SUPERVISOR DECLARATION

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

Signature: ……

Supervisor I: MOHD ADRINATA BIN SHAHARUZAMAN

Date: 16 MEI 2011

Signature: ……

Supervisor II: SUSHELLA EDAYU BINTI MAT KAMAL

Date: 16 MEI 2011

SIMULATION OF FRONT IMPACT ON A CAR BUMPER

MOHD HAFIZ BIN MOHD YAZIZ

This report submitted in partial fulfillment of the requirements for the award bachelor's degree in mechanical engineering (automotive)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

MEI 2011

DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature: …….

Author: MOHD HAFIZ BIN MOHD YAZIZ

Date: 16 MEI 2011

ACKNOWLEDGEMENT

Alhamdulilah, I am very grateful to Allah s.w.t because I have finished this Projek Sarjana Muda report in time.

First and foremost, I would like to thank my supervisor, En. Mohd Adrinata bin Shaharuzaman who had taken a lot of effort to meticulously go through my log report and came up with helpful suggestion and guidance on how to do final year project. Without helping from him, I surely came into deep problem in completing this report.

And at the same time, I would like to take the chance here to express my deeply thankful to technicians that give a hand during the completion of final year project .

Finally, I would like to express my heartfelt gratitude to my family, friends, and also lecturer for their support, constructive suggestion and also criticism.

ABSTRACT

It is important for every car produce by any company to send their cars to the crash test organization to test the compatibility of their cars before announce the new car to the public. This is to make sure the cars are safe enough to be use by their customers. Most of the safety research organization done the high speed impact test which makes them neglected the effectiveness of bumper system to protect the front component of the car such as headlamp. This is because after the crash test with high speed impact, the bumper will be fully damage and they will analyze the whole body of the cars. In this paper, it will discuss about the front impact on a car bumper and the bumper system. The objectives of study are to investigate damage on a car bumper due to front impact and to determine an optimal design for the front bumper. The study will based on Perodua Kancil bumper which the simulation of front impact of the bumper will be made in the simulation software. But before that, the simple impact experiment must be done to verify the software. The methodology to do the experiment and preparation of its apparatus has been done. Lastly the simulation of the bumper will be done by using different material to compare which material are the most suitable for the bumper. Energy absorber have been used one of the strategy to reduce the impact energy.

ABSTRAK

Setiap kereta baru yang dikeluarkan oleh setiap syarikat perlu menghantar kereta mereka kepada organisasi yang menjalankan ujian perlanggaran impak untuk menguji kesesuain dalam keselamatan kereta mereka sebelum dipamerkan ke pihak umum. Ini untuk memastikan kereta itu selamat untuk pengguna. Kebanyakan organisasi keselamatan menjalankan ujian perlanggaran dengan kelajuan impak yang tinggi dan menyebabkan mereka tidak mengambil kira keberkesanan bumper sistem untuk melindungi componen-componen yang diletak di bahagian depan kereta seperti lampu depan. Ini adalah kerana selepas ujian perlanggaran dengan kelajuan impak tinggi, bumper akan rosak sepenuhnya dan menyebabkan mereka terus menganalisa semua bahagian casis depan kereta. Perbincangan akan melibatkan impak dari depan terhadap bumper dan sistem bumper. Objektif utama pencarian adalah untuk menyiasat kerosakan pada bumper kereta disebabkan impak dari depan dan untuk menentukan rekaan yang optimum bagi bumper depan kereta. Simulasi impak dari depan terhadap bumper kereta akan dilakukan di dalam perisian simulasi dengan meggunakan bumper Perodua Kancil. Sebelum itu, impak eksperimen akan dijalankan untuk menyemak perisian simulasi yang digunakan. Kaedah untuk menjalankan eksperimen dan untuk penyedian radas-radas telah disiapkan. Simulasi bumper akan dilakukan dengan menggunakan material yang berbeza untuk membandingkan material yang paling sesuai untuk bumper menyerap tenaga impak yang telah dikenakan. Penyerap tenaga telah digunakan salah satu strategi untuk mengurangkan kesan tenaga impak.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

Since the car produced by many manufacturers was increasing, the car accidents also start to increase. This is because the speed of the car was increased year by year along with the technology. Then, people start to research about the car compatibility in crashes because of the awareness of human life and safety. This make some of the research team out there introduced the crash test which is front, rear and side impact test. The crash test is important because people can see the compatibility of the car whether it safe to be use for passenger or not. Furthermore, the existing of crash test has made the car manufacturer to include the safety features of the car and strengthen the car body to perform well in the crash test. This is because they want customer to buy their car when see the rating of the safety of their car and also to make consumer of the car feel safe when drive their cars.

