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Nonlinear Response of Magnetoelastic Solids

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A magnetoelastic solid consists of an elastomeric matrix and a distribution of micron-sized ferrous particles. The composite is treated as a solid with combined elastic and magnetic properties. Recently, growing interest in these materials for industrial applications has motivated a renewed interest in electromagnetic continua with particular reference to large magnetoelastic deformations. We first derive governing equations of equilibrium and constitutive laws by introducing an amended free energy formulation. The resulting equations, based on use of the referential magnetic field vector as an independent variable, provide a compact formulation that may be expressed in either Lagrangian or Eulerian form. The equations are then applied to the solution of a prototype boundary-value problem in which a rectangular block is bent into a sector of a circular cylindrical tube with a referential magnetic field normal to one of the faces of the block. A closed-form solution for this problem is obtained for a particular choice of energy function. The magnetic field in the deformed configuration becomes radial in the deformed configuration and the stress/strain response stiffens with increasing magnetic field strength.

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