Utilization Of Coconut Fibres To Increase The Soundproof Capacity Of Wall Partition

Nuril Mahda Rangkuti, Irwan, Edy Hermanto

Abstract: The noisy sounds of mechanized vehicles and manufactures make the researchers to find a potential and practical material for wall partition which muffle the distrected sounds. This research aimed at knowing usefulness of the utilization of coconut fiber, PC cement and sand for wall partition. Through the testing and acoustic measurement by using the impedance tube support software is DAQ and HQ control on three varieties of mixed coconut fiber 0%, 7% and 15% for wall partition. Data analysis showed that the variation of the 15% mixture of coconut fibres showed the highest absorption coefficient value; it was 0.9756, i.e in the 4th sample with 4000 Hz frequency with fast sound wave velocity of 3902.4 m / s. It concluded that the greater the percentage of coconut fiber mixture with other materials, then the bigger capacity to muffle the noise is found. Keywords: coconut fiber; concrete; acoustic; absorption; noise.

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1. INTRODUCTION

Concrete is the world’s most commonly used construction material, surpassing steel, wood and aluminum combined [1]. The most common form of concrete is Portland cement concrete, which consists of mineral aggregates (usually gravel and sand), cement and water. The portland cement and concrete industry is a major consumer of natural resources - rock, minerals, potable water, and fossil fuel, which is increasing year-by-year resulting in a faster rate of depletion of such natural resources needed for the manufacture of portland cement and concrete [2]. In construction, concrete is a composite building material made from a combination of aggregates and cement binders. The word concrete in English comes from the Latin concretus which means to grow together or combine into one. In Japanese, the word city-zai is used, which literally means materials such as bone; probably because the aggregates resemble animal bones. Various research and experiments in the field of concrete had been done in an effort to improve the quality of concrete. Improvement of the quality of concrete may be done by providing added materials of the several added ingredients that exist such as coconut fibres. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water with a certain ratio. This comparison is of course not arbitrary due to the desired strength, material characteristics and function of the building to be one of the factors considered in the manufacture of concrete. The properties and characteristics of the constituent material will affect the performance of the concrete made. Performance of the concrete-impact on the desired strength, ease of workmanship and durability within a certain time. To make good quality concrete, in the sense that it meets the stricter requirements due to higher demands, it must be carefully calculated ways of obtaining good concrete and hardened concrete is also generated well. Good concrete is a strong, durable, water-resistant, wear-resistant concrete, and slightly altered volume (small shrinkage). Concrete is a mixture of cement, fine aggregate, coarse aggregate and water with a certain ratio. This comparison is of course not arbitrary due to the desired strength, material characteristics and function of the building to be one of the factors considered in the manufacture of concrete. Therefore, information technology has been used for various purposes, and application technology has been used in many for industry, business and trade [3]. With the advancement of technology, information, communication, production, transportation and entertainment produces unwanted sounds that cause noise. Noise is always associated with the discomfort caused by an object [4]. Sound suppression material is very important to absorb sound so as to reduce the intensity of sound resonance that reaches the ear so as to create a comfortable quality space for its users [5]. To overcome the unwanted sounds like noise, it is developed various types of soundproofing material. In addition, silencers are also required to create buildings with certain acoustic characteristics so as to create comfort for its users [5]. The need for acoustic wall paneling continues to increase with increasing noise and demand for private studio space [6]. It should be note that materials for sound absorption such as glasswool and rockwool [7] have been used for many years. However, the price is expensive, and many trial errors for various materials substitute material began to be made. Among them are various kinds of cork and fiber composite materials. Coconut fiber has a structure similar to existing silencers. On the other hand, Coconut grows and is produced Indonesia in large quantities [8]. Coconut fiber is one of the most untapped waste in Indonesia, while the coconut harvest is big enough every year. As a form of environmental conservation, it can be realized with the use of materials derived from this natural fiber, which is to make coconut coir as partition acoustics. Indonesia is rich with coconut tress. This coconut fibre is such potential material for the wall construction. It was as an attempt to seek specific characteristic of coconut fibre, until the finding has opportunity to use the fibre material for basic construction of was partition. A few researchers have a fibrous silencer which can be marked by the presence of pores. Sound absorption of this material depends on variable thickness, density, and fiber orientation. A porous sound absorber can be produced one of them by utilizing natural fiber waste [9]. It aimed to find those materials give usefulness to muffle the voice. Materials that have been known and widely used as an absorbent and silencer are glasswool, rockwool, and lignocellulosic materials. The lignocellulosic material which is known to have good absorption properties is coconut husk. The purpose of this research was intended to find the characteristics of soundproof concrete material with the utilization of fiber of coconut fiber, PC cement, and sand as the main raw materials. The purpose of this study was to test and measure to the effect of coconut fiber added to muffle the sound. Referring to above discussions, the
problem noises in modern life, it raises research question on the potential coconut fibre to the mixed concrete for wall partition which have significant effects on the noisy sound.

