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Nonlinear free vibration of functionally graded shear deformable sector plates by a curved triangular p-element

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Abstract :

A *p*-version of the finite element method based on a curved triangular *p*-element is developed and applied to nonlinear free vibration analysis of functionally graded sector plates. The material is assumed to be temperature dependent and graded in the thickness direction according to the power-law distribution in terms of volume fractions of the constituents. In the geometrically nonlinear formulation, the Von Karman assumptions with Mindlin first-order shear deformation theory are used. The shape functions are constructed from the shifted Legendre orthogonal polynomials. The curved edge of the sector plate is represented accurately using the blending function method. The nonlinear equation of motion is obtained using the harmonic balance method and solved iteratively using the linearized updated mode technique. The linear and nonlinear frequencies are calculated for a functionally graded SUS304/Si_3N_4 clamped circular plate. The accuracy of the proposed method is demonstrated through convergence and comparison studies. Sector plates made out of three types of functionally graded materials (SUS304/Si_3N_4, AL/AL_2O_3, AL/ZrO_2) are considered. The effects of sector angle, thickness, and volume fraction exponent on the hardening behavior of a clamped sector plate are also investigated. It is shown that the increase or decrease of the hardening behavior depends upon these parameters.

Keywords

Geometrically nonlinear free vibration; Functionally graded material; Mindlin plate theory; Sector plate; Curved triangular *p*-element.

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