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Forced vibration response of axially functionally graded non-uniform plates considering geometric nonlinearity

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Abstract

Nonlinear forced vibration analysis on axially functionally graded (AFG) non-uniform plates has been carried out in the present study. Nonlinear strain displacement relations are used to incorporate geometric nonlinearity in the system. The problem is formulated using energy method and governing equations are derived on the basis of Hamilton's principle. An indirect approach is adopted for solving the problem where, the problem is reduced to a static case by assuming that the dynamic system fulfils the force equilibrium conditions at maximum amplitude of excitation. One of the multidimensional Secant methods, known as Broyden method, is utilized for solving the set of nonlinear equations. Different combinations of clamped and simply supported boundary conditions are considered in the analysis and generated results are furnished in non-dimensional frequency-amplitude plane. Taper parameter and excitation amplitude are observed to significantly affect the forced vibration response of the plates. The deflection shapes for various boundary conditions are presented and the forced vibration response in the proximity of second mode is also investigated. The results of the present analysis are validated with the studies available in the literature.

Keywords:

axially functionally graded plate; frequency-amplitude response; deflection shape; variational approach; Hamilton's principle;

List of symbols

A_0	Cross-sectional area of the plate at ($\xi=0,\ \eta=0$)
a	Length of the plate
b	Width of the plate
d_i	Unknown coefficients
E_0	Elastic modulus of the plate material at ($\xi=0$)
$\{f\}$	Load vector
I_0	Moment of inertia of the plate at ($\xi=0$)
k	Material gradient parameter
[K]	Stiffness matrix
[M]	Mass matrix