LECTURER DECLARATION

"I declare that I have already read this thesis entitle "W-shape Beam Subject to Quasi-static Loading" and the point of my view that this report is quality for its scope and quality to fulfill the award for Bachelor Degree of Mechanical Engineering (Structure & Material)."

Signature : ………………………………….

Name of Supervisor : ………………………………….

Date : ………………………………….

W-SHAPE BEAM SUBJECT TO QUASI-STATIC LOADING

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This Thesis is Submitted to Faculty of Mechanical Engineering as Partial Fulfillment of Requirement for the Award of the Bachelor Degree of Mechanical Engineering (Structure & Material)

Faculty of Mechanical Engineering

Universiti Teknikal Malaysia Melaka

MAY 2010

STUDENT DECLARATION

"I hereby declare that this thesis entitle "W-shape Beam Subject to Quasi-static Loading" is my own work and results except for the work that had clearly stated the sources."

Signature : ………………………………….

Name : Mohd Fariq Bin Mohamad

Date : ………………………………….

To my dearest parents and friends.

ACKNOWLEDGEMENT

All praises to Allah S.W.T, the most merciful and gracious, and my peace and blessings of Allah be upon his messenger, Muhammad S.A.W. First of all, I would like to express my gratitude to his greatness, with whose indulgence has given me strength and convenience to complete this report successfully.

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ABSTRACT

This project is entitle ‘W-shape Beam Subject to Quasi-static Loading’. Nowadays, most people used main road and expressway for commuting transport. Roadside safety is important to reduce the number of fatalities and serious injuries resulting from run-off-road crashes. W-beam barrier may be the most widely used type of roadside safety hardware. Various methods used to test and improve the efficiency of this hardware. In this project, W-shape barrier material properties and behaviors were obtained by performing the tensile and Rockwell hardness tests. Then, W-shape barrier with 50 mm width was applied with various rate of compression, ranging from 5 mm/min to 30 mm/min to observe the deforming mode. The deforming mode was captured by digital and video cameras. The energy absorbed was calculated by measuring the area under the load-displacement curve obtained from Instron Universal Testing Machine. The W-shape beam absorbed approximately 250 J of energy in 69 mm of permanent deformation.

ABSTRAK

Projek ini bertajuk ‘Beban Statik yang dikenakan terhadap Rasuk Berbentuk W’. Pada masa kini, kebanyakan orang menggunakan jalan raya dan lebuh raya untuk berulang alik pengangkutan. Keselamatan tepi jalan adalah penting untuk mengurangkan jumlah kematian dan kecederaan parah diakibatkan oleh kemalangan yang melibatkan kenderaan terbabas. Perintang berbentuk W merupakan jenis perintang yang paling banyak digunakan untuk keselamatan tepi jalan.Pelbagai kaedah digunakan bagi menguji dan meningkatkan kecekapan perkakasan ini. Dalam projek ini, ciri-ciri bahan perintang berbentuk W diperolehi dengan menjalankan ujian tegangan dan ujian kekerasan Rockwell. Kemudian, perintang berbentuk W dengan lebar 50 mm diaplikasikan dengan kelajuan mampatan yang berbeza, meliputi 5 mm/min hingga 30 mm / min untuk membuat pemerhatian mod kecacatan. Mod kecacatan perkakasan ini dirakam menggunakan kamera digital dan perakam video. Tenaga serapan diperolehi dengan kaedah mengira luas bawah graf beban-sesaran yang diperolehi daripada Mesin Ujian Universal Instron. Tenaga yang diserap oleh peralatan ini dianggarkan sebanyak 250 J pada 69 mm kecacatan kekal.

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CHAPTER 1

INTRODUCTION

1.1 Background of the study

One of the major problems in road transportation is to assure adequate safety level for road users. To maintain and improve road safety, it is often necessary to install certain devices that are intended to restrain vehicles and pedestrians from entering dangerous areas. The road safety barriers that are designed according to the European EN 1317 standard provide certain levels of vehicle containment; properly redirect errant vehicles back on the road and provide guidance for pedestrians and other road users. To provide appropriate safety levels for impacting vehicle occupants, the safety barriers should be designed so as to absorb as much impact energy as possible through their deformation and at the same time maintain their integrity.

1.2 Objective of Study

There are two main objectives of this study. One of the objectives of this study is to obtain the experimental data for W-shape beam. Furthermore, the objective of this study is to study the pattern of load-displacement curve from compression test.

1.3 Scope

This study is to observe the W-shape beam (crash barrier) subject to quasi-static loading. The specimen is cut from crash barrier, W-shape with 50mm width as available in laboratory. The total specimen is 11. The lateral loading is applied with various speed of compression, ranging from 5mm/min – 30mm/min. The deforming modes are captured by digital \and video cameras. The load-displacement is obtained from Instron Universal testing Machine will be compared for various rate of loading. The energy absorbed is calculated by measuring the area under the curve.

