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Effect of Fiber Length Against Hardness And Composite Impact Coconut Fiber - Polyester Resin

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Abstract - *This study aims to determine the mechanical properties of coconut fiber composite - polyester resin. In order to obtain a good interface between fiber and matrix, coco fiber is treated in the form of immersion with an alkaline solution. The composites are prepared by way of printing on steel molds that are thickened in thickness with random fiber orientations of different length and volume fractions. The test of mechanical properties performed is a hardness test referring to the ASTM D 785 testing standard and impact test referring to ASTM D 256. The results show that, shorter fibers have higher hardness values compared to long fibers and hardness increases with increasing fiber volume fraction. While impact strength will increase with increasing length and volume fraction of fiber contained in natural fiber-based composite material.*

***Key Words*: component, coco fiber, fiber length, natural fiber, parquet, haradness, impact strength**

1. INTRODUCTION

Recently public attention has shifted to natural fiber as a resource because of its rapid growth, cheap, renewable and environmentally friendly. Along with the development of material technology, the role of natural fibers began to replace the position of synthetic fibers such as glass fiber or carbon fiber as a reinforcing material on composites. Plant fiber from agriculture is a renewable material that has the potential to create green material products to replace synthetic materials currently used such as glass fiber, carbon fiber and plastic fibers. The combination of bio-fiber and bio-polymer can be a composite or composite green product that can be dredged by biodegradable [1].

Composite applications with natural fiber reinforced thermoplastic matrices have been applied in the furniture, packaging, housing and automotive industries because of some advantages such as low cost, low density, good thermal insulation properties, reduced tool wear, reduced thermal properties, and renewable resources [2]. However, natural fibers are generally hydrophilic because they are celluloses containing strong polarization hydroxyl groups [3]. The main problem of using natural fibers with thermoplastics is the poor interface between fiber and thermoplastic. Therefore, the optimization of interface bonds between natural fibers based on cellulose and thermoplastics has been the focus of a large number of studies conducted over the last two decades [4]. Coconut fiber has high weather resistance because it has higher lignin content compared to other fibers that is 40 - 45% and lower cellulose content of 32 - 43% [5]. This property causes problems when used with a hydrophobic polymer matrix primarily of overall mechanical properties as well as other physical properties of fiber [6].

A workable approach is to chemically modify the fiber surface to get more hydrophobic fibers. One treatment commonly used in fiber surface modification is soaking with alkali (NaOH) in order to increase the bonding strength between the fibers and the matrix such as studies conducted on coco fiber with Polybutylene succinate resin (PBS) pellets [7] and polyester resin [8].

The objective of this research is to study coconut fiber composite experiment with polyester resin matrix to determine the hardness and impact strength with variation of length and fiber volume fraction on the condition of fiber get the initial treatment in the form of soaking with 5% alkaline solution. This research is the first step to know the mechanical properties of coconut fiber-resin composite polyester resin for wooden floor parquet application as a substitute for wooden floor parquet.

2. MATERIAL AND METHODS

2.1. Plant Material

Coconut fiber obtained from CV. Puri Bintang Gemilang Bitung Municipality of North Sulawesi- Indonesia (39 Km from Manado State of Polytechnic). While the matrix used in this research is Unsaturated Polyester Resintipe Yucalac BQTN 157 which supplied from PT. Justus Kimia Raya and the catalyst used are Methyl ethyl ketone peroxide (MEKP). The chemical used for the initial treatment is an alkaline type of Sodium hydroxide (NaOH).

2.2. Preparation of Fiber Materials

The coconut fiber was supplied from the industry was washed with clean water to remove impurities attached during the fiber separation process and dried without direct sunlight for 2 hours. The fibers are cut into pieces of 10, 20, 30, 40, and 50 mm in accordance with the composite variations that will be made for analyzing their mechanical properties (impact and hardness). Then the fiber is immersed in a separate container according to the fiber length in 5% NaOH solution and 95% water for 2 hours. The fibers are washed with running water and rinsed with distilled water to remove the chemical effect until the pH level approaches 7. After that the fiber is dried at room temperature for 3 days before the composite process is made

2.3. Composite Creation

In this study, composites were made with different fiber lengths that were randomly distributed on polyester resins with volume fractions of 30%, 40%, and 50%. The test specimens were made with sizes (300 x 100 x 8) mm with the composite compositions prepared as shown in table 1 below:

Table -1: Composite compositions for test specimens

Composite Panel Type	Coir Length (mm)	Composite Panel Compositions (vf %)		
		Coir Fiber	Polyester	MEKP
A1	10	30	69	1
A2		40	59	1
A3		50	49	1
B1	20	30	69	1
B2		40	59	1
B3		50	49	1
C1	30	30	69	1
C2		40	59	1
C3		50	49	1
D1	40	30	69	1
D2		40	59	1
D3		50	49	1
E1	50	30	69	1
E2		40	59	1
E3		50	49	1

The composites are prepared by means of printing on steel molds equipped with thickness borders and for ease of mold removal from the mold, the mold is first smeared using wax. The resin and catalyst were mixed with the mixer for ± 15 seconds, then the fiber of a certain length according to the length specified in the study was mixed by hand and inserted in the mold and pressurized with a hydraulic press machine and left for 2 hours at room temperature before the test object was removed of the mold.

