UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND DEVELOPMENT OF YAMAHA Y15ZR FRAME SLIDER (CARBON STEEL)

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours. The member of the supervisory is as follow

…….

(Project Supervisor)

ABSTRAK

"Frame slider" juga dikenali sebagai pengawal engine dan kadang kala disebut sebagai bar pelanggaran berdasarkan "Glossary Expert" (2017). Bar ini dijadikan untuk menghalang motorsikal dari rosak dan meminimakan kebarangkalian untuk kecederaan ketika kemalangan. Pada hari ini, pengguna memandang bar ini sebagai aksesori yang membantu untuk mengurangkan kos berbanding dengan penukaran aksesori lain yang jauh lebih mahal sepeti set pelindung motorsikal. Masalah yang terdapat pada bar yang ada di pasaran ialah rekaannya yang sama diantara satu sama lain dan pengeluarannya yang terhad di pasaran dan tidak sejajar dengan pengeluaran motosikal Y15ZR. Projek ini dijalankan dengan mereka dan membangunkan bar penghalang untuk model Yamaha Y15ZR dengan menggunakan perisian lukisan berbantu computer (CAD) dan pembuatan berbantu computer (CAM). Selain itu, di dalam projek ini juga, prototaip yang siap dibina akan djalankan ujian tekanan dengan menggunakan Instron Model DX Static Hydraulic Universal Testing System. Walaupun mesin ini berupaya untuk menjalankan berbagai ujian seperti ujian ricih dan ujian tarikan, hanya ujian tekanan yang dijalankan kerana ianya adalah focus untuk kajian ini.

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ABSTRACT

Frame slider is also indicate as an Engine Guards but sometimes it is referred as Crash Bars “Glossary Expert” (2017). Frame slider was fabricated to prevent and minimize the possibility of any crash. Nowadays, user indicate that the frame may be the only thing standing in the way of an expensive repair job that could cost hundreds of dollars because of a simple fault during handling the motorcycle. Current design of moped bike (Y15ZR model) frame slider available in market are still limited because of expensive and adverse appearance but demand of frame slider keep increasing proportional to number of Y15zR model. This project conducted a design and development of a moped Y15ZR model frame slider via utilization of Computer-aided design (CAD) and Computer-aided-manufacturing (CAM) tools. In this project also, the frame slider will undergo a performance test by using Instron Model DX Static Hydraulic Universal Testing System. There are many types of test that can be conduct on by using this equipment such as tension, compression, bend flex and shear testing, this project focusing on compression test at the product

DEDICATION

For my beloved parents,

Norfadzlon Bin Mohd Noh

and

Habibah Binti Mohd Kassim

Thank you for always supporting and encouraging me.

For my beloved supervisor,

Mr.Mohd Faez Bin Zainol

Who guide me well in this research. Thank for your valuable advices and taught.

For my friends,

Thank you for your continuous support and cheer throughout completing this research

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TABLE OF CONTENT

LIST OF TABLES

TABLE OF FIGURE

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AISI	-	American Iron and Steel Institute
AMG	-	Automatic Mesh Generation
CAD	-	Computer-Aided Design
DF	-	Degree of Freedom
FEM	-	Finite Element Method
P	-	Probability
Rpm	-	Revolution per minute
STL	-	Stereo Lithography
HSS	-	High Speed Steel
°	-	Degree
%	-	Percent
°C	-	Degree Celsius
ε	-	Plastic strain
$\dot{\varepsilon}$	-	Plastic strain rate
$\dot{\varepsilon_0}$	-	Reference strain rate
σ	-	Stress
A	-	Yield stress
B	-	Hardening modulus
C	-	Strain rate sensitivity coefficient
e	-	Power of ten
GPa	-	GigaPascal
g	-	Gram
g/cm^3	-	Gram per centimeter cube

J/kgK	-	Joule per kilogram Kelvin
J/m^2	-	Joule per meter square
kg/m^3	-	Kilogram per meter cube
$MN/m^{3/2}$	-	Mega Newton per meter power of three over two
MPa	-	MegaPascal
mm	-	Millimeter
mm/min	-	Millimeter per minute
mm/rev	-	Millimeter per revolution
m^2/s	-	Meter square per second
N	-	Newton
N/s/mm/°C	-	Newton per second per millimeter per degree Celcius
n	-	Strain hardening exponent
W/mK	-	Watt per meter Kelvin
rev/min	-	Revolution per minute
s	-	Second
T_{melt}	-	Melting temperature
T_{room}	-	Room temperature

CHAPTER 1
INTRODUCTION

1.0 Introduction

This chapter contains the background, problem statement, objective and scope of research. Background of frame slider and motorcycle will briefly describe in the background section. Problem encountered before the study, objective and scope of the study will stated in this chapter.

