THE APPLICATION OF PINEAPPLE FIBRE POLYPROPYLENE (PP) COMPOSITE FOR FABRICATION ON INTERIOR PART OF AUTOMOTIVE COMPONENT

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Draft Report
Projek Sarjana Muda 2

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MAY 2017

SUPERVISOR'S DECLARATION

I have checked this report and the report can now submitted to JK-PSM to be delivered back to supervisor and the second examiner

Signature :……

Name of Supervisor :……

Date :……

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovations).

Signature :. .....

Name of Supervisor : .....

Date : .....

DEDICATION

To my beloved mother, father, all my family members and my fellow friends.

Thank you so much for the support and sacrificing.

ACKNOWLEDGEMENT

Alhamdulillah, thanks to Allah S.W.T for giving me a chance to complete my research for this final year project with the title, “The Application of Pineapple Fibre Polypropylene (PP) Composite for Fabrication on Interior Part of Automotive Component”.

First of all, I would like to express my deepest appreciation to my supervisor, Dr. Mohd Ahadlin bin Mohd Daud for his valuable idea, advices, encouragement and guidance throughout completing this project for these two semester. Without his guidance and support, this research would not been the same and completed as presented here. Thanks also for others lecturer for their support and contribution for this research.

Secondly, truthful appreciations for the assistant engineers Mr. Rizal, Mr. Mahader, and Mr. Faizol for their guidance, support and knowledge that have been sharing since I started my project till the end. Also, not to be forgotten my personal in charged, (PIC), Miss Ayu Natasya for her supervision and interest to help me in handling this research.

Lastly, thank you so much to my beloved mother, father and all my family members for their moral support throughout completing this research. Not forgotten to all my fellow friends especially Nur Fadhilah Maidin and Nur Hidayah Saidin who always give a lot of support, sharing knowledge, and helping for each other for this project. Thank you so much.

ABSTRACT

Recently, natural fibre existed as outstanding materials which become an importance material to replace the luxurious and nonrenewable synthetic fiber. In recent years, many natural fibres such as sisal, banana, kenaf, oil palm and jute have been used as reinforcement in the thermoplastic composite. Furthermore, the process of compounded materials between natural fibre and thermoplastic are for the applying it in the manufacturing of automotive, construction, furniture and goods industry. Also, Pineapple leaf fibre (PALF) is the one of natural fibres which is having a good potential to reinforce with thermoplastic materials and create a new superior composite materials. Therefore, this phenomenon related with this research which is purposely to investigate the mechanical properties PALF reinforced with polypropylene (PP) as a matrix with varying fiber weight fraction, to identify the physical properties of PALF reinforced with PP and to analyze the microstructure of PALF/PP composite. The process was starting with preparation from raw pineapple leaf and then treated with alkaline treatment. PALF and PP were compounded using hot compression process by using hot press and cooling machine to create a sample. The samples were prepared according to the standard requirement to perform for tensile test (ASTM D3039), density test (ASTM D792) and hardness test (ASTM D2240). For scanning electron microscope (SEM), is used to investigate the composition structure between fibre and matrix composite. Based on the result, it was found that tensile test and maximum load towards PALF/PP composite was decreasing linearly with increment of fibre loading. However, the trend for hardness and density was increasing linearly as the fibre loading increased. From this study, can be identified that 10 wt% of fibre loading is the best achiever for the composition structure of PALF/PP composite.

