COMPLEMENTARITY OF EXPERIMENTAL AND NUMERICAL METHODS FOR DETERMINING RESIDUAL STRESS STATES

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Residual stress states in engineering structures are determined usually by measuring components of stress tensors with depth below the material surface. There are destructive and nondestructive methods to measure strain tensor components and converting them into stress tensor components by a variety of techniques derived from constitutive (material) equations. In this study, four methods for determining the strain tensor components are presented: X-ray Diffraction (XRD), Magnetic Barkhausen Noise (MBN), Hole Drilling (HD), and Cut-and-Section (CS) methods; first two are nondestructive, and the third and fourth are semi-destructive and destructive, respectively. However, in many cases, the structures available for residual stress measurements are only parts of much more complex engineering structures. To determine the stress tensor in the complex structures, it is necessary to apply numerical methods in which the experimentally determined stress components are used as initial or boundary conditions in an iterative process to estimate the original stress state. An application of the experimental methods to measure residual stress states in one laboratory specimen, hydrogen-charged milled magnesium, and two industrial components, weld area of a gas pipeline and an L-shaped supporting column and will be presented. A complementarity of the experimental and two numerical methods, Finite Element Method and Boundary Element Method, to determine stress will be demonstrated.

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