Advances in Social Science, Education and Humanities Research, volume 394
3rd International Conference on Innovative Research Across Disciplines (ICIRAD 2019)

Development of Natural Fiber Composites Based on Thickness Swelling Using Palm Fiber and Coconut Fiber Paper

Dewi Oktofa Rachmawati[1], I Gede Aris Gunadi[2]
Physics Education
Ganesha University of Education
Singaraja, Bali, Indonesia
[1]dewioktofa.r@undiksha.ac.id, [2]igedearisgunadi@undiksha.ac.id

***Abstract*— Palm and coconut fibers are able to accommodate different water, have good insulation of temperature and sound. The combination of palm and coconut fibers as a reinforcement of natural fiber composites is influenced by the characteristic thickness of the constituent materials. This study aimed at describing the effect of thickness on various variations of the composition of palm and coconut fiber as a reinforcement of natural fiber composites. Natural fiber composites were made by hand lay-up methods. The comparison of fibers and matrices was 40% and 60%. The variation in the composition of the weight of coconut fibers in the fiber was 20%, 40%, 60%, 80%. The fiber used a chopped fiber model with a length of 3 cm. Thick development data analyzed descriptively to refer to SNI 03-02105-2006. The density of natural fiber composites in all variations in the composition of the weight of coconut fibers in the fiber was in the range of values of 1.0893 to 1.0956 gr / cm3. Soaking with water for 24 hours showed that the composite board had a thick development of 2% to 5.9%. Composite of natural fiber with the composition of 80% fibers and 20% coconut fibers experienced the largest thickness development which was 0.65 mm.**

Keywords—natural fiber; composites; thickness analysis.

I. Introduction

A composite material is a material composed of a combination of two or more main elements that are macro different in shape with a composition that cannot be separated [1]. According to reference [2], a composite is a material structure consisting of two or more combinations of materials, which are formed at the macroscopic scale and fused physically. In simple terms according to reference [3], composite means a combination of two or more different materials. Composites consist of the main ingredients namely matrix and reinforcement which are added to increase the strength and stiffness of the matrix. This amplifier is usually in the form of fiber.

Matrices are phases in composites that have the largest (dominant) volume part or fraction. The matrix, generally more resilient but the strength and the stiffness is lower than the amplifier. The matrix has the following functions; 1) transferring tension to the fiber, 2) forming a coherent bond, the surface of the matrix/fiber, 3) protecting the fiber, 4) separating the fiber, 5) releasing the bond, 6) remaining stable after the manufacturing process.

The quality of composites is also influenced by the type of resin used [4]. Resin gives strength to impact and external pressure exerted on the material [5]. Based on research conducted by BPPT Jakarta on composite tensile strength quality reinforced by a polyester matrix with natural fibers at 40% - 50% by weight, unsaturated polyester resin (UPR) has the highest tensile strength quality. Another advantage of UPR is that it is easy to handle in liquid form, fast cure, perfect dimensional stability, good physical and electrical properties, easy to color and modify.

Amplifiers function as reinforcement in composite materials, which have less elasticity but are stiffer and stronger. The shape of the reinforcement can be various in granules, fine fibers, discontinuous fibers, continuous fibers, and slabs. The type of reinforcement that is often used in the form of fiber because this form is more easily formed than the slab and the ability to continue the load is greater than the shape of the buffer. And the types of fibers commonly used as reinforcement are carbon fiber, glass fiber, and aramid. The main function of the amplifier is to transfer stresses between fibers, provide resistance to adverse environments and protect the surface of the fiber from mechanical and chemical effects. Fiber contribution largely affects the tensile strength of composite materials.

Fiber functions as supporting strength of the composite; thus, the high and low strength of the composite is very dependent on the fiber used. The voltage applied to the composite is initially received by the matrix and is passed on to the fiber. Fiber will hold the load to the maximum load. Therefore, the fiber must have a tensile stress and modulus of elasticity higher than the composite matrix. This study aimed at developing natural fiber-based on changes in the influence of thickness. Fiber material made from coconut fiber and coconut fiber.