ABSTRAK

Sejak kebelakangan ini, gentian asli telah muncul dan dikenali sebagai bahan yang terunggul di mana menjadi bahan yang terpenting dalam menggantikan gentian sintetik yang mahal serta tidak boleh diperbaharui. Sejak kebelakangan baru-baru ini, Banyak gentian asli seperti sisal, gentian daripada pisang , kenaf, gentian daripada kelapa sawit dan jut telah digunakan sebagai bahan pentetulang di dalam komposit termoplastik. Tambahan lagi, proses menyebatikan bahan-bahan di antara gentian asli dan termoplastik adalah untuk diaplikasikan di dalam proses pembuatan industri automotif, pembinaan, perabot dan barang-barang keperluan. Juga, Gentian daun nenas (PALF) adalah salah satu daripada gentian asli yang mepunyai potensi yang baik untuk dijadikan sebagai pentetulang untuk komposit termoplastik dan menghasilkan satu bahan komposit yang baru serta unik. Oleh itu, fenomena ini berkait dengan kajian ini yang bertujuan untuk mengkaji sifat-sifat mekanikal apabila PALF mengukuhkan polipropilin (PP) yang merupakan matrik berdasarkan kuantiti pecahan gentian yang berbeza, untuk mengenalpasti sifat-sifat fizikal apabila PALF mengukuhkan PP serta untuk menganalisis microstruktur komposite PALF/PP. Proses dimulakan dengan penyediaan daun nenas dan dirawat dengan rawatan alkali. PALF dan PP disebatikan dengan menjalani proses pemanasan pemampatan dengan menggunakan mesin pemanas dan penyejuk untuk menghasilkan sampel. Sampel-sampel disediakan mengikut keperluan piawaian untuk menjalani ujian ketegangan (ASTM D3039), ujian ketumpatan (ASTM D792) dan ujian kekerasan (ASTM D2240). Untuk mikroskop elektron pengimbas (SEM) telah digunakan untuk menyiasat komposisi struktur kompositdi antara gentian dan matrik. Berdasarkan kepada keputusan yang diperolehi, telah didapati bahawa ujian ketegangan dan pendayaan maksimum terhadap komposit PALF/PP mempunyai keputusan yang menurun selari dengan peningkatan muatan gentian. Walaubagaimanapun, tren untuk kekuatan dan ketumpatan meningkat selari dengan peningkatan muatan gentian. Daripada kajian ini, boleh dikenalpasti bahawa 10 wt% adalah muatan gentian yang paling terbaik untuk struktur komposisi komposit PALF/PP.

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LIST OF SYMBOLS AND ABBREVIATIONS

PP	-	Polypropylene
PS	-	Polystyrene
WPCs	-	Wood Plastic Composites
BD	-	Board Density
MR	-	Mixing Ratio
NaOH	-	Sodium Hydroxide
ASTM	-	American Society for Testing and Materials
SEM	-	Scanning Electron Microscopy
PMC	-	Polymer Matrix Composite
FRP	-	Fibre Reinforced Polymer
PUR	-	Polyurethane Thermoplastic
WPALFM	-	Woven Pineapple Leaf Fibre Mat
HIPS	-	High Impact Polystyrene
UV	-	Ultraviolet
PVA	-	Polyvinyl Alcohol
PALF	-	Pineapple Leaf Fibre
PALFs	-	Pineapple Leaf Fibres

CHAPTER 1

INTRODUCTION

1.1 Background

Natural fibres are generally known as vegetables fibres that are extracted from the fruit, phloem or leaf of the plant. Recently, many types of natural fibres being study to strengthen with polymer such as flax, hemp, jute, straw, wood fibre, rice hunks, cane for sugar and bamboo, grass, reeds, ramie, oil palm empty fruit bunch, sisal, coir, kapok, banana fibre, pineapple leaf fibre and papyrus. These natural fibres are the most widely used in the composite technology such as fabrication on interior part of automotive components and building construction material. People like to use these natural fibres to replace the synthetic materials which are not renewable and unfriendly environmental.

Natural fibres are gradually being used as reinforcement in thermoplastic and thermoset market. Many researchers have carried out studies about natural fibres to ensure the potential of these fibres to be reinforced in thermoplastics and thermoset which can be applied in industries. Generally, the most thermoplastics and thermoset that usually been used are polypropylene (PP), polystyrene (PS), polyester, epoxy, and polyethylene (PE). One of the studies that related about PP has been carried out by (Dikobe & Luyt, 2009)on morphology and properties of polypropylene was found out that polypropylene (PP) is one of the most product polymers and used in many areas, such as home appliances,

automotive components and industrial applications. PP's applications are often limited due to its low impact strength, Young's modulus properties, low temperature and high temperature loading conditions. Hence, the effective way to improve the properties of PP by blending with different polymers is an economic.

