4.2.16. NEW METHODS FOR MECHANICAL PROPERTIES EVALUATION OF STEEL STRUCTURES WITH CONSIDERATION OF ITS MICROSTRUCTURE

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Problem of reliable determination of actual technical condition of large number of metallic constructions in basic branches of industry is inseparably linked with the determination of actual physical and mechanical properties of the material of such structures by means of non-destructive testing.

Metallic structures that are used in oil and gas industry are subjected to numerous static and cyclic, compression and bending loads and their combinations that are often alternating. This results and influence of the corrosive damage and fluctuation in temperature cause change of actual physical and mechanical properties and microstructure in the metal structures over long period. The above mentioned factors have negative impact on the residual life of the object and may be the reason of fatigue defects initiation and structural damage.

The paper reviews the results of theoretical investigations aimed on improvement of methods for the determination of actual physical and mechanical properties of steel structures with consideration of its microstructure.

Physical and mechanical properties changes is conditioned by structural changes of metal. Previously the relationship of resistivity with structural changes in long-term used metallic constructions has been proved.

Following this idea structural changes could be estimated and then mechanical properties of steel structures could be evaluated with consideration of its microstructure. Previously new method for determination of physical and mechanical properties has been suggested. It is based on the measurement of hardness and parameter that characterizes thermal conductivity and their usage for the calculation of yield stress values by means of artificial neural networks algorithms. For the implementation of the above mentioned method, a special device called FMH-1 has been developed [1].

In this paper such structural-sensitive parameters as thermal conductivity and resistivity are being evaluated for estimation of steel microstructure. Thermal conductivity and electrical conductivity relationship for the pure metals is governed by Wiedemann-Franz law. Our idea was to verify Wiedemann-Franz law for microstructure evaluation of carbon steels. The referenced data for 142's foreign steel grades with different structure type (austenitic, martensitic, ferritic, duplex) were used. Method is based on difference of thermal conductivity to electrical conductivity ratio for different steel grades. And we found this difference as structure dependent.

Calculations showed that structure identification is possible for two steel groups. The first group contains austenitic and duplex steels, second group contains martensitic and ferritic steels.

Next stage in the work was to use integrated approach to the determination of yield stress with using artificial neural networks algorithms for approximation of the dependence of mechanical property as a nonlinear function of three parameters (hardness, thermal conductivity and resistivity) within the same structural group.

Thus we have developed new method of physical and mechanical properties evaluation of steel structures which lies in:

– determination of steel structural group after analysis of the thermal conductivity and resistivity relationship (according to the Wiedemann-Franz law);

– yield stress evaluation as a function of such informative parameters as hardness, thermal conductivity and resistivity with the help of artificial neural networks within the same structural type.

We foresee improvement of the proposed method in order to increase evaluation accuracy and extend range of the mechanical properties to be evaluated.

References:

1. **Karpash O., Karpash M.** New neural-based method for evaluation of mechanical properties of steels / Proceedings of 9th International Conference of Non-destructive testing, Berlin, 25–29 September 2006. – P. 114.