

**MAGNETIC BRAKE DESIGN AND SIMULATION**

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## DECLARATION

“I hereby declared that I have read through this thesis and found that it has comply the partial fulfillment for awarding the degree of Bachelor Mechanical Engineering (Automotive)”

Signature : .....

Supervisor's Name : Mr. Mochamad Safarudin

Date : 27<sup>th</sup> March, 2008

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This thesis is submitted to the Faculty of Mechanical Engineering, in partial fulfillment of the partial requirement for the Bachelor of Mechanical Engineering (Automotive)

**FACULTY OF MECHANICAL ENGINEERING  
UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

March 27, 2008

## DECLARATION

“I hereby declared that this thesis is my original work except for questions and citations,  
which have been duly acknowledgment”

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Date : 27<sup>th</sup> March 25, 2008

## **DEDICATION**

To my beloved mother, father, brother and sister, and all my friends

All member of Bachelor of Mechanical Automotive (BMCA)

My PSM supervisor, Mr. Mochamad Safarudin

All lecturers from BMCA and FKM department

Staff of Faculty Mechanical Engineering

Staff of Universiti Teknikal Malaysia Melaka (UTEM)

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## ABSTRACT

Magnetic brake is a new evolution brake in nowadays automotive industry. This brake uses magnetic field as its medium to function and it is different from other type of brake from its mechanism, operation and how it work. It uses electromagnet. In this project, the magnetic brake will be design and simulate. This project will be carried out base on from understanding and knowledge gain from the literature review and from discussion with my lecturer and others. The design for the brake will be design base on the knowledge gain from the research that had been done. The concept model design of the magnetic brake is done using CATIA software to create a 3D model of the brake and shows the parts for the brake. From research and knowledge gain, parameter that is needed such as mass, tyre radius, energy needed, braking energy, acceleration and other parameter that can be gain whether from journal, articles and other or from calculation. Simulation is done in MATLAB software. From the research and knowledge from the articles; formulas and equations that is needed for the simulation in MATLAB is gain. Result of the simulation will show the behavior of the vehicle after braking with the magnetic brake.

## ABSTRAK

Brek magnetik adalah satu brek evolusi baru dalam industri automotif sekarang. Brek ini menggunakan medan magnet untuk berfungsi dan ia berbeza daripada brek-brek lain dari segi mekanisma, operasi dan cara berfungsi. Brek magnetic menggunakan elektromagnet. Dalam projek ini, brek magnet akan di reka bentuk dan simulasi akan dijalankan. Projek ini akan dijalankan berdasarkan pemahaman dan pengetahuan yang telah di perolehi daripada ulasan karya, jurnal dan perbincangan dengan pensyarah dan lain-lain. Rekabentuk brek magnetik ini akan dihasilkan berdasarkan pemahaman daripada kajian yang telah dilakukan. Reka bentuk konsep brek magnet ini dibuat menggunakan perisian CATIA untuk mencipta satu model 3D brek dan untuk menunjukkan bahagian-bahagian brek. Daripada kajian dan informasi yang telah diperolehi, parameter-parameter yang diperlukan seperti berat, jejari roda, jumlah kuasa diperlukan, tenaga membrek, pecutan, dan lain-lain parameter dapat diperolehi samada secara terus dari jurnal, karya dan lain-lain atau melalui pengiraan. Simulasi dijalankan didalam perisian MATLAB. Melalui kajian dan informasi dari karya-karya; rumus dan persamaan yang diperlukan untuk menjalankan simulasi didalam MATLAB akan dipeolehi. Hasil simulasi akan memberi keputusan mengenai kelakuan kenderaan selepas membrek menggunakan brek magnetik.



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## LIST OF SYMBOLS

$m$	=	Mass (kg)
$r$	=	Wheel Radius (m)
$t$	=	Time (s)
$u$	=	Initial Velocity (m/s)
$v$	=	Velocity (km/h @ m/s)
$a_x$	=	Longitudinal Acceleration ( $m/s^2$ )
$a_y$	=	Lateral Acceleration ( $m/s^2$ )
$g$	=	Earth Gravity ( $9.81kgm^{-2}$ )
$N$	=	Speed (rpm)
$T$	=	Torque (Nm)
$G$	=	Gear ratio
$G_T$	=	Transmission Gear ratio
$G_F$	=	Final Drive Gear ratio
$\eta_T$	=	Transmission Efficiency
$I_T$	=	Transmission Inertia ( $kgm^2$ )
$I_D$	=	Drive Shaft Inertia ( $kgm^2$ )
$I_W$	=	Wheel and Axle Shaft Inertia ( $kgm^2$ )
$I_E$	=	Engine Inertia ( $kgm^2$ )
$\omega_e$	=	Engine Speed ( $rads^{-1}$ )
$\omega_D$	=	Drive Shaft Speed ( $rads^{-1}$ )
$\omega_W$	=	Wheel Speed ( $rads^{-1}$ )
$F_X$	=	Tractive force at the ground (N)
$F_R$	=	Rolling resistance force (N)

## LIST OF SYMBOLS

$F_D$	=	Aerodynamic Drag force (N)
$F_{HX}$	=	Hitch (towing) force (N)
$F_t$	=	Frictional Force (N)
$f_r$	=	Rolling Resistance
$\Theta$	=	Surface Gradient ( $^{\circ}$ )
$E$	=	Energy (Joule/J)
$P$	=	Power (Watt/W)
$C_{\sigma f}$	=	Front longitudinal tire stiffness (N/m)
$C_{\sigma r}$	=	Rear longitudinal tire stiffness (N/m)
$f$	=	Rolling Resistance Coefficient
$I_z$	=	Vehicle moment of inertia about yaw axis $\text{kgm}^2$
$C_{\sigma r}$	=	Rear axle cornering stiffness (N/rad)
$C_{\sigma f}$	=	Front axle cornering stiffness (N/rad)
$\mu$	=	Coeff. of friction
$T_i$	=	Initial Torque (Nm)
$s$	=	Steer Angle ( $^{\circ}$ )
$\lambda$	=	Slip

## CHAPTER 1

### INTRODUCTION

#### 1.0 Introduction

Brake is a device used to stop or slowing down a vehicle from moving. Brake is a very important component that leads to the safety and protection of the passenger of the vehicle. It is used widely whether on cars, bicycle, airplanes, trucks and other vehicle as well. There are many types of brake such as hydraulic brake, electric brake, and hybrid brake which all of them share the same goal but different shape by their ways and method of operating.

