PARKING BRAKE TESTER

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This report is submitted in partial fulfillment of the requirements for the
Bachelor in Mechanical Engineering (Structure and Materials)

Faculty Mechanical Engineering
Universiti Teknikal Malaysia Melaka

APRIL 2009

DECLARATION

I hereby declare that this project report entitled

PARKING BRAKE TESTER

is written by me and is my own effort and that no part has been plagiarized without citations.

Signature : ……...

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Date : 10th April 2009

DEDICATION

To my beloved parents,
Fauzi bin Ismail and Fatimah binti Zakaria.
Who inspired me with their love and kindness.

To all my friends,
For giving me support and idea.

ACKNOWLEDGEMENTS

I would like to generously thank many people that assisted and supported my Projek Sarjana Muda (PSM). This PSM report is the product of hard work with several people. A special thanks to our beloved lecturer, Mr Herdy Rusnandy, who was continually encouraging, insightful, and help me throughout this project. Without his guidance and useful advice, I don't think my PSM report can be finished successfully and on time. I would like to thanks to my friends whom I had the pleasure to meet and work with in my project.

A special appreciation also to my friends who kindly help me by providing interesting discussions and insights that helped me achieve a larger perspective in my PSM report. Last but not least, my family should be thanked. They have stood by me and watched my study evolve for the better. They have also been a source of constant support, encouragement and financially help me. Finally, I would like to thank everyone who is willing to spend their precious time reading my PSM report.

THANK YOU.

ABSTRACT

My Projek Sarjana Muda (PSM) is regarding a study of parking brake tester. This project enables me to collect all the relevant information about parking brake system, chances of improving current system, the application of the tester, and optimum requirement of a certain parking brake system and its tester. The system used several gauges tapped from the main frame of the parking brake simulation model. The case study need me to design a system that enable people to measure and test the parking brake system and look for its efficiency. Throughout my observation and understanding, I understand that there are numerous studies done by previous student and certain company to improve the current parking brake system and all of the system either produced with cheaper cost or greater performance and efficiency. After all of this effort, a tester would come in handy when they can test their product. This system will provide the experimental value for the tensile force and torque applied on the parking brake system. Besides that, the initial cost for installation for this system also been considered roughly because the gauges used might be expensive and complicated. However, all of the criteria and specification will be put into first priority.

ABSTRAK

Projek Sarjana Muda ini adalah berkenan kajian dan proses pembuatan Penguji Parking Brake. Projek ini membolehkan saya mengumpul semua maklumat berkaitan sistem parking brake, peluang-peluang menambah baik system sedia ada, aplikasi penguuji tersebut dan keperluan optimum bagi sesebuah sustem parking brek dan pengujinya. Sistem ini menggunakan beberapa pengukur yang diletakkan di beberapa tempat di gahagian rangka utama platform simulasi parking brek. Kajian kes memerlukan saya untuk mereka bentuk satu sistem yang membolehkan manusia menguji tahap keberkesanan sesuatu parking brek. Sepanjang pemerhatian dan pemahaman ,adalah difahami bahawa sudah terdapat beberapa kajian oleh beberapa orang pelajar yang lepas dan sesebuah syarikat tertentu untuk menambah baik sistem parking brek dan keseluruhan sistem brek umumnya sama ada dikeluarkan dengan kos yang lebih murah ataupun dengan sistem yang lebih berkesan. Setelah semua ini dihasilkan, alat penguji memang berguna untuk menguji keberkesanan produk yang dihasilkan. Sistem ini akan menunjukkan nilai eksperimental pada torque yang bertindak ke atas setiap roda apabila parking brek dikenakan.

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T	=	Torque on wheel
Zp	=	Polar modulus of section
τ	=	shearing stress
ν	=	Poisson Ratio
P	=	Value of the pressure obtained from the gauge
A	=	Area of the acting force in the hydraulic cylinder

CHAPTER 1

INTRODUCTION

1.1 Background

Brake puts friction to a good meaning. Vehicle can stop accordingly with brake. The parking brake is commonly attached to the rear drum brakes. Drum brakes is invented as early as 1902 by Louis Renault. The name resembles the system and mechanism. The parking brake system is a secondary braking system used to hold a parked car in position. They are applied independently of the service brake since it does not require any vacuum force from the engine. Since there is no inertia to overcome, less braking power is required to hold the vehicle stationary and less force is required to apply. The application of only two of the four brake assemblies is required to hold the vehicle and they are commonly from the rear wheel. There are three styles of rear parking brake systems. Two types using the service brake and the other one is an exclusive service brake mechanism and operates the shoe or piston mechanically. The parking brake lever is located near the driver's seat usually between the driver and the front passenger's seat. There has been various ideology and research in order to improve current braking system. So there are inventions on the parking brake using cable that usually linked to the rear wheel as it is more stationary to the front wheel and most of them are drum brakes as most conventional cars lately equipped with rear drum brakes because it is cheaper. In our modern world, there are already braking system that operates using electric which means it is electronically control by a module. For parking

brake that uses cable, it actually transmits the lever movement through a typical series of components such as pull rods, parking brake cable, intermediate lever, equalizer, adjusting nuts.

