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Preliminary study on sound absorption of natural kenaf fiber

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ABSTRACT – The increasing number of researches on utilizing natural fibers for acoustic panel to cater environmental and health problems has led to the study of the natural kenaf fibers. Several parameters such as thickness and air gaps are studied and measurement using impedance tube shows that kenaf fiber are feasible to be used as substitute for synthetic material as the absorption coefficient are found to be greater than 0.5 starting at the low frequency region for most cases.

1. INTRODUCTION

Conventional sound absorption materials used for building acoustic such as glass fiber and foam glass are known to be harmful to both the environment and human. In a comparison done between different sound insulation panel materials including synthetic and natural materials, the data suggests that the fabrication and production of synthetic materials have a positive global warming potential by contributing more carbon dioxide to the atmosphere when compared with natural materials. Besides, the mineral-made synthetic fibers contain a certain amount of toxic and can be a threat to human health if it is inhaled, and if contacted, may lead to skin irritation [1]. Natural fibers, which do not contribute too much on the environmental issue and contain very low toxicity are hence an alternative in sound absorption material. Vegetable fiber panels are found to have compatible and higher performance in indoor noise control comparing with conventional material [2]. Good acoustic performance has been discovered on sugarcane wasted fibers [3] where the absorption coefficient is found to have an average of 0.65 at 1.2 to 4.5 kHz. Whereas the acoustic performance of paddy waste fibers [4] had been studied and the average value of absorption coefficient is found to have reached 0.8 above 2.5 kHz. This paper presents the preliminary studies on the acoustic performance of Kenaf fiber. Kenaf is a hibiscus plant that is related to cotton, okra and hollyhocks, scientifically known as *Hibiscus cannabinus*, it is a member of Malvaceae family [5]. Kenaf is usually used as building materials, organic absorbents, and paper products [6]. Traditionally it is used in ornamentals, food, medicine, musical instruments and superstitious rites.

2. METHODOLOGY

2.1 Preparation of Material

Kenaf fiber sheet in a form of chopped strand mat with thickness of 5 mm is being cut into a disc shape with diameter of 33 mm in order to fit onto the removable cap of the impedance tube. Several disc-shaped kenaf fiber were layered to vary the thickness of the sample as shown in Figure 1.

Figure 1 Raw kenaf fiber (left) and layers of kenaf fiber forming a sample with thickness of 10 mm (right).

2.2 Experimental set up

The impedance tube method was used for the measurement of sound absorption coefficient. Figure 2 shows the experimental set up of the measurement. The data acquisition system used was the RT Pro Photon+v6.34 analyzer.

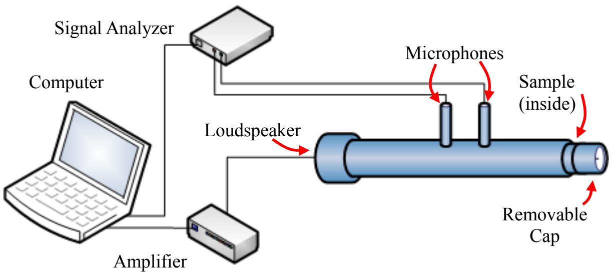

Figure 2 Diagram of absorption coefficient measurement setup.

White noise was the sound source fed by the loudspeaker to the interior of the tube, whereas the sample to be tested was placed in the removable cap at the other end of the impedance tube. The cap can be adjusted to form an air gap behind the sample. The two microphones used were G.R.A.S ½ inch prepolarized free-field microphone type 40AE and ½ inch CCP preamplifier type 26CA to record the incident sound and the reflected sound from the sample.

3. RESULTS AND DISCUSSION

3.1 Effect of thickness of fiber

Figure 3 shows the sound absorption coefficient of kenaf fiber for different thicknesses. The result shows that sample with thickness of 10 mm has absorption coefficient greater than 0.5 above 3500 Hz. Whereas, for the 30 mm sample, the absorption coefficient is greater than 0.5 above 1000 Hz and approaches unity at around 2000 Hz. The increment of the thickness can be seen to significantly improve the absorption coefficient.

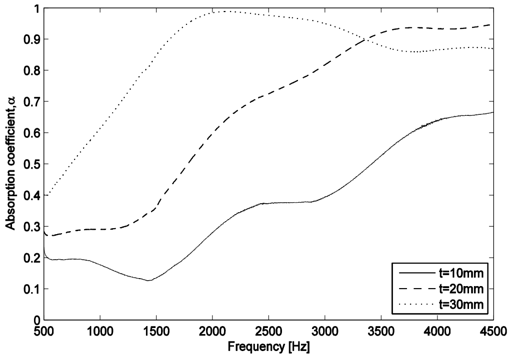

Figure 3 Sound absorption coefficient of Kenaf fiber with thickness of, 10 mm (—), 20 mm (---), 30 mm (···).

