RESIDUAL BRAKE TORQUE MEASUREMENT ON DYNAMOMETER IN TERMS OF WHEEL LOAD AND SIDE FORCES

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ABSTRACT

Residual brake torque (RBT) is generated in disc brakes as a result of residual contact between brake disc and brake pads when the braking pressure is not applied. Among the negative implications of RBT are, notably, dispensable additional fuel consumption as well as increased pad (taper) wear. Several measurable properties of the brake system have a direct influence on the level of residual torque. A major effect is connected to the caliper properties determining the clearance gap. This is characterised by the default air gap between pads and disc and its distribution regarding vehicle inner and outer sides (piston and fist sides for floating type calipers).

Initial air gap is mainly influenced by the sealing groove design (between piston and housing, where the sealing ring is positioned). The retraction of the piston due to the sealing ring, also called rollback, mainly depends on the load case (e.g. applied pressure and temperature). Insufficient air gap will lead to residual clamping forces between pads and rotor and thus the sliding forces of the pads and the friction coefficient itself will have direct influence on the residual brake torque.

In addition, there are also parameters which can exert influence on the residual brake torque, which are not caliper, but primarily rotor-related. These include axial thermal deformation, thermal coning effects, lateral runout of the rotor due to geometrical tolerances (LRO) and also LRO excited by tensioning the rotor to the wheel hub.

Obove-mentioned influences on caliper drag are typically well known and understood. To accomplish customer’s requirements according to RBT, the calipers are extensively tested (e.g. NEDC/WLTP, coast down, ATE) in different test procedures on dynamometers. Some test specifications contain hard requirements on the intended drag torque (e.g. less than 0.1 Nm).

In contrast to the challenging requirements, other possible influencing parameters, e.g. disc deflection, caused by vehicle dynamics, is currently not included in any test on dynamometer. During e.g. curve driving, the lateral forces are generated between tire and road and can also be transferred into the rim/rotor/hub/bearing contact at the knuckle. Additionally this is overlain by the wheel load. It must be assumed that the side forces and wheel load affect the deflection of the disc. Thus, this may also influence residual brake torque.

This paper shows Continental’s setup for application of wheel load and side forces on dynamometer. Based on previous results from vehicle test, the disc deflection during dynamic driving is characterized and the wheel load setup was enhanced to apply side forces. Different positions of side force and wheel load induction are compared.

Furthermore the setup is used to identify the influence of dynamic disc deflection on caliper drag. This is done with an exemplarily floating type caliper (FN) and fist type caliper (MN) as well. Dedicated measurements illustrate the influence of left and right curve driving and dynamic lane change on the level of RBT.