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ACOUSTICAL CHARACTERISTIC OF CHICKEN FEATHER PANEL

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ABSTRACT

Billion kilograms of waste produced from various types of poultry processing become severe problem to environmental pollution. Chicken feather waste as accessories, pillow fillers and animal feed, are some product samples which are not significantly reduce the chicken feather waste. This study aims to determine characteristics of chicken feather in form of acoustic panel in the field of architecture as an alternative of acoustical material. This study applies an experimental method by processing chicken feather waste into panel samples. In the process of utilizing chicken feathers into a panel- shaped composite material, additional of Polyvinyl Acetate (PVAc) as adhesive. Three types of sample surfaces named as FS, CS4 and CS5 were measured for their average absorption coefficients and resulted in 0.49, 0.57, and 0.51, respectively. Study confirmed the potential of chicken feather panels as an alternative of acoustical absorptive materials.

Key words: Speech production, LP coefficients, Pitch, Formant frequency, LP residual, Bisyllabic words, Kannada Language

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1. INTRODUCTION

In daily life, chicken has been one of the primary food for people to consume. The increasing demand for chicken is caused by the price of chicken flesh that is affordable for consumers starting from the middle to the upper economic level [1]. In accordance, tons of chicken waste produced annually, specific to Indonesia reach to 1.5 million tons [2]. As consequence, the waste of global poultry industry then become threat for environment**.** Billion kilograms of

feather waste are produced annually by poultry processing plants, creating serious substantial waste problems [3]**.** Therefore, new technology and methods for waste disposal and utilization are needed to reduce its threats to the environment [4]**.**

The result of slaughtering poultry produce a huge waste, approximately $4x10^9$ kg annually worldwide [5]**.** The nutritional contents of chicken feathers are about 91% protein (keratin), 1% fat, and 8% water. Half of a chicken feather is fiber and a rigid core with hollow tube structure. Both feather fiber and chicken feathers are made from keratin (about 90% by weight), an insoluble and very durable protein found in animal hair, nails, and horns [6].

Basically, chicken feathers have been used for long time, such as pillow filling material, feather duster, and accessories. Chicken feather attracts many researchers' attention in the development of science and technology. In 1998, the US Department of Agriculture (USDA) developed technology to separate chicken feathers into fibers and particles (quill feathers) [7]**.** One study in Philippines utilize chicken feather waste into composite material as building material, mixture with cement to be used as structural material for housing in the tropics [8]. This research opens the way for the use of chicken feathers as additional material in composite products.

Several other studies that have been examined on recycling chicken feather waste as an effort to produce a derivative of sound absorbing material made of chicken feather waste as an alternative material for acoustic materials. Researchers show that chicken feathers may produce sound absorption close to the coefficient $\alpha = 1$, the best sound absorption value [9].

Similar research applies for fiber board with slight decrease in strength, but increase dimensional stability and decay resistance compared to boards made of wood fiber. Other researchers use fibers to develop new bio-composites [10] or as reinforcement in plastics [11], [12].

This research is processing chicken feather waste into a panel which will be used as an acoustic material. Yet limited researches performed using chicken feather waste as an acoustic panel material, and this study should lead the latest findings.

2. RESEARCH METHODS

The method of making acoustic panels from chicken feather waste is carried out by experiments of several treatments, one of the best treatments is by mixing certain ratio of chicken feathers and PVAc adhesives with clean water as solvent.

2.1. Materials and Tools

The material used is chicken feather waste. Waste is cleaned with a disinfectant solution and then finely chopped using a grinding machine. The adhesive material of PVAc and water as the second solvent. In this experiment, some equipment were used, i.e. hydrolyte press machine, electric oven, measuring cup, stirring container, aluminum spoon, digital scales, plastic and mold for specimen made of cylindrical iron pipes with a diameter of 10 cm.

2.2. Specifications

In this study, three surface types of feather panel were made. Flat surface (FS) and surface with additional of four and five concaves (CS4 and CS5). Specimen were formed by iron mold with diameter of 10 cm and 2.5 cm thick; the thickness adjusted to the standard material in market but higher in density of 350 kg/m^3.

