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Analysis of Physical and Mechanical Propoerties of Composite Board Made From Bamboo Fiber and Polyester Resin

Silviana Simbolon[1,a)], Sulanjari[1], Ihat Solihat[1]

[1]*Mechanical Engineering Department, Universitas Pamulang, Tangerang Selatan, 15417, Indonesia*

E-mail: [a)] dosen01923@unpam.ac.id

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Abstract: *The study was conducted to determine the characteristics of bamboo fiber reinforced composite materials. Composite samples were made with fiber composition in percent weight, namely 20%, 30%, 40% and as a matrix material using polyester resin. Then the bamboo fiber and matrix are mixed according to the composition and stirred manually until evenly distributed. Furthermore, the mixture of raw materials is poured into a mold and then left for 60 minutes, then the sample is released from the mold and cut into pieces according to the shape of the test specimen. The dried sample is tested which includes density test and compressive strength test. From the test results obtained that The mixing composition has a significant effect on the density and compressive strength of the composites. The density and compressive strength values in the composite with 20% bamboo fiber were 1.55 g/cm^3 and 270 kgf/cm^2, while the sample with the composition of 30% bamboo fiber obtained density values of 1.48 g/cm^3 and compressive strength of 274 kgf / cm^2. A sample with 40% bamboo fiber has density and compressive strength of 1.24 g/cm^3 and 284 kgf/cm^2. The results of the sound absorbance test on bamboo fiber show that the percentage of sound absorption increases linearly as shown in the graph.*

Keywords: *Composite, Bamboo Fiber, Polyester Resin, Density, Compressive Strength.*

Abstrak: Penelitian ini dilakukan untuk menentukan karakteristik bahan komposit yang diperkuat serat bambu. Sampel komposit dibuat dengan komposisi serat dalam persentase berat, yaitu 20%, 30%, 40%, dan sebagai bahan matriks menggunakan resin poliester. Kemudian serat bambu dan matriks dicampur sesuai dengan komposisi dan diaduk secara manual hingga terdistribusi dengan merata. Selanjutnya, campuran bahan mentah dituangkan ke dalam cetakan dan dibiarkan selama 60 menit, kemudian sampel dilepas dari cetakan dan dipotong menjadi potongan sesuai dengan bentuk benda uji. Sampel yang telah kering diuji, termasuk uji densitas dan uji kekuatan tekan. Dari hasil uji diperoleh bahwa komposisi pencampuran memiliki pengaruh signifikan pada densitas dan kekuatan tekan komposit. Nilai densitas dan kekuatan tekan pada komposit dengan serat bambu 20% adalah 1,55 g/cm^3 dan 270 kgf/cm^2, sementara sampel dengan komposisi serat bambu 30% memiliki nilai densitas 1,48 g/cm^3 dan kekuatan tekan 274 kgf/cm^2. Sampel dengan serat bambu 40% memiliki densitas dan kekuatan tekan masing-masing 1,24 g/cm^3 dan 284 kgf/cm^2. Hasil uji daya serap suara pada serat bambu menunjukkan bahwa persentase penyerapan suara meningkat secara linear seperti yang terlihat dalam grafik.

Kata Kunci: Komposit, Serat Bambu, Resin Poliester, Densitas, Kekuatan Tekan.

INTRODUCTION

A composite material is a combination of two materials with different physical and chemical properties. When they are combined they create a material which is specialised to do a certain job, for instance to become stronger, lighter or resistant to electricity. The composite material is calcified into two groups, namely conventional composite and non-conventional composite. conventional composites are non- renewable and non-recyclable, pollution problem has become an issue when conventional composites are used [1].

Non-conventional composites are composite materials that use filler materials from natural materials, for example coconut fibers, bamboo fibers, and others [2].

The advantages of natural fibre composites are biodegradable, low cost, environmental friendly (low pollution) and low density which resulting in good specific strength [2], [3]. Composite materials are widely used in the automotive industry, aircraft, as sound absorbing materials and others [1], [4].

Composite research using natural fibers has been widely conducted and developed. Nuthong et al, reported Composite polymer PLA (Polylactic acid) which reinforced with natural fibers; bamboo fibers, fibers vetiver grass and coconut fibers have been fabricated and studied, where Composite of bamboo fibers / phenol resin of two direction type (2D2L) produced tensile strength of 13 – 16 N/mm^2 , and punch shear strength of 17-27 N/mm^2 [5]. Fazlin A. Khair et al, reported utilization of bamboo, a natural material having hollow structure to act as sound absorber and the result reveals that bamboo having length of 2 cm has average absorption coefficient of 0.95 at frequency above 3 kHz [6].

