Accepted Manuscript

Surface stress effects on the nonlinear postbuckling characteristics of geometrically imperfect cylindrical nanoshells subjected to torsional load

S. Sahmani, M. Bahrami, M.M. Aghdam

PII: S1359-8368(15)00516-8

DOI: 10.1016/j.compositesb.2015.08.076

Reference: JCOMB 3756

To appear in: *Composites Part B*

Received Date: 23 April 2015

Revised Date: 15 August 2015

Accepted Date: 22 August 2015

Please cite this article as: Sahmani S, Bahrami M, Aghdam MM, Surface stress effects on the nonlinear postbuckling characteristics of geometrically imperfect cylindrical nanoshells subjected to torsional load, *Composites Part B* (2015), doi: 10.1016/j.compositesb.2015.08.076.

Surface stress effects on the nonlinear postbuckling characteristics of geometrically imperfect cylindrical nanoshells subjected to torsional load

S. Sahmani, M. Bahrami*, M.M. Aghdam

Department of Mechanical Engineering, Amirkabir University of Technology, P.O. Box 15875-4413, Tehran, Iran

Abstract

The prime aim of the current investigation is to predict the nonlinear torsional buckling and postbuckling behavior of geometrically imperfect cylindrical nanoshells including surface stress effects. To this end, the size-dependent governing differential equations of cylindrical nanoshell based on von Karman-Donnell-type of kinematic nonlinearity are derived using a combination of Gurtin-Murdoch elasticity theory and the classical shell theory, and employing the principle of virtual work. Subsequently, by considering the transverse displacement and Airy stress function as independent variables, a boundary layer theory is put to use which takes surface stress effects into account in conjunction with the nonlinear prebuckling deformations, large postbuckling deflections and initial geometric imperfection. Finally, an efficient solution methodology based on a two-stepped singular perturbation technique is conducted to obtain the size-dependent postbuckling equilibrium paths of nanoshells. It is revealed that after the minimum point of postbuckling load, by increasing the value of applied torsional load, the difference between postbuckling load-deflection curves corresponding to the perfect and imperfect nanoshells tends to decrease.

Keywords: A. Nano-structures; B. Buckling; B. Elasticity; C. Analytical modeling.

1. Introduction

Shell structures have been widely used in several industries such as aerospace and marine. Many studies to analyze the mechanical behavior of shell structures are available in the literature; see, for example, [1-7]. Additionally, because of the rapidly developing nanoscience and nanotechnology, the applications of nano-electro-mechanical systems (NEMSs) become wider. Due to the requirement of miniaturization of such systems, it is essential to understand the mechanical characteristics of nanostructures exactly in order to ensure their reliable functions. On the other hand, the size-dependent of material deformation response

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