ALTERNATIVE MATERIAL FOR MOTORCYCLE BRAKE PEDAL

NOR FADHLINA BINTI AB RAZAK

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

‘I admit that I have read this dissertation and in my opinion this dissertation is satisfactory in the aspect of scope and quality for the bestowal of Bachelor of Mechanical Engineering (Automotive)

Signature : …….
Supervisor Name : …….
Date : …….

Signature : …….
Supervisor 2 Name : …….
Date : …….

ALTERNATIVE MATERIAL FOR MOTORCYCLE BRAKE PEDAL

NOR FADHLINA BINTI AB RAZAK

This report was submitted in accordance with the partial requirements for the honor of
Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

MAY 2009

"I admit that this report is my own work except
the summary and some statement which is each of them,
I already state the source of it"

Signature	: …….
Author Name	: Nor Fadhlina Binti Ab Razak
Date	: 18th May 2009

For my beloved mum, Mrs. Ainon binti Mustafa and my caring dad, Mr. Ab Razak bin Abd. Hamid

ACKNOWLEDGEMENT

I would like to express my gratitude to all those who gave me the possibility to complete this project. I want to thank to Allah S.W.T for giving me good health to do the necessary research work. I have furthermore to thank my fellow friends who encouraged me to go ahead with my project.

I am deeply indebted to my supervisor, Mr. Nurfaizey from the Faculty of Mechanical Engineering Department whose help, stimulating suggestions and encouragement helped me in all the time of research and writing of this project.

I also want to thank my friend Suthan, for all his assistance on generating the use of Catia Programming. My housemates, who were great, help in difficult times because of my computer crash.

Especially, I would like to give my special thanks to my parents whose patient love enabled me to complete this work, sacrifice their money for hoping me that I can finish my project on time.

ABSTRACT

Basically, this report about knows the current material use for brake pedal in industry nowadays. In selecting the material, there are two ways have been use; first is using the finding information and next is using CES software. From the finding information about current material for brake pedal, the material that has been found out is low alloy steel. All the properties for low alloy steel need to be use in CES software to find the nearly material to that material. There are an explanations about low alloy steel properties, the element in low alloy steels, heat treatment and advantages of that material also some explanation on how brake pedal function. Today, with more materials than ever before, the opportunities for innovation are immense. But advance is possible only if a procedure exists for making a rational choice. This project use Ashby method as a reference to develops a systematic procedure for selecting materials and processes, leading to the subset which best match the requirements of a design. It is unique in the way the information it contains has been structured. The structure gives rapid access to data and allows the user great freedom in exploring the potential of choice. The method is available as software, giving greater flexibility. There are four main steps in selecting the material, which call translation (includes function, constraints, objective and free variables), screening (eliminate the material that cannot do the job at all), ranking which mean how far the material that passed the test can do their job, and supporting information for all the material that in logic range. In this project, the Finite Element Analysis also use for analyze the strength of the material chooses.

