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Postbuckling of functionally graded nanobeams based on modified couple stress theory under general beam theory

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Abstract

In this paper, analysis of shear deformable functionally graded (FG) nanobeams in postbuckling based on modified couple stress theory is presented. The nonlinear behavior of postbuckling is defined based on von-Karman geometric nonlinearity. A material-length scale parameter is used to capture the size-dependent behavior of small-scale beams. It is assumed that the material properties (Young's modulus and material-length scale parameter) of FG beam vary across the thickness according to a power law; however the Poisson's ratio is held constant. General beam theory is applied to describe the shear deformation effect. Governing differential equations and boundary conditions are derived using the principle of minimum potential energy. This study presents exact and generalized differential quadrature (GDQ) solutions for the static postbuckling response of FGM nanobeams under different boundary conditions. Results of both methods are compared. Difference between postbuckling response obtained by first-order and higher-order beam theories reveals the significant effect of the shear deformation. Moreover, the obtained results indicate that the first-order beam theory has some errors in estimating the amplitude of buckling. Also, effects of length-scale parameter, material gradient, length-to-thickness ratio and Poisson's ratio are presented.

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