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Thermal and Geometric Effects on Nonlinear Response of Incompressible Hyperelastic Cylindrical Shells

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Abstract : This paper investigates the nonlinear response of thin, incompressible, hyperelastic cylindrical shells in the presence of a time-varying temperature field while considering initial geometric imperfections. The governing equations of motion are derived using an improved Donnell's shallow shell theory. The hyperelastic material is modeled using the Mooney-Rivlin model with two parameters, incorporating temperature-dependent terms. The Lagrangian method is applied to obtain the equation of motion. The resulting governing equation is addressed through the Lindstedt-Poincaré and Multiple Scale methods. The linear and nonlinear models presented in this study are verified against existing open literature, demonstrating the accuracy and reliability of the presented model. The study focuses on understanding the influence of temperature variations and geometrical imperfections on the natural frequency and amplitude-frequency response of the systems. Notably, the investigation reveals the coexistence of hardening and softening peaks in the amplitude-frequency response, which vary in magnitude depending on these parameters. Additionally, resonance peaks exhibit changes as a result of temperature and geometric imperfections.

Keywords : hyperelastic material, cylindrical shell, geometrical nonlinearity, material naolinearity, initial geometric imperfection, temperature gradient, hardening and softening
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