Simulation of Front Impact on a Car Bumper will be done using the Abaqus software. Before that, to verify Abaqus software, an impact test experiment to the aluminum plate must be done. As we know, impact is a high force or shock applied over a short time period when two or more bodies collide. From the definition we know that to measure the impact we should consider the force, the time period, how many body collide and how do the impact occur. As for that, to know how do the impact occur we must consider what the speed of the each collide bodies, angle of the impact occur and what the weight of each bodies. That is why crash test organization such as NCAP has theirs' own standard to do the test (it was also the

same for other organization or research council). From all these explanation, we can define that Frontal impact occur when two object collide from its front define by its impact velocity and impact angle.

Before proceeds with the simulation or the impact, it is a must to understand what is the bumper system or bumper means. Bumper is a shield made of steel, aluminum, rubber, or plastic that is mounted on the front and rear of a passenger car. The bumper is designed especially to absorb crash energy during minor and low-speed collisions. By absorbing the force due to impact, the damage of the car component can be reduce or avoid. Most of the car will use energy absorbers or brackets and others are made with a cushioning material. Next chapter will discuss more about the bumper system.

1.2 PROBLEM STATEMENT

In order to prevent unnecessary damage to the structure of passenger cars in low speed crashes, a 15 km/h and 40 percent overlap was implemented in the 1980s and revised again in 2006 (RCAR 2008).

Most of the group research of the crash test done research on the high speed collision to analyze the whole body deformation which start from the front. This situation needed them to stress more on the deformation of the whole vehicle body when impact occurred while sometime makes them neglect the bumper system effectiveness. This type of crash test usually to rated the safety of the car passenger (Use human dummy as a car passenger to analyze the injury from the crash impact). This make them neglect the bumper system efficiency to protect front component when low speed collision occur.

1.3 OBJECTIVES

The project objectives are:-

1. To investigate damage on a car bumper due to front impact.
2. To determine an optimal design for the front bumper.

In order to investigate damage on a car bumper, this project will only focus on a car bumper due to front impact which by analyzing how does the bumper system works. As we already know, for safety reason most of the car will go through the crash test conducted by some crash test organization. Then, the car will be rated by the car performance in the crash test. In the crash test, they will also investigate the human dummy response on how it will affect the human dummy after the crash (which means the risk injury of the car passengers). But for this project, this ergonomic and safety investigation will not be included because the main focus of the project is the bumper system.

After finish the simulation of front impact on a car bumper, the data from simulation will be gathered and the deformation of the bumper will be analyzed. After the simulation of the car bumper has done and analyzed, a new optimal bumper design will be design to replace the old bumper by fix its quality and hardness. The simulation of the car bumper will be covered in PSM 2.

