IMPROVEMENT OF FRONT CAR BUMPER SYSTEM

MUHAMAD FIRDAUS BIN MAHMUD

Report submitted in partial fulfillment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering with Automotive

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

JUNE 2008

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Automotive/~~Manufacturing~~*

Signature
Name of Supervisor: ZAMRI MOHAMED
Position: Lecturer
Date: 10 November 2008

Signature
Name of Panel: AZIZUDDIN BIN ABD AZIZ
Position: Lecturer
Date: 10 November 2008

* Delete any

DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature
Name: MUHAMAD FIRDAUS BIN MAHMUD
ID Number: MH05049
Date: 10 November 2008

ACKNOWLEGDEMENT

Firstly I would like to express my deep gratitude to my supervisor, Mr Zamri Bin Mohamed for his precious guidance, admonition and incessant encouragement to me in the way to completing this project. I appreciate and utilize all his advice and supervision that contribute to finishing this project.

I would also like to wish my special thanks to beloved Faculty of Mechanical Engineering for giving me permission to borrow and use the Proton Pesona in the Mechanical Laboratory as my guidance model in designing the front car bumper.

Last but not least, my sincere gratitude to my entire friend in my section group of M13 and M12 that always give me a support and help to overcome my problem and difficulties contribute to completing this project.

ABSTRACT

Designing the bumper with the focus on an improvement aspect is very important in the automotive industry. The goals are to increase the performance of the bumper and also to find the solution to reduce the cost of the bumper hence able to reduce the production cost. The costs of the bumper is high because of the amount of material used and it also involves many processes including making the grille at the center of bumper. The new design considers on reducing the amount of material use and also eliminating the process involve in manufacture the bumper for example eliminating the grille attachment. The new design also must improve the ability to absorb more impact load and increase the protection of the front car component. This project intention is to design an improved of front car bumper and to find the solution for the problem of high cost and the replacing cost for the front bumper and lastly emphasizing the cost reducing aspect. The method have been employed was study the front bumper system, design and analyze the alternative front bumper using CAD software. The suitable material that can be used as the bumper in terms of economical but still maintaining the toughness is Plastic-Polycarbonate (Molded) which is not expensive compare to the best material from the analysis E-Glass Fiber, Plastic-Nylon Type 6/6 and Plastic ABS (Molded). The suitable material to be use for making beam is AISI E 52100 Steel. Rearrangement of the mounting positions gives a different effect on the ability to withstand the impact force. Additional plate in the improvement design proved increasing the toughness of the beam.

ABSTRAK

Merekabentuk bumper dengan member focus kepada aspek pembaikan adalah sangat penting didalam industri automotif dalam usaha untuk meningkatkan prestasi bumper dan juga untuk mencari penyelesaian untuk mengurangkan kos bumper dengan itu mampu mengurangkan kos produksi. Kos bumper adalah tinggi kerana jumlah bahan yang digunakan dan juga bilangan proses yang terlibat adalah banyak termasuk proses membuat grille pada bahagian tengah bumper. Rekabentuk baru mempertimbangkan tentang pengurangan bahan yang digunakan dan juga mengurangkan proses yang terlibat dalam menghasilkan bumper sebagai contoh menghapuskan proses pemasangan grille. Namun rekabentuk bumper yang baru juga perlu bertambah baik dalam keupayaan untuk menyerap lebih banyak daya hentaman, meningkatkan pertahanan komponen hadapan kereta. Tujuan projek ini adalah untuk merekabentuk bumper kereta yang dipertingkatkan kualitinya dan untuk mencari penyelesaian bagi masalah harga bumper dan harga menukarganti bumper yang mahal dan akhir sekali menekankan aspek pengurangan kos. Kaedah yang digunakan ialah melakukan pengkajian terhadap system bumper kereta, merekabentuk dan menganalisis rekabentuk bumper alternatif dengan menggunakan perisian CAD. Bahan yang sesuai untuk digunakan dalam pembuatan bumper dari aspek ekonomikal tetapi tetap mengekalkan kekuatannya ialah Plastic-Polycarbonate (Molded) yang kurang mahal dibandingkan dengan material terbaik daripada analisis E-Glass Fiber, Plastic-Nylon Type 6/6 and Plastic ABS (Molded). Bahan yang sesuai untuk dibuat ‘beam’ ialah AISI E 52100 Steel. Penyusunan semula posisi pemasangan member kesan yang berbeza pada keupayaan bumper untuk menampung daya impak. Penambahan plat didalam rekabentuk yang diperbaharui terbukti meningkatkan kekuatan pada ‘beam’.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF GRAPH

