I hereby declare that I have read this thesis and in my opinion this is sufficient in terms of scope and quality for the award of the Bachelor of Mechanical Engineering (Automotive)

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MATERIAL SELECTION AND OPTIMIZATION DESIGN

FOR CAR SIDE DOOR IMPACT BEAM

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A THESIS REPORT SUBMITTED TO

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FACULTY OF MECHANICAL ENGINEERING

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APRIL 2009

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"I hereby the author, declare this report entitled

"Material Selection and Optimization Design for Car Side Door Impact Beam"

is my own except for quotations and summaries which have been duly acknowledged"

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ABSTRAK

Pengeluaran kereta amat menitikberatkan isu kenaikan harga minyak dan pencemaran dari kenderaan. Berat kereta sangat mempengaruhi kecekapan minyak dan pencemaran udara. Cara yang paling baik untuk meningkatkan kecekapan minyak ialah dengan mengurangkan berat kenderaan. Bar tekanan pada sisi kereta adalah salah satu ciri keselamatan yang ada pada kereta. Ia dilekat pada bahagian pintu kereta. Tujuan bar ini adalah untuk melindungi penumpang dari hentakan semasa kemalangan. Kebanyakkan bar tekanan in dibuat daripada aloi besi yang kuat. Tetapi bar aloi besi mempunyai kelemahan dari segi ketumpatan atau berat yang tinggi. Untuk mengatasi masalah ini, bahan bar tersebut perlu diganti dengan bahan yang lebih ringan.

Dalam kajian ini, bahan dan reka bentuk baru bagi bar tekanan pada sisi kereta akan dikaji. Terdapat 3 peringkat dalam kajian ini, iaitu peringkat pemilihan bahan, peringkat reka bentuk keratan rentas bar dan pringkat pengstrukturan optimum. Dalam peringkat pemilihan bahan, bahan yang dipilih perlu memenuhi kriteria asal bar tekanan sisi iaitu mempunyai kekuatan dan kekerasan yang tinggi. Cambridge Material Selector (CES) digunakan dalam peringkat pemilihan bahan. Pada peringkat reka bentuk, beberapa bentuk keratan rentas direka dan dibawa ke peringkat pengstrukturan optimasi. Pengstrukturan optimasi dibuat berdasarkan perisian Solidwork COSMOS. Bahan dan reka bentuk baru akan dipilih selepas membuat perbandingan dengan bar tekanan sisi yang sedia ada.

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ABSTRACT

The increase of fuel price and emission from the vehicle are concerned by car manufacturer. The weight of car has a direct influence on the fuel efficiency and emission gases. The best way to increase the fuel efficiency is to decrease the weight of the vehicle. Car side door impact beam is a passive safety features in a car. It is mounted on the door panels of passenger cars to protect passengers' safety from side impact damage. The conventional car side door impact beam is mostly made with high strength alloy steel. High density or heavy weigh are the disadvantage of high strength alloy steel impact beam. The best way to reduce the weight of car side door impact beam without sacrificing the safety is to employ lighter material on it.

In this research, a new material and a new design for the car side door impact beam are carried out. There are 3 stages in this research, which are material selection stage, design cross-section type of beam stage, and structural optimization stage. In material selection stage, the new material is chosen based on the requirements of car side door impact beam, which are high strength and stiffness, high toughness, and high energy absorption capability. Cambridge Material Selector (CES) software is used in material selection stage. In design stage, a few cross section types are designed and brought to structural optimization stage. A structural optimization system based on the Solidwork COSMOS is employed. A suitable material and design of new car side door impact beam is chosen after the some comparisons with conventional car side door impact beam are done.

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LIST OF SYMBOL

M	=	Material index
E	=	Young's modulus
ρ	=	Material density
σ_y	=	Elastic limit or stress at the tension site of beam
I	=	Moment of inertia
R	=	Outer radius
R	=	Inner Radius

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Project Sarjana Muda (PSM1) is compulsory finished up by an undergraduate student with a Bachelor holder in Mechanical Engineering (Automotive) field. To complete this research, a title regarding to the material selection, design and analysis of car side door impact beam is done. There are 3 stages in this research which are material selection stage, design for cross-section type car side door impact beam stage, and optimization stage. In material selection stage, a material selection software call Cambrigde Engineering Selector (CES) is used. COSMOS software is used in conceptual design stage and optimization stage.

