

FORCED VIBRATIONS OF A THREE-LAYERED DOUBLE-CURVED SHELL WITH AN ELASTIC HONEYCOMB CORE

*A. Pidgorny Institute of Mechanical Engineering Problems
of the National Academy of Sciences of Ukraine
2/10 Pozharsky St., Kharkiv 61046, Ukraine; e-mail:admi@ipmach.kharkov.ua*

This paper presents a mathematical model of vibrations of a three-layered double-curved shell under geometrically nonlinear deformation. The middle layer is a honeycomb manufactured using FDM additive technologies. The mechanical properties of the honeycomb were assessed by a homogenization procedure. The outer layers of the shell are thin, and they are made of carbon-filled plastic. The model is based on a higher-order shear theory and accounts for the orthotropy of the mechanical properties of all the shell layers. Each layer of the shell is described by five variables (three displacement projections and two rotation angles of the normal to the middle surface). The properties of linear vibrations were studied using discretization by the Rayleigh–Ritz method. Because the middle layer of the shell is far lighter and more compliant in comparison with the outer layers, the computational process has some features. The eigenfrequencies and eigenmodes of the shell were found for a further analysis of nonlinear vibrations. The mathematical model of forced vibrations of the shell under geometrically nonlinear deformation is a system of nonlinear ordinary differential equations derived by the assumed-mode method. Nonlinear periodic vibrations and their bifurcations were studied using a numerical procedure, which is a combination of the continuation method and the shooting technique. The properties of the nonlinear periodic vibrations and their bifurcations in the regions of fundamental and subharmonic resonances were studied numerically. A spherical panel and a hyperbolic paraboloid panel were considered. It was shown that when a disturbing force is applied at a point out of the panel's center of gravity, the panel's eigenmodes interact, and the frequency response and the bifurcation diagram change qualitatively in comparison with the case where that force is applied at the panel's center of gravity. An agreement between the results was studied as a function of the number of terms in the Rayleigh–Ritz and assumed-mode expansions.

Keywords: *three-layered structure, nonlinear vibrations, bifurcations, forced vibrations, orthotropic material.*

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