1.2 Objective

To design and fabricate the parking brake tester that can simulate the real parking brake system and the condition of the real car

1.3 Scope

The scopes of this project are:

a) Study the parking brake system

b) Determine the measurable forces and torque in parking brake system

c) Investigate suitable location for gauges in parking brake

d) Design and fabricate parking brake tester

e) Test and evaluate the performance of parking brake tester

1.4 Problem Statement

Parking brake is used to retain vehicle stationary while in position. Usually, manufacturers nowadays only set a goal to stop the vehicle while sometimes ignoring other possibilities if the parked cars were in inclined angle or extra load sustained inside the vehicle. The value of loads sustainable by the cables, linkage and the parking brake

are also questionable. One need to understand that to test parking brake performance direct to the vehicle is not practical because hard to install equipment in the limited space and complicated mechanism, so there is needed parking brake tester that can simulate mechanism and condition of the real car

CHAPTER 2

LITERATURE REVIEW

2.1 Parking

Parking is the act of stopping a vehicle and leaving it unoccupied for more than a brief time. It is against the law virtually everywhere to park a vehicle in the middle of a highway or road; parking on one or both sides of a road, however, is commonly permitted. Parking facilities are constructed in combination with most buildings, to facilitate the coming and going of the buildings' users.

Based on vehicle arrangement, we can determine the parking mode. There are usually 4 parking modes commonly used. There are parallel parking, perpendicular parking, angle parking, and Anderson parking. These are self-park configurations where the vehicle driver is able to access the parking independently. Besides these basic modes of motor vehicle parking, there are instances where a more urgent approach to arranging motor vehicles is appropriate. For example, in parts of some large cities, such as Chicago, where land is expensive and therefore parking space is at a premium, there are parking lots for motor vehicles where the driver leaves the keys to the vehicle with an attendant who arranges vehicles so as to maximize the number of vehicles that can be parked in the lot. Vehicles may be packed up to five vehicles deep in combinations of perpendicular and/or parallel parking with limited circulation aisles for the parking attendant. Such arrangements are known as attendant parking. When the lot or facility is provided to serve the customers of a business, it is considered valet parking

Inner city parking lots are often temporary, the operators renting land which is vacant pending the construction of a new office building. Some inner city lots are equipped with individual lifts, allowing cars to be stored above each other. Another ad hoc arrangement is tandem parking. This is sometimes done with residential motor vehicle parking where two motor vehicles park nose-to-end in tandem. The first motor vehicle does not have independent access, and the second motor vehicle must move to provide access. As with attendant parking, the purpose is to maximize the number of motor vehicles that can park in a limited space.

2.2 Brake

Brake is a compulsory device in every vehicle. In fact, brake invented along with the vehicle invention in order to slow down and stopping the movement of the vehicle. There are several types of brake that is air brake, hydraulic brake and mechanical type. The kinetic energy lost by the moving part is usually transformed to heat by friction. Note that kinetic energy increases with the square of the velocity ($\boldsymbol{E = 1/2 \cdot m \cdot v^2}$ relationship). This means that if the speed of a vehicle doubles, it has four times as much energy. The brakes must therefore dissipate four times as much energy to stop it and consequently the baking distance is four times as long. Even some airplanes are fitted with wheel brakes on the undercarriage.

Friction brake on cars stores the heat inside the disc rotor or the drums and gradually releases the heat away to the air. That’s why we can see some ventilated disc rotor and drum with some fin in order to spread heat faster and more efficient. Ventilated disc rotor usually installed on the front wheel as the force and load are more concentrated to the front wheel rather than the rear.

Another type of braking which is not so popular but yet efficient is engine braking. This can be achieved when one engage into low gear but this method doesn’t really familiar

to some people as they concern about the gearbox condition. Maintaining a brake system is quite cheap when you suffer a gearbox breakdown.

