UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EXTENDED HYBRID ELECTRIC MOTORCYCLE MOTOR MOUNT DESIGN, ANALYSIS AND INSTALLATION

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Mechanical Engineering Technology
(Automotive) (Hons.)

by

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This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the Degree of Bachelor of Mechanical Engineering Technology (Automotive)(Hons.). The member of supervisory is as follow:

.....

(Project Supervisor)

ABSTRAK

Motosikal adalah salah satu pengangkutan bermotor yang paling banyak digunakan di dunia. Kebanyakan penduduk di dunia, hampir semua mempunyai kenderaan bermotor ini. Swingarm adalah komponen utama sebuah motosikal. Ia menyokong pemegang tayar belakang manakala berputar menegak untuk membenarkan penggantungan untuk mengurangkan kesan hentaman di jalan raya. Pengeluar motosikal berterusan berusaha untuk memperbaiki produk mereka dan membuat komponen (contohnya swingarm itu) lebih ringan, lebih kuat dan lebih murah. Laporan penyelidikan memperincikan pembangunan yang inovatif untuk reka bentuk swingarm. Hibrid elektrik motosikal reka bentuk, analisis dan pemasangan adalah fokus utama projek ini. Projek ini telah dijalankan untuk mereka bentuk, melaksanakan analisis kekuatan, merangka dan pemasangan pendakap untuk hub motosikal elektrik pada swingarm motosikal. Maklumat yang telah digunakan adalah berdasarkan daripada kajian terdahulu mengenai rangka. Pengukuran persamaan kepada model hibrid motosikal elektrik casis telah dilakukan. Dalam masa yang sama, pembangunan perisian yang bertambah baik dalam beberapa dekad ini. Kebanyakan perisian baru membuat analisis dan mereka bentuk lebih mudah untuk difahami. Projek ini bertujuan untuk mereka bentuk swingarm baru untuk motosikal elektrik hibrid. Perisian CATIA digunakan untuk mereka bentuk swingarm ini. Swingarm motosikal adalah komponen penting di bahagian belakang motosikal. Literatur menunjukkan bahawa swingarms perlu cukup kuat untuk menangani pelbagai beban berdasarkan pengalaman dalam bidang ini, cukup sengit untuk meningkatkan tindak balas motosikal dan kestabilan, dan berat yang cukup untuk meningkatkan prestasi motosikal dan mengurangkan jisim belakang.

ABSTRACT

Motorcycles are one of the most affordable forms of motorised transport in many parts of the world. For most of the world's population, they are also the most common type of motor vehicle. The swing arm is the main component of the rear suspension of a modern motorcycle. It supports the rear axle while pivoting vertically to allow the suspension to absorb bumps on the road. Motorcycle manufacturers are continually striving to improve their products and make components (e.g. the swingarm) lighter, stronger and cheaper. This research report details the development of an innovative for swing arm design. Hybrid electric motorcycle motor mount design, analysis and installation is the main focus of this project. This project was carried out to design, perform strength analysis, fabricate and installation the bracket for electric motorcycle hub on a motorcycle swingarm. The information that has been used is based on the previous study about the frame. The approximation measurement of the model of hybrid electric motorcycle chassis had been done. In the meantime, the software development is improving in this few decades. Most of the new software makes the analysis and designing easier to understand. This project aim to design new swingarm for hybrid electric motorcycle. CATIA software is used for designing this swingarm. The motorcycle swingarm is a critical component in the rear part of the motorcycle. The literature shows that swingarms need to be strong enough to handle various loads experienced in the field, stiff enough to increase motorcycle response and stability, and light enough to improve motorcycle performance and reduce the rear unsprung mass.

DEDICATION

I dedicate my dissertation to my family and many friends. A special feeling of gratitude to my be loving parents whose give me endless support throughout my studies and to my family whose never left me alone and are very important to me.

I also dedicate this dissertation to my special friends, especially my supportive classmate of BETA for helping me through the process of completing this thesis. A special thanks to my supervisor who always guide and help me to develop this as well as this report. Thank you for everything.

