

DESIGN AND DEVELOPMENT OF COMPOSITE SUSPENSION PUSH ROD FOR  
FORMULA STUDENT RACE CAR

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FORMULA STUDENT RACE CAR

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This technical report is submitted in accordance with the requirements of the  
Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering  
Universiti Teknikal Malaysia Melaka

MAY 2009

## CONFORMATION

I admit that have read this work and in my opinion this work was adequate from scope aspect and quality to award in purpose Degree of Bachelor of Mechanical Engineering (Automotive)

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Date : .....

**DECLARATION**

“I hereby, declare this thesis entitled Design and Development of The Composite Suspension Push Rod for Formula Student Race Car is the result of my own research except as cited in the reference”

Signature :.....

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Date : 12 MAY 2009

## DEDICATION

To my beloved father,

Tuan Haji Abdul Rahman b. Haji Abdul Razak

And to my beloved mother,

Puan Hajjah Noor Azian bt. Haji Nasiruddin

who keep me continuously motivated with their great support and encouragement  
throughout my Bachelor Degree program.

## ACKNOWLEDGEMENT



Alhamdulillah and Thank to Allah S.W.T. with all His Gracious and His Merciful forgiving me strength and ability to accomplish this research project successfully. I would like to take the outmost opportunity to express my sincere and gratitude to my supervisor, Mr. Muhd Ridzuan bin Mansor who is always giving me supports and guidance in completing this Final Year Project until up to this stage in victory.

Also with the greatest thanks to my beloved parents and Family who always pray and give the encouragement while pursuing my research and project. Their sacrifices are never being forgotten.

My greatest thanks also credited to Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka because give me a chance to get a lot of knowledge and helpers to complete my research project and also my study.

And last but not least, to all my fellow friends who involves direct or indirectly that always stand strong beside me in giving opinions and supports throughout our relationship, I really thankful and appreciate it. All yours are the most valuable things for the rest of my life.

## ABSTRACT

The contemporary Formula Student racing car makes extensive use of advanced composite materials in its construction. The design, manufacture and performance testing of the composite suspension push-rods that typically could be used in a Formula Student racing car are described in this report. The design of the push rod is based on the current design use by Formula 1 race car and also current Formula Student race car. This push rod was fabricated by manual hand lay-up technique using glass fiber and polyester resin as the composite materials. The push-rod was manufactured using uniform lay-up of woven cross-ply technique. The component performance evaluations were conducted using three point bending and tensile test to determine the strength of push rod suspension when the maximum load is applied. Results obtained shows that the developed composite suspension push rod are able to function successfully according to the required specification for the Formula Student race car.

## ABSTRAK

Kebanyakan kereta lumba bagi Formula Pelajar menggunakan bahan komposit dalam pembuatan kereta tersebut. Merekabentuk, pembuatan dan juga menganalisis kekuatan bahan komposit itu diutarakan dalam laporan ini. Rekabentuk rod penolak dalam projek ini adalah berdasarkan rekabentuk semasa yang digunakan pada kereta lumba Formula 1 dan juga kereta lumba Formula Pelajar. Rod penolak ini akan di fabrikasi menggunakan teknik 'lay-up' untuk 'fiberglass' dan juga 'polyester resin'. Eksperimen 'three point bending' dan juga tegangan akan dijalankan untuk mengetahui ketahanan rod penolak tersebut apabila daya maksimum dikenakan pada rod penolak. Keputusan dari eksperimen ni akan menunjukkan samada pembangunan rod penolak menggunakan bahan komposit berfungsi dengan baik mengikut ketetapan yang telah ditetapkan bagi Formula Pelajar.



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## LIST OF SYMBOLS

$F_{\text{tire}}$	=	Force act at front tire
$K_{\text{Tf}}$	=	Front Roll Stifness
$\Phi$	=	Roll angle
$F_{\text{FZM}}$	=	Weight transfer due to roll moment
$F_{\text{FZL}}$	=	Weight transfer due to lateral force
$v$	=	Vehicle speed
$W_{\text{f}}$	=	Force at front
$W_{\text{r}}$	=	Force at rear
$r$	=	Radius of cornering speed
$A_{ij}$	=	Extensional stiffness matrix [A]
$h$	=	Laminates of composite
$k$	=	Number of ply
[Q]	=	Stiffness matrix
[T]	=	Transformation matrix
[R]	=	Matrix transform of engineering shear strain
$I_x$	=	Moment of inertia
$r_x$	=	Radius of gyration
$\sigma_{\text{critical}}$	=	Critical stress

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## CHAPTER 1

### INTRODUCTION

#### 1.1 Introduction

Formula Student is the event that challenges university students to design, build, develop and compete as a one team and come out with a small single seat racing car. The purpose of this tournament is to give the experiences to the students about the real life as an engineer. They will face the real engineering life start from design until manufacture the racing car.

Nowadays, the formula student race car has makes a lot of improvement especially in term of weight from the heavyweight body chassis and components to lightweight components. This is because the minimum body car weight can gives higher performances for the car especially in handling performances. Before this, the components such as suspension system use metal. Now, many race car components use composite material such as carbon fiber and fiber glass to reduce the weight.

The suspension system material also has made some improvement from using material like steel to composite material such as fiber glass. Many of team in formula one such as Ferrari team using composite as a material at suspension system. The most important reason using composite material at the suspension system is the handling performances. Reducing the weight of the components can give a higher performance to car (Savage, 2008).



Figure 1: The original composite F1 chassis, McLaren MP4-1 (Savage, 2008)

## 1.2 Problem Statement

In order to make some improvement in performances of car especially in terms of reducing weight, sufficient understanding about the composite material especially in fiber glass composite and also understanding about the function of push rod suspension is a subject matter to complete this project. Thus, analysis using Finite Element Analysis (FEA) software is required to analyze the force for tension and compression at the push rod suspension.

## 1.3 Objectives

An objective of this project is to produce a composite push rod suspension for a Formula Students race car.

## **1.4 Scope of Study**

The scopes of this project are:

- a) To design the push rod suspension using CAD software, CATIA.
- b) Fabricate sample of composite push rod suspension using glass-fiber reinforced polymer composite.
- c) Test the sample using 3-point bending and tensile test.

## **1.5 Expected Result**

In order to reduce the weight for the current steel push rod suspension, the final result is to produce the lightweight glass-fiber reinforced polymer composite push rod suspension for UTeM's Formula Student race car.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 History of Formula Student

First Formula Student or Formula Society of Automotive Engineers (SAE) was held in 1979 at University of Houston and conceived by Dr. Kurt M. Marshek. Before this, the formula SAE was known as SAE Miny-Indy (Formula SAE, 2007). Miny-Indy means the car was small compared to the Formula 1 race car. First car entered this competition was made out of wood and used five horsepower engine. The engineering students who had entered this first Formula SAE competition must designed and build a small race car using the same engine power. For the first formula SAE competition, thirteen universities were entered but only eleven universities had completed this race. University of Texas is the first university has won his race.

On 1980, three students from University of Texas at Austin had proposed a new rules and regulation and also new concept of Mini-Indy. All the engine must used four stroke engines with 25.4 intake restriction (Formula SAE, 2007). Then, Dr. Robert Woods from University of Texas changed the concept of the competition. He wanted students to design and build a race car for limited series production.

Starting from this until now, the Formula SAE has make a lot of changes in term of concept, rules and regulation and also many more. Now, a formula SAE has become more establish and attracts many schools and universities to join this competition.