The material properties and behaviors are obtained by performing a tensile test as well as the hardness test. The tensile coupon specimen is cut from W shape according to standard.

1.4 Problem Statement

The crash barriers have to sustain impact of different vehicle types (from passenger cars to trucks) under different impact conditions regarding the vehicle velocity, impact angle and road conditions. In case of a lower-weight vehicle (passenger car) impact, the restraint system should possess the ability to deform, so that the kinetic energy of an impact is absorbed mostly by the barrier and vehicle deformation. This significantly reduces deceleration levels experienced by vehicle occupants and increases their safety. However, in a case of higher-weight vehicle (truck, bus) impact, the system should contain and redirect the vehicle back on the road without complete breakage of the principal longitudinal elements of the system. Thus, the crash barrier design is a compromise between its stiffness (deformability) and strength.

The crash barrier must be able to absorb the impact energy from vehicle in order to fulfill the roadside safety requirement. In this project, the specimen is preparing from the W-shape barrier. Three type of specimens needs to be preparing for three different experiments use in this study. There are three experiment needs to be done, tensile test, hardness test and quasi-static loading.

CHAPTER 2

LITERATURE REVIEW

2.1 Crash Barrier

Crash barrier is one of the impact energy absorption devices. Crash barriers are located in places where a vehicle may accidentally leave the carriageway and be subjected to considerable danger. These crash barriers can be in the form of safety fences. Road was designed and constructed to require guardrail. The location of posts, bridge piers, steep ditch slopes, or some other feature of the road creates a hazard to drivers who get off their lane.

The design of the road barrier is generally such that a vehicle hitting the barrier is steered back onto the road and absorbs the impact energy. This may be achieved by designing the supports so that they break off on impact, allowing the barrier to deform and push the vehicle back on track. In some cases cost cutting has led to a failure of this mechanism, with so-called "duck-nesting" (after the shallow nature of a duck nest) of barrier support bases. When this happens the supports tilt over at the base instead of breaking off, allowing the barrier to collapse and the vehicle to go over the barrier. Motorcycles are very vulnerable to crash barriers. Large vehicles with a high centre of gravity, such as sport utility vehicles, are also vulnerable to going over barriers on impact.

If the highway location is considered potentially very dangerous, a crash barrier safety fence may be required which will physically prevent vehicles from continuing in the undesirable direction.

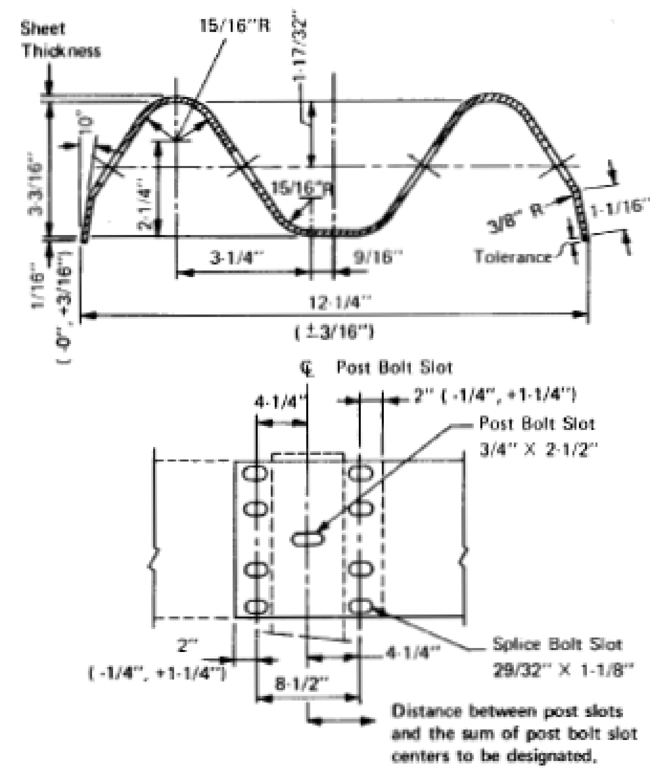
2.2 Crash Barrier Design

Ideally a crash barrier fence should present a continuous smooth face to an impacting vehicle, so that the vehicle is redirected, without overturning, to a course that is nearly parallel to the barrier face and with a lateral deceleration, which is tolerable to the motorist. The standard W-beam barrier design is shown in Figure 2.1.

To achieve these aims the vehicle must be redirected without rotation about both its horizontal or vertical axis (that is, without' spinning out' or overturning), and the rate of lateral deceleration must be such as to cause the minimum risk of injury to the passengers.

