CONCEPTUAL DEVELOPMENT OF GEAR BRAKING SYSTEM

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APRIL10, 2009

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 (Design & Innovation)"

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

Signature : ……

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Date : 10 April 2009

DEDICATION

To my beloved family's
My love ones
All friends
Lectures of FKM
Staff of UTeM

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ABSTRACTS

Antilock braking systems (ABS) is implemented in automobiles to ensure optimal vehicle control and minimal stopping distances during hard emergency braking. In contrast with the threshold braking and locked wheels, ABS is not the fastest method of slowing down besides ABS increased stopping distances over loose gravel. The concept of Gear Brake Systems (GBS) was developed to encounter these problems by providing low speed and high torque reversal rotational gear. This is done via additional these GBS into rear housing of conventional manual transmission of a vehicle. An ABS is interconnected into these GBS to serve as activation switch by providing signal when an emergency panic stopped attempted is detected. Besides that ABS provide GBS with initial speed reduction which reduced the amount of torque required to completely stop the vehicle.

ABSTRAK

Sistem pemberhentian anti-kekuncian (ABS) kini digunakan secara meluas dalam industri automotif bagi memastikan kawalan kenderaan yang optimal disamping meminimumkan jarak pemberhentian terutamanya ketika situasi genting. Sebagai perbandingan dengan teknik pemberhentian berganda "threshold braking" dan pemberhentian kekunci "locked wheels", didapati sistem ABS bukanlah merupakan teknik terpantas bagi memperlahankan kenderaan disamping kesan penggunaan ABS jalan berpasir akan meningkatkan lagi jarak pemberhentian. Konsep sistem brake menggunakan gear (GBS) dibangunkan bagi mengatasi masalah ini melalui kesan putaran terbalik pada halaju rendah dan tork tinggi. Ini dilakukan melalui memasangan system ini pada hujung perumah kotak gear manual kenderaan. ABS yang disambungkan kepada GBS bertindak sebagai suis pengaktifan dengan memberikan signal apabila pemberhentian kecemasan yang dilakukan dikesan. Disamping itu ABS memberikan GBS pengurangan awal jumlah tork yang diperlukan bagi pemberhentian yang sempurna.

CONTENT

LIST OF TABLE

LIST OF FIGURE

LIST OF SYMBOL

Vr	Reference velocity
Ω*w*	Wheel spin velocity
Rtire	Tire rolling radius
π	Pie = 3.142
mm	Millimeter
RPM	Revolution per minutes
OD	Overdrive
HP	Horsepower
ABS	Antilock braking system
GBS	Gear braking system
r	Ring gear/annulus
P	Planet gear
s	Sun gear
N	Number of teeth
Pd	Diametral pitch
Φ	Pressure angle
D	Pitch diameters
p	Circular pitch
a	Addendum
b	Dedendum
C	Clearance
Do	Outside diameters
Di	Inside diameter
Dr	Root diameters
ht	Whole depth
hk	Working depth
t	Tooth thickness

Db	Base circle diameter
T	Torque

LIST OF APPENDIX

CHAPTER I

INTRODUCTION

1.0 Introduction

In section I we explain about the ideas behind the project of development a Gear Brake System (GBS) where the need of emergency situations and the weakness of the Antilock Braking System (ABS) itself are discuss. The threshold braking and locked wheels braking methods reveal that ABS is not the fastest ways of stopping the vehicle and its tend to behave unexpectedly in certain roads conditions.

In section II we represent a short-course discussion regarding the system that being involve and give a brief explanation on the ways of it operates as reference learning for the GBS system. An introduction into brake types and gear design is being discussed as it provides a basic idea for the system operation. As the means of power transmit from the engine to the wheels, a manual gear transmission is essentially discussed here.

In section III we provide a product development and analysis for simulation model of the system that was motivated and design based on the J type overdrive (OD) unit manufactured by Laycock-de-Normanville. To suit the purpose of GBS as a braking system, we have changes the planetary gear sub-system of OD so that it provides a low speed and high torque reverse rotational from the engine to the wheels.

In sections IV we present the result of conceptual development of gear braking system in details by 3D drawing of GBS design and discuss briefly some issues arise that was facing in development process of the concept, system key features and technical challenges of the system

After detailing design of the GBS braking system, calculation is done to find adequate tooth profile of planetary gear to meshing, amount of power consumed by the system and volume of lubricant that are needed for the hydraulic pump to supply enough pressure for the operations of the system. This is presented in sections V

While this study provided basics concept for development of mathematical model for simulation and validation of the operating principles, we do some recommendation regarding further studies and works for more in-depth research on performance and behaviors of gear braking system in sections VI

1.1 Motivation for development of gear braking system

ABS is designed to stop vehicles as safely and quickly as possible. Safety is achieved by maintaining lateral stability and hence steering effectiveness and trying to reduce braking distances over the case where the brakes are controlled by the driver. Improving the stopping distance of a vehicle helps to reduce collisions, casualties and damage to vehicles and goods.

