DETERMINATION OF THE PLASTIC DEFORMATION AND RESIDUAL STRESS TENSOR DISTRIBUTION USING SURFACE AND BULK INTRINSIC MAGNETIC PROPERTIES

E. Hristoforou[1], P. Švec Sr.[2]

[1]National TU of Athens, Greece
[2] Slovak Academy of Sciences, Slovakia

e-mail: eh@metal.ntua.gr

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Abstract

We have developed an unique method to provide the stress calibration curve in steels: performing flaw-less welding in the under examination steel, we obtained to determine the level of the local plastic deformation and the residual stress tensors. These properties where measured using both the X-ray and the neutron diffraction techniques, concerning their surface and bulk stresses type II (intra-grain stresses) respectively, as well as the stress tensor type III by using the electron diffraction technique. Measuring the distribution of these residual stresses along the length of a welded sample or structure, resulted in determining the local stresses from the compressive to tensile yield point. Local measurement of the intrinsic surface and bulk magnetic property tensors allowed for the un-hysteretic correlation. The dependence of these local magnetic tensors with the above mentioned local stress tensors, resulting in a unique and almost un-hysteretic stress calibration curve of each grade of steel. This calibration integrated the steel's mechanical and thermal history, as well as the phase transformations and the presence of precipitations occurring during the welding process.Additionally to that, preliminary results in different grade of steels reveal the existence of a universal law concerning the dependence of magnetic and magnetostrictive properties of steels on their plastic deformation and residual stress state, as they have been accumulated due to their mechanical and thermal fatigue and history. This universality is based on the unique dependence of the intrinsic magnetic properties of steels normalized with a certain magnetoelastic factor, upon the plastic deformation or residual stress state, which, in terms, is normalized with their yield point of stress.

Keywords: magnetic properties, residual stresses, diffraction techniques