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A hard ferromagnetic and elastic beam-plate sandwich structure. (English) Zbl 1161.74023

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Summary: In this paper, the deformation of a composite hard ferromagnetic-elastic beam-plate structure is investigated. A sandwich structure, composed of two thin hard ferromagnetic layers, with a linear elastic layer in between, is considered. The deformation is due to the self generated magnetic field (magnetostriction). The aim is to assess the interaction forces among the perfectly bonded layers, through a consistent application of the classical nonlinear magneto-elastic theory. Once the general mechanical model is stated, the analysis is specialized to study longitudinal elongation, given its great relevance in technical applications. Owing to the non-local character of the magnetic action, a nonlinear integro-differential equation is derived. Some qualitative properties of the solution are pointed out and the asymptotic behavior near the end sections is examined in detail. A finite differences approach allows writing an approximating nonlinear system of equations in the non asymptotic part of the solution, which is solved through a Newton's iterative scheme. The numerical results are discussed and it is shown how the asymptotic part of the solution well approximates the full behavior of the structure. Furthermore, the longitudinal interaction force density is found to be singular at the end cross-sections, regardless of the assumed bonding type.

MSC:

74F15	Electromagnetic effects in solid mechanics
74E30	Composite and mixture properties
74K10	Rods (beams, columns, shafts, arches, rings, etc.)
74K20	Plates
74S25	Spectral and related methods applied to problems in solid mechanics

Keywords:

Magneto-elastic coupling; hard ferromagnet; composite structure; magnetostriction

Full Text: DOI