The magnetic brake is a brake that uses magnetic as its medium to stop a vehicle from its motion. It uses magnet in its component which differentiate it with other brake. However, the goal is still the same as other brake that is to reduce the speed of vehicle and for the safety of passenger and vehicle.

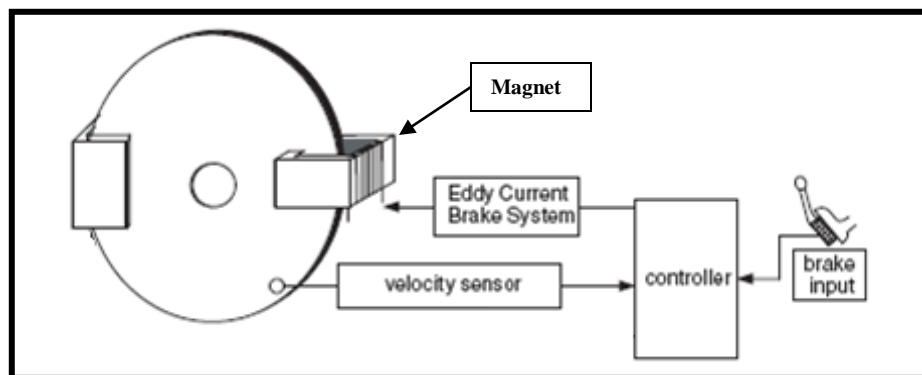


Figure 1: Magnetic Brake

## 1.1 Scope

- The scope of the project is to design a brake that uses magnetic as its mechanism or medium.
- The brake has to stop a car in a certain speed at a certain distance and time.
- Simulate the behavior of the brake whether the design is successful.

## 1.2 Objective

The objective of this bachelor project is to train and enhance student ability to use their practical knowledge and experiences in the field of engineering in the relevant undertake to the project. It is to produce students that is capable to develop research method, analysis, design, product production and capable of doing an assessment and evaluation on ones. It is also to train students so that they are able to operate works with minimum valuations and more independent in conducting and producing an academic project and further capable in delivering project work revenue through seminar and written report. As an addition, this project also is for planting and enhances student interest so that they are interested to dabble in the field of research.

The objective of this project is as below:

- To design a magnetic brake for a passenger car.
- Simulate the brake performance and behavior for the brake designed.

### **1.3 Project Problem Statement and Background**

Today, the automotive market is continuing to sharpen its focus on fuel efficiency and safety. Vehicle brake design is evolving to meet these needs but the demand continues for enhanced level of performance and value. The magnetic brake is one solution to today's automotive needs. The magnetic brake is design to improve the efficiency of brake for the safety of passenger. The magnetic brake can operate more efficiently than other brake because it uses current as its medium to operate that is better than other medium such as hydraulic, pneumatic, cable and other. Furthermore, it uses electricity to operate.

## **CHAPTER 2**

### **LITERATURE REVIEW**

The literature is information and past studies on the magnetic brake and that are related to it. The literature review for this project is found through sources from the journal, magazine, articles, books and others.

#### **2.1 Introduction to Brake**

A brake is a device for slowing or stopping the motion of a machine or vehicle, and to keep it from moving again. It is a machine element for applying a force to a moving surface to slow it down or bring it to rest in a controlled manner. In doing so, it converts the kinetic energy of motion into heat which is dissipated into the atmosphere. The kinetic energy lost by the moving part is usually translated to heat by friction. Alternatively, in regenerative braking, much of the energy is recovered and stored in a flywheel, capacitor or turned into alternating current by an alternator, then rectified and stored in a battery for later use.

## 2.2 Types of Brakes

### 2.2.1 Friction Brakes

Friction brakes, the most common kind, operate on the principle that friction can be used to convert the mechanical energy of a moving object into heat energy, which is absorbed by the brake. The essential components of a friction brake are a rotating part, such as a wheel, axle, disk, or brake drum, and a stationary part that is pressed against the rotating part to slow or stop it. The stationary part usually has a lining, called a brake lining, which can generate a great amount of friction yet give long wear; it formerly contained asbestos, but this is being replaced by less efficient materials for environmental reasons.

The principal types of friction brake are the block brake, the band brake, the internal-shoe brake, and the disk brake. The block brake consists of a block, the stationary part, which is shaped to fit the contour of a wheel or drum. For example, a wooden block applied to the rim of a wheel has long been used to slow or stop horse-drawn vehicles. A simple band brake consists of a metal band, the stationary part, which can be tightened around a drum by means of a lever. It is found on hoists and excavating machinery. The internal-shoe brake has a drum that contains two stationary semicircular pieces, or shoes, which slow or stop the motion of the drum by pressing against its inner surface. This is the type of brake most often found on automobiles, with an internal-shoe brake drum located on the central part of each wheel. A disk brake of the type used on automobiles has a metal disk and pistons with friction pads that can close on the disk and slow it.