2.3. Procedure of Making the Panels

Collected chicken feathers are washed clean. Added with formaldehyde to make chicken feathers free of germs and larvae. The first step is dissolve PVAc glue in appropriate water, stirred slowly by slight pressure for easy mix. The result of mixed compound is put into a cylindrical iron mold, coated by thin plastic in order to prevent sticky material on the mold wall. Set aside about 30 minutes so that all materials fused, then pressed in a hydraulic press with pressure of two tons / cm^2, left for 30 minutes to balance the adhesive- feathers compound. Next is to bake the specimen at 100 °C for 60 minutes, then removed from the oven, dried at ambient temperature to normalize the feathers for a day, then dried under the sun for three days.

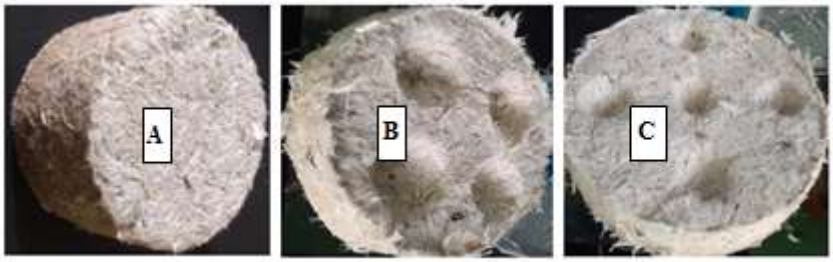

Figure 1 Specimen: A. Flat Surface (FS); B. 4 Concaves Surface (CS4); C. 5 Concaves Surface (CS5)

2.4. Measurement Method

Panel of specimen were measured in Acoustic Workshop Laboratory of Building Science and Technology, Department of Architecture, Faculty of Engineering, Hasanuddin University, Indonesia. Set up of Impedance Tube B&K type 4206, a tube for measuring the absorption coefficient of specimen, as seen in Figure 2.

Figure 2 Impedance tube type 4206

A B C D

Figure 3 A. Specimen in tube, B. Power amplifier, C. FFT Analyzer, D. Computer set.

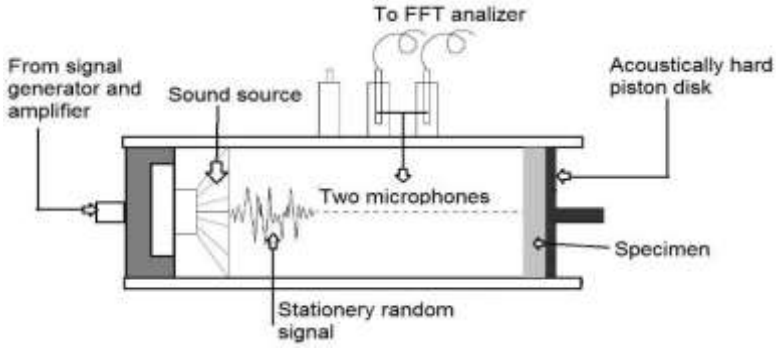

Figure 4. Schematic diagram of the two microphone of Impedance Tube

3. RESULT AND DISCUSSION

Number of specimen of this study were 18 panels, with 10 cm in diameter and 2.5 cm thicknesses. There are ten specimen of Flat surface (FS) and eight specimen of concave surfaces named as 4 Concave surface (CS4) and 5 Concave surface (CS5).

3.1. Absorption Coefficient of Chicken Feather Waste Panel Material

Panel samples that have been formed are measured to obtain accurate material absorption coefficient values. Measurements were made using the conventional two microphone impedance tube (B&K 4206) method according to ISO 10534-2 of 10 cm tube diameter as shown in Fig. 2 and Fig.3. Presented in form of curves, the measurement were taken at frequency range of 100 Hz - 1,600 Hz. The measurement results then later be analyzed statistically.

Sample measurements provide a proper evaluation of the feasibility of chicken feathers as sound absorption material, specifically to improve the sound environment in a room of artificial environment and as can be stated that chicken feathers panel have the potential as a sustainable alternative sound absorbing material [13].

3.1.1. FS Panel sample

There are 10 test samples made for panels with a flat surface. Each of them was named to determine the absorption value of each sample, FS 2.5 (A-B-C-D-F-G-H-I-J). After measuring the absorption coefficient, the results of the graph are shown in Figure 5.

