TENSILE PROPERTIES OF ALKALI TREATED SUGAR PALM FIBER

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ABSTRACT

A study of the effect of alkaline treatment on the tensile properties of sugar palm fiber. The fiber were treated using sodium hydroxide (NaOH) with 2%, 4% and 6% concentration solution for 1 hour soaking time. The purpose of treating fiber with alkali was to enhance the tensile strength and young modulus of single sugar palm fiber. The maximum tensile strength for untreated fiber is 63.05 MPa.The maximum tensile strength for occurred at 2% NaOH solution with 1 hour of soaking time, i.e 67.85 MPa. But, the maximum fiber for treated 4% NaOH solution with 1 hour of soaking time is 76.37MPa and for fiber treated 6% NaOH solution is 82.13 MPa.

ABSTRAK

Satu kajian ke atas kesan rawatan alkali pada sifat-sifat tegangan gentian kelapa gula. Gentian dirawat menggunakan natrium hidroksida (NaOH) dengan 2%, 4% dan penyelesaian kepekatan 6% untuk masa rendaman 1 jam. Tujuan merawat serat dengan alkali adalah untuk meningkatkan kekuatan tegangan dan modulus muda tunggal serat sawit gula. Kekuatan tegangan maksimum bagi gentian yang tidak dirawat adalah 63,05 MPa. Kekuatan maksimum tegangan untuk berlaku pada 2% NaOH penyelesaian dengan 1 jam masa berendam, iaitu 67,85 MPa. Tetapi, gentian maksimum untuk dirawat 4% NaOH penyelesaian dengan 1 jam masa merendam adalah 76.37MPa dan serat dirawat 6% NaOH adalah 82.13 MPa.

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LIST OF ABBREVIATION

UB	Unit Break
ASTM	Society for Testing and Materials

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The growing environmental awareness has resulted in a renewed interest in the use of natural material for many applications. Natural fibres are prospective reinforcing materials and their uses until now have been more traditional than technical. They have long served many useful purposes but the application of the material for the utilization of natural fibres as reinforcement in polymer matrix took place quite recently. It show the paradigm has forced industries like automotive, packaging and construction to search for new materials to make the conventional composite materials be a environmentally friendly material. These inorganic fibers present disadvantages like their non-biodegradability, expensive, abrasive and non-renewable.

Furthermore, compared to inorganic reinforcing fibers, natural fibers have a number of benefits, including low density and bio-degradability, less abrasiveness, lower cost and renewable. Natural fiber composites are likely to be environmentally superior to glass fiber composites in most cases. But sugar palm fiber mostly has mechanical properties lower than inorganic fiber. However, there are some solution’s to increase the mechanical properties of sugar palm fiber like treated with alkali solution.

Many studies had been carried out on natural fibre likes kenaf, bamboo, jute, hemp, coir, sugar palm and oil palm. The advantages of these natural resources are low weight, low cost, low density, high toughness, acceptable specific strength, enhanced energy recovery, recyclability and biodegradability. For these reasons, synthetic fibre reinforced polymers have emerged as a major class of structural materials and are widely used as substitution for metals in many weights critical components in aircraft, aerospace, automotive, marine and other industries. In general, plant fibre can be classified based on their origins coming from plants, animal or mineral. Thus, a good number of automotive components previously made by glass fiber composites are now being manufactured using natural fiber reinforced composites.

However, in this research, according Bachtiar D., Sapuan S. M. and Hamdam M. M. (2010), natural fiber that is *ijuk* fiber (*Arenga pinnata* or *Arengasaccharifera*) is used as a suitable candidate to reinforce polymer matrix in composite. *Ijuk* fiber is a kind of natural fiber that comes from *Arenga pinnata* plant, a forest plant that can be found enormously in Southeast Asia like Indonesia and Malaysia. This fiber seems to have properties like other natural fibers, but the detail properties are not generally known yet. Generally, *ijuk* has desirable properties like strength and stiffness and its traditional applications include paint brush, septic tank base filter, clear water filter, door mat, carpet, rope, and chair/sofa cushion.

