The Effect of Corn Cob Powder Volume Fraction on the Quality of Composite Acoustic Boards for Airport Buildings

Nur Akhmad Triwibowo[1] , Muhammad Adil[1], Fajar Nugroho[1]

[1] Adisutjipto Aerospace Technology Institute, Jalan Janti Blok R Lanud Adisutjipto, Yogyakarta, Indonesia
akhmadtriwibowo@itda.ac.id

Abstract. Noise at the airport can be reduced by building materials that can dampen sound in the form of acoustic boards. One of the natural materials that has potential as a candidate for acoustic sound dampening board material is corn cobs. This study will determine the effect of the volume fraction of corncob powder on the quality of the composite acoustic board. The volume fraction variations studied were 0%, 45%, 55% and 65% corncob powder. The quality of the acoustic board reviewed only includes sound attenuation capabilities in the form of Noice Absorption Coefficient (NAC) values and bending strength. Acoustic board production process using the Hand Lay-Up method. This study concluded that the addition of corncob powder to epoxy resin (range 0% -65%) can increase the sound attenuation ability. The best dampening ability is found in composites reinforced with 65% corn cob powder with a Noice Absorption Coefficient (NAC) value of 0.275 at a frequency of 160 Hz, according to ISO 11654:1997 standards. In addition, the addition of corncob powder to epoxy resin (range 0% -65%) can increase bending strength. The best bending strength of the 65% variation of corncob powder was 17.91 MPa. The best volume fraction variation is the composition of 65% corncob powder.

Keywords: corncob powder, epoxy resin, composites, acoustic boards, noise absorption coefficient, bending strength

1 Introduction

Airplane engines have high-intensity sounds that cause sound effects. This can interfere with the comfort of airplane passengers while at the airport and if it continues for a long time can cause health problems for airport officials. To reduce the noise, we need a building material that can dampen sound in the form of acoustic boards. A good sound absorbing material is obtained from a porous material where intermolecular friction or friction is generated when the sound wave hits the material. Sound absorbing acoustic boards can come from synthetic fibers or natural fibers. Various types of sound absorbing materials have been developed.

R. Andrie Asmara et al. (eds.), *Proceedings of the 5th Annual Advanced Technology, Applied Science, and Engineering Conference (ATASEC) 2023*, Advances in Engineering Research 229,
https://doi.org/10.2991/978-94-6463-358-0_23

Corn cobs are widely available as agricultural waste. National corn production from year to year is increasing. According to data from the State Secretary of the Republic of Indonesia, in 2009 national corn production amounted to 19.76 million tons of dry shelled (PK), in 2011 it was 19.80 million tons, and in 2012 it was 22 million tons PK. Utilization of corn cobs has been widely studied. Yusriani et all (2022) have tested the mechanical properties of composite boards made from corn cob and banana stem fiber. Ardinal et all (2020) have reported the effect of adding corn cob waste to making light bricks. In addition, Primaningtyas et al (2018) have studied the effect of corncob powder particle size on the synthesis of non-asbestos brake lining composites. Rifa'i et all (2020) has reviewed the relationship between HDPE plastic and corn cobs for making composite bricks. Ibrahim has also researched the effect of powder volume on the rate of water absorption in corn cob particle composites with an epoxy matrix

One of the natural materials that has potential as a candidate for sound absorbing material is corncob. Corn cobs are porous and light. Pores on corncobs can absorb sound. Corncob is a natural organic material that has the potential to be used as a sound absorbing material. Utilization of corn cobs as a candidate material for sound dampening acoustic boards can reduce agricultural waste. For this reason, corn cob is very interesting to be further studied as an acoustic board.

2 Materials and Methods

This study used materials such as epoxy resin, hardener and corn cobs. Corn cobs were crushed into powder, filtered through a 100 mesh sieve and dried. Corncob powder was mixed with epoxy resin and hardener with various volume fractions of 0%, 45%, 55% and 65% (Table 1) and stirred evenly. The mixture was put into a 25 cm x 25 cm x 1 cm mold and dried in the open air. The dry composite is removed from the mold and cut according to the requirements for soundproofing and bending testing (ASTM D 790)

Table 1. Variation of Acoustic Board Volume Fraction

Volume Fraction of Corn Cob Powder	Volume (cm^3)		Total Volume (cm^3)
	Corn Cob Powder	Epoxy & Hardener	
0%	0	625	625
45%	281.25	343.75	625
55%	343.75	281.25	625
65%	406.25	218.75	625

