"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Mechanical Engineering (Material and Structure)"

Signature : ……………………………………

Supervisor's Name : Prof. Dr. Md. Radzai Bin Said

Date : 18th MAY 2009

THE STUDY OF CYLINDRICAL TUBE UNDER QUASI-STATIC LOADING

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"I hereby declared this report is mine except summary and each quotation that I have mentioned the resources"

Signature:…………………………

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Date: 18th May 2009

To my beloved father and mother

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ABSTRACT

Vehicle's crash caused a lot of trouble and undesired things. Though, the effect of the crash can be minimized or prevented as stated as crashworthiness. The crashworthiness of a vehicle depends on its material and structural. Thus, impact energy absorption devices is introduced and used in all vehicles structural nowadays. The impact energy absorption devices are consumable mechanical structure which useable and useful in any collisions. Thus cylindrical tube is being studied on axially and laterally impact. An investigation into energy absorption requires an understanding of materials engineering and structural mechanics. Performance of energy absorbers is determined from various parameters. From material properties, the common parameters those are important were determined by hardness test and compression test. Experimental works and theoretical analysis using theorems from previous studies are discussed and compared. Axially loading gave better result in energy absorbing compared to laterally loading.

ABSTRAK

Perlanggaran antara kenderaan menyebabkan pelbagai masalah dan perkara-perkara yang tidak diingini. Bagaimanapun, kesan daripada perlanggaran tersebut boleh diatasi ataupun dielakkan seperti mana yang disebut sebagai ketahanan kepada kesan perlanggaran. Ketahanan kepada kesan perlanggaran bergantung kepada bahan yang digunakan dan struktur kenderaan tersebut. Oleh sebab itu alat penyerapan tenaga pasak diperkenalkan dan digunakan dalam struktur semua jenis pada hari ini. Alat penyerapan tenaga pasak adalah bahagian struktur mekanikal yang boleh diganti yang mana boleh digunakan dan sangat berguna ketika apa jua perlanggaran. Oleh sebab itu tiub silinder diperkenalkan sebagai satu kajian baru yang mana memfokuskan tentang cara mencipta dan merekabentuk bahan dan struktur yang boleh menyerap tenaga kinetic secara berkesan dan boleh dijangka. Kajian tentang penyerapan tenaga memerlukan pemahaman tentang kejuruteraan bahan dan mekanik struktur. Pelaksanaan alat penyerap ditentukan oleh bebarapa terma. Dua jenis ujikaji dijalankan bagi menentukan kebolehan tiub silinder dalam menyerap tenaga. Keputusan ujikaji dan analisis teori menggunakan teorem daripada kajian yang telah dijalankan sebelum ini dibincang dan dibandingkan.Daya mampatan secara tegak memberikan keputusan yang lebih baik dalam penyerapan tenaga berbanding daya mampatan secara dari sisi.

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A = Cross Sectional Area (m^2)

E = Young's Modulus (N/m^2)

σ = Stress (N/m^2)

LMV = Low mass vehicle

SUV = Sports utility vehicles

SID = Side impact dummies

CIPSS = circular in-plane standard system

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Crashes occur because of various factors including the driver, vehicle, roadway and environment. Crashes are rare events. Crash and catastrophe analysis has been discussed frequently in pastimes- traditional engineering. But then, in recent time, experimental and theoretical analyses became a part of everyday planning as the world of transportation has become a major sector in the world, and the used of transports has been a necessity to peoples. The main criteria of safety issue are vehicles deceleration pulses and deformation of the compartment where good crash energy management allows increasing the safety of both, vehicles and passengers. This concept is called crashworthiness; the ability of the vehicles to prevent injuries to the occupants in the event of a collision.

One measure to view the impact of crash energy is crash analysis. The Crash analysis depends upon deterministic view such the stochastic view, statistical analysis and frequency. These parameters play an important role where crash situations that occur most frequently are chosen from these statistics and are used as crash test parameters. However, the crash tests costs a huge amount of money implication that there are only some numbers of tests is realized annually per factory. Crash analysis helps the experts to investigate accidents as they needed data and simulations. Through the analysis, the obtained result will helps in creating or modifying the vehicles structure. The energy absorbed is the most important factors in the analysis, thus it needs more correct techniques in new modeling and calculating methods. The same goes to other energy absorption devices. As it used widely for road user safety system or even at construction site, these devices are tested many times before they are qualified.

This project investigated the crash energy absorption in the study of cylindrical tube under axial, lateral loading and multilayer cylindrical tube under lateral loading quasi statically to determine the important parameters by performing compression test.

1.2 Objectives

In this project, energy absorption, lateral or side impact in a crash will be studied theoretically. Other than that are to determine the material properties and the behaviors collapsed and energy absorbed by cylindrical tube.

1.3 Scope

This study will cover the crashworthiness in vehicle's crash and the energy absorption during the crash, besides laterally and axially loaded on cylindrical tube. Hardness test is performed and continued by compression test. Then, the results from both testing are discussed. The proposal for this project can be referred in Appendix A.

