World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:14, No:12, 2020

Geometrically Non-Linear Axisymmetric Free Vibration Analysis of Functionally Graded Annular Plates

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Abstract : In this paper, the non-linear free axisymmetric vibration of a thin annular plate made of functionally graded material (FGM) has been studied by using the energy method and a multimode approach. FGM properties vary continuously as well as non-homogeneity through the thickness direction of the plate. The theoretical model is based on the classical plate theory and the Von Kármán geometrical non-linearity assumptions. An approximation has been adopted in the present work consisting of neglecting the in-plane deformation in the formulation. Hamilton's principle is used to derive the governing equation of motion. The problem is solved by a numerical iterative procedure in order to obtain more accurate results for vibration amplitudes up to 1.5 times the plate thickness. The numerical results are given for the first axisymmetric non-linear mode shape for a wide range of vibration amplitudes and they are presented either in tabular form or in graphical form to show the effect that the vibration amplitude and the variation in material properties have significant effects on the frequencies and the bending stresses in large amplitude vibration of the functionally graded annular plate.

Keywords : non-linear vibrations, annular plates, large amplitudes, functionally graded material
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020