EFFECT OF PINEAPPLE LEAF FIBER LENGTH ON THE PROPERTIES OF PINEAPPLE FIBER – STARCH COMPOSITES

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Draft Final Report
Projek Sarjana Muda II

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JUNE 2015

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This report is presented to fulfil part of the requirement for my Degree of Bachelor in Mechanical Engineering (Structure & Materials)

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JUNE 2014

SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis 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 (Structure and Materials)"

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Date : MAY 2015

DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature :

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ACKNOWLEDGEMENT

First and foremost, Alhamdulillah and full of gratefulness to Allah the Almighty for his kindness and bless that helps me to finish the Final Year Project Report fluently and successfully. To my family, lots of thanks for supporting me through the whole processes of my Final Year Project and lots of thanks to Universiti Teknikal Malaysia Melaka (UTeM) for giving me an opportunity and chances to full fill my Final Year Project report.

I would like to express my deepest gratitude to my advisor, Dr. Zulkiefli Bin Selamat for his excellent guidance, caring, patience, providing full information and ideas since the day I started to prepare the report until the end of the preparation of the report. I'm very thankful for his invaluably constructive criticism and advice in order for me to finish up this report.

Besides, many thanks to committee members of Final Year Project, technician in Fasa B, Ms. Ayu Natasha master students that providing guidance, and providing helps the whole process of this course nicely and smoothly. I am also using this opportunity to express my warm gratitude to everyone who supported me throughout this report. I am very thankful for their aspiring guidance and friendly advice during preparing the report.

ABSTRACT

Nowadays, increasing in researcher about renewable natural fiber had been done in order to become one of the alternative solutions in replacing the synthetic fiber such as glass fiber as reinforced composites materials due to non – biodegradable and non – ecofriendly to the system. Besides, the natural fibers have low cost of production yet have good set of mechanical properties and environmental friendly. Wide industry had chosen the natural fiber as an alternative in developing their product. For example, Mitsubishi Company had used natural fiber to build the interior part of compartment in their car design. One of the natural fiber resources is pineapple leaf fiber (PLF) that had been planted widely in Malaysia. From the current research, PLF contain high cellulose and exhibit good mechanical properties especially from Josapine family. Therefore in this study, the PLF from Josapine was used as reinforced materials and the binder was corn starch (SH) and the effects of the PLF loading and PLF fiber length on the mechanical properties of PLF/SH composites also have been analyzed. Compositions were fixed for 50/50, 60/40 and 70/30 followed by 2 cm, 4 cm and 6 cm of PLF length. PLF has been undergo alkaline treatment to increase the strength of fiber than proceed to extraction and composition process. All nine samples have been undergo four different tests to determine the mechanical properties which are tensile test, hardness, density and microstructure analysis. PLF loading of 70% with 6 cm in length shows the higher values of tensile stress, density and hardness which are 32.98 MPa, 33.63 and 1.20 g/cm^3. Besides, it also shows good adhesion between the PLF and the SH matrix.

ABSTRAK

Dewasa kini, penggunaan bahan serat dari alam semula jadi telah mendapat perhatian yang tinggi dari para penkaji bagi menggatikan penggunaan serat sintetik sebagai bahan pengukuh ini kerana, bahan ini memberikan kesan yang buruk kepada alam sekitar tidak seperti bahan serat dari sumber semula jadi. Selain itu, serat dari alam semula jadi ini juga rendah kos pengeluaraan, mempunyai ciri – ciri mekanikal yang sangat baik dan tidak memberi kesan bahaya kepada persekitaran. Industri terkemuka juga telah banyak menggunakan bahan serat dari alam semulajadi sebagai salah satu bahan yang digunakan untuk menghasilkan produk mereka. Sebagai contoh, syarikat pengeluar kereta terkenal Mitsubhisi telah menggunakan bahan serat semula jadi bagi bahagian dalaman kereta mereka. Di Malaysia, industri pengeluaran buah nenas semakin berkembang maju akan tetapi, industri ini hanya memfokuskan kepada penghasilan buah sahaja. Berdasarkan kajian yang terkini, serat dari daun nenas mempunyai kandungan selulosa yang tinggi dan mempunyai ciri – ciri mekanikal yang sangat baik terutamanya dari jenis Josapines. Oleh itu, dalam kajian ini serat nenas dari jenis Josapines akan digunakan sebagai bahan pengukuh manakala bahan matrik adalah dari sagu jagung. Kajian ini juga akan mengkaji tentang panjang serat dan kandungan serat daun nenas terhadap komposisi PLF/SH. Komposisi akan ditetapkan pada 50/50, 60/40 dan 70/30 manakala panjang serat adalah 2 cm, 4 cm dan 6 cm. Bagi meningkatkan kekuatan serat tersebut, serat nenas akan menjalani proses rawatan kimia sebelum proses pembuatan. Kesemua sembilan sampel akan menjalani empat ujian yang berbeza bagi menentukan ciri – ciri mekanikal komposit tersebut. Berdasarkan hasil ujian, kandungan serat nenas 70% dan panjang serat 6cm memberikan hasilkan yang paling tinggi iaitu 32,98 MPa, 33.63 dan 1.20 g/cm^3 bagi daya ketegangan, kekuatan dan kepadatan. Selain itu, ia juga mempunyai daya lekatan yg baik.

