Development of Tire Test Mode under Circuit Driving Condition to Estimate Degradation of a Tire

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Temperature of tire is the main parameter to effect on tire's degradation phenomena. High performance tires such as a UHP(Ultra High Performance) tire or a racing tire should be designed to protect temperature rise and keep stable handling peformance. However, main compoenent of a tire is rubber and rubber has hysteresis characteristics which generatres friction heat between tread and road and internal heat due to repetitive deformation of side wall. Therefore, temperature rise of tire cannot be avoided and degradation of tire also cannot be prevented. The only option for tire designer is to create robust tire profile and use heat protection material. And, it is very important to find relationship of tire's temperatue rise and its degradation performance.

This study presents the process to develop test mode of tire's degration performance at high speed under circuit driving condition. Vehicle test was performed at Castelloli racing circuit in Spain. Data of vehicle level such as vehicle speed, heading angle, laptime, etc and tire level such as internal pressure, internal temperatrue, temperature of tread, etc was measured. Relationship betreen vehicle's performanc drop and temperatrue rise of tire was analyzed. Tire force data to develop test mode was acquired from vehicle dynamic simulation. Detail process is as follows.

[1] Veicle dynamic modeling

Audi R8 was used to test in the circuit and its dynamic model was created by using IPG/Carmaker. Table 1 shows kinds of component data and how to be measured. To verify vehicle model, test data from proving ground and simulation data were compared. Fig.1 shows verification results.

Component	Type	Test Machine
Vehicle	CG, Inertia	K&C test rig
Suspension	Qusaistatic and Dynamic Compliandce	K&C / Spring & Damper test rig
Brake	Pressure Distribution	Vehicle test
Powertrain	Front/Center/Rear Differential Torque Map	Vehicle test Engine Dynamometer
Aerodynamic	Drag Coefficient	Wind tunnel
Tire	MF-tire	FlatTrac

Tab. 1: Example table

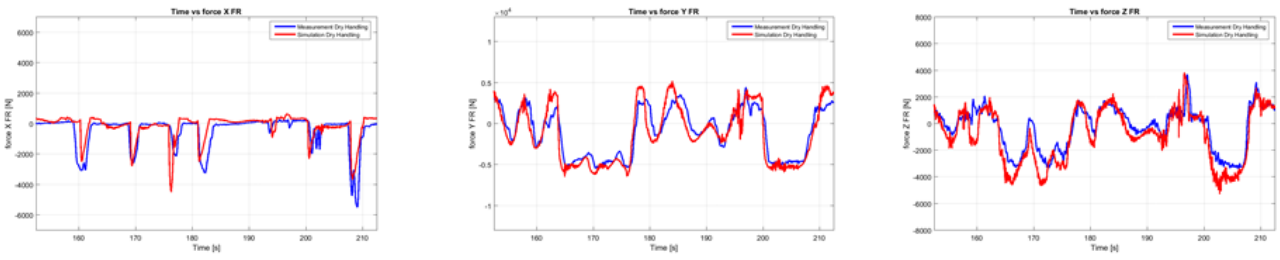

Fig. 1: Vehicle model and verification

[2] Development of test mode

Fig.2 shows development process of test node.The main goal of this study has been to develop an test method for ultra-high speed tires on laboratory. This has been achieved by measuring their performance under racing conditions on proving ground with an Audi R8. Load cases have been calculated by means of the Audi R8 virtual model, which has been correlated with real proving ground measurements. Analysing the information taken from the load cases performed to the tires on circuit, the systematic test process was created using side and drad wear energy equation[1)]. The test process was modified and adaped for the laboratory which simulates the tire's degradation and behavior on road.

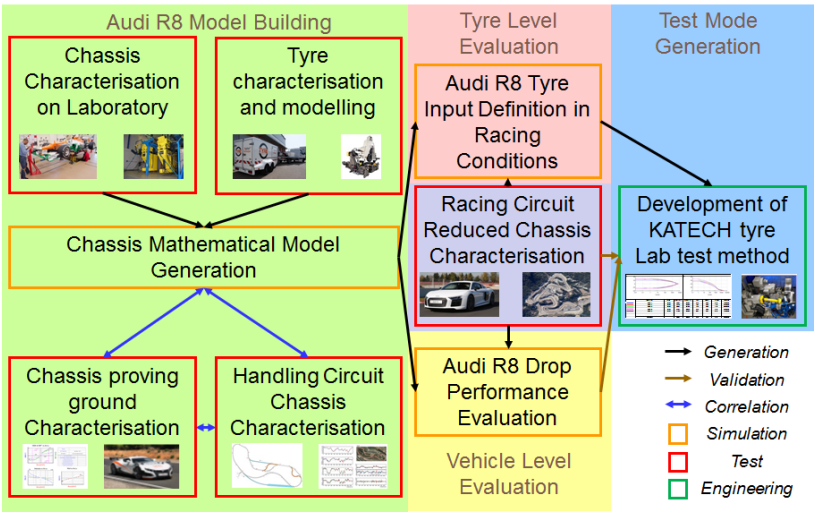

Fig. 2: Development process of brake dynamometer test mode

[3] Result

Fig.2 compares internal temperature and pressure of a tire. Correlation target is to reach stabilized temperature and pressure evolution. Overshoot observed since Castelloli testing is a close loop manouvre (vehicle response corrected by the driver) while rig testing is an open loop manouvre (repeating initial cycle). To match the overshoot phenomena remains as a furure work.

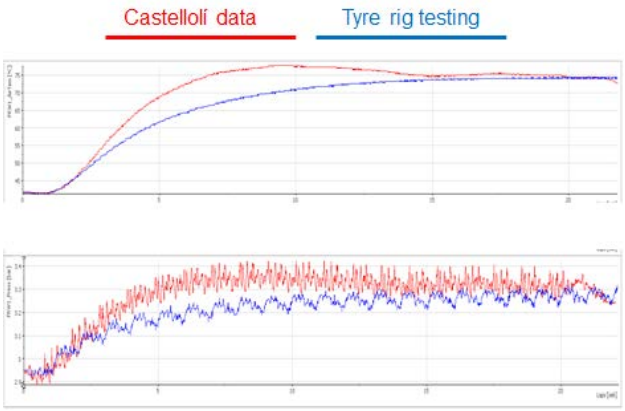

Fig. 2: Result comparison of brake dynamometer and vechile tests

References

[1] Aircraft Tire Wear Profile Development and Execution for Laboratory Testing, AIR5797, 2013