II. METHODOLOGY

This research was experimental research by doing testing. The experiments carried out were making natural fiber composites by varying the composition of palm fiber and coconut fibers as reinforcement. Figure 1 shows the stages of implementation in this study.

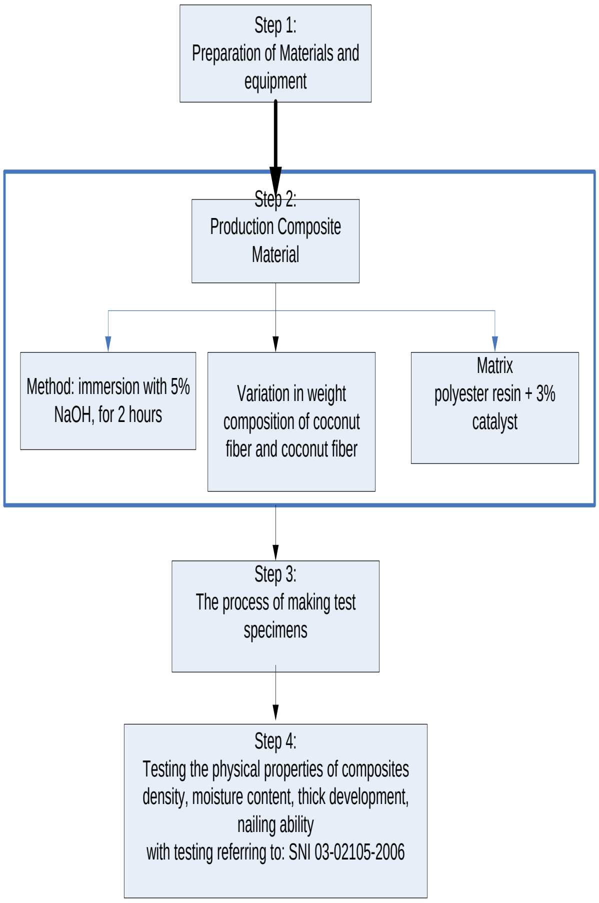

Fig. 1. Research Stages

A. Preparation Stage

This stage includes 1) preparing materials used in the study, namely coconut fiber and coconut fiber, Yukalac 157 unsaturated polyester resin, Mepoxe type catalyst (metal, ethyl, ketone, peroxide), wax, acetone, 5% NaOH. 2) Preparing equipment, namely printing equipment, wood clamps, digital scales, measuring cups, saws, paint brushes, gloves, mixers, scissors, small spatulas, rulers, markers. 3) Design and manufacture printing equipment measuring 20 x 9 x 1 cm made of plates, 4) design and make composite press / press tools. 5) Making liquid 5% NaOH is done by mixing 98% NaOH solids in grams in 100 ml of the solvent, i.e. aqua dest, or 51.02 g in 1000 ml of aqua dest.

B. Production Stage Stage

Making composites with a composition of 40% fiber and 60% matrix using the hand lay-up method consists of 1) processing of coconut fiber and coconut fiber, 2) determining the composition of the fiber weight, 3) mixing the matrix with the catalyst, 4) composite printing. To get the interface strength and mechanical attachment, eliminate the ineffective constituent components of fiber, remove dirt and cork attached to the fibers, the fibers and coconut fibers are soaked with 5% NaOH alkaline solution for 2 hours. NaOH treatment in natural fibers has been investigated by [6], providing optimum fiber tensile strength. Furthermore, the soaked fiber was washed with running water and dried naturally. The selection of fibers is done to get the same diameter cut to the size of 3 cm. The process of making coconut fiber and coconut fiber-reinforced composites is as follows:

a) Preparing fibers with a predetermined weight composition based on the print volume. The fiber used is dried fiber so that the absorption with adhesive can be optimal. Fiber with too much water content will result in mixing with suboptimal adhesives. Fibers and coconut fibers were cut into 3 cm lengths to get this type of short fiber.

