A Tensile Test of Bio-board Made from Bamboo - Pineapple Fiber - Coconut Fiber as Nonvolatile Material

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Abstract: The Bio board is considered superior to fossil fuel plastic derived from conventional plastics in terms of energy efficiency, petroleum consumption and carbon emissions, but is inferior in its application. Any breakthrough in improving bio board manufacturing capabilities can help reduce dependence on petroleum-based polymers, plastic waste accumulation and better control of CO_2 emissions in the environment. Therefore, this research investigates bio fiber based natural fiber materials to achieve non-volatile, antimicrobial, biodegradability and good mechanical strength such as hardness and impact strength. In this case, bio board characterization is also carried out through techniques such as Thermo Gravimetry Analysis and Spectrofotometry Infrared Transformation Fourier and structure morphology through Scanning Electron Microscopy.

1 INTRODUCTION

In recent years, composites are more environmentally friendly while synthetic fibers can be a source of environmental pollution. Composite is currently considered the most promising material in the community because of its distinctive mechanical properties, biodegradable and abundant availability of raw materials. Many researchers have shown increased interest in the development of reinforced polymer biodegradable fibers (BFRP) as a substitute for conventional materials, especially in the fields of automotive, marine, packaging, furniture and building construction industries. The production of natural fiber composite materials is very interesting and widely applied, because of the problem of global warming and the reduced availability of petroleum. Natural fibers play an important role in developing biodegradable composites to solve ecological problems and current environmental problems (Kasim et al, 2016).

Natural fibers such as bamboo, flax, sisal, pineapple, abaca and coir have been studied as reinforcement and fillers in composites. Bamboo is a plant that can grow quickly, so it is potentially a source of abundant fiber included in the Bambuseae family, under the genus Gramineae. Pineapple leaf fiber (pineapple leaf fiber), which is rich in cellulose, is relatively inexpensive and widely available has the potential to strengthen polymer composites (Yusri Yusof et al, 2016). Coconut coir (coir) is a residue from coconut production in many areas, which produces coarse coir fibers. Coir is a ligno-cellulose natural fiber. This is a fruit fiber obtained from the outer skin, or the skin of a coconut fruit. This fiber is widely used to make various kinds of flooring, furniture, yarn, ropes and others. Therefore, research and development efforts have been made to find new uses for coir, including the use of coir as an amplifier in polymer composites (Yashwanth et a, 2016).

Several studies have shown that the mechanical properties of polymers such as tensile strength and stiffness can be improved by the combination of three types of plant fibers that differ in mechanical

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properties, thus indicating the potential to switch to 100% plant fiber composites (Yusoff, B.R. et al., 2016). A combination of two or more plant fibers in a matrix is known as a hybrid green composite. This high composite mechanical property has shown progress in material design because it is able to overcome failures of old products.

To improve some of the good qualities that have been possessed by bamboo fiber, pineapple leaves and coconut fiber, several treatments have been carried out such as extracting fiber using the hand-lay up method or contact moulding which is used as a reinforcing polymer in unsaturated polyester resin to be tested for increased tensile strength and flexural properties of fibers using the Universal Testing Machine (UTM) tool and observe the effects on composite microstructure through optics and electron microscopy scanning. Therefore, it is expected that the third combination of composite bamboo fibers, pineapple leaves and coir (B = bamboo, PLF = pineapple leaf fiber and C = coir) BPLFC / polyester can increase the strength of high E-modulus and good flexibility in the resulting composite.

2 EXPERIMENTAL

2.1 Material

Materials needed in the manufacture of fiber composite materials are bamboo fiber (*Bambusaa* Sp), pineapple leaf fiber (*Ananas comosus* L. Merr) and coconut fiber (coir), Unsaturated matrix Polyester type 157 BQTN, hardener methyl ethyl ketone peroxide (MEKPO), alkali solution (NaOH) and H_2O_2. The main equipment used in this study is tensile testing equipment, electronic scales, ovens, universal testing machines, calipers, digital cameras and other supporting equipment. The composite matrix is also very influential on the strength of the composite material. One type of composite matrix that is easily obtained and used by people from the general and industrial circles on a small or large scale is polyester resin. Polyester resin has the ability to bind to natural fibers without causing reaction and gas. However, one disadvantage of polyester is the high shrinkage volume.

