COMPUTER SIMULATION ON CIRCULAR RING TO LATERAL COMPRESSION, QUASI-STATIC LOADING

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'I/we* acknowledge that have read this work

and in my/our* opinion this work is adequate in terms of scope

and quality for the award of degree mechanical engineering (Structure and Material)

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"I admit that this report is the result of my own work except summary and citation of every source I have explained"

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For beloved father and mother

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ABSTRACT

Finite Element method was used to simulate the energy absorption for the circular ring in lateral compression. The simulation is base on the quasi-static lateral compression. The computer simulation was performed by Abaqus. The comparisons of experimental result and simulation results were done to verify the simulation result. The percentage error of energy absorbs between simulation and experimental result is around 21.58%. This is because the assumption in modeling (wire part) is the main source of error. However, it is found that the corresponding circular ring behaviors when under lateral compression ring experiment are very similar to the theory. The thickness was neglected in computer simulation result the locking displacement of the compression was occurred early if compare to experimental locking displacement. Aluminium material has lower energy absorbstion capacity if compare with mild steel. This is because the mild steel has higher Young's modulus. This report was done and fulfills the title given in my Final Year Project.

ABSTRAK

Kaedah unsur terhingga digunakan untuk mensimulasikan penyerapan tenaga untuk cincin melingkar di mampatan lateral. Simulasi berasaskan pada suatu mampatan lateral Kuasi-statik. Dengan simulasi komputer akan tampil oleh ABAQUS. Perbandingan keputusan eksperimen dan hasil simulasi dilakukan untuk mengesahkan keputusan simulasi. Ini adalah salah satu kaedah kalibrasi. Kesalahan peratusan menyerap tenaga antara simulasi dan keputusan eksperimen adalah sekitar 21,58%. Hal ini kerana andaian dalam pemodelan (bahagian kawat) adalah sumber utama dari kesalahan berasal. Namun, dijumpai bahawa perilaku berkaitan cincin melingkar ketika berada di bawah percubaan cincin mampatan lateral sangat dekat dengan teori. ketebalan ini mengabaikan dalam hasil simulasi komputer perpindahan kunci mampatan itu terjadi awal bila dibandingkan dengan perpindahan kunci eksperimental. bahan Aluminium telah menyerap tenaga yang lebih rendah jika dibandingkan dengan baja ringan. Hal ini kerana baja ringan mempunyai modulus Young yang lebih tinggi. Laporan ini dilakukan dan memenuhi tajuk yang diberikan dalam Projek Saujana Muda (PSM) saya.

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A	=	Area
a	=	Acceleration
D	=	Operator Matrix
E	=	Constitutive Matrix
H	=	Hinge
L	=	Length of circular ring
M	=	Mass
P	=	Load
T	=	Time
u	=	Displacement
v	=	element nodal displacement
W	=	Work
ε	=	Strain
σ	=	Stress

LIST OF APPENDIX 1 (Figure)

CHAPTER 1

Introduction

1.1 Background of Project

According to the law of conservation of energy, the total amount of energy in an isolated system remains constant. The energy cannot be created or destroyed. Energy can exits in many types such as potential energy, kinetic energy, heat energy, sound energy etc. However, energy can be transfered to another type of energy. When a car was crush, the kinetic energy on the car will transfer to the object and deformation on the car happened. We cannot destroy the kinetic energy; as a result, the impact occurred would damage the car and bring an injured to the driver and passengers.

Therefore, energy absorber is very important device, which can absorb the energy, longer the collision time and will reduce the impact force. The energy absorber's shape and structure will affect the quality and performance of the absorber while colliding occurred.

There are many type of structures among the energy absorber device. Besides, the material properties are one of the most important criteria. In this project, the specimen is used circular mild steel ring for the experiment.

1.2 Objectives

The project main objective is about the study the comparison between experimental energy absorbs with the computer simulation. The computer simulation performed by using Abaqus.

Another objective is study the deformation mode when lateral quasi-static load apply on the mild steel circular ring. Compare those experimental work with computer simulation.

