material. The wear amount was determined by the difference in the mass and dimensions of the samples before and after the test.

A non-tempered 45-grade steel sample was used as the reference sample. The selected samples were tested for wear, and the results were compared with the reference steel indicators.

The wear testing of the samples was conducted under conditions that simulated the pressure force and friction speed corresponding to the stone crushing process. The samples were weighed before and after the test using a digital MH-696 balance with an accuracy of 0.01 grams. The wear rate of the samples was determined based on the amount of wear per unit time.

$$\varepsilon_{one} = \frac{m_{start} - m_{end}}{t}, \qquad (1)$$

In this context: m_{start} - is the mass of the sample before the experiment; m_{end} - is the mass of the sample after the experiment. t - is the duration of the experiment.

Since the wear amount expressed in terms of mass for different materials may not be entirely accurate, it is convenient to express the wear amount relative to the material's density, i.e., in terms of volume.

$$\Delta_n = \Delta_m/\rho \cdot 1000 \qquad (2)$$

In this context: ρ\rho is the density of the material in kg/m^3 (for example, the density of steel is 7800 kg/m^3).

Each sample was tested for wear in an abrasive environment using quartz sand as the abrasive medium. The tests were conducted for 2 hours under varying loads of 10N, 20N, 30N, 40N, and 50N. To ensure the reliability of the results, each test was repeated 5 times.

During the tests, the pressure force applied by the abrasive particles on the friction surface was gradually increased. The test results are presented below.

1. The initial hardness of the standard 110G13L steel bucket tooth sample is 60-62 HRA, and its hardness after impact work hardening is 80-82 HRA. The total wear amount of this sample was found to be 0.32 g.
2. The hardness of the 205-70-19570 sample manufactured in China is 73-75 HRA. The total wear amount of this sample was found to be 0.39 g.
3. The hardness of the tempered 45G steel sample is 77-79 HRA. The total wear amount of this sample was found to be 0.45 g.
4. The hardness of the ChX22 cast iron sample is 68-70 HRA. The total wear amount of this sample was found to be 0.53 g.
5. The hardness of the untempered 45G steel sample is 63-65 HRA. The total wear amount of this sample was found to be 0.89 g.

Table 3
Wear Rates of Samples

№	Sample material	Wear amount (g)	Relative Wear Resistance
1	110G13L Steel Sample	0,32	2,8
2	205-70-19570 Sample (China)	0,39	2,3
3	Tempered 45G Steel Sample	0,45	2,0
4	ChX22 Cast Iron	0,53	1,7
5	Untempered 45G Steel	0,89	1,0

The test results indicate that, compared to untempered 45 steel, the wear resistance of the other samples is 1.7 to 2.8 times higher.

Conclusion

To increase the wear resistance of the materials used in the working parts of stone crushing machines, which are widely used in the construction of buildings, structures, and roads, it is necessary to enhance their hardness in addition to their strength and impact toughness. The studies conducted in this direction have shown that it is possible to improve the wear resistance of the working parts of stone crushing machines by optimizing the amount of alloying elements such as chromium and manganese in steel and cast iron materials and through thermal treatment.

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