1.7.26. DEFORMATION DAMAGE DIAGNOSTICS BY ACOUSTIC EMISSION METHOD

Kozinkina A.I., Vorovich Research Institute of Mechanics and Applied Mathematics SFU, Rostov on Don, Russia;
Berezin A.V., Mechanical Engineering Research Institute of Russian Academy of Sciences, Moscow, Russia

The inclusion of damage accumulation is necessary to a state diagnostics of material and constructions under stress. The acoustic emission method may be considered as a direct method of measurement of defects in the sense that to each collective act of damaging material structure there corresponds a primary elastic impulse which process of radiation represents an act of acoustic emission. Hence, the measurement of intensity of АЭ acts flux and its total number allows investigating a kinetic of damage accumulation. At present paper considered is an acoustic emission procedure for quantitative estimating concentration of defects void – type in metallic construction materials. The idea of many-step behavior of deformation and destruction process as well as the relation between the integrated characteristic of AE acts flux and the peculiarities of this process forms the basis for procedure.

For most of materials, a selection of three stages, namely initial, basic and final ones, is thought to be worthwhile. The initial stage is due to appearance of local stresses and accumulation of defects at microlevel in size of order 1 nanometers. The basic stage consists in formation of incipient voids and its coalescence up to the critical size of order $1…10^2$ microns and more which are commensurable with the sizes of structural heterogeneity of materials. At the given stage, thus, it is formed a local critical loosening which leads to occurrence of the neck or the main crack. The final stage consists in sharp localization of plastic deformation, growth of macrodefect, avalanche destruction.

It has been established, that relationship between the integrated characteristic of AE acts flux and residual strain is close to parabolic. It is approximated by a polygonal line with two characteristic bend points separating the stages of damage accumulation as well as the plastic and the destruction components of residual strain. Alternatively, at consideration of body plastic deformation in view of formation and growth of voids it is possible to show, that its concentration, defined as ratio between volume of voids and volume of a material, is determined by a destruction component of residual strain.

When experimental results, obtained by various techniques, are compared it is apparent that accuracy of defect concentration determination on the basis of AE data is correlated with accuracy of x-ray diffraction method and electronic microscopy method. The obtained values c are also in agreement with various estimations of critical defects concentration at formation macrocrack, received by other researchers. So, in conformity with the destruction statistical theory the initiation of occurs at a local concentration of voids $c \approx 10^{-2}–10^{-3}$. It accords well with the experimental data observable at creep, in the course of lateral rolling, at another metallic materials test.