LIST OF SYMBOLS

$\sum$	Summation
$\int$	Integration
Δt	Time interval

LIST OF ABBREVIATIONS

CD	Coefficient of Drag
FEA	Finite Element Analysis
GM	Glass Mat Thermoplastic
2D	Two Dimensions
3D	Three Dimensions
CAE	Computational Aided Engineering
ABS	Acrylonitrile Butadiene Styrene
HDPE	High Density Polyethylene
LDPE	Low Density Polyethylene
FEP	Fluorinated Ethylene Propylene
AISI	American Iron and Steel Institute

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Introduction

Bumper has been an important feature in protecting the vehicle from serious damage to the car component in a low speed collision. Especially when the collision causing damage to the expensive-to-repair part like fender, hood and intercooler. Bumper is also involves in improving the performance of the car. Bumper size and the aerodynamic feature of the bumper are the important aspects in lowering the coefficient of drag, CD. The efficient bumper design will also increase the down force of the car when it accelerates to give more grips to the tire and the road. This will give a good handling to the driver ever in high speed driving.

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.

Bumpers beam are made of heavy sheet metal and are mounted on the front and rear of the car. Bumpers are bent and formed into specific shapes in order to absorb and deliver momentum during a collision. In the event of a collision, the bumper absorbs some of the impact, which decreases damage to the car and its occupants. It also protects the front of the car by diverting all of the car's momentum to the object with which it has collided. The bumper beam is mounted to the car's chassis with special impact absorbers. These shock absorbers are often spring loaded. In slow speed collisions, this allows the bumper to compress, and then extend back to its original position. All bumpers are designed to absorb the energy of the impact. They do this through a series of valves and air chambers. Some car bumpers have hydraulic chambers. In the event of a collision, the absorption unit allows air and/or hydraulic fluid to pass through small openings. Forcing the air/fluid through the valve openings absorbs the energy from the collision. The bumper's job is to minimize damage, primarily to the occupants of the vehicle and to the vehicle itself.

1.2 Problem Statement

Nowadays the part cost for front bumper is still high and the cost for replacing is quite expensive especially if surrounding area or part also damaged. Many part that make up a bumper system, involving a lot of material and processes there for the manufacturer difficult to reduce the price. Customer also blame to the manufacture that the bumper easily to damage although the collision was slow. The material of the bumper should be analyzed to find the alternative material that can improve the toughness.

1.3 Objective

The main objectives of this project is first to study the front bumper properties and the sample of the car was the Proton Pesona. The bumper design of the Proton Pesona has been benchmarked to determine the real dimension of the bumper. Second objective is to design the generic front bumper using Solidwork software including the

improvement that suitable to be made increase the performance of the bumper. The designs then were analyzed using Finite Element Analysis method (FEA) to study the toughness of the bumper design by performing the impact test. The aim of this process is to determine the strength of the front bumper, identify the segment or part that the crack will occur or where the concentration of stress is high when force is attached in front of the bumper. This is to ensure that the designed bumper is functioning properly in absorb the impact energy and protecting the front car component. The third objective is to emphasize the improvement and cost reduction aspect of the designed bumper including the beam design.

This project will focus on designing a improvement front bumper that meets all the regulation aspect. In this research the consideration of improving the front car bumper will be the most important things. To achieve the objective of the project, the following research activities are performed:

1. Literature review, collecting and gathering the information about front bumper.
2. Benchmark the current front car bumper design (Proton Pesona)
3. Make a comparison between the current design and the alternative design.
4. Perform CAE simulation to the alternative bumper.

