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Exact solutions of inflected functionally graded nano-beams in integral elasticity

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Abstract

The elastostatic problem of a Bernoulli-Euler functionally graded nanobeam is formulated by adopting stress-driven nonlocal elasticity theory, recently proposed by G. Romano and R. Barretta. According to this model, elastic bending curvature is got by convoluting bending moment interaction with an attenuation function. The stress-driven integral relation is equivalent to a differential problem with higher-order homogeneous constitutive boundary conditions, when the special bi-exponential kernel introduced by Helmholtz is considered. Simple solution procedures, based on integral and differential formulations, are illustrated in detail to establish the exact expressions of nonlocal transverse displacements of inflected nano-beams of technical interest. It is also shown that all the considered nano-beams have no solution if Eringen's strain-driven integral model is adopted. The solutions of the stress-driven integral method indicate that the stiffness of nanobeams increases at smaller scales due to size effects. Local solutions are obtained as limit of the nonlocal ones when the characteristic length tends to zero.

Key words: Bernoulli-Euler nano-beams, size effects, nonlocal integral models, CNT, analytical solutions.