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Finally, I would like to thank anyone that has contributed either they are in connection with me or not, for giving me the support and help in to make this project success.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

BST	-	Black Stone Tek
CAD	-	Computer Aided Design
CAE	-	Computer Aided Engineering
CAM	-	Computer Aided Manufacturing
CATIA	-	Computer Aided Three-dimensional Interactive Application
EDS	-	Electro Dynamic Shaker
FE	-	Finite Element
FEA	-	Finite Element Analysis
FEM	-	Finite Element Model
HEM	-	Hybrid Electric Motorcycle
MBS	-	Multi Body Simulation
RBT	-	Rolling Bench Test
MIG	-	Metal Inert Gas
ANSYS	-	Analysis System

CHAPTER 1

INTRODUCTION

1.1 Project background

Nowadays, there are a lot of motorcycle swing arm designs available in the market with a variety purposes. The fast growing technologies happening in this era, all the motorcycle swing arm become more advance in design. Meanwhile, the hardness of the swing arm is important in order to support the weight of the bike or motorcycle.

By developing this mounting bracket for Hybrid Electric Motor (HEM), the swing arm design with 3D and 2D using software CATIA. Indeed, the analysis also using this software to analyse the force acting to swing arm. After that, fabricate the swing arm and install to motorcycle to run the testing.

1.2 Problem statement

In order to build a successful motorcycle, manufacturer or designer must first look at its most fundamental component, the chassis. The major data distribution on the motorcycle is the frame. The motorcycle will require a frame design that has been computer generated and analysed; also it must be fabricated and structurally tested. To ensure a successful motorcycle especially the swing arm that hold the axle of the tyre. The wheel alignment is mostly same means that the front and rear wheel are in-line. That is, they point in the same direction and are not offset from each other. Rake is the angle of inclination with respect to the vertical of the axis of rotation about which the

front wheel is turned during the steering process. This is usually the angle with respect to the vertical of the steering head of the frame. In design of the swing arm, holder calliper of disc brake also need to design the suitable position to hold the calliper disc brake for rear tyre.

1.3 Objectives

The objective of this project are as following:

i. To design the bracket for electric hub on a motorcycle swing arm.
ii. To perform the strength analysis.
iii. To fabricate the swingarm.

1.4 Scope of project

This project proposes a design and implementation of a mounting bracket for electric motor hub on a motorcycle swing arm and perform the strength analysis. Fabricate the working bracket and mount on the hybrid electric motorcycle (H.E.M.). The strength of the swing arm have to analysis to know how strength the swing arm that can support whole body of motorcycle and passenger. Design holder for disc brake calliper also important to ease the user to remove when to replace brake component or other component that react with this calliper. Calliper holder must not to design to complicate but it be nice when it design more simple and neat. This design depend on ergonomic. Ergonomic requirement should be fulfil to meet the customer needs. This holder is better when paired with the swing arm using the bolt and nut to facilitate when need to remove.

1.5 Methodology of project

The methodology in order to do this project is as follows.

i. Research some related developments, studies and examples of current project.
ii. Design and fabricate of detail structure that need to be built.
iii. Development of the project.
iv. Testing the performance.

1.6 Thesis organization

This report contains five chapters. Chapter one describes about the introduction of the project, the Design, analysis, Fabricate, install and testing of mounting bracket swing arm for Hybrid Electric Motor (HEM). The problem statement of the project, the objectives of the project, a purpose that describes the motives to develop the project, the scope of the projects, and organization of the report are stated and explained in chapter one.

Chapter two is about the literature review about the field of study regarding the project. This chapter reviews on theoretical information, results of researches related to the field of this project, and applications needed to be applied on design swing arm motorcycle. All the information gathered were discussed and explained.

Chapter three is relates to the methodology of the project. The methods used to approach any solution associated with finishing the project is present as a whole. The methods that are discussed will be the processes starting from designing the Swing Arm until testing of the motorcycle.

