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Abstract

An enhanced model of nonlocal torsion based on the Eringen theory is provided in this paper. The variational formulation is given and then the governing differential equation and boundary conditions of nonlocal nanobeams subjected to torsional loading are consistently derived. No higher-order boundary conditions are required for the enhanced model. It is further assumed that the ends of nanobeams are not perfectly restrained thus focusing the attention also on the influence of elastically compliant boundary conditions on the behaviour of nonlocal models. Closed-form solutions are then provided for nanocantilevers and fully clamped nanobeams subject to distributed torsional loads. It is shown that the dimensionless small-scale parameter must fulfil a suitable inequality in order to avoid that a positive distributed torsional load provides a negative torsional rotation. The size-dependent static torsional behaviour of the proposed model in terms of torsional rotations and moments is tested. Contrary to the nonlocal Eringen model, the proposed enhanced model provides the small-scale effect also for nanobeams subjected to uniform distributed torsional loads. Comparisons with Eringen model, gradient elasticity theory and classical (local) model are provided.

Key words: Nanobeams, size effects, nonlocal torsion, analytical solutions.