1.2 PROBLEM STATEMENT

The sugar palm fibre is still not been studies widely. Sugar palm can be used to reduce the usage of epoxy as it is a chemical that is not environmental superior. This is also to determine the tensile strength and young modulus of the sugar palm. The fact is sugar palm fibre can be obtained directly from natural resource, cheap and also has advantages due to their renewable nature, low cost, and easy availability. But, the mechanical properties such as tensile strength and young modulus of sugar palm fiber still lower than inorganic fiber. In this work, the alkali treatment is used for the improvement of the properties of strength.

1.3 OBJECTIVE

The objective of this project are to identify how effect of alkali treatment on the tensile properties of sugar palm fiber reinforce and determine mechanical properties of tensile strength and also to determine tensile modulus (Young modulus).

1.4 SCOPES

To improve mechanical properties of natural fiber like sugar palm fiber. The experiment is conducted for the fiber treatment alkalization and examination of the effect of fiber on mechanical properties such as tensile strength and the result to compare with untreated sugar palm fiber. The experiment will using different concentration of alkali 2%, 4%, 6% sodium hydroxide solution to investigate the change on mechanical properties like tensile strength. It includes the determination of mechanical properties under tensile testing on the basis of ASTM standard.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter investigate different type of fiber that currently available at the market. Each fiber have different characteristic, speciality, mechanical strength, function, but the function is same, to help reduce dependence on mineral resources.

2.2 TYPE OF FIBER

There are two types inorganic fiber in the market and been common to be used by people, these carbon fiber and glass fiber. Now, many researchs do to find natural fiber (organic fiber). Many natural fiber there are used in industry now. Sugar palm also can be classified in natural fiber. The descriptions on carbon fiber, advantages and disadvantages are as follow.

2.2.1 Carbon Fiber

Figure 2.1 : Carbon Fiber

Source : Google image

http://en.wikipedia.org/wiki/Carbon-fiber-reinforced_polymer

Figure 2.1 show the picture of carbon fiber. Carbon fiber, alternatively graphite fiber, carbon graphite or CF, is a material consisting of fibers about 5–10 μm in diameter and composed mostly of carbon atoms. The carbon atoms are bonded together in crystals that are more or less aligned parallel to the long axis of the fiber. The crystal alignment gives the fiber high strength-to-volume ratio (making it strong for its size). Several thousand carbon fibers are bundled together to form a tow, which may be used by itself or woven into a fabric.

The properties of carbon fibers, such as high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion, make them very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports. However, they are relatively expensive when compared to similar fibers, such as glass fibers or plastic fibers.

Carbon fibers are usually combined with other materials to form a composite. When combined with a plastic resin and wound or molded it forms carbon fiber reinforced plastic (often referred to as carbon fiber) which has a very high strength-to-weight ratio, and is extremely rigid although somewhat brittle. However, carbon fibers are also composed with other materials, such as with graphite to form carbon-carbon composites, which have a very high heat tolerance. Carbon fiber has advantages such as it is very light, it's very strong, it can be formed to most any shape, it can be laid-up to offer complicated compliance and stiffness characteristics and it's non-corroding.

2.2.2 Fiber Glass

Figure 2.2 : Fiber Glass

Source : Google image

http://en.wikipedia.org/wiki/Fiberglass_molding

Figure 2.2 show the picture fiber glass. Fiberglass is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk is strength and weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes.

The plastic matrix may be epoxy, a thermosetting plastic (most often polyester or vinylester) or thermoplastic. An individual structural glass fiber is both stiff and strong in tension and compression that is, along its axis. Although it might be assumed that the fiber is weak in compression, it is actually only the long aspect ratio of the fiber which makes it seem so because a typical fiber is long and narrow, it buckles easily. On the other hand, the glass fiber is weak in shear that is, across its axis. Therefore if a collection of fibers can be arranged permanently in a preferred direction within a material, and if the fibers can be prevented from buckling in compression, then that material will become preferentially strong in that direction.

Furthermore, by laying multiple layers of fiber on top of one another, with each layer oriented in various preferred directions, the stiffness and strength properties of the overall material can be controlled in an efficient manner. In the case of fiberglass, it is the plastic matrix which permanently constrains the structural glass fibers to directions chosen by the designer. With chopped strand mat, this directionality is essentially an entire two dimensional plane; with woven fabrics or unidirectional layers, directionality of stiffness and strength can be more precisely controlled within the plane.