2.3 Brake Maintenance

Some research revealed that the brake fluid absorb water from the surroundings 12% annually. When water accumulates in the brake line, the brake fluid will become less responsive due to the changes in the chemical characteristics. It also changes the boiling point of the fluid hence making the fluid less effective dealing with heat as brakes also produces heat and the heat is greater when braking force is applied harder and more frequent. A long stretch of going downhill really putting your brake system under heavy stress and this can lead to brake malfunctioning if maintenance is not a consideration. Because of this reason, some manufacturers suggested that the brake fluid needed to be flushed every 100000 km but this numbers are different according to manufacturers.

Then, the brake system also needed to be checked for wear and tear especially the pads and the brake shoe/lining. There are also the retract pin at the caliper that tends to wear with prolong usage and it can give an unpleasant screeching sound as it does not travel in the right axis. There is also thickness limitations of the disc rotor usually stated on the disc plate itself. Otherwise, one can refer to the manual if it does not state on the disc. Disc rotor also tends to warp in certain conditions.

Drum brakes with internal shoes have a particular disadvantage; when the drums are heated by hard braking the diameter of the drum increases due to the expansion of the material and the brakes must be further depressed to obtain effective braking action. This increase of pedal motion is known as *brake fade* and can lead to brake failure in extreme circumstances. For this reason drum brakes have been superseded in most modern automobiles and light trucks with at least front wheel (often now four wheel) disc brakes. Drum brakes are still used in some modern cars owing to weight and cost

advantages. An advanced technology hybrid car using drum rear brakes is the Toyota Prius. (Hybrid vehicles greatly reduce everyday wear on braking systems owing to their energy recovery motor-generators). Early type brake shoes contained asbestos. When working on brake systems of older cars, care must be taken not to inhale any dust present in the brake assembly. Since the introduction of ceramic and kevlar linings, a majority of daily-driven older vehicles have been fitted with asbestos-free linings since.

2.4 Gauges

2.4.1 Strain Gauge

The strain gauge has been in use for many years and is the fundamental sensing element for many types of sensors, including pressure sensors, load cells, torque sensors, position sensors, etc. The majority of strain gauges are foil types, available in a wide choice of shapes and sizes to suit a variety of applications. They consist of a pattern of resistive foil which is mounted on a backing material. They operate on the principle that as the foil is subjected to stress, the resistance of the foil changes in a defined way.

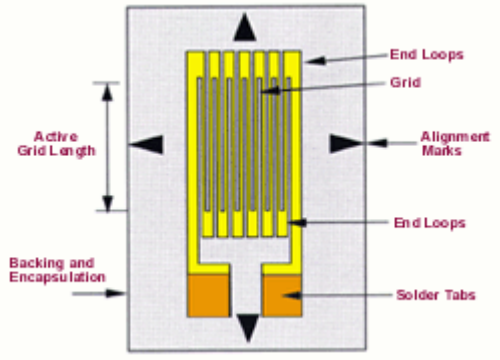


Figure 2.1 Strain Gauge structure

The strain gauge is connected into a Wheatstone Bridge circuit with a combination of four active gauges (full bridge), two gauges (half bridge), or less commonly, a single gauge (quarter bridge). In the half and quarter circuits, the bridge is completed with

precision resistors. The complete Wheatstone Bridge is excited with a stabilised DC supply and with additional conditioning electronics, can be zeroed at the null point of measurement. As stress is applied to the bonded strain gauge, a resistive changes takes place and unbalances the Wheatstone Bridge.

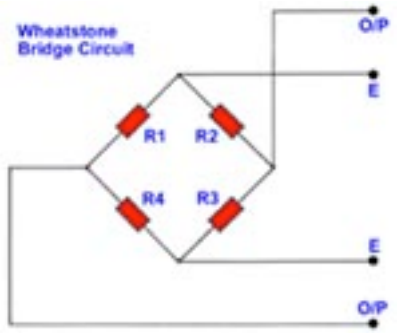
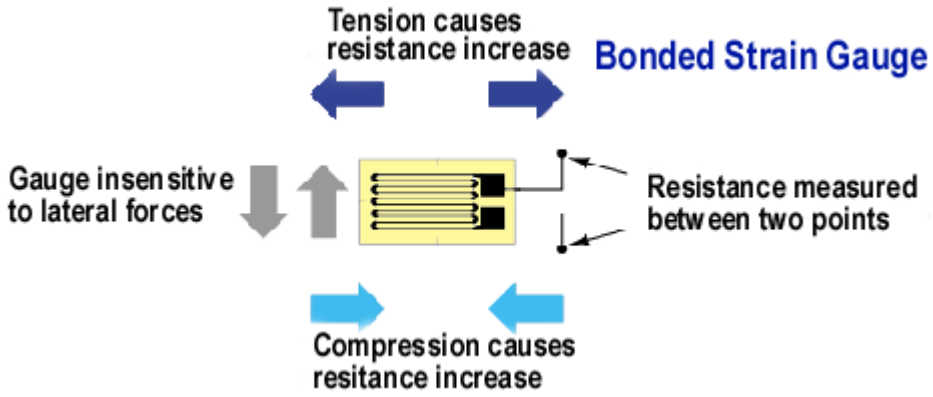


