Research Nature of Damage Parts Machines for the Purpose of Optimization Technology Recovery

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Abstract: The results of metallographic studies and microhardness damaged sections detail "axis" the excavator P & H 2800 XPC, subjected to accelerated deterioration the local. Lots of studies to be removed during the repairs identified by magnetic noise control and acoustic spectral analysis. A repair technology.

Introduction

High productivity of mining equipment operating under extreme conditions is provided by a complex of mechanical and special properties machine parts such as resistance to impact loads at low temperatures, abrasion resistance of the friction surface [1, 2, 3, 4, 5].

The investigated "axle" part of the P & H 2800 XPC excavator is the most loaded element in the hub-axis system, which receives unevenly distributed loads during operation, which leads to their accelerated wear (Fig. 1). The technology of manufacturing the "axis" part is much more complicated and more expensive than the details of the bush, so it is more economical to restore the "axis" part.

Fig. 1. Excavator P & H 2800 XPC - a;the nature of the damage is divided by the axis-b, the nature of the damage of the detail of the bush - c

The purpose of the work is the timely and accurate determination part boundary at the stage previous destruction, the development of the technology applying the wear-resistant layer that is optimal in size and properties, reducing the cost of repair, and improving its quality.
In accordance with the technical documentation, the warranty period for the "axis" part provided by a foreign manufacturer is 1 year.

The high cost of the "axis" component (more than 1,000,000 rubles) is the rationale for developing an effective technology for repairing this part.

**Materials and techniques of the experiment**

To determine the chemical composition of the main and welded metal, the "axis" part (before repair, during the selection of the wear-resistant layer material and after repair) was performed by spectral analysis using the Q4 TASMAN optical emission spectrometer.

Spectral acoustic analysis, with the automated acoustic system ASTRON, was used to identify the zones with a changed structure, as well as the degree of its change, measurements were made on a transverse sample at 11 points at a distance of 9 mm.

The magnetic noise control method was performed with the INTROSCAN instrument, with a voltage analyzer and a metal structure. The studies were carried out on a transverse sample at 9 points at equal distances from each other.

For the metallographic study, the plane of the sample was aligned by successive grinding, polishing and etching. Micro-alysis were performed on an Axio Observer microscope with an increase of × 130, × 500, × 800. The etching of the samples was carried out with a 4% solution of HNO₃ and 2% HNO₃ in ethyl alcohol.

The microhardness was measured on a PMT-3M device [6] with an increase of 100 times by indenting the tip (quadrilateral pyramid with a square base), under a load of 1.96 N applied for 20 s, the analysis of the data was carried out according to [7].

**Results and discussion**

The chemical composition of the factory surfacing is determined, %: C – 0.34; Si – 0.37; Mn – 1.2;
Cr – 5.0; Mo – 0.9; Ni – 1.0; V – 0.15; W- 0.9, the thickness of which is about 10 mm. The chemical composition of the base metal %: C – 0.43; Si – 0.22; Mn – 0.5; Cr – 1.2; Mo – 0.3; Ni – 4.1.

Below are the results of investigations the surface layer a part by a magneto-noise method (Fig. 2) and acoustic emission analysis (Fig. 3).

At point 8 of the measurement delay time acoustic waves (Fig. 3), changes in their lengths can be observed. At point 6 (Fig. 2) there is a jump in the indices of the magnetic noise. Indications may indicate the presence of structural changes and possible microcracks.

Fig. 2. The results of measurements of the magnetic noise level of the sample surface
Zones with a change in the amplitude of acoustic waves and the intensity of magnetic noise on a sample with an imported surfacing were found, samples for microstructure research and microhardness measurements were cut from this zone, the following results were obtained.

![Graph of values of delay time of amplitudes of acoustic waves](image)

**Fig. 3.** Graph of values of delay time of amplitudes of acoustic waves

![Worn detail of the "axis" of the pair of bushing-axis of the P & H 2800 XPC excavator](image)

**Fig. 4.** Worn detail of the "axis" of the pair of bushing-axis of the P & H 2800 XPC excavator – a, a sample with an imported surfacing – b

In the metallographic study, the interface between the layers was revealed, as well as the microstructure of the deposited and base metals (Fig. 4, b). In the cross-section, the initial sample of the "axis" part consists several layers (Fig. 4, b) a = 1.12 mm, b = 2.61 mm, c = 7.92 mm, which differ in their degree of etching, microstructure and size Grains. The structure of surfacing at the boundary of the HAZ and the base metal is a ferritic cement mixture with dendrites that transform into a weld metal, the microhardness is from 305 to 501 HV. The boundary of the HAZ and the welded metal layer, is characterized by high microhardness heterogeneity, which is from 438 to 590 HV, the structure is martensite. Increased, relative to other areas of surfacing, hardness is probably due to an increased cooling rate of the lower part of the liquid phase of the bath.

Microcracks (Fig. 5, a) with a size of 0.14 were found in the section "c" (Fig. 4, b); 0.05; 0.06 and 0.09 mm, the layer is characterized by a sharp transition of microhardness from 305 to 501 HV (HAZ). Microcracks are oriented in one direction in the direction of tensile stresses, but at different angles. In the zone "b" (Fig. 4, b), microcracks were also detected, but in a smaller quantity than in the section "c" (Fig. 4, b), the size reached 0.2 mm, while the microhardness values were From 540 to 438 HV (Figure 5, d, e).
The etching of layer "a" (Fig. 4, b), subjected to shock loads, was performed in a 2% solution of HNO$_3$ ethyl alcohol and investigated at an increase of 130 and 800 times, a deformed metal structure was revealed.

Based on the results of metallographic studies, micro cracks were detected in areas with acoustic waves and the level of magnetic noise, and the boundaries site to be sampled were determined.

Fig. 5. Microstructure of HAZ and weld metal with microcracks:
- a, b - microhardness from 305 to 501 HV;
- c - microhardness from 499 to 416 HV;
- d - microhardness from 416 to 590 HV;
- e - microhardness from 540 to 438 HV

To restore the details, the flux-cored wire was used by NIIMONTAZH, Krasnodar city. Surfacing was carried out under a layer of AN-60 flux, 35X5GFNVM flux-cored wire 2.0 mm in diameter, current - 250 A, voltage 26-28 V. Before surfacing, the original layer was not removed.

The results of the studies by spectral-acoustic analysis and the magneto-noise control method are presented below (Fig. 6, 7).

Fig. 6. Graph of the delay time values of the amplitude of acoustic waves, the reconstructed part...
The graphs (Figures 6, 7) show that there are no zones with a sharp change in the lengths of acoustic waves and the level of magnetic noise in the section with mechanized surfacing. This indicates that there is no change in structure and mechanical properties.

The metallography of the deposited layer was performed, the structure is fine-grained, the grain number is 7 [8]. Defects in the fusion zone of the initial (import) and reductive surfacing were found. The values of the microhardness deposited layer reach, on average, 450 HV.

Fig.7. Results of measurements of the level of magnetic noise, the surface of the restored part

Conclusions
1. The untimely repair of the details of the LOW machines leads to their accelerated wear.
2. The boundaries of separation of layers, identified by acoustic method and metallographic studies, coincide.
3. The use of a magnetic-noise control method and spectral-acoustic analysis helps to quickly determine the boundaries of the damaged area, reduce the amount of weld metal, reliably determine the quality repair.

This work was supported by a grant from the RNF, agreement № 14-09-00724 and a grant from the President of the Russian Federation to support young candidates of sciences, MK-1341.2017.8.

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