1.4 SCOPES

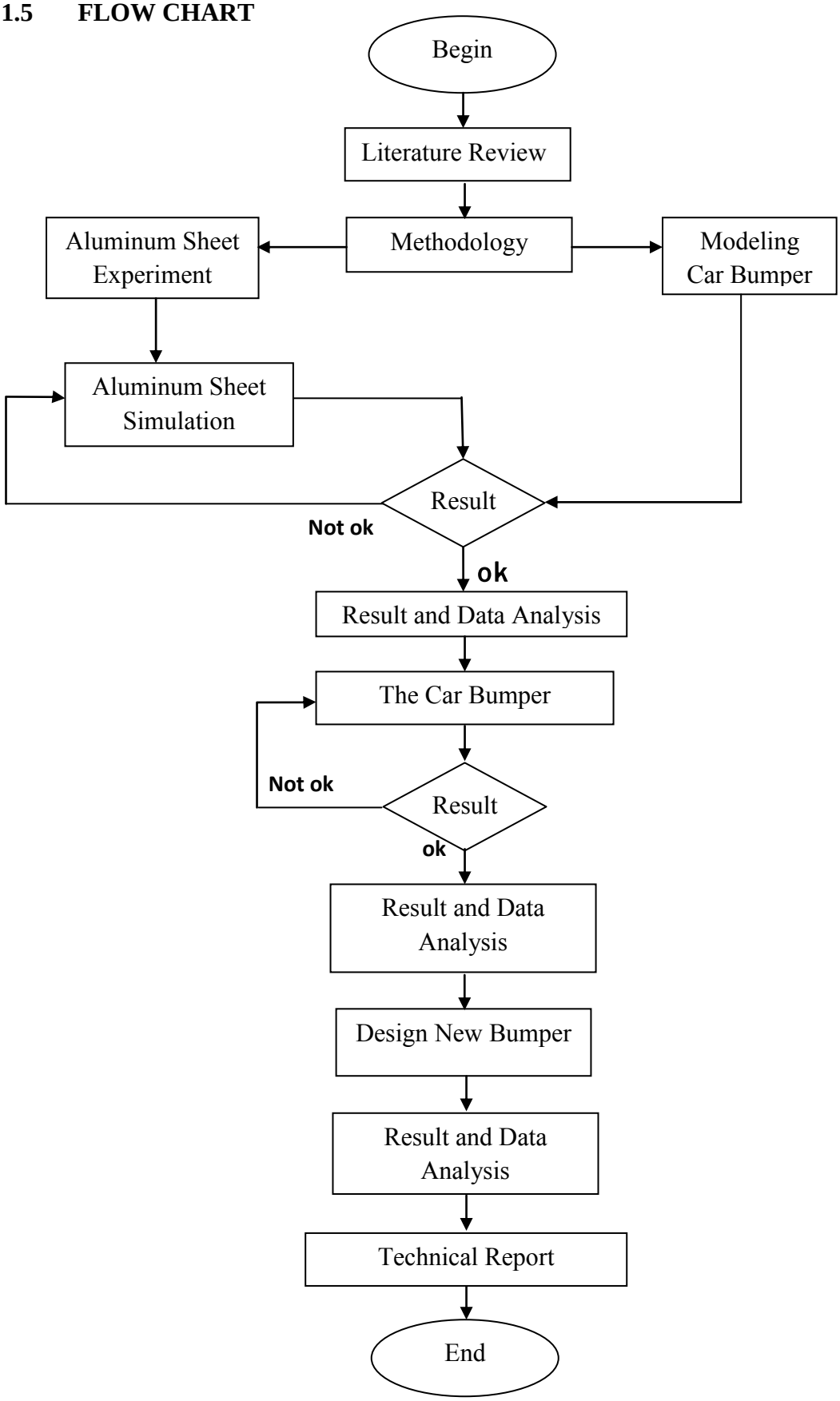
The project scopes are:-

1. Develop a finite element model for the front bumper
2. Simple Impact experiment on an aluminum sheet to verify the software.
3. Perform front impact analysis using software to obtain damage behavior on the front bumper.
4. Prepare Apparatus for impact experiment.

The CAD model will be built first in the CATIA before it can be export to the ABAQUS software to be analyzes it deformation from the impact crash. In the Abaqus software, the simulation of the car bumper will be runs by key in the specific data. After the simulation, data and result will be analyzed. But before proceeding with the simulation, the software must be verifies. To verify the software, the simple impact experiment on an aluminum sheet must be done.

This experiment will prove that this software can be done to analyze the damage behavior when some object been impact with some force and velocity. This was the main intention of doing the simple impact experiment. The Abaqus software had been choose because most of the automotive researcher used this software to do research about the damage behavior and deformation that cause by the impact or crashes. So, the experiment must be done to prove that abaqus software can be used in this project and the simulation can be done as it is the main objective of the project. In this project, we having some problem where as the impact experiment is not exist at our lab. As for that, we need to prepare our own material to do the impact experiment because the project cannot go on if the impact experiment not be done.

1.5 FLOW CHART



CHAPTER 2

LITERATURE REVIEW

2.0 LITERATURE REVIEW

Before starting this project, some of published literatures, previous researches and books have been reviewed to build up a solid background in the area of bumper system analysis and finite element analysis.

2.1 BUMPER

A bumper is a shield made of steel, aluminum, rubber, or plastic that is mounted on the front and rear of a passenger car. When a low speed collision occurs, the bumper system absorbs the shock to prevent or reduce damage to the car. Some bumpers use energy absorbers or brackets and others are made with a foam cushioning material.

Figure 2.1: Bumper

(source: http://www.socaleuro.com/forum/showthread)

The car bumper is designed to prevent or reduce physical damage to the front and rear ends of passenger motor vehicles in low-speed collisions. Automobile bumpers are not typically designed to be structural components that would significantly contribute to vehicle crashworthiness or occupant protection during front or rear collisions. It is not a safety feature intended to prevent or mitigate injury severity to occupants in the passenger cars. Bumpers are designed to protect the hood, trunk, grille, fuel, exhaust and cooling system as well as safety related equipment such as parking lights, headlamps and taillights in low speed collisions. But some of the car manufacturers avoid the main purpose of designing the bumper which they just design the bumper for styling purpose only.

