Macroscopic modelling of polymeric materials

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This work is concerned with the influence of hypo- and hyper- elasticity on the numerical predictions of the behavior of polymers. A hypo-elastic model applies the rate of deformation tensor as the main kinematic variable, while the deformation gradient tensor serves as basis for the kinematics in hyper-elasticity. To enable a fair comparison between the two different descriptions of the kinematics, the other ingredients of the models are identical, and the two models are used solve the same elasto-viscoplastic equations. Polymeric materials are very often pressure dependent and a Raghava yield surface is employed in this study. In addition, non-associated plasticity is assumed using the same mathematical formulation as for the yield surface. It is further assumed isotropic hardening. A simple ductile damage model is added in both approaches to describe a large range of polymeric materials. The two models are implemented in LS-DYNA using user-material subroutines. Numerical benchmarks as well as experimental data obtained on several thermo-plastics are used to assess the pros and cons of the two frameworks. Moreover, by evaluating both accuracy and numerical costs a critical assessment of the kinematics formulations is provided for further use in an industrial context.