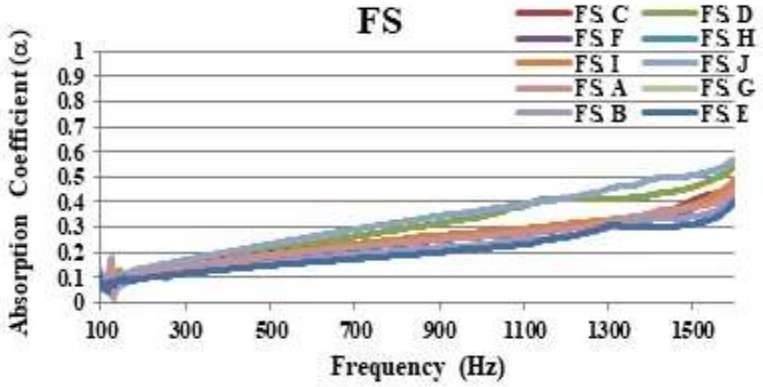

Figure 5. Absorption Coefficient of FS (A-J) samples

In the measurement of absorption coefficient of ten FS samples as shown in Figure 5. From the ten samples, there are 5 samples that have absorption coefficient values were close to a similar value, as shown in Figure 6.

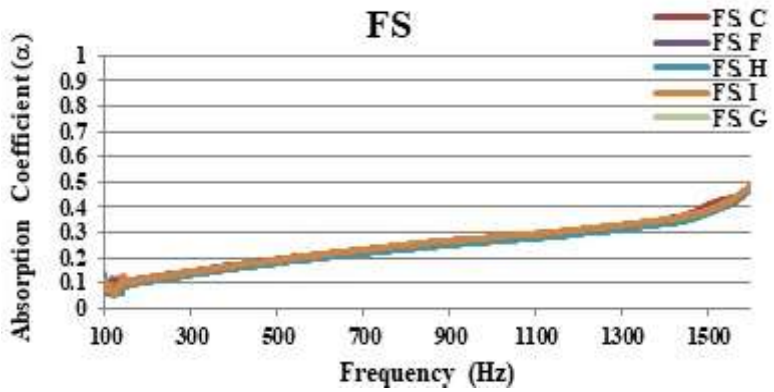

Figure 6. FS Absorption Coefficient Curve (C-F-H-I-G) sample

From the five samples shown, researcher then made an average data table to represent the testing value of a 2.5 cm thick FS sample, the results can be seen in Table 1.The table shows the five curves of the FS sample. At the frequency of 100 Hz, three samples with a value of α 0.09 and a frequency of 1000 Hz, the five samples showed values of α 0.27 and α 0.26 and at a maximum frequency of 1600 Hz, only FS.G samples were high compared to the other four samples namely α 0.47 and 0.48. The five curves are made into one average curve shown in Figure 7.

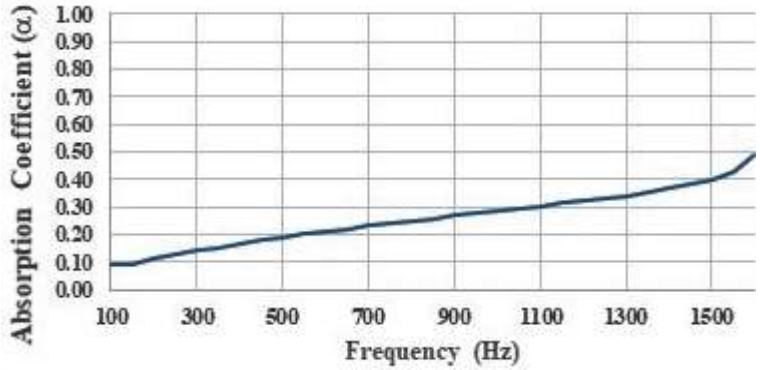

Figure 7. Average absorption coefficients of Flat Surface (FS) specimen

Table 1 Absorption Coefficient of FS

Frequency (Hz)	Absorption Coefficient				
	FS. C	FS. F	FS. H	FS. I	FS. G
100	0,09	0,09	0,11	0,08	0,09
200	0,12	0,12	0,10	0,12	0,13
300	0,14	0,15	0,13	0,14	0,17
400	0,17	0,17	0,16	0,17	0,20
500	0,19	0,19	0,18	0,19	0,23
600	0,21	0,21	0,20	0,21	0,26
700	0,22	0,23	0,22	0,23	0,29
800	0,24	0,25	0,23	0,25	0,32
900	0,26	0,27	0,25	0,27	0,34
1000	0,27	0,27	0,26	0,27	0,26
1100	0,28	0,29	0,28	0,29	0,39
1200	0,30	0,31	0,29	0,31	0,42
1300	0,32	0,33	0,31	0,33	0,45
1400	0,34	0,34	0,33	0,35	0,49
1500	0,40	0,38	0,37	0,39	0,51
1600	0,47	0,47	0,48	0,49	0,57

In the FS sample measurement, the average curve is listed as shown in Table 2. At frequencies from 100 Hz to a maximum frequency of 1600 Hz, the absorption coefficient movement is very regular according to the received frequency pressure which are the absorption coefficient values range from α 0.09 to 0.49.

