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Applicability of Thermo-Visco-MORPH - an extended Model of Rubber Phenomenology

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Under mechanical loading filled elastomers not only exhibit pronounced material softening and moderate inelastic behaviour, e.g. Mullins and Payne effect, but also creep and relaxation phenomena are apparent.

Common material models to simulate the complex behaviour of those elastomers are for example the Model Of Rubber PHenomenology (MORPH) and the Dynamic Flocculation Model (DFM). Therein, time- and temperature-dependent effects are neglected within the modelling process. Although, for applied high velocities during in mechanical tests and especially with increasing filler content, the contribution of time-dependent effects is well pronounced and neglecting them is no longer reasonable. The rate-dependent effects as well as relaxation phenomena are well-known to be temperature-dependent, too.

In this presentation we follow the common approach of finite viscoelasticity to extent MORPH to viscous effects, see e.g. [1]. This extension is realized via a Prony-Series approach. In order to preserve parameter identifiability, a functional dependency of the relaxation times and their weights is assumed. Temperature effects are included via a functional dependency on the temperature as well - instead of a WLF-approach, which proves to be invalid within our model approach. In many cases along with the extension approach via Prony-Series, the viscoelastic material parameters are identified with the help of dynamical mechanical measurements. In the corresponding standard evaluation routines of those measurements only linear viscoelastic behaviour is assumed in order to obtain storage and loss modulus as resulting output. The raw data of the force and displacement signals are often not provided. The presented approach indicates the boundaries of this assumption.

Due to the FE-implementation approach via representative directions, the computational effort is relatively high such that the model is checked for its applicability in 2D and 3D simulations of component parts.

REFERENCES

[1] N. H. Kröger, R. Ragunath, D. Juhre, Extension of DFM and MORPH in representative directions to viscous effects via Prony series approach. *PAMM*, Vol. **16**, pp. 363–364, 2016.