2.4. Test Procedure

The molded composite panel is left for 15 days at room temperature. The manufacture of specimens and tests refers to the ASTM standard. For hardness testing refers to the ASTM D 785 test standard, where the printed specimen is cut to the size of 40 x 40 x 8 for each test specimen variation. Prior to the hardness testing, the test object is polished with a polishing machine (Struers LaboPol-21) to ensure a smooth and smooth surface. Measurement of Rockwell hardness values on L scale using hardness test machine (Zwick / Roell 8187.5 LKV). Each test object variation is performed 13 repetitions of data retrieval at different points and then averaged to display the final value. For impact testing using ASTM D 256 standard with 13 repetitions of data retrieval. The equipment used is the HEW type Zwick Roell impact test machine.

3. RESULTS AND DISCUSSIONS

Statistical analysis showed significant differences between all types of composite panels against their mechanical properties (hardness and impact strength) as shown in Table 2.

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Table -2: The mechanical properties of coco fiber - polyester of various types of composite panels

Comp. panel type	Coir length (mm)	Composite panel composition (vf %)			Mechanical Properties	
		Coir Fiber	Resin Polyester	MEKP	Hardness (HR – L)	Impact Strength (J/m)
A1	10	30	69	1	99.26 (0.360)	9.90 (0.509)
A2		40	59	1	100.00 (0.196)	10.15 (0.605)
A3		50	49	1	100.80 (0.023)	11.45 (0.738)
B1	20	30	69	1	98.17 (±0.870)	11.68 (±0.871)
B2		40	59	1	99.88 (±0.536)	11.88 (±0.665)
B3		50	49	1	100.15 (±0.549)	12.94 (±0.528)
C1	30	30	69	1	94.55 (±0.660)	14.37 (±0.620)
C2		40	59	1	95.73 (±0.793)	15.78 (±0.805)
C3		50	49	1	96.68 (±1.056)	16.80 (±0.699)
D1	40	30	69	1	90.49 (±0.955)	17.59 (±0.583)
D2		40	59	1	91.18 (±0.986)	18.34 (±0.363)
D3		50	49	1	92.00 (±1.438)	19.50 (±0.434)
E1	50	30	69	1	86.36 (±1.018)	21.47 (±0.245)
E2		40	59	1	87.81 (±1.429)	22.50 (±0.209)
E3		50	49	1	89.97 (±1.438)	24.45 (±0.175)

The value of the mechanical properties (hardness and impact strength) shown in Table 1 is the average hardness value with the standard deviation for each composite type with different composition. Viewed from the statistical analysis shows that the composite panel type A with 10 mm fiber length has the highest hardness value and the least standard deviation compared with other composite types. This figure shows the level of data accuracy for this type of composite better with other composite types. This condition also informs that this type of composite hardness has almost equal hardness properties for all composite surfaces meaning that the bond structure between fiber and matrix is better. On the contrary, the E type composite with 50 mm fiber length has the highest impact strength compared to other types of composites. This can be seen from the uniformity of data obtained from the impact strength test, the small standard deviation in this type of composite indicates the data obtained is more accurate than the composite type.

3.1. Effect of Fiber Length and Volume Fraction on Hardness

The hardness of the coco fiber composite composite with the polyester matrix to the fiber length in the fraction of fiber volume of 30%, 40%, and 50% is shown in Figure 1. It is seen that the hardness value will decrease with increasing fiber length in polyester composite. The trend of this hardness decrease starts from the fiber length of 10 mm to 50 mm, either on volume fraction 30%, 40%, or 50%. For the 10 mm coco fiber filler, the observations made on the 30% fiber volume fraction have 99.26 HRL hardness, volume fraction 40% has 100.00 HRL hardness, and at a 50% volume fraction having a hardness of 100.80 HRL. The size of the fiber with a length of 20 mm decreased the hardness value but increased the hardness value by increasing the volume fraction of 90.49 HRL, 91.18 HRL, and 92.00 HRL respectively for volume fractions 30%, 40%, and 50%. Likewise with the fiber length of 30 mm, 40 mm, and 50 mm, where the lowest value for the hardness number is achieved at 50 mm fiber length with a volume fraction of 30% that is 86.36 HRL while the highest hardness is produced at 10 mm fiber length and 50% for 100.80 HRL. Increasing the hardness value with increasing fiber length has also been investigated by [9] which examined on fiber sisal and glass with epoxy matrix. Characteristics of increased hardness values with diminished fiber dimensions have also been studied on shellfish, where the shorter the fiber size the hardness value will increase [10]. While the increase in hardness with increasing fiber volume fraction has also been studied on other natural fibers [11]. Conducted a study of the hardness properties of the areca-epoxy fibers which concluded that composite hardness would increase with increasing fiber volume fractions [12].

