

# Accepted Manuscript

Buckling and free vibration analysis of functionally graded sandwich micro-beams resting on elastic foundation by using nonlocal strain gradient theory in conjunction with higher order shear theories under thermal effect

Mohammed Al-shujairi, Çağrı Mollamahmutoğlu



PII: S1359-8368(18)31218-6

DOI: [10.1016/j.compositesb.2018.08.103](https://doi.org/10.1016/j.compositesb.2018.08.103)

Reference: JCOMB 5933

To appear in: *Composites Part B*

Received Date: 20 April 2018

Revised Date: 20 July 2018

Accepted Date: 23 August 2018

Please cite this article as: Al-shujairi M, Mollamahmutoğlu Çağrı, Buckling and free vibration analysis of functionally graded sandwich micro-beams resting on elastic foundation by using nonlocal strain gradient theory in conjunction with higher order shear theories under thermal effect, *Composites Part B* (2018), doi: 10.1016/j.compositesb.2018.08.103.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

# Buckling and free vibration analysis of functionally graded sandwich micro-beams resting on elastic foundation by using nonlocal strain gradient theory in conjunction with higher order shear theories under thermal effect

MohammedAl-shujairi<sup>1,2</sup>, Çağrı Mollamahmutoglu<sup>1,\*</sup>

<sup>1</sup> *Yildiz Technical University, Faculty of Civil Engineering, Department of Civil Engineering, Mechanic Division Davutpaşa Campus, 34210 Esenler-Istanbul, Turkey*

<sup>2</sup> *University of Babylon, Collage of Engineering, Department of Mechanical Engineering, Iraq*

## Abstract

Based on the nonlocal strain gradient theory (NLSGT), and various higher order shear deformation beam theories a formulation for buckling and free vibration of size dependent functionally graded sandwich micro-beams resting on two parameter elastic foundation including Winkler and Pasternak shear layer springs with thermal effects is presented. The sandwich FG micro-beams are assumed to be formed with homogenous ceramic core and ceramic-metal FG skins. According to the Mori-Tanaka homogenization scheme and the classical rule of mixture the material properties of the FG part of the sandwich size dependent beam changes continuously through the thickness of the beam. Equations of motion and the associated boundary conditions are derived via Hamilton's principle. Static buckling loads and natural frequencies are obtained by using generalized differential quadrature method (GDQM) for size dependent sandwich FG beam with different boundary conditions. As original contributions to the literature, the effects of the nonlocal parameter ( $ea$ ), the length scale parameter ( $l_m$ ), aspect ratio ( $L/h$ ), gradient index ( $k$ ), different cross-section shapes, temperature change ( $\Delta T$ ) and stiffnesses of Winkler and shear layer springs ( $K_w, K_s$  respectively) on the buckling and free vibration of the sandwich FG micro-beam are

---

\* Corresponding Author: Tel: +905348859266  
E-mail addresses: cagri.mollamahmutoglu@gmail.com, mollamca@yildiz.edu.tr

Download English Version:

<https://daneshyari.com/en/article/11004199>

Download Persian Version:

<https://daneshyari.com/article/11004199>

[Daneshyari.com](https://daneshyari.com)