b) Mixing unsaturated polyester resin that has been measured with a catalyst by stirring with constant rotation. A 3% catalyst is needed from the volume of unsaturated polyester resin to obtain a curing process that is not too fast. Leave for 5 minutes to expel bubbles trapped in the matrix.

c) Preparing a 9cm x 20cm x 1cm mold and coating the aluminum foil mold and coating it with wax to facilitate the removal of the composite from the mold.

d) Adding 1/3 part mixture of polyester resin and catalyst to the mold.

e) Putting the fiber evenly on the mold and pour 2/3 of the mixture of polyester resin and catalyst remaining on the fiber.

f) Flattening the mixture of polyester resin and catalyst on the fiber using a paintbrush or spatula while pressing for a long time to remove bubbles that appear and are trapped in the matrix.

g) Giving pressure and letting it dry (about 1 day).

C. Produce Testing Specimens

Composites were cut with a saw or grinding for the process of making test specimens. The size of the test specimen was 3cm x 10cm x 1 cm for each composition of fiber weight. Before testing physical properties, natural fiber composites were allowed to stand for 30 days to obtain stable conditions. Phase IV was testing the physical properties of composites namely density, moisture content, thickness development, and nailing ability.

D. Testing

Composite density was tested by reducing the mass and volume of the composite when conditions are stable. The water content was tested by reducing the difference between the composite wet mass and dry mass. The development of thickness was tested by removing the difference between the wet and initial thick thickness with the initial thickness of the composite. Nailing ability test was obtained by composite integrity when nailed with threaded nails at a distance of 1 cm and 2 cm. Data on composite density, moisture content, thickness development, and nailing ability were analyzed descriptively according to SNI 03-02105-2006 about the physical properties of composites.

III. Result and Analysis

A. Result

Based on measurements of fiber density fibers obtained, palm fiber was greater than the density of coconut fiber. Palm fiber, density is 1.115 gr / cm3 and coconut fiber density was 1.098 gr / cm3. Type of coconut fiber and coconut fiber are short fibers, having a length of 3 cm as shown in figure 1.

Fig. 2. Coconut and Palm Fiber

The mold was made of double plywood with 1.5 cm thickness, measuring 20x9x1 cm as seen in figure 3. The volume of natural fiber composite molds was 180 cm^3.

Fig. 3. Molding of Fiber

Before being produced, fibers and coconut fiber were soaked with 5% NaOH solution for 2 hours, then rinsed with water thoroughly as in figure 4. After that, it was allowed to dry naturally.

Fig. 4. Yields of Fiber Soaked with 5% NaOH Solution

After that, the amount of natural fibers and matrices was prepared. The required fiber volume was 40% x 180 = 72 cm3, and the required matrix volume was 60% x 180 = 108 cm3. Variation in composition of coconut fiber and coconut fiber were 0%, 20%, 40%, 60%, 80%, 100%.

Fig. 5. Natural Fiber

Produced composites were left for 30 days to obtain a stable composite. The composite test sample was grinded with a size of 10x3x1cm as in figure 6.

Fig. 6. Testing Sample

The density of natural fiber composites were obtained from mass and volume stable measurements. Data on the density of natural fibers with variations in the composition of fiber fibers and coconut fibers are presented in table 61.

TABLE I. DENSITY OF NATURAL FIBER

No	Composition				Massa stabile (gram)	Vol (cm^3)	Density gr/cm^3
	Palm Fiber		Coconut Fiber				
	(%)	(gram)	(%)	(gram)			
1	0	0.000	100	72.00	30.33	27.90	1.087
2	20	16.062	80	63.22	31.29	28.73	1.089
3	40	32.124	60	4.41	29.93	27.46	1.090
4	60	48.185	40	31.61	29.88	27.38	1.091
5	80	64.247	20	15.80	33.90	30.94	1.096
6	100	80.309	0	0.00	30.62	27.90	1.097

Initial thickness was obtained by measuring the thickness of the natural fiber composite after being conditioned for 30 days at ambient temperature, 31°C, while the wet thickness was obtained by measuring the thickness of the composite after being immersed for 24 hours. Data on the development of natural fiber composite thickness for variations in the composition of coconut fiber and coconut fiber are presented in table 2.

