

**DEVELOPMENT OF A SIDE-POT BODY PANEL FOR A FORMULA
STUDENT RACE CAR**

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'I/We* admit that have read this dissertation and in my/our* opinion this dissertation is
satisfactory in the aspect of scope and quality for the bestowal of
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RACE CAR

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“I admit that this report is my own work except the summary and some statement which is each of them, I already state the source of it”

Signature :

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For my beloved father, beloved mother and beloved person

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ABSTRACT

The paper presents a conceptual design of side-pot body panel for UTEM formula style race car. The development process involved two major stages; conceptual design and structural analysis. In first stage, a side-pot body panel design was selected and a 3D model of a side-pot body panel was developed using CATIA V5R16 computer aided design software. Further analysis of a material selection has brought the selection of Glass Fiber Reinforced Polymer (GFRP) as the side-pot body panel material. The 3D of a side-pot model will be applied in detailed structural analysis using finite element analysis; MSC Patran Nastran 2005. In the later stage was the fabrication of side-pot body panel using wet-lay up process. Thus the discussion and conclusion is made. The recommendation is suggested to make an improvement in future study.

ABSTRAK

Laporan ini mengetengahkan mengenai konsep rekabentuk “side-pot” untuk kereta lumba UTeM. Proses pembangunan melibatkan dua factor penting iaitu rekabentuk konsep dan analisis struktur. Bahagian pertama rekabentuk “side-pot” telah ditentukan dan model 3D untuk “side-pot” telah dihasilkan menggunakan perisian CATIA V5R10. Analisis telah dijalankan bagi menentukan jenis bahan dan hasil analisis mendapati bahan yang sesuai untuk projek ini adalah polimer yang diperkuat dengan gentian kaca. Analisis struktur “side-pot” telah dilakukan menggunakan perisian MSc Patran Nastran 2005 untuk menentukan kekuatan pada “side-pot”. Seterusnya, diskusi dan kesimpulan telah dilakukan. Cadangan penambahbaikan untuk pembangunan “side-pot” telah dicadangkan untuk pembangunan pada masa hadapan.

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LIST OF SYMBOL

k	=	number of ply
a	=	gravitational acceleration, m/s^{-2}
Q	=	stiffness matrix
t	=	thickness of composite ply
E_{11}	=	modulus of elasticity
E_{22}	=	modulus of elasticity
V_{12}	=	poisson ratio

CHAPTER 1

INTRODUCTION

In recent years, advanced fiber reinforce composite have gradually emerged as a new class in engineering design of structural component. The composite properties of high strength and also their high ratio of surface area to weight have made the suitable candidate for structural applications including aircraft and automobile.

Formula student is a competition where the students have the opportunities to design, fabricate and also to represent their college to compete with other team. Formula Student also called Formula Society of Automotive Engineer (FSAE). There are several important factors in order to produce competitive formula student cars which are the performance of the car and also the car aesthetic. Society of Automotive Engineer (SAE) had stated the rules and the standard specification in order to provide a guideline for the participant.

In Universiti Teknikal Malaysia Melaka, Formula Student is still new. In recent year, there are several cars for the formula student was build. Even though, the car specification did not follow the standard for the Formula Society of Automotive Engineer (FSAE), the car is very competitive. The car bodywork is using the fiberglass but not required specific justification on the thickness and also the composite calculation for the composite strength.

1.1 Objectives

This thesis is done to design and fabricate the side-pot body panel for a formula student racing car by using composite material.

1.2 Problem Statement

The goals for this project are to design and fabricate the side-pot by using glass fibers-reinforced polymer composite. The side-pot is built to the requirements specified by the Society of Automotive Engineers (SAE). Specifically, the intention is to design, analyze and fabricate the chassis, as well as designing and constructing a test for the side-pot. The specifications dictated by Formula SAE are meant to challenge student's knowledge, creativity and imagination in designing for a formula SAE car. In the end, the side-pod had been designed, analyzed and fabricated that meets the students deliverable deadlines and fundamental design goals.

1.3 Scopes

The basic component for a formula student racing car consist of the frame chassis, the side-pot, nose, the cockpit and also the space for engine compartment. The limitation of this thesis is to design a side-pot by using CATIA software and analyze the design by using the finite element software. The other scopes are to fabricate a side-pot for a formula student racing car by using a fiber reinforced polymer. Briefly the scopes are:-

- i. Designing the side-pot
- ii. Finite element analysis of the design
- iii. Side-pot fabrication

1.4 Benefit of Study

Formula student is an advantage for a student to learn and gain an experience during the process of producing a formula student racing car. This study involved both theoretical and also practical skill. This part of the study also develops the student soft skill including teamwork, time management and also a problem soft skill. In addition, the knowledge in manufactured the side-pot is the valuable experience. Research skill also has gain in order to finish up this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Formula Student Racing Car

Formula student is a student event who represents the university from the entire world. Basically, the student design, fabricate a car and compete with a small formula style race car. The car must satisfy the competition rule and also the safety requirements. Figure 1 show the example of Formula SAE Racing Car.



Figure 1: Formula SAE Racing Car (The University of Western Australia, 2006)

Formula student or well known as a Formula SAE is a competition which is sponsored by the Society of Automotive Engineers (SAE) to provide an educational

experience for a students and also to expose in project management. Formula SAE competition give teams the maximum design flexibility and the freedom to express their creativity and imaginations. Formula SAE competition also gives the students chance to demonstrate and prove both creativity and engineering skills in comparison with the teams from other university. All participants must follow the standard car specification guideline which is providing by Society of Automotive Engineers (refer to Appendix 1). Society of Automotive Engineers aim was to address a need for the free exchange of ideas and to develop a standard for those in the emerging automotive industry. This need was mention by Peter Heldt editorial in *The Horseless Age* from 1902:

“Now there is a noticeable tendency for automobile manufacturers to follow certain accepted lines of construction, technical questions constantly arise which seek solution from the cooperation of the technical men connected with the industry. These questions could best be dealt with by a technical society. The field of activity for this society would be the purely technical side of automobiles.” (formula SAE, 2008)

By referring to the Peter Heldt editorial, Formula Society of Automotive Engineers is the way for Society of Automotive Engineers (SAE) to realizing their dream.

