

Present Paper at SAE 2015 Brake Colloquium & Exhibition

We presented a paper at SAE 2015 Brake Colloquium & Exhibition on October 5, 2015. This paper will be published in SAE International's scholarly journal.

1. TITLE

Effect of Material and Dimensional Homogeneity on Thermo-mechanical Deformation of Brake Discs during High-speed Braking

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3. ABSTRACT

Brake judder is one of the most serious problems in automotive-brake systems, and brake discs play a significant role in judder. There are two types of brake judder: cold and hot. Hot judder is caused by the thermo-mechanical deformation of a disc rotor due to high-speed braking. There are several causes and shapes of the deformation, e.g., coning and circumferential waviness. Circumferential waviness of brake discs is typically found as a butterfly shape in a 2nd rotational-order and corrugation (or hot-spotting) around a 10th order, which are caused by thermo-mechanical buckling. The author focused on the effects of material and dimensional homogeneity on the transient and permanent wave-like deformation of ventilated discs in low rotational-orders during repetitive high-speed braking. The tested discs were in two groups that had the same design and gray-cast-iron class but were cast in two foundries by using horizontal- and vertical-molding machines, respectively. Consequently the two groups of disc castings differed in the circumferential homogeneity of material. These discs were machined intentionally to have two kinds of dimensional variations in four rectangular orientations on the basis of the gating locations of each casting group. The temperature and deformation of disc rotors on the same radius were measured simultaneously during braking at a constant speed and torque. Measured deformation shapes were analyzed through fast Fourier analyses. As a result, both material and dimensional homogeneity were found to affect a disc's wave-like deformation in the 1st and 2nd rotational-orders with different significance between the two casting groups.

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