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Vibration analysis of geometrically imperfect three-layered shear-deformable microbeams

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Abstract

The vibration behaviour of a geometrically imperfect three-layered shear-deformable microbeam is analysed via model development and numerical simulations. Taking into account all the translational and rotational motions, considering continuous variations through the thickness for the displacement field, employing the modified couple stress theory for including small-size effects, and using constitutive relations for both stress and the deviatoric part of the couple stress tensor, the size-dependent elastic energy stored in the three-layered shear-deformable microbeam is obtained. The kinetic energy, work of an internal damping mechanism, and the work due to an external harmonic excitation force of the three-layered microsystem are also obtained and dynamically balanced by the size-dependent elastic energy by means of Hamilton's principle. The continuous expressions obtained for the axial, transverse, and rotational motions of the three-layered microsystem are truncated to high-dimensional reduced-order models with the help of a weighted-residual method. Numerical simulations are conducted by means of the backward differentiation formula (BDF) in conjunction with a