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Study of Fiber Direction Configuration in Hibiscus Tiliaceus Bark Fiber Reinforced Polyester Composite

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A B S T R A C T

This study aims to determine the effect of seat direction configuration on changes in impact energy and toughness. The specimen is a polyester composite material reinforced with Hibiscus tiliaceus bark fiber (HTBF). HTBF is given alkali treatment by soaking in 5% NaOH solution for 6 hours. The test specimens were made using the hand layup method, using a total of six fiber layers with varying fiber direction configurations: 00/00/450/-450/00/00; 00/450/00/00/-450/00 ; 450/00/00/00/00/-450. The result of study changes in fiber angle configuration variations do not have a significant effect on the impact energy and impact toughness of HTBF natural fiber reinforced polyester composites. Impact energy on fiber volume fraction 20% HTBF, with variations in fiber configuration 00/00/450/-450/00/00; 00/450/00/00/-450/00 ; 450/00/00/00/00/-450, respectively: 18.67, 18.68, 18.68 J, impact toughness respectively: 0.113, 0.113, 0.112 J/mm2. What influences the energy and impact toughness of polyester composites with HTBF reinforcement is the variation in the volume fraction of HTBF natural fiber

Keywords: Polyester composite, Impact energy, Impact toughness, Hibiscus tiliaceus bark fiber

Introduction

In the Industry 4.0 era, the development of green technology or environmentally friendly technology is increasingly developing, especially in developed countries such as the USA, Japan, Canada, Netherlands, Germany and Switzerland. An example of green technology is the application of natural fiber as reinforcement in composite materials. This condition is a demand for technology that empowers potential natural resources whose use is direct. Research has been carried out in line with the advancement of the exploitation of the use of natural materials in everyday life, especially the use of natural fibers as reinforcement for composite matrices. The advantages of natural fibers compared to synthetic fibers are that they are abundant, have low specific costs, and can be renewed and recycled, and does not pollute the environment (N. Karthi, K. Kumaresan, S. Sathish, S. Gokulkumar, L. Prabhu, 2020). Therefore, research on the use of natural fibers as a composite reinforcing material has begun to develop. The use of lightweight materials in cars is one way to achieve demand. Techniques for increasing fuel efficiency and reducing environmental pollution due to greenhouse gases produced by the automotive industry are carried out by using natural fibers.

The use of natural fibers and hybrid fibers as reinforcement for synthetic polymer matrices in automotive polymer bumper beam materials. Based on mechanical evaluation, the resulting impact properties are lower by using hybrid natural fibers as composite reinforcement compared to conventional glass fiber reinforced thermoplastic as a bumper beam material in general.(Adesina, O.T., Jamiru, T., Sadiku, 2019). Its attractive mechanical properties, sustainability, low cost, and low weight have benefited research in the field of natural fibers. In the study (Ferreira et al., 2019) identified the effect of silica microparticle inclusions and the stacking sequence of cross-layered glass fiber fabric and short layers of sisal fiber on actual density, tensile and flexural strength and strength modulus. hybrid epoxy composite. In general, hybrid composites with a greater number of glass fiber layers produce higher values of tensile and flexural strength (348 MPa and 663.28 MPa), tensile and flexural modulus (22 GPa and 2.50 GPa) and higher apparent density. high (2.02 g/cm³). However, it should be noted that the incorporation of silica particles improves the mechanical performance of composites containing larger amounts of sisal fibers. The work (Sherwani et al., 2021) aims to determine the mechanical properties of palm fiber (Arenga pinnata Wurmb. Merr) (SPF)/glass fiber (GF) hybrid composites reinforced with poly lactic acid (PLA) which have the potential to be used in motorcycle components. The mechanical properties (hardness, compression, impact, and creep) and flammability properties of SPF/GF/PLA hybrid composites were investigated and compared with commercial motorcycle Acrylonitrile Butadiene Styrene (ABS) plastic components. Composites were initially made using a Brabender Plastograph, followed by compression molding methods. This research also describes tensile and bending stress-strain curves. The results show that SPF/GF/PLA treated with alkali has the highest hardness and impact strength values of 88.6 HRS and 3.10 kJ/m2, respectively. Based on the results, base and benzoyl chloride treatment can improve the mechanical properties of SPF/GF/PLA hybrid composites, and short-term creep tests show that base-treated SPF/GF/PLA composites show the least creep deformation. The findings of the horizontal UL 94 test show that the alkaline treated SPF/GF/PLA hybrid composite has good fire resistance, suitable for application as a motorcycle component.

