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Size-dependent bending and stability analysis of FG nanobeams via a novel simplified first-order shear deformation beam theory

Ismail Bensaid*[1], Ahmed Bekhadda[1] and Bachir Kerboua[2]

[1]*IS2M Laboratory, Faculty of Technology, Mechanical Engineering Department, University Abou Beckr Belkaid (UABT), Tlemcen, Algeria*
[2]*Faculty of Technology, Mechanical Engineering Department, University Abou Beckr Belkaid (UABT), Tlemcen, Algeria*

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Abstract. This paper is concerned to investigate the static bending and buckling response of Functionally Graded (FG) nanobeams by employing a new refined first order shear deformation beam theory. The elegancy of this novel theory is that, not only has one variable in terms of equations of motion as in classical beam theory (EBT) but also accounts for the effect of transverse shear deformation without any requirement of Shear Correction Factors (SCFs). The material properties of FG nanobeam are supposed to change gradually across the thickness direction and are evaluated via the power-law model. Nonlocal elasticity theory of Eringen is incorporated in order to capture the small scale effect into current investigation. The nonlocal governing equations of motion and boundary conditions are obtained through Hamilton's principle and they are solved using analytical solution. The obtained results are compared with some cases existing in the literature. Effect of various parameters such as length to thickness ratio, nonlocal parameter and material index on the static and stability behaviors of the FG nanobeam are perused and discussed in detail.

Keywords: FG nanobeam; nonlocal elasticity theory; bending; buckling; novel refined beam model; one variable shear deformation

1. Introduction

Recent rapid advances in the field of nanotechnology especially in the design of miniaturized devices strongly motivated the industrialists to develop and integrate structural elements such as beams and plates at nano or micro length scale. These nanoscale engineering structures show exceptional mechanical, thermal, magnetic and electrical properties, which led to stimulation in modeling of micro/nano scale structures (Heireche *et al*. 2008a, Alizada and Sofiyev 2011, Ebrahimi *et al*. 2016). It is seen that the size effect has a key role on the static and stability behaviors of material in these applications. Nanosize engineering materials have attracted wide interest in modern science and technology since the invention of Carbon Nanotubes (CNTs) by Iijima (1991). These types of nanostructures have important mechanical, thermal and electrical features that are greater

*Corresponding author, Ph.D., E-mail: bensaidismail@yahoo.fr

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