ECCMR2017

10th European Conference on Constitutive Models for Rubbers (ECCMR)
MUNICH (Germany) from 28-31 August, 2017

Efficiency of rubber material modelling and characterisation

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Experimental investigation of filled rubber reveals several complex properties like hysteresis, permanent set, Mullins-effect. The latter is also associated with an induced anisotropy. In the time-domain relaxation and creep are observed. These properties emerge in a complex manner from simple interactions of the basic components. Thus, in many situations phenomenological descriptions of the material behaviour together with appropriate characterisation methods are a good choice.

Furthermore, the efficiency requirements for industrial components are continuously increasing with time. Related to that, the precision requirements for simulation results and also the acceptance of higher simulation costs are increasing, too. In this context, also the efficiency requirements concerning rubber material modelling and rubber characterisation methods are evolving.

Among other aspects, in this contribution a new, interesting and efficient approach for modelling complex inelastic material behavior at large strains based on rheological models is presented. The basic kinematical assumption is the additive decomposition of the deformation rate. The framework is implemented in Abaqus via the user interface UMAT using an objective time stepping scheme. The performance and suitability of the framework is demonstrated by analysing cyclic loading of a cord-rubber composite with a Morph-rubber-matrix.

Concerning characterisation methods a new specimen setup is presented, which enables homogeneous tension-compression-tests with an extended range of strain amplitudes. Due to a special mounting geometry, tests from a compression strain of -45% up to a tension strain of 400% can be performed with a nearly homogeneous deformation field within the measuring zone.