Common uses of fiberglass include high performance aircraft (gliders), boats, automobiles, baths, hot tubs, water tanks, roofing, pipes, cladding, casts, surfboards and external door skins.

2.2.3 Natural fiber

Natural fiber now mostly used in industrial. Natural fiber such as hemp, flax, oil palm, jute and sugar palm fiber have been reported as being used in polymer composites. The use of natural fiber at the industrial level improves the environmental sustainability of the parts being constructed, especially within the automotive market. In the building industry, most interest in natural fiber is economical and technical and allow insulation properties higher than current materials.

Sugar palm fiber also potential source of natural fiber from Arenga pinnata. The use sugar palm fiber also has economical advantages if the carbon or glass fiber can be replace by using sugar palm fiber.

2.3 The Tensile Test

Figure 2.3 : Modern tensile testing machines

From William F. Smith and Javad Hashemi (2011), the tensile test is used to evaluate the strength of sample such as metal or alloy. In the test, the sample is pulled up to failure in a relatively short time at a constant rate. The force (load) on the specimen being tested is measured by the load cell while the strain is obtained from the extensometer attached to the specimen and the data is collected in a computer-control software package. The force data obtained from the chart paper for the tensile test can be converted to engineering stress data, and a plot of engineering stress versus engineering stain can be construct.

2.4 Young Modulus

According William F. Smith and Javad Hashemi (2011), young modulus or modulus elasticity in the first part of the tensile test, the metal is deformed elastically. This is if the load on the specimen is released, the specimens will return to its original length. In general, metals and alloys show a linear relationship between stress and strain in elastic region of the engineering stress-strain diagram, which is described by Hooke's law where E is the modulus of elasticity.

$$E = \frac{\sigma\text{ (stress)}}{\epsilon\text{ (strain)}} \quad (unit\ of\ Pa\ ) \tag{2.0}$$

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Chapter 3 will covers process in methodology throughout this project experiment progress. The content in this chapter includes project flow chart, select sugar palm fiber and experiment process including immersed the fiber, measure weight, measure diameter, make the difference concentration of alkaline sodium hydroxide solution, cut the fiber, and tensile test.

Project planning is important to determine the best and excellent result for the project. The flow chart.