TABLE OF CONTENT

CHAPTER	CONTENT		PAGE
	DECLARATION		**i**
	ACKNOWLEDGMENT		**ii**
	ABSTRACT		**iii**
	ABSTRAK		**iv**
	TABLE OF CONTENT		**v**
	LIST OF FIGURES		**ix**
	LIST OF TABLES		**xi**
	LIST OF SYMBOLS		**xii**
CHAPTER 1	**INTRODUCTION**		**1**
	1.1	OBJECTIVE	2
	1.2	PROBLEM STATEMENT	3
	1.3	SCOPE	4

CHAPTER 2	**LITERATURE REVIEW**		**5**
	2.1	COMPOSITES	5
	2.2	REINFORCEMENT	7
	2.3	NATURAL FIBER	8
	2.4	MATRIX (BINDER)	13
	2.5	FIBER LENGTH	16
	2.6	FIBER EXTRACTION METHOD	16
		2.6.1 Chemical Treatment	19
	2.7	TESTING	22
		2.7.1 Tensile Test	22
		2.7.2 Density Measurement	23
		2.7.3 Hardness Test	24
		2.7.4 Microstructure Analysis	25
CHAPTER 3	**METHADOLOGY**		**27**
	3.1	EXPERIMENTAL OVERVIEW	28
	3.2	MATERIAL SELECTION	29
	3.3	COMPOSITION OF MATERIALS	30
	3.4	CHARACTERISTIC AND MECHANICAL PROPERTIES OF PINEAPPLE LEAF FIBER	30
	3.5	PROCESSING METHOD	32
		3.5.1 Chemical Treatment	33

		3.5.2 Matrix Preparation	34
		3.5.3 Determine Appropriate Parameter	36
		3.5.4 Compression Moulding	39
		3.5.5 Cutting Process	43
	3.6	MECHANICAL TESTING	44
		3.6.1 Tensile Test	44
		3.6.2 Hardness Test	47
		3.6.3 Density Measurement	48
		3.6.4 Microstructure Analysis	49
CHAPTER 4	**RESULT AND ANALYSIS**		**51**
	4.1	TENSILE TEST	51
		4.1.1 Result	52
	4.2	SHORE HARDNESS TEST	55
		4.2.1 Result	56
	4.3	DENSITY	57
		4.3.1 Result	58
	4.4	MICROSTRUCTURE ANALYSIS	60
CHAPTER 5	**DISCUSSION**		**62**
	5.1	EFFECT OF PLF LENGTH BASED ON PLF LOADING ON TENSILE	62

	5.2	EFFECT OF PLF LENGTH BASED ON PLF LOADING ON HARDNESS	64
	5.3	EFFECT OF PLF LENGTH ON PLF LOADING ON DENSITY	66
	5.4	MICROSTRUCYURE ANALYSIS	67
	5.5	COMPARISON RESULTS WITH OTHER RESEARCH FINDING	69
CHAPTER 6	**CONCLUSION AND RECOMMENDATION**		**70**
	6.1	CONCLUSION	70
	6.2	RECOMMENDATION	72
	REFFERENCES		**73**
	APPENDIX		**79**

LIST OF FIGURES

FIGURE	TITTLE	PAGE
2.1	Josapine Pineapple.	12
2.2	Cross – Section of Large Bundle of Josapine Leaf Fiber	12
2.3	Pineapple Leaf Fiber	12
2.4	Scrapping Operations Roller	18
2.5	Process of Extracting using Ceramic Plate	18
2.6	The Kenaf Extractor Machine	19
2.7	Dried Process of Fiber under Solar Drying House	19
2.8	Example of Sodium Hydroxide Solution	21
2.9	Example of Hydrochloric Acid Solution	21
2.10	Exampled of Distilled Water	22
3.1	Flowchart of the Process	28
3.2	The dried PLF after completed the Alkaline Treatment	33
3.3	The Separating PLF	34
3.4	Starch in Pallets Form	35
3.5	Starch in Liquid Form	35
3.6	First Trial Sample	37