TABLE II. DEVELOPMENT OF NATURAL FIBER

Composition				Density (gr/cm^3)	Thick Wet (mm)	Initial Thick (mm)	Dev of Thick (%)
Palm Fiber		Coconut Fiber					
%	gram	%	Gram				
0	0.00	100	72.0	1.09	10.15	9.98	1.7
20	16.06	80	63.2	1.09	10.20	10.0	2.0
40	32.12	60	4.4	1.09	9.25	8.98	3.0
60	48.19	40	31.6	1.09	10.35	9.97	3.8
80	64.25	20	15.8	1.1	11.55	11.01	4.9
100	80.31	0	0.0	1.1	10.65	10.06	5.9

Dry mass was obtained by weighing the mass of the natural fiber composite after being heated for 6 hours at 100°C, while the initial mass is obtained by weighing the mass of the composite after being conditioned for 30 days. Data on the absorption capacity of natural fiber composites for variations in the composition of coconut fiber and coconut fiber is presented in table 3.

TABLE III. ABSORPTION CAPACITY OF NATURAL FIBER

Composition				Density (gr/cm^3)	Initial mass (gram)	Dry Massa (gram)	Absorption (%)
Palm		Coconut					
%	gram	%	(gram)				
0	0.00	100	72.0	1.09	30.33	29.24	3.7
20	16.06	80	63.2	1.09	31.29	30.21	3.6
40	32.12	60	4.4	1.09	29.93	28.63	4.6
60	48.19	40	31.6	1.09	29.88	28.51	4.8
80	64.25	20	15.8	1.1	33.90	32.22	5.2
100	80.31	0	0.0	1.1	30.60	29.05	5.3

The composite board to be tested for nailing ability is a composite board that has been conditioned for 30 days. The ability to nail a natural fiber composite board in terms of the state of the composite board when nailed at a distance of 1 cm, 2 cm, 3 cm. Types of nails used were concrete nails with a nail diameter of 0.3 cm and a nail length of 3.23 cm.

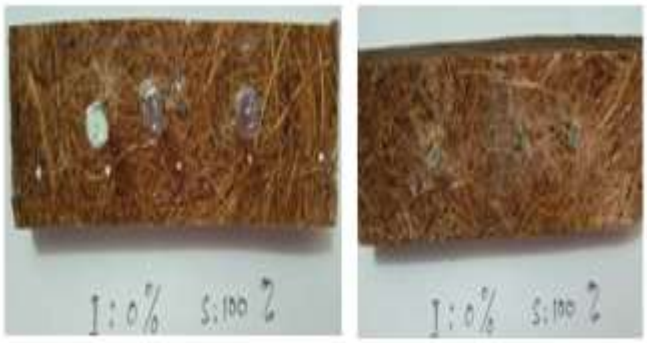

Fig. 7. Ability in spikes with natural fiber composites (Fiber Composition I: 0% and S: 100%)

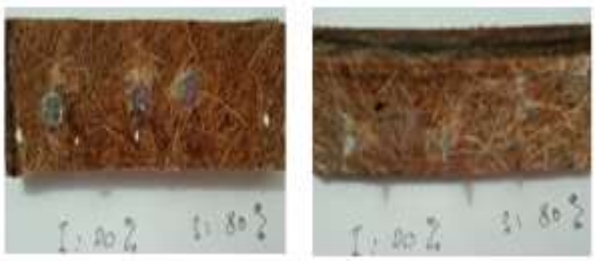

Fig. 8. Ability in spikes with natural fiber composites (Fiber Composition I: 20% and S: 80%)