Composites can be defined as combinations of two or more materials that for better results in properties than individual materials. The good things about combination of materials are their high strength and stiffness. (Campbell, 2010) carried out studies about composite materials has been found out reinforcement between fibre and polymer usually is harder, stronger, and stiffer than matrix. Fibres produce high strength composites because of their small diameter. However, polymers have low strength and stiffness but high ductility. In the studies, the composite materials between fibre and polymers shows a good results which is lighter weight, optimum strength and stiffness, improved fatigue life and corrosion resistance. (Falemara & Owoyemi, 2015) also found out on strength and sorption properties of bamboo (Bambusa vulgaris) wood fibres reinforced with plastic composites. The studies identified that wood plastic composites (WPCs) as sustainable materials, resistant to insects, marine borers and rot when used for structural members. In this study also found out, that WPCs produced at the highest Board Density (BD) 700kg/m^3 and highest mixing ratio (MR) of 3:1 showed as the highest dimensional stability and thickness reduction.

Pineapple is the second highest tropical fruit commercially produced in the world, around 25.1 million metric tonnes. The pineapple leaf fibre is one kind of fibre derived from the leaves of the pineapple plant. The leaf shape of pineapple look like a sword that taper at the ends with black and green colours on the edges of the leaves are sharp thorn. In addition, to obtain a strong fibre, soft and smooth, the selection should be done in pineapple leaves enough and protected from the sun. Pineapples leaf fibres reveal excellent properties which are high cellulose content and moderately low microfiber angle. Pineapple leaf fibres are a waste product of agriculture and can be obtained without high additional cost input for industrial purposes. Therefore, many researchers discover and carried out research to investigate effect and benefits of pineapple leaf fibres reinforce in thermoplastics and thermoset.

(M Asim et al., 2015) presented about mechanical properties of pineapple leaf fibres reinforced composites on a review on pineapple leaves fibre and its composites. In a study of stress behaviour of pineapple leaf fibre reinforced polyethylene composite, stress is inversely proportional fibre content. The tensile and bending properties of composites are depending on volume fraction. This study showed very useful with high quality strength of composites. Recently, pineapple leaf fibres used in making for textile fabrics, sports item, automobiles, cabinets, and mats. This fibre also is used in making machinery parts such as belt cord, conveyor belt cord, transmission cloth, air-bag tying cords, and some cloth for industry uses. This fibre good in making carpet because its chemical processing, dyeing behaviour and appealingly pleasing fabric. The pineapple leaf fibre is the highest cellulosic content and also highest tensile strength which is suitable for its application such as building and construction materials, cabinets and automotive components.

(Saxena & Pappu, 2011) presented about recent trends and future potentials on composite materials from natural resources which discovered about benefits of natural fibre reinforce polymers composites. This substitution offer many advantages such as lower cost, energy saving, reduced tool wear and tear, high stability for manufactured parts, good insulation properties, renewable, easy to recycle, no toxicity material and reduced fossil fuels. This natural fibre also used in automobile for example trim parts, various panels, shelves and brake which are attracting in automobile industries because of its reduction in weight 10%, energy production 80% and cost reduction 0f 5%.

Based on the findings, pineapple leaf fibres as natural fibre have a good potential used as a reinforcement of polymer composites. Few researchers have presented composites by using natural fibre such as oil palm and bamboo fibre. Therefore, this research interest to study the mechanical properties of pineapple fibre PP composites that applied on fabrication on interior part of automotive components by verified the properties through physical and mechanical test.

1.2 Problem Statement

Nowadays, it is becoming a trends about people bought any kind of car from different brand and the popular brands of automobile also competes each other to launch new cars with diverse kind of sophisticated features. Mostly, automobile industries nowadays used synthetic materials for fabrication part of automotive components including iron, aluminium, plastic steels, glass, rubber, petroleum products, copper, steel and others. These parts are used to create dashboard needles, wiring, engine block and transmission gears. However, the important concerns about the synthetic materials are increasing price of petroleum and depletion of fossil fuels. All this problem can be solved by replace the synthetic materials with natural fibre composites which can reduce environmental stress. The natural fibre composites much more light weight, renewable, environmental friendly and low cost. Due to the advantages of natural fibres' properties, this research is all about to identify the mechanical and physical properties of natural composites if it is good or not to be applied in the automotive industry.