3.7	Second Trial Sample	37
3.8	Third Trial Sample	38
3.9	Sample in the Mould Before Compression Process	40
3.10	The Hot Press Machine	40
3.11	Dimension of the Specimen According to the Standard	44
3.12	Dimension of the Specimen for Tensile Test	45
3.13	Universal Testing Machine (Instron 5585)	45
3.14	The Mounted Sample on the Machine	46
3.15	The Fracture Sample	46
3.16	The Analogue Hardness Shore D	47
3.17	Procedure to Measure the Hardness Shore Scale	48
3.18	Electronic Densimeter	49
3.19	Zeiss LSM 510 Inverted Microscope.	50
4.1	Graph of Tensile Stress (MPa) against PLF Loading (%)	53
4.2	Graph of Young Modulus, E (GPa) against PLF Loading (%)	54
4.3	Graph of Strain, ε against PLF Loading (%)	55
4.4	Graph of Hardness (Shore –D) against PLF Loading (%)	57
4.5	Graph of Density (g/cm^3) against PLF Loading (%)	59
5.1	Graph of Tensile Stress (MPa) against PLF Loading (%)	64
5.2	Graph of Shore Hardness – D against PLF Loading (%)	65
5.3	Graph of Density (g/cm^3) against PLF Loading (%)	66

LIST OF TABLES

TABLE	TITTLE	PAGE
3.1	The composition of PLF/SH	30
3.2	General properties of PLF	31
3.3	Properties of Specific Cultivars of PLF	31
3.4	Mechanical Properties for Specific Cultivars of PLF	32
3.5	Samples of Trial Experiment to Determine Parameters	37
3.6	Mass of PLF and SH according to the Composition	39
3.7	Total Nine Samples according to Composition With Length	41
4.1	Data of Tensile Test	52
4.2	Data of Hardness Test	56
4.3	Data of Density Test	58
4.4	The Microstructure View for Each Length Followed By PLF Loading (%).	60
5.1	Microstructure View for Each Length Followed by PLF Loading (%)	68
5.2	Finding Obtained by Other Researcher	69

LIST OF SYMBOLS

GF	=	Glass Fiber
FRP	=	Fiber Reinforced Plastic
PLF	=	Pineapple Leaf Fiber
SH	=	Starch
CO_2	=	Carbon Dioxide
MPa	=	Mega Pascal
GPa	=	Giga Pascal
%	=	Percent
wt%	=	Percentage
^0C	=	Celcius
cm	=	Centimeter
g	=	Gram
m	=	Meter
μm	=	Micrometer
E	=	Young Modulus
ε	=	Strain
σ	=	Tensile Stress

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION.

Green composites are an idea of the combination of two or more natural resources materials basically made up of two materials that are Fibers/Reinforced and Matrix/Binder. This combination will give unique properties especially in mechanical properties where thus properties are difference from their each material. The examples of Fibers/Reinforced materials are extraction of natural fiber from various sources such as banana leaf, pineapple leaf, kenaf, bamboo and coconut. The example of Matrix/Binders materials are starch, epoxy, polypropylene and etc. In the past history, the mankind had been used the composites materials as innovation to improve the quality of life. For example, to make the mud bricks become more studier, the mud will be combined with the straw that is also known as adobe. In this case, the mud will become the binder by holding the straw together. Therefore it will increased the strength of the construction of the building itself.

Nowadays, natural fibers or green composites are being increasingly used as reinforcement in polymer composites and have high potential in replacing the fiber glass reinforced composites. This is due to their low cost, low density but have good sets of mechanical properties compared to fiber glass reinforced composites. On top of that, natural fiber offer many technological and environmental benefits when it used in reinforced composite such as high strength and good in stiffness quality even though it has low density. Besides, natural fibers are comes from many resources that are originally from the contained of fiber in the plant itself such as bamboo fiber, coconut fiber, pineapple leaf fiber, hemp fiber and jute fiber. Nowadays, many industrial or companies have been changed in using the natural fiber composites as one of the materials used in their production.

For example, Mitsubishi that is worldwide automotive company try to used bamboo fiber to produce automobile interior part and many more. In addition, from the previous research that had been done, it shows that the natural fiber consume lesser energies during production, cause lesser abrasion to the machines and no risk to human health especially during inhalation. Other than that, it also contained less carbon dioxide imitation and biodegradable that make it more environmental friendly to the earth. Moreover, based on previous study, the natural fibers also have good thermal permeability and the strength of the fiber will be increased if it undergoes a chemical treatment.

