Faculty of Mechanical and Manufacturing Engineering Technology

A STUDY ON BODY PANEL FABRICATION ON LIGHT VEHICLE STRUCTURE

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A STUDY ON BODY PANEL FABRICATION ON LIGHT VEHICLE STRUCTURE

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ABSTRAK

Shell Eco-Marathon bertujuan memberi inspirasi kepada pelajar pelajar kejuruteraan untuk membangunkan pendekatan baru untuk mobiliti mampan dan kecekapan bahan api. Salah satu perkara utama untuk mencapai penggunaan bahan api yang sedikit adalah dengan mengurangkan berat struktur panel kereta. Antara bahan yang boleh mengurangkan berat badan kereta ialah Nylon Polyamide. Jadi, dua jenis sambungan iaitu slot dan lap yang berbentuk tulang anjing telah dihasilkan menggunakan mesin 3D printer. Sifat tegangan maksimum dan modulus Young untuk sampel tersebut telah diuji menggunakan ujian tegangan. Ianya bertujuan untuk menentukan kekuatan jenis sambungan bahan Nylon Polyamide manakah yang terbaik bagi menghasilkan struktur panel badan kereta yang akan dihasilkan oleh pasukan UTeM yang menyertai cabaran Shell Eco-Marathon. Berdasarkan ujian tersebut, hasil menunjukkan nilai purata untuk kekuatan tegangan jenis sambungan slot yang bersaiz besar adalah 8.236 MPa manakala sambungan jenis lap adalah 6.9495 MPa lebih rendah daripada nilai slot. Oleh itu, dapat disimpulkan bahawa gabungan jenis slot yang bersaiz besar adalah lebih sesuai untuk menghasilkan struktur panel badan kereta bagi pertandingan SEM.

ABSTRACT

The Shell Eco-Marathon aims to inspire engineering students to develop new approaches to sustainable mobility and fuel efficiency. One of the main points to achieve fuel consumption is by reducing the weight of urban's car body panel. Among the material that can reduce the weight of car body panel is Nylon Polyamide. So the two types of joining dog bone sample which is slotted and lap joint have been created using 3D printer machines. It aims to determine the joining strength of the sample to produce a car body panel for the Shell Eco-Marathon competition. The properties of maximum tensile strength and Young's modulus of the sample was tested using tensile test. This study was conducted to analyze the suitability of Nylon Polyamide material that will be uses to fabricate a new car body panel for UTeM team that participated in SEM challenge. Based on that, the result show the average tensile strength of large size for slot joint is 8.236 MPa while for lap joint is 6.9495 MPa which is lower than slot joint. So, it can be conclude that the slot joint of the large size more suitable to fabricate the body panel of urban car that participate in SEM competition.

DEDICATION

This task is dedicated to my family especially my parent. You all are very important in my life.

Also to my supervisors, lecturers, assistant engineer and all my friends especially course mate. This project was success because of your support.

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Muhamad Faizal Bin Sulaiman

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, the development of manufacturing technology has been at the highest level where makers in various industries compete in producing quality and energy efficient products. In the various sector, the automotive sector is also competing in producing energy efficient concepts product. In order to realize the concept, a vehicle will be developed using aerodynamic design as well as using lightweight materials. Apart from the car manufacturing industry that competes with each other in producing a car that has the features mentioned, there are also organizers who hold competitions for students so they can venture into the field early. Among the types of competitions held are Shell Eco-Marathons, Formula Varsity, and others.

These types of competitions is an educational project that challenges competing student teams to design, build, test and drive the most energy efficient cars and also the fastest car. These competitions can inspire technology engineering students to develop a new approach for sustainable mobility and fuel efficiency. To build a car for this competition, the overall weight of the car should be considered. This is because car weight plays an important

role in reducing fuel and makes the car fastest. The main part that will contribute to weight gain is weight. In the FIA rules, the body panels of a racing car are defined as the whole part in contact with air flow. Thus the structure of the body panel plays an important role in the overall design of the system for a racing car. In principle, the role of the body panel structure is to provide an aerodynamic form that can meet the low appeal as well as contribute to the need for impact strength as well as a reduction in the overall weight of a racing car.