Figure 2.2 Strain Gauge wiring diagram

Analogically, if a strip of conductive metal is stretched, it will become skinnier and longer, both changes resulting in an increase of electrical resistance end-to-end. Conversely, if a strip of conductive metal is placed under compressive force (without buckling), it will broaden and shorten. If these stresses are kept within the elastic limit of the metal strip (so that the strip does not permanently deform), the strip can be used as a measuring element for physical force, the amount of applied force inferred from measuring its resistance.

Such a device is called a strain gauge. Strain gauges are frequently used in mechanical engineering research and development to measure the stresses generated by machinery. Aircraft component testing is one area of application, tiny strain-gauge strips glued to structural members, linkages, and any other critical component of an airframe to measure

stress. Most strain gauges are smaller than a postage stamp, and they look something like this:



A strain gauge's conductors are very thin: if made of round wire, about 1/1000 inch in diameter. Alternatively, strain gauge conductors may be thin strips of metallic film deposited on a nonconducting substrate material called the carrier. The latter form of strain gauge is represented in the previous illustration. The name "bonded gauge" is given to strain gauges that are glued to a larger structure under stress (called the test specimen) The task of bonding strain gauges to test specimens may appear to be very simple, but it is not. "Gauging" is a craft in its own right, absolutely essential for obtaining accurate, stable strain measurements. It is also possible to use an unmounted gauge wire stretched between two mechanical points to measure tension, but this technique has its limitations.

Typical strain gauge resistances range from 30 Ohms to 3 kOhms (unstressed). This resistance may change only a fraction of a percent for the full force range of the gauge, given the limitations imposed by the elastic limits of the gauge material and of the test specimen. Forces great enough to induce greater resistance changes would permanently deform the test specimen and/or the gauge conductors themselves, thus ruining the gauge as a measurement device. Thus, in order to use the strain gauge as a practical instrument, we must measure extremely small changes in resistance with high accuracy.

Such demanding precision calls for a bridge measurement circuit. Unlike the Wheatstone bridge shown in the last chapter using a null-balance detector and a human operator to maintain a state of balance, a strain gauge bridge circuit indicates measured strain by the degree of imbalance, and uses a precision voltmeter in the center of the bridge to provide an accurate measurement of that imbalance.

2.4.2 Bourdon Meter/Pressure Meter

Figure 2.3 Bourdon meter (with back cover removed)

A Bourdon gauge uses a coiled tube, which, as it expands due to pressure increase causes a rotation of an arm connected to the tube. The pressure sensing element is a closed coiled tube connected to the chamber or pipe in which pressure is to be sensed. As the gauge pressure increases the tube will tend to uncoil, while a reduced gauge pressure will cause the tube to coil more tightly. This motion is transferred through a linkage to a gear train connected to an indicating needle. The needle is presented in front of a card face inscribed with the pressure indications associated with particular needle deflections. In a barometer, the Bourdon tube is sealed at both ends and the absolute pressure of the ambient atmosphere is sensed. Differential Bourdon gauges use two Bourdon tubes and a mechanical linkage that compares the readings.

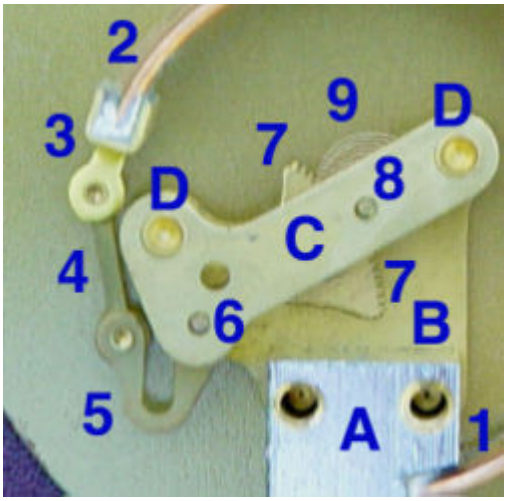


Figure 2.4 Bourdon Meter parts

Mechanical Details

Stationary parts:

- A: Receiver block. This joins the inlet pipe to the fixed end of the Bourdon tube (1) and secures the chassis plate (B). The two holes receive screws that secure the case.
- B: Chassis Plate. The face card is attached to this. It contains bearing holes for the axles.
- C: Secondary Chassis Plate. It supports the outer ends of the axles.
- D: Posts to join and space the two chassis plates.

