Modeling a beam with a lattice structure made of bi-modulus material

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Abstract

Recent developments in additive manufacturing technologies make the mass fabrication of functional materials with substructures (mechanical metamaterials) cheaper and economically feasible. Predicting the mechanical behavior of such materials and structural elements becomes a critical issue for engineering science. For this purpose, we used advanced material models based on the so-called generalized continua theory, in particular a strain gradient elasticity (SGE). According to this theory, the substructure is represented by an additional material constant, namely, the length scale parameter. Though the SGE theory for simple isotropic materials is studied quite broadly, there is a place for its extension. Some materials, such as epoxy resins and nylons, used in the stereolithographic manufacturing of metamaterials, demonstrate different elastic responses in tension and compression. In this work, a material model is introduced in the context of SGE taking into account the bi-modulus nature of the manufacturing materials. The Green-Mkrtichian approach to model a bi-modulus material where the form of strain energy depends on signs of principal strains is utilized. With the developed model, the effect of tension-compression asymmetry in a beam with a 2D substructure is studied numerically.

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