1.1 Background

Frame sliders purpose is to protect the bike in the event of a crash. Specifically, it will be an important part during in the event of a low side type crash, when the motorcyclists lose traction and the motorcycle slides out from the rider and down the road. While the motorcycle is travelling on its side, frame sliders will prevent or minimize any damage that might occur to the frame, other hard parts, and bodywork. There is obviously a greater possibility for damage at higher speeds, but many find frame sliders to be life-savers at low speeds or accidental tip-over. Next it also use to stretch out the time it takes for the collision to fully happen, spreading out the force of the impact by letting the bike coast, or slide, to a more natural stop. This lowers not just the force of the impact, but, it shows how the frame slider helps to minimize the effect of collision, it also lowers the amount of total force on the bike absorbs in several ways. First, the features of frame slider that consist a slider puck which is design to break off

the impact on the flat side of the bike, the engine block, or any other part on the fairing such as the signal lamp from touches the ground, it shows that the puck is important features of the frame slider. Second, a frame slider absorbs a lot of the shock of the collision and then distributes the force more evenly throughout the frame, in the same way that slapping a window is a lot less dangerous than punching it.

Figure 1.1: Frame slider.

Since 1950s, there is only on type of motorcycle available. This all-purpose type of machine was designed for street use and was modified for more specialized applications. As motorcycles became more popular, new configurations were created to address certain interests and needs. Initially, special models were designed for off-highway riding. However, the range and variety of models has grown as manufacturers identified and addressed new market niches. By the 1980s, several distinct types of street-legal motorcycles had emerged. The characteristics and capabilities of current street motorcycles vary with their style. Different categories have different strengths and weaknesses, which may be helpful to recognize. This study focused on the development of frame slider for moped bike, nowadays, mopeds bike have been trend among the manufacturer and distributer in Malaysia. The established manufacture company have released their own moped bike, for example Honda Rs150R and Yamaha 15zr. This trend occur due its suitability to be used on normal street and highway. Other than that the design is attractive and the price is reasonable. Next the feature that is

styled and constructed in the manner of road-racing motorcycles with streamlined bodywork, the emphasis is on handling, acceleration, top speed, braking, and cornering prowess also attract the interest of motorcyclist. Performance handling and braking systems are the rule on the bike, which tend to be lighter and more technologically advanced than other types of motorcycles.

Figure 1.2: Yamaha Y15ZR

Figure 1.3: Honda RS150

1.2 Problem Statement

Current design of moped bike (Y15ZR mode) frame slider available in market are still limited because of expensive and adverse appearance but demand of frame slider keep increasing proportional to number of Y15zR model. Next, frame slider come in several design, the most common is cylindrical design with varying of lengths. Other frame sliders may have an irregular shape that doesn't protrude too far from the mounting point. Then based on what is offered on market, the price is expensive and the offering product does not come with performance testing data. Next, due to increasing demand Y15ZR in market, it create opportunity for accessories manufactures to provide more quality product and less expensive to customer, one of the accessories is frame slider which always apply to superbike model.

1.3 Objective

The objective of this project is:

1. To design and develop a moped Y15ZR model frame slider via utilization of Computer-aided design (CAD) and Computer-aided-manufacturing (CAM) tools.
2. To analyze the structure , stress, and displacement of the design via utilization of Solidworks
3. To fabricate the product and undergo the actual performance testing for commercialize

1.4 Scope

This project focuses on the design and development of a Yamaha Y15ZR frame slider using (CAD) and (CAM) tools. The design process for the frame slider is carried out by utilization of Solidworks software. The design gain from the (CAD) tool will be fabricate by utilization of CNC machine and conventional lathe machine. The material use to fabricate the frame slider is carbon steel. The structure, stress, and displacement analyze is carried out by using Solidworks software. Besides that, during the testing process, Hydraulic Universal Testing System is utilize to undergo a compression test. Moreover, this project focusing on producing a best design with a better quality and higher aesthetic value

1.5 Expected Result

The main focus of this project is able to produce a frame slider with a high durability that can withstand superior sliding and be able to absorb shock in the event of crash. The frame slider produce must have a high aesthetic value to fulfill the customer satisfaction in modifying a bike.

