Thermomechanical Multiscale FEM Approach for Sliding Elastomers on Rough Surfaces

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ABSTRACT

Understanding the frictional behaviour of elastomers on rough surfaces is of high practical importance in many industrial applications. For example the traction of a tire is directly linked to the material properties of the considered elastomer and the surface conditions of the road track, see [1]. Additionally, the frictional behaviour of elastomers is heavily temperature dependent and the heating of the elastomer during sliding cannot be neglected, see [2]. One goal of our studies is to gain a deeper understanding of the underlying thermomechanical contact physics at all length scales. Another aim is to determine a macroscopic coefficient of friction for varying material and surface properties and to validate the results with experimental data.

For predicting the coefficient of friction certain physical effects like hysteresis, flash temperature effects or adhesion have to be taken into account. In addition the micro roughness of the surface contributes mainly to the frictional behaviour of elastomers, see [3] or [4]. To capture all details and information down to micro scale at acceptable computational costs it becomes necessary to incorporate all coupled physical aspects into a multiscale framework. A multiscale approach for sliding rubber samples is presented in [4]. In this study a new multiscale finite element approach for elastomer friction on rough road surfaces is suggested.

One of the main aspects of elastomer friction on rough surfaces is the internal energy dissipation due to cyclic loading and unloading, called hysteresis. This effect causes also the heating of the elastomer sample. For modelling the coupled effect of hysteresis and flash temperature in the multiscale framework a finite linear thermomechanical viscoelastic material model containing a series of maxwell elements is used for the elastomer. With a spectral analysis of the considered road surface a decomposition into a micro- and macro-roughness is applied. The pressure-, velocity- and temperature-dependent friction law gained from homogenized micro calculations is then incorporated at the macro scale in the FEM formulation. Details of the thermomechanical multiscale framework and first results will be presented.

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