JOURNAL OF
NATURAL SCIENCES AND MATHEMATICS RESEARCH

Available online at http://journal.walisongo.ac.id/index.php/jnsmr

Sound Absorbent And Damping Rate of The Natural Composites Design

Sekarani Andari Kunthi[1], Baiq Siti Hawa[1], Firda Auliya[1]
[1] Department of Physics, Faculty of Science and Technology, Universitas Islam Negeri Walisongo Semarang, Central Java, Indonesia

Corresponding author:
sekarandarikunthi@gmail.com
Received: 23 Januari 2018,
Revised : 25 Maret 2018,
Accepted : 01 Juni 2018.

Abstracts

This research was conducted to determine the sound attenuation level of composite. The composite used in this study is compound Kalimantan sawdust and pineapple leaf fiber. The research objective was to determine the damping rate of composites (fine Kalimantan sawdust and compound of coarse Kalimantan sawdust with pineapple leaf fiber), so it can be used as an alternative sound absorbent material. The composite testing process uses a Sounds Level Meter by adjusting the frequency of the sound source. The space partition is a composite, measured the value of sound intensity at a certain distance, then given a partition, the sound intensity is again measured with the same distance. The results of the absorption coefficient of pineapple leaf fiber composite and red meranti wood sawdust can be used as an alternative sound absorbing material besides glass wool so that it can minimize side effects for public health.

Keywords: composite, Kalimantan wood sawdust, peneapple leaf fiber

1. Introduction

Noise is a big problem in Indonesia, especially those who live in urban areas which are hectic and busy with community activities. Loud noise caused by various vehicles in urban areas can cause concentration problems and can damage human health. This must be handled immediately so as not to have a bad impact on the environment. Noise disturbances can cause sense of hearing damage such as deafness. Nowadays, many people have done ways to overcome the noise that occurs in a room by using materials that function as sound damping and sound absorbent. This material in a building acts as an acoustic panel attached to the dividing wall and ceiling. Absorbent material is the matter that can absorb sound energy from a source. Sound-absorbent materials have an important role in the construction of recording studios, offices, schools and other spaces that function to reduce noise [1].

However, the sound absorbing material used uses chemical materials and glass fiber which can cause lung problems if it is frequently used. The materials contained in the environment should be utilized [2]. Therefore, the application of technology that provides alternative solutions to the above problems needs to be developed. This research will begin with the formation of a composite, namely a composite combination of coarse and fine Kalimantan wood sawdust and pineapple leaf fibers. For the purposes of the composite test, a solid cylinder was formed to keep the sound from coming out. The combination of the two materials that have been designed is expected to function as an effective weak radiating cell as a sound suppressor [3]. This study uses a standard test method using a Sound Level Meter (SLM) in conjunction with AFG with a variety of frequencies to determine the sound intensity of the composite. The results of this study are expected to be used as a field of acoustic material technology to tackle noise in cities that are crowded with community activities and are environmentally friendly [4].

Red Meranti Wood (Shorea spp.)

Red meranti has the name Botania Shore spp., Family Dipterocarpaceae [5]. The names of the areas of Kalimantan yellow meranti wood include: brother, awing, dammar ,engkabang, kakan, kenuar, kontoi Lampung, lanan, putang, ponan and tenggkawang. The characteristics of the red meranti tree's height are the tree's height reaches 50 m, the diameter is generally 100 cm, the color of the wood varies almost to white, mostly glossy wood. Red meranti wood is mainly used for veneer and plywood [6]. In addition, red meranti wood is used for residential buildings, windows, packing crates, and acoustics.

Pineapple Leaf Fiber

Pineapple-leaf fibers are a type of fiber that comes from plants that come from pineapple plants. Pineapple leaves are shaped like swords that are tapered at the ends with a blackish green color and on the edges of the leaves there are sharp thorns. In addition, pineapple leaves have an outer layer consisting of an upper and a lower layer. Between these layers there are many bundles of fibers that are bound to one another. Separation or extraction of pineapple fiber from its leaves (fiber extraction) can be done in two ways, namely by hand (manually) or by means of a decorticator [7]. In this study, the extraction of pineapple leaf fiber used a water retting process. The process of water retting is a process that is done by immersing in water for several days and because of the influence of microorganisms (bacterial action), the pineapple leaf fibers will separate from the skin of the leaves [8].

In general, absorbent materials are naturally resistant, fibrous (fibrous), porous (porous) or in special cases are active resonators. When the sound waves generated by the speakers hit the composite, some of the sound energy will be absorbed and converted into heat [9]. Sound will enter the pores of the composite, then the particles are reflected to other particles, and so on so that the sound is confined in the composite. This is called the absorption process. The amount of sound absorption in the absorbent composite is expressed by the absorption coefficient (α) [10].

