Indonesian Journal of Maritime Technology (ISMATECH)
Vol. 1, Issue 1, June 2023
pISSN: 0000-0000, eISSN: 0000-0000)
DOI: https://doi.org/10.0000/ismatech.v1i1

Analysis of Combination of Natural Fiber Bamboo and Rattan Fiber for Alternative Material in Ship Hull

Deas Putri Ananda[1*], Alamsyah [1], Hijriah [2], Andi Mursid Nugraha Arifuddin [1], Samsu Dlukha Nurcholik [1]

[1]Department of Naval Architecture, Kalimantan Institute of Technology, Balikpapan, 76127, Indonesia
[2]Department of Civil Engineering, Kalimantan Institute of Technology, Balikpapan, 76127, Indonesia

KEYWORDS
Rattan Fiber
Bamboo Fiber
Tensile Test
Bending Test
Composite

ABSTRACT – The growing public awareness of the environmental atmosphere has triggered a paradigm shift to design composite materials that are environmentally friendly and energy efficient. Composite materials made from natural fibers have been able to replace metal, steel, and wood because of their ease of use and features. Indonesia has a lot of natural fiber potential, one of which is rattan and bamboo fiber which has significant potential for composites. The use of bamboo and rattan fibers as reinforcement in composite materials has increased rapidly and has undergone a high-tech revolution in recent years in response to the increasing demand to develop biodegradable, sustainable and recyclable materials. In this research, a test made from natural fibers was carried out to find out whether the composite was suitable for use as a substitute for fiberglass on ship hulls. The results of the Tensile test for composites reinforced with natural fibers of bamboo and rattan fiber in the 90° fiber direction obtained the average value of the three experiments with a value of 67,41 Mpa and in the 45° fiber direction the average value of the three experiments was obtained with a value of 57,67 Mpa. The results of the bending test for composites reinforced with natural fibers of bamboo and rattan fiber in the 90° fiber direction obtained an average value of the three experiments with a value of 114,64 Mpa and Dan in the 45° fiber direction obtained an average value of the three experiments with a value of 129,93 Mpa.

*Corresponding Author | Suardi | ✉ suardi@lecturer.itk.ac.id

INTRODUCTION

The growing public awareness of the environmental atmosphere has triggered a paradigm shift to design composite materials that are environmentally friendly and energy efficient. The industrial revolution for synthetic fiber-based materials is developing very rapidly in the field of material engineering, especially composites. Composite materials made from natural fibers have been able to replace metal, steel, and wood because of their ease of use and features. Industry worldwide requires millions of tons of this material annually, and will continue to increase. Naturally, its synthetic and non-renewable nature has a negative impact on both nature and humans. Therefore, humans try to create new materials with the help of modern tools to produce materials that are easier to reach (Rahmaniah, 2011).

Indonesia has a lot of natural fiber potential. Potential natural fibers are grouped based on their origin, including mining, animals and plants. Especially for plants, agricultural crops, plantations and natural forests all contain natural fiber. Rattan and bamboo fibers are examples of biological natural resources that can replace wood. Due to their high strength, environmental friendliness, ease of formation, fast growth, and abundance, rattan and bamboo bark fibers have significant potential for composites. The use of bamboo and rattan fibers as reinforcement in composite materials has increased rapidly and has undergone a high-tech revolution in recent years in response to the increasing demand to develop biodegradable, sustainable and recyclable materials. The use of natural fiber composites in shipbuilding is one of the alternative materials that can be used until now. This composite has a goal, namely, the first is to improve the mechanical properties and/or certain specific properties, besides that the composite also provides convenience in terms of flexibility in shape/design which can save costs. (Abdul, 2015).

Based on the explanation above, this study analyzes the effect of variations in the direction of rattan and bamboo fibers with fiber direction variations of 90° and 45°, in the manufacture of composites. The layout and direction of the fibers in the matrix will affect the strength of the composite, where the location and direction can affect the performance of the composite. . The orientation of the fibers affects the tensile strength of the composite, the direction of the perpendicular fibers does not provide reinforcement instead it will weaken, the fibers and the matrix will be released from their bonds. (Elegant, 2019)

METHOD

Tensile Test

The tensile test is a method for testing the strength of a material or material by providing an axial force. The Universal Testing Machine is used to test the tensile strength of composite materials. The extensometer is used to measure changes in length, while the loadcell sensor will measure the tensile force at the crosshead. After the test object has been stretched a length measuring tool or a length meter on the test piece shall be used to measure the distance between the two points. The tensile strength of the composite can be determined by testing the sample according to the ASTMD638-14 standard which can be seen in Figure.1.

