

Challenges of tire contact mechanics

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Modern tires are highly specialized products. For instance, sportive, low aspect ratio tires excel in handling, while luxury tires provide more comfort.

All customers, however, expect their new tires to be robust and have reasonably long tread life. At the same time, few really understand and appreciate the knowledge and experience necessary to provide those qualities.

Looking from design, production or performance point of view, tires are very complex engineering products. They consist of around twenty different components: rubber compounds, polymeric and/or steel cords. The designer has to fine-tune the interaction between these components in order to ensure long tread life of the tire, as well as its high performance in targeted areas. The optimization of the tire performances in turn requires not only the understanding of the material properties, but also the knowledge of the service conditions. An important part is the information about where the tire will be used, under which loading, weather or road conditions, since these all influence to which extent a given tire design can fulfill its main function: namely, the vehicle handling and traction.

Another important part in tire design is testing. The full scale tire tests often include lasting road tests or use of sophisticated and expensive laboratory equipment. Consequently the testing is extremely costly. Modern testing also faces a more challenging task: it must uncover the physical background behind an observed tire performance.

This understanding comes from different levels. The first, most obvious step is to perform and understand a full scale test. This can, however, only be done to a limited extent. Most of these full scale tests involve a car and are done on a test track or on a highway. The weather conditions, the selection of the vehicle used, the conditions of the road surface, even the behavior of the driver will heavily influence the test result and makes reproducibility (and understanding of physics) difficult. In other words, the high variability of the real life conditions (i.e., the stochastic nature of the full scale testing) combined with the extremely high costs has driven the development of indoor, laboratory test facilities. At present, a wide variety of laboratory devices has been established to characterize (for instance) the force and moment response of a tire, or to predict its tread life, or tread wear performance. These devices are used in everyday testing with certain degree of success. They are, however, only schematic representations of the real service conditions. A significant and important simplification, as it might be expected, is substitution of real road surface by laboratory test surfaces.

There is a tendency to use durable surfaces, like still plates; or to install very abrasive surfaces, like sand paper to accelerate the treadwear process.

The use of these artificial surfaces has its consequences: the understanding built in laboratory is difficult to transfer to real life. An interesting example can be the laboratory testing of winter tires. Although the natural ice surfaces are reasonably simple to reproduce, the indoor reproduction of snow tracks is a long standing challenge. The analysis of the results obtained on any re-

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