Moving Parts:

1. Stationary end of Bourdon tube. This communicates with the inlet pipe through the receiver block.
2. Moving end of Bourdon tube. This end is sealed.
3. Pivot and pivot pin.
4. Link joining pivot pin to lever (5) with pins to allow joint rotation.
5. Lever. This is an extension of the sector gear (7).
6. Sector gear axle pin.
7. Sector gear.

8. Indicator needle axle. This has a spur gear that engages the sector gear (7) and extends through the face to drive the indicator needle. Due to the short distance between the lever arm link boss and the pivot pin and the difference between the effective radius of the sector gear and that of the spur gear, any motion of the Bourdon tube is greatly amplified. A small motion of the tube results in a large motion of the indicator needle.
9. Hair spring to preload the gear train to eliminate gear lash and hysteresis.

2.5 Parking Brake Component

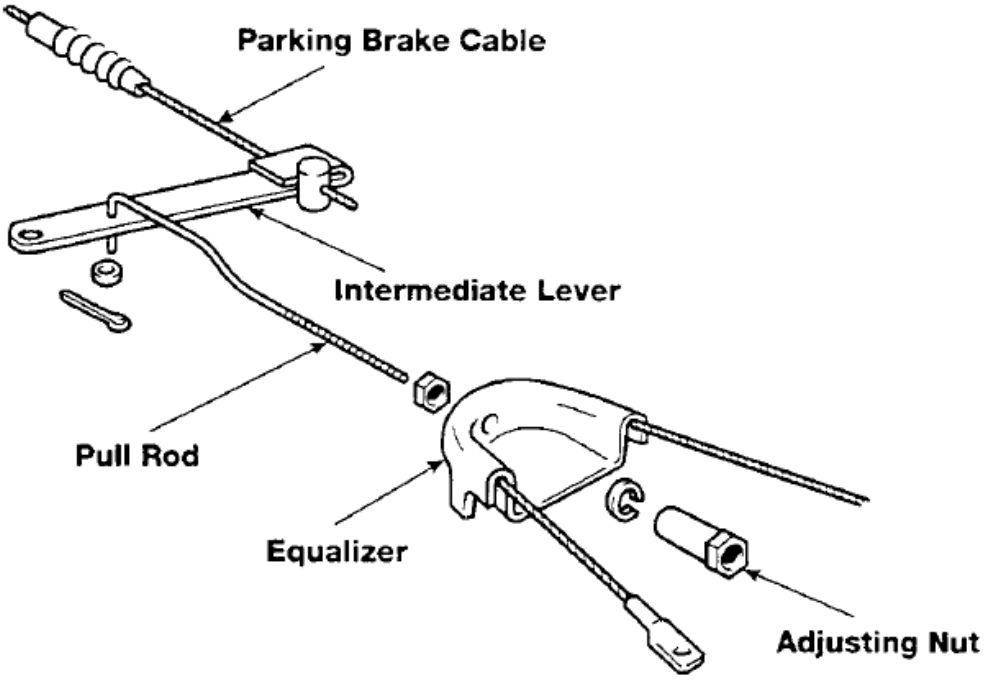


Figure 2.5 Parking brake assembly

The parking brake cable transmits the lever movement through a typical series of components as shown below to the bake drum subassembly. The intermediate lever multiplies the operating force to the equalizer. The equalizer divides the lever operating force to brake assemblies at both wheels. The two major parts may vary in design however, their function remains the same.

CHAPTER 3

METHODOLOGY

3.1 Introduction

There are several types of method that had been adopted to accomplish the objectives of this study. The research methodology for this research includes discussion on the method of previous fabrication, the approaches that had been used, and data analysis. The project flow depend on the flow chart that been prepared and the explanation for every steps will be described in this chapter. This chapter also will be discussed based from chapter 2.

3.2 Research Process

The research process for this study can be divided into 2 phases. In the first phase, the research will involve the literature reviews which include common information about parking brake or the testing system,. From the findings of the literature review, specimen sample had been developed according to the specimen specifications that have been choose and the standard test procedure will be carried out. The data conducted from test was gathered and used for analysis data. Beside the analysis data will state comparison on the