PRODUCT DESIGN CONSIDERATION FOR SHORT GLASS FIBER REINFORCED COMPOSITE BRAKE PEDAL DESIGN

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"I admit that I have read this report and I found that it is suffice from the aspect of scope and quality to pass the Bachelor Degree of Mechanical Engineering (Thermal-Fluid)"

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Date :15 December 2005

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This report is hand over to Mechanical Engineering Faculty as a requirement to pass a Bachelor Degree of Mechanical Engineering (Thermal-Fluid).

Faculty of Mechanical Engineering
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DESEMBER 2005

ADMISSION

" I admit this report is done all by myself except statement that I have already stated on each one of them"

Signature : ....

Author : Muhd Mustafa Bin Ghazali

Date : 15 December 2005

THIS WORK IS DEDICATED TO MY BELOVED MOTHER, FATHER, SISTER AND BROTHERS. YOU ALL ARE MY INSPIRATION, TO "MY FIANCE" THANKS FOR THE SUPPORTS AND A TRUE LOVE. FOR MY FRIEND ALWAYS REMEMBER "WE ARE THE BEST"

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ABSTRACT

This thesis discusses the main parameters required in designing a short glass fiber reinforced composite for brake pedal. The design of a composite brake pedal involves four major considerations that are closely intertwined. They are material, processing, design and cost estimation. Based on the study of these four main elements, several design concepts was produced and some will than him be chosen to be made prototype. The selection was made based on the analysis result that was produced from SolidWorks software. At the end, the detail of design of brake pedal was discussed in this thesis. .

ABSTRAK

Kertas ini membincangkan parameter utama yang diperlukan dalam merekabentuk pedal brek menggunakan (short glass fiber reinforced composite). Rekabentuk pedal brek memerlukan beberapa pertimbangan utama yang saling berkaitan. Antaranya ialah bahan, proses yang digunakan, rekabentuk, proses pembuatan dan anggaran cost. Berdasarkan penelitian kepada elemen-elemen utama ini, beberapa konsep rekabentuk dihasilkan dan salah satu daripadanya akan dipilih untuk dijadikan sebagai model. Pemilihan dibuat berdasarkan kepada keputusan daripada analisis yang dilakukan dengan menggunakan program SolidWorks dan akhir sekali perincian rekabentuk juga dibincangkan di dalam kertas ini.

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LIST OF SYMBOL

SYMBOL	DEFINITION
A	Area
C	Centriod
R	Radius
M	Moment
I	Second moment of area
U_s	Shear strain energy
T	Torqeu
F	Force

GREEK SYMBOL	DEFINITON
δ	Elongation
τ	Shear Stress
σ	Longitudinal stress
Σ	Total

SUBCRIP	DEFINITION
x	x axis
y	y axis
b	Width
h	High

y	Distance
θ	Angle
t	Thickness
max	Maximum

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CHAPTER 1

INTRODUCTION

1.0 Background

The past few decades witnessed an uprising in the use of glass fiber as a reinforcing agent. This is due to its high strength to weight ratios, dimensional stability and resistance to heat, cold, moisture and corrosion. For various reasons, many composites are reinforced by short fiber instead of continuous fiber. The major automotive manufactures need to achieve weight saving throughout the automobiles which they manufacture. The major weight saving achieved so far has been the substitution of sheet body panel with short glass fiber reinforced composites. Substitution of short glass fiber reinforced composite material in the car components had successfully implemented for the quest of fuel and weight reduction. Among the component in automotive were substitution by short glass fiber reinforced composite material are brake pedal.

In the previous work, many parameters that must be considered for design short glass fiber reinforced composite brake pedal. But not all parameter was considered in the design process. If all parameters are considered, it will disturb of the process. Therefore only the major parameters are considered for design short glass fiber reinforced composite brake pedal. In this project, research about considering all parameter for design brake pedal will be done. From the studied, certain important parameter will be discussing more detail. At the end of the process, one a new model brake pedal will be proposed.

