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A comparative study on estimation of critical buckling temperatures of single-walled carbon nanotubes

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A comparative study on estimation of critical buckling temperatures of single-walled carbon nanotubes.

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ABSTRACT. In this comparative study to estimate the values of critical buckling temperatures of carbon nanotubes, modelled as Timoshenko beam, two new nonlocal elasticity models based on Biot and Kounadis approaches are addressed. The previous results obtained from literature are compared with those obtained from two new models under simple boundary conditions. The comparative results reveal that the differences between critical buckling temperatures obtained from three nonlocal elasticity models is more pronounced ,especially at the high modes and for the short nanotubes.

Keywords: A. Nano-structures, B. Buckling, B. Thermomechanical, C. Analytical Modelling.

1. Introduction

The subject of nonlocal elasticity, containing the small scale effects, has received substantial attention in the last decade. The present literature contains a large number of interesting nonlocal elasticity studies for the different bending , buckling, and vibration problems realized based on the Eringen nonlocal elasticity and Timoshenko beam models. Especially, very recently the significant contributions in this context are developed. New closed form solutions were derived in [1] for Timoshenko nanobeams, by using a nonlocal Eringen-like constitutive law having two material length-scale parameters. An enhanced version of the Eringen differential model with an additional term involving the derivative of the axial stress for the different nanotechnological applications was proposed in [2]. A fully gradient elasticity model for bending of nanobeams was obtained in [3] by using a nonlocal thermodynamic approach. A gradient version of the Eringen uniaxial elastic model was proposed in [4] for functionally graded nanorod. Elastic equilibrium of two-phase random composite beams under torsion, with simply and multiply connected cross-sections, were investigated in [5] and solved by a FEM analysis. New nonlocal models were proposed in [6] starting from a nonlocal thermodynamic approach, for the bending problem of functionally graded Bernoulli-Euler nanobeams. An effective solution procedure based on Laplace transform was developed in [7] for torsion of functionally graded nonlocal viscoelastic circular nanobeams.

Due to the superior properties, the carbon nanotubes have many potential applications subjected to the temperature effect such as nanoscale sensors, actuators and reinforcing elements for nanoelectronics. Therefore, the investigations conducted for the thermal buckling of carbon nanotubes have attracted considerable attention in recent years. The thermal buckling behaviour of single walled carbon nanotubes under the simultaneous actions of constant axial compression and a uniform temperature rise was investigated [8] by using molecular dynamics simulations. The critical buckling temperature of armchair double walled carbon nanotube subjected to axial compression due to temperature rise was analysed [9] based on Timoshenko beam model. The critical buckling temperature of armchair and zigzag single walled carbon nanotubes subjected to a uniform temperature rise

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