In practice the happenings at a barrier fence are so complicated that it has not yet been possible to devise a theoretical treatment which represents what actually does occur. As a result safety barrier research is usually carried out in full-scale road tests. The following discussion must therefore be regarded as a theoretical description based on a greatly simplified model of what occurs during an actual collision.

Barriers typically go through an experimental phase in which a barrier that has passed crash test evaluation is subjected to an in-service evaluation, and an operational phase in which a barrier that has proven acceptable in the in-service evaluation is used while its performance is further monitored. Barriers are also considered operational if they are used for extended periods and demonstrate satisfactory performance in construction, maintenance, and accident experience (Brockenbrough, 2009).



SPECIFICATIONS

Corrugated sheet steel beams shall conform to the current requirements of A.A.S.H.T.O. M180, Class A, Type 2.*

Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance, and accepted manufacturing practices.

INTENDED USE

This corrugated sheet steel beam is used as a rail element in standard barrier designs G2, G4, MB2, MB4, MB4B, and BCT.

Note: Typical designations are RE-3[2@6'-3"=12'-6"]-73 and RE-3[4@6'-3"=25'-0"]-73.

* If another class or type is required this should be indicated by a modified part number. For example, if corrosion resistant steel is required show thusly: RE-3[2@6'-3"=12'-6" Class A, Type 4]-73.

W BEAM

HM-TF-13 STANDARD

RE-3 [DESIGNATE POST SLOT CENTERS & SUM OF CENTERS] -73

Figure 2.1 : Standard W-beam Barrier Design

(Source: Dutta, (1998))

2.3 Types of Crash Barrier

The multitude of crash barriers available can be divided into three main types:

i. Rigid concrete barriers
ii. Temporary barrier system
iii. Steel beam barrier

Figure 2.2 shows different kinds of median barriers and guardrails. Barriers are tested and certified to perform to specific Federal criteria (a specific level of anti-ram protection). In selecting barriers, it is important that transit agency security engineers consider the capabilities of these systems to protect against the threats specific to the facility. The different design of crash barrier was used depend on the weight and speed of crashing vehicle upon impact. There is a wide range of weights and speeds based on anticipated threat and physical approach.

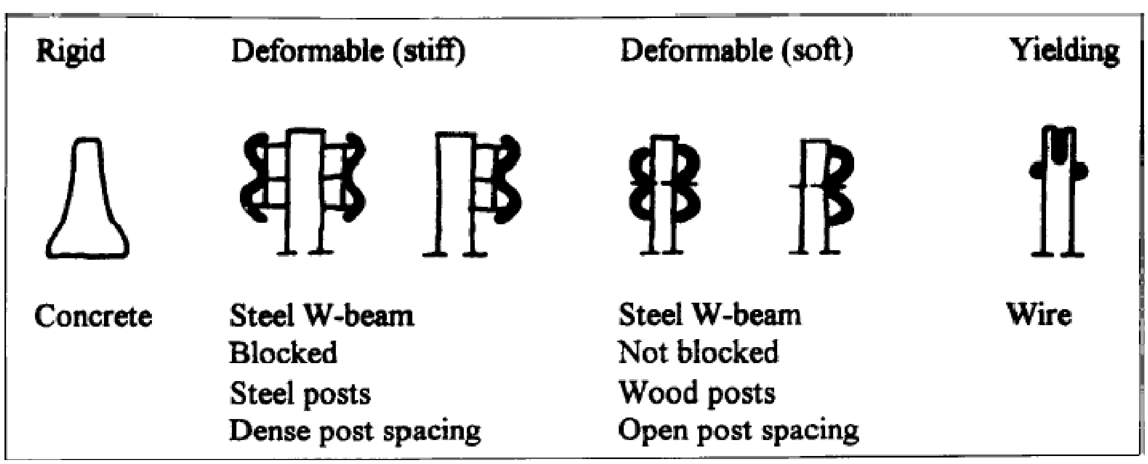


Figure 2.2: Types of guardrail according to rigidness

(Source: Elvik, (1994))

2.3.1 Rigid Concrete Barriers

Concrete barriers have been used for a considerable length of time, although now their usage is generally being phased-out on high-speed roads, primarily because the rigidity of the concrete results in peak deceleration rates which can result in (otherwise avoidable) fatalities. Figure 2.3 shows an example of concrete barrier.

Another disadvantage of concrete barrier is that even minor scrapes can result in extensive damage to the vehicle bodywork. Limited success has been achieved in introducing greater flexibility into concrete barriers by the incorporation of reinforcing steel. However, it also created a problem of how to repair the barrier after impact.

In general, concrete barriers are now being limited to low speed roads where the high risk associated with a vehicle crossing the central reservation outweighs the probable rise in the cost of damage-only accidents. They should never be used on high speed roads unless it is absolutely essential to prevent a vehicle encroaching, whatever the effect on the vehicle's occupants.

Figure 2.3: Concrete Barrier