2. RESEARCH METHOD

This experiment method was to measure the effectiveness of coconut fibers for wall partition. It focused on the physical and mechanical characteristics, soundproofing and microstructure of concrete with the utilization of coconut fibres, PC cement, and sand as its forming material. Thus, the coconut fibres used were from North Sumatra with three variations; comprising (1) 0%, (2) 7%, and (3) 15% of coconut fibres in the wall partition material to know the soundproof. In a lab work, researcher applied: 1: 4 concrete mixture (cement: sand), this method was referred to the (Indonesian Concrete Standard /PBI 1971) in sub chapter 4.3 p. 36, for Bo (non structural) concrete mixtures can be used any mixture which commonly applied for non structural, with the requirement that the ratio of the amount of sand and gravel (crushed stone) to the amount of cement, shall not exceed 8: 1, and it is planned to be 0.56 (in accordance with Indonesian Standard or PBI 1971). The test of specimen is printed on a 11 cm (4 inch) PVC pipe, and cut to a height of 5cm. For this research, it was done at Mechanical Engineering Laboratory of University of North Sumatra.

3. RESULTS AND DISCUSSION

3.1. Sound Absorption Measurement (α) Variation Coconut fiber 0%

Table 1. Soundproof Test Table on Concrete Mix with Coconut fiber 0%

<table>
<thead>
<tr>
<th>No</th>
<th>Sample</th>
<th>Frequency 250 (Hz)</th>
<th>Frequency 500 (Hz)</th>
<th>Frequency 1000 (Hz)</th>
<th>Frequency 2000 (Hz)</th>
<th>Frequency 4000 (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>0.4651</td>
<td>0.2355</td>
<td>0.5305</td>
<td>0.3225</td>
<td>0.5098</td>
</tr>
<tr>
<td>2</td>
<td>II</td>
<td>0.2172</td>
<td>0.4548</td>
<td>0.3019</td>
<td>0.4198</td>
<td>0.6067</td>
</tr>
<tr>
<td>3</td>
<td>III</td>
<td>0.3151</td>
<td>0.3089</td>
<td>0.3092</td>
<td>0.4306</td>
<td>0.7098</td>
</tr>
<tr>
<td>4</td>
<td>IV</td>
<td>0.1287</td>
<td>0.3768</td>
<td>0.3609</td>
<td>0.5738</td>
<td>0.4066</td>
</tr>
<tr>
<td>5</td>
<td>V</td>
<td>0.3846</td>
<td>0.4637</td>
<td>0.6757</td>
<td>0.5757</td>
<td>0.7539</td>
</tr>
<tr>
<td>6</td>
<td>VI</td>
<td>0.1752</td>
<td>0.3608</td>
<td>0.4094</td>
<td>0.5171</td>
<td>0.7654</td>
</tr>
<tr>
<td></td>
<td>Average Absorption (α)</td>
<td>0.2809</td>
<td>0.3670</td>
<td>0.4312</td>
<td>0.47325</td>
<td>0.6253</td>
</tr>
</tbody>
</table>

Source: Research result, 2018

From the graph above, it shows that at 0% composition displays the greatest absorption value; it is indicated by frequency 4000 that is equal to 0.75. The differences in this graph occur because in the testing of many factors causing increased frequency of outside sound or outer vibration and also because of the difference in the low frequencies given to the sample during the test.