1.2 Objective of project

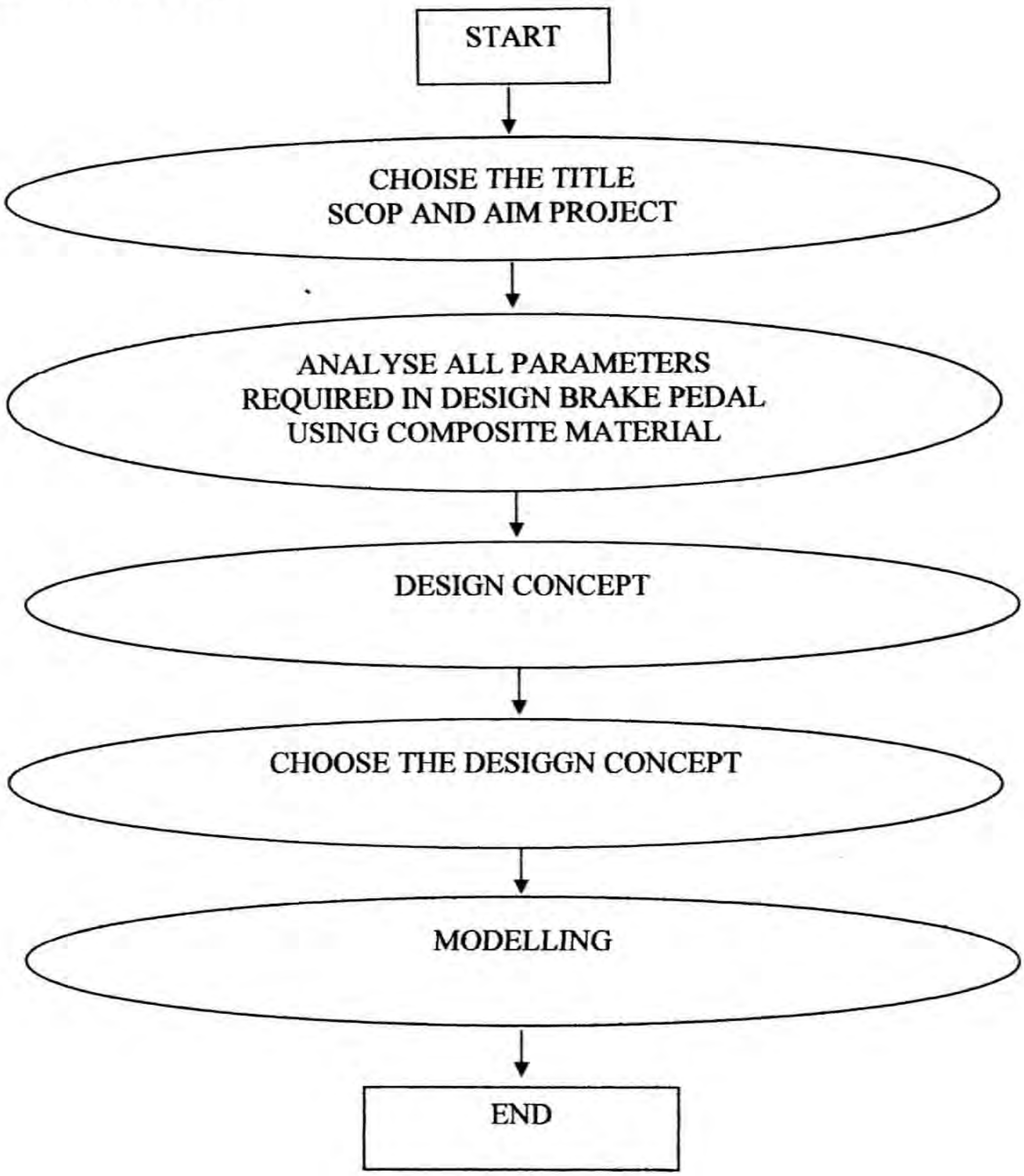
The major objectives of this project are:

a) To do literature survey and identify all parameter required in designing automotive for short glass fiber reinforced composite brake pedal.
b) To study overall design parameters that the part must meet in normal and adverse condition
c) To determine the major parameter required to design short glass fiber reinforced composite brake pedal.
d) To design the one model brake pedal using short glass fiber reinforcement material.

1.3 Structure of the thesis

A literature survey of research work in various areas relevant to this research is presented in Chapter 2. The survey explained introduction about brake pedal and fiber reinforce composites. The survey also covered polymeric-based composite materials in automotive and advantages of composites in the automobile industry. Lastly the survey also covered about benefits of short fiber composite materials and polymeric-based composite automotive pedal box system. The important factors consideration in designed using short glass-fiber reinforcement covered in chapter 3 explained about material consideration, processing consideration, design consideration, manufacturing process consideration and cost estimation. The conceptual design of a short glass fiber reinforce composite brake pedal is described in Chapter 4. It consists of product design specifications (PDS) and in chapter 5 deals with the detail design of the short glass fiber reinforce composite brake pedal.

1.4 Gannt chart



CHAPTER 2

LITERATURE SURVEY

2.0 Introduction

Recent years have seen a large rise in the number of applications for engineering thermoplastics within the automotive industry. Injection moulded, fibre reinforced parts are replacing structural metallic components because they offer a good strength-to-weight ratio, are durable, and can be produced for a lower total cost. The majority of engineering composites utilised within the injection moulding industry consist of a polymer matrix containing short (<1mm) reinforcing fibers. Typically, electrical quality glass (E-glass) is used for the fibers although carbon and Kevlar are also used for applications where increased performance is desirable, despite the higher cost. Similarly, the choice of polymer used within the composite is determined by a number of factors such as mechanical properties, cost, heat resistance and the ability to bond well with the reinforcing fibers. It can be shown that the orientation of the fibers has a major influence upon the properties of the composite as a whole, but the nature of the injection moulding process means that it is very difficult to control the fiber orientation within the part. The fiber orientation is determined by the way the polymer flows through the mould, which is affected by such factors as the rheology of the material, moulding conditions and the geometry of the mould. This poses many problems for an injection moulder because it suggests that once a part design has been finalised, the manner in which the part is produced has animpact upon the final mechanical properties of the part. Consequently, the design stage of the part must include processing details which can be used to produce a reliable estimate of the fiber orientation after the part has been manufactured. Otherwise the worst possible orientation state must be assumed, and over-engineering and correspondingly high production costs will result

