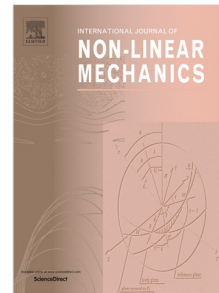


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Dynamics of a mass-spring-beam with 0:1:1 internal resonance using the analytical and continuation method

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Abstract

The nonlinear harmonic response of an autoparametric system comprised of a linear oscillator with a vertically attached flexural beam is investigated and the capability of the beam as a vibration absorber is assessed. A weak torsional spring is used for constraining the rotation of the beam giving rise to an almost non-flexural rotational mode with a low frequency. The system parameters are also tuned to enforce the zero-to-one-to-one internal resonance condition. The Lagrange's formulation accompanied by the assumed-mode method is used to derive the discretized equations based on the order three nonlinear Euler-Bernoulli beam theory. An analytical solution is developed based on the method of multiple scales where the generalized coordinate corresponding to the non-flexural rotational mode is approximated by higher order perturbation expansion than the other coordinates, due to much larger contribution of the non-flexural rotation to the response. Comprehensive response and bifurcation analysis are performed using analytical and direct numerical solutions. The results are obtained for vertically-aligned and also initially inclined beams and various interesting behaviors are recognized for different non-dimensional system parameters. Different types of bifurcations such as the Pitch-fork, Hopf, Period-doubling and symmetry breaking bifurcations are observed in the solution of slow-flow equations and some of them are found to be beneficial for vibration absorption in a limited range of excitation amplitudes and frequencies.

Keywords: zero-to-one-to-one internal resonance, flexural pendulum beam, simultaneous non-flexural and elastic deformation, quasi-periodic oscillation

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