Thermomechanically Coupled Brush Model
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ABSTRACT

This paper introduces a thermomechanical coupled model to describe the tire-to-road contact. The mechanical part is calculated by an extended brush model which provides a basis for the calculation of the thermal part. In general the brush model is a well-known model to describe a rolling, deformable tire. This model allows calculating the forces in longitudinal and lateral direction within the contact area with a small amount of free parameters [3], [4]. Important parameters are e.g. the vertical load, the slip ratio and tire stiffness in longitudinal and lateral direction as well as a coefficient of friction. The latter can be identified with measurement data for example. The rolling movement and the resulting adhesion and sliding area can be described with this model as well. The length of the sliding zone depends mainly on the existing slip ratio in longitudinal and lateral direction. Due to friction within the contact area heat is generated and the tire tread and the rubber inside are heated. Besides the mechanical parameters, material-dependent values like thermal diffusivity, density and heat capacity play also an important role for the calculation of the temperature. The Temperature calculations are based on the assumptions of Jaeger [1] and Ling et al. [2]. Temperature measurements at the run out point have shown that especially for large slip angles the temperature within the contact area increases strongly. The rubber behavior of the tire is on the one hand depending on the excitation frequency and on the other hand depending on the temperature. The complex elastic and the complex shear modulus change with temperature and therefore the temperature increase influences the tire characteristics.

Firstly, the mechanical model is calculated with the brush model. On the basis of the mechanical results the thermal part is computed. With the help of measurement data and for example infrared camera pictures the thermomechanical model can be validated.

The model is able to reproduce the steady state. Furthermore first approaches to solve the transient state are made. Simulation results show good agreement with measured data, both for the mechanical and the thermal part. In comparison to models based on the finite element method the thermomechanical brush model has an advantage relating to computing time and computing power. In addition it is easily transferable for any tires. The model should help to predict the temperature within the contact area for any tires and any driving conditions to identify potential temperature influences on the overall tire behavior.

REFERENCES

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