Acoustic impedance is basically the value of resistance given by a medium to the propagation of sound waves. Sound coefficient (α) affects acoustic impedance. To determine the intensity of a noise or noise in an environment, the Sounds Level Meter (SLM) is used. The threshold value for the noise limit is 85 dB and the maximum uptime is 8 hours per day. Sounds Level Meter is a tool for measuring sound, the working principle of SLM is that when an object vibrates, it will cause a change in air pressure that can be captured by SLM, which will then move the meter scale. In this research, the adhesive used is Efoxit glue. The ratio used is 5: 3.

2. Experiments Procedure

This research is a kind of laboratory experimental research using Sounds Level Meter (SLM) with AFG. The research was conducted at the State Islamic University of Walisongo

Semarang. The tools and materials used in this study were:

1. Sounds Level Meter (SLM)
2. AFG (Audio Function Generator)
3. Hydraulic press
4. Iron pipe with a diameter of 3.8 cm
5. Pineapple leaf fiber
6. Red Meranti wood sawdust
7. Efoxit
8. Resonator Space (RT)

The variables in this study are as follows:

1. Independent variables, in this study the independent variables used are the composite material and the distance from the SLM to the sound source.
2. Control variable, in this study the control variable used is the thickness of the composite material
3. The dependent variable, in this study the dependent variable used is the final intensity

Figure 1. Experiment Process

The steps for making a sample in this study are as follows: Red meranti wood sawdust is filtered to separate from coarse wood and fine fibers. The fiber from pineapple leaves is cut to a length of ± 1 cm. After that, the leaf fibers are in the oven at 70ºC for 15 minutes. The composite was mixed with efoxite glue with a resin ratio of 5: 3. The composites are pressed using a hydraulic press until the sample has a thickness of 1 cm - 2 cm. The samples were dried for 2 days. Figure 1 show the experimen process.

The steps of this research are as follows:

1. Arrange the resonator space in the sequence as shown below
2. The frequency on the AFG is set at 8000 Hz
3. The room divider on the resonator space is sampled
4. The intensity of the sound at the sound source is measured
5. Steps 2 to 4 are repeated by replacing the room divider on the resonator space with the sample
6. Steps 2 to 5 are repeated by changing the frequency at the AFG by 8500 Hz, 9000 Hz, 9500 Hz.

3. Result and Discussion

The study was conducted with different sample thicknesses. Sample thickness was 1 (2cm), sample 2 (1.7cm), sample 3 (1.7cm), and sample 4 (1.4cm). Based on the results of research conducted at a frequency of 8000 Hz, the sound intensity before there is insulation is shown in Figure 2.

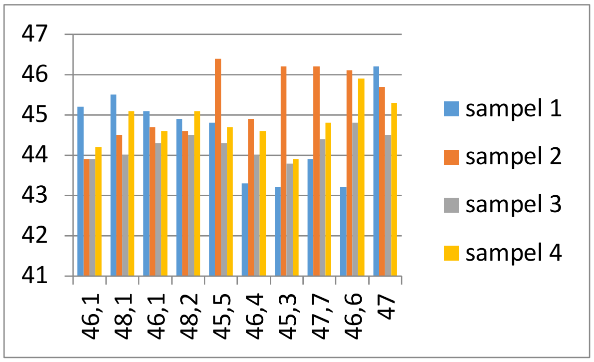

Figure 2. Sound Intensity Graph after passing each material at a frequency of 8000Hz.

Samples 1, 2, 3, and 4 have different sound absorption levels. For a frequency of 8000 Hz sample 3 has the best sound absorption level. This is indicated by the smallest sound intensity obtained when the sound is passed through a room that is insulated with sample 3. In addition, the results of the calculation of the absorption coefficient of each material, sample 3 has the greatest coefficient compared to the others. The material that has a good absorption rate after sample 3 at a frequency of 8000 Hz is sample 2. This is indicated by the intensity of the sound after passing it has a large enough difference. In addition, the absorption coefficient of sample 3 is not much different from sample 2. For samples 1 and 4 at a frequency of 8000 Hz it is not good.

This is indicated by the smallest absorption coefficient value.

For a frequency of 8500 Hz, the sound intensity value is obtained before there is a baffle, and after there is a baffle, it is shown in Figure 3.

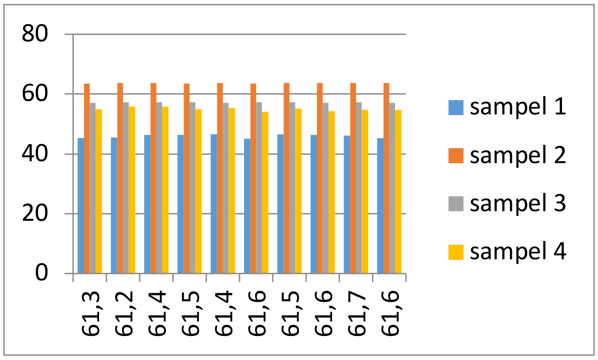

Figure 3. Sound Intensity Graph after passing each material at a frequency of 8500Hz.

