`

EFFECT OF PINEAPPLE LEAF ON THE PROPERTIES OF PINEAPPLE LEAF FIBRE/THERMOPLASTIC SAGO STARCH COMPOSITE

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This report submitted fulfill part of the requirement for the Degree of Bachelor in Mechanical Engineering

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DECLARATION

I declare that this project report entitled “Effect of pineapple leaf fibre on the properties of pineapple leaf fiber/thermoplastic sago starch composite” is the result of my own work except as cited in the references

Signature : .....

Name : .....

Date : .....

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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.

Signature :. .....

Name of Supervisor : .....

Date : .....

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ABSTRACT

Nowadays, increasing in researcher about renewable natural fiber had been done 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 environmentally 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 undergoing alkaline treatment to increase the strength of fiber than proceed to extraction and composition process. All nine samples have been undergoing 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/cm3. Besides, it also shows good adhesion between the PLF and the SH matrix.

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ABSTRAK

Pada masa ini, peningkatan dalam pengkaji mengenai serat semula jadi yang dapat diperbaharui telah dilakukan untuk menjadi salah satu penyelesaian alternatif dalam menggantikan gentian sintetik seperti gentian kaca sebagai bahan komposit bertetulang kerana tidak dapat dihancurkan secara biodegradasi dan tidak mesra alam. Selain itu, gentian semula jadi mempunyai kos pengeluaran yang rendah tetapi mempunyai sifat sifat mekanik yang baik dan mesra alam. Kebanyakan industri telah memilih serat semula jadi sebagai alternatif dalam mengembangkan produk mereka. Sebagai contoh, Syarikat Mitsubishi telah menggunakan serat semula jadi untuk membina bahagian dalaman dalam reka bentuk kereta. Salah satu sumber serat semula jadi adalah serat daun nanas (PLF) yang telah banyak ditanam di Malaysia. Dari penyelidikan semasa, PLF mengandungi selulosa tinggi dan menunjukkan sifat mekanik yang baik terutama dari keluarga Josapine. Oleh itu, dalam kajian ini, PLF dari Josapine digunakan sebagai bahan bertetulang dan pengikatnya adalah pati jagung (SH) dan kesan pemuatan PLF dan panjang serat PLF terhadap sifat mekanik komposit PLF / SH juga telah dianalisis. Komposisi diperbaiki untuk 50/50, 60/40 dan 70/30 diikuti dengan panjang 2 cm, 4 cm dan 6 cm PLF. PLF telah menjalani rawatan alkali untuk meningkatkan kekuatan serat daripada meneruskan proses pengekstrakan dan komposisi. Kesemua sembilan sampel telah menjalani empat ujian yang berbeza untuk menentukan sifat mekanik iaitu ujian tegangan, kekerasan, kepadatan dan analisis struktur mikro. Pemuatan PLF 70% dengan panjang 6 cm menunjukkan nilai tegangan tegangan, ketumpatan dan kekerasan yang lebih tinggi iaitu 32.98 MPa, 33.63 dan 1.20 g / cm3. Selain itu, ia juga menunjukkan lekatan yang baik antara matriks PLF dan SH.

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CONTENT

Table of Contents

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LIST OF FIGURES

`

LIST OF TABLES

`

LIST OF ABBEREVATIONS

PALF	Pineapple leaf fibre
TPSS	Thermoplastic Sago Starch
GTPS	glycerol-plasticized jackfruit seed starch

LIST OF SYMBOLS

E	Young modulus
E	Strain
σ	Tensile strength

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

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 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, and polypropylene. In the 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 increase 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 offers 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 coming 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 use bamboo fiber to produce automobile interior part and many more. In addition, from the previous research thathad been done, it shows that the natural fiber consumes lesser energies during production, cause lesser abrasion to the machine 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 environmentally 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.

1.2 PROBLEM STATEMENT.

Recently, natural plant fibers have been used in scientific research 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 (CO2) 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 lead 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 OBJECTIVES.

There are 2 mains goals to achieve in this project:

I. Study the effect of Glycerol on the properties TPSS (thermoplastic Sago Starch)

II. Comparative study about the effect of PALF loading on the properties of PALF /TPSS.

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1.4 SCOPE

This research studied the effects PLAF loading on the mechanical properties of PALF/TPSS composite had been carrying out. The various ratio of PALF on PALF/TPSS composite were be selected and the ratio of composition in the PALF/TPSS composite was fixed at, 70:30, 60:40 and 50:50. An alkaline treatment will be conducted to extract thin PALF bundles and enhance the PALF properties before the formation process of PALF/ST composite used hot press. The mechanical properties of PALF/ST composite will be determined used tensile test, flexure test, hardness test, density measurement and macrostructure analysis.

