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A real-time Thermal Model for the Analysis of Tire/Road Interaction in Motorcycle Applications

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ABSTRACT

While in the automotive field the relationship between road adherence and tire temperature is mainly investigated with the aim to enhance the vehicle performance in motorsport, the motorcycle sector is highly sensitive to such theme also from less extreme applications.

The small extension of the footprint, along with the need to guarantee driver stability and safety in the widest possible range of riding conditions, require that tires work as most as possible at a temperature able to let the viscoelastic compounds - constituting the tread and the composite materials of the whole carcass structure - provide the highest interaction force with soil.

Moreover, both for tire manufacturing companies and for single track vehicles designers and racing teams, a deep knowledge of the thermodynamic phenomena involved at the ground level is a key factor for the development of optimal solutions and setup.

This paper proposes a physical model based on the application of the Fourier thermodynamic equations to a three-dimensional domain, accounting for all the sources of heating like friction power at the road interface and the cyclic generation of heat due to rolling and to asphalt indentation, and for the cooling effects due to air forced convection, to road conduction and to turbulences in the inflation chamber. The complex heat exchanges in the system are fully described and modelled, with particular reference to the management of contact patch position, correlated to camber angle and requiring the adoption of an innovative multi-ribbed and multi-layered tire structure.

The completely physical approach induces the need of a proper parameterization of the model, whose main stages are described, both from the experimental and identification points of view, with particular reference to non-destructive procedures for thermal parameters definition.