PERFORMANCE TEST OF ELECTRIC AND ELECTRO-HYDRAULIC PARKING BRAKE

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"I hereby admit that have read this project paper entitled "Performance Comparison between Manual Parking Brake, Electronic Parking Brake and Electro-Hydraulic Parking Brake" by Muhd Syafiq Bin Mohd Yusof and in our opinion was adequate in terms of scope aspect and quality to award in purpose Degree in mechanical engineering (Automotive)"

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ABSTRACT

The automotive technology is pacing to new era, where vehicle runs on alternative fuel such as hydrogen and can be driven by wire. Though, a need to develop an electric and electro-hydraulic parking brake was identified by UTeM's researcher. The functional requirements of the new brake system are must able to support the max torque produce by the engine, reliable and guarantee safe for user. In simple word the performance of the new parking brake system should be at least equivalent with the conventional system. Thus, this final year project report provided a solution to the requirements of the electric and electro-hydraulic parking brake by planning and running a few test. The objective of the test is to measure the torque and force applied by the brake and force required to trigger the brake. The test should also provide data of response time for each of the new parking brake system. At the end of this project, comparison of performance between the new parking brake systems and the conventional parking brake system will be made. The performance comparison should help to conclude if the new systems are reliable and have the potential to replace the conventional system thus globally commercialize.

ABSTRAK

Teknologi automotif sedang rancak berubah ke era baru, di mana kenderaan bergerak menggunakan bahan bakar alternatif seperti hidrogen dan berfungsi lebih secara elektronik berbanding mekanikal. Disebabkan demikian, para penyelidik UTeM telah mengenal pasti keperluan untuk membangunkan sistem brek parkir yang berfungsi secara elektrik dan elektro-hidraulik. Sistem brek yang baru dibangunkan in haruslah terbukti mampu berfungsi dengan baik, mampu menyokong daya pulas maksima yang dihasilkan oleh enjin serta dijamin selamat untuk pengguna. Dalam erti lain, sistem parkir brek yang dibangunkan ini haruslah sekurang-kurangnya setara dengan sistem konvensional dalam aspek prestasi. Dengan demikian, laporan projek tahun akhir ini akan merancang dan menyediakan penyelesaian terhadap cara ujian perbandingan prestasi akan dijalankan dan seterusnya menjalankan ujian tersebut. Menerusi projek tahun akhir ini beberapa ujian akan dijalankan terhadap sistem brek parker elektrik dan elektro-hydraulic. Objektif kepada ujian ini adalah untuk mengukur daya dan daya pulas yang dihasilkan oleh system tersebut serta daya yang diperlukan untuk memicu sistem brek ini. Selain itu ujian juga akan dijalankan bagi mengukur masa tindak balas dari waktu pemandu memberi input sehingga kenderaan berhenti bergerak. Di akhir projek ini, perbandingan sistem baru dengan sistem konvensional akan dibuat. Perbandingan ini diharap dapat membantu untuk menyimpulkan adakah sistem baru ini berpotensi mengantikan sistem konvensional dan sehingga dapat dipasarkan secara global.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURE

NOMENCLATURE

a	=	Acceleration
F	=	Force
GF	=	Gage Factor
k	=	Spring Constant
L	=	Length
m	=	Mass
r	=	Length of Moment Arm
$R_{1,2,3,4,x}$	=	Resistance
τ	=	Torque
σ	=	Stress
ε	=	Strain

APPENDIX

CHAPTER I

INTRODUCTION

A brake is a compulsory and most critical part in a machine or vehicle used to applied a force against the friction of the road resulting slowing or stopping the motion of the body. Parking brake usually activated by driver using a hand lever. In 2009 an electronic and electro-hydraulic parking brake was developed by the UTeM's researcher in order to simplify the way to activate the brake. This is a breaking research and development as the automotive industries preparing for the next generation drive by wire car.

This final year project report is about the performance test of new Electronic and Electro-Hydraulic Parking Brake Systems. This report briefly explains the method used in performance and responsive test of the brake system as well as the procedure on how to measure the torque and forces in the system. In the test to measure brake torque and forces, strain gauge will be use widely as precise measuring instrument. Besides of high-tech instrument, the test will be carried out using a simple spring method as a low cost alternative. This method should be reliable for responsive test too.

Based on the data obtain, comparison between manual, electric and electro-hydraulic parking brake will be made to conclude if the new system is reliable for real life situation and thus commercialized. There are tremendous potential in this new parking brake systems as the automotive technology just started to evolve from mechanical to drive by wire.

1.1 Objective

To test the performance as well as obtaining the torque and force in the system of electric and electro-hydraulic parking brake.

1.2 Scope

1. To measure the brake torque and force of the brake system.
2. To test the responsiveness of the brake system.
3. Performance comparison between manual parking brake, electronic parking brake and electro-hydraulic parking brake.

1.3 Problem Statement

To achieve the objective of the project, the scope listed above should be made as guidance while running the project. In the process to measure brake torque and forces of the brake system, choosing a low cost but precise method is somehow challenging. Responsiveness test heard as uncomplicated, but the way to compute the response time from driver input until the brake fully triggered can be tricky. Before the performance comparison between conventional, electric and electro-hydraulic parking brake can be made, installation and functional test should be carried out on a car. Studies on the installation and safety precaution should be made before running on the installation and functional test. This particular part of the project is challenging and should be made up as a test to measure the level of mechanical and automotive knowledge.