3.2. Sound Absorption Measurement (α) Coconut fiber Variation 7%
### Table 2. Soundproof test table on concrete mix with coconut fiber 7%

<table>
<thead>
<tr>
<th>No</th>
<th>Sample</th>
<th>Frequency 250 (Hz)</th>
<th>Frequency 500 (Hz)</th>
<th>Frequency 1000 (Hz)</th>
<th>Frequency 2000 (Hz)</th>
<th>Frequency 4000 (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>0.5321</td>
<td>0.4844</td>
<td>0.5244</td>
<td>0.5198</td>
<td>0.7522</td>
</tr>
<tr>
<td>2</td>
<td>II</td>
<td>0.2935</td>
<td>0.4830</td>
<td>0.8280</td>
<td>0.4199</td>
<td>0.9008</td>
</tr>
<tr>
<td>3</td>
<td>III</td>
<td>0.2491</td>
<td>0.5818</td>
<td>0.6641</td>
<td>0.5237</td>
<td>0.8776</td>
</tr>
<tr>
<td>4</td>
<td>IV</td>
<td>0.4847</td>
<td>0.4680</td>
<td>0.5433</td>
<td>0.7829</td>
<td>0.4826</td>
</tr>
<tr>
<td>5</td>
<td>V</td>
<td>0.5872</td>
<td>0.5384</td>
<td>0.5118</td>
<td>0.8976</td>
<td>0.9656</td>
</tr>
<tr>
<td>6</td>
<td>VI</td>
<td>0.2416</td>
<td>0.5001</td>
<td>0.3472</td>
<td>0.6073</td>
<td>0.9578</td>
</tr>
</tbody>
</table>

**Average Absorption**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5980</td>
</tr>
<tr>
<td>2</td>
<td>0.5092</td>
</tr>
<tr>
<td>3</td>
<td>0.5764</td>
</tr>
<tr>
<td>4</td>
<td>0.6222</td>
</tr>
<tr>
<td>5</td>
<td>0.8227</td>
</tr>
</tbody>
</table>

Source: Result of research, 2018

Data obtained displayed that at the frequency of 4000 which produced the highest absorption coefficient value of 0.9656. Differences in this graph occurred because in the testing of many factors that cause the increase of the frequency of outside sound or vibration outside and also because of the difference in the low frequency of the given sample in the test and the addition of fiber factor in the sample so that the absorption coefficient was increasing from the previous variation.

### 3.3. Sound Absorption Measurement (α) Coconut fiber Variation 15%

<table>
<thead>
<tr>
<th>No</th>
<th>Sample</th>
<th>Frequency 250 (Hz)</th>
<th>Frequency 500 (Hz)</th>
<th>Frequency 1000 (Hz)</th>
<th>Frequency 2000 (Hz)</th>
<th>Frequency 4000 (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>0.3424</td>
<td>0.5427</td>
<td>0.5909</td>
<td>0.7992</td>
<td>0.9012</td>
</tr>
<tr>
<td>2</td>
<td>II</td>
<td>0.6786</td>
<td>0.7634</td>
<td>0.7721</td>
<td>0.6658</td>
<td>0.8423</td>
</tr>
<tr>
<td>3</td>
<td>III</td>
<td>0.7293</td>
<td>0.7030</td>
<td>0.6004</td>
<td>0.6617</td>
<td>0.8028</td>
</tr>
<tr>
<td>4</td>
<td>IV</td>
<td>0.7568</td>
<td>0.4889</td>
<td>0.7688</td>
<td>0.8460</td>
<td>0.9756</td>
</tr>
<tr>
<td>5</td>
<td>V</td>
<td>0.5115</td>
<td>0.6809</td>
<td>0.7647</td>
<td>0.7779</td>
<td>0.9101</td>
</tr>
<tr>
<td>6</td>
<td>VI</td>
<td>0.5553</td>
<td>0.5080</td>
<td>0.6812</td>
<td>0.7119</td>
<td>0.9098</td>
</tr>
</tbody>
</table>