The basic ABS algorithm continuously releases the brake pressure only to later reapply the full brake pressure, once wheel lock-up has been prevented. Essentially, as the wheel slip increases past a critical point where it is possible that lateral stability and hence our ability to steer the vehicle could be lost, the controller releases the brakes. Then, once wheel slip has decreased to a point where lateral stability is increased and braking effectiveness is decreased, the brakes are reapplied. In this way the ABS cycles the brakes to try to achieve an optimum tradeoff between braking effectiveness and lateral stability.

The continuous consequent periodic release and application of the brake pressure modulated by the ABS algorithm, inherent process nonlinearities, limitations on our abilities to sense certain variables and uncertainties associated with process and environment such as when road conditions changing from wet asphalt to

ice make the ABS control problem challenging and thus increases the stopping distance.

In this paper, we consider brake system for an "emergency stop," and hence for our study the brakes are in an ABS mode. We seek to develop a system that will ensure that the braking torque commanded by the driver is achieved by the brake system. Clearly, solving the emergency braking problem is of significant importance since there is a direct correlation between safety and the reliability of the brakes in providing the commanded stopping force. Moreover, tire-slip algorithms of ABS controllers could also enhance braking effectiveness while in ABS mode.

Prior research on the braking system considered here has shown that one of the primary difficulties with the brake system lies in compensating for the effects of changes in the "transmission system", that occur due to shifting an manual or automatic transmission into reverse while the car is moving forward will not engage reverse gear.

1.2 Project Problem Statement

ABS was designed to help the driver maintain some steering ability and avoid skidding while braking rather than to slow down and stop the vehicle. This substantially improves driving stability by ensures that the vehicle can still be steered and moved out of the way of unexpected obstacles. This is however in contras increase vehicle stopping distance as well as stopping time especially over loose gravel.

1.3 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 are 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 are interested to dabble in the field of research. The objectives of this project are as below:

- Develop a mechanism for braking system by means of gearing.
- Design a concept of gear braking system

1.4 Scope

- Develop a concept of brake system that using gears as its mechanism
- Design the details of the system and system 3D drawing
- Kinematically analyze and determine tooth profiles of gear

1.5 Planning and Execution (GANT-CHART)

The planning schedules of the project are as follow:

	PSM 1													
	Week													
Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Product Defination and Planning														
Project background														
Project objectives														
Project scopes														
Concept Development														
Braking techniques														
The ABS System														
Manual Transmission System														
System-level Design														
Generate concept														
Evaluate concept														
Select concept														
Detail Design														
Mechanical components														
Hydraulic flows														
Electrical circuits														
Calculations and Analysis														
2006 Pontiac GTO Specifications														
Wheel velocity														
Braking energy														
Power														
Energy source														
Conclusion														
Report Writing														
Seminar and Presentation														

Table 1: Gant-chart of project planning for PSM1

	PSM 2													
	Week													
Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mechanical Detail Design														
Annulus														
Bearing														
Circlip														
Unidirectional Clutch														
Thrust Washer														
Thrust Plate														
Front Casing														
Gear Carrier														
Oil Thrower														
Planet Gear														
Planet Gear Shaft														
Rear Casing														
Sliding Clutch														
Sun Gear														
Thrust Bearing Housing														
Assembly Drawing														
Results														
Details Design														
Discussion														
System Analysis														
Conclusion														
Recommendations														
Report Writing														
Seminar and Presentation														

Table 2: Gant-chart of project planning for PSM2

CHAPTER II

LITERATURE REVIEW

2.0 Introduction

The literature is information and past studies on the braking techniques, brake types, braking systems, gear technologies, manuals transmission system and planetary gear train. The literature review for this project is found threw sources from thesis, reports, journal, articles, manuals, books and web pages.

2.1 Braking Techniques

There are several braking techniques which will be discussed here, which will consider cars with and without ABS, as many of the techniques listed here will not be relevant in car equipped with ABS or anything that mentions wheels locking. A good braking technique is a compromise between the two following factors:

a) When the limits of grip have been reached that makes wheel locked, the tire no longer retains the ability to accept steering inputs thus lose control.
b) The point of maximum deceleration is just before the point of wheel lock

Rank	Braking method
First	Threshold braking
Second	Locked wheels
Third	ABS

Forth	Cadence braking
Fifth	Parachute

Table 3: The fastest method of braking

Table above show the fastest method of slowing down for a vehicle, noted that the ABS is placed third after threshold braking and locked wheels methods. This has elements of truth; threshold braking and locked wheels methods can slow a vehicle more quickly that a car fitted with ABS if done correctly in the right conditions. But in practical terms the benefits of ABS massively outweigh the slightly longer braking distances and ABS is an absolute must as it will allow vehicle to steer out of the way of unexpected hazards thus significantly improves safety and control for drivers in most on-road situations.

