Tire/Road Skid resistance: Introduction of a Complete Physical Tool Based on Contact Modelling

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1. ABSTRACT

Tire/road skid resistance is related to the friction magnitude generated between car tires and the road surface during vehicle maneuvers. It is one of the key parameters of road safety enabling drivers to shorten their stopping distances and also to follow their desired trajectories on curved roads. However, the physic governing it is of very complicated nature and more in wet conditions. Indeed the factors affecting the phenomenon are numerous and so interrelated hence the difficulty of modeling. For example, the magnitude of the skid resistance will depend as much on the pavement texture scales as on the rheological behavior of the tire rubber, without forgetting the water playing a role of lubricant that disturbs even more also the contact.

Yet the knowledge behind this phenomenon and therefore its modeling remains paramount and make it as a prediction tool as much on the side of road builders as vehicle manufacturers. Indeed, this tool will optimize pavement texture through the choice of materials and implementation and tire materials. It will allow, put on board vehicles, also to adapt the operating conditions of the vehicle to always ensure a better grip. For future autonomous vehicles without human intervention, this tool on board would become vital for the safety of users.

This paper introduces a new physical tire/road skid resistance prediction tool. The approach is based on modeling a dynamic- viscoelastic-rough-lubricated contact. This tool is one the most complete existing in the sense that it takes into account all the parameters related to the tire, the road, the contact conditions, and the contact operating conditions. At the tire side, the tools take into account its geometry (width, rim diameter, flank height, tread pattern, and depth), inflation pressure, rubber material behavior (viscoelasticity). At the road, its texture is taken into account via the surface topography. At the contact interface, the dry or wet condition can be taken into account via the lubricant depth, viscosity, and density. The operating conditions are taken into account via the load, speed and slip rate of the tire.

The validation of the tool was made by performing braking tests with ABS of a city-type vehicle on wet roads of different textures on their surfaces at multiple speeds. By already considering the general shape of the variation curve of the adhesion as a function of the slip rate, the tool perfectly reproduces the shape. The classification of the skid resistance magnitudes and stopping distance on the different surfaces at around 20% (mu ABS) and 100% (total slip) of slip rate of the wheels are correctly reproduced by the tool as well. Beyond adhesion, in its current state, the tool can also predict rolling resistance when the set slip rate is set to 0%. This part will be validated. The tool can also be used with some evolution to predict rolling noise. This will make it a complete surface design tool for road builders and road safety for future autonomous vehicles.

2. KEYWORDS

Skid resistance, tire, road, texture, wet, viscoelastic, contact, slip rate…