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"I hereby declare that have read this thesis and in my opinion this report is sufficient in term of scope and quality for the award of the degree of
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Date: …….

DESIGN AND FABRICATE A BRAKE SYSTEM AND MECHANISM OF AN ELECTRIC RACING CAR

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DECLARATION

"I hereby declare that the work in this is my own except for summaries and quaotationswhich have been duly acknowledge"

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Khas Buat Ayah Dan Ibu Tersayang

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ABSTRACT

Brake is one of crucial components in almost every vehicle. The need of brake performances is much based on what kind of applications or transportations that particular vehicle is meant to be. Racing car or motorcycle brakes are often made with different kind of material and different characteristics compared to conventional vehicle brakes. Formula Varsity (FV) car that being built has no motor on it yet, so, the brake design is made based on the weight and reference speed targeted on that car. Based on the result of surveys, designing House of Quality methods is used to determine crucial factors of the brake characteristic to be carried out on further designing method using CAD software. The design of the brake disc rotor is decided to be using conventional Perodua Kancil's disc brake with some customization made on it such as lathe to flatten it and drilling to match the mounting holes on it. Moreover, a pedal box assemble is being designed using CATIA V5 software with two designs and choosing one of those designs using design scoring method which is Weighted Decision Method. The design 'B' is chosen. Some calculation is being made to determine any crucial parameter such as clamping force, which is 607.95N per disc and the torque required to stopping the car per disc brake is 741Nm. The analysis is done by using ANSYS software for both disc brake and pedal box assembly. For disc brake analysis, the clamping force is 700N and 789.34 Nm of torque acted on it. The result shows 0.00048699mm of deformation, 11.211Mpa of Von-Misses stress, 6.4637Mpa of shear stress along the disc neck and the safety factor turn out to be more than enough to withstand the clamping force which is more than 10 safety factor based on the software results. For pedal box analysis, there are two sections of force acting and the other parts are fixed. Section A is put 100N of force and section B is 300N of force. The bearing is fixed. The results are 0.070922mm of deformation on the end region of pedal, 33.269Mpa of Von-Misses, 5.8817Mpa of shear stress and the safety factor is shown minimum of 2.591. Based on the results, it shows that both designed part and assembly is meet all the requirements based on the calculations.

ABSTRAK

Brek merupakan salah satu komponen penting dalam hampir setiap kenderaan. Bagi tujuan perlumbaan, brek biasanya dibuat untuk ketahanan, kekuatan brek, prestasi dan banyak lagi. Brek sering kali direka berdasarkan kuasa enjin yang ditentukan bagi sesuatu kenderaan serta berat kereta dan agihan berat pada kenderaan tersebut. Kereta lumba Formula Varsity (FV) yang sedang dibina belum lagi mempunyai enjin, maka, reka bentuk brek dibuat berdasarkan berat dan kelajuan rujukan yang disasarkan pada kereta lumba yang sedang dibina tersebut Dengan keputusan survey yang diperolehi, kaedah 'House of Quality' pula digunakan bagi menentukan faktor-faktor penting serta ciri-ciri brek yang seterusnya akan direka bentuk dengan menggunakan perisian CAD. Reka bentuk cakera brek diputuskan agar menggunakan cakera brek konvensional Perodua Kancil dengan beberapa modifikasi dibuat seperti melarik untuk meleperkan serta penggerudian agar cakera sepadan dengan lubang pemasangan di atasnya. Selain itu, kotak pedal pula direkabentuk menggunakan perisian CATIA V5 sebanyak dua reka bentuk dan salah satu daripada reka bentuk dipilih melalui kaedah 'Weighted Decision Method'. Reka bentuk 'B' dipilih setelah menggunakan kaedah tersebut. Beberapa pengiraan dibuat untuk menentukan parameter penting seperti daya apitan brek, iaitu sebanyak 607.95N bagi setiap cakera serta tork yang diperlukan untuk menghentikan kereta bagi setiap cakera brek adalah 741Nm. Analisis dilakukan dengan menggunakan perisian ANSYS bagi untuk kedua-dua brek cakera dan pemasangan kotak pedal. Untuk analisis brek cakera, berkuat kuasa pengapit 700N dan 789,34 Nm tork bertindak ke atasnya. Hasil bagi analisis menunjukkan sebanyak 0.00048699mm bagi'deformation', 11.211Mpa 'Von-Misses stress', 6.4637Mpa 'shear stress' di sepanjang leher cakera dan faktor keselamatan pula menunjukkan bahawa ianya lebih daripada cukup untuk menahan daya pengapit yang dikenakan iaitu sebanyak lebih daripada 10 faktor keselamatan berdasarkan keputusan perisian. Untuk analisis kotak pedal, terdapat dua bahagian daya bertindak dan bahagian-bahagian lain adalah tetap. Seksyen A diletakkan daya sebanyak 100N dan seksyen B ialah 300N daya. Keputusannya ialah sebanyak 0.070922mm bagi 'deformation' di kawasan hujung pedal, 33.269Mpa 'Von-Misses stress', 5.8817Mpa 'shear

