

4.2.12. IMPACT OF PLASTIC STRAIN AND ITS CONCENTRATION ZONES ON MAGNETIC CHARACTERISTICS OF CARBON STEEL

Gorkunov E.S., Povoltskaya A.M., Soloviev K.E., Zadvorkin S.M.,
Institute of Machine Science UrO RAS, Yekaterinburg, Russia

Elaboration of methods for evaluation of internal stresses in steel articles is one of the topical tasks of non-destructive testing, since these stresses can sum during operation of metal structures with existed ones and exceed permissible values. Moreover, resistance of steel to destruction is defined in many aspects by local concentrations of internal stresses being the potential centers of crack formation. Presently, magnetic methods for evaluation of stressed-strained state of steel products and, in particular, ones using attached electromagnets, find increasingly wider application. Application of these methods is based on relationships between magnetic characteristics of metal and internal stresses formed in it in the result of plastic deformation, which occur due to magnetoelastic effect inclusively.

Flat breaking-test specimens of normalized carbon steel (0.45% of carbon) were serving as subjects of studies. Following plastic deformation of these specimens by uniaxial tension, clearly pronounced structural non-homogeneities in the form of strips of plastic deformation localization were revealed in them.

Demagnetization current proportional to coercive force and Barkhausen noise parameters (root-mean-square values of voltage and the number of Barkhausen jumps per reversal magnetization cycle) along and normally to the direction of tensile load were measured by means of superposed probes in different points along the whole length of the specimen working portion.

Analysis of obtained dependences of demagnetization current, rms values of voltage and the number of Barkhausen jumps per reversal magnetization cycle on the place of sensors location on a specimen has shown that significant variation of coercive force and Barkhausen noises occur near local non-homogeneities occurring during deformation. Obtained results are explained on the basis of existed notions on anisotropy of internal stresses in preliminarily plastically deformed materials.

Revealed noticeable variation of coercive force values and parameters of Barkhausen noises in the area of probable destruction of deformed specimen (in this case, it is clearly pronounced strips of plastic deformation localization) can serve as a basis for elaboration of magnetic methods for testing the pre-destruction state of elements of steel structures.

Work is performed within the frames of RFFI 09-08-01091-a grant, project under the program of the RAS Presidium "Fundamental problems of interaction mechanics in technical and natural systems" and project under the program OEMMPU RAS "Tri-biological behavior and strength properties of structured materials and surface layers".