Research (Sari & Padang, 2019) hibiscus tiliaceus (HT) fiber was treated with 8% potassium hydroxide (KOH) for two hours at room temperature. The tensile strength and thermal properties of the treated fibers were examined using tensile testing and thermogravimetric analysis (TGA). The surface structure of hibiscus tiliaceus fibers was analyzed using Scanning Electronic Microscopy (SEM). The experimental results showed that in the KOH treatment, the tensile strength increased to 5144.9 MPa, the thermal and cellulose resistance of the fibers increased because the hemicellulose content is reduced in the fiber. SEM images show that after alkali, the surface of hibiscus tiliaceus fibers becomes clear, fibrous and rougher.

The particular importance of using bark as a raw material, rather than for energy recovery, is due to circular economy considerations, since bark fiber is usually a by-product or even waste from other sectors, and therefore its use globally will reduce the amount of waste (Palanisamy, S.; Kalimuthu, M.; Nagarajan, R.; Fernandes Marlet, J.M.; Santulli, 2023). In its application in polymer composites, especially under a short random fiber geometry, the bast fibers are extracted and treated, usually chemically with alkali. These fibers can be characterized more thoroughly for the purpose of further use, also in competition with other fibers that do not originate from bark, but from tree bark, leaves, etc., and in relation to the production systems that have been developed (cotton, hemp, flax, hemp, etc.) The latter material is already widely used in the production of composites, a possibility that has so far not been widely explored for bast fibers. Hibiscus tiliaceus, is a type of plant that is often found on beaches on the island of Lombok, Indonesia (Darmo & Sutanto, 2023). In the study, the hybrid fiber of musa acuminata stem (MASF)-hibiscus tiliaceus bark fiber (HTBF) was applied as a reinforcement for polyester composites with liquid rubber filler or Carboxyl Terminated Butadiene Acrylonitrile (CTBN) filler. The research results show that the polyester composite material reinforced with MASF-HTBF hybrid fibers with CTBN filler has better mechanical properties than single natural fibers, so it is important for further development as a material for making vehicle bumpers.

Research to improve mechanical properties, especially impact energy and toughness of polyester matrix composite those reinforced with natural fibers have not been successful. Energy and impact toughness are still below standard as parquete flooring materials are made from stone plastic composite (SPC), laminate and vinyl and automotive bumpers are made from low carbon steel plates. Likewise, the shrinkage that occurs due to heat is also greater. The main molecules that make up fiber (cellulose, hemicellulose, lignin) cannot form interfacial bonds with polyester. As a result, the interfacial bond formed is imperfect/defective. Defects that arise include debonding, agglomeration (clumping of polyester), the appearance of voids which affect the mechanical properties of the polyester matrix composite.

Therefore, research on the effect of fiber direction configurations to improve the mechanical properties of polyester composite material, reinforced with natural fiber HTBF.

Methodology

All figures should be numbered with Arabic numerals (1,2,3,….). Every figure should have a caption. All photographs, schemas, graphs and diagrams are to be referred to as figures. Line drawings should be good quality scans or true electronic output. Low-quality scans are not acceptable. Figures must be embedded into the text and not supplied separately. In MS word input the figures must be properly coded. Lettering and symbols should be clearly defined either in the caption or in a legend provided as part of the figure. Figures should be placed at the top or bottom of a page wherever possible, as close as possible to the first reference to them in the paper.

The figure number and caption should be typed below the illustration in 8 pt and left justified [***Note:*** one-line captions of length less than column width (or full typesetting width or oblong) centered]. For more guidelines and information to help you submit high quality artwork please visit:http://www.elsevier.com/wps/find/authorsview.authors/ authorartworkinstructions. Artwork has no text along the side of it in the main body of the text. However, if two images fit next to each other, these may be placed next to each other to save space. For example, see Fig.

a

b

Fig. 1. (a) Hibiscus tiliaceust tree**;** **(b)** Hibiscus tiliaceust bark fiber

The research utilized hibiscus tree bark fiber as an alternative composite reinforcement material as shown in Fig.1. To get good fibers, waru leather is soaked in water for approximately 3 weeks so that the bark that attaches the fibers to the skin can be removed and the fibers will separate into expected fiber sheet. The average fiber thickness of waru leather is 0.115 mm. The matrix uses BTQN 157 polyester with 1% MEKPO catalyst. Waru tree bark fibers were treated with 5% NaOH alkali for 6 hours. Then a composite was made using the hand layup method, with 6 layers layered according to variations in fiber direction configuration. The volume fraction of fiber is 30%. Variations in fiber direction configuration are: Impact energy and toughness are obtained by impact testing. The dimensions of the impact test specimen are 12.7 mm thick according to ASTM D 3039 standard as shown in Fig. 2.