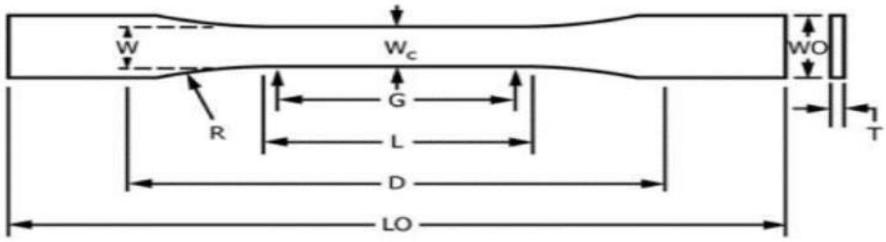

Figure 1. Dimensions of Tensile Test Specimens (ASTM, 2004)

Bending Test

To determine the bending strength of a material can be done by testing the composite material. Bending strength or bending strength is the greatest bending stress that can be accepted due to external loading without experiencing major deformation or failure. The type of material and load both affect the amount of bending strength. Composite tensile strength can be determined by testing the sample according to the ASTMD760 standard which can be seen in Figure. 2.

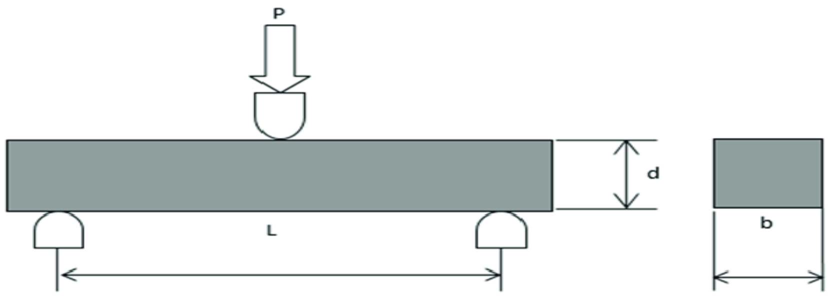

Figure 2. Dimensions of ASTM D790 Bending Test Specimens (ASTM, 2004)

Tensile Test Calculation

Tensile Strength is the force per unit area of the material that receives the force. To be able to obtain the tensile strength of a material, it can be calculated using Equation 1.

$$\sigma = \frac{p}{A_0} \quad (1)$$

The strain used for the engineering stress-strain curve is the average linear strain, which is obtained by dividing the gage length of the test object, ΔL, by its initial length, L0, and can be calculated using Equation 2 and Equation 3.

$$\varepsilon = \Delta L / L_0 \quad (2)$$

$$\varepsilon = \frac{L-L_0}{Lo} \quad (3)$$

Bending Test Calculation

In a homogeneous material testing a simple rod with two mounting points and loading in the middle of the test rod (three point bending), the maximum stress can be calculated using Equation 4.

$$\sigma = \frac{3PL}{2bd^2} \tag{4}$$

RESULTS AND DISCUSSION

Tensile Test Result

1. Grain direction 90°

Table 1. Tensile test results of woven bamboo and rattan fiber at 90°

Volume Fraction		Stress (Mpa)			Strain			Force (N)		
Resin	Serat	Span 1	Span 2	Span 3	Span 1	Span 2	Span 3	Span 1	Span 2	Span 3
80%	20%	64.42	48.42	60.17	0.02	0.01	0.02	4187.64	3147.45	3911.62

From the data obtained in Table 1 it is known that the tensile test specimens of the composite woven bamboo and rattan fiber with a volume fraction of 80% polyester resin and 20% 90° woven variation had the highest tensile strength and stress at 67.4197 Mpa and 0.037061 Mpa.

2. Grain direction 45°

Table 2. Tensile test results of woven bamboo and rattan fiber at 45°

Volume Fraction		Stress (Mpa)			Strain			Force (N)		
Resin	Serat	Span 1	Span 2	Span 3	Span 1	Span 2	Span 3	Span 1	Span 2	Span 3
80%	20%	64.42	48.42	60.17	0.02	0.01	0.02	4187.64	3147.45	3911.62

From the data obtained in Table 2 it is known that the tensile test specimen of the composite woven bamboo and rattan fiber with a volume fraction of 80% polyester resin and 20% woven bamboo rattan fiber and the 45° woven variation has the highest tensile strength at 64,425 MPa and has a strain value the highest at 0.023388

To more clearly know the results of the overall tensile test, the table below shows the tensile values, the average strain of all composite specimens with a volume fraction of 80% polyester resin and 20% woven variations of 90° and 45°. The data can be seen in Table 3.

Table 3. The average value of the tensile test

Information	Volume Fraction	Specimen Variations	Averange Results From Tensile Test
Stress (Mpa)	70% : 30%	90°	65.852
		45°	57.675
Strain	70% : 30%	90°	0.0207
		45°	0.0186

From Table 3, we can get a combined graph of all composite specimens with a volume fraction of 80% polyester resin and 20% woven fiber variations of 90° and 45°, the following diagram can be seen in Figure 3.