3.1.2. CS4 Panel Samples

In CS4 samples, four samples were successfully tested, used as comparison to the 10 flat surface samples. These four samples were made with surfaces modified with four concave on surface in order to reduce the incoming noise. Thus, it is expected that the absorption value will be higher than the flat surface sample, shown in Figure 8. Here, it is clear that there are differences of the FS with the CS4 specimen. Result showed an increase in the absorption coefficients of the material. From the above samples, researchers took one sample to be used as a basis for measuring the average value of CS4 samples

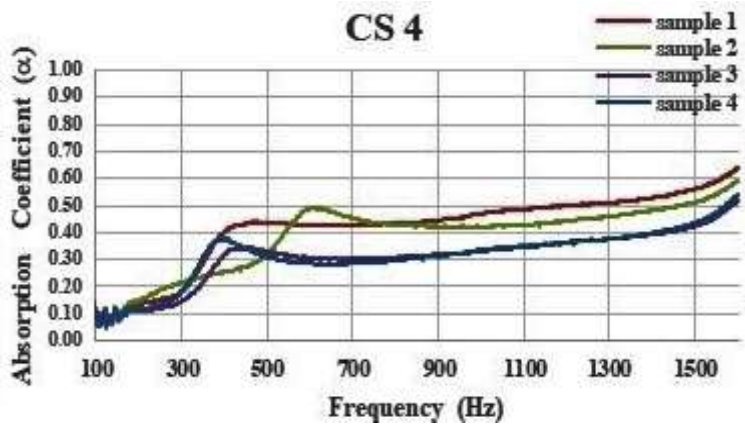

Figure 8 Absorption coefficient of CS4

Table 2 Average absorption coefficients of Flat Surface (FS) specimen

Frequency (Hz)	Absorption Coefficient
100	0,09
150	0,09
200	0,11
250	0,13
300	0,14
350	0,15
400	0,17
450	0,18
500	0,19
550	0,20
600	0,21
650	0,22
700	0,23
750	0,24
800	0,25
850	0,26

Frequency (Hz)	Absorption Coefficient
900	0,27
950	0,28
1000	0,28
1050	0,29
1100	0,30
1150	0,31
1200	0,32
1250	0,33
1300	0,34
1350	0,35
1400	0,37
1450	0,38
1500	0,40
1550	0,43
1600	0,49

Table 2 shows the values of average absorption coefficient of CS4 and presented in graph as can be seen in Fig.8. Throughout frequency of 100 Hz to 250 Hz, there is a fairly small propagation with α 0.08 to 0.15 and starts to rise at a frequency of 300 Hz to 600 Hz with α 0.18 to α 0.38, then propagate average sound at a frequency of 650 Hz to a frequency of 1000 Hz with α 0.37, then continue to rise to a maximum frequency of 1600 Hz with α 0.57.

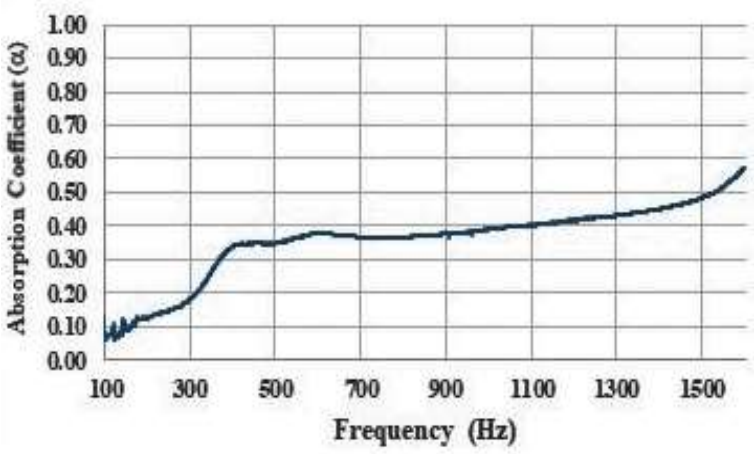

Figure 9 Average absorption coefficients of 4 Concave surface (CS4) specimen

3.1.3. CS5 Panel Samples

As comparison, researchers measure sample of 5 concave surface (CS5) as shown in Figure 10. There are still differences in the flat surface sample graph with the 5 concave specimen. In the four samples there is an increase in the absorption value of the material. Four samples were made into one sample to measure the average value of the CS5 sample.