1.4 Chapter outline

This study covered the study of cylindrical tube that is loaded laterally and axially. First chapter will explain briefly about the background and the objectives of this study. Then second chapter, will cover about crashworthiness, energy absorption system and previous studies about crushing on cylindrical tube. After that, methods and procedure that used in this study will be explained on the third chapter. The next chapter will be the results and discussion after getting the output .Lastly, the final chapter will conclude about this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Energy and momentum in car crashes

What happens in a crash? When a car traveling at 89 km/h hits a solid object, the following occurs**:** At 0.1 second, front bumper and grill collapse. At 0.2 second, the hood crumples rises and strikes the windshield. Spinning rear wheels lift from the ground. Fenders begin to wrap themselves around the solid objects. Instinct causes the driver to stiffen his legs against the impending crash. They snap at the knee joint. Although the car's frame has been halted, the rest of the car is still going at 89.km/h. At 0.3 second, the steering wheel starts to disintegrate and the steering column aims for the driver's chest. At 0.4 second, two feet of the car's front is wrecked, the rear is still moving at 57 km/h. The driver's body is still traveling at 57 km/h. At 0.5 second, driver is impaled on the steering column. The blood rushes into his lungs. At 0.6 second, the driver's feet are ripped out of tightly-laced shoes. The brake pedal snaps off. The car frame buckles in the middle. The driver's head smashes into the windshield. The rear wheels, still spinning, fall back to the ground. At 0.7 second, hinges rip loose, doors fly open, and the seats break free striking the driver from behind. At 0.8 second, the seat striking the driver does not bother him because he is already dead. 0.9 Second to 1.0 second, the last 3 tenths of a second mean nothing to the driver. [1]

2.2 Crashworthiness

Crashworthiness is defined as capability of motor vehicle structure to provide adequate protection to its occupant from injury and to its cargo from damage in the event of crash. [2] Compatibility is the important key to be considered if the best possible safety for cars of different size and weight is to be achieved, especially for the design of low mass vehicles (LMV) without excessive reduction of safety level compared to heavier cars. LMV's could contribute to reduce fuel consumption in traffic, provided that they are able to offer a level of safety comparable to larger cars.

Compatibility in frontal collisions calls for significantly different deceleration-time curves in rigid barrier impacts for cars with different weight. Cars designed according to compatibility criteria can change future accident and injury statistics in a way that injury severity in LMV's can be reduced significantly. This lack of compatibility is considered to be the main reason for the unfavorable appearance of small vehicles in accident statistics. The reasons for the higher injury risk for occupants of small vehicles can be found in the low mass, which results in a higher total change of velocity in car to car collisions, and in comparison to heavier cars, in a usually lower stiffness of the crush zone and the cabin structure. [3]

Crashworthiness is divided into two types which are external crashworthiness and internal crashworthiness. The external crashworthiness is the first impact during the collisions. While the internal crashworthiness is the second impact such as occupant strikes. [4] The condition during the collision between two vehicles is shown in Figure 2.1.

Figure 2.1 The collisions opponent.

It is important to understand the basics of vehicle crash management. The basic idea is to design vehicle structures which minimize the amount of injury-causing crash energy that reaches the occupants. Generally, this can be accomplished by developing structural zones that absorb crash energy outside the passenger compartment which called "crush zones" and they collapse in a prescribed way at specified loads, thereby providing the appropriate energy absorption and deceleration of the passenger compartment. Meanwhile, passengers are protected inside the passenger compartment by restraint systems such as seat belts and air bags. There has been lot of research and development has been carried out over the years to design and integrate these systems. In the case of the crush zones, the energy is absorbed by the folding and bending deformation of the metal structure.

To the strongest extent, automotive engineers attempt to maximize the transmission of crash energy through the structure axially so that the structure folds like an accordion as it absorbs the crash energy. This design is rational because frontal impacts are the most frequent vehicle crashes and cause the most injuries and fatalities. In vehicle crashes, most of the crash energy is absorbed through the in and out folding of the side plates of the main energy absorbing structural beams during the collapse process. The longitudinal beams at the front end of a vehicle generally act as the main structural members for absorbing crash energy in a frontal impact, and the crushable length of these components defines the distance over which the crash energy can be absorbed. Bumper to frame rail attachments are designed to transfer the impact force directly to the lower front rails. The upper rails also need to be part of the load path to absorb some of the impact energy, and to transfer some of the force of the crash in order to minimize vehicle bending moment. The design objective for rails is to balance the load path into the passenger cell of the body structure so as to distribute the loads between the roof and the floor. The structure between the rails and the rockers also must be strong enough to resist plastic deflection into the passenger space. To allow proper functioning of the passenger restraint system, the bending moment on the passenger compartment must be limited to avoid collapse of the roof structure and floor bending. Other than axial collapse resulting from front and rear end crashes, bending collapse is the other common mode of energy absorption in automotive structural components. A-pillars, windshield headers and roof side rails are typical structural members where combined forces cause bending mode collapse. Such collapse is typically caused either by buckling of the compressed surface or by cracking and tearing of the surface under tensile stress. Buckling is the preferred mode of collapse because it results in a more stable and predictable energy absorption. [5]

2.3 Energy absorption

In term of vehicles, during the frontal crash, the longerons absorb most energy of all vehicles construction elements as shown in Figure 2.2 by load paths on car body elements during frontal impact. In order to assess the crashworthiness of longerons, the crash analysis is performed.

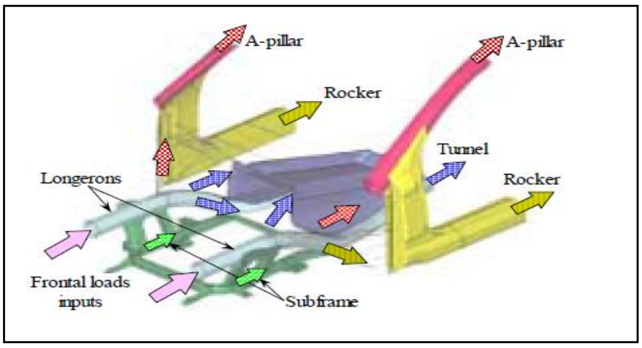

Figure 2.2 Load paths on car body elements during frontal impact