In the end of this project, the expected outcome is all the problem stated above can be solve, the part cost of the front bumper and the cost for repairing can be reduce. Reducing the parts that make up the bumper system, there for reducing the price is possible. The suitable material for the fascia and the beam will be determined so that the improvement designs have the toughness and increase in ability to withstand the impact force. The alternative design predicated to give a good protection to the front car component when low speed collision happened and work properly in absorb the energy of the impact. Also it should be easy to assemble and attached (installation).

1.4 Limitations

The limitation for this project is hard to find the journal and book about design the low cost front bumper in the Knowledge Management Centre (KMC) of University Malaysia Pahang. The whole literature review journals are searched in internet.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will provide detail description of literature review done according to the project title of front car bumper system. A bumper is a car shield made of steel, aluminium, 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. 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 (Status Report, Vol 4, No 2, IIHS, 2007).

2.2 Front Bumper System

Generally, a bumper is attached to either end of a vehicle to absorb impact in a collision, thereby protecting passenger. As shown in figure 1, a conventional bumper system comprises a bumper cover 1 defining an outer appearance of the bumper system,

an energy absorber 2 formed of an elastic material such a polypropylene foam body or an urethane foam body to absorb energy, an impact beam for supporting the energy absorber 2, and a stay 4 for connecting the impact beam 3 to a vehicle body (Won-Jun Choi, 2003).

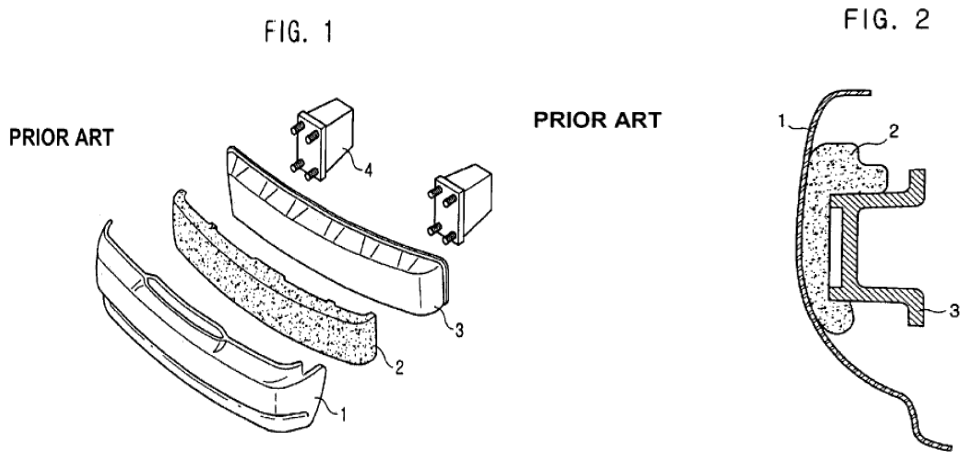

Figure 2.1: General component and arrangement of front bumper system

Source: Won-Jun Choi 2003

The impact beam has previously been formed of a steel material having a closed or “C” shaped section. However, in recent years, to meet with a tendency toward more lightweight and compact vehicles, impact beam formed of a variety of material have been developed. Particularly as proven that an impact beam formed of a glass mat thermoplastic (GMT) thought a compression molding process in superior to other materials, it is widely employed to vehicle for export. However, the conventional GMT-made impact beam as shown in figure 2, formed to be thick thought its overall body to provide a necessary rigidity and strength. Therefore the space saving and weight reducing effect is not so remarkable when compared with the steel beam. In addition, when tips are formed on an upper or lower end of the beam to improve the performance, the bumper cover and the energy absorber may be damage by the tips in the case where the mounting space is not sufficient. Furthermore although a reinforcing sheet has been

applied to several conventional beams, since there is a need for an additional process for forming the reinforcing sheet, the manufacturing cost are increased (Won-Jun Choi, 2003).