1.1 Background

Nowadays, automobiles continue to become smaller and more compact. The cost of car is minimized, and the fuel efficiency is maximized by car manufacturer. The interior space and weight of car is directly affected by the reduction of car size. Lighter and compact component are used to reduce the weight of the car. The low alloy steel car side door impact beam with high density is widely used in the vehicle. The high

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weight of steel is directly increased the weight of vehicle and decreased the performance of vehicle. Thus, the improvement in car side door impact beam is required.

The automobile safety is concentrated by the car manufacturer and numerous safety features have been built into cars. A good design safety features can minimize the harmful effects of accident and protect human life. The most common fatality crashes in the world is collisions between vehicles travelling in opposite direction. Next are single vehicle crashes where the vehicle leaves the road followed by intersection crashes and then pedestrian impacts. When a vehicle leaves the road, the most commonly struck object is a tree or a pole (Euro NCAP, 2004). These types of accident are considered as side impact crashes.

Car side door impact beam is one of a passive safety feature in a car. It is mounted on the door panels of passenger cars to protect passenger's safety from side impact damage. The requirements of impact beam are needed to have large static strength and high impact energy absorption capability. The conventional impact beam normally is made by low alloy steel.

1.2 Problem Statement

The conventional material used for car side door impact beam mostly is low alloy steel. The advantages of low alloy steel are high strength and high toughness and the disadvantage of low alloy steel is high density. To decrease the weight of vehicle, a material which is lighter, higher strength and stiffness, and higher impact energy absorption than low alloy steel is required to replace the conventional material. When choosing a material for a new car side door impact beam, the requirements and properties of car side door impact beam are considered. The conventional design for car side door impact beam which available in the automotive field are tubular steel beam, sheet steel stampings and roll formed high strength steel. These designs are used in most

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of the vehicle on the road now. To design a new cross section type for car side door impact beam, the properties of material which is choose in material selection stage is considered. And sometime, the shape or design can influence the material selection stage.

1.3 Objective

The objectives are of this research are listed as follow:

- To select suitable material for car side door impact beam.
- To do the structural analysis as well as optimization design for car side door impact beam.

1.4 Project Scope

This project is more to material and design engineering. The project scopes are:

- To select suitable material for car side door impact beam using CES software.
- To select suitable cross section types of car side door impact beam by conceptual design and structural analysis using COSMOS software.
- To do optimization design to reduce weight of car side door impact beam using COSMOS software.

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1.5 Thesis Outline

Thesis outline is a summary of every chapter and introduce about the chapter. In Chapter 1, the project title which is car side door impact beam, problem statement, contents of the thesis, the objective and scope of project are introduced. In Chapter 2, the literature review for car side door impact beam, material selection, design and optimization of new car side door impact beam are covered. The methodology to complete the research is explained in Chapter 3. The material selection stage is shown in chapter 4. In Chapter 5, the new cross section design is recommended. Strength test is done on the new cross section beam. Procedures of strength test and results are explained in Chapter 6. In chapter 7, optimization stage is explained. The final chapter of this study is conclusion and recommendation of this study.

1.6 Summary

This chapter is simply introduced the project title in this research. In order to select a new material and complete a design, problem statement is considered. When the problem is verified, the objective and scope of project is focused on the problem statement. In order to make the report tidily, a thesis outline is added to smooth the work.

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CHAPTER 2

LITERATURE REVIEW

2.0 The Safety Features of Car

To minimize the harmful effects of car accidents and protect the human life and health, automobile safety is concerned by all car manufacturers. Modern cars are provided the widest range of safety features which include standard equipment and available to be bought. There are 2 types of safety features, which are active safety and passive safety. Active safety features is installed to vehicle for drive safer and prevent crashes. Active safety features are Dynamic Steering Response (DSR), Traction Control System (TCS), Electronic Stability Control (ESC) and etc. Passive safety is referred to when a crash is happened, various passive safety system are worked together to minimize injury to the passengers. The passive safety features are seatbelt, airbag, impact beam and etc. Car side door impact beam is included in passive safety category (Euro NCAP, 2004).

2.1 Car Side Door Impact Beam

Car side door is a part of car body and it is used to open and close by pivoting on a plurality of vertical space hinges. The car side door structure comprises an inner panel

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