11th. World Congress on Computational Mechanics (WCCM XI)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

# THERMO-MECHANICAL ROUGH SURFACE CONTACT OF RUBBER-LIKE SOLIDS

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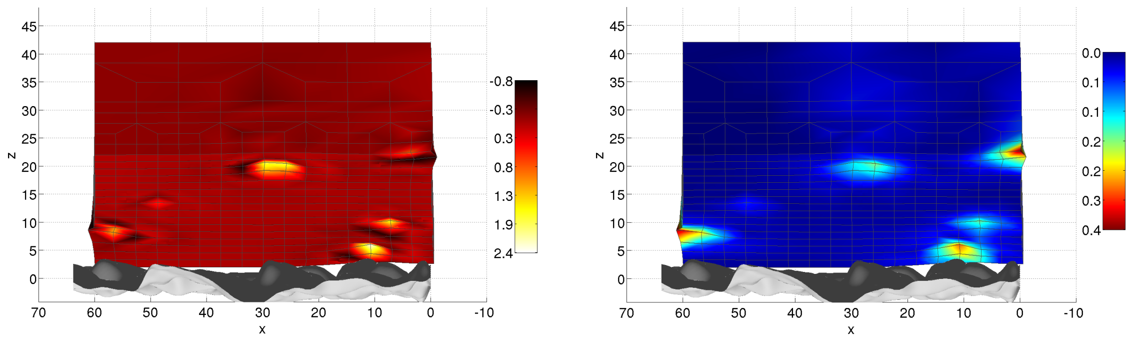
**Key words:** *Contact Mechanics, Rough Surface, Coupled Problem*

The optimization of tire designs towards less rolling resistance and high sustainability are major goals in many current research projects. The mechanical response of tire-rubber compounds is rate dependent and strongly depends on the service temperature. Due to the interdependence of mechanical and thermal properties, the treatment of a coupled problem is necessary for meaningful results in this field. Therefore stable and efficient algorithms to compute the thermo-mechanical response of tires are required in this optimization process.

A recent study on the calculation of the rolling resistance has been presented in [2]. The presented algorithm is focused on the overall performance of the tire and simulates its steady state behavior. Therefore a relative kinematics description with a spatially fixed mesh is introduced. As a benefit of this framework, the contact area can locally be discretized very fine without loosing computational efficiency. Within this formulation the mesh needs to be axis-symmetric and therefore tread patterns can not be taken into account in detail. This fact can be seen as a drawback of this formulation, especially as the overall performance is significantly influenced by the high frequent deformations of the tread blocks and effects resulting thereof occurring in the contact area with the rough road surface. These large local deformations of the rubber by the highest asperities cause a lot of mechanical dissipation in very small areas. Due to the low heat conduction of the material the dissipated energy causes a significant increase of the temperature in these areas (see figure 1 (A)), which was described as the so-called flash-temperature in [3]. Consequently the system performance can only be described correctly if these effects and the heat conduction in the contact interface are taken into account in detail. Here the development of new tread patterns and application of new materials requires intensive research.

In recent years different macroscopic and multiscale approaches to describe these effects have been presented, e.g. [3]. The contributions often focus on the calculation of the resulting friction coefficient in order to identify parameters for phenomenological laws.




(A) (B)

Figure 1: (A)Temperature distribution and (B) visco-elastic strains in the tread block after contact with rough surface.

Here the calculations are often isothermal and the surfaces are idealized by sinusoidal descriptions.

In this contribution an approach for the detailed calculation of the dissipation in the tread rubber is presented. The bulk material is described by the thermo-visco-elastic material law presented in [2]. Differing from that approach, the thermo-mechanical coupling is treated with the isothermal operator-split scheme. The observed tread block is pressed onto a realistic road surface texture. This texture was measured optically and processed into a spectral representation applying the fast Fourier transformation, see [1] for details. Figure 1 (A) shows the resulting increase of temperature and figure 1 (B) the equivalent visco-elastic strains in a simple rubber block, which was pressed onto the rough surface within 0.005 s. For reasons of visualization the front edge is lifted to expose the contact area. As mentioned above the highest asperities cause large local deformations of the rubber. Consequently the large dissipation in the contact area causes a significant increase of temperature. Multiple repetitions of this simulation, with varying surface patterns of the road are supposed to give steady state results for the pattern.

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