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MATERIAL SELECTION FOR NATURAL FIBRE COMPOSITE AUTOMOTIVE COMPONENT

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MATERIAL SELECTION FOR NATURAL FIBRE COMPOSITE AUTOMOTIVE COMPONENT

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DEDICATION

Special dedication to my beloved family members, my friends, my fellow colleague, my

supervisor and all faculty members.

For all your care, support and believe in me.

ABSTRACT

The conventional materials for automotive interior door panel was replaced with natural fibre composite materials selection in order to overcome the lack performance of premature product that easy to damage, risk the safety of consumers and to reduce the consumption of fuel that can affect the environment issue. As a result of extensive research and development, new natural fibre composite materials are selected based on the listed of product design specification for automotive door panel materials composite that have been proclaims by Borealis Group. The decision of selecting the composite materials was performed using an Analytic Hierarchy Process (AHP) method and the best volume of fraction and the stiffness of composite materials of a fibre and matrix for the selected composite materials will be calculated by using Rule of Mixture (ROM) method. The results show that flax fibre from natural (plant) fibre and polyamide (PA) matrix polymer is the best selection of material composite for vehicles interior door panel in automotive industries. The suitable volume of fraction of composite material for interior door panel is 10% of fibre with 90% of matrix. Borealis Group which proclaims the PDS value for automotive interior as the density < 1180 kg/ and young modulus > 2.3 GPa. The results show that the value of flax + PA was within the above mentioned in PDS value range. For conclusion, the reduction of density can reduce the weight of the vehicles and reduce the fuel consumption that can affect the environmental issues. Lastly, the highest properties of young modulus from composite materials also will able to give a good performance to produce the automotive interior door panel.

ABSTRAK

Bahan-bahan konvensional untuk bahagian dalaman jenang pintu automotif telah digantikan dengan pemilihan bahan komposit gentian asli supaya prestasi kekurangan produk pramatang yang mudah rosak, membahayakan keselamatan pengguna (pemandu dan penumpang) dapat diatasi dan mengurangkan penggunaan bahan api (daripada kenderaan) yang boleh menjejaskan isu persekitaran. Berdasarkan penyelidikan yang dilakukan, bahan komposit gentian asli yang baru dipilih berdasarkan senarai daripada spesifikasi reka bentuk produk untuk bahan-bahan jenang pintu automotif yang telah disenaraikan dan digunapakai oleh Borealis Group. Pemilihan bahan komposit dijalankan menggunakan kaedah Analytic Hierarchy Process (AHP) dan jumlah terbaik pecahan dan ketegaran bahan komposit pada satu gentian dan matriks untuk bahan komposit terpilih akan dikira dengan menggunakan kaedah Rule of Mixture (ROM). Analisis menunjukkan gentian pokok flaks daripada gentian asli (tumbuh-tumbuhan) dan polimer ,polimer matriks polimida (PA) adalah pilihan yang terbaik untuk dijadikan sebagai bahan komposit bagi bahagian dalaman jenang pintu kenderaan di dalam industry automotif. Jumlah yang sesuai bagi pecahan bahan komposit untuk jenang pintu kenderaan ialah 10% daripada gentian dan 90% daripada matriks. Nilai PDS bagi bahan komposit untuk jenang pintu kenderaan mengikut standard Borealis Group, ketumpatan (density) < 1180 kgm^3 dan young modulus > 2.3GPa. Hasil analisis menunjukkan bahawa nilai bahan komposit yang dipilih berada dalam lingkungan nilai PDS. Konklusinya, pengurangan ketumpatan (density) membantu untuk mengurangkan berat kenderaan sekaligus mengurangkan penggunaan minyak yang boleh menyebabkan pencemaran pada alam sekitar. Nilai young modulus yang tinggi juga oleh bahan komposit berupaya memberi prestasi yang baik dalam membuat bahagian dalaman jenang pintu kenderaan.

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SYMBOLS

CO^2	-	Carbon dioxide
%	-	Percentage
G	-	Gram
cm^3	-	Centimeter per cube
m^3	-	Meter per cube
MPa	-	Mega Pascal
GPa	-	Giga Pascal
m	-	Mass
kg	-	Kilogram
ρ	-	Density
V_f	-	Volume fibre
V_m	-	Volume matrix (polymer)

CHAPTER 1

INTRODUCTION

1.0   Introduction

This chapter discuss about the project material selection for natural fibre composite automotive component (interior door panel). The topics included in this chapter is background of study for the project, problem statement that need to overcome, objective of the project, scope of study in this project, project significance and thesis outline for every chapter had discusses. Every topic in this chapter leads to a basic of idea for the project report.