Chapter four explains the results and discussion of this project. After finished constructing the Swing Arm, testing procedure is done to evaluate the work. The data from the analysis will determine the effectiveness and efficiency of Swing Arm

Lastly, chapter five is the conclusion and recommendation for this project. The project findings will be concluded and suggestion to promote improvement as well as the broadening the scope of the project is stated for further study regarding this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The motorcycle swing arm is a key component of the rear suspension of a motorcycle. It connects the rear wheel of the motorcycle to the main chassis and it regulates the rear wheel-road interactions via the spring and shock absorber. Two basic designs exist, namely the single-sided and double-sided swing arms. The single-sided swing arm has the benefit of allowing for easier removal of the rear wheel during racing. The disadvantage is that due to the asymmetry, a twisting moment acts in the arm which does not exist in a double-sided swing arm.

2.2 Development of Rigs for Testing

Nowadays, there are highly competitive for automotive world, automotive manufacturers are focussing their efforts on shortening product development cycle without compromising performance and reliability Kharul R et al. (2005). This means it reduces test time by identifying failure modes early in the design process and avoid past design by optimizing their components necessary for life Singanamalli A et al. (2004). Research also indicates that a greater level of stability can be achieved by properly optimizing the design parameters without compromising ride comfort requirements Mangaraju KV et al. (2004).

A large amount of research has been done in developing the test platform for the design of automotive components. Product development is no longer limited to the experimental test but is now included in the test (computer simulation) virtual environment. The advantages of virtual tests including rate design prototypes early in

the development process before it is available and also allows data to be acquired to help by providing a test trial Kharul R et al. (2010). Virtual model of the best in conveying an understanding of system behavior, interactions and sensitivity, while good physical exam to determine the absolute level of performance and the response of complex systems P. Wilkinson. (2007). It is very difficult to predict the future of motorcycle history loading. One solution is to fit strain gauges and transducers ridden other bikes on the road-track a variety of conditions. With adequate test, one can build a picture of the normal engine load cycles over the life expectation. The second solution is to build a test rig that can simulate road conditions Piazza SD. (2008). The first one is not an option because of BST has no motorcycle for testing purposes, but they are willing to invest in test rigs.

Physical tests must be conducted to validate the design and determine the accuracy or virtual simulation test. Virtual testing cannot replace physical testing Kharul R et al. (2010). Physical testing can be performed on the test platform to validate the simulation if it reproduces realistic failure as it happens on the field Balakrishnan S. (2012). A similar approach is required in this study to develop a test platform that resembles a proper road conditions to test the durability and performance of the swingarms.

The literature shows that there is a growing need for developing virtual tests that can simulate experiments. Multi-body simulation (MBS) has been used to simulate the suspension test rigs and thereby calculate acceleration, moments and bending forces in order to motorcycles shown in Figure 2.1 R. Kharul et al. (2010). Forces are calculated in MBS can then be used in the FEA components to calculate the stress and strain. In certain cases, be carried out prior FEA stress and strain distribution indicator which then allows pressure measurements to be done strategically during the test experiments K. Dressler et al. (2009).