1.3 Objectives

1.3.1 To investigate the mechanical properties pineapple leaf fibre reinforced with polypropylene (PP) as a matrix with varying fibre weight fraction

1.3.2 To identify the physical properties of pineapple leaf fibre reinforced with polypropylene (PP)

1.3.3 To analyse the microstructure of PALF/ PP composite

1.4 Scope

The scopes of research are:

1.4.1 Preparation of pineapple leaf fibre (PALF) – fibre extraction from leaf

1.4.2 Treatment of fibre – alkaline treatment (NaOH solution)

1.4.3 Preparation of polypropylene(PP)

1.4.4 Preparation of sample (composite material) - Compounding of PALF and polypropylene polymer by using manual mixer and hot press machine

1.4.5 Testing to find out mechanical properties

i. Tensile test (ASTM D3039)

1.4.6 Testing to find out physical properties

i. Density test (ASTM D792)

ii. Hardness test (ASTM D2240)

iii. Microstructure analysis (SEM)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Definition a composite material is a combination of two or more different materials to create unique and superior materials. There are several composite of classifications. The most common is Polymer Matrix Composite (PMC) or Fibre Reinforced Polymers (FRP). For this classification, polymer is used as the matrix and natural fibre as reinforcement. The fibres are usually glass, carbon and natural fibres. For the polymers that commonly used are polypropylene, polyethylene (thermoplastics) and epoxy, polyester (thermosets).

(Mrazova, 2013) carried out study about advanced composite materials of the future in aerospace industry which have mentioned there that composite material is a material that consists of strong carry load materials that reinforced with some weaker material. The stronger one is referred to the reinforcement while the weaker is referred to matrix. The role of reinforcement is to provide the strength and stiffness which helps to support the structural load. However, the matrix is responsible in maintaining the position and orientation of the reinforcement.

Table 2.1: Advantages and disadvantages of composite materials (Mrazova, 2013)

Advantages	Disadvantages
i. Weight reduction which saving in the range 20% to 50%	i. Some higher recurring cost
ii. Mechanical properties can be tailored with tapering thicknesses of reinforcing cloth and cloth orientation	ii. Higher nonrecurring costs
iii. High impact resistance for armor shields planes which reducing accidental damage to the engine pylons	iii. Higher material costs
iv. High damage tolerance improves accident survivability	iv. Non visible impact damage
v. Galvanic electrical can avoided the corrosion problems which would occur when two dissimilar metals are in contact. Here nonconductive glass fibre plays a roll.	v. Isolation is needed to prevent adjacent aluminium part galvanic corrosion.
	vi. Repairs are different than those to metal structure

Based on the studies by (Lopresto et al, 2016) has mentioned that composite materials are made of two or more different materials to create properties that cannot be obtained from any one material component alone. In the composite, one of the materials is performed as matrix while the other one is performed as reinforcement. The properties of composite material are depends on the nature reinforcement and matrix. However, the composite can be tell they are combination between two materials but they do not dissolve or blend into each other easily, the materials need to undergoes several process before it become a new composite material.

Refer to the (Aparecido et al, n.d.) study, the use of natural composites can provides many benefits when applied it towards technologies industry. Nowadays, automotive industry is shifting to Eco green outlook which to fulfil the customer requirement that is looking for ecologically vehicles. Materials that applied on car are renewable natural resources, biodegradable and recyclable. In addition, in the automotive industry, the application for this natural composite has grown so fast which are not structural components only but also in finishing parts.

Recent research and development (Aková, 2013) shown that composite materials are increasingly used in the automotive and construction industries. The composite materials are chemically treated to highly cross linked or three dimensional network structure which is highly solvent resistant, tough and creep resistant. Thermoplastics are more advantageous than thermoset because it has low processing cost, ease of moulding complex parts, flexible, tough and show good mechanical properties.

Table 2.2: The Applications of Natural Fibres in Automotive Industry
(Aková, 2013)

Automotive Manufacturer	**Model Applications**
i. AUDI	A2, A3, A4, A6, A8, Roadster, Coupe, Seat backs, side and back door panels, boot lining, hat rack, spare tyre lining
ii. BMW	3, 5, 7 series Door panels, headliner panel, boot lining, seat backs, noise insulation panels
iii. CITROEN	C5 Interior door panelling
iv. FIAT	Punto, Brava, Marea, Alfa Romeo 146, 156

v. LOTUS	Eco Elise Body panels, spoiler, seats, interior parts
vi. PEUGEOT	406 Seat backs, parcel shelf
vii. RENAULT	Clio, Twingo Rear parcel shelf
viii. ROVER	2000 and others Insulation, rear storage shelf/panel
ix. SEAT	Door panels, seat backs
x. TOYOTA	Brevis, Harrier, Celsior, Raum Door panels, seat backs, spare tyre cover
xi. VOLKSWAGEN	Golf, Passat, Bora Door panel, seat back, boot lid finish panel, boot liner
xii. VOLVO	C70, V70 Seat padding, natural foams, cargo floor tray
xiii. FORD	Mondeo CD 162, Focus