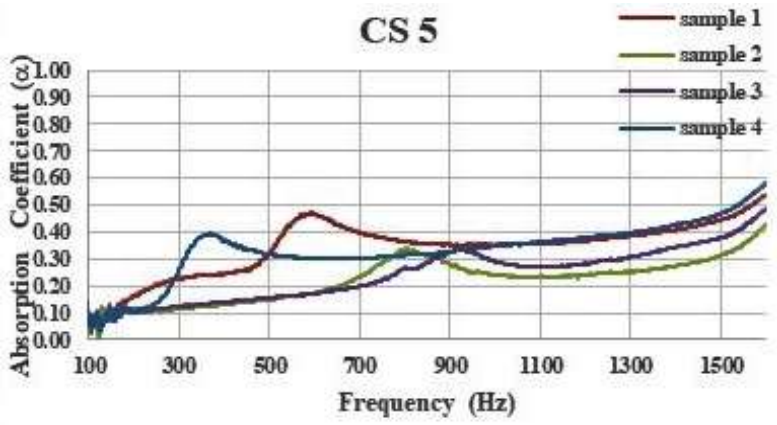

Figure 10 Absorption coefficient of CS5

Table 3 Average absorption coefficients of 4 Concave surface (CS4) specimen

Frequency (Hz)	Absorption Coefficient
100	0,08
150	0,09
200	0,13
250	0,15
300	0,18
350	0,26
400	0,34
450	0,35
500	0,35
550	0,36
600	0,38
650	0,37
700	0,37
750	0,36
800	0,37
850	0,37

Frequency (Hz)	Absorption Coefficient
900	0,38
950	0,38
1000	0,39
1050	0,40
1100	0,40
1150	0,41
1200	0,42
1250	0,42
1300	0,43
1350	0,44
1400	0,45
1450	0,46
1500	0,48
1550	0,52
1600	0,57

Measurements of average absorption coefficient of four CS5 as shown in Figure 11. From the figure, it can b seen that from frequency of 100 Hz to 350 Hz the absorption coeficients are only α 0.07 to α 0.18 and subsequently flat at the frequency of 300 Hz to 450 Hz which is α 0.22 and then increases α 0.22 to α 0.27 at a frequency of 600 Hz - 700 Hz, then return to the same frequency of 750 Hz-950 Hz with α 0.32, and begin to rise to the maximum frequency of 1600 Hz with α 0.31 to α 0.51. The detail values of measurements as illustrated in Table 4.

3.2. Comparison of Absorption Coefficients of FS and CS Specimens

From experiments of the three types of specimen (FS, CS4 and CS5), differences of absorption coefficients values can be recognized. By additional concave on surface of CS4 and CS5, comparing to flat surface of FS specimens, the performance of absorption coefficient was relatively improved, as can be seen in Figure 12 and Table 5.

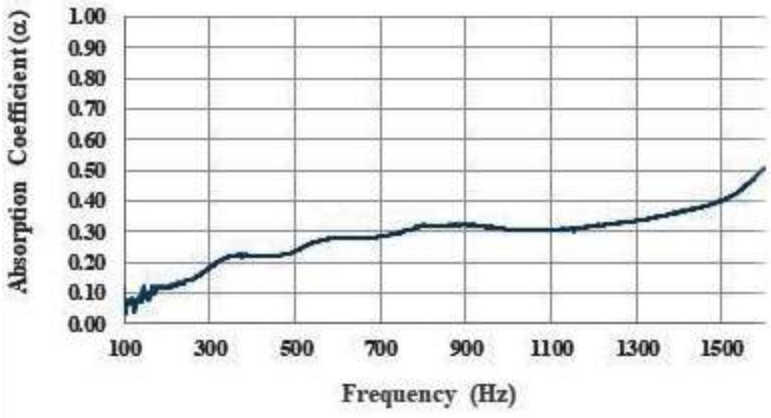

Figure 11. Graph of average α for 5 Concave surface (CS5) specimen

Table 4. Values of average α for 5 Concave surface (CS5) specimen

Frequency (Hz)	Absorption Coefficient
100	0,07
150	0,09
200	0,12
250	0,14
300	0,18
350	0,22
400	0,22
450	0,22
500	0,24
550	0,27
600	0,28
650	0,28
700	0,28
750	0,30
800	0,32
850	0,32

