ABSTRACT

The present work deals with the problem of compressible isotropic hyperelastic solids under finite bending. The problem is fully nonlinear and, conversely to the classical Rivlin solution [1], it is formulated in the framework of three-dimensional kinematics involving both large displacements and strains according to the context of finite elasticity. The model entails three kinematic assumptions, which stand for the planarity of the cross sections (Bernoulli-Navier hypothesis), the invariance of the curvature along the longitudinal direction of the solid (uniform bending) and the curvature of the cross sections (anticlastic curvature), that is assumed constant along the width of the solid [2]. Based on the semi-inverse approach and according to the kinematic assumptions, the 3D displacement field is found, and, in turn, the deformation gradient is assessed. Then, the equilibrium conditions, specialized for a compressible Mooney-Rivlin material, provide proper relations among the unknown kinematic parameters, thus leading to the closure of the problem. Emphasis in placed on the "moment-curvature relation", which is found to be governed by two independent dimensionless parameters: the *Eulerian slenderness* and the *compactness index* of the solid cross sections [3]. Similarity is observed with respect the previous works of *Lamb* (1890) regarding the mechanical response of bent plates and the experiments performed by *Searle* (1933) as well. Moreover, such an analysis allows broadening the "Elastica" to the more general context of finite elasticity.

In this work, the main results provided by the theoretical model are compared with those obtained by FE simulations and an experimental investigation based on a specifically designed mechanical apparatus, founding good agreement also for the case of extremely inflexed solids.

References

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