stress’ dan faktor keselamatan pula ditunjukkan sebanyak minimum 2.591. Berdasarkan keputusan yang diperolehi, ianya menunjukkan bahawa kedua-dua komponen system brek yang direka bentuk adalah memenuhi semua keperluan yang didapati berdasarkan pengiraan.

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LIST OF ABBREVIATIONS

CATIA	Drawing software for detail design
CAD	Computer Aided Data
ANSYS	Analysis Software
FV	Formula Varsity
UTeM	Universiti Teknikal Malaysia
SAE	Society of Automobile Engineers
FSAE	Formula Society of Automobile Engineers

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

One of major factor of victory in a race track is braking aspect. This is because the first leg of the journey in race track driving lessons is the proper use of brakes. A good driver knows when to brake and when not to brake because in a race track, it is not all about speed and acceleration. In a track race, a good driver should bring a good combination of acceleration and deceleration in order to get fastest lap time.

Even though, the driver is good enough to drive a racing car the victory is still far from achievable if the car does not included with a good brake system. It is well said on the racing field by the greatest engineer and drivers that brake plays a big crucial role in ensuring the safety of drivers and to ensure every skill of the driver can be squeezed out optimally. Despite good performance of a particular brake, it must also have a good reliability as a race never been a good condition for metal wear.

1.2 OBJECTIVE

The objectives of this project are to design and fabricate a braking system for an electric racing car for Formula Varsity (FV) organized by Universiti Teknikal Malaysia Melaka (UTeM). Besides of designing, analyzing the functionality and performance of the brake system by using any CAD software would be the objective of this project as well.

1.3 Scope

The scope of this project is to:

I. Demonstrating the functionality of the brake system prototype.
II. Study the requirement of braking system suit for Electric Racing Car.
III. Study the best mechanism for an Electric Racing Car.
IV. Study the braking distance.

1.4 Problem Statement

A team has been formed to build an Electric Racing Car for a competition called Formula Varsity (FV) by Universiti Teknikal Malaysia (UTeM). Each member has been given task to design each part of the car such as chassis, body work (body shell), brake, knuckle, wheel base, ergonomically cockpit, and electrical system. For the record, the previous FV racing car was reported that it does not have a good brake system. The brake distance was hard to match the competition regulation as the brake has weak braking capability. Therefore, the job of team member is to design and analyze a new brake system and mechanism for an newly build Electric Racing Car due to give best performance in terms of braking distance, heat generated, light weight, smaller dimension and ease to be operated by the driver. The durability and the life span of the brake system also have been taken into consideration in designing the brake system.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Brake is a device which is used to slow and stop any motion of machinery that brake attached to it. Generally, the main function of disc brake is to transmit mechanical force and dissipation of heat produced implies to be functioning at both medium and high temperature. The rotor provides braking or friction surface for brake pads to rub against when brake force is applied.

