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ON ASSESSMENT OF RESIDUAL LIFE OF METAL CONSTRUCTION OF HOISTING MACHINES USING THE PARAMETER OF THE COERCIVE FORCE

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Abstract: According to the Rules of the device and the safe operation of hoisting machines [1], after the crane worked its legal life, it is necessary to assess its remaining lifetime and make a conclusion about the possibility of further exploitation.
Keywords: *residual life, hoisting machines, the coercive force.*

The question of the method for estimating the residual life of hoisting machines is especially acute in connection with the fact that over 80% of handling equipment in Ukraine expended its service life. However, to date there is no full-fledged methodology for assessing the residual life. The most common method - testing of metal cut from the most loaded places on metal structures. Using this method is associated with certain difficulties: the need to unload structure before the work will be undertaken; preparation of repair documentation for the repair of excavated areas of the metal; the use of welding in a dangerous place. In connection with the above-mentioned limitations of the destructive testing method is recommended to use non-destructive method of control. In this case, the conclusion about the state of the metal is based on any properties of the metal (the corrosion current, hardness, elongation, impact strength, etc.). Basic requirement in the selection of this property - it is a good correlation between the change and the damage accumulation in metal structures.

Recently, the method of the coercive force began to apply for the diagnosis of crane metal structures. Existing guidelines on definition of metal structure state based on the values of the coercive force (Hc) [2] indicate the difference of Hc changes, but it gives the results of the experiment only for the four levels of tension.

The main aim of the report is to propose a model through which you can find the variation of coercive force at random level of tension.

For a basis of taken data from the experiment described in source [2] (Appendix 6).

The experiment consisted of the following: 4 flat sample 400x65x6 (St3sp5) were subjected to cyclic loading at maximum stress cycle, 200, 250, 300, 350 MPa, respectively. Hc were measured in the process of loading, after a certain number of cycles in a dangerous cross section. As a result - received four depending: H on the number of loading cycles, respectively, for the four levels of stress (Fig. 1).

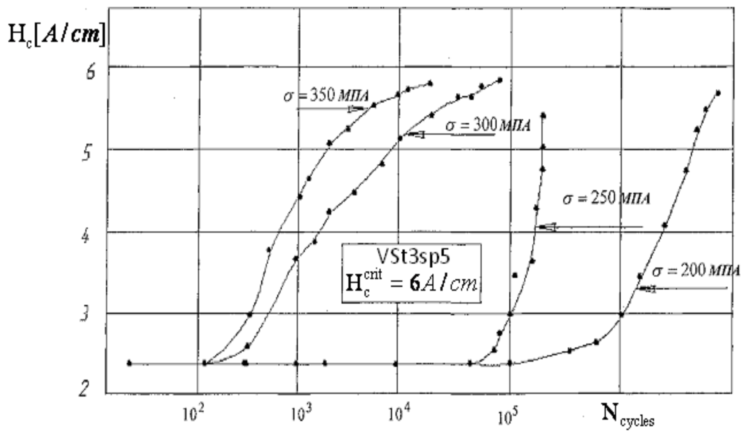


Fig. 1 Dependence of the Hc parameter of the number of loading cycles of the sample

If the expert in examination of metal gets in a dangerous element of the coercive force of Hc = 4 A / cm, then this information is not sufficient to assess the extent of accumulated damage. For uniqueness it is necessary to know what stresses acting in the element, because for high (350MPa) operating tension value Hc = 4 A / cm corresponds to 95% residual life (Fig. 2), and for low tension (200 MPa) - 10% residual resource.

For the convenience of further considerations we construct the dependence of Hc = f (N) (Fig. 1) in the coordinates of Hc, D (Fig. 2). By "D" we mean the damage of accumulated in the metal under the action of a certain number of cycles. According to the linear hypothesis of damage accumulation,

$$D = \frac{n}{N}, \quad (1)$$

where n - number of cycles of loading the sample;
N - number of cycles of loading the sample before destruction.