3.2 FLOW CHART

Figure 3.1 illustrate the project flow chart

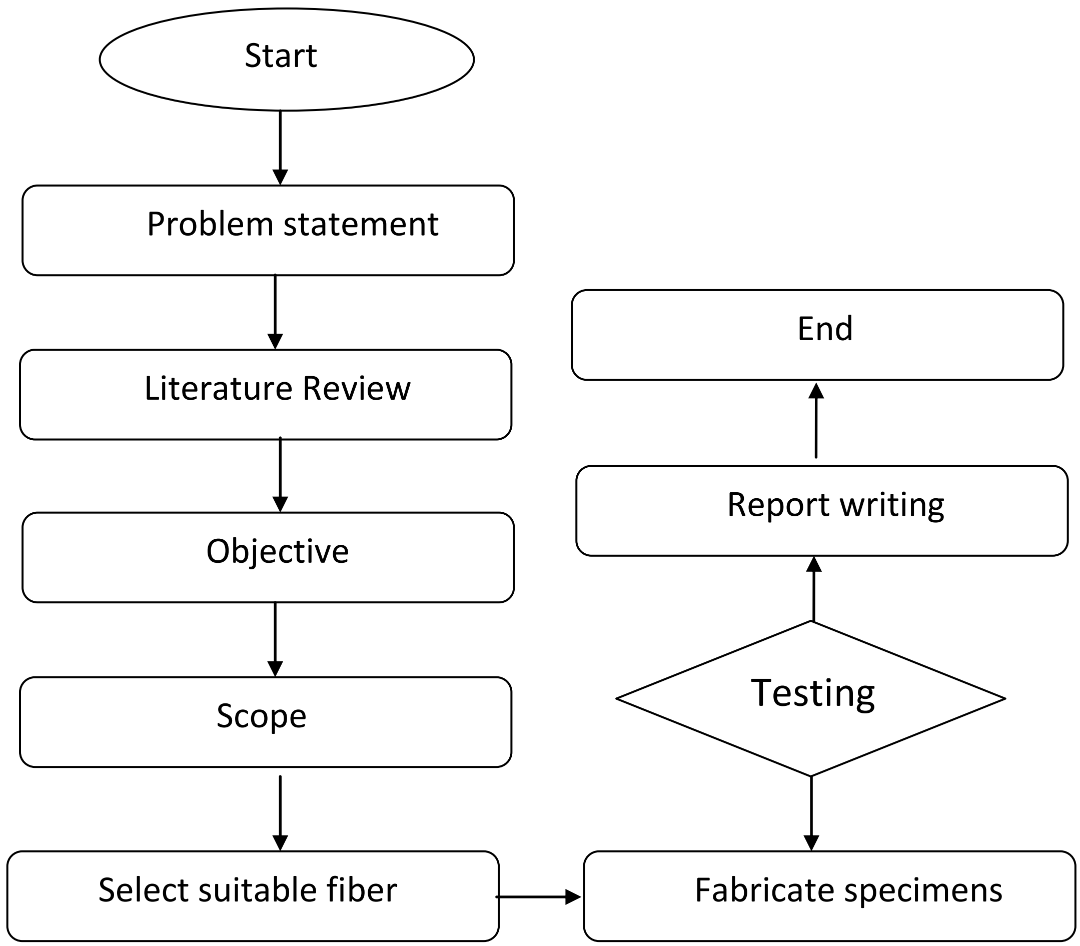

Figure 3.1: Flow chart

The project starts problem statement. Problem statement is important to identify the way point of this project. Literature review is focus on the project background. This part covers about the existing product in current market and their specifications. Project objective is then identified. Project objective is the step what to achieve throughout the project.

The next step will continue with identifying the project scope. Project scope is the boundaries of research or project. This scope will helps in designing project and during the fabrication process. The scope will control the range of the project.

Next step select suitable or almost same width fiber form the bundle fiber. Later, project fabrication is step the where the specimens and test the tensile strength test. Fabrication process include cutting and attachment.

The last step is report writing include result and discussion. Result of project when the analysis has been done. Discussion of the project is about the analysis whether the is suitable to be used in industries to reduce dependent on glass fiber and carbon fiber and also to used natural fiber. Other improvement that should be done to the end product.

MATERIALS AND PROCESS

3.3 Materials

3.3.1 Preparation of material

The procedures of the analysis include preparation of materials fiber, sodium hydroxide (NaOH) as treatment solution, parameter treatment, fabrication of single.

Sugar palm fiber was collected from at Pekan Pahang and retting process was applied in order to separate the stalk from the core of fiber. The full length of trunk of an Arenga Pinnata tree is completely covered by black fiber.

Figure 3.2 : Sugar palm fiber trees

For alkali solution, sodium hydroxide (NaOH) is very suitable for to do the analysis. Sodium hydroxide, also known as lye or caustic soda, has the molecular formula NaOH and is a highly caustic metallic base and alkali salt. It is a white solid available in pellets, flakes, granules, and as a 50% saturated solution. Sodium hydroxide is used in many industries, mostly as a strong chemical base in the manufacture of pulp and paper, textiles, drinking water, soaps and detergents and as a drain cleaner

Figure 3.3 : Sodium hydroxide

Source : Google image

http://www.google.com.my/search?um=1&biw=1360&bih=705&hl=en&tbm=isch&sa=1&q=sodium+hydroxide+pallets&btnG=

3.4 Process to do the analysis

3.4.1 Select suitable fiber

Take the sugar palm fiber in large amount from the sugar palm tree. Thus select the almost same thickness. Figure 3.4 at below show the bundle of sugar palm fiber.

Figure 3.4 : Bundle of Sugar palm fiber

3.4.2 Cutting the sugar palm fiber

After select the best bundle of sugar palm fiber, cutting process is a process to fixed the long sugar palm fiber in each fiber is 10cm. At least 1500 must be cut. Cutting process is done using rules and scissor. The figure 3.5 show the fiber after cutting in 10cm.

Figure 3.5 : Sugar palm fiber after cutting in 10cm

3.4.3 Measure weight sugar palm fiber

After cutting the fibers in amount 1500 specimens, measure the weight sugar palm fiber until reach 2 grams for each sample untreated, treated fiber with alkaline solution sodium hydroxide (NaOH) 2%, 4% and 6%. The figure 3.6 show the during process measure the weight of sugar palm fiber