Introduction

In the tyre industry FEM is adopted in the design process of new tyres. However in practice most models are still not able to accurately match experiments. Besides modeling the tyre itself, the interaction of the tyre with the road needs to be incorporated. The cornering, braking, traction, rolling resistance and wear performance of a tyre depend on the generated friction forces. Friction depends not only on the tread properties of the tyre, but also on the road surface and environmental conditions.

Objective

The aim of this project is to gain more insight in modeling of a tyre using FEM, with a focus on the development of a robust friction model which can capture the interaction with the road.

Hysteretic friction

Early studies have shown that rubber friction is related to internal friction of the rubber and depends on the complex elastic modulus \( E(\omega) \) \cite{Grosch}. Sliding with a constant velocity \( v \) over asphalt gives oscillations over a broad frequency range due to the surface roughness. A method to take this into account is presented in \cite{Persson}, where every length scale \( \lambda \) contributes with a different frequency \( (\omega \sim v/\lambda) \) to the global friction coefficient.

\[
\begin{align*}
\text{log}(v) [\text{m/s}] & \quad \mu_-3 \quad -2.5 \quad -2 \quad -1.5 \quad -1 \quad -0.5 \quad 0 \quad 0.5 \quad 1 \quad 1.5 \quad 2 \\
\mu & \quad 0 \quad 0.5 \quad 1 \quad 1.5 \quad 2
\end{align*}
\]

\[ v \lambda \]

\[ v \lambda \]

Figure 1: Road surface and friction curve.

To develop and validate the model friction experiments are performed on a Laboratory Abrasion and skid Tester (LAT 100). On the LAT 100 a small solid rubber tyre is placed on a rotating disk, where the speed, surface of the disk, load and temperature can be varied and measured. The friction model will be coupled to a FE model of the sample wheel. These models will be validated with measured slip characteristics.

Figure 2: Sample wheel and Finite Element Model.

Tyre model

With a tyre/road interaction model it is possible to calculate the force and moment characteristics of a tyre under different driving conditions, see figure 3. Dedicated experiments will be performed for validation.

References