Preliminary study on Acoustical Characteristics of Sago Midrib Composite

by Nurul Jamala

Preliminary study on Acoustical Characteristics of Sago Midrib Composite

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Abstract. This research is a preliminary study on the use of sago midrib as an acoustic material. This study aims to determine the sago as acoustic material by measuring the absorption coefficient using (impedance tube method) of 100 Hz-1.6 KHz frequencies. The results of measurement were analyzed and compared with common acoustic material available on market as reference. From the measurement of the sago midrib composite, absorption coefficient has fluctuated from low to high frequencies as the absorption coefficient of reference material is found to be more stable.

Keywords: acoustical characteristics, absorption coefficients, impedance tube, sago midrib

1. Introduction

Sago trees/plants are found in many regions of Indonesia. Regions those are known as sago producers are Papua, Maluku (mainly Seram and Halmahera), Sulawesi, Kalimantan (especially West Kalimantan) and Sumatra (especially Riau). Large natural sago forests are found along the coastal lowlands and river mouths in Papua, Seram, Halmahera and Riau[1], [2]. In other areas the existing sago forests are mostly wild sago and become sago forests. In Java, sago is found limitedly in Banten and in several places along the north coast of Central Java[3], [4].

Sago trees are trees that produce primary and alternative food for people in Indonesia. According to a report[5] morphologically there are various types of sago plants, with high stems, wide trunk, wide leaves and long leaf bones. The leaf stalks from sago plants/trees are collected, stacked and crushed for many purposes.

Researches of sago trees had widely studied, ranged from the use of sago as food, sago fiber as composite material[6], [7], sago briquettes[8], sago piths[9] challenges and prospects for sago flour as a food source[10]–[12]. Although, foods taken from sago trunks are quite common, but not many reports of the midrib parts utilizations. Therefore this study will examine the opportunities for using sago midrib as building material alternative, specifically for its basic acoustical characteristics. It is expected in this initial study, new building materials with good acoustic characteristics will be introduced.

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2. Research Method

This study has several stages, i.e. making materials, measuring acoustic characteristics, analysis, discussion and results as follows.

2.1. Material Making

Crushing. The cleaned sago midribs are cut into pieces about 100 cm long as seen Figure 1. The cut midrib then inserted into crusher so that the midrib becomes flat, opened, and reduced moisture contents, see Figure 2.

Drying. The post crushed material process is then dried. Drying process is carried out under direct sunlight until dry by water content below 10%. In this study, the drying process took about 1 month to reach dry with water content below 10%, as seen in Figure 3.

Cutting and compiling material. Dried material cut into 100 cm and 30 cm lengths. The material is then arranged layered longitudinally and transversely on steel mold, glued with Koyo Bond. Materials were stacked in several layers to get the desired thickness. Two types of material thickness were made, namely 2 cm and 3 cm, as seen in Figure 4.

Pressing. Material of flattened sago midrib after arranged transversely and longitudinally, then

Figure 1. Cleaned Sago midrib

Figure 2. Crushing process

Figure 3. Dried Sago midrib

Figure 4. Layered in longitudinal and transversal with glue

Figure 5. The material is pressed using a cold press

Figure 6. Sago midrib composite

covered with steel plate on top and clamped with bolts in several positions then pressed coldly with 2 Mpa pressure. Pressure is maintained for 24 hours until the material is formed into a sago midrib composite board as shown in Figure 5 and Figure 6.

Two types of sago midrib composite board thickness were 2 and 3 cm were measured. Composite board material is cut in a circular shape with a diameter of 10 cm as sample for measurement of absorption coefficient, see Figure 7. Measurement of plywood with thickness of 16 mm is also performed for comparison purposes. The absorption coefficient of the sago composite board is measured by two microphone method on impedance tube as shown in Figure 8. This method is a standard method commonly carried out by researchers or acousticians to get the absorption coefficient including the tube's sensor calibration [13]–[16]. This tube is intended to measure acoustic parameters by using a small sample placed on one end of the tube. A sound source emitted by computer speaker which is amplified then forwarded into the impedance tube which is then captured by the two microphones. Results are recorded and processed using the PULSE labshop software version 16.1. Data of recorded sound waves in impedance tube will produce absorption coefficient at frequency of 100 Hz to 1600 Hz. The record is then processed using KaleidaGraph program and displayed in curves.

