EVALUATION STUDY ON STATIC ANALYSIS OF AUTOMOTIVE BRAKE SYSTEM USING NUMERICAL APPROACH

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I hereby declare that I have read
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is sufficient in terms of scope and quality for award of the
Bachelor of Mechanical Engineering (Structure and Material)

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A project report submitted in partial fulfillment
of the requirements of the award of
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I hereby declare that this thesis is the result of my own research except summary and sentence as cited in the references

Signature : .....

Name : .....

Date : .....

For my father and mother with lots of love

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First of all, I am very grateful to Allah S.W.T, with His blessing, finally I finished my Final Year Project in evaluation study on static analysis of automotive brake system using numerical approach. I am very happy, through this project, He provide me the strength, idea and a fine physical condition as me getting towards the finishing of my project.

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ABSTRACT

Nowadays, the development of vehicle system has brought the industry to the next level. The manufacturing of the vehicle has open up the market for the components in the vehicle itself. One of the components of the vehicle is braking system. The braking system has developed through times and following the needs of the vehicle itself. In this project, evaluation study on dynamic analysis of automotive brake system was carried out using numerical approach. The purpose of this particular project is to study the properties of the braking system and to improve it. The braking system need to be designed and analyzed both theoretical and by using software. The analysis is based on existing braking system in the market. Using the type of material, possible force acting and assuming the value of variables, the theoretical value was achieved. The theoretical values was used to fill the software requirement of force.

ABSTRAK

Pada masa kini, pembangunan dalam sistem permotoran telah membawa industri ke tahap yang baru. Proses pembuatan sesebuah kenderaan telah membuka pasaran untuk komponen-komponen kenderaan itu sendiri. Sistem brek adalah salah satu daripadanya. Sistem brek telah berkembang melalui peredaran masa dan bergerak seiringan dengan keperluan kenderaan itu sendiri. Dalam projek ini, pengembangan kajian dalam analisis dinamik pada brek automotif dilakukan menggunakan pendekatan berangka, kajian ini adalah untuk mengkaji ciri-ciri sistem brek dan memperbaikinya. Sistem brek ini haruslah di lukis dan dikaji menggunakan kedua-dua cara iaitu secara teori dan analisis menggunakan perisian komputer. Analisis ini dilakukan pada brek yang sudah sedia ada di pasaran. Menggunakan bahan yang tertentu, daya yang mungkin bertindak dan anggapan pada nilai yang ada, nilai teori yang di kira digunakan dalam perisian.

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LIST OF SYMBOLS

Symbol	Description
B_F	Braking Force
M	Total Weight
a	Deceleration
D_x	Deceleration
V_f	Final velocity
V_i	Initial velocity
Δt	Time to stop the car

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CHAPTER I

INTRODUCTION

1.1 Introduction

The task in this project is to study the critical area of disc brake using numerical approach. The criteria of this study is to search the possible critical area that been put by strain or stress or any kind of force that may exist there. This study is to find a way to empower the disc brake by changing the material, creating new design or any methodology that is suitable for the disc brake. Disc brake is a device for slowing or stopping the rotation of a wheel. A brake disc, usually made of cast iron or ceramic, is connected to the wheel or the axle. In order to stop the tyre from rotating, the friction material in the form of brake pads that mounted in a device called a brake caliper is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop.

1.2 Problem statement

Towards the development of the manufacturing marketing, every manufacturing company have been competing between each other to ensure they catch customers attention to their product. This is included the vehicle manufacturer. The component of the vehicle is also affected by this scenario. The breking system is part of important manufacturing product to be manufactured. This scenario force the manufacturer to enhance the product with a lower cost and high perfomance to ensure they get place in the market. Departments involved have to do research on improving the braking system to the maximum capability such as the design and material of the system.

