XLII Summer School – Conference
“Advanced Problems in Mechanics”

June 30 - July 5, 2014,
St. Petersburg (Repino), Russia

APM 2014

BOOK OF ABSTRACTS

http://apm-conf.spb.ru

STATIC AND DYNAMIC TECHNIQUES FOR NONDESTRUCTIVE ELASTIC MATERIAL PROPERTIES CHARACTERISATION

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Modern composite materials have promising perspectives for an application in the advanced composite repairs of pipelines. Their technical data could be estimated by using conventional fracture methods or nondestructive technique. In the case of high costs of advanced composites, their experimental testing with conventional fracture methods looks as less effective due to the destructive nature of such experiments. On these reasons different nondestructive techniques have been adapted or developed for a characterisation of advanced composite material properties. There are static approach using three-point-bending test and two dynamic methods, namely, impulse excitation method and inverse technique based on vibration tests.

Tree-point-bending test and impulse excitation method use beam-like specimens for a characterisation of the elastic material properties. Tree-point-bending test allows the determination of Young's modulus of the material in the longitudinal direction of specimen which is calculated in terms of the measured centre deflection, applied load and geometry of a beam. To keep this approach nondestructive, only the elastic behavior of composite beams is allowed. It can be obtained usually for strains less than 0.5%.

Vibration test based on the impulse excitation is adapted for a determination of the elastic properties of small beam samples. This method originally developed for the testing of heavy concrete specimens can be applied for a lightweight structure providing the non-contact vibration excitation and sensing, so that no additional mass will corrupt the resonance frequencies. Beam like specimens used in this method have specific resonances that are determined by the frequency equation. In order to compute the elastic properties, it is necessary to establish dimensions, density and experimental fundamental frequencies in bending and twisting of the beam with free-free boundary conditions.

The basic idea of the inverse technique based on vibration tests of plate-like specimens is that simple mathematical models (response surfaces) are determined only by the finite element solutions in the reference points of the plan of experiments. The identification parameters are obtained minimising the error functional, which describes a difference between the measured and numerically calculated parameters of structural responses.

The present techniques have been successfully applied for a characterisation of the orthotropic material properties of laminated composites. Later these nondestructive techniques have been adapted for a testing of small-dimension specimens to study the elastic properties of aluminum alloys with different carbon nanotubes volume content.

The authors gratefully acknowledge the support of the European Commission, Marie Curie programme, contract no. PIRSES-GA-2012-318874, project "Innovative Non-Destructive Testing and Advanced Composite Repair of Pipelines with Volumetric Surface Defects (INNOPIPES)".