Accepted Manuscript

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PII: S0997-7538(17)30788-X

DOI: 10.1016/j.euromechsol.2018.02.012

Reference: EJMSOL 3555

To appear in: *European Journal of Mechanics / A Solids*

Received Date: 21 October 2017

Revised Date: 26 January 2018

Accepted Date: 20 February 2018

Please cite this article as: Arefi, M., Analysis of a doubly curved piezoelectric nano shell: Nonlocal electro-elastic bending solution, *European Journal of Mechanics / A Solids* (2018), doi: 10.1016/ j.euromechsol.2018.02.012.

Analysis of a Doubly Curved Piezoelectric Nano Shell: Nonlocal Electro-Elastic Bending Solution

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Abstract

Nonlocal electro-elastic bending analysis of a doubly curved nano shell is studied in this paper based on nonlocal elasticity theory and first order shear deformation theory. Nonlocal piezo-elasticity relations are used for analysis of the problem. The doubly curved piezoelectric nano shell is subjected to transverse loads and applied voltage. In addition, the structure is resting on Winkler-Pasternak foundation. The governing equations of nonlocal electro-elastic bending are derived based on principle of virtual work. The nonlocal electro-elastic bending results of doubly curved nano shell are investigated using Navier's method. Influence of nonlocal parameter, applied electric potential, Winkler and Pasternak's parameters of foundation is studied on the mechanical and electrical components of the piezoelectric doubly curved nano shell.

Key words: Doubly curved Piezoelectric Nano Shells; Nonlocal Parameter; Applied electric potential.

1. Introduction

Studying the behaviors of structures in small scales such as micro and nano has been developed in the decade 1970's by introduction of some new non-classical theories. These theories are including Eringen nonlocal theory, strain gradient theory and couple stress theory to predict the behavior of structures in nano or micro scales. Since introduction of these theories many works on the size dependent analysis of nano and micro structures were performed by researchers. Recently combination of size dependent analysis of nano and micro structures with non-classical and non-traditional structures and geometric such as curved beams was developed by researchers. In this work, nonlocal electro-elastic analysis of a doubly curved nano shell is studied based on first order shear deformation theory. a comprehensive literature survey is presented to justify necessity and novelties of this work.

Reddy and Chandrashekhara [1] presented nonlinear dynamic analysis of a doubly curved shell based on shear deformation theories and geometric nonlinear relations. Kapania and Yang [2] studied post-buckling analysis of an imperfect doubly curved shell. The influence of various aspect ratio and imperfections was studied on the results. Fan and Zhang [3] used curvilinear coordinate system to study static and dynamic analysis of the simply supported orthotropic doubly curved shells based on a unified analytical solution for thin, moderately thick, and thick laminated shells. Vibration analysis of geometrically imperfect single and multilayered composite double-curved shallow panels was studied by Librescu and Chang [4] subjected to transverse loads and various in-plane boundary conditions. They studied influence of transverse shear deformations, lamination and various in-plane boundary conditions on the responses of doubly curved shell. Free vibration analysis of doubly curved laminates was studied by Huang [5]. Liew and Lira [6] presented free vibration analysis of