**Average Absorption**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5956</td>
</tr>
<tr>
<td>2</td>
<td>0.6144</td>
</tr>
<tr>
<td>3</td>
<td>0.6963</td>
</tr>
<tr>
<td>4</td>
<td>0.7437</td>
</tr>
<tr>
<td>5</td>
<td>0.8903</td>
</tr>
</tbody>
</table>

Source: Result of research, 2017

Data analysis showed that in the 15% mixture of coconut fiber that as the third variation displayed the highest absorption coefficient value of 0.9756 in sample 4 with frequency 4000 Hz with 0.20% absorption coefficient and with the speed of sound wave velocity shows 3902.4 m / s with the method of coconut fiber stocked or placed in the middle position of the sample. Based on previous research (conducted by Pinter Susanto Zalukhu), it was with mixing or stirring evenly on the sample material, the lowest absorption coefficient value was 0.0324, At 500Hz frequency, while the highest absorption coefficient value was 0.93411 at 2000 Hz frequency with variation 6 %. It concluded that the research with the laying of fibres in the middle was less effective than that of overall mixing on the material making sample test specimens, it was due to the outside of the test object too tight (slippery surface), in contrast, in the middle has a cavity, then the sound given was unable to be absorbed by the specimen perfectly.

### Table 4. Table coefficient of fiber coconut fiber absorption coefficient

<table>
<thead>
<tr>
<th>No</th>
<th>Mixed variations</th>
<th>Sound absorbance coefficient 250 Hz</th>
<th>Sound absorbance coefficient 500 Hz</th>
<th>Sound absorbance coefficient 1000 Hz</th>
<th>Sound absorbance coefficient 2000 Hz</th>
<th>Sound absorbance coefficient 4000 Hz</th>
<th>NRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0%</td>
<td>0.2809</td>
<td>0.3670</td>
<td>0.4312</td>
<td>0.47325</td>
<td>0.6253</td>
<td>0.4355</td>
</tr>
<tr>
<td>2</td>
<td>7%</td>
<td>0.3980</td>
<td>0.5092</td>
<td>0.5764</td>
<td>0.6222</td>
<td>0.8227</td>
<td>0.5857</td>
</tr>
<tr>
<td>3</td>
<td>15%</td>
<td>0.5956</td>
<td>0.8144</td>
<td>0.8963</td>
<td>0.7437</td>
<td>0.8903</td>
<td>0.7080</td>
</tr>
</tbody>
</table>

Source: Result of research, 2017

Note: NRC (Noise Reduction coefficient) coefficient of average sound absorption from 250 to 4000 Hz.

### 4. CONCLUSIONS

Data analysis of the testing on the added coconut fiber composites with natural matrix gives some conclusions as followings:

1. The obtained value of sound absorption coefficient showed an increasing graph in every addition of coconut fiber variation. The lowest absorption coefficient value was 0.1287, at the frequency of 250 Hz, while the highest absorption coefficient value of sound was 0.9756 at 4000 Hz frequency. The fastest sound wave propagation value was 32,175 m / s, at the frequency of 250 Hz. Thus, the wave propagation the largest sound was around 3902.4 m / s at a frequency of 4000 Hz. Those significant values concluded that the addition of coco fiber affected and increased the better absorption value.

2. A specimen of fiber composite silencer beam with natural matrix to be better sound absorbance value: the use of coconut fibres suggestedly to make higher percentage for getting obtained higher sound absorption results. Using the small chopped coconut fibres facilitated the mixing of materials at the time of casting. In testing noise absorption with Tube Impedance requires patience and accuracy to know the value of absorption more leverage. For further research can be done from basic materials.
of plywood, gypsum and plastering of buildings. It must learn the software (DAQ vactory and HQ control) which is used as supporting tool of Tube Impedance.

REFERENCES