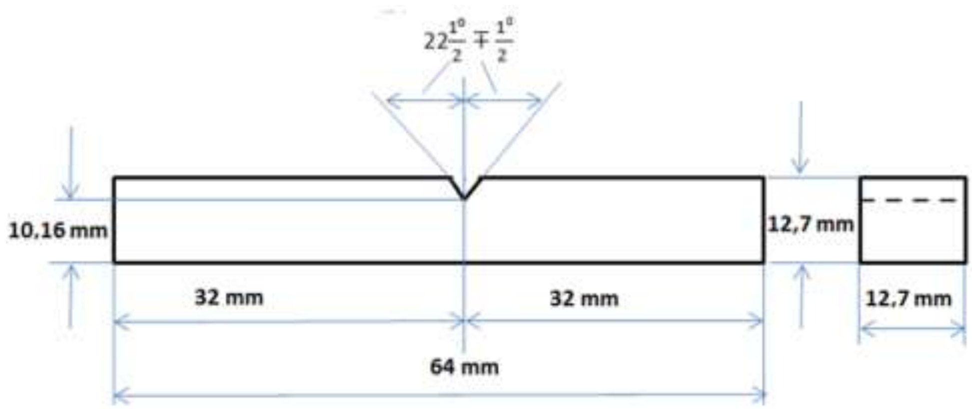

Fig. 2. Test specimen according ASTM D 256 standard

Result

Impact testing using the Izod method, specimens refer to ASTM D 3039 standard. The test results are in the form of energy and impact toughness as shown in Fig.3. Based on Fig.3. Changes in fiber angle configuration variations do not have a significant effect on the impact energy and impact toughness of HTBF natural fiber reinforced polyester composites. The conclusion of this research is strengthened by the research results (Irfa'i et al., 2021). Impact energy on fiber volume fraction 20% HTBF, with variations in fiber configuration $0^0/0^0/45^0/-45^0/0^0/0^0$; $0^0/45^0/0^0/0^0/-45^0/0^0$; $45^0/0^0/0^0/0^0/0^0/-45^0$, respectively: 18.67, 18.68, 18.68 J, impact toughness respectively: 0.113, 0.113, 0.112 J/mm^2. What influences the energy and impact toughness of polyester composites with HTBF reinforcement is the variation in the volume fraction of HTBF natural fiber, in line with the results of the study (Bakri et al., 2022). The composite samples were tested by the tensile and water absorption tests. Then, the fracture of tensile test was analyzed by scanning electronic microscopy (SEM). The result shows that the tensile strength of composite increases with increase in the volume fraction. Meanwhile, the percentage of water absorption decreases with rise in the volume fraction. n the fiber direction configuration $0^0/0^0/45^0/-45^0/0^0/0^0$, with volume fractions of 0%, 5%, 10%, 15%, 20%HTBF the impact energy respectively is: 0.028, 0.035, 0.082, 0.108, 0.113 J and the impact toughness respectively is: 4.78 , 6.26, 13.39, 17.52, 18.68 J/mm^2

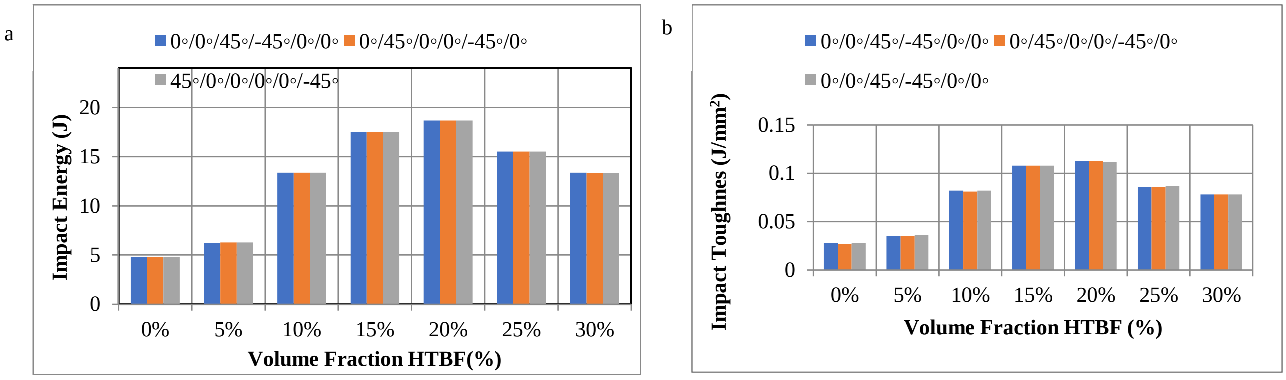

Fig.3. (a) Impact energy; (b) Impact toughness

Conclusion

Changes in fiber angle configuration variations do not have a significant effect on the impact energy and impact toughness of HTBF natural fiber reinforced polyester composites. What influences the energy and impact toughness of polyester composites with HTBF reinforcement is the variation in the volume fraction of HTBF natural fiber.

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