An Analytical Study for the Effect of Machining Patterns on Brake Squeal

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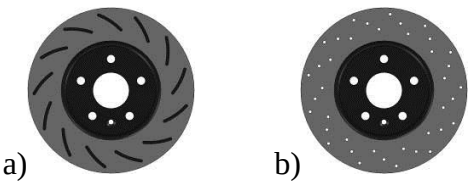
Abstract

Automotive brake noise and vibration are considered as a stubborn problem over the past few decades. Moreover, it becomes severe with the performance improvement of the automotive cars, since the improved driving performance should be controlled by the larger braking force that brings higher heat and noise. Recent performance brake kits have a tendencies to adopt cross-drilled patterns and/or slotted patterns for reducing temperature and obtaining additional functions such as gas ventilation and cleaning friction surface, however, the effects resulting from the patterns for the squeal noise are not clearly identified.

Many of methodology for understanding the noises have been suggested, and the squeal, one typical type of brake noise, was unveiled a phenomenon caused by dynamic instability. Therefore, it can be defined as a type of elastic instability that includes elastic modes within the audible frequencies of brake components. Analytical approaches for predicting squeal are generally adopting finite element methods. The recent researches for squeal are focusing on the relationship between of the in-plane modes and the out-of-plane modes of a disc rotor, which can be influenced to the squeal by the coupling of in-plane circular vibration and out-of-plane diametric vibration.

This study deals with the effect of machining patterns such as cross-drilled and slotted on automotive disc brake squeal. Three different type of disc brake with patterns are tested to investigate mode frequency. This experiment results are correlated with the finite element analysis models for detailed investigation, and the models are analyzed with changed designate shape factors such as radius, width and depth. As the outcome, it is revealed that the cross-drilled patterns are inducing reduction of the both frequencies of in-plane mode and the out-of-plane mode, and the slotting patterns are leading to reduce out-of-plane mode frequency and to increase in-plane mode frequency.

Keywords: Automotive disc brake, Squeal noise, Modal superposition, Cross-drilled/Slotted pattern, Finite element method.



a) b)

Figure 1. Machining patterns of the rotor-frictional surface: a) slotted pattern; b) cross-drilled hole pattern

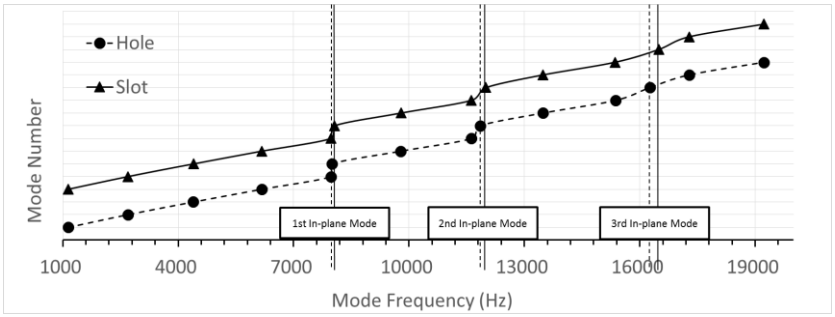


Figure 2. Mode changes made by machining patterns