STUDY ON THE HEAT DISSIPATION PROPERTIES ON PALM WASTE BRAKE PAD

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Laporan ini dikemukakan sebagai memenuhi sebahagiaan daripada syarat penganugerahan Ijazah Sarjana Muda Kejuruteraan Mekanikal (Automotif)

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Date : ……..

For my beloved mum, Mrs. Noraani binti Othman and my caring dad,
Mr. Muhamad bin Marsidin

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ABSTRACT

The aim of this project is to study heat dissipation on new friction pad material, palm waste. The study is completed by modeling a finite element model using Abaqus software package from Simulia. The 3D modeling was developed using CATIA V5 software package from Dassault Systemes. Finite element method is numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. The temperature distribution pattern and highest temperature achieved by the new friction material is compared to the common friction material that has been manufactured in the market today. It is found that the temperature distribution of the new material is similar to the common friction material. The highest temperature achieved by palm waste material is 139.76°C, meanwhile the highest temperature achieved by common friction material is 116.31°C. The temperature difference between common friction material and the new material is not significant where it is only difference about ±20°C. These results obtained are considered acceptable.

ABSTRAK

Projek ini dijalankan bertujuan mengkaji pergerakan haba untuk bahan geseran baru iaitu bahan buangan kelapa sawit. Kajian ini telah dilengkapkan dengan menggunakan kaedah unsur terhingga (*finite element method*) dengan menggunakan perisian *Abaqus* yang dibangunkan oleh *Simulia*.Model 3D di dalam kajian ini telah dibangunkan dengan menggunakan perisian *CATIA V5* yang dibangunkan oleh *Dassault Systemes.* Kaedah unsur terhingga adalah kajian analisa yang digunakan untuk mendapatkan jalan penyelesaian bagi kebanyakan masalah kejuruteraan. Pola edaran suhu dan suhu tertinggi yang dicapai oleh bahan geseran baru telah dibandingkan dengan bahan geseran yang biasa digunakan dan dijual di pasaran kini. Hasil kajian menunjukkan pola edaran suhu bagi bahan geseran baru adalah hamper sama dengan bahan geseran biasa. Suhu tertinggi yang dicapai oleh bahan geseran sawit adalah 139.76°C, manakala suhu tertinggi yang dicapai oleh bahan geseran biasa adalah 116.31°C. erbezaan suhu tertinggi yang dicapai oleh kedua-dua bahan geseran tidak terlalu besar yang mana mempunyai beza ±20°C sahaja. Hasil kajian yang diperoleh dari kajian ini boleh diterima.

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CHAPTER 1

INTRODUCTION

This chapter consist the objective and the scope of the project. It also includes the introduction to finite element method and palm waste.

1.1 Overview

This research was conducted to study the heat dissipation properties of palm waste brake pad. Brake pads are a component of disk brakes used in automotive and other applications. Brake pads are steel backing plates with friction material bound to the surface that faces the disk brake rotor. A disc brake is usually made of cast iron or ceramic composites (including carbon, Kevlar and silica). Brake pads usually made from asbestos as their reinforcing fibres.

In this study, palm waste material has been used to replace the traditional material that used to make the brake pad, asbestos. The reason of this material replacement is to recycle the palm waste that can be used in many ways. Oil palm waste is worth more than crude palm oil (CPO): an estimated 30 billion ringgit ($9.2 billion) against 22 billion ringgit from Sabah's exports of 5.4m tonnes of CPO and it is about a third of

Malaysia's output. It is completely a total waste if this material is not recycled (MPOC.org, 2010).

The aim of the study is to compare between two types of brake pads which are palm waste and ordinary brake pad and to see how the heat transfer occurring when pressure is applied to them. Then, the performance of both brake pads are also analyze based on the result obtained.

1.2 Problem Statement

Most brake pads are manufactured from asbestos, semi metallic and ceramics material. Since the 1970s, asbestos had gained widespread acknowledgement as a carcinogen although the introduction of the asbestos ban in the United States only came about in1989. All forms of asbestos are carcinogenic. This ban was overruled in 1991 due to widespread complaints of develop the difficulty of finding asbestos replacements existing uses of asbestos are still permitted, while new applications or uses of asbestos are banned (LaDou et al, 2000). Due to the health concerns, manufacturer nowadays wants to replace the asbestos as the material in brake pads production. Thus, we try to use green material like palm waste to replace with the common material that have been used in brake pads to see whether their performance can be better than other materials. There are some considerations that we need to make in determining the performance of the palm waste brake pad:

- Maintain a sufficiently high friction coefficient with the disc brake.
- Not decompose or break down in such a way that the friction coefficient with the brake disc is compromised, at high temperatures
- Exhibit a stable and consistent friction coefficient with the brake disc.