2.1 Brake pedal

The brake pedal is located on the left side of the accelerator pedal. Stepping on this pedal begins the process of slowing down or stopping a vehicle. The pedal is solidly mounted to the firewall, and works as a force-multiplying lever. If the power assist fails, the pedal's leverage is designed to allow the driver to still generate thousands of pounds of pressure at each wheel cylinder. Attached to the piston within the master cylinder via a pushrod, the brake pedal is a most important item indeed. When the brake pedal is pressed, the brake shoes and friction pads are forced into contact with the brake drums and rotors to slow the rotation of the wheels. The friction between the tires and the road surface then slows the speed of the vehicle. A brake pedal should not sink more than an inch or two, no matter how hard it is pressed with the foot; and the driver should not feel as if he were stepping on a wet sponge a spongy pedal spells trouble in the braking system. Usually, brake pedal is made from steel and aluminum.

2.2 Pedal force and pedal travel

Safety standards provide for certain limitations on pedal force. Ergonomic considerations and driver acceptance limit pedal force and pedal travel to a particular range established over the years. The maximum force exerted with the right foot for the 5^{th} percentile female is approximately 445N (100 1b); for the male approximately 823 N (185 1b). Both pedal force and pedal travel are important parameters for the human operator to safety modulate braking effectiveness. Brake system without sufficient pedal travel feed-back, particularly on slippery roads, may cause loss of vehicle control to due inadvertent brake lockup.

The pedal apply speed of skilled drivers is approximately 1 m/s (3 to 3.5 ft/s); of normal drivers around 0.5 ft/s. for a pedal travel of 100 mm pedal apply times are between 100 and 200 ms. A "soft" pedal does not only cause unsafe driver response but also increased stopping distances. The maximum loads applied by the driver's feet on the brake, clutch and accelerator pedal were 2700 N (Sapuan 1998).

2.3 Fiber Reinforced Composites

The most popular type of composite material is the fiber-reinforced composite geometry, where continuous or discontinuous thin fibers of one material are embedded in a matrix of another. The matrix supports and transmits forces to the fibers, protects them from environments and handling, and provides ductility and toughness, while the fibers carry most of the load and impart enhanced stiffness. Wood and bamboo are two naturally occurring fiber composites, consisting of cellulose fibers in a lignin matrix. Bricks of straw and mud may well have been the first human-made material of this variety, dating back to near 800 B.c. Automobile tires now use fibers of nylon, rayon, aramid (Kevlar), or steel in various numbers and orientations to reinforce the rubber and provide added strength and durability. Steel-reinforced concrete is actually a double composite, consisting of a particulate matrix reinforced with steel fibers.

Glass-fiber reinforced resins, the first of the modern fibrous composites, were developed shortly after World War II in an attempt to produce lightweight materials with high strength and high stiffness. Glass fibers about 10p,m in diameter are bonded in a variety of polymers, generally epoxy or polyester resins. Between 30 and 60% by volume is made up of fibers of either E-type borosilicate glass (tensile strength of 500 ksi and elastic modulus of 10.5×10^6 psi) or the stronger, stiffer, high-performance S-type magnesia-alumina-silicate glass (with tensile strength of 670 ksi and elastic modulus of 12.4×10^6 psi).

It is important to note that a fiber of material tends to be stronger than the same material in bulk form because the size of any flaw is limited to the diameter of the fiber. Moreover, the complete failure of a given fiber does not propagate through the assembly, as would a flaw in an identical bulk material.

Glass fibers are still the most widely used reinforcement, primarily because of their lower cost and adequate properties for many applications. Current uses of glass-fiber-reinforced plastics include sporting goods, boat hulls and bathtubs. Limitations of the glass-fiber material are generally related to strength and stiffness. Alternative fibers have been developed for applications requiring enhanced properties. Boron-tungsten fibers (boron deposited on a tungsten core) offer an elastic modulus of 380,000 MPa (55×10^6 psi) with tensile strengths in excess of 2750 MPa (400 ksi). Silicon carbide filaments (SiC on tungsten) have an even higher modulus of elasticity.

Within the composite, the reinforcing fibers can be arranged in a variety of orientations. Fiberglass, for example, contains short, randomly oriented fibers. Unidirectional fibers can be used to produce highly directional properties, with the fiber directions being tailored to the direction of loading. Woven fabrics or tapes can be produced and