DESIGN AND FABRICATION OF PEDAL COMPONENTS FOR UTEM FORMULA STYLE RACE CAR

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This report is presented in

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"I declare this report is on my own work except for summary and quotes that I have mentioned its sources"

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For my beloved mum, Mrs. Rokiyah bt Abdullah and my caring dad,
Mr. Jamaludin bin Awang

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ABSTRACT

These thesis are about the design and fabricate a new brake pedal and fuel pedal for UTeM formula varsity style race car. The project design has been produced using CATIA software such as drawing design, structure analysis and weight measuring. This project also studied about the materials properties of Aluminium Alloy 6061 T6 and Low Carbon Steel AISI 1010 using CES EduPack 2010 software. Moreover, the pedals components have been generated using Milling machine process. The new pedals design had reduced weight about 0.245 kg. From the calculation done, the safety factor for both brake and accelerator pedals are 3.31 and 22.72 respectively. From the research done on the pedals components, the measurement, material studies, ergonomic factors, and material selection method were explained.

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ABSTRAK

Tesis ini adalah tentang rekabentuk dan fabrikasi pemijak brek dan pemijak minyak yang baru untuk kereta lumba Formula Varsity UTeM. Reka bentuk projek ini telah dihasilkan dengan menggunakan perisian CATIA seperti menghasilkan lukisan rekaan, analisis rekaan dan mengukuran berat rekaan tersebut. Projek ini juga mempelajari mengenai sifat bahan seperti *Aluminium Alloy 6061 T6* dan *Low Carbon Steel AISI 1010* dengan menggunakan pengisian CES EduPack 2010. Selain itu, bahagian-bahagian pemijak telah dihasilkan menggunakan proses mesin Pengilling. Rekabentuk pemijak baru telah mengurangkan berat sekitar 0,245 kg. Dari perhitungan yang dilakukan, faktor keselamatan untuk kedua-dua pemijak brek dan pemijak minyak masing-masing 3.31 dan 22.72. Dari kajian yang dilakukan pada bahagian pemijak, saiz, bahan kajian, faktor ergonomik, dan kaedah pemilaihan bahan telah dijelaskan.

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LIST OF SYMBOLS

σ_y = Yield Strength

$\sigma`$ = Von Mises Stress

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LIST OF ABBREVATIONS

CAD	= Computer Aided Design
CAE	= Computer Aided Engineering
CATIA	= Computer Aided Three-dimensional Interactive Application
CES	= Cambridge Engineering Selector
CNC	= Computer Numerical Control
FEA	= Finite Element Analysis
FOS	= Factor of Safety
MSDS	= Material Safety Data Sheet
PDS	= Product Design Specification
SAE	= Society of Automotive Engineering
UK	= United of Kingdom
UTeM	= Universiti Teknikal Malaysia Melaka

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Brake pedal and accelerator pedal for UTeM formula style race car are an important part for a vehicle and more specific in this project. Pedal is one of mechanical design and the shape is depending on the material choosing. So, in this project we need to understand the material properties that use in nowadays industry. In choosing the pedal design, sketching and material properties are considered in this research. In future study, we need to compare this material to the alternative material and considering the new design of pedal if needed.

Formula Varsity is a national student competition organized by Faculty of Mechanical Engineering UTeM where participants compete in a challenge to design, built and race a working prototype of a single seater open wheel formula style racing car in real track condition.

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1.2 Objective of Project

To design and fabricate a new pedal components (fuel and brake pedal) for UTeM formula style race car 2010.

1.3 Scope of Study

Scopes for this project are:

i. To produce detail and 3D design of the pedal components using CAD software based on 2010 UTeM Formula Varsity specification and regulation.
ii. To perform material selection and load analysis on the components.
iii. To fabricate the pedal components.
iv. To measure the overall weight of the pedal components.