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CHAPTER 2

LITERATURE REVIEW

2.1. COMPOSITES

Back in few centuries ago, mankind used bricks with straws to make a building become stronger and studier. It even lasts long that before. So, man aware that the used of composite materials in construction. They produce contemporary composites that coming from continuous research and innovation until it produces a basic glass fibre that been used worldwide in building the composites for the aerospace and others. According to Cambridge Dictionary (n.d.), the meaning of composites is a material made up of more than one substance that is used for building things. Besides, it is the combination of materials that have it owns properties that made up from different substances.

Composites are being used in our daily life as it involves a lot in construction and many. Composites help to make a thing becoming stronger as per example is straw that been used in house construction. For instance, the combination of mud and straw in a block of brick provides it a strong property against both squeezing and tearing or bending. The straw continued to provide reinforcement to ancient composite products, including pottery and boats (Ngo, 2020). Besides, green composites are being used widely in helping the growth of composites industry nowadays. Green composites are known as biopolymers reinforced with natural fibre that are more environment friendly rather that fibre reinforced plastics.

In the 21st century, people are looking more on eco-friendly product including in mechanical properties. So, people are trying to use less glass and plastic to be more eco-friendly. In few recent research, man used a lot of green composites and natural fibre to

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replace glass and plastic. Due to low-cost materials, natural fibre composites are tremendously used in building and construction industry for panels for partition and false ceiling, partition board, wall, and floor. (J.M Chard at el. 2010)

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 characterize 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 strengthen 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 is the important class in reinforcements, as they will satisfy 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)

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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 has been used an alternatives replacement in fiber – reinforced plastics. This is due to the lignocellulose 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. 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 are 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.

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 have no 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 thermoplastic's 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 CO2 released is neutral with respect to the assimilated amount. Other than that, it also environmentally friendly materials which can be directly composed at the end of their life cycle. Other than that, it also lows cost yet high performance which means good mechanical properties fulfils the economics interest of the industry (Taj et al.2007).

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2.4. PINEAPPLE LEAF FIBRE (PALF)

Pineapple Leaf Fibre (PALF) serving as reinforcement fibre in most of the plastic matrix has shown its significant role as it is cheap, exhibiting superior properties when compared to other natural fibre as well as encouraging agriculture-based economy. PALF is multi-cellular and lignocelluloses materials extracted from the leave of plant *Ananas cosomus* belonging to the *Bromeliaceae* family by retting (separation of fabric bundles from the cortex). PALF has a ribbon-like structure and is cemented together by lignin, pentosan-like materials, which contribute to the strength of the fibre (George *et al.*, 2000). Figure 2.1 shows that the PALF is a multicellular fibre like other vegetable fibres. Their study also found that the cells in this fibre have average diameter of about 10 μm and mean length of 4.5 mm with aspect ratio of 450. The thickness of the cell wall (8.3 μm) lies between sisal (12.8 μm) and banana leaf fibre (1.2 μm). The excellent mechanical properties of PALF are associated with this high cellulose and low microfibrillar angel.

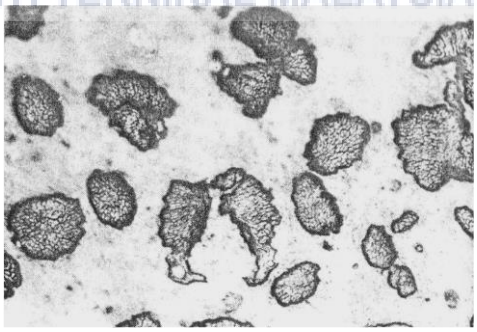

Figure 2.1 Optical micrograph of PALF cross section

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2.5. NATURAL FIBRE

Most of the researchers are looking forward to replacing the synthetic fiber as the natural fiber. As for instance is the reinforced composites materials as it is non-biodegradable and non- eco-friendly to the system. The best and good mechanical properties and environmentally friendly is the natural fibre which is low cost in term of production. Huge industry used natural fibre as one of the alternatives to develop their product. One of the examples that can be used is pineapple leaf as it is one of the natural fibers. Pineapple fiber has been planted widely in Malaysia. As we known that pineapple leaf contains high cellulose and good mechanical properties especially from the Josapine type.

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". This PLF has been tested using alkaline treatment which helps in increasing the strength of fibre than followed by the extraction and composition process. Based on the experiments, all nine samples have been undergoing 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/cm3". All shown good adhesion among all the PLF and SH matrix.

George *et al.* (1995) compared the properties exhibited by melt-mixing and solution mixing methods to produce PALF-LDPE composites. From Figure 2.5(a), when the mixing time is less, tensile strength and young's modulus are decreasing because of the ineffective