1.3 Objectives

The objectives of this study are:

1. To develop finite element model of brake pad that can be used to analyze the heat dissipation on both material (palm waste and asbestos)
2. To study the heat dissipation on the brake pads.

1.4 Scope

The scopes of the project are:

1. Develop finite element model of both brake pads
2. Simulation of the heat transfer using FEA software for the finite element models.

1.5 Expected Results

At the end of the research, it is expected that the result between theoretical result (analysis) and the actual result will be mostly the same. It is also expected that the palm waste brake pad will exhibit better properties than the ordinary brake pads.

CHAPTER 2

LITERATURE REVIEW

2.1 Automotives Brake System

An automotive brake functions by converting the vehicle's kinetic energy into heat energy. During braking, the heat energy is first born by the two contact surfaces of the brake, namely the brake disc and the brake pad (or drum and shoe in the case of the drum brake), and is the transferred to the contacting components brake such as calipers of the brake, as well as the surroundings (D Chan & G W Stachowiak, 2004). A typical automobile braking system comprises of a braking device having different components, which are used for slowing or stopping down a vehicle. More precisely, these devices decrease or stop the speed of a moving or rotating body by absorbing kinetic energy mechanically or electrically. They are widely used in motor vehicles, buses, trucks, trains, airplanes, and other types of automobiles. The worldwide automobile industry is currently witnessing rapid innovative developments day by day. According to a research study by Frost & Sullivan, there is likelihood that after 2010, the global automotive

industry will start using brake-by-wire systems instead of hydraulic braking systems. The various technologies such as electro mechanical braking system and the electronic wedges brake are soon going to replace the older braking systems. With the help of these brake-by-wire systems, automobile drivers will be having more control on their vehicles particularly in case of sheer emergency.

The braking system used in automobiles is mainly used for helping the driver control the deceleration of the vehicle. It is one of the crucial systems, which is especially designed for decreasing the speed of the fast moving vehicle. A typical automobile braking system comprises of a braking device having different components, which are used for slowing or stopping down a vehicle. More precisely, these devices decrease or stop the speed of a moving or rotating body by absorbing kinetic energy mechanically or electrically (Automotive-online, 2010). These systems automatically control wheel slips and prevent the wheels from spinning. They are widely used in motor vehicles, buses, trucks, trains, airplanes, passenger coaches, trailers, and other types of automobiles. Brake systems used in automobiles has come a long way in recent years. The adoption of anti lock brake systems along with the introduction of different brake components made of carbon fiber, steel, aluminum etc have really provided better stopping performance in comparison with traditional braking systems.

2.2 Brake Components and Functions

A disc brake system usually consists of a brake disc rotor, two brake pads and a caliper (hubpages.com , 2007). The combination of these components allows the rotating whel to experience severe braking in a short stopping distance. The braking surface is the area on which the braking action of the friction material takes place.

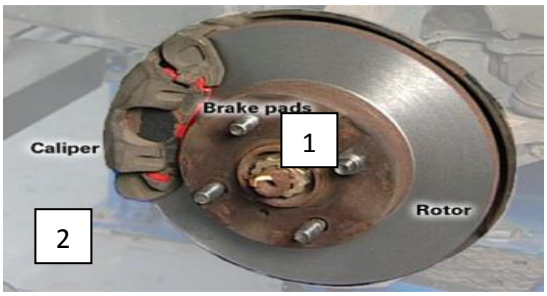

Figure 1: Brake system components: 1)Brake pads, 2) Caliper, 3)Rotor (cdxetextbook.com, 2010)

2.3 Brake Pads

The gradual phasing-out of asbestos in automotive brake friction materials in many parts of the world has sparked the onset of extensive research and development into safer alternatives (D Chan & G W Stachowiak, 2004). As a result, the brake friction industry has seen the birth of different brake pads and shoes in the past decade, each with their own unique composition, yet performing the very same task and claiming to be better than others. This suggests that the selection of brake friction materials is based more on tradition and experimental trial and error rather than fundamental understanding.