Bamboo is a type natural fibre composite that is classified as stalk fibre, bamboo consists of cellulose fibre which are aligned along the length of the bamboo. It is these cellulose fibres that give bamboo maximum tensile flexural strength and rigidity in that direction. the mechanical properties of bamboo depends on many factors such as species, culm position, age and so on [7], [8]. Bamboo is widely reached in several countries, one of which is Indonesia, the source of raw material for fiber from bamboo is quite abundant in Indonesia, therefore it is necessary to develop and master the technology for making composite materials using natural fibers such as bamboo. Therefore it is necessary to conduct research on the manufacture of bamboo fiber adri composites with polyester resin adhesives, and the purpose of this study is to determine the effect of composition on the density and compressive strength of composites

METHODOLOGY

For the manufacture of composites, bamboo fiber is used as raw material with polyester resin adhesive, previously the bamboo fibers are cut into 3-6 cm sizes. There are two compositions made in this study, namely: sample 1 with a composition of 20% by weight of bamboo fiber and 80% by weight of polyester resin, sample 2 with a composition of 30% by weight of bamboo fiber and 70% by weight of polyester resin and sample 3 with composition of 40% of bamboo fiber and 60% polyester resin.

The two raw materials are weighed according to the composition, then mixed until they are homogeneous, and then put in the chips and left for 60 minutes until they harden. Furthermore, the resulting composite sheet is dipped into a size of 3 x 3 x 3 cm for density testing and compressive strength testing.

The density test of the test sample was carried out in dry conditions. First, the test sample is weighed using a digital scale and the results are recorded as m. Then measuring the dimensions of the sample to calculate the sample volume V. The calculation is carried out using equation (1) to obtain the density value of the test sample.

$$\rho = \frac{m}{V} \text{.....(1)}$$

Compressive strength testing also uses a UTM machine by placing the test sample on a pedestal. Then the test sample is loaded vertically as shown in Figure 1.

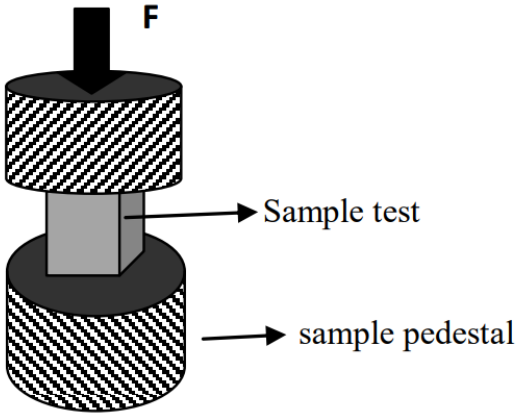

Figure 1. Loading on compressive strength test

Then the maximum load is recorded until the test sample cracks as the Pr value. After that, the calculation of the flexural strength value is carried out using Equation (2).

$$\sigma = \frac{F}{A} \text{.....(2)}$$

where σ is the compressive strength (kgf/cm^2), F is the maximum cracking load of the sample (kgf) and A is the cross-sectional area or the applied surface (cm^2). Furthermore, the composite samples underwent sound attenuation testing using a sound source and a sound level meter test equipment. The composite testing was conducted at distances of 4, 9, and 15 cm from the sound source.

RESULT AND DISCUSSION

The result of measurement density is shown at Figure 1, The density measurement results show that the sample with a composition of 20% bamboo fiber has a density value of 1.55 g/cm^3 and a composition of 30% has density value of 1.48 g/cm^3 bamboo. The increase in the bamboo fiber fraction up to 40%, the density value tends to decrease to 1.24 g/cm^3.

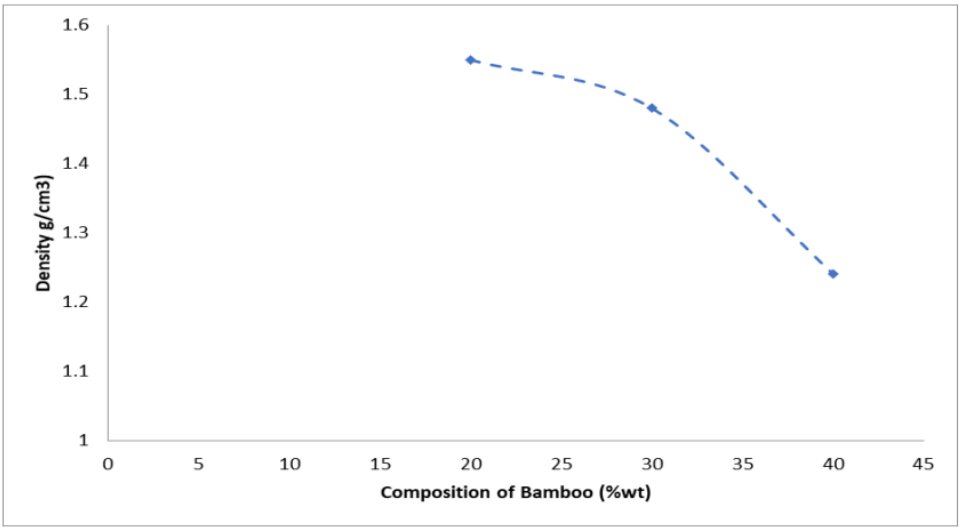

Figure 2. The realationship curve of density with composition of bamboo

The results of the compressive strength test are shown in Figure 3. Based on Figure 2, it is found that the dense strength value of the Bamboo-resin composite is influenced by the composition of the mixing, where the sample with a composition of 20% bamboo fiber has a compressive strength value of 270 kgf / cm^2 (27 MPa), whereas with the increase in the bamboo composition fraction the compressive strength value increased. Samples with a composition of 30% bamboo fiber obtained a compressive strength value of 274 kgf/cm^2 (27.4 MPa), and sample with 40% bamboo fiber has compressive strength of 284 kgf/cm^2 (28.4 MPa).