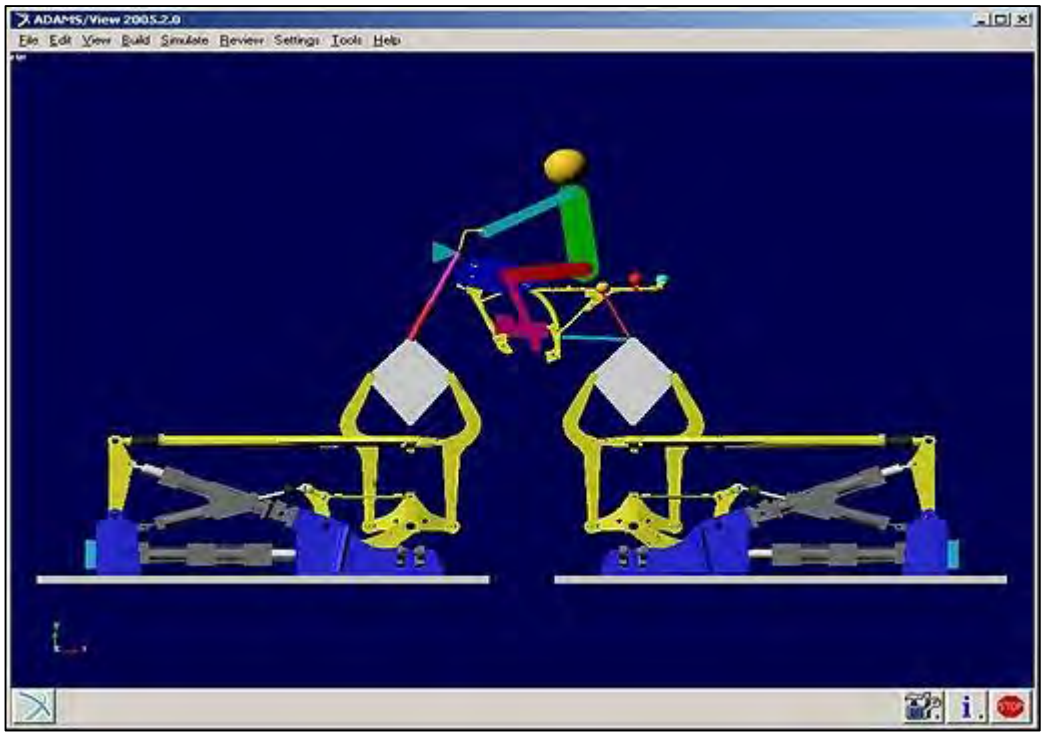

Figure 2.1. Example of multi-body simulation using ADAMS® simulation software. Kharul R et al. (2010)

From this discussion on the test rig, it is clear that for successful design and testing of automotive components, there is a need to incorporate a virtual (FEA) and experimental methods.

2.2.1 Automotive Component Test Rigs

A large amount of research has been done in developing the test platform for the design of automotive components. Product development is no longer limited to the experimental test but is now included in the test (computer simulation) virtual environment. The advantages of virtual tests including rate design prototypes early in the development process before it is available and also allows data to be acquired to help by providing a test trial Kharul R et al. (2010). Virtual model of the best in conveying an understanding of system behavior, interactions and sensitivity, while

good physical exam to determine the absolute level of performance and the response of complex systems P. Wilkinson. (2007).

Durability test has been widely used in the design of automotive components. Servo hydraulic platform (used for durability testing) is one of the main experimental methods used in the automotive design K. Dressler et al. (2009). Endurance test rig was built to test the fatigue life of the motorcycle handlebars shown in Figure 2.2 K. Lin. (2005), the suspension of the vehicle shown in Figure 2.3 and the motorcycle frame R. Ide et al. (2009), to name a few. During the test, the results are usually obtained by measuring the strain in the component and then calculate the corresponding stresses.

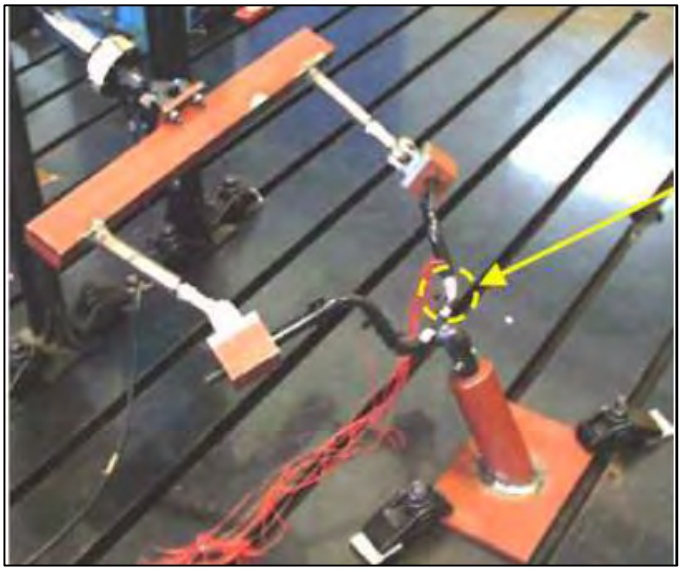

Figure 2.2. Durability test rig for motorcycle handlebars. K. Lin et al. (2005).