2.2 Society of Automotive Engineers (SAE)

There were several automobile manufactures in the United States in the early of 1900s. In order to meet their needs for promoting their business and raising public awareness, they had joined trade groups. Sequentially to expand their individual technical knowledge base, many of the engineers in the automobile business expressed a desire to change their ideas among them. (formula SAE, 2008)

Two authors were tireless advocates of the concepts that moving into creation of Society of Automobile Engineer (SAE) which. The two authors are Peter Heldt of *The*

Horseless Age and Horace Swetland of *The Automobile*. Horace Swetland is become the voice of the automobile engineer hence Horace Swetland become original SAE officer. During meeting in 1916, there was a new society representing engineers in all types that officially establish. The term “automotive” from Greek *autos* (self), and Latin *motivus* (of motion) origins to represent any form of self powered vehicle. In fact of, the Society of Automobile Engineers became the Society of Automotive Engineers. (formula SAE, 2008)

2.3 Formula Society of Automotive Engineers (SAE)

First race for Formula SAE was held at University of Houston in 1979 which called SAE Mini-Indy. The cars were made by wood and using the five horsepower Briggs and Stratton engine to accelerate the car. The University of Texas at El Paso was the first won which overall participated was thirteen colleges. There were several rules that should be followed by each university. The rules were about the type of engine and the overall project cost. University of Texas at Austin was hosted in 1984 for the SAE Mini-Baja competitions. Dr. Robert Woods, had changed the concept during the competition at University of Texas at Arlington in 1985. The idea by Dr. Robert Woods was to make this competition as an activity committee and also gave the student chance to build a pure racing car. General Motors hosted the competition in 1991, Ford Motor Co. in 1992, and Chrysler Corp. in 1993. After the 1992 competition, SAE Mini-Indy competition was changed to Formula Society of Automotive Engineers.

2.4 Bodywork

The main objective for car bodywork is to protect the car driver. The purpose for the composite bodywork is to reduce the weight. The bodywork dimension must exactly suitable with the frame or chassis structure. The functional of the bodywork design are lightness, rigidity, a smooth surface, control of airflow and also the aesthetic value of the car. The method to manufacture the bodywork is very important to achieve perfect bodywork especially in side-pot fabrication. The fabrication of the side-pot is using the composite material.

In order to fabricate the side-pot design, the selection of composite is important. The factors that must be considered are the composite cost, strength and easy in bonding. In fabricate the side-pot by using the composite material, it necessary to create a mold first. The mold is important to achieve the good surface finish. The most suitable composites for the side-pot fabrication were the fiber composite.

2.5 Composite

Composites, as they known today, emerged almost immediately after the introduction of polymers during the World War II. By 1942, the first applications of composites involved fiber-reinforced plastics to protect radar equipment. In 1950's, composites have been use in aeronautical and aerospace applications, particularly use in United States (Papathanasiou and Gue, 1997). In 1970's, the sporting equipment such as tennis racquets had been manufactured by using the composites material (James et al. 2006). In 1980's, automotive technology had started to use the composites material. The first application is for the Corvette rear leaf spring by using the fiber-reinforced composites (Mallick, 1993).

In general terms, a composite is a material made up from two or more other substances which give properties, in combination, that are not available from any of the ingredients alone. In the automotive, the term usually refers to a combination of strong fibers of some sort, encapsulated in a plastic resin (Forbes, 1996).

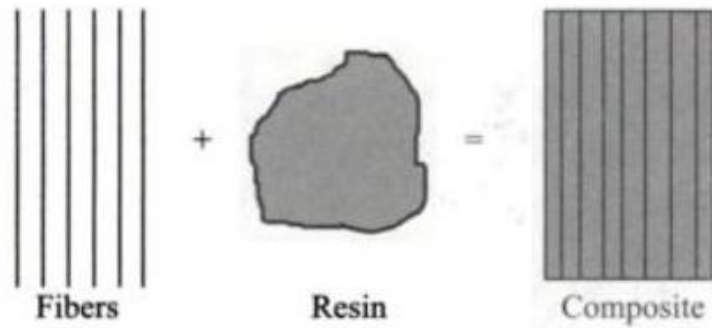


Figure 2: Formation of composite material using fibers and resin
(Forbes, 1996)

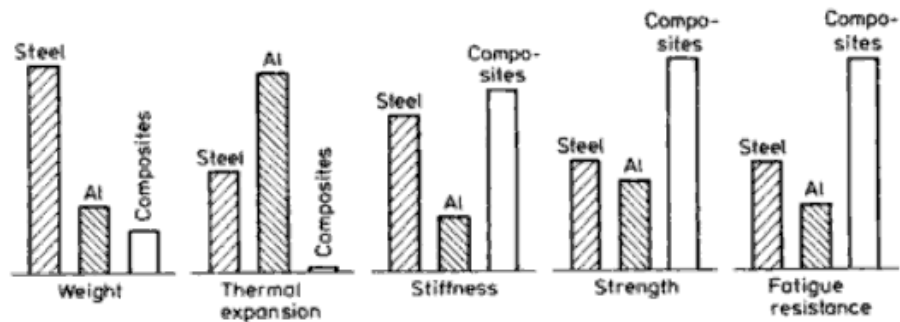


Figure 3: Comparison between conventional materials over composite
(Forbes, 1996)