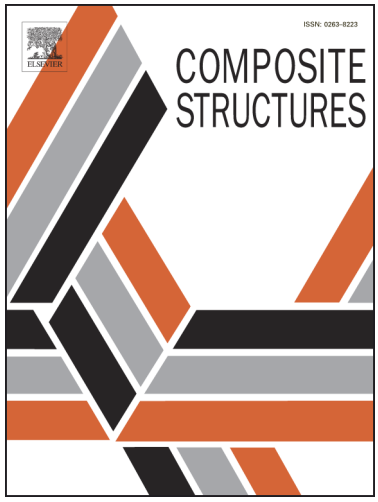

On natural frequencies of Levy-type thick porous-cellular plates surrounded by piezoelectric layers

M. Askari, A.R. Saidi, A.S. Rezaei

PII: S0263-8223(16)32333-9
DOI: http://dx.doi.org/10.1016/j.compstruct.2017.07.073
Reference: COST 8728

To appear in: *Composite Structures*

Received Date: 29 October 2016
Revised Date: 19 June 2017
Accepted Date: 19 July 2017

Please cite this article as: Askari, M., Saidi, A.R., Rezaei, A.S., On natural frequencies of Levy-type thick porous-cellular plates surrounded by piezoelectric layers, *Composite Structures* (2017), doi: http://dx.doi.org/10.1016/j.compstruct.2017.07.073

On natural frequencies of Levy-type thick porous-cellular plates surrounded by piezoelectric layers

M. Askari, A. R. Saidi*, A. S. Rezaei

Department of Mechanical Engineering, Shahid Bahonar University of Kerman, Kerman, Iran

Abstract

In this paper, an analytical solution for free vibration of rectangular porous-cellular plates enclosed by piezoelectric layers is presented by using third-order shear deformation plate theory. Using Hamilton's principle and Maxwell equation, the governing equations of the system are obtained for both closed and open circuit conditions. Due to the coordinate dependency of mechanical properties of porous materials, the governing equations of motion are highly coupled. By using four auxiliary functions, these equations convert into two independent partial differential equations. The decoupled equations are solved analytically by employing Levy-type boundary conditions for the plate. Finally, after validation of the obtained results, the effects of various parameters such as porosity and geometrical dimensions on the natural frequencies of plate are investigated for different electrical and mechanical boundary conditions. It is found that the natural frequencies of the plate decrease as the coefficient of plate porosity increases. Also, the piezoelectric layers cause the natural frequency of the plate to increase in various vibrating modes.

Keywords: Free vibration, Levy-type solution, Porous materials, Piezoelectric materials, Third-order shear deformation theory

1. Introduction

In order to analyze the mechanical behavior of plates, several theories are proposed in which the extension of the displacement field along the plate thickness is different and the number of extended terms is directly related to thickness-length ratio of the plate. To analyze the mechanical behavior of thin plates, it is reasonable to use classical plate theory (CPT). In 1951, Mindlin [1] introduced first-order shear deformation theory (FSDT) that can be considered as a modified model of classical theory for moderately thick plates. This theory, due to considering the displacement induced by shear forces, may be considered as a good alternative for classical theory so as to analyze the moderately thick plates. By increasing the number of extended terms, other theories may be obtained. Following this approach, a new higher-order theory; i.e., Reddy's third-order shear deformation theory (TSDT) has been proposed [2].

* Corresponding author. Tel.: +98-34-32111763, fax: +98-34-32120964
E-mail address: saidi@uk.ac.ir (A.R. Saidi)