Nobili, Andrea; **Tarantino, Angelo**

Pseudo-spectral methods in one-dimensional magnetostriction. (English) Zbl 1329.74184

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Summary: In this paper a pseudo-spectral method is proposed to solve a one-dimensional model of a saturated hard ferromagnetic thin-film structure within the Euler-Bernoulli kinematics. The model accounts for the non-local nature of the magneto-elastic coupling and interaction is in the form of a logarithmic potential. The proposed solution method adopts global polynomial interpolation at a main grid, given by the Gauss-Lobatto points, and it employs a secondary grid, consisting of the Gauss points, to perform the Gaussian quadrature. The two grids are non-overlapping to avoid the singularity. Interpolation relates the unknowns, evaluated at the secondary grid, to their values at the collocation grid. Furthermore, the integration interval is parted about the singularity point. The procedure is assessed through the relative equilibrium residual for different values of the approximating polynomial degree and of the quadrature order. Maximum, average and standard deviation of the error are presented. An asymptotic analysis yields the Boundary Solution to the problem and results are compared when the latter is introduced in the numerical scheme. It is shown that its contribution is important in reducing the overall error. The equilibrium residual is plotted and its behavior discussed. It is further shown that numerical precision significantly affects the results at midspan, owing to the self-equilibrium of the system, thereby a limit exists to the best accuracy which may be gained through a more accurate interpolation.

MSC:

74K35 Thin films
74S25 Spectral and related methods applied to problems in solid mechanics
65L60 Finite element, Rayleigh-Ritz, Galerkin and collocation methods for ordinary differential equations
74F15 Electromagnetic effects in solid mechanics

Keywords:

pseudo-spectral methods; magnetostriction; non-local theory

Software:

HYBRJ; minpack

Full Text: DOI

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