THE OBLIQUE IMPACT ON CRASH BARRIER

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A project report submitted in partial
fulfillment of the requirements for the award of
the Degree of Bachelor Mechanical Engineering (Design & Innovation)

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Mei 2008

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"I hereby declared that I have read this thesis an in my opinion this thesis is sufficient in terms of scope and qualify for the award of the Degree of Bachelor Mechanical Engineering (Design & Innovation)"

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"I hereby declared that this is my own work except the ideas and summaries which I have clarified their sources"

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Special dedicate to my family, supervisor, my friends, and all that help me to finish my thesis.

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ACKNOWLEDGEMENT

The most important person who has big impact and great contribution to my research is Assoc. Prof. Dr. Mohd Radzai bin Said who is my project supervisor. He has helped and guided me to complete this research successfully. Under his supervision, I have gained a lot of experience and knowledge about this project's research.

I also thankful to PESB. Sdn. Bhd. especially Mr.Steven Ng for his guidance on guardrail information and its' standard. He also provided specimen of the guardrail.

Meanwhile, Mr. Ooi Pey Hann (Motorola Engineer) and Mr.Amzatul Akman bin Mokhtar (Pursing Master in UTeM) have give an idea and suggestion on completing the simulation.

I also like to express my gratitude to UTeM lecturers especially Mr.Lee Yuk Choi, Mr. Mohd. Zaid bin Akop, Mr. Nor Azmmi bin Marispan and Mr.Faiz bin Redza for helping me on giving opinion and suggestion for this research.

The UTeM technicians also have been a great guidance in allowing me to use the laboratory for the simulation process.

Last but not least, I am grateful to my family and friends. They have been a great moral support and dedication to continue my research and complete it with great success.

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ABSTRACT

Guardrail is typically designed to guide and restrain errant vehicles, ranging from small cars to heavy goods vehicles. The main objective of this thesis is to investigate the impact energy absorption of a guardrail due to impact with a vehicle in the various angles. The various angles of oblique loading are test with 20˚, 45˚, 75˚ and 90˚. The model of the guardrail will be built with Solidworks 2007 and the finite element model will be used to simulate the impact of guardrail with ABAQUS software. The ABAQUS software will produce some important output data for this research such as reaction force, type of energy and deformation. These data will be used to gain the energy absorb after the impact to the guardrail. The energy absorb can be obtained from two methods. Deduction between the total energy and kinetic energy will be the first method to obtain the energy absorb. The next method is the result of area under curve for reaction force versus deformation graph and the NCSS software will be used to obtain the result.

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ABSTRAK

Penghadang biasanya direka untuk memandu serta mengekang kenderaan yang telah menyimpang, antaranya adalah kenderaan kecil hingga kenderaan berat. Objektif utama tesis ini adalah untuk menyelidik impak serapan tenaga oleh guardrail ke atas impak dengan kenderaan dari berbagai sudut. Berbagai sudut bebanan oblik diuji dengan 20˚, 45˚, 75˚ dan 90˚. Model penghadang akan dibina menggunakan perisian solidworks 2007 dan model unsur terhingga yang digunakan untuk membuat simulasi impak terhadap penghadang adalah menggunakan perisian ABAQUS. Perisian ABAQUS menyumbang data-data penting untuk pembelajaran ini seperti daya tindakbalas, jenis tenaga dan perubahan bentuk. Data-data ini akan digunakan untuk mendapatkan penyerapan tenaga selepas impak pada penghadang jalanraya. Penyerapan tenaga ini boleh dihasilkan melalui dua kaedah. Perbezaan antara jumlah tenaga dan tenaga kinetic merupakan kaedah pertama untuk mendapatkan penyerapan tenaga. Kaedah kedua pula ialah dengan mendapatkan luas di bawah graf daya tindakbalas melawan pesongan rasuk dan perisian NCSS akan digunakan untuk mengeluarkan hasil kajian ini.

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LIST OF ABBEREVIATIONS

AASHTO	American Association of Stata Highway and Transportation Officials
AISI	American Iron and Steel Institute
ASTM	American Society Testing and Material
FEA	Finite Element Analysis
FEM	Finite Element Methods
IEA	Impact Energy Absorption
JKR	Jabatan Keselamatan Jalan Raya
PDRM	Polis Diraja Malaysia
PESB	Prestar Engineering Sdn. Bhd.

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CHAPTER 1

INTRODUCTION

In Malaysia, the number of road accident cases increase year by year. According to Polis Diraja Malaysia (PDRM), the road number of accidents has increased from 144801cases in 1994 to 341232 cases in 2006. (Refer Appendix 1)

Accidents occur because of reckless driving, alcohol consumption and driving factor. As a step to prevent these accidents, Jabatan Keselamatan Jalan Raya (JKR) has organized road safety campaigns and advertisements.

The safety level is also important for road users and that is one of the ways to decrease road accidents. It is often necessary to install devices intended to restrain vehicles and pedestrians from entering dangerous areas in order to maintain and improve road safety.

1.1 Terminology

Guardrail is a device which is designed according to the European 1317 standard providing certain levels of vehicle containment; properly redirect errant vehicles back on the road and provide guidance for pedestrians and other road users.

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Figure 1.1 Guardrail system

Figure 1.1 shows one of the barrier systems installed in our country and this type of barrier has been used to study the Impact Energy Absorption (IEA).