1.3 Objective

Before beginning to start the project, aiming for what the result must achieved must be set first. This is to know at the end of the project, whether this is a successful one or not. The objectives of this project are:

1 To investigate the critical defect in disc
2 To enhance the design of disc by using numerical approach.

1.4 Scope

Specifying the work, the scope put in the picture to know where the project will lead to. This to ensure the project is going as planned and it also states the control of the study. Here are the scopes for the project:

1 Only disc will be studied in this propose project.
2 The limitation of this study is only for linear defect of disc brake.
3 The analysis of the defect is done by using numerical approach only.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter is to explain about the braking system. It shows how it works, material usually use for it and designing of the system. To analyze the brake disc, it is vital to ensure what are they experiencing, where the critical areas and how to analyze it.

2.2 Brake system

Experiments with disc-style brakes began in England in the 1890s; the first ever automobile disc brakes were patented by Frederick William Lanchester in his Birmingham factory in 1902, though it took another half century for his innovation to be widely adopted. Modern-style disc brakes first appeared on the low-volume Crosley Hotshot in 1949, then Chrysler's Imperial division also offered a type of disc brake from 1949 through 1953, though in this instance they were enclosed with dual internal-expanding, full-circle pressure plates. Reliable modern disc brakes were developed in

the UK by Dunlop and first appeared in 1953 on the Jaguar C-Type racing car. The Citroën DS of 1955, with powered inboard front disc brakes, and the 1956 Triumph TR3 were the first European production cars to feature modern disc brakes.

These brakes offered greater stopping performance than comparable drum brakes, including resistance to "brake fade" caused by the overheating of brake components, and recovered quickly from immersion (wet brakes are less effective). Unlike a drum brake, the disc brake has no self-servo effect and the braking force is always proportional to the pressure placed on the braking pedal or lever. Many early implementations for automobiles located the brakes on the inboard side of the driveshaft, near the differential, but most brakes today are located inside the wheels.

The braking system on vehicle is the single most important safety component owned. Without a good system of stopping the vehicle, the vehicle would not be able to be driven. The brakes not only stop or slow the vehicle when are driving, but it holds the car still in a dangerous situation. The brakes will also help when using them while driving the car on a turn. Most people have no idea how the disc brake system in their vehicle works.

The brake system is primarily designed for maximum safety and is precisely made to stop heavy vehicle while driving at great speeds. Even though the system is very precise, it is not that difficult to understand. There are a couple of different systems that can be found on vehicles including disc brake systems. The other type of brake system that can be found on cars is a drum brake system and a combination of the two.

The disc brake system contains the master cylinder, brake pedal, brake lines, calipers, rotors and pads. The master cylinder can be found beneath the hood of your car and it pushes brake fluid right through these brake lines. These braking lines lead to the wheels where the calipers are located. The fluid from the brake lines causes the brake

pads to compress and push on to the rotor. When the brake pads compact onto the rotor it will slow down and stop the vehicle.

To make sure that the brake is performing properly or when plan to tow a heavy load with the vehicle, it have to be checked each of these components to be sure they are working properly. The vehicle can also be done some improvements to the disc brake system to be sure that it is the best that it can be.

The quality of the brake fluid is one of the first things that should be checked. The brake fluid should be a standard brake fluid that has not been in the car for too long a period of time. It also can be a higher grade brake fluid if one planned to use the vehicle for racing. With a higher grade brake fluid, one will notice a much firmer feel in the pedal when the brakes are being applied. The higher grade brake fluids must be changed much more often than the standard type. To have a better feel from the disc brake system, the vehicle can be installed with some stainless steel type brake lines in the vehicle. These will give a much firmer feel when the driver steps on the brake pedal.

The brake pads are another component that should be checked to make sure that the vehicle is getting a good performance from the disc brake system. There are performance brake pads available to be used on the vehicle for improvement in the response when the brakes are applied. These are not necessary and a standard set of brake pads is sufficient to stop the car if they are in good condition.

