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Static analysis of ultra-thin beams based on a semi-continuum model

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Abstract A linear semi-continuum model with discrete atomic layers in the thickness direction was developed to investigate the bending behaviors of ultra-thin beams with nanoscale thickness. The theoretical results show that the deflection of an ultra-thin beam may be enhanced or reduced due to different relaxation coefficients. If the relaxation coefficient is greater/less than one, the deflection of micro/nano-scale structures is enhanced/reduced in comparison with macro-scale structures. So, two opposite types of size-dependent behaviors are observed and they are mainly caused by the relaxation coefficients. Comparisons with the classical continuum model, exact nonlocal stress model and finite element model (FEM) verify the validity of the present semi-continuum model. In particular, an explanation is proposed in the debate whether the bending stiffness of a micro/nano-scale beam should be greater or weaker as compared with the macro-scale structures. The characteristics of bending stiffness are proved to be associated with the relaxation coefficients.

Keywords:

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