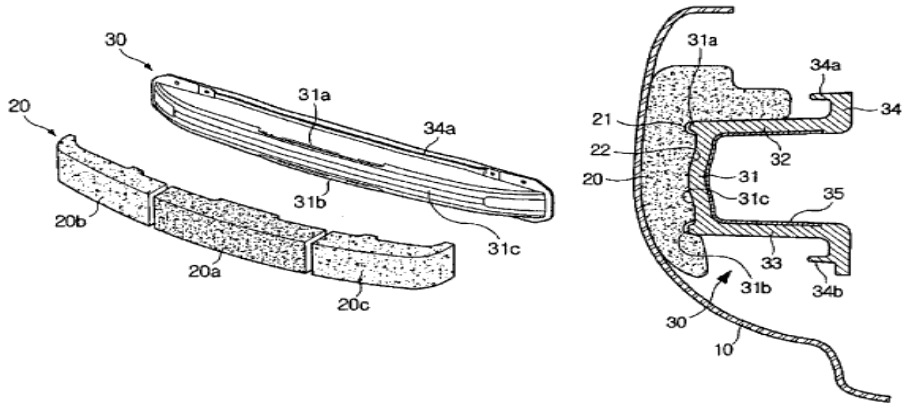

Figure 2.2: Attachments of foam material

Source: Won-Jun Choi 2003

Meanwhile, the energy absorber 2 is disposed between the bumper cover 1 and the impact beam 3 to absorb impact energy. When the energy absorber 2 is subject to an impact greater than its critical elastic force, it crack and must therefore be replaced. However in the conventional bumper system, since the energy absorber is integrally formed, the whole bumper system must be replaced, increasing the repairing costs (Won-Jun Choi, 2003).

An energy absorption and management system for a motor vehicle includes a bumper interconnected to the vehicle frame through a pair of substantially identical energy absorbing assemblies or bumper bracket. Each assembly includes an outer portion and an inner portion. The outer portion has a pair of spaced apart sides which are interconnected through an actuate segment. The inner portion preferably stepped in a longitudinally extending direction such that they include first and second substantially

horizontal segment which are vertical spaced from one another. If the motor vehicle is involved in a frontal impact of a predetermined speed, energy is absorbed and managed though deformation of the outer and inner portions. Deformation of the outer portion is controlled by the inner portion which is welded or otherwise fixedly attached thereto at spaced apart points (Ronald S. Kemp, Oxford Nov. 16, 1999).

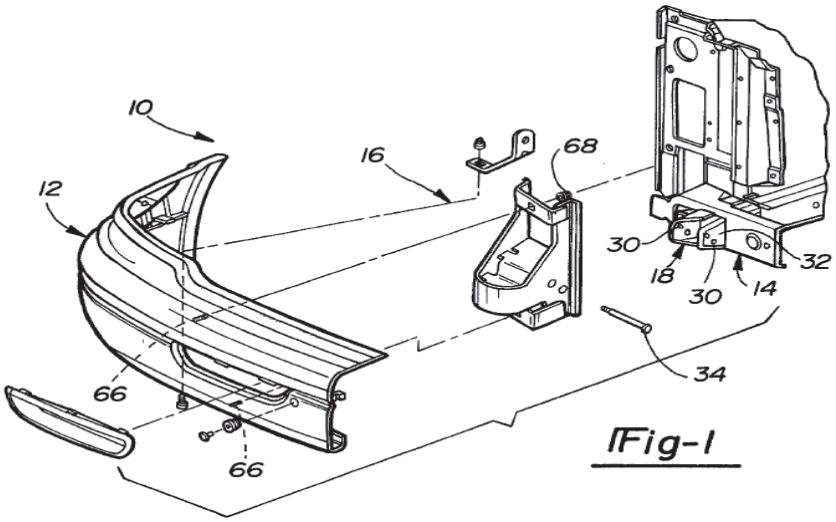

Figure 2.3: An illustration of bracket attachment

Source: Ronald S. Kemp 1999

2.3 Bumper Hydraulic Absorbing System

A shock-absorbing bumper system for an automotive vehicle includes a conduit subsystem for conducting hydraulic fluid therein, a supply subsystem for supplying hydraulic fluid, a pressure balancing subsystem for regulating the pressure of hydraulic fluid, front and rear bumper subsystem for respectively extending and retracting front and rear bumper and for absorbing shock, a switching subsystem for directing hydraulic fluid, and feedback subsystem for absorbing shock (Yang Chin-Hun, Jun 1991).