1.1 OBJECTIVES.

There are two main goals to achieve in this project:

i. To determine the effect of pineapple leaf fiber (PLF) loading on properties PLF/Starch (SH) composite.
ii. To study the effect of PLF length on the properties of PLF/SH composite.
iii.

1.2 PROBLEM STATEMENT.

Recently, natural plant fibers have been used in scientific researches as potential alternatives to glass fibers (GF) in fiber-reinforced plastics (FRP). Relative to glass fibers, these lignocellulose fibers have lower densities, cost relatively lower, consume lesser energies during production, pose no abrasion to machines and have no health risk when inhaled. Furthermore, natural fibers are also widely available, renewable, recyclable, and biodegradable and made of carbon dioxide (CO_2) neutral (Wambua et al. 2003). The used of synthetic fiber as reinforced composites will affect the environment and cause pollution to the soil as there are non-renewable, non-biodegradable and not eco- friendly even though it has good mechanical properties (Abdul Khalil et al. 2006). In Malaysia the focus of pineapple industry is the fruit and somehow produced abundant of bio waste inform of leaves mainly composted or burned thus wasting the good potential of fiber sources. The burning process of the leaves will leads to environmental pollution problems (Mohamed et al 2009 & Mohanty et al. 2005).

From a large selection of plant fibers, pineapple leaf fibers (PLF) obtained from the leaves of pineapple plant of Josapine have the highest cellulose contents which make the fibers mechanically sound (Vinod et al. 2013). Pineapple Leaf Fiber exhibit excellent mechanical properties due to rich cellulose content of more than 70% which are potential to be used as reinforcement in polymer composites (Mohamed et al. 2010). Therefore, the combination of pineapple leaf fiber used as reinforce material and the starch based composite as the matrix materials that are totally both green composites materials used to produce PLF/SH composite may reveal a good potential result in mechanical properties especially for plastic industries product.

1.3 SCOPE.

This research will study the effects of PLF loading and PLF fiber length on the mechanical properties of PLF/SH composites. The various ratio of PLF/SH composite will be selected and the ratio of composition in the PLF/SH composite was fixed at 70:30, 60:40 and 50:50. Meanwhile the PLF length will be fixed with the length of 2 cm, 4 cm and 6 cm. An alkaline treatment will be conducted to extract thin PLF bundles and enhance the PLF properties before the formation process of PLF/SH composite used hot press. The mechanical properties of the PLF/SH composites will be determined used tensile test, flexure test, hardness test, density measurement and microstructure analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 COMPOSITES.

As many years before, the mankind had been aware of the function of composites materials. For example, ancient pharaohs made their slaves used bricks with straw to make the make the building become more studier and even last longer. The cotemporary composites are come from the continuous research and innovation for the past few decades that produce glass fibers used as automobile bodies to particulate composites for the aerospace and the other application. (iitk.ac 2004)

Composites can be defined as multifunctional material systems that provide characteristics that not obtainable from any discrete material. Other than that, the combination of the materials itself has its own unique properties. For example, in terms of its strength to resistance to heat or other desirable properties it is better than the single components. (Kelly 2011)

Composites also can be defined as material system that consist one or more discontinuous phases embedded in continuous phase. In order to form the composites, it needs two types of different materials that are completely immiscible and combine together. The continuous phases are in termed of matrix while the discontinuous phases come from the reinforcing agent or filler. The plasticizers, pigment, heat and light stabilizers are commonly added to provide certain unique properties needed. (Rosa D.D.S and Lenz D.M 2013)

Generally green composites also known as biopolymers reinforced with natural fiber that are more environmental friendly compared to fiber reinforced plastics. Other than that, green composites are also widely used in application range thus contribute rapidly growth of composites industry nowadays. (JEC Composites Magazine February – March 2010).

Nowadays, rapid study in replacing the glass and plastic reinforced had been done in order to find more eco- friendly product that provided good mechanical properties. Therefore, in recent study, it shows that green composites or natural fiber composites are highly competitive and recommended replacement. Due to low cost materials, natural fiber composites are tremendously used in building and construction industry for panels for partition and false ceiling, partition board, wall, floor and etc. (J.M Chard at el. 2010)

Composites cannot be made from constituent with divergent linear expansions characteristics. The composites should be the contact interface area between the reinforcement and the matrix materials. Whenever there is interphase, there should have two interfaces between each side of the interfaces and the adjoint constituent. For example, laminates are composites material which has different layers of materials that will give them specific character of composites materials having a specific function to be perform. Generally, the reinforcing materials can withstand maximum load and can served the desirable properties. (iitk.ac 2004)

2.2 REINFORCEMENT.

Reinforcements are generally can be describe as the materials used to strengthen the structure. It can be made up from the materials or from the fiber. Other than that, it can be come from the human or from the naturals based resources (Choudhury et al.2009).