Frequency (Hz)	Absorption Coefficient
900	0,32
950	0,32
1000	0,31
1050	0,30
1100	0,31
1150	0,31
1200	0,32
1250	0,33
1300	0,34
1350	0,35
1400	0,36
1450	0,38
1500	0,40
1550	0,44
1600	0,51

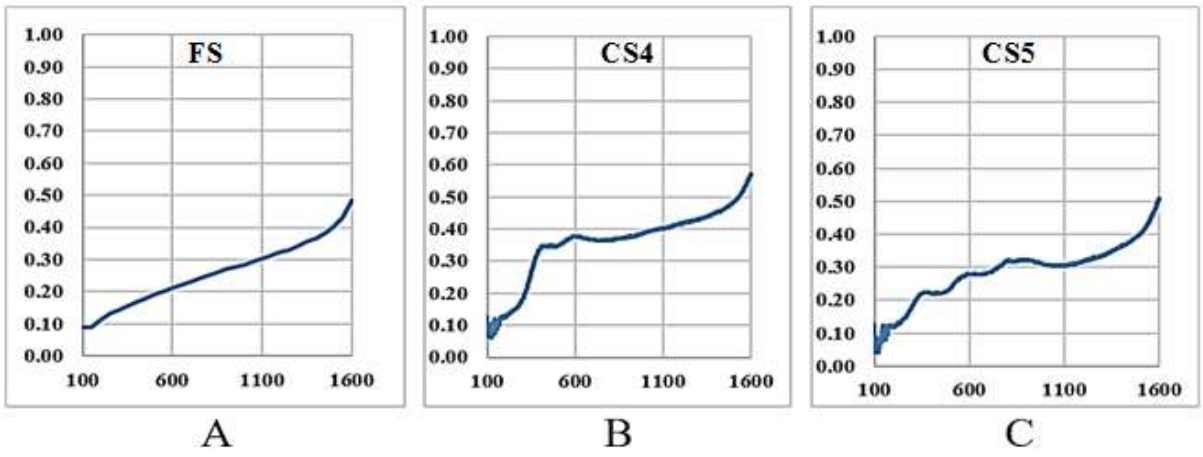

Figure 12. Average absorption coefficients of: A) FS sample; B) CS4 sample; C) CS5 sample.

Table 5 Comparison of the average absorption coefficients for FS, CS4 and CS5

No.	Specimen	Frequency (Hz)								α Max
		200	400	600	800	1000	1200	1400	1600	
1	FS	0.11	0.17	0.21	0.25	0.28	0.32	0.37	0.49	0.49
2	CS4	0.13	0.34	0.38	0.37	0.39	0.42	0.45	0.57	0.57
3	CS5	0.12	0.22	0.28	0.32	0.31	0.32	0.36	0.51	0.51

In Figure 12.A, samples flat surface, show an increase in the absorption coefficient value in line with the increase of frequency ie, the higher the frequency, the absorption value will increase. In Figures 12.B and 12.C, the modified sample surface of CS4 and CS5 gave more absorption coefficient values as the sound frequency raised. The maximum average absorption coefficient for CS4 and CS5 samples are α 0.57 and α 0.51 at frequency of 1600 Hz, while the FS sample is only α 0.49 at frequency 1600 Hz.

4. CONCLUSION

In this study, from all the experiments that have been carried out to find the characteristics of the acoustic panel utilization of chicken feather waste can be concluded as follows:

In the FS sample with a flat surface treatment the absorption coefficient value is smaller that is α 0.49 compared to the CS4 and CS5 models with the treatment giving a concave model on its surface so that it can absorb sound with the absorption coefficient values α 0.51 and α 0.57, which means the sound absorption coefficients are relatively good and possible as an alternative of absorptive panel material.

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