Brake pads convert kinetic energy of the car to the thermal energy by friction. When a brake pad is heated by contact with a rotor, it transfer small amounts of friction material to the disc, turning it dull grey. Brake pad and disc stick to each other to

provide friction to stop vehicle. A characteristic of a good brake is maintaining a sufficiently high friction coefficient with the brake disc. It is also must not decompose or breakdown in such a way that the friction coefficient with the brake disc is compromised at high temperatures. Brake pads must exhibit a stable and consistent friction coefficient with the brake disc (Eriksson, M., 1999).

2.3.1 Main Components of Brake Pads

There are four main components of brake pad. First, reinforcing fibres; which provide mechanical strength to the friction material. Second are binders which maintain brake pad structural integrity under thermal and mechanical stress. The third component is fillers which improving manufacturability as well as reduces overall cost of the brake pad. Lastly, frictional additives; component added to brake friction material in order to modify the friction coefficient and wear rates (Eriksson, M., 1999).

2.3.1.1 Reinforcing Fibers

Asbestos fibers have been used as reinforcing material in brake pads as early as 1908 when English inventor Herbert Frood came up with a combination of asbestos, brass wire and resins for use as a friction linings. Asbestos is cheap and provided friction linings with excellent durability and thermal resilience. This is a key attribute as braking temperatures can reach hundreds of degrees Celcius. In the late 1980s, it was public knowledge that asbestos is a carcinogen and brake pad manufacturers started looking for suitable alternatives (Haynes Publishing, 1998).

The purpose of reinforcing fibres is to provide mechanical strength to the friction material. Recent research has shown that the braking load is actually carried by tiny plateaus that rise above the surroundings lowlands on the friction material. These plateaus are formed by the reinforcing fibres surrounded by the softer compacted

components. Therefore the importance of the reinforcing fibres in friction material cannot be underestimated. Friction materials typically use a mixture of different types of reinforcing fibres with complementing properties (Lexus, 2010).

2.3.1.2 Binders

Binders are the glues that hold the friction material together. Phenolic resin is the most common binder in current use (Blau, P. J., 2001). The purpose of a binder is to maintain the brake pads structural integrity under mechanical and thermal stresses. The binder holds the components in the brake pad together and prevents its constituents from crumbling.

2.3.1.3 Fillers

Fillers are used to maintain the overall composition of the friction material, and some other function as well. They can be metals, alloys, ceramics, or organic materials . The fillers in a brake pad are present for the purpose of improving its manufacturability as well as to reduce the overall cost of the brake pad (Lexus, 2010). Fillers are added to friction materials in small quantities to accomplish specific purposes such as rubber chips to reduce brake noises (Blau, P. J., 2001). The actual choice of fillers depends on the particular components in the friction material as well as the type of friction material. For example, a metallic pad that generates a lot of braking noise would require more filler such as cashew and mica (noise suppressors than barium sulphate (heat stability).

2.3.1.4 Frictional Additives

Frictional additives are components added to brake friction materials in order to modify the friction coefficient as well as wear rates. The frictional additives can be divided into two categories: lubricants, which decrease friction coefficients and wear rates, and abrasives, which increase friction coefficients and wear rates (Lexus, 2010).

2.4 Abaqus/CAE

Abaqus is a powerful finite element software package. It is used in many different engineering fields throughout the world. Abaqus performs static and/or dynamic analysis and simulation on structures. It can deal with bodies with various loads, temperatures, contacts, impacts, and other environmental conditions. Abaqus is developed and supported by Hibbitt, Karlsson & Sorensen, Inc. (HKS). Abaqus includes four functional components:

- Analysis Modules
- Preprocessing Module
- Postprocessing Module

2.5 Finite Element Method

The finite element method is numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. Because of its diversity and flexibility as an analysis tool, it is receiving much attention in almost every industry. In more and more engineering situations today, we find that it is necessary to obtain approximate solutions to problem rather than exact closed form solution. It is not possible to obtain analytical mathematical solutions for many engineering problems. An analytical solutions is a mathematical expression that gives the values of the desired