3.2 Effect of air gap

Figure 4 shows the sound absorption measured on a 20 mm thick kenaf fiber, with different air gap thicknesses.

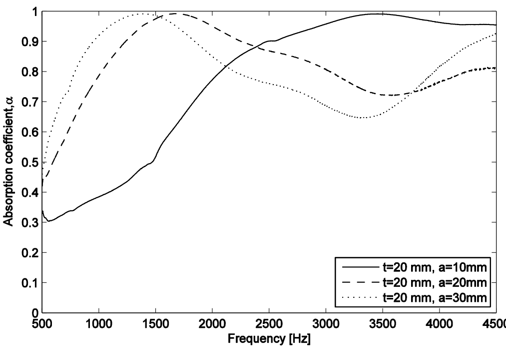

Figure 4 Sound absorption coefficient of 20 mm thick Kenaf fiber with air gap thickness of, 10 mm (—), 20 mm (---), 30 mm (···).

The results show that the peak shifts to lower frequency as the air gap increases, but in consequences, the absorption at high frequencies are reduced. Figure 5 plots the sound absorption coefficient of fiber with thickness of 10 mm, measured with rigid backing, and 10 mm of air gap. This also compared with 20 mm fiber. Comparing the 10 mm without and with air gap backing, the latter has greater absorption coefficient as already shown in Figure 4. However, with identical total thickness, i.e. for 20 mm fiber and 20 mm fiber-air, the performance of air gapped fiber is lower than that from the sample with more fibers.

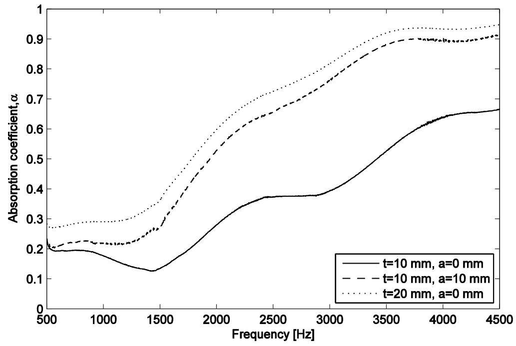

Figure 5 Sound absorption coefficient of kenaf fiber with thickness of 10 mm backed with rigid backing (—), 10 mm with air gap of 10 mm (---), and 20 mm with rigid backing

4. CONCLUSIONS

Measurement on the sound absorption of kenaf fiber shows that kenaf fiber has a potential to be employed as an alternative acoustic material. The experimental results show that for 30 mm thick sample, the performance can closely reach unity above 1.5 kHz. Additional air gap for thinner sample of 20 mm thick is also shown to improve the absorption coefficient close to unity.

5. REFERENCES

[1] F. Asdrubali, "Survey on the Acoustical Properties of New Sustainable Materials for Noise Control," in *Euronoise 2006,* 30, 2006.

[2] L. P. Bastos, G. D. S. V. de Melo, and N. S. Soeiro, "Panels Manufactured from Vegetable Fibers: An Alternative Approach for Controlling Noises in Indoor Environments," *Advances in Acoustics and Vibration*, vol 2012, 2012.

[3] A. Putra, Y. Abdullah, H. Efendy, W. M. Farid, M. R. Ayob and M. S. Py, "Utilizing Sugarcane Wasted Fibers As a Sustainable Acoustic Absorber," in *Procedia Engineering*, 53, 2013.

[4] A. Putra, Y. Abdullah, H. Efendy, W. M. F. W. Mohamad, and N. L. Salleh, "Biomass from Paddy Waste Fibers as Sustainable Acoustic Material," *Advances in Acoustics and Vibration*, vol 2013, 2013.

[5] F. D'Alessandro, and G. Pispola, "Sound Absorption Properties of Sustainable Fibrous Materials in an Enhanced Reverberation Room," in *The 2005 Congress and Exposition on Noise Control Engineering,* 2005.

[6] A. M. Mohd Edeerozey, H. M. Akil, A. B. Azhar, and M. I. Zainal Ariffin, "Chemical Modification of Kenaf Fibers," *Materials Letters*, 61(10), 2023-2025, 2007.