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Thermal Effects on Brake Squeal using both experimental methods and complex eigenvalue analysis

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The aim of this paper is to analyze the influence of thermal effects on brake squeal by comparing experimental and finite element methods. Experiments on a pin-on-disc test rig with an infra-red camera are carried out, varying key parameters, such as rotational velocity and contact pressure. Finite element models of the pin and disc are built in Abaqus and complex eigenvalue analysis is used to predict frequencies of squeal under different conditions. The results of experiments and simulation are compared in orderto achieve a better understanding of brake squeal and to improve the predictive model.

Keywords: brake squeal, thermal effects, complex eigenvalue analysis

1. Introduction

Brake squeal is one of the most difficult problems related to vehicle braking systems. This squeal is usually considered as a friction-induced vibration in the high frequency domain between the brake components during braking [1]. This noise is an irritation to humans, who may believe that the brake system is not working properly, although the system actually performs as designed. Brake squeal is a difficult problem, affected by a number of different factors at macro and micro levels, some of which are currently not well understood [2].

This paper focuses on the influence of thermal effects on brake squeal, including both pin-on-disc tests and complex eigenvalue analysis. A pin-on-disc rig with an infra-red camera and a microphone is set up for squeal tests. Thermal analysis and complex eigenvalue analysis are carried on the finite element model. Results are compared and analyzed to improve the prediction model for squeals.

2. Methods

In order to understand the influence of thermal effects, both the experimental method and simulation method are included.

2.1. Experiments on the pin-on-disc rig
The test rig as Figure 1 shows is designed and used for squeal tests. An infrared camera is added to record the change of temperature during tests.

Figure 1: Pin-on-disc squeal test rig.

2.2. Finite element analysis
Pin and disc models are built in Abaqus as shown in Figure 2. Dynamic analysis including the thermal effect and complex eigenvalue analysis for squeal prediction are carried out with this model.

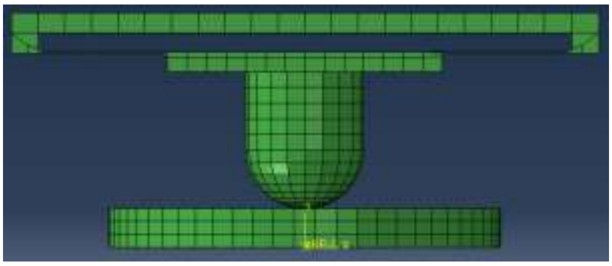

Figure 2: Finite element model of pin and disc.

3. Discussion

Some frequencies of squeal exist at the beginning of an experiment and others gradually evolve as the test runs. The squeal may be influenced by friction, thermal effects and wear. By processing and analyzing the results, we can determine that some instabilities are brought in by temperature changes caused by the friction between the pin and the disc. These change the interfacial pressure distribution. The boundary conditions and key parameters for the simulation model are calculated and an improved predictive model is developed.

4. References

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