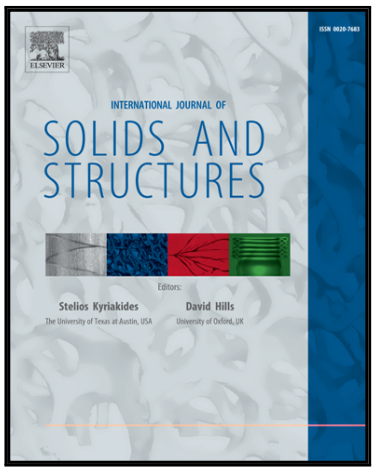

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Instabilities in the axisymmetric magnetoelastic deformation of a cylindrical membrane

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Abstract

We study the inflation of a weakly magnetizable isotropic incompressible cylindrical membrane and the effects of an external magnetic field generated by a current carrying wire placed along the axis of cylinder. A variational formulation based on magnetization is used and the computational results obtained by using four elastic constitutive models (neo-Hookean, Mooney–Rivlin, Ogden, and Arruda–Boyce) are studied and compared. Cylinders of various aspect ratios are studied in each case. Our study shows that the external magnetic field alters the elastic limit point, does not lead to equilibrium solutions below certain value of internal pressure, and can give rise to multiple equilibrium states for a given value of pressure. Presence of magnetic limit point, a phenomenon recently reported in the literature is reconfirmed. Magnetic limit point is a state where a further strengthening of the applied magnetic field at a given pressure does not yield any static equilibrium state. In this case it is detected when the cylindrical membrane deflates into the volume enclosed by itself. We also observe a quadratic relation between the defined magnetic energy parameter and the internal pressure at the magnetic limit point. Relaxed form of the strain energy density is used to account for wrinkling in this case of inward inflation. A finite difference method coupled with an arc-length technique is used for the computations and the stability of the solution is determined from the second variation.

Keywords: magnetoelasticity; finite deformation; membrane; limit point; wrinkling

Mathematics Subject Classification: 74B20, 74F15, 74G60, 74K15

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