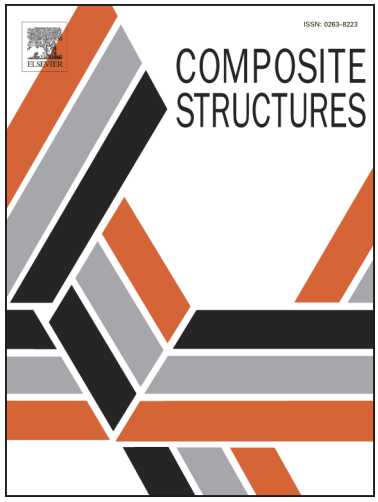

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The influence of size-dependent shear deformation on mechanical behavior of microstructures-dependent beam based on modified couple stress theory

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Abstract

In this investigation, a parametric study is performed to explore the influence of size-dependent shear deformation on static bending, buckling and free vibration behavior of microbeams based on modified couple stress classical and first shear deformation beam models. It is indicated that the influence of size-dependent shear deformation on mechanical behavior of the microbeams has an ascending trend with respect to dimensionless material length scale parameter. Moreover, the sensitivity of size-dependent shear deformation to dimensionless gyration radius and Poisson ratio has an ascending and descending trend, respectively. The results show that the size-dependent shear deformation has the highest influence on the mechanical behavior of the microbeam with clamped-clamped boundary conditions followed by clamped–pined, pined–pined and clamped–free boundary conditions. As an application to micro electro mechanical systems (MEMS), the effect of size-dependent shear deformation on static pull-in voltage of an electrostatic microbridge is studied.

Keywords

Microstructures-dependent beam; Size-dependent shear deformation; Static pull-in instability; Material length scale parameter; Modified couple stress theory.

1. Introduction

Microbeams are utilized in a wide range of applications in many microscale sensors, actuators and devices such as heated atomic force microscope cantilever [1], electro-thermal micro-actuator [2], micro-beam sensor for decteion of thermal conductivity [3], force and torque sensor for micro-manipulation applications [4], electrostatic microgripper system for microassembly applications [5], microfixture with electrothermal microclamp cell [6] and dual-axis micro-mechanical probe[7] and also the behavior of microscale structures has been proven experimentally to be size dependent [8-14]. Since the classical continuum theory is incapable of predicting size effect, several non-classical continuum theories developed to overcome this

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