

Damage and Fracture in Metamaterial Plates under Impact Loading

Dmytro Breslavsky¹, Sergii Bondar², Oksana Tatarinova³, Francesco Pellicano⁴, Holm Altenbach⁵

¹ National Technical University «Kharkov Polytechnic Institute», Ukraine. Dmytro.Breslavsky@khpi.edu.ua

² National Technical University «Kharkov Polytechnic Institute», Ukraine. Serhii.Bondar@khpi.edu.ua

³ National Technical University «Kharkov Polytechnic Institute», Ukraine. Oksana.Tatarinova@khpi.edu.ua

⁴ University of Modena and Reggio Emilia, Italy. francesco.pellicano@unimore.it

⁵ Otto von Guericke University, Magdeburg, Germany. holm.altenbach@ovgu.de

Paper ID: 117

[Symposium S8: Fracture, and damage of materials](#)

Abstract

Multilayer panels are widely used in various industrial applications. Recently, the production of their inner layers as metamaterials has become widespread, which allows significantly improving the mechanical properties of such structural elements. The report is devoted to the presentation of the results of experimental research and numerical modeling of deformation, accumulation of hidden damage and fracture of three-layer plates with a metamaterial inner layer, manufactured using laser cutting and 3D printing technology. The results of experimental investigations of specimens from the material of the inner layer and three-layer plates are presented. Data from short-term and long-term tests of specimens at different temperatures, static and impact loading of manufactured three-layer plates are presented. To analyze the stress-strain state and damage accumulation in plates with a metamaterial inner layer, a calculation method based on the solution of the problem of long-term deformation is used. The results of the solution of the problem of impact loading of the plate are considered as initial conditions. For the analysis of rapidly spreading damage, an evolution equation for the scalar damage parameter is used. The formulated boundary – initial value problem is solved based on the combined application of the Finite Element method and the time integration method. The developed software using a three-dimensional finite element in the form of a tetrahedron is used for

modeling. The results of numerical studies are presented and compared with experimental data. The problems of tension and bending of metamaterial plates, impact deformation and fracture of three-layer plates, and damage accumulation in the cells of the inner layer of the plates are considered. Dmytro Breslavsky and Francesco Pellicano acknowledge NATO SPS program, project G6176 “Composite Metamaterials for Aerospace Structures -CoMetA” for the financial support.

Keywords:

Metamaterial Plate Impact Damage Fracture Boundary – initial value problem