Abstract

This dissertation is devoted to the analysis of the active constrained layer damping (**ACLD**) of geometrically nonlinear vibrations of sandwich plates and shells composed of laminated composite facings, functionally graded (**FG**) facings and fuzzy fiber-reinforced-composite (**FFRC**) facings. The constraining layer of the **ACLD** treatment is considered to be composed of the vertically/obliquely reinforced 1-3 piezoelectric composite (**PZC)** material. Based on the layerwise displacement theories and the von Kármán type geometrically nonlinear strain-displacement relations, three dimensional nonlinear electro-mechanical finite element (**FE**) models of the overall sandwich plates and shells integrated with the patches of the **ACLD** treatment have been developed. Since the analysis is carried out in the time domain, the viscoelastic layer of the **ACLD** treatment is modeled by using the Golla-Hughes-McTavish (**GHM**) method. Backbone curves are derived to determine the level of the amplitude of the uncontrolled response such that the substantial nonlinearity is present in the uncontrolled response. The analyses reveal that in case of controlling the geometrically nonlinear vibrations of laminated composite sandwich plates, the performance of the **ACLD** treatment is maximized if the constraining layer is made of the vertically reinforced 1-3 **PZC** material while the constraining layer composed of the obliquely reinforced 1-3 **PZC** extremizes the performance of the **ACLD** treatment for controlling the geometrically nonlinear vibrations of doubly curved laminated composite sandwich shells. The investigations carried out on the **ACLD** of geometrically nonlinear vibrations of functionally graded (**FG**) sandwich plates and shells reveal that the decay time in case of the **FG** sandwich plates and shells with flexible HEREX C70 130 honeycomb core is much smaller than that in case of the same with ceramic core. The analyses also reveal that the **ACLD** treatment in which the constraining layer is made of the vertically reinforced 1-3 **PZC** exhibits maximum capability of causing active damping of geometrically nonlinear vibrations of both the **FG** sandwich plates and shells unlike the previous case of doubly curved laminated composite sandwich shells.

Finally, a novel type of **FFRC** sandwich plates and shells is considered wherein

the facings are composed of the **FFRC** laminates and the **ACLD** of geometrically nonlinear vibrations of such **FFRC** sandwich plates and shells using 1-3 **PZC** materials has been studied. The novel constructional feature of the **FFRC** laminate is that the short carbon nanotubes (**CNT**s) which are either straight or wavy are radially grown on the periphery of the long continuous carbon fiber reinforcements of the **FFRC** lamina. The analyses reveal that the **ACLD** treatment in which the constraining layer is made of the vertically reinforced 1-3 **PZC** material maximizes the damping of the geometrically nonlinear vibrations of the **FFRC** sandwich plates while the constraining layer composed of the obliquely reinforced 1-3 **PZC** maximizes the controllability of the **ACLD** treatment for causing active damping of the geometrically nonlinear vibrations of doubly curved **FFRC** sandwich shells. The investigation also reveals that if the fiber reinforcements of the composite facings of the sandwich plates and shells are coated with radially grown straight or wavy **CNT**s, the performance of the **ACLD** treatment increases as compared to that without **CNT**s. More importantly, it is found that the performance of the **ACLD** treatment is better in case of controlling the geometrically nonlinear vibrations of the **FFRC** sandwich plates and shells with wavy **CNT**s than that in case of controlling the same with straight **CNT**s. Thus it is suggested that the wavy **CNT**s can be properly exploited to gain structural benefits from the exceptional properties of **CNT**s and develop high performance smart structures superior to the existing ones.