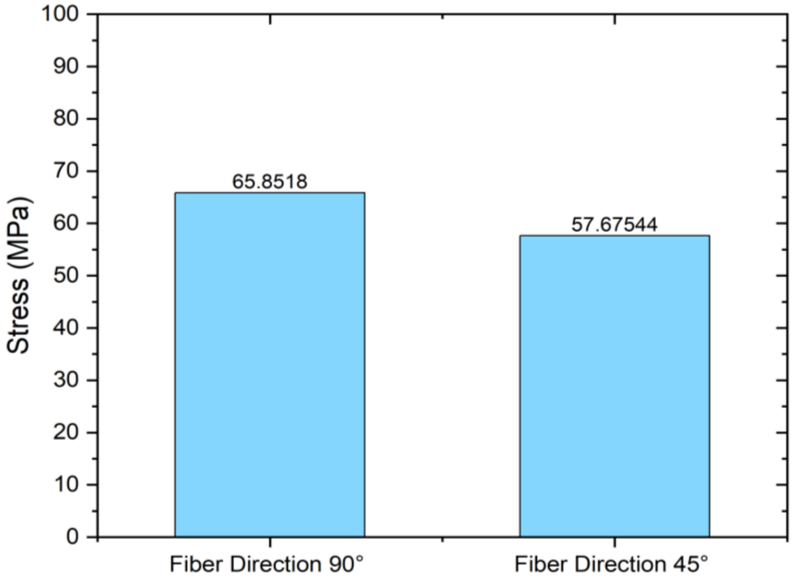

Figure 3. Average tensile test specimens of 45° and 90° variations

Bending Test Result

1. Grain direction 90°

Table 4. Results of bending test of woven bamboo and rattan fiber at 90°

Volume Fraction		Strain			Stress (Mpa)		
Resin	Serat	Span 1	Span 2	Span 3	Span 1	Span 2	Span 3
80%	20%	0.0859	0.1814	0.09022	75.171	174.645	94.131

From the data obtained in Table 4. it is known that the bending test specimen of the composite woven bamboo and rattan fiber with a volume fraction of 80% polyester resin and 20% woven and the 90° woven variation has the highest strength value in specimen 2 which is 174.645 Mpa and has a strain the highest in specimen 2 is 0.1814

Recreation Space			
Lounges	200	Gymnasiums	300
Library			
General Lighting	150	Bulletin Board	150
Reading Area	500		
Multimedia/Computer Room	300	Game Rooms	200
TV room/Movie Theater	150	Reception Areas	300

2. Grain direction 45°

Table 5. Bending test results of woven bamboo and rattan fiber at 45°

Volume Fraction		Strain			Stress (Mpa)		
Resin	Serat	Span 1	Span 2	Span 3	Span 1	Span 2	Span 3
80%	20%	0.1209	0.1234	0.119	130.386	125.955	133.467

From the data obtained in Table 5 it is known that the bending test specimen of the composite woven bamboo and rattan fiber with a volume fraction of 80% polyester resin and 20% woven and the 45° woven variation has the highest strength value in specimen 3 which is 133.467 Mpa and has a strain the highest was in specimen 2, which was 0.1234.

Table 6 shows the average bending strength and average strain of all composite specimens with a volume fraction of 80% polyester resin and 20% woven and woven variations of 45° and 90°. The resulting data can be seen in the table below.

Table 6. The average value of the bending test

Composite Specimen	Variations	Stress (Mpa)	Strain
a composite of woven bamboo and rattan fibers with a volume fraction of 80% polyester resin and 20% fiber	90°	114.649	0.1192
a composite of woven bamboo and rattan fibers with a volume fraction of 80% polyester resin and 20% fiber	45°	129.936	0.121

Based on Table 6, it is possible to graph the average bending strength and average strain for composite specimens with a volume fraction of 80% polyester resin and 20% woven fiber and variations of 45° and 90° weaves, and the result is shown in Figure. 4.