All of the components in the disc brake system are vital to properly stop the vehicle. For the safety while driving the vehicle, it is important to regularly inspect the brakes and make sure that all of the components are in good condition. Tyres are not a part of the disc brake system on the vehicle, but they play a big role in how quickly the

vehicle stops. Make sure that the tyres have adequate tread and are in good condition as well.

A disc brake caliper is the device on which brake pads are mounted in the operation of a disc brake system. Disc brakes slow or stop the vehicle through the rotation of the wheel. Usually made of cast iron or ceramics, these brakes are connected to the wheel and operate on friction created by the brake pads. Calipers are important because they create the gripping motion of the disc brake that actually makes the vehicle stop.

The U-shape caliper has either one or two pistons, and the caliper is activated by fluid to engage the brake pad during a slowing or stopping motion. The caliper has to withstand intense heat and friction and is most susceptible to damage by brake fluid. Brake fluid must be frequently changed to prevent damage and rusting, which could eventually yield the disc brake caliper useless.

It's really important to be in tune with how the disc brake system is working, and immediately replace the caliper when it is damaged. In addition, one should not skimp when purchasing a caliper; find one that is durable and high-quality. Disc brake calipers should last beyond 161,000 kilometer or the life of the car, but poor maintenance could lead to be looking for a new caliper sooner than normal. Make sure to flush the brake fluid every year and keep the brake pads up to date. Reinstall the brake caliper every time brake pads changed.

When step on the brake pedal, these are actually pushing against a plunger in the master cylinder, which forces hydraulic oil (brake fluid) through a series of tubes and

hoses to the braking unit at each wheel. Since hydraulic fluid (or any fluid for that matter) cannot be compressed, pushing fluid through a pipe is just like pushing a steel bar through a pipe. Unlike a steel bar, however, fluid can be directed through many twists and turns on its way to its destination, arriving with the exact same motion and pressure that it started with. It is very important that the fluid is pure liquid and that there is no air bubbles in it. Air can compress which causes sponginess to the pedal and severely reduced braking efficiency. If air is suspected, then the system must be bled to remove the air. There are "bleeder screws" at each wheel cylinder and caliper for this purpose.

When the brakes are applied, hydraulically actuated pistons move the friction pads in to contact with the rotating disk, applying equal and opposite forces on the disk. Due to the friction in between disk and pad surfaces, the kinetic energy of the rotating wheel is converted into heat, by which vehicle is to stop after a certain distance. On releasing the brakes the brakes the rubber-sealing ring acts as return spring and retract the pistons and the friction pads away from the disk. (Source: Kumar (2008))

2.3 Material of the disc brake

Disc brake rotors are commonly manufactured out of a material called grey iron. The SAE maintains a specification for the manufacture of grey iron for various applications. For normal car and light truck applications, the SAE specification is J431 G3000 (superseded to G10). This specification dictates the correct range of hardness, chemical composition, tensile strength, and other properties that are necessary for the intended use. Gray irons are commonly classified by their minimum tensile strength. A class 30 gray iron indicates that it has a nominal tensile strength of 30,000 psi. In the International Standard or Sl System a similar iron would be grade 230 with a tensile strength of 230 MPa (megapascals) or 230 newtons per square millimeter.

2.4 Designing of the disk brake

Generally disk brakes are simply solid cast iron, but others are hollowed out with fins joining together the disc's two contact surfaces (usually included as part of a casting process). This "ventilated" disc design helps to dissipate the generated heat and is commonly used on the more-heavily-loaded front rotors. Many higher performance brakes have holes drilled or cast through them. This is known as cross drilling. Brake pads will outgas and under use may create boundary layer of gas between the pad and the rotor hurting braking performance. The hole is created to provide place for the gas to escape. Modern brake pads do not suffer as much from out gassing problems and often the purpose is cosmetic. Rotors may also be slotted, where shallow channels are machined into the disc to aid in removing dust and gas. Some discs are both drilled and slotted.