

Extended Model of Rubber Phenomenology for time- and temperature-dependent effects and its Applicability to Component parts

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Filled elastomers are showing not only pronounced material softening and moderate inelastic behavior, e.g. Mullins and Payne effect, but also creep and relaxation phenomena can be observed. Common material models to characterize the complex behavior of those elastomers are for example the Model Of Rubber PHenomenology (MORPH) and the Dynamic Flocculation Model (DFM). In general, one neglects the time- and temperature-dependent effects and conducts experiments for characterization for modes which are quasi-static. With higher velocity in tension 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 as well.

In this presentation a modelling approach for the extension of MORPH to viscous effects is shown. This extension is realized via a Prony-Series approach. Hereby, a functional dependency of the relaxation times and their weights is assumed. In order to cover temperature-dependent effects as well, a WLF ansatz is included. The model is validated via experimental data for different strain-rates in several isothermal test environments.

In order to check the applicability of the extended MORPH model, FE-simulations (2D simulation of a rolling tire – see figure(1), 3D simulation of a bushing) in Abaqus are carried out.

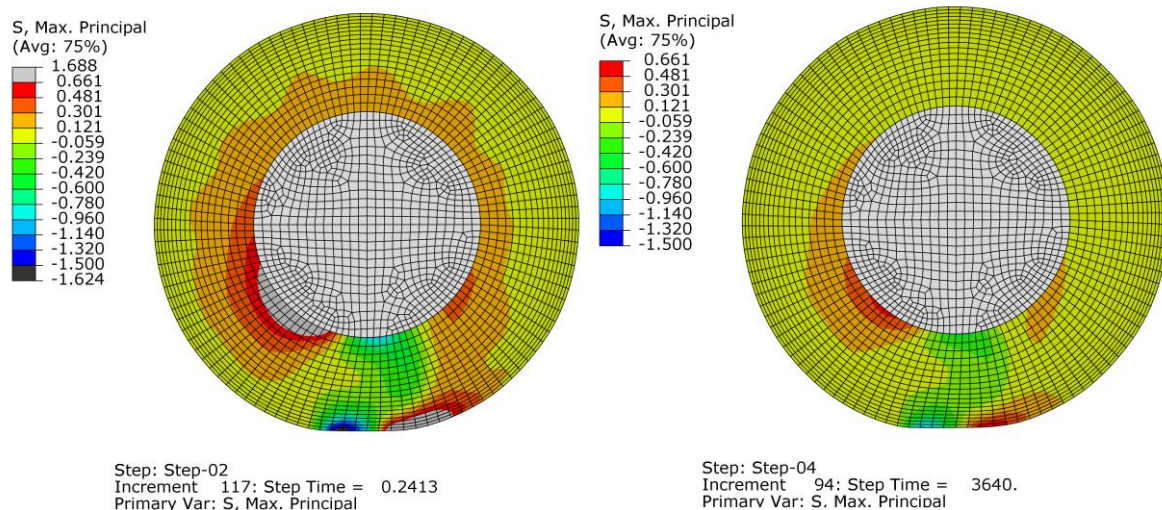


Figure 1: FE-Simulation of a rolling tire with stress relaxation

References

- [1] Ihlemann, J. ; Kontinuumsmechanische Nachbildung hochbelasteter Gummiwerkstoffe; Fortschr.-Ber. VDI Reihe Vol. 18(288).VDI Verlag
- [2] Freund, M., Ihlemann, J.; Generalization of one-dimensional material models for the finite element method; Journal of Applied Mathematics and Mechanics; 90(5) (2010), 399-417
- [3] Kröger, N.H., Raghunath, R.; Juhre, D.; Extension of DFM and MORPH in representative directions to viscous effects via Prony series approach; Proceedings in Applied Mathematics and Mechanics; 2016, 363-364