Česká společnost pro nedestruktivní zkoušení materiálu
37. mezinárodní konference **DEFEKTOSKOPIE 2007**
Praha, 7. - 9. 11. 2007

ACOUSTOELASTICITY – A NEW MANNER OF NONDESTRUCTIVE EVALUATION OF DANGEROUS STRESSED STATES OF GAS AND OIL PIPELINES

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A nondestructive evaluation of mechanical stresses in engineering constructions provides the earlier prediction of their destruction and elimination of further damage. The great importance of nondestructive evaluation of stressed states of bridges, power stations, gas and oil pipelines is evident, because the failure of those civil engineering constructions leads to great amount of human victims and deterioration of environment.

Some problems of relevant prevision of dangerous stressed states of large-sized engineering constructions may be successfully solved on a base of precise ultrasonic measurements of material's acoustoelastic properties [1]. Taking into account the nonlinear terms in the wave equation, one must find the dependence between the velocity of shear or longitudinal wave and the values of the mechanical stresses or strains in the medium. This dependence may be the foundation of the nondestructive manner of the evaluation of stressed states of solids.

The reliability of acoustoelastic manner for applied biaxial stress evaluation in linear pipelines of large (820-1420 mm) diameter was proved experimentally. So, the diameter of steel pipes used in our experiments was 1020 mm and thickness from 9 to 14 mm. The pipes were closed by special steel bottoms and were exposed to inner pressure of water. The precise measurements of time-of flight of shear and longitudinal waves propagated across the plane of stress acting were made before and during the loading.

Special compact device IN-5101A produced by «Encotes» Ltd was using in the experiments. IN-5101A realizes the acoustoelastic effect, e.g. linear dependences between elastic wave velocity and mechanical stresses, and provides reliable measurements of uniaxial and biaxial stresses in different engineering materials under long-term load and different climate environments. The advanced technology for nondestructive testing of mechanical stresses in engineering materials and pipelines was used in our investigations.

The values of stresses acting along and across the pipe axes (axial and circumferential stresses, correspondingly) were automatically evaluated in real time by the special computational block, based on the theoretical studying [1] and placed inside the experimental equipment. The elasticity theory predicts for the thin pipe walls that the «normal» stresses are essentially smaller than axial and circumferential stresses. So, the stressed state of a small part of a thin envelope of the pipe is performed as in-plane stress. The results of our investigations show that the observed data are quite closed to the results of the solution of a problem which was founded by Habriel Lame in 19th century. The difference between stresses, evaluated by ultrasound and by theoretical computations, is not exceed 5-10% of the corresponding steel yield point. So, it in quit good accuracy for nondestructive stress evaluation.