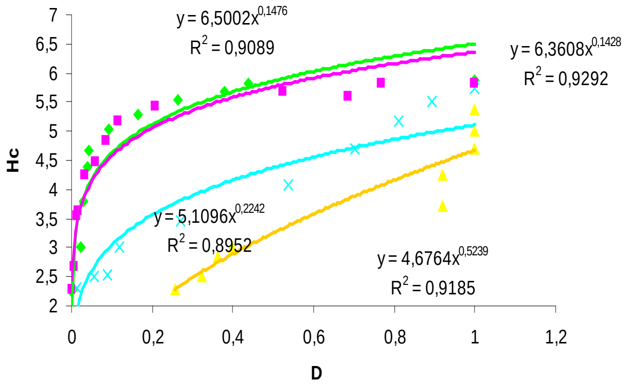
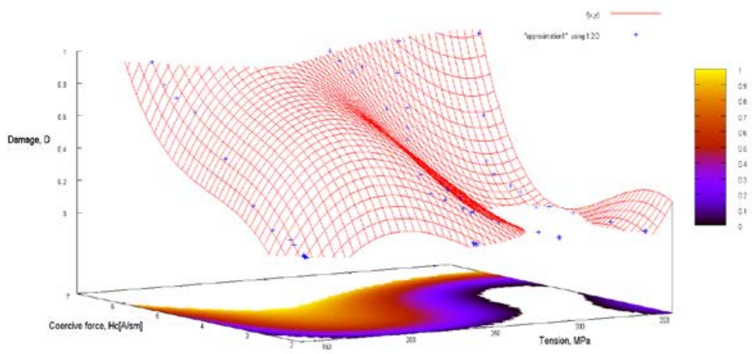
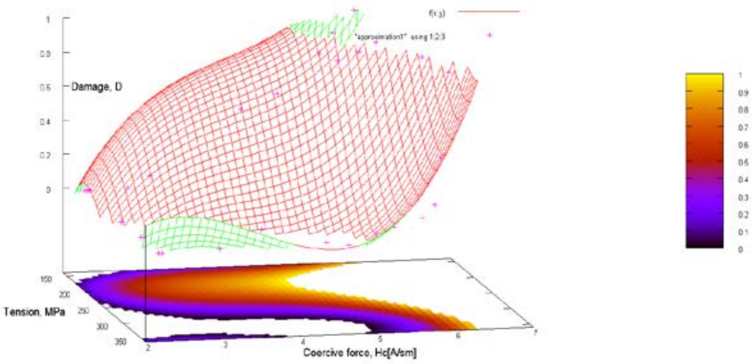


Fig. 2 Dependence of the Hc parameter of the damage of the metal sample (green - 350 MPa, magenta - 300 MPa; turquoise color - 250 MPa; yellow - 200 MPa).

To overcome emerging complexities was constructed approximating polynomial on the basis of experimental data. The approximation was performed by least squares using the program named "Gnuplot". The figure 3 shows the graph of the approximating polynomial and the experimental points.



a)



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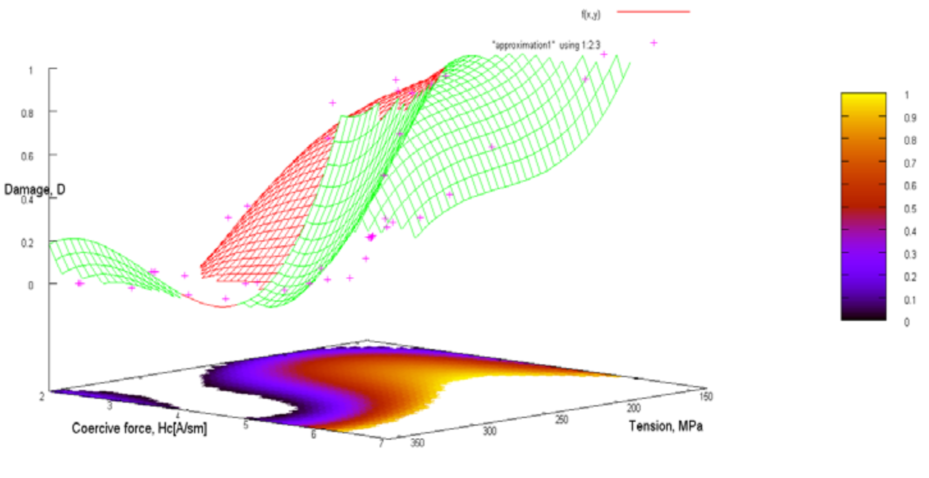

c)

Figure 3 Approximating curves and experimental data

Analytical expression for the polynomial has the form:

$$\begin{aligned} D(\sigma, H_c) &= 0.705418 \cdot 10^{-6} \cdot \sigma^3 + 0.0586377 \cdot H_c^3 - 1.17296 \cdot 10^{-5} \cdot \sigma^2 \cdot H_c + \\ &+ 0.00042347 \cdot \sigma \cdot H_c^2 + 0.00131768 \cdot \sigma \cdot H_c - 0.000511574 \cdot \sigma^2 - \\ &- 0.759132 \cdot H_c^2 + 0.125177 \cdot \sigma + 2.96663 \cdot H_c - 13.3748 \end{aligned}$$

Knowing tension in the metal site and the coercive force it possible to determine the degree of accumulated fatigue damage.

Using this mathematical model we can predict with 95% probability that the accuracy of the damage will be located within 30% of the absolute error.

Diagnosis of metal structure by parameter of the coercive force is rapid method for estimating the damage of the metal. After finding dangerous places should be adopted a more precise (and as well, less productive), another method, such as scattering of the hardness.

CONCLUSION

The dependence of the coercive force of the number of cycles, who have spent hoisting machine, not clear-cut and varies depending on the magnitude of maximum stress cycle.

To assess the residual life of metal structures of hoisting machines is necessary to know the law changing of coercive force at each level of tension.

The authors of the article proposed a model by which you can find the degree of damage of site metal structure with random value of tension.

Shown that the expert survey in conjunction with the measurement of the parameter of the coercive force is necessary to determine the level of tension (theoretical and experimental methods)

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[2] Guidelines for the control of magnetic stress and strain of lifting metal structures and determination of their residual life. MV 0.00-7.01-05. Conveying Academy of Ukraine.