2.2 Bamboo fiber extraction

Cut bamboo and crusher using a crusher machine to obtain bamboo powder. Wash bamboo powder using water and soak it in sodium hydroxide (NaOH) at a concentration of 6% of the water volume for 3 hours at room temperature. The fiber is then washed twice with water. The washed fiber is dried at room temperature for 8 hours and then heated at 50^{o}C for 2 days. Dry fiber is stored in a sealed plastic bag to avoid contamination of atmospheric moisture before composite is formed (Rihayat, 2018).

2.3 Extraction of Pineapple Leaf Fibers

Pineapple leaf fiber is extracted manually. The extraction process is carried out to get fiber by breaking down pineapple leaves. First stage, pineapple leaves are broken down to obtain fibers with blunt objects and crucible fibers. Pineapple leaf fiber powder is then soaked in 5% NaOH solution for 1 hour at room temperature. After the fiber powder has been rinsed several times, then dried at room temperature for 48 hours (Kasim et al, 2016).

2.4 Coconut coir (Coir)

Coconut coir fiber is washed with water and dried. Then the coir fiber is cut short and in the crusher. Fiber that has become powder is soaked in 5% NaOH solution for 2 hours. The fiber is then washed thoroughly with water to remove excess NaOH attached to the fiber. After that the coir fiber powder was dried at room temperature for 3 hours for composite formation (Attanda, 2015).

2.5 Fiber Preparation

Bamboo fiber before being processed into a composite product is carried out by alkali chemical by immersing it in 6% NaOH concentration for 3 hours to eliminate the content of lignin and hemicellulosa contained in bamboo fiber. The reduction of these substances is very important because the natural fiber structure is open and can join or glue optimally with the polymer. Pineapple leaf fiber is also one of the natural fibers of leaves that have a high mechanical value. Various efforts to improve mechanical properties have also been investigated by researchers such as immersing leaf fibers into NaOH (Akil, 2011). In this study the pineapple leaf fiber was also carried out by the alkali treatment process by soaking in 5% NaOH for 1 hour. This in addition to increasing the value of Tensile Strength can also remove impurities and water content and the adhesion properties between hydrophilic and hydrophobic pineapple leaf fibers. Furthermore, coconut coir obtained from North Aceh plantations is very abundant, coconut husk is first washed with water, then cut into short size, then immersion process in 5% NaOH alkaline solution for 2 hours. The effect of alkali treatment on the surface properties of cellulose natural fibers has an effect on the natural properties of hydrophilic fibers which can optimally provide interfacial bonds (Bachtiar Dandi, et.al, 2015).

2.6 Static Tensile Strength Analysis

Testing of mechanical properties was carried out by tensile strength test of composite specimens using ASTM D 638 Type I. Tensile testing equipment was conditioned at a load of 200 kgf with a drawing speed of 20 mm / minute, the specimens were observed to break, the maximum stress (max F) and strain.

Tensile strength (σ) = Load/A (1)

3 RESULT AND DISCUSSION

3.1 Tensile Test

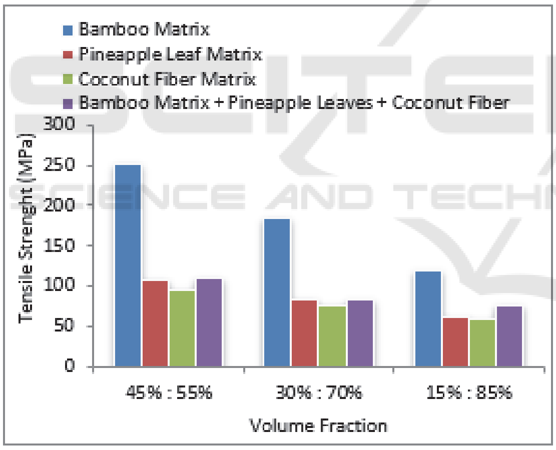

Figure 1: Tensile Test Curve

Effect of bamboo polyester (A / Ps) fiber and composite matrix fraction on tensile test characteristics as shown in Figure 1. where in the filler fiber mixture: the matrix produces the maximum value at a ratio of 45%: 55%, which is 252 MPa while in the ratio 30%: 70 % and 15%: 85% each has 184 MPa and 118.6 MPa. Composite stiffness increased significantly with increasing fiber content as a result of the addition of high rigidity material. This shows that the addition of bamboo fiber to the filler composition which produces higher tensile properties of composite materials also proves that theoretically polyester fiber reinforced bamboo fiber has good tensile properties because of the high cellulose content in bamboo fiber.

