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Frequency analysis of finite beams on nonlinear KelvinVoight foundation under moving loads

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Abstract

The vibration of an EulerBernoulli beam, resting on a nonlinear KelvinVoight viscoelastic foundation, traversed by a moving load is studied in the frequency domain. The objective is to obtain the frequency responses of the beam and the effects of different parameters on the system response. The parameters include the magnitude and speed of the moving load and the foundation nonlinearity and its damping coefficient. The solution is obtained by using the Galerkin method in conjunction with the multiple scales method (MSM). The governing nonlinear partial differential equations of motion are discretized into sets of nonlinear ordinary differential equations. Subsequently, the solution is calculated for different harmonics by using the MSM as one of the powerful perturbation techniques. The steady-state responses of the main harmonic as well as its two super-harmonics are then obtained. As a case study, a conventional railway track is dynamically simulated and the jump phenomenon in the response is observed for three harmonics. Moreover, a thorough stability analysis of the system is carried out. © 2010 Elsevier Ltd.

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Index Keywords

Damping coefficients; Euler Bernoulli beams; Finite beams; Frequency Analysis; Frequency domains; Jump phenomenon; Moving load; Multiple scales methods; Non-Linearity; Nonlinear ordinary differential equation; Nonlinear partial differential equations; Railway track; Stability analysis; Steady-state response; Superharmonics; System response; Viscoelastic foundation
Engineering controlled terms: Control nonlinearities; Equations of motion; Frequency response; Galerkin methods; Harmonic analysis; Ordinary differential equations; Partial differential equations; Perturbation techniques; Railroads
Engineering main heading: Nonlinear equations

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