1.1   Background of Study

Nowadays, the uses of wrong material selection can lead to the premature product easy to damage and risk the safety to the consumers and the pollution from the consumption fuel of vehicle to the environment. In order to overcome these issues, replacing the available (traditional) material or improve the materials with the right selection is one of the ways to avoid and reduces risk of the problems. Sathaye (2015) stated recycled or biodegradable or energy recoverable material is the trend that automotive industry used to reduce the environmental issues. They used natural fibre composite in their vehicles as a ways to make the vehicle 'Green' in nature.

According to the author, natural fibre composite was an inevitable material to be used to create the environmental friendly products because this material offer a potential benefits such as lightweight and improve total green rating of the vehicles component.

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Balasubramanian, Sultan, Cardona, & Rajeswari (2016) described composite materials are the factitious materials that being used in manufactured as a way to replace the traditional materials to overcome the disadvantages not only in their manufacturing industry but also to reduce environmental issues.

The uses of natural fibre composite have a high potential in every components not only in automotive industries but also in other industries because their properties are environmental friendly. This is because the properties of natural fibre are strongly from natural product which is influenced by their growing environment origin based on animal and plant (Rijswijk & Brouwer, 2001a). Behzad & Sain (2006) described for the last a few years the uses of materials from natural fibres for polymer composite materials was increased massively especially in automotive industries. This is because the natural fibres composite materials offers a lot of advantages such as low density, less cost, high specific strength and environmental friendly.

For this project studied, natural fibre from plant based are focused more to make it composite with the polymer matrix for a selection material in automotive component (interior door panel). In order to make a selection material for vehicles interior door panel, smart techniques are used by following the specific design requirement to overcome the problem statement in this project.

1.2   Problem Statement

The wrong selection of material to make the automotive components (vehicles interior door panel) can cause the environmental issue and lack of performance of the vehicles door panel in automotive industries. The environment problem are most commonly cause by the fuel consumption of the vehicles. A lack of performance of the vehicle door panel also can affect the safety of consumers when the collision occurs. This

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problem can be minimized if the correct materials of natural fibre composite for vehicles door panel are being studied and are used based on their correct application in automotive industries.

Before the development of selection material from natural composite, the cost of production to manufacturer and the weight of the vehicles by using conventional material to create vehicles interior door panel is high and heavy. The weight reduction had been one of the main focuses of automotive industry in order to reduce the fuel consumption in which able conducted to the environmental issues. Thus, the best selection of the most suitable natural fibre composite materials will reduce the weight of the vehicles component because of their properties such as lighter weight, low energy consumption and low cost product.

Moreover, the risk of impact from high collisions of door panel when accident also will be able to reduce if the material for interior door panel is select from the suitable mechanical properties and characteristic of resultant composite based from the specification of requirement for vehicles interior door panel.

1.3   Objectives

The aim of this study is to select the suitable material from natural fibre composites with polymer matrix for producing vehicle interior door panel in automotive industries. Hence, the objective is:-

i.   To study the application of natural fibre composite in vehicles interior door panel.

ii. To select the suitable natural fibre composite for synthesize vehicles interior door panel.

iii. To predict the properties of resultant composite.

1.4 Scope of Study

The material selection process will be performed by using an Analytic Hierarchy Process (AHP) decision making tools to select suitable natural fibre composite according to product design specification of particular automotive component for interior door panel. The material selection process will performed in concurrent engineering environment. Based on the objectives, the scopes of study are highlighted as follows:-

i.   The applications of natural fibre composite are focuses in vehicles interior door panel.

ii. Materials from natural fibre composite based on plant are used as a selection material for vehicles interior door panel.

iii. The mechanical properties of resultant composite are predicted based on the specification requirement of the vehicles door panel.

1.5 Project Significance

The project will be significance endeavour in using the suitable natural fibre composite with matrix polymer to create the good vehicles interior door panel in automotive industries due to its mechanical properties and characteristics. The correct material selection will give beneficial to the production automotive which is reduced the lightweight of vehicles and increase the safety on risk of impact when accident. The lightweight vehicles will decrease the fuel consumption which is environment friendly and synchronize with the Green Technology concept for greater future.

1.6   Thesis Outlines

There are five (5) chapters in this project report included the introduction of the project, literature review in which the studies of related works with the project title from the previous study of the other authors, the method that had been used to implement the knowledge and make analysis into the project, discussion and result that get from the using tools and lastly, the conclusion that can be made based on the result and data.

Chapter 1: This chapter briefly discusses about the general ideas of the project included the introduction, background of study, problem statement, objective of the project, scope of the project, project significance, thesis outline and the expected result from the project.

Chapter 2: This chapter focuses deeply to study the literature review on the previous works from the other authors that related with this project. The previous works are important to give some idea, information and results based on their previous experiment and data. Then, it can help to relate the knowledge from the previous studies with this project.