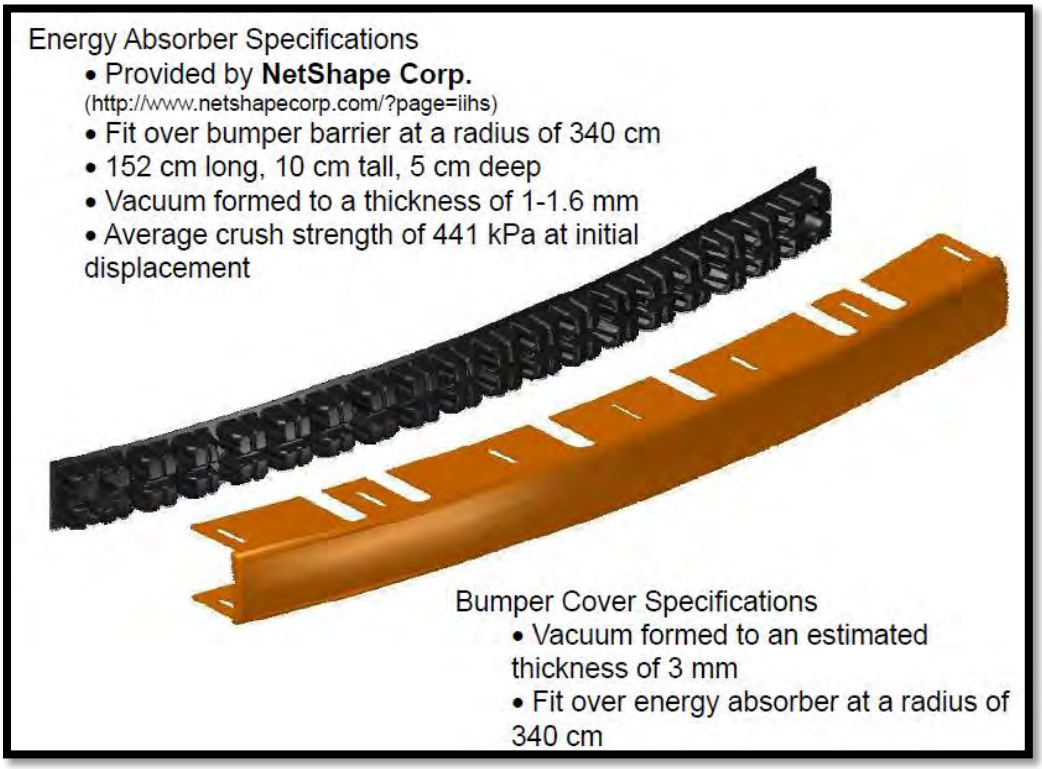


Figure 2.2: Bumper Energy Absorber

(source: RCAR(2007))

2.2 FRONT IMPACT CRASH TEST

Front Impact crash test is the test done to test the compatibility of motor vehicle. This test usually conduct by several council such as NCAP which to test the new car produce by some company. This test was conducted at some place of their

own and they done the analysis of deformation and material after they have done the test. This test also required several dummy, sensor and high speed camera.

Front Impact Crash Test can be categorized to several which are:-

- Percent Overlap
- Full overlap
- Car to car crash
- Car to barrier crash
- Pole impact
- Impact angle
- Low speed test
- High speed test

2.2.1 Percent Overlap

In the crash test conducted, they will set the percent of overlap between the front car and the barrier when the car is crash to the barrier. They measure it by percent of the width of the car overlap to the barrier.

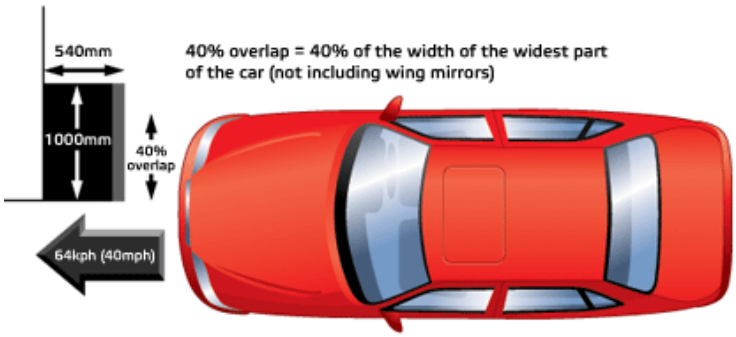


Figure 2.3: Percent Overlap

(source: http://www.euroncap.com/tests/frontimpact.aspx)

2.2.2 Full Overlap

The test conduct is no different with the percent overlap. The difference is just the front car is crash to the barrier with full overlap which we can also said it was 100 percent overlap.