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DEVELOPMENT OF A HYPERELASTIC MATERIAL MODEL FOR THE CONSIDERATION OF MULTIAXIAL LOAD CONDITIONS

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Products made from elastomers show a great variety. During the development and dimensioning process of technical elastomer parts, the numerical structural simulation by means of the Finite-Element-Analysis (FEA) has become an important tool for designers. The applied material model, which describes the correlation between stresses and strains, thereby forms an important basis for accurate FEA results. Elastomers show significant nonlinearities regarding the mechanical characteristics. Apart from a load, time and temperature dependency, the stress/strain-behaviour also crucially depends on the load condition. The differences in the mechanical material behaviour can be traced back to the amount and type of carbon black in the material mixture. Existing hyperelastic material models implemented in FEA solvers can only describe the different load conditions rather poorly. Therefore a new material model was developed which describes the prevalent local load condition by a so-called load condition parameter. This parameter influences the computation of stress and stiffness. Both mathematically and physically, the new material model is formulated consistently. The model was implemented as a user-defined subroutine into a commercial FE-program and can directly be used for structural analyses. Additionally the parameter can be used to visualise the local load condition in order to evaluate the design. Thus unfavourable load cases can directly be identified within the part. In order to be able to evaluate the multiaxial mechanical material behaviour, material tests of all basic load conditions (equibiaxial, pure shear, uniaxial) were accomplished. The measured stress/strain curves serve for the calibration of the developed material model. Compared to standard material models, the newly developed material model describes the multiaxial material behaviour of carbon black filled rubber with a significantly higher accuracy.