The sample 4 Hz frequency has the best sound absorption rate. This is indicated by the smallest sound intensity obtained when the sound is passed through a room that is insulated with sample 3. In addition, the results of the calculation of the absorption coefficient of each material, sample 4 has the greatest coefficient compared to the others. The material that has a good absorption rate after sample 4 at a frequency of 9000 Hz is sample 2. This is indicated by the intensity of the sound after passing it has quite a large difference. In addition, the absorption coefficient of sample 4 is not much different from sample 2. For samples 1 and 3 at a frequency of 8500 Hz it is not good. This is indicated by the smallest absorption coefficient value.

Samples 1, 2, 3, and 4 have different sound absorption levels. For the frequency of 8500 Hz sample 1 has the best sound absorption rate. This is indicated by the smallest sound intensity obtained when it is passed through the room which is insulated with sample 4. In addition, the results of the calculation of the absorption coefficient of each material, sample 1 has the greatest coefficient compared to the others. The material that has a good absorption rate after sample 1 at a frequency of 8500 Hz is sample 4. This is indicated by the intensity of the sound after passing it has a large enough difference. In addition, the absorption coefficient of sample 1 is not very different from that of sample 4. For samples 2 and 3, the frequency of 8500 Hz is not very good. This is indicated by the smallest absorption coefficient value.

For a frequency of 8500 Hz, the sound intensity value is obtained before there is a baffle, and after there is a baffle shown in Figure 4.

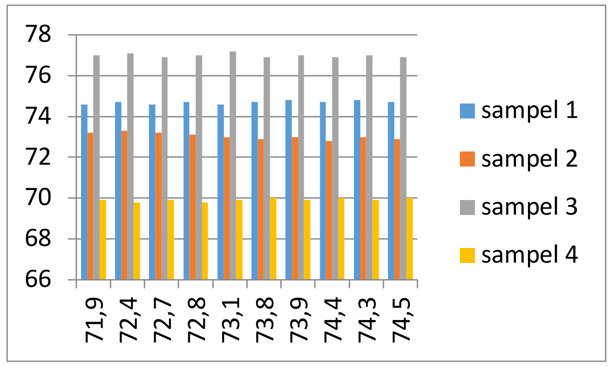

Figure 4. Sound Intensity Graph after passing each material at a frequency of 9000 Hz.

The absorption coefficient of each sample, between sample 1 and sample 4 are not significantly different, but for sample 2 and sample 3 it is significantly different.

The frequency of 9500 Hz uses a composite sample of fine sawdust with a thickness of 1.4 cm. Figure 5 show a graph of composite sound intensity with a frequency of 9500 Hz. The best sound intensity of 9500 Hz frequency is sample 4, it is indicated by the intensity of the sound that is passed when the room is insulated with a composite of fine red meranti wood sawdust showing the smallest value than the others.

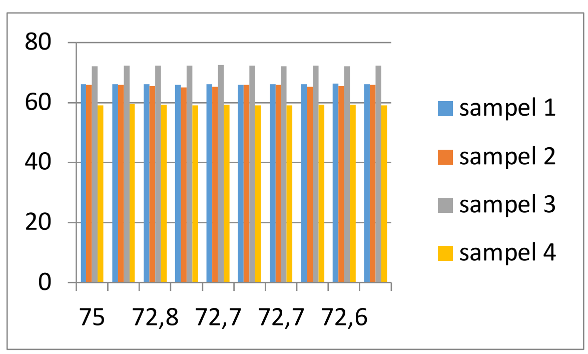

Figure 5. Sound Intensity Graph after passing each material at a frequency of 9000 Hz.

The average acquisition coefficient of sera for each sample at a frequency of 8000 - 9000 Hz is shown in Figure 6.

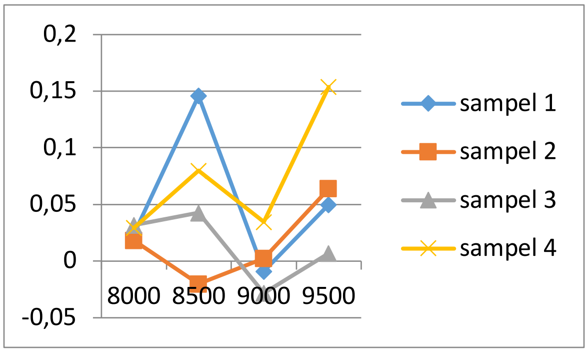

Figure 6. Graph of the average absorption coefficient of each sample at a frequency of 8000 Hz, 8500 Hz, 9000 Hz, and 9500 Hz.

