Nonlinear free vibration of a composite rectangular specially-orthotropic plate with variable fiber spacing

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Abstract

The geometrically nonlinear free vibration of a composite rectangular plate with variable fiber spacing is investigated. The investigation is limited to a single ply composite having straight and parallel fibers. The fibers are distributed more densely in the central region where high stiffness is needed than in other regions. The assumptions of von Karman's nonlinear thin plate theory are made. The problem is solved numerically using the hierarchical finite element method. The nonlinear equations of free motion are mapped from the time domain to the frequency domain using the harmonic balance method. The resultant nonlinear equations are solved iteratively using the linearized updated mode method. Results for the fundamental linear and nonlinear frequencies are obtained for simply supported and clamped composite square plates with three variable distributions of E-Glass, Graphite, and Boron fibers in Epoxy matrices. The efficiency of the hierarchical finite element procedure is demonstrated through convergence and comparison with published data. The variable fiber spacing, fiber volume fraction, type of fiber material, and boundary conditions are shown to influence the hardening behavior.

Keywords

- Composite rectangular plate;
- Variable fiber spacing;
- Geometrical nonlinearity;
- Free vibration;
- Hierarchical finite element method