CHAPTER 2
LITERATURE REVIEW

1.0 Introduction

Previous chapter explained about the problems related to the current design of frame slider. The main purpose of this chapter is to review all literature related to the study and current progress in design and development of Yamaha Y15ZR frame slider. There are frame slider, fabrication mechanism, material properties, design and development, and motorcycle safety system, and compression test will be discussed in this section

2.1 Frame Slider

Frame slider is also indicate as an Engine Guards but sometimes it is referred as Crash Bars “Glossary Expert” (2017). Frame slider was fabricated to prevent and minimize the possibility of any crash.. Some models hide the protectors behind plastic covers. Look for extended areas on the bike where the guards may be hiding. Nowadays, user indicate that the frame may be the only thing standing in the way of an expensive repair job that could cost hundreds of dollars because of a simple fault during handling the motorcycle

According to Jacob (2011) frame slider is used to stretch out the time it takes for the collision to fully happen, spreading out the force of the impact by letting the bike coast, or slide, to a more natural stop. This lowers not just the force of the impact, but, it shows how the frame slider help to minimize the effect of collision, it also lowers the

amount of total force on the bike absorbs in several ways. First, the features of frame slider that consist a slider puck which is design to break off the impact on the flat side of the bike, the engine block, or any other part on the fairing such as the signal lamp from touches the ground, it shows that the puck is important features of the frame slider. Second, a frame slider absorbs a lot of the shock of the collision and then distributes the force more evenly throughout the frame, in the same way that slapping a window is a lot less dangerous than punching it.

Lemmy (2001) pointed out in his article that the concept of fabrication a frame sliders is to disperse the impact from a crash across the frame and through the engine, which is usually a more rigid structure than the bike's frame. It should be noted that the bike itself would probably slide best in most crashes without any type of a slider so that the frame slider was design to reduce the shock impulse during the sliding. The design of frame slider that protrudes from the motorcycle body was to elevate the bike just enough to keep crucial parts from being ground away when sliding on the road.

Although the feature of frame slider had been widely known as an accessories and many company had come out with many ideas to be the distributor, the main function of frame sliders is still to protect the motorcycle's frame in the event of a crash, not its bodywork. This reasoning is based in the fact that it takes very little frame damage to total a motorcycle. The material of frame slider which is made up from alloy show that it cannot be heated or beaten during the repair process, the only applicable option in some cases is simply to replace the entire piece. The matter of costs associated with frame replacement is a best alternative compare to change the motorcycle frame which is cost a higher expenses (Tim Kreitz, 2006).

2.2 Material for Frame Slider

2.2.1 Alloy Steel

Current frame slider is made up from an alloy steel, it is designated by AISI four-digit numbers. They comprise different kinds of steels having composition exceeding the limitations of B, C, Mn, Mo, Ni, Si, Cr, and Va set for carbon steels.AISI 4140 alloy steel is chromium, molybdenum, manganese containing low alloy steel. It has high fatigue strength, abrasion and impact resistance, toughness, and torsional strength. The following datasheet gives an overview of AISI 4140 alloy steel. The following table 2.1 shows the chemical composition of AISI 4140 alloy steel .

Table 2.1: Chemical composition of AISI 4140 alloy steel (AZoM, 2012)

Element	Content (%)
Chromium, Cr	0.80-1.10
Manganese, Mn	0.75-1.0
Carbon, C	0.380-0.430
Silicon,Si	0.15-0.30
Molybdenum, Mo	0.15-0.25
Sulfur, S	0.040
Phosphorus,P	0.035

(Source: AISI 4140 Alloy Steel (UNS G41400)

2.2.1.1 Mechanical properties

The frame slider must have a good mechanical properties. The mechanical properties of a material are those properties that involve a reaction to an applied load. The mechanical properties of metals determine the range of usefulness of a material and

establish the service life that can be expected. Mechanical properties are also used to help classify and identify material. The most common properties considered are strength, ductility, hardness, impact resistance, and fracture toughness.Table 2.2 shows the mechanical properties of AISI 4140 alloy steel

Table 2.2: Mechanical properties of AISI 4140 Alloy steel (AZoM, 2012)

Properties	Metric	Imperial
Tensile strength	655 MPa	9500 psi
Yield strength	415 MPa	60200 psi
Bulk modulus (typical for steel)	140 GPa	20300 ksi
Shear modulus (Typical for steel)	80GPa	11600 ksi
Elastic modulus	190-210 GPa	27557-30458 ksi
Poisson's ratio	0.27-0.30	0.27-0.30
Machinability (based on AISI 1212 as 100 machinability)	65	65

(Source: AISI 4140 Alloy Steel (UNS G41400)

Table 2.2 depicted that the AISI 4140 alloy steel have high elastic modulus which is suitable for a frame slider that must be able to withstand a high impact during crash event. The material also have high yield strength which is it play the the primary role in describing the stress strain relation, whereas in the plastic regime the mechanical hardness expresses the resistance of material to permanent deformations (Eduardo,2011). According to Griffith theory (Lung & March, 1999), the fracture stress is proportional to the square root of the surface energy, that is, the larger the surface energy is the larger the load could be before the solid starts to break apart.

2.2.2 Carbon Steel

In this project, to developed a new design of frame slider, the features for the material such as tensile strength, yield strength, bulk modulus, shear modulus, elastic modulus,