DISC BRAKE SQUEAL GENERATION DURING DRY AND WET CONDITIONS

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“To my beloved family, especially my parents, wife and children”

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ABSTRACT

Brake squeal, is an annoying sound that occurs in the frequency range of 1 to 20 k Hz and typically measures above 70 dB(A). To date, there have been extensive works carried out to identify significant parameters or mechanisms that trigger squeal occurrences based on various disciplinces such as structural dynamics and tribology. However, it seems that there is a limited study conducted to relate brake squeal with wet conditions of the brake pad. Thus, this work attempts to explore disc brake squeal generation and its establishment during the dry and wet conditions. A series of brake squeal tests is performed according to SAE J2521 test procedure using laboratory brake noise test rig. Three wet conditions are considered that based on levels of water absorption in the brake pad. It is found that the dry brake pad produces less numbers of squeal occurrence compared to the three wet pads. The dry pad records sound pressure level below 100 dB(A) while all three wet pads produce squeal sound more than 100 dB(A). It is observed that brake squeal can also be triggered and influenced by different operating and environment conditions due to dry and wet brake pads. The wet pads are producing brake squeal at wide range of operating and environment conditions compared to the dry pad.

ABSTRAK

Decitan brek adalah bunyi yang membingitkan berlaku dalam julat frekuensi 1-20 kHz dan biasanya melebihi 70 dB(A). Setakat ini, terdapat kerja-kerja terperinci yang dijalankan untuk mengenalpasti parameter penting atau mekanisme yang mencetuskan bunyi decit berdasarkan pelbagai displin seperti dinamik struktur dan tribologi. Walau bagaimanapun, kajian yang terhad dijalankan untuk mengaitkan decitan brek dengan keadaan basah pad brek. Oleh itu, kajian ini bertujuan untuk mengkaji decitan brek cakera dalam keadaan kering dan basah. Satu siri ujian decitan brek dilakukan mengikut prosedur ujian SAE J2521 menggunakan ujian pelantar brek. Tiga keadaan basah ditakrifkan berdasarkan tahap penyerapan air dalam pad brek. Didapati bahawa pad brek kering menghasilkan kurang bunyi decitan berbanding tiga pad basah. Rekod menunjukkan pad kering menghasilkan paras tekanan bunyi di bawah 100 dB(A) manakala ketiga-tiga pad basah menghasilkan bunyi decitan lebih daripada 100 dB(A). Adalah diperhatikan bahawa decitan brek dicetuskan dan dipengaruhi oleh operasi brek dan faktor sekitar. Pad basah menghasilkan decitan brek dalam julat yang besar dalam operasi brek dan faktor sekitar berbanding keadaanpad kering.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Automotive brakes are designed to slowing down and/or to stop a vehicle by transforming kinetic (motion) energy into heat energy. As the brake pads contact the rotors it creates friction which produces the heat energy. The automobile braking system is considered to be one of the most fundamental safety-critical systems in a modern automobile. Brake systems are sometimes known for generating undesirable vibrations and unpleasant noise. One of the most commonly known problems with these systems is brake noise (Silva et al., 2013). Researchers agreed that squeal friction between disc and pad induces self-excited vibrations (Soobbarayen et al., 2013). Brake squeal is still a major problem for the motor vehicle industry. The reason for this is that a brake has to operate without squeal under very different conditions and that it is very hard to predict whether a brake will be quiet under all of those conditions (Gottfried, 2012).

In general, brake noise can be classified into numerous categories based on the occurring frequencies and excitation sources (Jörg et al., 1999, Papinniemi et al., 2002, Kinkaid et al., 2003, Chen et al., 2005) as shown in Figure1.1. Brake Squeal occurs when the frequency falls between 1,000-20,000 Hz range with amplitude 70 dB or above in sound pressure level (SPL). Brake noise and vibration costs approximately $1 Billion/year in warranty work in Detroit alone (Misra et al., 1999).

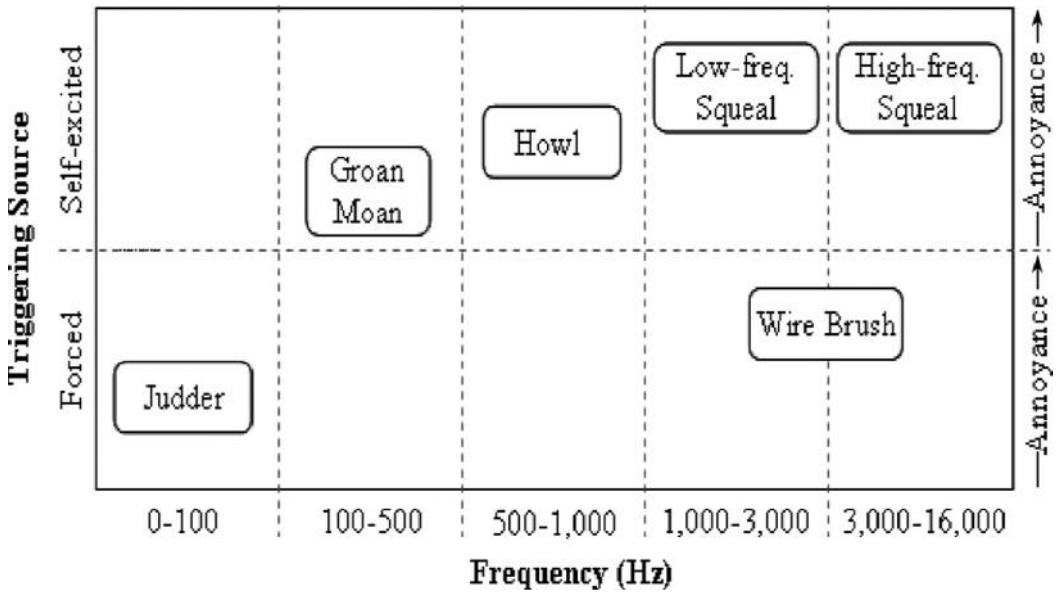

Figure1.1 Brake noise classification based on the frequency range of occurrence and excitation source (Dai and Lim, 2008)

1.2 Problem Statement

Brake squeal is one of the most important types of noise and vibration harshness issues that can happen during braking conditions and has received the most attention in both academic and industrial research and development. Understanding brake squeal is a challenging task. It involves many design variables in a complex brake system and there are involving complicated operational and environmental conditions under which squeal may occur. There are a few works that investigate the environmental condition in brake systems such as wet condition. Most of the previous studies investigated the effects of wet brake pads on friction and wear but not on squeal noise. Furthermore, most standardized tests for brake squeal are surprisingly only conducted under dry sliding conditions. Thus, it is important to know whether the wet brake pads have an influence on squeal noise.

1.3 Objective of study

To investigate squeal behavior during dry and wet pad conditions for passenger cars.

1.4 Scope of Study

1) Disc brake system of passenger car.
2) To be tested using laboratory test bench.
3) Squeal frequency from (1 kHz to 10 kHz).
4) To be tested in three wet conditions; light, medium and heavy wet.
5) To be conducted based on SAE J2521 test procedure.

1.5 Thesis Organisation

This study includes five chapters summarised as follows:

Chapter Two consists of a literature review about brake noise in general and brake squeal under wet condition in particular.

Chapter Three explains the methodology of the disc brake squeal experiment and lays out overall structure of this study.

Chapter Four presents the result of squeal generation under dry and wet pads conditions, and compares between squeal generation under dry pad and three wet pad conditions.

Chapter Five, provides conclusion and recommendation, that summarise the research results based on the experiment in this study, and give some suggestions about work that should be done in the future.

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