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Characterizing racing tires on a realistic indoor surface

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Tire characterization has become a critical part of vehicle engineering, particularly with the recent virtualization of the design process. As the only component of the vehicle in contact with the road surface, a proper understanding of tire performance is essential to optimize both component design and vehicle set-up. Traditionally, tires are characterized on a flat-belt machine, which uses sandpaper as its representation of the road surface. Resultant test data are very repeatable, but correlation with track measurements can diminish, particularly for high-g maneuvers. Hence, in this work a novel road-like surface that can be mounted to a flat-belt machine has been developed (Fig. 1). While applicable and beneficial for all tire testing, the focus of this paper is on motorsports tires.

Throughout development, the roughness of the road-like surface was a key focus. Fig. 2 shows the similarity of the road-like surface compared with a real track, and the significant difference compared to sandpaper, which is less rough over all wavenumbers. Another development focus was in its durability and repeatability. Tests show repetability within <1% (similar to sandpaper), and testing typically lasts ~40 hours before the belt needs replacing. Thus, the road-like surface has shown itself to be a viable alternative to sandpaper.

Beyond the roughness, durability, and repeatability, the surface 'realism' was validated against track data. Wheel force transducer (WFT) data were obtained for several compounds on different racetracks. Two methods of validation were used: 1) simulation, using Magic Formula (MF) models fitted to flat-belt data (Fig. 3, Fig. 4); and 2) drive file replays, where the tire's inputs recorded in the WFT data were used as inputs to the flat-belt machine. In general, the road-like surface provided a significantly improved correlation to the track WFT measurements, for both the MF model and drive file replay approaches.

The analysis was extended to multiple compounds, spanning soft to hard. The biggest improvement was seen in the soft compound. The least correlation was observed for the hardest compound. The reason for this could be different thermal operating windows, differences in wear characteristics, and the sensitivity of both of these to the track roughness. The latter of these is a topic of ongoing research, where the roughness of the road-like surface is tuned to match specific tracks. Overall, the novel road-like surface showed to be not just a viable alternative surface for characterizing tires on sandpaper, but one that correlated significantly better with track measurements. In turn, this new technology could be used to significantly improve virtual development. This is true for motorsports applications, where teams could gain a competitive advantage, and for vehicle manufacturers, who could more quickly bring (safer) cars to market.

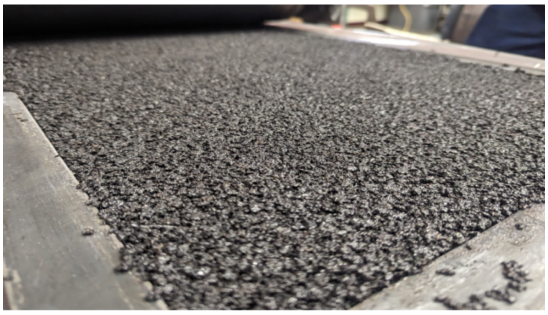

Fig.1 Close-up of the road-like surface after manufacturing.

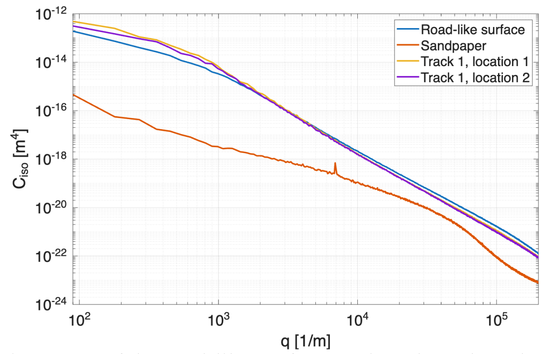

Fig.2 PSD of the road-like surface, real track, and sandpaper.

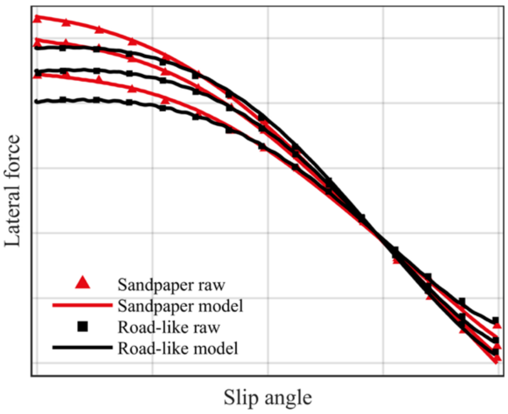

Fig.3 MF fits to flat-belt data for the two indoor surfaces.

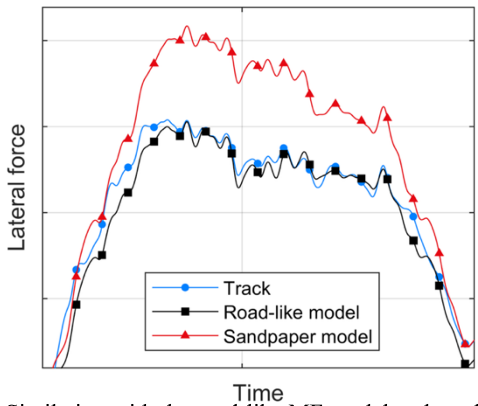

Fig.4 Similation with the road-like MF model and sandpaper MF model vs. track measurements from WFT data.

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