Based on table above, natural fibre composites are commonly used for manufacturing many components in the automotive sector. This is because the characteristic of natural composite fibre composites are highly ultimate breaking force and higher impact strength. Plant fibres are mainly used in this manufacture because of its reduction in weight about 10%, energy production of 80% and 5% cost reduction. (Aková, 2013)

2.2 Natural Fibre

Fibre can be defined as hair-like materials that are continuous filament or discrete elongated pieces which is similar to pieces of thread. The fibres can be spun into filaments, thread, rope and also be matted into sheets to make paper or felt. Fibres can be used as a component of composite materials. Fibres consists two types; there are natural fibres and synthetic fibre. For this research, just focus on natural fibres as constituent for composite materials.

Natural fibres is a substance that produced by plants and animals. The most viable structure fibres typically derive from specifically grown textile plants and fruit trees. Nowadays, natural fibres are more modern than they have ever been as they exposed their outstanding mechanical properties and 100% sustainable. Natural fibre composites with important reduction in weight became a serious alternative to conventional composite materials like glass and carbon fibres. However, natural fibre reinforced composites are more or less sensitive to humidity through absorption of water which is leading to physical degradation such as differential swelling between fibres and resin.

Refer to the research by (Ticoalu et al, 2010) shown that fibre composites offer many advantages such as high strength, light weight, water resistance, chemical resistance, high durability, electrical resistance, fire resistance and corrosion resistance. Natural fibres can be source from plants or animals that are not synthetic. Natural fibre reinforced thermoplastic have been used in automotive application while for infrastructure mostly made out of thermoset resin. From this research, there are several reviews about natural fibre composite for structural and infrastructure applications. One of them is application of natural fibre composite in the development of structural beams and pedestrian bridge which requires low to moderate design loads. By applying the natural fibre composite can lower the density, cost and environmental benefits.

From (Joshi et al, 2004) research, natural fibre composites is environmentally superior in most application. Natural fibre composite also has higher fibre content for equivalent performance which reduces the amount of polluting base polymers. In auto applications, lower weight of natural fibre composites improve fuel efficiency and reduce emission of components. In the future, the natural fibre composites can be more popular in

every sector because they are cheaper, lighter and environmental friendly. Therefore, the future research should focus on achieving equivalent or superior technical performance and component life.

Based on (Sanjay et al, 2016) research in the title of applications of natural fibres and its composites shows that the application natural fibres widely used in many sectors such as automobile, furniture, packing and construction due to their advantages which are low cost, low weight, less damage to processing equipment, improve surface finish of moulded parts composite, good relative mechanical properties, abundant and renewable resources. The natural fibres qualities strongly is because of growing environment, age of plant, species, temperature, humidity and quality of soil. Furthermore, in the United States, straw bales as composite materials are being used in construction of building. For automotive sector, many components of car mainly based on polyester or polypropylene and fibres like flax, hemp or sisal. The uses of natural fibre in the automotive industry, because of price, weight reduction and marketing. In German, the auto manufacturers have taken natural fibres composites for interior and exterior applications such as 35% Baypreg F semi rigid polyurethane thermoplastic (PUR) elastomer from Bayer and 65% blend of flax, hemp and sisal.

2.3 Pineapple Leaf Fibre (PALF)

PALF is referred to vegetable fibre that extracted from the leaves. The surface of this fibre is rough and rough. This fibre was obtained from the leaf of the plant *Ananas cosomos* belonging to *Bromeliaceae* family. PALF is showing superior mechanical properties, they have potential as reinforcing in thermoset, thermoplastics and elastomers. These fibres show high ultimate tensile strength and initial modulus because they have high cellulose content and low microfiber angle. PALF can easily obtained and possess excellent mechanical properties.

(Mohammad Asim et al, 2016) carried out study that PALF are consisted by cellulose (70% - 82%), lignin (5% - 12%), and ash (1.1%). PALF are capable for making high quality of polymer composites because they have good mechanical properties which are tensile flexural and impact strength.