Chapter 3: This chapter briefly discussed clarifications of methodology which is consist of flowchart of whole project and the descriptions of tools and technique that will be used to develop the project in order to solve the problem statements.

Chapter 4: This chapter are focuses to make a discussion based on the result and data that had been calculated using the selected materials by using the suitable tools or method in order to get the overall result for this project.

Chapter 5: This chapter are briefly concluding the overall input that get during the process to finish the project and suggestion for the future study.

CHAPTER 2

LITERATURE REVIEW

2.0   Introduction

In order to reduce the automotive weight and lower the risk of impact on the vehicle door panel, material type selection are considered as the main way to help achieve the goals of making the vehicles lighter and safer for the consumers. Materials are important and assume as a critical part in the economy, environment, defence and safety. According to Ji (2015) composite is one of the advanced materials other than high strength steel, aluminium, magnesium and so on with excellent performances to substitute traditional materials. This is because of the composite has a lot of benefits compared with the traditional materials (steel) such as higher strength and lower weight, better corrosion resistance, better energy absorption in case of impact and so on.

Chapter 2 contents of the definition about natural fibre reinforced polymer composite (NFRPC) and the types of natural fibre and their mechanical properties. Types of natural fibre from plant are research from the previous study and different research cases with the suitable types of polymer to ensure which types of composite fibre with matrix polymer are the best to use as a material for vehicles door panel. Based on cases study from Ji (2015) the vehicle door panel was not a simple panel but it is a substructure system that fulfil variety of functions because usually the structure of door panel are traditionally create with steel material. Besides that, the vehicle door panel are basically composed by an outer panel favour by an inner panel in which different kind of additional components are placed.

The material selections for vehicle interior door panel are important in structural component of automotives to avoid or deduct the risks of physical damage and for the safety of driver and passengers during at low speed collisions and high speed collisions. Nowadays, vehicles doors are complemented with a reinforcing element (side impact beam) placed between outer and inner panels' functions as to protect the driver and passengers in risk of a side impact accident (Ji, 2015).

Figure 2.1: Vehicle door panel deformation after crash. Source:

https://www.google.com/, accessed on April 26, 2018

The synergistic properties are prepared by natural fibre composite polymer matrix to improve their strength and endurance (E, A, & Tilahun, 2017). The best material selections from natural fibre composite for vehicle door panel also helped to reduce the automotive weight in which lighter vehicles lead to decrement of fuel consumption and could reduce the environmental issues such as emission of Green House Gas (GHG).

2.1   Natural Fibre Reinforced Polymer Composite (NFRPC)

Natural Fibre Reinforced Polymer Composites (NFRPC) are also called as Natural Fibre Composites (NFC) is the composite material that made of polymer matrix inner with

high strength natural fibres and usually the polymers are categorized into two categories, thermoplastics and thermosets (Mohammed, Ansari, Pua, Jawaid, & Islam, 2015). Composite is a combination of high mechanical and physical performance of fibres and the appearance, bonding and physical properties of the polymers. Composites is a hybrid materials that made of a polymer resin (such as epoxy, polyester and polypropylene) reinforced by fibre (such as glass, carbon, aramid and natural fibres) (Rijswijk & Brouwer, 2001b).

According to F.,& Dufresne (2011) the good properties and superior advantages of natural fibre over synthetic fibres in their physical properties such as low weight, low cost, less damage to processing equipment and have a good mechanical properties such as tensile modulus and flexural modulus, improved surface finish of molded parts composite, renewable resources being abundant will more easy to get attention in numerous applications of industry. Figure 2.2 shows the benefits of NFRPC in automotives.
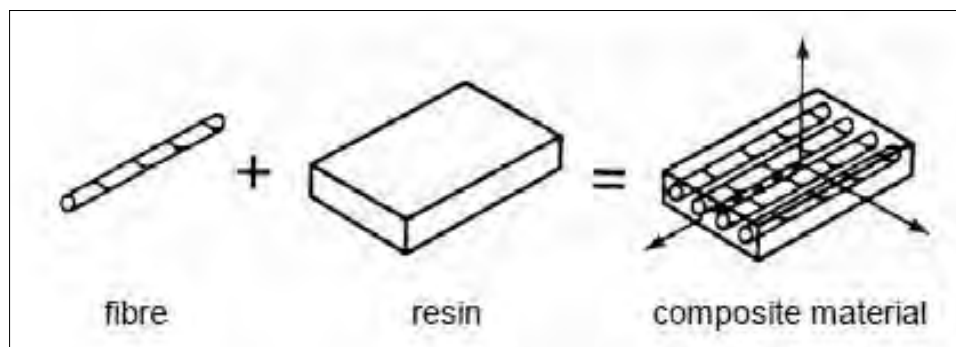

Figure 2.2: Composite composition. Source: Rijswijk & Brouwer, 2001b