ABSTRAK

Secara dasarnya, laporan ini adalah untuk mengetahui standard bahan yang digunakan untuk penghasilan pedal brek dalam industri pada masa sekarang. Dalam pemilihan bahan, terdapat dua cara digunakan; pertama adalah melalui pencarian dan yang kedua adalah menggunakan perisian CES. Dari hasil carian tersebut, bahan yang telah dijumpai dari sumber yang dipercayai adalah besi beraloi rendah. Semua sifat bahan bagi besi beraloi rendah akan digunakan dalam perisisan CES untuk mencari bahan yang hampir sama sifatnya dengan besi beraloi rendah dan setelah melakukan kajian menggunakan perisian CES, didapati bahan yang hampir sama dengan besi beraloi rendah ialah besi beraloi rendah, AISI 3140, penyejukan. Menerusi laporan ini, terdapat penjelasan mengenai sifat-sifat bahan baru tersebut, bahan- bahan yang terkandung dalam besi beraloi rendah, rawatan haba bagi bahan tersebut, kebaikan bahan itu serta menerusi laporan ini juga mempunyai penerangan bagaimana pedal brek berfungsi. Dalam laporan ini, kaedah Ashby digunakan sebagai rujukan untuk merancang kaedah yang sistematik dalam pemilihan bahan dan proses pembuatan. Hasilnya ialah satu bahan yang dapat memenuhi semua criteria yang diperlukan. Kaedah yang digunakan oleh Ashby ini adalah unik dalam penstrukturan segala informasi yang diperolehi. Struktur tersebut dapat member respon pantas terhadap segala data dan membolehkan pengguna memperolehi kebebasan dalam meneroka peluang-peluang yang berpotensi. Kaedah ini sesuai sebagai perisian dan kefleksibelan yang tinggi. Terdapat empat langkah untuk memilih bahan yang sesuai iaitu penterjemahan (merangkumi cara, sekatan, objektif dan pembolehubah bebas), penapisan (tapis bahan yang tidak berguna sama sekali), kedudukan (membuat analysis tentang bahan tersebut dan sejauh mana kebolehannya untuk melakukan kerja), dan maklumat galakkan bagi bahan yang telah melepasi had selamat. Dalam projek ini, Finite Element Analisis juga digunakan untuk menganalisis kekuatan bahan tersebut.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOL

CES	Cambridge Engineering Selector
E	Young's modulus in unit Pascal
FEA	Finite Element Analysis
FEM	Finite Element Model
N	Unit for Force, Newton
M_s	Martensite Start to Transform
M_f	Martensite Finish Transform
ρ	Density in unit kg/m^3
σ_v	Von Misses Stress in unit Pascal
τ	Torque in unit of Newton meter, N m

LIST OF APPENDICES

CHAPTER I

1 INTRODUCTION

1.1 Background of study

Brake pedal is an important part for a vehicle and more specific in this project, motorcycle. Brake pedal is one of mechanical design and the shape is depending on the material choosing. So, in this project we need to understand the material properties that use in nowadays industry. In choosing the brake pedal design, sketching and material properties are considered in this research. In future study, we need to compare this material to the alternative material and considering the new design of brake pedal if needed.

1.2 Objective of study

To fulfill the target to find alternative material instead of using steel and the necessary new sketching to replace steel as motorcycle brake pedal material.

1.3 Problem statement

In industry, the material that been use are very usual and they are still using the same material as a brake pedal of motorcycle. So, in this short term period of project, there is a need of student to select the new material for brake pedal which can stand for high force and less density than usual. The material properties influence the choosing in mechanical design, so that, research is needed to find the suitable alternative material and changing the shape if needed based on alternative material choose. Instead of using steel as brake pedal material, it is something new to analyze brake pedal with new material and can improve from the existing material.

1.4 Scopes of study

Scopes for this project are:

i. Literature review of this project which is contains the properties of existing material and finding the nearly material to the existing material so that can be comparing to the new material by using CES Software. It is also contain the heat treatment of that material and advantage also disadvantages of the material.
ii. Material selection contains the study of existing material for brake pedal for motorcycle.
iii. Drawing; by using Catia V5R16 Software to draw existing brake pedal so that can use it for analysis.
iv. Finite Element Analysis; continuous from the Catia drawing to simulate the brake pedal for new material.

1.5 Summary

This report contains four chapters which are for Chapter 1: Introduction, Chapter 2: Literature review, Chapter 3: Methodology, Chapter 4: Result and Discussion and Chapter 5: Conclusion and Recommendation. In first chapter contain the problem statement, objective of this project, scope and summary. For literature review, these explain about the existing material and their properties. The weakness of current material also include in this chapter. Next in methodology, how the project had been done is elaborate. The method for selecting the material is using Ashby Method. Ashby Method uses four steps in selecting the material. Next, by using Catia Software, brake pedal model was sketch and use it for further analysis which is Finite Element Analysis. Next is result and discussion of the analysis by using Finite Element Analysis to check wheatear the material is failed or not. Lastly, for the conclusion and recommendation, this will conclude all chapters in this project and some opinion for next study.

