INTERIOR DESIGN
DEPARTMENT UNIVERSITAS
SEBELAS MARET

The Potential of Flip-Flops Waste as An Environmentally Friendly Sound Absorbing Material

Ariana Ingga (Inggakumala@gmail.com), Dinna Nurhaliza, Brigita Brenda Karina, Silfia Mona Aryani, Silmi Cahya Pradini Priliana, Audi Febio

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Introduction

- Rubber flip-flops are one of the wastes that **have the potential to be processed into acoustic panels**, since this waste is **often found in Indonesia.** Especially the one that is made from a mixture of **natural rubber and EVA (Ethylene Vinyl Acetate)**

- This research is very important because it aims to **find out the sound absorption coefficient of waste flip-flops as a basic material** in order to **make environmentally friendly acoustic panels.**

Background Literature

- **Sound absorbing properties of materials made of rubber crumbs (F. Asdrubali, F. D'Alessandro and S. Schiavoni. (2008))**

Rubber **can be used as a sound absorbing material**, rubber can work well at blocking sound because **it adds mass to the surface**, stopping sound waves from escaping through walls and ceilings. The goal of the present paper is **to analyze the influence of such parameters on the normal incidence absorption coefficient of several prototypes** measured by means of the impedance tube technique in order to create materials with optimized acoustic performance.From the results of these analysis various prototypes with optimized acoustic properties were produced, In particular the **best performing sample is the one with a compaction ratio equal to 20% and a final thickness equal to 9.4 cm.**

Method

- The method used is **simulation and modeling**, making samples by **mixing flip-flops rubber particles and the binding material as neoprene glue.**
- Using a **4206 Impedance Tube** to testing the sound absorption coefficient. **Sound source > B&K 4187 Microphone > Labshop Software > Sound Absorption Coefficient Result**

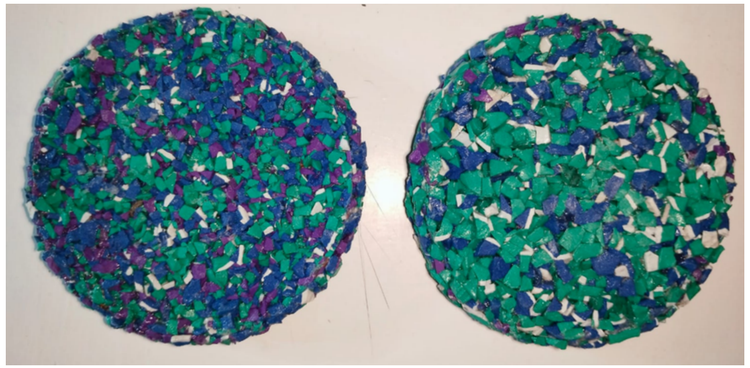


Figure 1. Sample 1 and Sample 2
Source : Personal Documentation, 2023

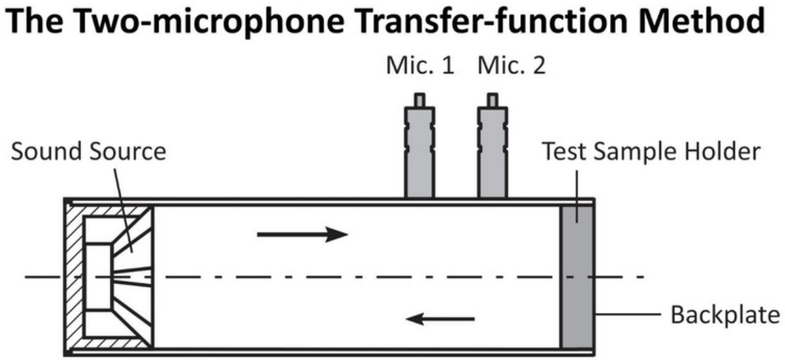


Figure 2. Schematic diagram of the impedance tube for the two-microphone transfer-function method
Source : Jérôme Lefebvre, 2016

Result

The results of the sample testing carried out at the Sebelas Maret University materials laboratory with eight frequencies **(200Hz, 400Hz, 600Hz, 800Hz, 1200Hz, 1400Hz, 1600Hz)**

- Sample testing changes in the sound absorption coefficient with an average of **more than 0.2**, so the material **can be classified as a sound-absorbing material**. It was found that both samples could **absorb sound well at frequencies around 1000-1600Hz.**

- Frequency absorption coefficients results of **1200 Hz** has a very drastic increase of 0.38 from 7mm particles, which show the **sample works at a high frequency.**

Discussion

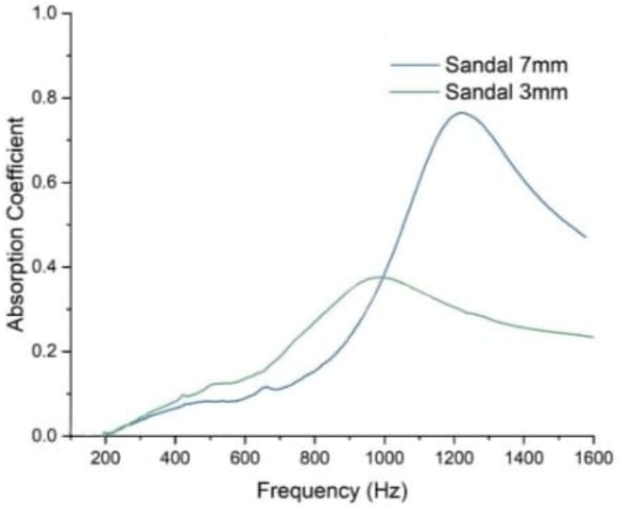
The test results of the two samples showed that the absorption coefficient value changed significantly **so it could be concluded that the particle size, humidity of the adhesive material, and sample and sample density influenced the panel's absorption ability** (Permatasari, Obimita Ika & Masturi, 2014).

The panel's absorption capacity was **stated to be quite good with an average of 0.21 and 0.31.**

Table 1. Result of comparison of the absorbtion coefficient of the two sample.

Frequency	3mm Particles	7mm Particles
200	0.07	0.04
400	0.08	0.0.6
600	0.13	0.08
800	0.27	0.15
1000	0.37	0.38
1200	0.3	0.76
1400	0.26	0.6
1600	0.23	0.45
NRC	0.21	0.31

Graph 1. Comparison of the absorbtion coefficient of the two sample.



Conclusion

From the research data and sample testing that has been carried out, the following conclusions can be drawn:

- **Particles with a size of 7 mm have a higher sound absorption coefficient** than particles with a size of 3 mm
- The factors **that influence** the sample sound coefficient are **the density level, sample thickness, sample hardness, humidity, and dryness level of the binder in the sample** (Permatasari, Obimita Ika & Masturi, 2014).
- Material from flip-flop waste **has the potential to become an environmentally friendly sound-absorbing material** based on the material requirements as a sound-dampening material **if it meets the sound absorption coefficient (α) above 0.159 (ISO 11654: 1997).** However, **its use will function better at high frequencies** because the NRC of **the two samples only reaches 0.21 and 0.31 in low to medium-frequency testing.**

References

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