1.1.4. EVALUATION OF MECHANICAL STRESSES IN STRUCTURAL STEELS BY DISTRIBUTION OF CRITICAL MAGNETIC FIELDS

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Results of studying the impact of elastic stresses (uniaxial compression, tension and torsion) on the behavior of magnetic characteristics and distribution of critical fields of 15CN4D structural steel are presented. Magnetic measurements by major and minor cyclic hysteresis loops were performed directly in conditions of load applied in closed magnetic circuit under the permeameter diagram.

With increasing of compression stresses, coercive force measured by major hysteresis loop and hysteresis loop obtained during magnetization of specimens up to induction of 0.4 T ("average" magnetic fields), HC and $h_C^{0.4}$, respectively, grows monotonously in value. Herewith, values of residual induction Br and magnetic permeability (both maximal μmax and initial μinit ones) decrease monotonously. Peaks of differential magnetic permeability μdif are shifted in the domain of stronger fields, while their value decreases. In contrary, when extension stresses are increased, HC and $h_C^{0.4}$ are decreased, while Br, μmax and μinit – increased. During tension, peaks of μdif are shifted in the domain of weaker fields, while their value increases. Such behavior of magnetic characteristics in the event of uniaxial extension/compression is explained by negative magneto-elastic effect, which is peculiar to iron-based alloys.

It should be noted that coercive force $h_C^{0.05}$ measured hysteresis loop obtained during magnetization of specimens up to induction of 0.05 T (Rayleigh domain) increases monotonously with decreasing of compression stresses and further on with increasing of extension stresses, i.e. character of its variation is inverse to variation of values HC and $h_C^{0.4}$.

With increasing of elastic tangential stresses, HC decreases, magnetic permeability increases, while Br does not change practically. Peaks of μdif are shifted in the domain of weaker fields, while their value increases. It should be noted that in contrary to the event of extension/compression, $h_C^{0.4}$ depends weakly on the value of tangential stresses. Behavior of $h_C^{0.05}$ during torsion just like during extension/compression is inverse to the behavior of HC: with increasing of tangential stresses, $h_C^{0.05}$ increases.

Distribution of critical magnetic fields during magnetization and reversal magnetization (primary and secondary magnetic rigidity spectra) of examined specimens of 15CN4D steel also varies uniquely with variation of elastic normal and shear stresses. With increasing of compression stress, distribution maximums of critical fields are shifted in the domain of stronger fields, height of maximums decreases, while width – increases. With increasing of extension or torsion stresses, spectra maximums are shifted in the domain of weaker fields.

Unambiguousness of obtained dependences provides conceptual possibility to use studied magnetic characteristics for evaluation of normal and shear mechanical stresses in structural steel.

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