Fig. 9. Ability in spikes with natural fiber composites (Fiber Composition I: 40% and S: 60%)

Fig. 10. Ability in spikes with natural fiber composites (Fiber Composition I: 60% and S: 40%)

Fig. 11. Ability in spikes with natural fiber composites (Fiber Composition I: 100% and S: 0%)

TABLE IV. ABILITY IN SPIKES OF NATURAL FIBERS

Composition		Thick	Lower Surface Conditions					
Palm : Coconout		(cm)	Distance (1 cm)		Distance (2 cm)		Distance (3 cm)	
(%)	(%)		light	Heavy	light	heavy	light	heavy
0	100	10.00	✓		✓		✓	
20	80	11.00	✓		✓		✓	
40	60	10.00		✓	✓		✓	
60	40	10.40	✓		✓		✓	
80	20	10.50	✓			✓	✓	
100	0	10.20		✓	✓		✓	

B. Analysis

The density of the composite board increased with the addition of the fiber weight composition. The density of composite boards in the variation of the composition of the fibers' weight and coconut fibers exceeded 0.90 gram/cm3. Then it was classified in high-density composite boards. High-density composite boards showed high fiber compression when compressing/applying pressure.

Water absorption by fibers (palm fibers and coconut fibers) containing lignin and cellulose caused the recovery of fibers to their original dimensions due to the development of fiber cell walls or the size of the fiber cavity. The adhesive was not able to enter the very small fiber cavity during the pressing process.

The greater the density of the composite board followed by the development of a thicker thickness. So the relationship of density and thickness development was linear. The development of composite board thickness in various variations of the composition of coconut fiber and coconut fiber is still below the value set by SNI 03-02105-2006, which was maxed 12% for composite board thickness ≤ 1.27 cm. Therefore, these natural fiber composite boards have high dimensional product stability. Its mechanical properties will decrease in a long period of time. The development of composite boards shows the ability of fiber absorption. The greater the development of composite boards, the greater is the absorption of the fibers.

IV. CONCLUSIONS

Some conclusions in this study are as follows:

(1) Natural fibers made from coconut fiber and coconut fibers have the properties to restore the original dimensions.

(2) Relationship to the development of thickness to linear proportionality.

(3) The development of thickness in the combination of palm fiber with coconut fibers is still below the value set by SNI 03-02105-2006 i.e. max 12% for composite board thickness ≤ 1.27 cm.

REFERENCES

[1] M.M. Schwartz, "Composite Materials Handbook", McGraw-Hill, Book Co, New York, 1984.

[2] F.R. Gibson, "Principle of Composite Material Mechanis," International Edition, McGraw- Hill Inc. New York, 1994.

[3] K. Diharjo, "Pengaruh Perlakuan Alkali terhadap Sifat Tarik Bahan Komposit Serat Rami-Polyester," Jurnal Teknik Mesin. Vol. 8, 2006. hal 8-13. Online https://id.scribd.com/doc/59030862

[4] F.R. Titani, "Pemanfaatan Serat Serabut Kelapa sebagai Penguat Pengganti Fiberglass pada Komposit Resin Polyester untuk Aplikasi Bahan Konstruksi Pesawat Terbang," JurnalTechno(P-ISSN: 1410-8607, E-ISSN: 2579-9096), Vol 3 No. 1, 2018. Online www.researchgate.net/pulication/329185116

[5] I. Pramuko & Purboputro, "Pengaruh Panjang Serat terhadap Kekuatan Impak Enceng Gondok dengan Poliester," Laporan Penelitian. Jurusan T. Mesin Universitas Muhammadyah Surakarta, 2006.

[6] S. Astuti, "**S**ifat Mekanis Serat Enceng Gondok sebagai Material Komposit Serat Alam yang Biodegradable," Journal of Mechanical Engineering (p-ISSN: 2598-7380 e-ISSN: 2613-9847), Vol. 2, No. 1, 2018. Online http://jurnal.untidar.ac.id/index.php/mechanical