1.3 Scope

The project scope is compare between computer simulation result and experimental result. The project flow was shown as below:

1. Introduction to the project.
2. Understand the theory of impact energy and energy absorber.
3. Preparation of experiment material.
4. Draw experiment specimen (circular ring).
5. Conduct experiment.
6. Simulation on the deformation of same structure circular ring with experiment.
7. Compare the experiment result with the computer simulation.

1.4 Problem Statement

This project was research about the ability and capacity of energy absorbs can be carry by a mild steel circular ring. This research is important because this study is the first step to discover and understand the mild steel circular ring behaviour when lateral force applied on it. Mild steel is widely use in automobile industry nowadays. Therefore, that is the reason why mild steel is chosen for this experiment and simulation's material.

This project had received attention and recently can be developed by using the computer simulation. The result of this experiment and computer simulation can be used in advance research and development.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter, we will discuss the literature study which related to the energy absorber. The efficiency of energy absorber device depends on the material used and structure of the device. Below is the list of the subject which will be discussed in the following section:

1. Lateral Compression of Tubes
2. Impact Energy Absorbers
3. On Obtaining Material Properties from the Ring Compression Test

2.2 Lateral Compression of Tubes

Nowadays, the need and importance of impact energy absorbing devices has clearly established.

Works from Yella Reddy and Reid[2], a device of energy absorbing components most often loaded either axially or diametrally. When the device was absorbing energy, deformation on the device will occur. There are many different deformation mechanisms when axial compression applies on it, such as axisymmetric buckling, asymmetric buckling, inversion or fracture. One of the important conditions to make sure the system is under axially compressed tube is the load is inclined at an angle less than about 15° to the axis of the tube itself.

For a lateral compression, the load-deformation characteristic is smooth with a curve line. Besides, the devices with laterally loaded tubes are easier to build than most other devices and their efficiency not affected by the direction of load applied. Operating load of laterally compressed tubes is far lower than those of axially compressed tubes. Meaning to say that a quasi-static compression applies to a same dimension of a specimen, laterally compression load is lower than axially compression load. Orthogonal layers of tubes in which adjacent tubes in the same layer do not interfere with each other during deformation. The energy absorbing capacities of laterally compressed tubes can be increase by encouraging the tubes to deform in alternative modes, which involve hinges that are more plastic.

During the compression, if the friction between the side plates and the tube is present the bottom half of the tube is subject to smaller forces (less by an amount equal to the magnitude of the friction force) than the top half of the tube and hence undergoes lesser, but similar deformation.

The material of tube is assumed that rigid-perfectly plastic and any interactions between bending and normal or shear stress resultants are neglected.

2.3 Impact Energy Absorbers

Every impact energy absorbers are expendable mechanical structural elements, which are brought into action in the event of an unwanted collision. The energy absorbers act like the mechanical fuses to limit the loads that may act on the main structure immediately after a collision.

The results of impact and collisions are loss of limb, life and property. Besides, another effect is undesirable short and long-term effects on environment. If every single accident occurred and the passenger and driver are die.

There are two type of methods of avoiding unwanted collisions are termed as Active Safety measure and Passive Safety measure. Those are implemented towards minimizing the effects of unavoidable collisions are called Passive Safety measures. The way to achieve the quality of active safety is good design and not just of engineering structures design. On the other hand, Passive safety aims at designing structures, which are crashworthy and provide additional safety devices so that catastrophes are prevented in the event of such a collision. That are some requirements for passive safety devices such as dissipate all the kinetic energy of impact and limit loads and deceleration on the structure and occupants.

Energy absorbers device can also serve as secondary purpose as structural components. When the passive safety device is attached to a rigid barrier, the mass of the energy absorbers is not a critical design parameter. On the contrary, if the energy Absorbers are to be fitted onto the moving structure, it is safeguarding, so the mass of energy absorbers must increase the total mass of the moving structure and hence the kinetic energy to be absorbed. Beside, the energy absorbers need to decrease the apply load and hence the overall efficiency and hence it is very important to make the energy absorbers as light as possible.

The velocities of impact also range over several orders of magnitude. In our project, we are going to analysis quasi-static compression energy absorber. Strain-rate effects defined as effects of higher rate of loading changes the mechanical properties of the material. If the velocities over 10^4 m/s local melting and vaporization of the material at the impact site becomes a possibility.