Impact Energy Absorption (IEA) is a conversion of mechanical or radiant energy into the internal potential energy or heat energy of system. Figure 1.2 represents the characteristic of the IEA.

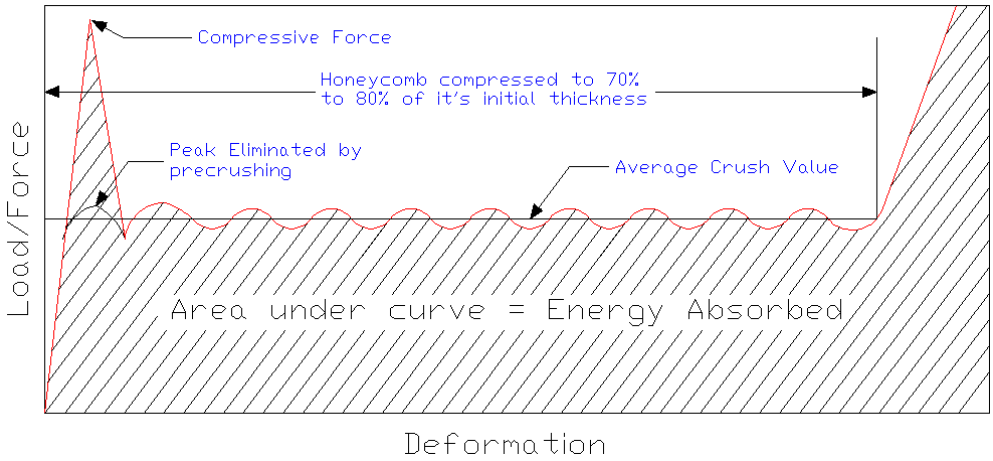

Figure 1.2 Crush force versus

ABAQUS is a suite of powerful engineering simulation programs, based on finite element method that can solve problems ranging from relatively simple linear analysis to the most challenging nonlinear simulations.

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1.2 Problems and solution

Road users are aware that highways in Malaysia are fitted with the safety barriers to prevent accidents. Unfortunately, serious injuries and fatalities still occur. Therefore, to provide appropriate safety levels for impact vehicles occupants, the safety barriers should be designed to absorb as much impact energy as possible through its deformation and at the same time maintain its integrity. Meanwhile, the part of the impact of energy absorption of the current safety barriers will be discussed in this paper.

Meanwhile, behavior of the safety barrier under test vehicle impact conditions was simulated by using the ABAQUS. In addition to that, the comparison between the experimental results about the impact of safety barrier which was done by other researchers and the simulation will be included.

1.3 Objective of research

In this research, there are five main objectives. These are to:

1. Study IEA in various angle of oblique loading by using ABAQUS.
2. Study deformation in various angles of oblique loading by using ABAQUS.
3. Compare kinetic energy between theoretical and computational.
4. Compare the result from the various angles.
5. Compare the IEA result between ABAQUS and NCSS.

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1.4 Scope of research

Three main scopes are covered in this research. These are:

1. W beam guardrail is used to study IEA
2. Various angles are covered like 20°, 45°, 75° and 90° in this research.
3. A vehicle which using to impact in computational assume as rigid part.

1.5 Research plan

This thesis is divided into six chapters which the introduction of the thesis will be covered in chapter 1. Besides that, the terms like terminology, problem of research, objective and scope are also described. Consequently in chapter 2, the literature reviews of previous work about impact in the guardrail and its standards is quoted. Meanwhile, the theory of finite element analysis and the overview of the ABAQUS will be covered in chapter 3.

Chapter 4 will be explained about the methodology and calculation which applied in this research. On the other hand, the result and discussion about the computational work will be discussed in the chapter 5. Lastly, the findings and the recommendation will be concluded in the chapter 6.

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CHAPTER 2

LITERATURE REVIEW

Literature review has been done to gain some ideas before conducting this project. In this chapter the previous works done by other researchers are discussed. Technical papers regarding highway guardrail (AASHTO Designation M180-89) is being referred. Furthermore, the guardrail design drawing is reviewed. Finally the overview of EN 1317 and the overall computational model development, the full scale crash test are described.

2.1 AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO is a leading source of technical information on design, construction and maintenance of highways and other transportation facilities, including aviation, highways, public transit, rail, and water. This specification covers corrugated sheet steel prepared for usage as beams in highway guardrails. The technical information about the material of the properties, dimensions and others can refer at Appendix 2.

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2.2 The guardrails

In Malaysia, there are several types of guardrails available, which perform differently on impact. They can either be flexible, such as a steel wire rope, or a steel beam such as concrete barriers. Table below 2.1 shows the details about the types of the safety barriers accepted by the VicRoads (the registered business name of the Roads Corporation which at Australia). The purpose is to deliver social, economic and environmental benefits to communities throughout Victoria by managing the Victorian arterial road network and its use as an integral part of the overall transport system. The functions and objects of the Corporation are outlined in the *Transport Act 1983*, *Road Safety Act 1986* and the *Road Management Act 2004*.

Table 2.1 Type of guardrails

(Sources: VicRoads, 2007)

Product Name	Illustration	Description
Flexible Longitudinal Guardrail System		
Brifen Wire Rope Safety barrier		- Flexible barrier system with 4 wire ropes supported on steel posts with variable spacing.
Semi-rigid Longitudinal Guardrail Systems		
Guard fence (W-beam)		- Semi rigid barrier system -

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