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Influence of Hygro-Thermo-Mechanical Loading on Buckling and Vibrational Behavior of FG-CNT Composite Beam with Temperature Dependent Characteristics

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Abstract : The authors report here vibration and buckling analysis of functionally graded carbon nanotube-polymer composite (FG-CNTPC) beams under hygro-thermo-mechanical environments using higher order shear deformation theory. The material properties of CNT and polymer matrix are often affected by temperature and moisture content. A micromechanical model with agglomeration effect is employed to compute the elastic, thermal and moisture properties of the composite beam. The governing differential equation of FG-CNTRPC beam is developed using higher-order shear deformation theory to account shear deformation effects. The elastic, thermal and hygroscopic strain terms are derived from variational principles. Moreover, thermal and hygroscopic loads are determined by considering uniform, linear and sinusoidal variation of temperature and moisture content through the thickness. Differential equations of motion are formulated as an eigenvalue problem using appropriate displacement fields and solved by using finite element modeling. The obtained results of natural frequencies and critical buckling loads show a good agreement with published data. The numerical illustrations elaborate the dynamic as well as buckling behavior under uniaxial load for different environmental conditions, boundary conditions and volume fraction distribution profile, beam slenderness ratio. Further, comparisons are shown at different boundary conditions, temperatures, degree of moisture content, volume fraction as well as agglomeration of CNTs, slenderness ratio of beam for different shear deformation theories.

Keywords : hygrothermal effect, free vibration, buckling load, agglomeration
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