

Disc Brake Squeal Occurrences under Dry and Wet Brake Pad Conditions

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Abstract

This paper investigates the effect of water absorption in the brake pad on squeal noise occurrences. A series of brake noise tests is performed at different hydraulic pressure and rotating speed conditions using the laboratory brake test rig. Four brake pad conditions are examined and tested, namely dry, low water absorption, medium water absorption and high water absorption. The test results show that the dry brake pad produces fewer numbers of squeal occurrence compared to the other three wet pad conditions. These three wet pads are also generating high sound pressure level, i.e. 100 dBA and above, than that recorded by the dry pad.

Keywords. Disc brake, Squeal noise, Test rig, Water absorption

Introduction

Automotive brake systems are designed to reduce vehicle speed as well as to completely stop the vehicle. It is very often that the brake systems generate undesirable vibrations and unpleasant noise. One of the most widely known problems with the brake systems is brake squeal noise [1]. This type of noise is regarded as the disc and pad induces self-excited vibrations [2]. Brake squeal is commonly defined as frequency between 1,000-20,000 Hz with the sound pressure level above 70 dBA. Brake squeal is always a major problem for the motor vehicle industry. Brake engineers are continuously facing challenging tasks to find a good solution to counter the brake squeal problem. The main reason is that it is very hard to predict whether the brake systems will be quiet under a wide range of brake operation and environmental conditions [3]. There are a few works that investigate the environmental condition of brake systems such as wet conditions. Most of the previous studies investigated the effects of wet brake pads on friction and wear [4,5] but not on the squealing brakes. Furthermore, most of the standardized tests for brake squeal were surprisingly carried out under the dry sliding conditions [6]. Thus, it is important to know whether the wet brake pads have an influence on a squealing brake.

Brake Noise Tests

In this investigation, a series of brake noise tests is conducted at different hydraulic pressure (0.3 MPa ~ 1.0MPa) and rotating speed (3 km/h and 10 km/h) conditions using a brake test rig as shown in Figure 1. The test rig contains of a local disc brake assembly driven by an 11 kW electric motor with the maximum speed of 1450 rpm and maximum braking torque of 400 Nm. The squeal noise data is captured using microphone type G.R.A.S. 26AH 1/2" Sys Check Preamplifier and Piezo BEAM[®] accelerometer type 8636C50. Four brake pad conditions, namely dry, low water absorption, medium water absorption and high water absorption as listed in Table 1 are examined and tested.

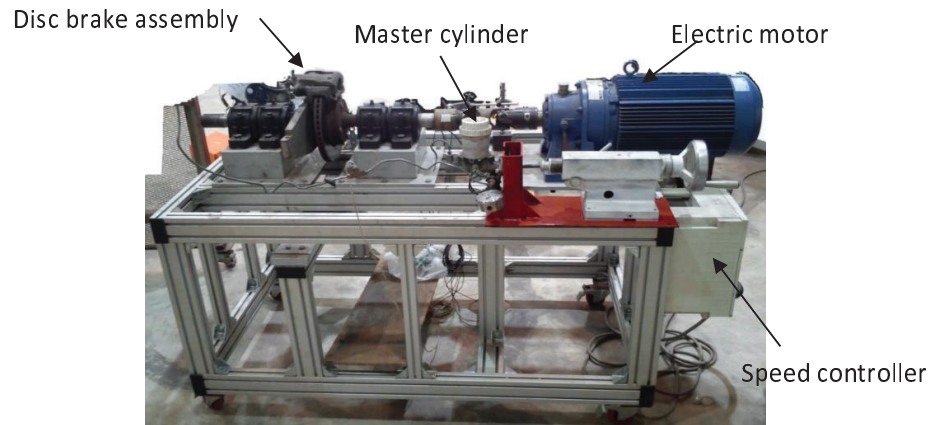


Figure 1. Brake Test Rig

Table 1: Brake Pad Conditions

No	Pad Conditions	Dry weight (gram)	Wet Weight (gram)	Percentage Absorb %
1	Dry	546.00	546.00	0.00
2	Low water absorption: 2 minutes in the water	546.00	546.17	0.03
3	Medium water absorption: 10 minutes in the water	546.00	547.01	0.18
4	High water absorption: 60 minutes in the water	546.00	547.41	0.26

Results and Discussion

From the brake noise tests, it is found that the dry pad generates only a few squeal noises as depicted in Figure 2. The squeal frequencies are dominant at 5500 Hz, 7000 Hz and 9000 Hz and the maximum sound pressure level (SPL) is recorded below 100 dBA. Unlike the dry pad, it is seen that the wet pads generate a lot more squeal noises as recorded in Figures 3, 4 and 5. The pad with low water absorption produces a wide range of squeal frequencies starting from 1000 to 10000 Hz with the maximum SPL of 105 dBA. Interestingly, this pad condition does not generate squeal at a frequency between 3000 to 4000 Hz, 4500 Hz and 7000 Hz (see red lines). As for the pad with medium and high water absorptions, the number of squeal noises is much higher than that recorded in the pad with low water absorption. These two pads are also generating a wide distribution of squeal frequency except for the medium water absorption pad where there is no squeal occurred at 4000 Hz (see red line). The maximum SPL is unchanged, i.e. 105 dBA for the medium water absorption pad, but it is slightly lower (100 dBA) for the high water absorption pad. Kim et. al. [6] and Lee et. al. [7] were also observed that the wet pad produced slightly higher sound pressure level than that generated by the dry pad. These different squeal behaviours between the dry and wet pads can be explained by conducting further investigation, including analysis of its microstructures and friction characteristics.