The types of reinforcement used for composites are fibers, filled, whiskers, flake, particulates and directionally solidified eutectics. Fibers can directly characterized by one very long axis with other two axes either often near circular or circular. For particles, it does not have preferred orientation and the shape and for whiskers, it has a preferred shape but small in diameter and length compared to fibers (iitk.ac 2004).

It also can be said that, the function of reinforcement is to strengthening the structure or materials employed in concrete or plastic. Besides, natural fibers contained highest cellulose and it's good as reinforcement in polymer composites. Other than that, reinforcement also helping in supports the load of the structure. Basically, combination between the materials or fiber and matrix/binder will help in maintain the position of the reinforcement itself (Manuwar et al.2007).

Fiber are the important class in reinforcements, as they will satisfied the desired condition and the fiber will transfer the strength to the matrix constituent influencing and will enhancing the properties as desired. The glass fibers are the earliest fibers to reinforce materials. Function of the ceramics and metal fibers to make the composites become stiffer and increasing in resistant to heat (iitk.ac 2004).

Reinforcement using natural vegetables fibers such as pineapple leaf fiber will give lower energy consumption in producing step, lower density, non – toxic, non - abrasive to the molding machinery, lower cost and easily colored, abundantly available, fully and easily recyclable. Other than that, it also high shatter resistant, good sound abatement capability, non – brittle fracture on impact, low mold shrinkage, high specific tensile modulus and low thermal expansion coefficient (Rosa D.D.S and Lenz D.M 2013).

Nowadays, the natural fiber reinforcements is rapidly being focusing this is due to the characteristic of the composites. Basically, they are renewable, eco – friendly, totally or partially used recyclable materials and most important things it has no harm to humans because it is biodegradable. Therefore, it's become more attractive alternative to glass fiber, carbon fiber and man – made fiber used for the manufacturing of the composites in industry.

2.3 NATURAL FIBER.

In general, fibers are in form of hair – like materials which are consist of continuous filaments or in discrete elongated pieces and most likely like a thread. In research it shows that it can be used as components in the formation of the composites. Other than that, the natural fiber have been used an alternatives replacement in fiber – reinforced plastics. This is due to the lignocellusoe fibers that have low densities yet good in mechanical properties compared to other synthetic fiber. Natural fiber can be classified into two types which are natural fiber and man- made fiber.

Over 3000 years ago, natural fibers had been used to reinforce the materials. Most recently it had been used to combine with the plastics. Throughout the study, it shows that lot of types of natural fibers are used in plastics such as hemp, jute, wood fiber, cane, grass seed, kenaf, banana fiber and pineapple leaf fiber. In India, the Jute are natural fiber that commonly used as the reinforcement. Other than that, in Pakistan, the natural fibers are growth rapidly in automotive and packaging materials industry. On top of that, thousands of tons natural fiber resources treated as agriculture wastes that are have no any useful utilization (Saira Taj et al.2007).

Natural fibers can come in different types of sources, for example vegetables fibers. The fibers can be extracted from the seed, leaf, skin, fruit and stalk. The most common used of natural fibers are cotton, hemp and flax. For example, hemp fibers are currently used as a seal within the heating and sanitary industries (D.Chandramohan and K.Marimuthu 2011).

From the research it shows that natural fibers have many advantages over the synthetic fibers. For example, in recent study it shows that, when the thermoplastics reinforced with the wood fillers, it will get reasonable light – weight, strength and stiffness. Yet some of the other plant proteins are renewable materials due to the thermoplastics properties. For example, the wheat gluten in group of cereals has the most unique properties compared to other plant proteins. Bamboo is one of the natural resources that abundant in Asia including Malaysia have been used in developing of bamboo reinforced thermosetting plastics (Taj et al. 2007).

Natural fiber – reinforced plastics are recently attracted the attention of the research due to their advantages over other materials that been used nowadays. For example, when the life cycle of the materials ended, they need several combustion processes or landfill, remarkably the amount of CO_2 released is neutral with respect to the assimilated amount. Other than that, it also environmental friendly materials which can be directly composed at the end of their life cycle. Other than that, it also low cost yet high performance which means good mechanical properties fulfils the economics interest of the industry (Taj et al.2007).