2.2 Brake Types

Brake is a device used to slow down later stop the motion of a mechanism or vehicle while a type of brakes is the apparatuses it used. Drum brake and disk brake mechanism for example that slows and stops a car is by fiction, that is pressing brake shoes or disk against a drum or wheel axel.

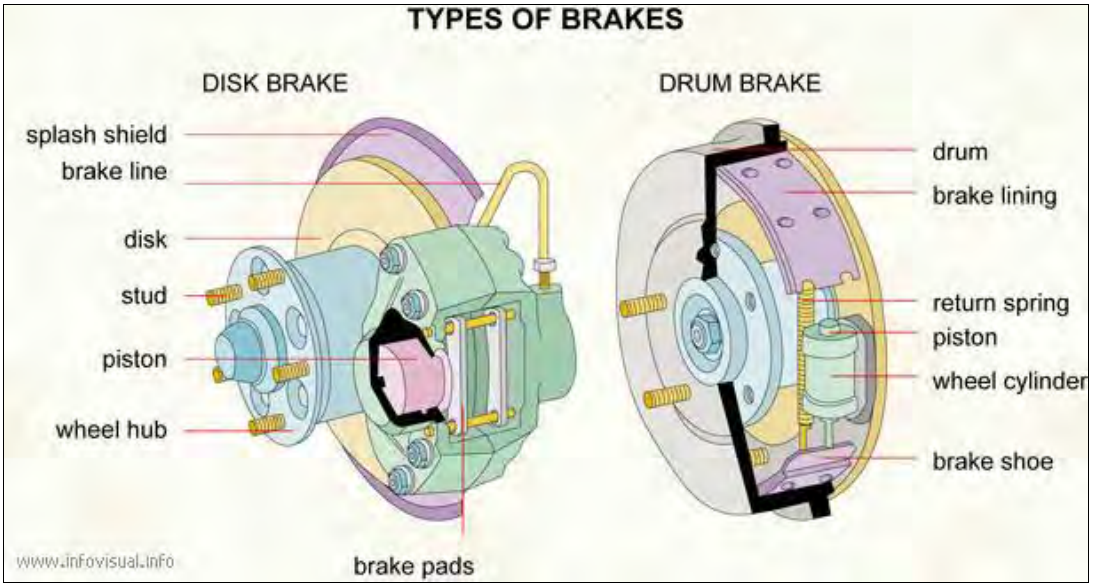

Figure 1: Disc Brake and Drum Brake Mechanisms

2.2.1 Friction Brakes

Friction brakes is the most common kind of brake type, operate on the principle that friction can be used to convert the mechanical energy of a moving object into heat energy, which is being 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 down and 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.

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 that 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.

2.2.2 Electric Brakes

A machine that is driven by an electric motor can sometimes use its motor as a brake. Because inertia keeps the machine's shafts moving after the current to the electric motor has been shut off, the machine keeps the motor's armature turning. While this is happening, if the motor's action can be changed to that of a generator, the electric current produced will be drawing its energy from the machine, thus slowing it. However, since such a braking method is not suitable for bringing the machine to a quick stop, it is usually supplemented by friction brakes.

2.3 Braking Systems

A manually operated brake pedal or handle is used to activate a brake. With low-power machinery or vehicles the operator can usually apply sufficient force through a simple mechanical linkage from the pedal or handle to the stationary part of the brake. In many cases, however, this force must be multiplied by using an additional braking system.

2.3.1 Air Brake System

An early system for multiplying the braking force, called the air brake system or air brake was first used on passenger trains in 1868. It is now widely used on railroad trains. The fundamental principle involved is the use of compressed air acting through a piston in a cylinder to set block brakes on the wheels. The action is simultaneous on the wheels of all the cars in the train. The compressed air is carried through a strong hose from car to car with couplings between cars; its release to all the separate block brake units, at the same time, is controlled by the engineer. An automatic feature provides for the setting of all the block brakes in the event of damage to the brake hose, leakage, or damage to individual brake units. The air brake is used also on subway trains, trolley cars, buses, and trucks.

2.3.2 The Hydraulic Brake System

The hydraulic brake system or hydraulic brake is used on almost all automobiles. When the brake pedal of an automobile is depressed, a force is applied to a piston in a master cylinder. The piston forces hydraulic fluid through metal tubing into a cylinder in each wheel where the fluid's pressure moves two pistons that press the brake shoes against the drum.