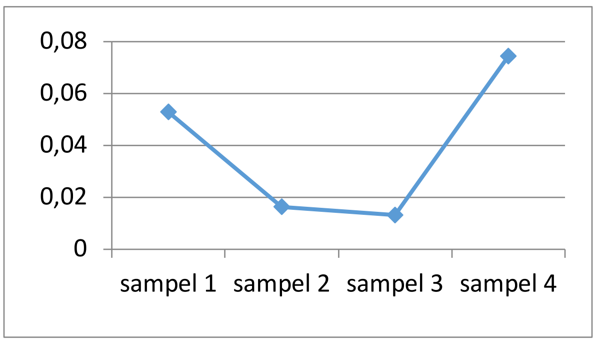

Figure 7. Graph of the mean absorption coefficient of each sample at a frequency of 8000 - 9500 Hz.

The average absorption coefficient of each sample at a frequency of 8000 - 9500 Hz is shown at Figure 7. The graph shows that sample 4 is the sample with the best attenuation level with a composite made of red meranti wood sawdust with a thickness of 1.4 cm. This is indicated by the average fiber coefficient of 0.074/cm. The coefficient figure is the largest compared to other samples. Sample 1 obtained the second absorption coefficient after sample 4, namely 0.052/cm. Not significantly different from sample 4. For sample 2 and sample 3, the average absorption coefficient of 0.016/cm and 0.013/cm has the smallest coefficient compared to sample 1 and sample 4. this corresponds to the absorption coefficient on wood [11]. The best material attenuation level of the three composite materials is red meranti wood sawdust, it is wood with large pores [12].

4. Conclusion

The average absorption coefficient of red meranti sawdust to the four frequencies is 0.074/cm. So that the best material attenuation level of the three composite materials is red meranti wood sawdust.

Acknowledgment

We would like to thank the Universitas Islam Negeri Walisongo Semarang for the support.

References

[1] L. L. Doelle, *Akustik Lingkungan (diterjemahkan oleh Lea Prasetia)*. Jakarta: Erlangga, 1993.

[2] F. Asdrubali, "Survey on The Acoustical Properties of New Sustainable Materials for Noise Control," *Euronoise*, 2006.

[3] A. Nordin, M.N.A.A.; Wan, Lauren; Zainulabidin, Muhd; Kassim, Angzzas; Mohd Aripin, "T1 - Research finding in natural fibers sound absorbing material VL - 11 ER -," *ARPN J. Eng. Appl. Sci.*, vol. 11, no. 14, pp. 8579–8584, 2016.

[4] B. Dwisetyo and D. Hermawanto, "Evaluation and Analysis of Uncertainty Measurement of The Sound Level Meter Calibration by Coupler Method," *J. Fis. dan Apl.*, vol. 17, no. 1, p. 14, 2020, doi: 10.12962/j24604682.v17i1.6874.

[5] T. A. Elvan Wahyu, Evi Sribudiani, "Inventory Regeneration Of Meranti (Shorea spp.) In Arberotum Area Of Riau University at Pekanbaru Riau Province Elvan." pp. 15–17, 2009.

[6] Suhasman, A. Arif, M. Muin, I. Sulistyawati, A. D. Yuniarti, and R. I. Maulany, *Prosiding Seminar Nasional Masyarakat Peneliti Kayu Indonesia (Mapeki) XV*. 2012.

[7] G. Gemeda and M. Nuredin, "Extraction

and Characterization of Ethiopian Pineapple Leaf Fiber," *Glob. Sci. Journals*, vol. 7, no. 1, pp. 317–326, 2019.

[8] C. H. Lee, A. Khalina, S. H. Lee, and M. Liu, "A Comprehensive Review on Bast Fibre Retting Process for Optimal Performance in Fibre-Reinforced Polymer Composites," *Adv. Mater. Sci. Eng.*, vol. 2020, 2020, doi: 10.1155/2020/6074063.

[9] M. Arenas, Jorge; Crocker, "Recent Trends in Porous Sound-Absorbing Materials," *SOUND Vib.*, 2010.

[10] R. Andari, "Determination Of Acoustic Properties Of Rice Bran Composites A Material Handler Noise," *Sci. Educ.*, vol. 7, no. 1, p. 11, 2018, doi: 10.24235/sc.educatia.v7i1.2517.

[11] Akustic, "Absorption Coefficients for Generic Building Constructions," 2010, [Online]. Available: http://www.acoustic.ua/st/web_absorption_data_eng.pdf.

[12] N. M. Stark, Z. Cai, and C. Carll, "Chapter 11 - Wood-Based Composite Materials Panel Products , Glued-Laminated Timber , Structural Materials," *Wood Handb. - Wood as an Eng. Mater.*, pp. 1–28, 2010.