CHAPTER II

2 LITERATURE REVIEW

2.1 Introduction

Design is the most important word that means everything to all people. In designing process, the materials choose is also important. Materials are physical substances used as inputs to production or manufacturing that derive from or composed matter. Some material have limited design based on that material properties, but the process to shape the material nowadays are more faster than at any previous time.

2.2 Material Selection

As general information, design is a process of translating or generating new idea based on market need into the detailed information from which a product that design before can be manufactured. Each of its stages requires decisions about the materials of which the product is to be made and the process for making it. Normally, the choice of material is dictated by the design. But sometimes it is the other way round: the new product, or the evolution of the existing one, was suggested or made possible by the new material.

The choice of material cannot be made independently of the choice of process by which the material is to be formed, joined, finished, and otherwise treated. Cost enters both in the choice of material and in the way the material is processed. It is also influence material usage on the environment in which we live. And it must be recognized that good engineering design alone is not enough to sell products. In almost everything from home appliances through automobiles to aircraft, the form, texture, feel, color, decoration of the product – it is important to give the person who owns or uses it. This aspect, known confusingly as 'industrial design', is one that, if neglected, can lose the manufacturer market. Good designs work; excellent designs also give pleasure. Below are the material selections for existing material.

2.2.1 Finding Information

In this study, the selected material for existing brake pedal material is low alloy steel. From [1] stated that steel most comment and widely used metallic material especially for automobile body frame. Furthermore, low alloy steel is corrosion resistance and this proved by the current brake pedal which is normally has no corrosion.

Low alloy steel is a material which has been added small amounts of alloying elements as chromium, nickel, molybdenum, vanadium, zirconium, copper, and columbium. Most low alloy steels are suitable as engineering quenched and tempered steels and are generally heat treated for engineering use. Low alloy steels with suitable alloy compositions have greater hardenability than structural carbon steel and, thus, can provide high strength and good toughness in thicker sections by heat treatment.

Generally, the higher the alloy content, the greater the hardenability of low alloy steel and the higher the carbon content, the greater the available strength. The response to heat treatment is the most important function of the alloying elements in these steels. Effect of alloy addition is to raise the yield point of the steel in the as-rolled condition to

a level substantially higher than that of the structural carbon grades, and at the same time provide weldability and formability. Thus, they offer the advantages of higher strength-to-weight ratios, increased resistance to wear and abrasion, and in some cases improved resistance to atmospheric corrosion. General characteristics are similar, but the various grades may be categorized in a general way according to their resistance to atmospheric corrosion.

Figure 1: Existing Brake Pedal (Honda EX5)

Table 1: Mechanical Properties of Low Alloy Steel [2]

Mechanical Properties	Metric
Ultimate Tensile Strength	180 – 2450 MPa
Elongation at Break	0.6 – 37.0 %
Modulus of Elasticity, *E*	76.5 - 223 GPa

Table 2: Physical Properties of Low Alloy Steel [2]

Physical Properties	Metric
Density, ρ	7600-8080 kg/m³

Table 3: Material Component Properties of Low Alloy Steel [2]

Material Component	Metric
Chromium, Cr	0.150 - 5.50 %
Nickel, Ni	0.200 - 18.5 %
Molybdenum, Mo	0.0600 - 4.80 %
Vanadium, V	0.00500 - 0.300 %
Zirconium, Zr	0.0100 - 0.150 %

2.2.2 CES Edupack

The methods lend themselves readily to implementation as computer-based tools; one, the CES materials and process selection platform, has been used for the case studies and many of the figures. They also offer potential for interfacing with other computer-aided design, function modeling, optimization routines, but this degree of integration, though under development, is not yet commercially available [3]. All this will be found in the following chapters, with case studies illustrating applications.

"CES EduPack is the software-based package to accompany Ashby book, developed by Michael Ashby and Granta Design. Used together, Materials Selection in Mechanical Design and CES EduPack provide complete materials, manufacturing and design course."[4]

Step to select the material using this software is:

i. Open CES Edupack;
ii. Select Level 3 'Advanced' configuration;
iii. At above toolbar, select button "Select" and select All Bulk Materials and click OK button;
iv. At left side, there are criteria that need to be select. Select "Selection Criteria" and click "New" button and choose Limit Graph;

v. From now on, insert the criteria that found in the research before.