(M. K. Khalid, M. R. Mansor, al. 2011)

Brake is widely used on automobile device like car, motorcycle, train, and many more. It is become more important in performance automobile application as braking is a critical aspect of any racing applications such as racing cars and racing motorbikes. When a car is in motion, it has kinetic energy along with it resulted from the motion itself. In order for the car to slow down or to be stopped, this kinetic energy must be decreased by passing out the energy into another body or converting the energy into

another form of energy (as the energy cannot be destroyed) or put down some other external force against the vector of the motion to slow down or stopping the car. In case of brakes, the kinetic energy is mostly converted into heat energy and passed out into some other body like caliper, brake rotor, or into the convection of air passing through the brake.

Brakes happen to be processed and improved since its creation. The actual improve in traveling speeds along with the increasing of the weight of various vehicles features constructed most of these advancements innovations. The faster an automobile runs and also the weightier it's, the actual harder it's to be stopped. A highly effective braking system is required to accomplish this task. The current vehicles often use a mix of compact disk brakes as well as drum brakes. Disc brakes are usually located on the front two wheels and drum brakes on the back two wheels.

(Allen, Oliver E. 1996).

2.1 HISTORY OF BRAKE

The early braking systems to be used in vehicles with steel rimmed wheels consisted of nothing more than a block of wood and a lever system. When he wanted to stop, the driver had to pull the lever located next to him and make the wooden block bear against the wheel.

The technique demonstrated efficient within each equine attracted or even steam driven automobiles. This began getting outdated for the finish from the 1890s, once the Michelin siblings started changing metal rimmed tires using the rubberized tire. The actual wooden block technique, obviously, had been ineffective along with rubberized. The actual drum dependent braking program can be viewed as the actual forefather from the present day braking system. The forefather who is still alive, because drum brakes are continued used these days. (Jerome, John. 1972)

The person mostly acknowledged using the improvement from the present day drum braking system is actually France manufacturer Louis Renault, within 1902. Still, raw ideas from the drum brake had been around prior to which. Wilhelm Maybach experienced utilized an identical, however less complicated style a previous year. Actually just before which, within 1899, Gottlieb Daimler created the concept in order to cover the cable around the drum as well as point this towards the automobiles framework. The actual ahead movement from the vehicle stiffened the cable, which makes it simpler for that car driver in order to draw the actual lever and obtain the actual wooden block to complete its function. Exactly what Daimler created is known as servo assistance and it is nevertheless being used these days, using the required improvements, certainly. (Jerome, John. 1972)

These kinds of braking techniques had been just about all exterior, an element that quickly converted into an issue. Dust, heat as well as water made all of them much less efficient. It had been period for that internal expanding shoe of braking system. Through putting the shoe inside the drum brake, dust and water had been held away, permitting the actual braking procedure to stay efficient. The end from the mechanically-activated brakes arrived within 1918, whenever Malcolm Loughead, among the creators associated with exactly what later on had been being Lockheed Plane Company, created the concept. Loughead come up with the four-wheel hydraulic-brake system with regard to vehicles. This technique utilized liquids in order to move the actual pressure about the pushed your pedal towards the pistons after and then towards to the brake shoes. (Jerome, John. 1972)

