On modeling size-dependent strain gradient elastic adhesively bonded joints

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Abstract

As a bonded structure scales down to the microscale, the role of the adhesive joint becomes more relevant concerning the overall performance of the microdevice. At the small scale, the microstructural and size-dependent properties of thin adhesive start to play a key role in the mechanical response of the layered assembly (1). The present work focuses on the derivation of a soft imperfect interface law in a composite, constituted by two solids, separated by a thin adhesive layer in the framework of linear strain gradient elasticity. The model is obtained by means of an asymptotic analysis. The contact laws, expressed in terms of the jumps and means values of the displacements, normal derivatives of the displacements, represent a formal generalization of the soft elastic interface conditions (2). The present study reveals the stiffening behaviors of layered structures and size-dependent phenomena, typical of micro-scale structures (3). Two benchmark problems are investigated through their closed-form solutions: i) a simply-supported laminated beam with soft core subjected to a uniform distributed load; ii) a mode 2-type loading configuration of a layered axially deformable beam. Size effects and non-local phenomena, due to high strain concentrations, are highlighted.

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