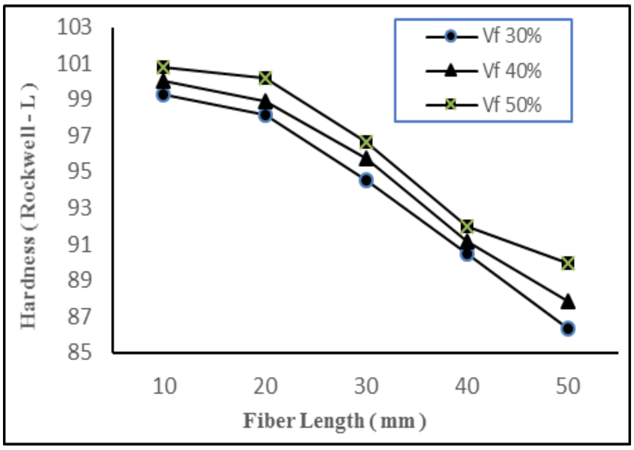

Fig – 1: Variation of hardness at different fiber length

3.2. Effect of fiber length and volume fraction on impact strength

The impact strength on the variation of the volume fraction of 30%, 40%, and 50% on the fiber display 10 mm, 20 mm, 30 mm, 40 mm, and 50 mm as shown in Figure 2. The effect of coco fiber length to impact strength indicates that 10 mm fiber length at 30% fiber volume fraction undergoes a change in strength value starting from 9.9 J / m and ending at 11.45 J / m. Likewise with increasing fiber length and volume fraction, impact strength value will increase where the highest value is achieved at 50 mm fiber length and volume fraction 50% that is equal to 24.45 J / m. This increased impact strength value has also been investigated on the sisal fiber and glass using the epoxy matrix, which concludes that increasing the fiber length will increase the impact strength value [9]. While research with coco fiber and abaca fiber with PP polymer thermoplastic matrix shows an increase in impact strength value with increasing volume fraction [10].

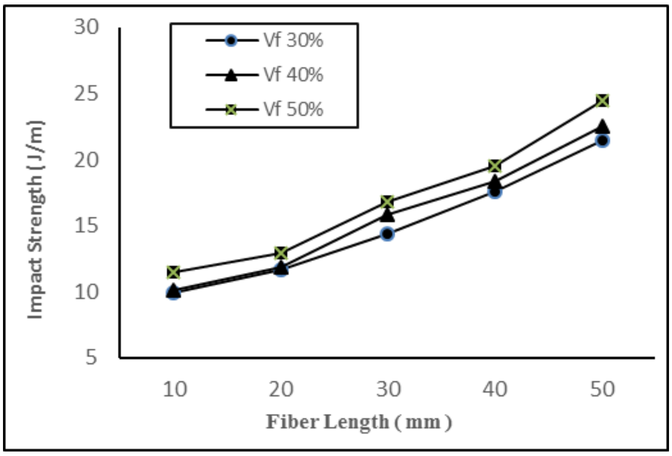

Fig – 2: Variation of Impact at different fiber length

In this study, the measurement of impact strength and composite hardness using coconut fiber that has undergone chemical treatment by soaking in alkaline solution. The alkalization effect will provide bonding strength between the fibers and the matrix so as to improve its mechanical properties [12,13]. The impact strength will increase with increasing fiber content. This is because of the increased probability of agglomeration of the fibers so that it will produce regions with stress concentrations requiring less energy for crack propagation [14]. This condition causes the energy needed to break the material becomes larger. As shown in Figure 2, the impact strength of all composite panel types increases in value with increasing length and fiber fraction. These results indicate that the fiber is capable of absorbing energy because the strong interfacial bond between the fiber and the matrix becomes better due to the alkalization process. With the increase in fiber content, greater energy is required to remove the fibers from the bond so that the value of hardness will be great. It is believed that the hardness of coco fiber composite composites with thermoplastic resins has higher hardness values among other natural fibers. This is due to the relatively small amount of cellulose possessed among other types of natural fibers which causes the coco fiber to be more rigid and tough [5].

4. CONCLUSIONS

In this study, investigations were conducted on various types of composite panels formed with different fiber length compositions and different fiber volume fractions as well. The fibers used were treated with an alkaline solution of 5%. The results obtained from this study can be summarized as follows:

1. Decreasing fiber length will give higher hardness value. For the fraction of 50% the hardness is also higher than the lower volume fraction

2. Measurement of hardness by Rockwell method on L scale shows that the fiber length of 10 mm and the volume fraction of 50% have the highest hardness of 100.80 HRL.

3. Increasing the length and fiber fraction in the composite meterial will increase the impact strength.

The greatest impact strength was achieved on fiber length composition of 50 mm and fiber volume fraction 50% ie equal to 24.45 J / m.

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