1.2 Problem Statement

Based on the previous Shell Eco-Marathon competition, there are some weaknesses in the existing car design, which is as follows:

i. Existing Shell Eco-Marathon body panel design does not enough strong due to heavy load.

ii. The existing design is insufficient as it does not fully meet aerodynamic design requirements. The design offers minimum resistance to air or fluid when the body is moving in the medium (air or any fluid).

iii. The materials used do not conform to the purpose of the car being developed. The use of high-weight materials will cause the car to be inefficient.

Figure 1.1: Shell Eco-Marathon Asia Cars in competitions (Sarah, 2018)

1.3 Objective of Project

The objective of this project can be concluded as follows:

i. To redesign the existing body panel that complies with Shell Eco-Marathon requirement.

ii. To produce two type joint of "dog bone" shape sample for body panel by using 3D printing machine.

iii. To run the tensile strength test of Shell Eco-Marathon body panel through printed "dog bone" shape.

1.4 Scope of Project

This project is focusing on the redesign and analyse of the integrated body panel of an urban concept car which able to travel with less amount of energy. This focus area is done based on the following aspect:

i. Produce a new design of the existing Shell Eco-Marathon car body panel by evaluate the current design by using CATIA V5 software.

ii. Carry out the selection of appropriate materials through material selection process.

iii. Produce “dog bone” shape sample of Shell Eco-Marathon body panel by using the 3D printing machine.

iv. Determine the tensile strength of selected material and joint type by run the tensile strength analysis on “dog bone” shape sample of the new body panel design.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the current state for making a body panel based on the light vehicle will be discuss, about the material selection, design consideration, process and load criteria of the body panel are explained detailed in this chapter. All of the information stated in this chapter is through a study that has been done for this project.

2.2 Material Requirements in Automotive Field

In the automotive industry, the choice of materials for a vehicle is the most important factor that should be considered for automotive design. According to (Todor and Kiss, 2016) there are various types of materials that can be used to produce car body and chassis, but the most important criteria that a material should meet are:

i. Lightweight

ii. Economic effectiveness

iii. Safety

iv. Recyclability of their product and life cycle considerations

2.2.1 Lightweight

Lightweight materials are very important element in the construction of car structures in the automotive industry. Besides that, it also improves fuel efficiency compared to other factors. This is evidenced based on the experiments execute and the results show that 10% of weight reduction can lead to 6 to 8% improvement in fuel usage. Therefore, weight reduction can be achieved by three ways:

i. Rigidity and durability.

ii. Optimizes design of load carrying elements and external attachments to reduce their weight without any loss in rigidity or function.

iii. Optimize production processes, such as reducing spot welding and replacing new joining techniques

2.2.2 Economic Effectiveness

One of the most important factors in the automotive industry is the cost of determining whether new materials have the opportunity to be selected for the vehicle components. Costs include three components where the actual cost of raw materials, manufacturing value added, and costs for designing and testing the product. Aluminum and magnesium alloys are more expensive than iron are used today. Because the cost may be higher, the decision to choose a

light metal must be allowed based on a better function. Meanwhile high cost is one of the main obstacles in the use of composite materials.

2.2.3 Safety

The ability to absorb impact energy and survive for passengers is called "crashworthiness" in the structure of the vehicle. At first two concepts in the automotive industry should be considered is crashworthiness and penetration resistance. In a more precise definition of crashworthiness, it is the potential of energy absorption through failure modes and control mechanisms. However, the penetration resistance is concerned with total absorption without allowing projectile or fragment penetration.

2.2.4 Recyclability of Their Products and Life Cycle Considerations

The most important concerns in automotive industries are ‘protection of the resources’, ‘reduction of CO_2 emissions’, and ‘recycling’. There are some guidelines in Asian countries and European Union about this issue while the United States has not issued any regulations concerning automotive end of life requirements. For example, in the United Kingdom, around two million vehicles reach their end of life each year and these vehicles are considered as hazardous waste until they are been fully treated.

When a consumer decides not to use a vehicle anymore, the following options are available to be taken:

i. Sell the whole vehicle to another user.
ii. Disassemble the vehicle.