CHAPTER II

LITERATURE REVIEW

2.1 Automotive Brake

Brake is a device used to apply a force to an object to retard its motion. The most common method is to bring the moving surface into contact with a fixed surface, thereby generating friction which opposes the direction of movement. In a vehicle such as car and small truck, braking can be triggered by driver in 2 ways which is by the foot pedal and the hand lever. The brakes on today's cars and trucks have come from long way and history. The basic of hydraulic never changed, but friction material and other components have. From one-piece cast iron, the material of disc brake has changed to ceramic composite for high performance racing car or heavy trucks.

For better understanding of the brakes on today's car, the evolution history of brake should be considering review. Prior to the 1920s, all the brake systems were mechanically operated rather than hydraulic. Rods or cables connected to the brake cable were used to tighten band brakes around the flywheel, driveshaft or a wheel drum. The set rods or cables connected to the brake cable were also used to rotate a cam or

wedge that pushed a set of brake shoes outward against the inside drum. In this era, most of the vehicle only had rear wheel brakes. A hollow flexible steel “Bowden” cable was used to operate brake drum in few vehicles with front wheel brakes. For a better 4 wheel braking, it required complex arrangement of equalizer yokes pulleys to even out the braking forces so the rear wheels would not lock up and skid when the brakes were applied.

According to Mike Mavrigian (1998), hydraulic brakes invention by Malcom Loughead in 1918 is a real breakthrough. He helps eliminated the rods, levers and cables that were previously needed to work the brakes because hydraulic brakes could transmit force equally to piston at each wheel brake without losses. Hydraulic also reduced the amount of pedal effort required to stop the vehicle, which made for easier braking and safer driving. In 1920, Duensenberg became the first production vehicle to offer hydraulic brakes. Chrysler was the next in 1924, and soon all the vehicle manufacturers offered hydraulic brakes.

2.1.1 Disc Brake

Most modern cars have disc brakes on the front wheels, and some have disc brakes on all four wheels. The most common type of disc brake on modern cars is the single-piston floating caliper and the number of piston can be more according to its application. Disc brake consists of three main components. The components are brake pad, disc rotor and caliper.

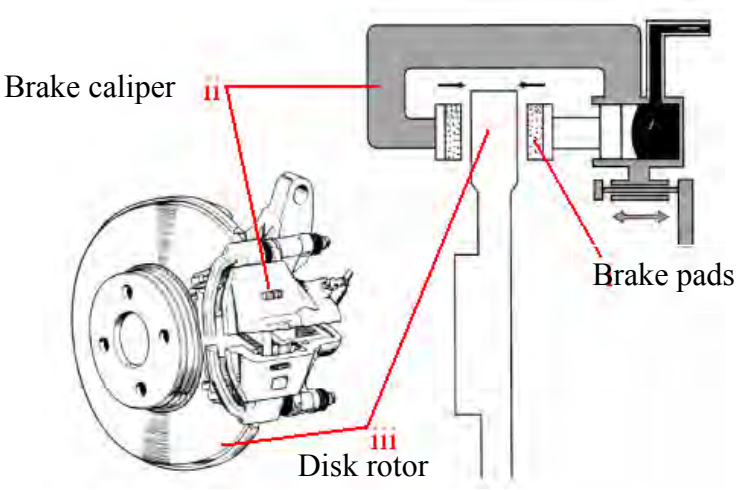

Figure 2.1 Disc Brake Diagram

i. The brake pads

Brake pads are steel backing plates with friction material bound to the surface. The surface of the friction material faces the disk brake rotor. When the brake is triggered, the hydraulically force are applied, the caliper clamps or squeezes the two pads together into the spinning rotor to slow or stop the vehicle. When a brake pad is in contact with the rotor can gets heated, it transfers small amounts of friction material to the disc, turning it dull gray.

Disc brake system is usually consisting of two brake pads per disc rotor. Even though, racing calipers utilize up to six pads with varying material frictional properties for optimum performance. Usually, brake pad has a piece of metal on them called wear indicator shown in Figure 1. This metal piece makes a squealing sound when intact with disc brake rotor to indicate it is time to change the brake pad as in Figure 2.

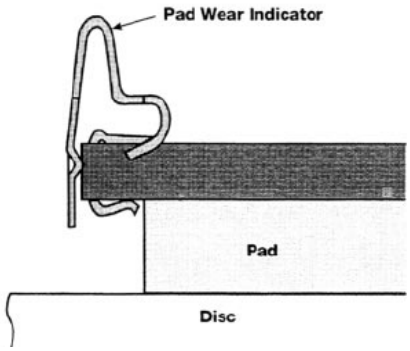

Figure 2.2 Brake Pad Wear Indicator

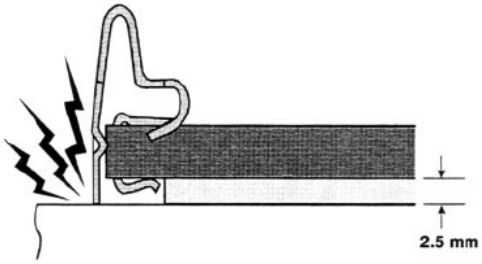

Figure 2.3 Noise From Brake Pad Indicator

ii. The caliper

The caliper contain piston the piston in the caliper emerges from the hollow cylinder where it resides inside the caliper. The brake caliper fits over the rotor like a clamp. In one side of each caliper, there is one or more hollow cylinder where the piston resides and as inlet of hydraulic fluids. When driver step on the brake, the brake fluid from the master cylinder creates hydraulic pressure on one or more pistons in the brake caliper forcing the pads against the rotor.

iii. The disk rotor

There are three types of disc rotor. The ventilated disc rotor consists of a wider disc with cooling fins cast through the middle to ensure good cooling. Proper cooling prevents fading and ensures longer pad life. Some ventilated rotors have spiral fins