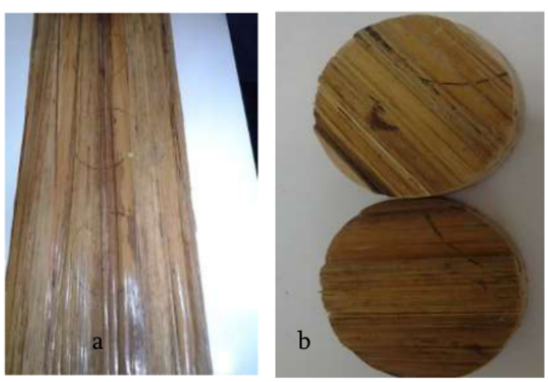

Figure 7. (a) Sago midrib composite ready to be cut;
(b) Cut Sago midrib composite

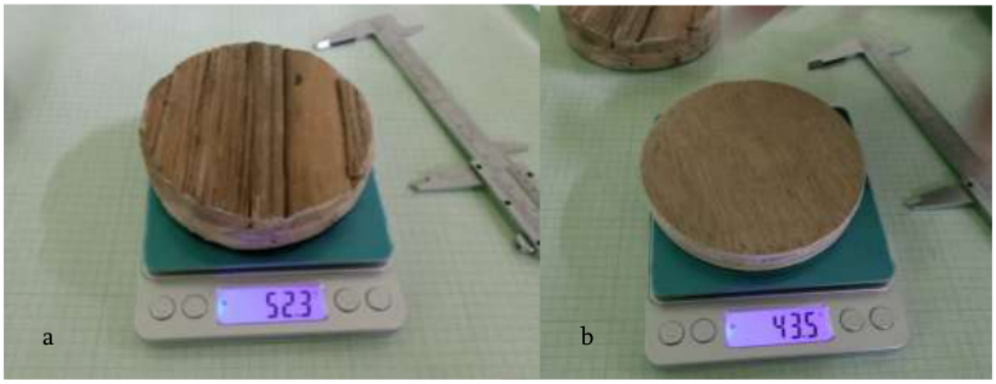

Figure 8. Weighting samples (a) Sago midrib and (b) Plywood for density measurements

3. Measurement Setup

Two types of sago midrib composite board thickness were 2 and 3 cm were measured. Composite board material is cut in a circular shape with a diameter of 10 cm as sample for measurement of absorption coefficient, see Figure 7. The circular cut Sago midrib material weighed and measured several times to determine the material density as seen Figure 8. Measurement of plywood with thickness of 16 mm is also performed for comparison purposes. The absorption coefficient of the sago composite board is measured by two microphone method on impedance tube as shown in Figure 9. This method is a standard method commonly carried out by researchers or acousticians to get the absorption coefficient including the tube's sensor calibration [13]–[16]. This tube is intended to measure acoustic parameters by using a small sample placed on one end of the tube. A sound source emitted by computer speaker which is amplified then forwarded into the impedance tube which is then captured by the two microphones. Results are recorded and processed using the PULSE labshop software version 16.1. Data of recorded sound waves in impedance tube will produce absorption coefficient at frequency of 100 Hz to 1600 Hz. The record is then processed using KaleidaGraph program and displayed in curves.

Data analysis method is by comparing the measurement results of the absorption coefficient of sago composite material (SM20 and SM30) with plywood (PW16) as reference material.The material is considered as easily found on market and also has the shape and dimensions that similar to SM20 and SM30materials. To see the effect of thickness on the absorption coefficients of material, then all dimension of samples are measured. Densities of specimen are also calculated to see whether it has effects on the specimen acoustical characteristics. Calculation of densities applied by the formula of

Figure 9. Absorption Coefficients measurement by using impedance tube

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$D = W / (\pi \cdot r^2 \cdot t)$, where D = density, W = weight, r = radius, and t = thickness of specimen. With diameter of all specimen is 10 cm, then the complete calculation are presented on Table 1.

Table 1. Dimension and density of specimens

Material	**Thickness [m]**	**Diameter [m]**	**Weight [Kg]**	**Density [Kg/m3]**
SM20	0.02	0.1	0.0524	83
SM30	0.03	0.1	0.0687	73
PW13	0.013	0.1	0.0435	107
PW16	0.016	0.1	0.0565	113

4. Results and Discussions

In Figure 10, it appears that α SM20 generally fluctuates below 0.4 with two peaks valued at 0.3 in the low frequency of 400 Hz and at high frequency of 1250 Hz, while the highest value 0.4 is reached at a frequency of 1550 Hz. The absorption coefficients of sago composite of 3 cm thickness [α SM30] are shown in Figure 11. This figure shows that α SM30 also has a fluctuating tendency as in αSM20. A SM30 generally fluctuates below 0.4 with a peak of 0.2 in the low frequency region of 400 Hz, at an intermediate frequency of 950 Hz and a height of 1550 Hz with a value of 0.4.Figure 12 shows the comparison of absorption coefficients of sago composite αSM20, αSM30 and plywood, αPW16. This comparison was made with the aim to be able to see the acoustic characteristics of sago midrib material compared to the acoustic characteristics of the widely available plywood material on the market. In this picture αSM20, αSM30 fluctuates with an average value (mean value) of 0.2 while αPW16 tends to be stable with a value of 0.05 starting at a low frequency area of 150 Hz to a frequency of 1,400 Hz.