For the result, the nearly material as low alloy steel is low alloy steel, AISI 43200, annealed. Below are the properties of low alloy steel, AISI 3140, annealed:

Table 4: Material Properties of Low Alloy Steel, AISI 4320 (Annealed)

Properties	Metric
Young's Modulus, *E*	201 – 212 GPa
Tensile Strength	520 – 640 MPa
Elongation	23 – 35 %
Density,ρ	7800 – 7900 kg/m^3
Price	2.869 – 4.663 MYR/kg

This material is assume to be the material for existing brake pedal for Honda EX5 because it is difficult to find the exact material that use for that brake pedal. So, by using CES Software, the material that nearest to low alloy steel properties is low alloy steel, AISI 4320, annealed.

2.3 Element in Low Alloy Steels

Steels are among the most commonly used alloys. The complexity of steel alloys is fairly significant. Not all effects of the varying elements are included. The following text gives an overview of some of the effects of various alloying elements. Additional study should be performed prior to making any design or engineering conclusions. These are the element in low-alloy steels [5]:

i. Carbon has a major effect on steel properties. Carbon is the primary hardening element in steel. Hardness and tensile strength increases as carbon content

increases up to about 0.85% C. Ductility and weldability decrease with increasing carbon.

ii. Manganese is generally beneficial to surface quality especially in resulfurized steels. Manganese contributes to strength and hardness, but less than carbon. The increase in strength is dependent upon the carbon content. Increasing the manganese content decreases ductility and weldability, but less than carbon. Manganese has a significant effect on the hardenability of steel.

iii. Silicon is one of the principal deoxidizers used in steelmaking. Silicon is less effective than manganese in increasing as-rolled strength and hardness. In low-carbon steels, silicon is generally detrimental to surface quality.

iv. Copper in significant amounts is detrimental to hot-working steels. Copper negatively affects forge welding, but does not seriously affect arc or oxyacetylene welding. Copper can be detrimental to surface quality. Copper is beneficial to atmospheric corrosion resistance when present in amounts exceeding 0.20%. Weathering steels are sold having greater than 0.20% Copper.

v. Boron is added to fully killed steel to improve hardenability. Boron-treated steels are produced to a range of 0.0005 to 0.003%. Whenever boron is substituted in part for other alloys, it should be done only with hardenability in mind because the lowered alloy content may be harmful for some applications. Boron is a potent alloying element in steel. A very small amount of boron (about 0.001%) has a strong effect on hardenability. Boron steels are generally produced within a range of 0.0005 to 0.003%. Boron is most effective in lower carbon steels.

vi. Chromium is commonly added to steel to increase corrosion resistance and oxidation resistance, to increase hardenability, or to improve high-temperature strength. As a hardening element, Chromium is frequently used with a toughening element such as nickel to produce superior mechanical properties. At

higher temperatures, chromium contributes increased strength. Chromium is strong carbide former. Complex chromium-iron carbides go into solution in austenite slowly; therefore, sufficient heating time must be allowed for prior to quenching.

vii. Nickel is a ferrite strengthener. Nickel does not form carbides in steel. It remains in solution in ferrite, strengthening and toughening the ferrite phase. Nickel increases the hardenability and impact strength of steels.

viii. Molybdenum increases the hardenability of steel. Molybdenum may produce secondary hardening during the tempering of quenched steels. It enhances the creep strength of low-alloy steels at elevated temperatures.

ix. Vanadium increases the yield strength and the tensile strength of carbon steel. The addition of small amounts of Vanadium can significantly increase the strength of steels. Vanadium is one of the primary contributors to precipitation strengthening in micro alloyed steels. When thermo mechanical processing is properly controlled the ferrite grain size is refined and there is a corresponding increase in toughness. The impact transition temperature also increases when vanadium is added.

Zirconium can be added to killed high-strength low-alloy steels to achieve improvements in inclusion characteristics. Zirconium causes sulfide inclusions to be globular rather than elongated thus improving toughness and ductility in transverse bending.