Polyester composite reinforced with pineapple leaf fiber (B/Ps) shows the highest tensile test characteristic values in a mixture ratio of 45%: 55%, 106 MPa. Furthermore, along with the reduced fraction of fiber volume, the tensile properties of the material also decrease as shown by the mixture ratio of 30%: 70% *i.e.* 82.9 MPa and 60.5 MPa in the ratio of the mixture of fiber volume fraction and matrix 15%: 85%. The use of polymers in forming fiber composites is also very influential on the characteristic values as research of pineapple leaf fibers mixed with polypropylene polymers only produces the highest value of tensile strength 70.22 MPa with fiber : matrix ratio of 70%: 30% (Kasim et al, 2016).

Unlike the case with bamboo and pineapple leaves which have a higher tensile strength price, coconut coir fiber has a low tensile characteristic value. This can be seen as shown in Figure 1. that in the mixture of fiber: matrix 45%: 55% produces tensile test value of 94.5 MPa. While in the mixture ratio of 30%: 70 and 15%: 85% each produces a value of 76 MPa and 59.4 MPa.

In general, the mechanical performance of fiber / polymer composites depends on the strength and modulus of strengthening, strength and toughness of the matrix, and the effectiveness of surface tension transfer between fiber and matrix. the surface bond between fiber and matrix plays an important role in determining the mechanical properties of composites.

Composite Hybrid is a combination of two or more plant fibers in the matrix. Research on hybrid composites has been investigated in the development of polymer composites. In research conducted by (Jaafar, 2018). Single fiber composite kenaf, bamboo, and PLA coconut coir showed lower Tensile Strength values than hybrid composites. Based on Figure 1. from the tensile strength testing of hybrid polyester composite material reinforced with bamboo fiber, pineapple leaves and coconut fiber with a ratio of 45% fiber and 55% binder having a tensile strength of 89.65 MPa. Tensile strength 85.4 MPa obtained by hybrid composites at a ratio of 30%: 70% and 68.85 with a ratio of 15%: 85. This shows that hybrid composites are able to produce better tensile strength values compared to a mixture of coco fiber (C: Matrix) and pineapple leaf fibers (B: Matrix). The shortcomings of single fiber composites that have less optimal characteristic properties can be increased by combining two or more types of fibers in the matrix so that they will produce composites that have better mechanical characteristics (Oerbandono et.al, 2015).

This effect is caused by the good mechanical properties of bamboo fibers associated with the composition of natural fibers. So that the hybrid polyester composite can produce a value of 109.6 MPa (Tara et.al, 2011). Indeed, the value is still below the price of bamboo fiber / Polyester (A / Ps) and this is due to the difference in volume fraction between mixing three fibers (A: B: C / Ps) less than the single fiber volume fraction as polyester matrix reinforcement so that it shows different properties tensile strength between single fiber composite and hybrid composite (Rihayat et.al, 2019).

Recent studies have yielded promising results with the hybridization of natural fibres as reinforcing mechanical properties such as tensile strength, flexure and the impact of hybridization of bamboo, pineapple leaves and coconut fibre as reinforcing polymer composites which greatly influences the formation of composites (Manalo et.al, 2015). Evaluation of the effects of hybridization on the mechanical performance of hybrid bamboo, pineapple leaves and polyester fibre reinforced coconut fibres found that the attractive nature of NFC was enhanced by the addition of bamboo fibre. The mechanical properties of natural fibers are highly dependent on the content of cellulose. In other words, different cellulose content affects the mechanical properties of natural fibers. Therefore, it can be said that natural fibres with a higher cellulose content produce better tensile properties (Suryani, 2017).

4 CONCLUSION

Based on this research it can be concluded that, in general, the mechanical performance of fibre/ polymer composites depends on the tensile properties. Based on the analysis result, it can be concluded that each natural fiber produces different strengths compiling with polyester matrices. Of the three natural fiber used in this studio (bamboo, pineapple, and coconut fiber), bamboo has the best level of tensile strength and the worst coconut fiber. The best composition of the filler mixture: the matrix is at 45%: 55%.

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