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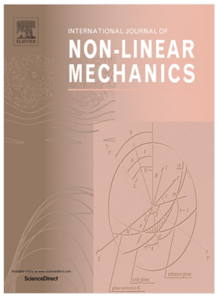

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Numerical Analysis of Nonlinear Free and Forced Vibrations of buckled Curved Beams Resting on Nonlinear Elastic Foundations

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Abstract

This paper presents a novel numerical procedure to predict nonlinear free and steady state forced vibrations of clamped-clamped curved beam in the vicinity of postbuckling configuration. Nonlinear Euler-Bernoulli kinematics assumptions including mid-plane stretching are proposed to exhibit a large deformation but a small strain of von Kármán. To simulate the interaction of beam with the surrounding elastic medium, nonlinear elastic foundation with cubic nonlinearity and shearing layer are employed. The nonlinear integro-differential equation that governs the buckling of beam is discretized using the differential-integral quadrature method (DIQM) and then is solved using Newton's method. The problem of linear vibration is discretized using DIQM and then is solved as a linear eigenvalue problem. Afterwards, a single-mode Galerkin discretization is used to reduce the nonlinear governing equation into a time-varying Duffing equation. The Spectral differentiation matrix operators are exploited to discretize the Duffing equation. The discretized Duffing equation is a nonlinear eigenvalue problem which is directly solved using pseudo arc length continuation method. Results obtained by the proposed numerical solution are compared with analytical solutions available in the literature and good agreement is obtained. Parametric studies are carried out to show the effects of applied axial load, imperfection and nonlinear elastic foundations on the natural frequency as well as forced damped vibration behavior of the beam. The above mention effects play very important role on the dynamic behavior of buckled curved beam.

Keywords: Differential integral quadrature method (DIQM), Spectral collocation method, Nonlinear integro-differential equation, Curved beam, Nonlinear vibration, imperfection.