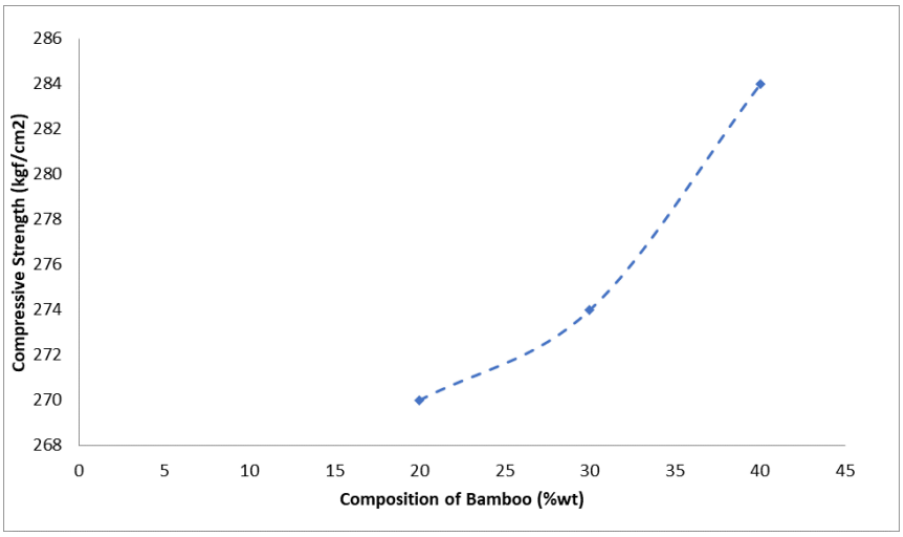

Figure 3. The realationship curve of compressive strength with composition of bamboo

When compared with the results of this study with research from Van Vuure A.W et al, it is still lower, that is, a composite bamboo (40%) -polyester resin (60%) obtained a compressive strength of 149.5 Mpa [9].

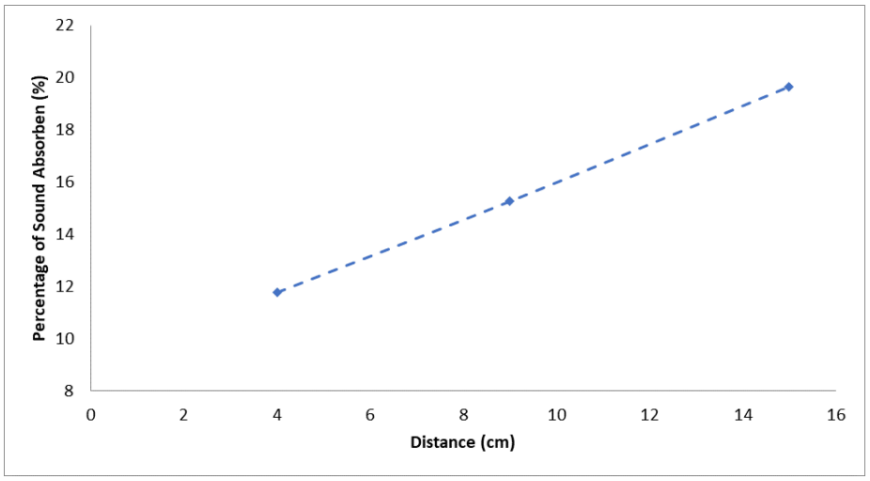

Figure 4. The percentage of sound absorbance of samples

The Sound absorbance test was carried out on samples with the lowest concentration of bamboo fiber, namely at a composition of 20%. This is done because the research conducted by Jenny Delly shows that the absorption coefficient of a composite material is proportional to the concentration of the constituent fibers. The results of the sound absorbance test on bamboo fiber composites are shown in Figure 4. The results of the distance variation show that the percentage of sound absorption increases linearly as shown in the graph.

CONCLUSSION

A composite material has been successfully made with a mixture of bamboo fiber and polyester resin polymer. The mixing composition has a significant effect on the density and compressive strength of the composites. The density and compressive strength values in the composite with 60% bamboo fiber were 1.48 g/cm^3 and 275 kgf/cm^2, while the sample with the composition of 70% bamboo fibers obtained density values of 1.24 g/cm^3 and compressive strength of 284 kgf/cm^2. The results of the sound absorbance test on bamboo fiber show that the percentage of sound absorption increases linearly as shown in the graph.

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