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A New Deformation Beam Theory for Static and Dynamic Analysis of Microbeams

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Abstract

In this paper, a new deformation beam theory is proposed for static and dynamic analysis of microbeams. This theory including two unknown functions takes into account shear deformation and satisfies both of shear and couple-free conditions on the upper and lower surfaces of the beam. Based on this deformation beam theory and the modified couple stress model, the governing equations and the related boundary conditions are derived using the principal of the minimum total potential energy. These equations are used to investigate the effect of shear deformation on the static bending, buckling and vibration responses of a simply supported microbeam. In order to evaluate the accuracy and ability of this beam theory in capturing shear deformation effects, the obtained responses for both thick and thin microbeams are compared to the other existing beam deformation theories such as the Euler–Bernoulli, Timoshenko and higher order beam theories. The obtained results for the thick beam reveal that the deflection, natural frequency and the critical buckling load predicted by the proposed beam theory is comparable to those obtained using higher order theories which have more number of unknown functions. With increasing the beam length (thin beams), the difference between the results diminishes as expected.

Keywords: Deformation beam theory, microbeams, Modified couple stress, shear deformation, static and dynamic analysis.

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