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Out-of-Plane Free Vibration of Functionally Graded Circular Curved Beams with Temperature Dependent Material Properties in Thermal Environment

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Abstract : A first known formulation for the out-of-plane free vibration analysis of functionally graded (FG) circular curved beams in thermal environment and with temperature dependent material properties is presented. The formulation is based on the first order shear deformation theory (FSDT), which includes the effects of shear deformation and rotary inertia due to both torsional and flexural vibrations. The material properties are assumed to be temperature dependent and graded in the direction normal to the plane of the beam curvature. The equations of motion and the related boundary conditions, which include the effects of initial thermal stresses, are derived using the Hamilton's principle. Differential quadrature method (DQM), as an efficient and accurate numerical method, is adopted to solve the thermoelastic equilibrium equations and the equations of motion. The fast rate of convergence of the method is investigated and the formulations are validated by comparing the results in the limit cases with the available solutions in the literature for isotropic circular curved beams. In addition, for FG circular curved beams with soft simply supported edges, the results are compared with the obtained exact solutions. Then, the effects of temperature rise, boundary conditions, material and geometrical parameters on the natural frequencies are investigated.

Keywords : out of plane, free vibration, curved beams, functionally graded, thermal environment
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