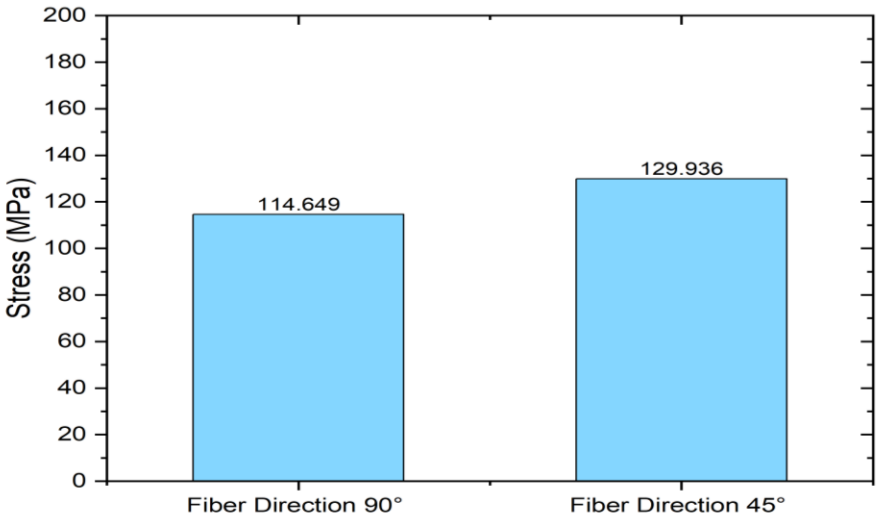

Figure 4. Average stress bending test specimens of 45° and 90° variations

CONCLUSION

The highest tensile strength value was in the first experiment of the 45° webbing variation of 64.42523077 Mpa, and the average value of the three experiments was obtained with a value of 57.6754359 Mpa. The highest bending strength value was in the three experiments of 45° webbing variations of 133.467 Mpa, and the average value of the three experiments was obtained with a value of 129.936 Mpa. The highest tensile strength value was in the first experiment of the 90° webbing variation of 67.41969231 Mpa, and the average value of the three experiments was obtained with a value of 65.85180425 Mpa. The highest bending strength value was in the second experiment of the 90° webbing variation of 174.645 Mpa, and the average value of the three experiments was obtained with a value of 114.649 Mpa. From the test results and compared with the requirements from BKI, none of the specimens met the minimum requirements of BKI. And cannot be used as an alternative material on ship hulls.

REFERENCES

[1] Analisa Papan Laminasi Serat Bambu Petung Dengan Seratt Fiberglass Woven Roving Untuk Material Kulit Kapal. (2022). *Jurnal Teknik Perkapalan, Vol. 10, No. 2*.

[2] Eda Rachman Kurniadi, I. S. (2019). Analisa Material Komposit Resin Berpenguat Serat Rotan Untuk Pembuatan Prostesis Kaki Palsu Bagi Penderita Disabilitas.

[3] Imam Pujo Mulyatno, S. J. (2008). Analisa Teknis Penggunaan Serat Kulit Rotan Sebagai Penguat Pada Komposit Polimer Dengan Matriks Polyester Yukalac 157 Ditinjau Dari Kekuatan Tarik Dan Tekuk. *Kapal, Vol. 5, No.3,*.

[4] Jokosiswor, S. (2009). Pengaruh Penggunaan Serat Kulit Rotan Sebagai Penguat Pada Komposit Polimer Dengan Matrik Polyester Yukalac 157. *Teknik – Vol. 30 No. 3*.

[5] Pardi, a. (2017). Fabrikasi Kapal Fiberglass sebagai Alternatif Pengganti Kapal Kayu Untuk Meningkatkan Produktifitas Nelayan di Perairan Bengkalis. *KAPAL, Vol. 14, No. 2*.

[6] Rokki Manurung, S. S. (2020). Analisa Kekuatan Bahan Komposit Yang Diperkuat Serat Bambu Menggunakan Resin Polyster Dengan Memvariasikan Susunan Serat Secara Acal dan Lurus Memanjang. *SJoME Vol. 2 No. 1*.

[7] Sachdev, R. (2018, November 27). *How to write the background of your study*. Retrieved from Editage: https://www.editage.com/insights/how-to-write-the-background-of-your-study

[8] Siti Nikmatin1, Y. P. (2012). Karakterisasi Selulosa Kulit Rotan Sebagai Material Pengganti Fiber Glass Pada Komposit.

[9] Sudirman Habibiea*, N. S. (2021). Serat Alam Sebagai Bahan Komposit Ramah Lingkungan, Suatu Kajian Pustaka. *Jurnal Inovasi dan TeknologI Material, Nomor Artikel 202101, Vol. 2, No. 2*.

[10] Wikipedia. (2020). *Mind Map*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Mind_map

[11] Willson F. Tambunan, U. B. (2019). Analisa Kekuatan Tarik, Kekuatan Puntir, Kekerasan, dan Mikrografi Baja ST 60 Sebagai Bahan Poros Propeller Setelah Proses Normalizing dengan Variasi Waktu Penahanan Panas. *Jurnal Teknik Perkapalan, Vol. 7, No. 2*.

[12] Hendri Hestiawan, A. F. (2014). Studi Pengaruh Fraksi Volume dan Susunan Serat Terhadap Kekuatan Tarik dan Bending Komposit Resin Berpenguat Serat Rotan (Calamus Trachycoleus). *Jurnal Mechanical, Volume 5, Nomor 1*.