Abstract

This dissertation is devoted to the analysis of the active constrained layer damping **(ACLD)** of geometrically nonlinear transient vibrations of laminated composite structures. The constraining layer of the **ACLD** treatment is considered to be composed of either the vertically/obliquely reinforced 1-3 piezoelectric composite (**PZC**) or the active fiber composite (**AFC**) material. The Golla-Hughes-McTavish **(GHM)** method is implemented to model the constrained viscoelastic layer of the **ACLD** treatment in time domain. First, the performance of the vertically reinforced 1-3 **PZC** as the material of the constraining layer of the **ACLD** treatment for controlling the geometrically nonlinear vibrations of laminated composite beams and plates has been investigated. These analyses reveal that the **ACLD** treatment, in which the constraining layer is made of the vertically reinforced 1-3 **PZC** material, appreciably controls the geometrically nonlinear vibrations of the laminated composite beams and plates. Further investigations are carried out to evaluate the performance of the vertically/obliquely reinforced 1-3 **PZC** and the **AFC** as the materials of the constraining layer of the **ACLD** treatment for controlling the geometrically nonlinear vibrations of doubly curved laminated composite shells.

Finally, a novel type of doubly curved functionally graded (**FG**) laminated composite shell is proposed and the **ACLD** of geometrically nonlinear vibrations of such **FG** laminated composite shell has been analyzed under a thermal environment using 1-3 **PZC** and **AFC** materials. The novel constructional feature of this shell is that the fiber orientation angle in each layer of the shell varies across the thickness of the layer according to a power law. Thus the material properties of the layer vary across the thickness of the layer with respect to the laminate (global) coordinate system. In all cases, backbone curves are derived to determine the level of the amplitude of the uncontrolled response due to which substantial geometric nonlinearity is present in the uncontrolled response.

Emphasis has been placed on investigating the effects of the variation of piezoelectric fiber orientation angle in the 1-3 **PZC** as well as in the **AFC** constraining layer on the damping characteristics of the overall laminated structures.

Key words: Active constrained layer damping treatment; 1-3 piezoelectric composite materials; Active fiber composites; Nonlinear vibration.