1.4 Problem Statement

i. The pedal positions not suit/appropriate to the driver's legs because the position of pedal distance not appropriate with the driver's foot.

ii. The pedal design not suitable to the driver because the distance ratio between pedal lever and fulcrum inaccurate.

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1.5 Summary

This technical report is basically described about how to design and fabricate new components pedals for UTeM Formula varsity race car. This report has ninth chapters which are the first section is Introduction. In the chapter of Introduction, there are stated about objective, problems and scope of the project. Second chapter is Literature Review which explains about the study that has been done in order to get the information about this project. The third chapter is Methodology which explains in basic about the step is needed in order to achieve the project objective. The fourth chapter is the chapter Design Selection. This chapter explain detail about the step and method used in term of deciding the most suitable design for the pedal components of style race car. Fifth chapter is chapter of Materials Selection. This Materials Selection chapter explain in detail about the method and comparison used in selected materials. Sixth chapter is chapter of Structure Analysis. This analysis of structural chapter explains in detail about method to get the suitable design for this project. The seventh chapter is Manufacturing Process which will explain the step of manufacturing the pedal components. The eighth chapter is Result and Discussion where stated the reason for outcome result and also all the problem arise during project. The last chapter is Conclusion and Recommendation which will conclude all of the project activities that has already been done and also recommendation that can be done in further study.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Design is the most important word that means everything to all people. In designing process, the materials choose is also important (Budynas et. al. 2008). Materials are physical substances used as inputs to production or manufacturing that derive from or composed matter. Some material have limited design based on that material properties, but the process to shape the material nowadays are more faster than at any previous time. The pedal components on conventional vehicles are actuated by the foot or both feet of the driver (Brad 2007). For this reason it is important to know the foot force capabilities of individuals comprising the driving population. Pedal function to control the amount of braking required on each axle to achieve that perfect balance in braking (Earl 1976). Besides that, the pedal box is set-up to use either a hydraulic clutch or a cable clutch (Ingerslev 2007)

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2.2 Accelerator Pedal Concept

A pedal controlled by an extension return spring hooked to the carburettor. The pedal is mounted in bulkhead by mean a small shaft enclosed by a pair of anchorage (Finken et. al. 1970). The throttle cable is used to link the pedal and the carburettor. The pedal profile has been carefully engineered to deliver the optimum pedal ratio (Tilton Engineering Inc. 2010).

2.3 Brake Pedal Concept

Pedal connection to brakes disc and access to hydraulic cylinder, pivot shaft and the type of brakes signal. The common pivot shaft is located at the far end of pedal. The brake pedal light switch is situated on top of pedal (Higginbotham et. al. 1972). The operation performed in braking is the reverse of the carried out in accelerating (Hamid 2007).

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2.4 Interdepencies with Other Systems

i. Frame- need to accommodate the full length of the pedal box plus room for adjustability.

ii. Ergonomic- it determines the initial pedal angle as there exists a foot angle that gives the maximum amount of force transfer from the driver.

iii. Brakes- the brake system has the most interdepencies with pedal box. .

iv. Intake- the accelerator interacts with the carburetor/throttle body on the intake system.

2.5 Ergonomic considerations in Pedal Design

The distance between steering wheel and brake pedal must be kept to approximately 600 mm. The pedal design must not cause fatigue to the feet of the driver. The design must not provide comfort and enough space installing and removal of the pedal box system (Jack E. Gibas et. al. 1970). Besides that, tool feature that adjusts the anthropometric data for secular trends so that the manikin sizes are likely to correspond to the driver' sizes when the car is eventually introduced on the race and throughout the car platform's market life cycle (Lars et. al. 2006).Table 2.1 had shown the ergonomic consideration in pedal design. Moreover, Figure 2.1 also has shown the guideline design for the pedal on a seat height. Besides that, for the pedal ratio is the overall pedal length or distance from the pedal pivot called the fulcrum to centre of the pad that foot will push by the distance from to the fulcrum to the master cylinder push rod attachment point (Ruiz 2005).

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