Abstract

Elastomers are widely used in aerospace, automotive and civil engineering applications thanks to their ability to undergoing high strains and strain rates in large temperature range. Several models have been developed in the literature to investigate those nonlinearities.

The purpose of this work is, on the one hand, to investigate the nonlinear viscoelastic behaviour of rubber-like materials. On the other hand, the different viscoelastic parameters are identified using our experimental data.

A nonlinear viscoelastic model at finite deformation has been developed as a functional approach (Christensen) combined to the internal variables (Simo) and (Holzapfel) approches. Also, a shift time method based upon the time-strain superposition principle (TSSP) has extensively been used. That allow us to consider a reduced time, which is an integral over time of a deformation gradient tensor function, instead of the real time.

The free energy density and the intrinsic dissipation of the modified Simo and Holzapfel models were developed with respect to thermodynamic assumptions. Thus, we have conclude that the free energy density function should be ~~a~~ polyconvex (versus internal variables and deformation tensors) and the intrinsic dissipation should be a positive quantity for all process.

The hyperelastic potential and the relaxation modulus are identified with the finite element software ABAQUS using experimental data of simple shear and uniaxial extension at low strain rates and relaxation at different strain levels, respectively. Two optimisation methods have been investigated to identify the reduced time function. Then, the constituve equations has been discritized over this time using the MATLAB software.

Keywords: nonlinear viscoelasticity, finite strain, time-strain superposition principle, identification, discretization of constitutive equations.