

Forced Vibrations of 3D Beams with Large Amplitudes

S. Stoykov, P. Ribeiro

A p-version finite element and the harmonic balance methods are used to investigate the geometrically nonlinear forced vibrations of 3D beams with rectangular cross section. The beam theory used in the model is based on Timoshenko's theory for bending and Saint-Venant's for torsion. The beam may experience longitudinal, torsional and bending deformations in any plane. The equation of motion is derived by the principle of virtual work; employing the harmonic balance method it is converted into a nonlinear algebraic form and then solved by a continuation method. Because the nonlinear equation of motion presents quadratic and cubic nonlinearities, one constant term and the first three harmonics are assumed in the Fourier series. A force which excites both bending and the torsional displacements is applied and the response curves are derived and the characteristics of the motions are investigated using time plots, phase planes and Fourier spectra.