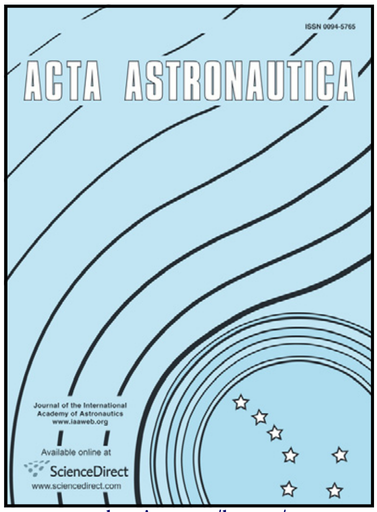

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S. Sahmani, M. Bahrami, R. Ansari

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Surface effects on the free vibration behavior of postbuckled circular higher-order shear deformable nanoplates including geometrical nonlinearity

S. Sahmani[1], M. Bahrami[*1], R. Ansari[2]

[1]*Department of Mechanical Engineering, Amirkabir University of Technology, P.O. Box 15875-4413, Tehran, Iran*
[2]*Department of Mechanical Engineering, University of Guilan, P.O. Box 41635-3756, Rasht, Iran*

Abstract

This investigation deals with the free vibration characteristics of circular higher-order shear deformable nanoplates around the postbuckling configuration incorporating surface effects. Using the Gurtin-Murdoch elasticity theory, a size-dependent higher-order shear deformable plate model is developed which takes account all surface effects including surface elasticity, surface stress and surface density. Geometrical nonlinearity is considered based on the von Karman type nonlinear strain-displacement relationships. Also, in order to satisfy the balance conditions between the bulk and surfaces of nanoplate, it is assumed that the normal stress is distributed cubically through the thickness of nanoplate. Hamilton's principle is utilized to derive non-classical governing differential equations of motion and related boundary conditions. Afterwards, an efficient numerical methodology based on generalized differential quadrature (GDQ) method is employed to solve numerically the problem so as to discretize the governing partial differential equations along various edge supports using Chebyshev–Gauss–Lobatto grid points and pseudo arc-length continuation technique. A comparison between the results of present non-classical model and those of the classical plate theory is conducted. It is demonstrated that in contrast to the prebuckling domain, for a specified value of axial load in the postbuckling domain, increasing the plate thickness leads to higher frequencies.

Keywords: Nanostructures; Postbuckling; Elasticity; Free vibration; Surface energy effects; Nonlinear dynamics.

1. Introduction

In order to obtain reliable applications of miniaturized electromechanical systems, the mechanical responses of nanostructures need to be analyzed exactly. Therefore, during the last decade, many

[*]Corresponding author. Tel.: +98 21 66405844, Fax: +98 21 66419736.
E-mail addresses: mbahrami@aut.ac.ir (M. Bahrami).