Soutenance d'une thèse de doctorat de l'Université de Lyon en cotutelle internationale entre l'Ecole Nationale d'Ingénieur de Tunis (Tunis, Tunisie), et l'INSA de LYON (Villeurbanne, France)

La soutenance a lieu publiquement

Candidat	M. GRINE Fahmi
Fonction	Doctorant
Laboratoire INSA	LaMCoS
Ecole Doctorale	ED162 : MÉCANIQUE, ENERGÉTIQUE, GÉNIE CIVIL, ACOUSTIQUE DE LYON
Titre de la thèse	« Initially-stressed hyperelastic materials: modeling, mechanical and numerical analysis of singular problems and identification of residual stress. »
Date et heure de soutenance	29/09/2021 à 14h00
Lieu de soutenance	Salle Bellecour-Terreaux (bâtiment Sophie Germain) (Villeurbanne)

Composition du Jury

Civilité	Nom	Prénom	Grade / Qualité	Rôle
MME	Ben Amar	Martine	Professeure	Rapporteur
M.	Pagano	Stéphane	Directeur de Recherche CNRS	Rapporteur
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M.	Arfaoui	Makrem	Maître de Conférence HDR	Co-directeur de thèse
M.	Renard	Yves	Professeur	Co-directeur de thèse

Résumé

The presence of initial stress in natural and manufactured materials and structures has been known for a long term and it is experimentally well attested in diverse scopes from biomechanics, geophysics, to welded structures and industrial manufacturing. This internal stress has a substantial effect on the material and structural behaviour and can be the origin of heterogeneous and anisotropic behaviour.

This thesis aims to contribute to the development of different formulations and theoretical results in the theory of initially-stressed hyperelasticity. A first contribution is the development of constitutive models for initially stressed hyperelastic materials which has permitted to identify the kind of anisotropy generated by the initial stress field based on the analogy with the constitutive formulation for fibrous materials. The exploitation of this analogy for linear transverse isotropic elasticity has provided some insight into the use of anisotropy and fibre orientation to design some elastic machines by coupling different deformation modes in a continuum boundary value problem.

In addition, the identification of the residual stress and material parameters of an initially stressed linear elastic model is addressed and an analysis of the different parameters influencing the quality of the reconstructed fields is carried out.

Furthermore, two singular boundary value problems are considered and analyzed. The first problem is dedicated to the rigidity contrast (discontinuity) influence on the asymptotic mechanical field near a crack tip subjected to an anti-plane transformation. Whereas in the second one, a particular generalization of the three-dimensional Linear Elastic Fracture Mechanics (LEFM) to a model for an initially-stressed hyperelastic material is developed. A numerical analysis of the second singular problem using an XFEM formulation is realized accompanied by tests of convergence and stability.