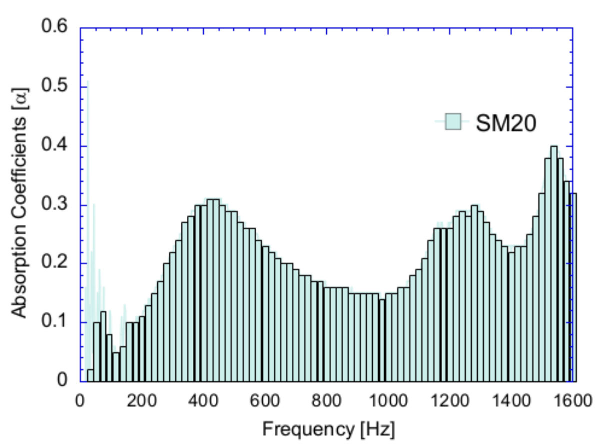

Figure 10. Absorption coefficients of Sago midrib 20 mm (SM20) with respect to frequency

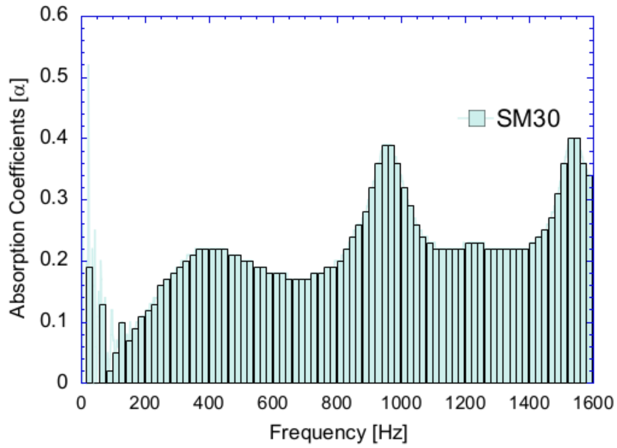

Figure 11. Absorption coefficients of Sago midrib 30 mm (SM30) with respect to frequency

Table 1 shows that additional 50% of specimen thickness from 2 cm to 3 cm has increased the weight of specimen by 25% from 0.0524 to 0.0687, making the density to become lower from 83 to 73 kg/m^3. Lower density give more porosity to specimen and perform better on absorption coefficient in the middle frequencies ranges of 800 – 1100 Hz, but relatively perform in the same value under 0.4 during high frequency range of 1400 to 1600 Hz.

Meanwhile, although different in thickness and densities, both specimen of plywood PW13 and PW16 were industrially produced then had almost similar performance of absorption coefficient throughout the range of experiment frequencies. From the explanation above, it is known that composite materials made from sago midribs have higher sound absorption compared to plywood. However, the ability to absorb sound on SM20 and SM30 material has fluctuated at several frequencies. This can occur due to the structural conditions of SM20 and SM30 materials which are

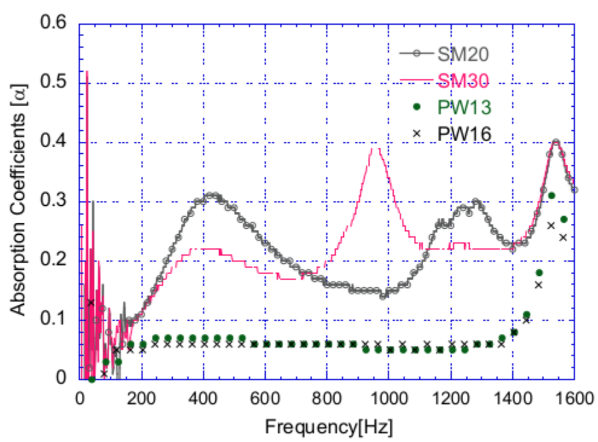

Figure 12. Comparison of absorption coefficients of Sago midribs and Plywoods with respect to

handmade and porous, so there is still a lot of uniformity in the structure and surface. Unlike PW16, although has lower absorption coefficients, thestructuresof material aremore solid with smoother surface so that measurement results are more stable.

5. Conclusions

Acoustic characteristics of sago midrib composite material in the form of absorption coefficients at frequencies of 100 Hz to 1.6 KHz show that although fluctuations still occur at certain frequencies, this composite material has absorptive properties or characters with a mean value of 0.2. This occurs in two types of material thickness measured, namely 2 cm and 3 cm. Based on the results of measurements and comparison of acoustic characteristics with plywood material it can be indicated that this sago midrib composite material has a good prospect as an acoustic material. Further research on the use of sago midrib as a building and acoustic material is still very necessary, especially in its durability.

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