The four-wheel hydraulic system was initially utilized on the year 1918 Duesenberg as well as rapidly caught upon, mainly because of the truth that this made braking easier compared to the mechanical system. Through past 1920s, this technique had been installed of all high-priced automobiles as well as right after this expanded to around the world of automotive. Since the automobiles leaking away the actual set up plants, these people began getting each quicker as well as weightier. Hydraulic drum based brakes had been efficient, however they experienced the inclination in order to ineffectively deliver heat. This particular function created space for the development of

the disk brake system. Modern-style disk brakes very first made an appearance about the low-volume 1949 Crosley Hotshot, even though these systems needed to be stopped within 1950 because of designed difficulties. Chrysler's Imperial additionally provided a kind of disk braking system through 1949 to1953, although in cases like this these were surrounded along with twin internal-expanding, full-circle stress pressure plates. Reliable modern disk brakes had been created in the United Kingdom through Dunlop as well as very first made an appearance within 1953 about the Jaguar C-Type racing car. (Stephen Dirksen.1997)

Aided by the disc braking mechanism alongside Loughead hydraulics, Chrysler became the best vendor to help execute the device in it has the autos (Imperial). On the Europe, the device was first adopted by way of Jaguar (C-Type) in addition to Citroen (DS). Always, the system appeared to be dropped for three numerous years in America alone, because continue to expected numerous important efforts from driver to operate the system. It was subsequently sole in 1964 when the system is developed their very last comeback, appeared in the Studebaker Avanti. At this point the system was succeeded. (Allen, Oliver E.1996).

The difference was made by the development of the power braking system. Through assisting the actual movement on the piston in the master cylinder, the driver now not needed to make an application as much demands to discover the van to prevent properly. The actual evolution on the brakes on their own has as slowed up. Other techniques though became popular. ABS(Antilock Brake System),electronic brake-force distribution(EBD), brake assist system and several various solutions have come to help braking become more effective and safe as possible. However, the actual foundations to begin with from earlier 1900s are the basis meant for modern day brakes.

2.2 Types of Brakes

There are many types of brakes system that have been used in the modern days. Most of them are friction application of brakes and some of them are using different approach to stopping a car like by using electromagnetic phenomena and pumping fluid to gives negative force towards the body that is in motion.

2.2.1 Drum Brake – Single Leading Edge

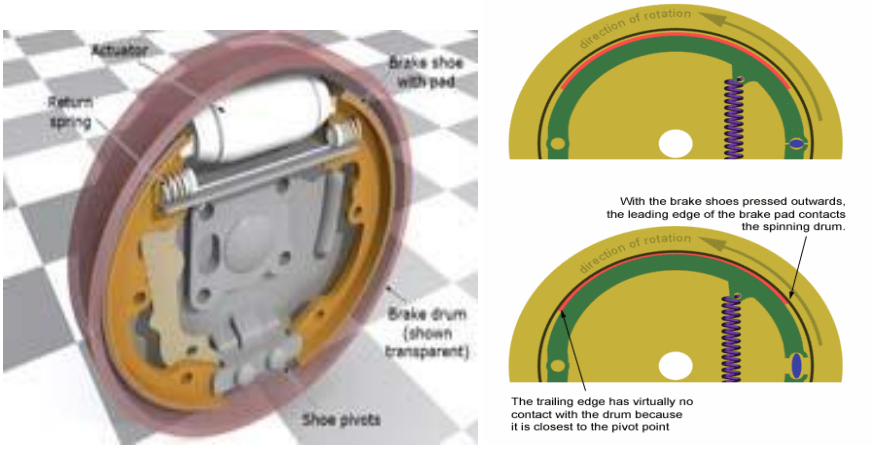

Figure 2.1 Single Leading Edge Drum Brake

(Source: Chris Longhurst. (1994-2011))

One will find two semicircular braking system shoe fitted in the spinning drum that is mounted on the knuckle of the wheel. Once the car driver is hit the brake pedal, the brake shoe turn out to be prolonged outwards in order to providing pressure and force towards the within walls of the entire drum. This can create friction (leading in to making heat), that reduce the kinetic power, which decreases the vehicle velocity. The example on the above shows a simple model of single leading edge drum brake system. The actuator in this scenario is the blue elliptical item. When the blue elliptical object is turned in about 90 degree, the lobe of the blue object will force against the brake shoes