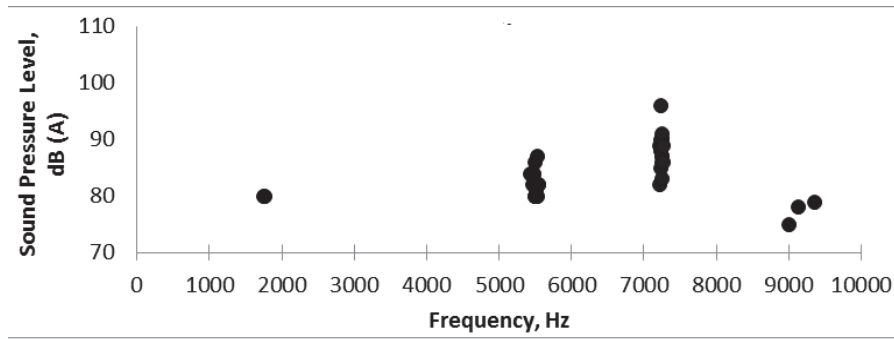


Figure 2. Brake Squeal Test Results with the Dry Pad

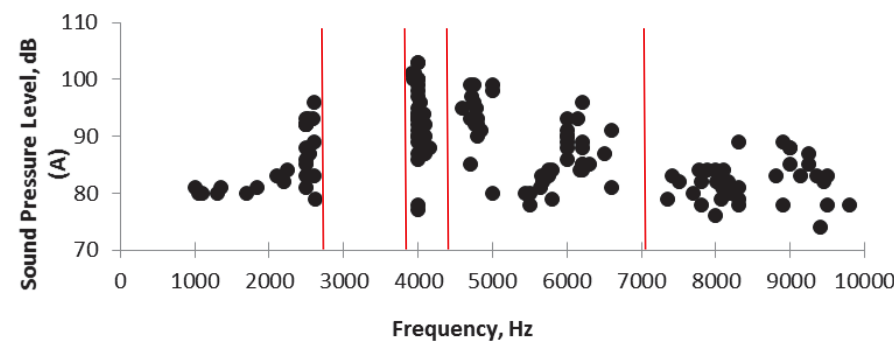


Figure 3. Brake Squeal Test Results with Low Water Absorption Pad

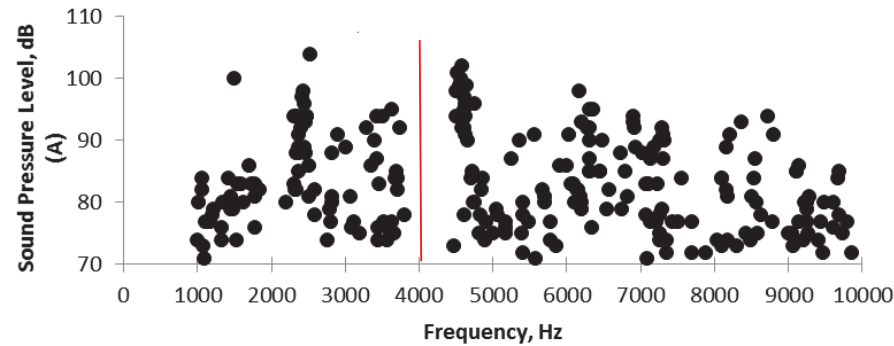


Figure 4. Brake Squeal Test Results with Medium Water Absorption Pad

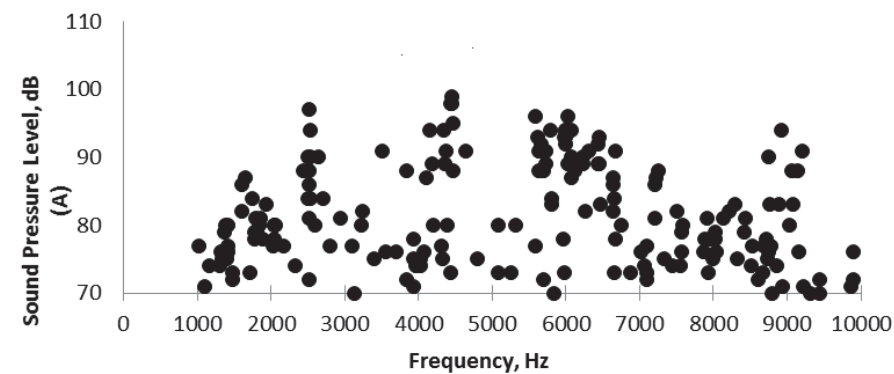


Figure 5. Brake Squeal Test Results with High Water Absorption Pad

Conclusion

This paper highlights the effect of pad conditions on the squealing brakes. Four pad conditions are dry, low, medium and high water absorption. The noise tests are successfully conducted using brake noise test rig and the test results reveal that indeed the wet pads are more likely to generate a lot more squeal in a wider range compared to the dry pad. On top of that, the wet pads are also producing high sound pressure level than the dry pad.

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