In this study, sound insulation testing was carried out using a test box (Fig. 1) measuring 80 cm long, 25 cm wide and 25 cm high. The use of this test box is intended as a substitute for the room. The working system of this silencer test is that the sound

source comes from a smartphone which is amplified with the help of a speaker. Smartphone with Audio Frequency Generator (AFG) application will issue a sound with frequency variations, namely 250 Hz, 500 Hz, 1000 Hz, 1250 Hz, 1250 Hz, 1500 Hz, 1750 Hz, 2000 Hz, 2250 Hz, 2500 Hz, 2750 Hz, 3000 Hz, 3250 Hz, 3500 Hz, 3700 Hz, 4000 Hz. The damping test object in the form of an acoustic board is made with dimensions of 25cm x 25cm x 1cm which is then placed in the center of the box as a partition between the two rooms between the sound source and the sound catcher. In the opposite room, a Sound Level Meter is installed to capture and record sound intensity

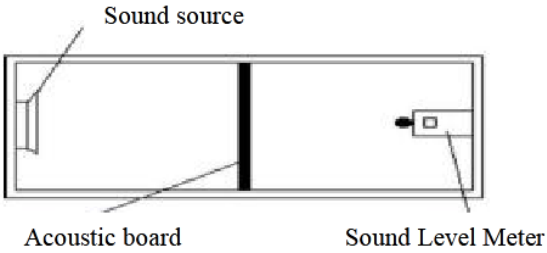

Fig. 1. Soundproofing Test Box

In this study, bending tests were carried out referring to the ASTM D790 standard with static test conditions. Based on the test standard used, namely ASTM D790, the shape of the specimen and its size can be seen in Figure 2 below.

Fig. 2. Bending test specimens

3 Results and Discussion

3.1 Soundproofing Testing

Figure 3 shows the results of soundproofing tests for various variations of corncob composition

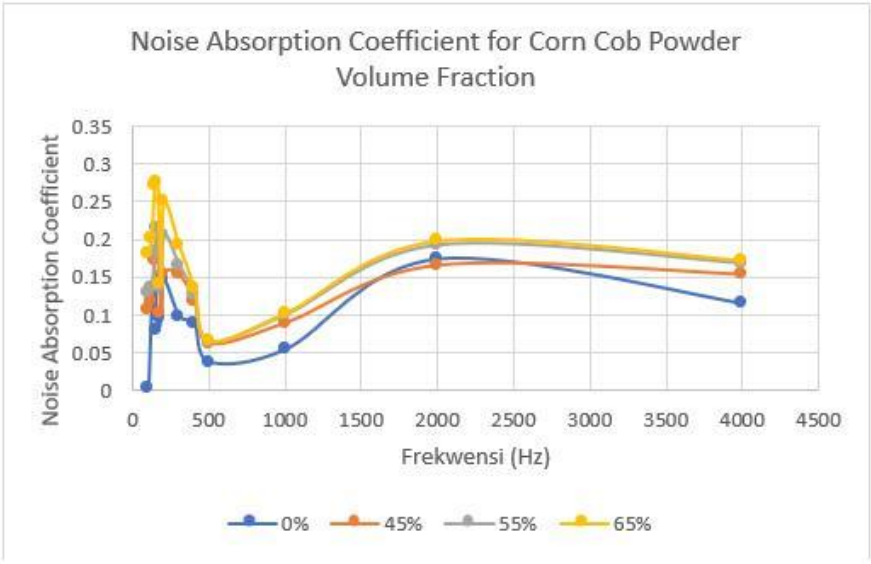

Fig. 3. Sound Attenuation Test Results

From the test results, it is known that all variations of sound attenuation specimens have quite identical damping characteristics. It can be shown in graphical form the relationship between NAC and frequency increase. The highest NAC of the four specimens was the specimen with a filler volume fraction of 65% at a frequency of 160 Hz, namely $\alpha = 0.275$. Meanwhile, the lowest NAC value of the four specimens was the specimen with 0% filler volume fraction at a frequency of 500 Hz, namely $\alpha = 0.037$.

The addition of corncob powder filler can increase the sound attenuation ability of the acoustic board. Epoxy and composite materials reinforced with corncob powder have the ability to dampen sound with a value of $\alpha<0.3$.

Physically, the corncob component has many pores that can dampen sound. So the addition of the volume fraction of corncob powder to a certain extent increases the sound attenuation of the composite. Especially if the distribution of the corncob powder is evenly distributed in all parts of the composite

3.2 Bending Test

Fig.4shows the results of bending tests for various volume fractions of corncob powder

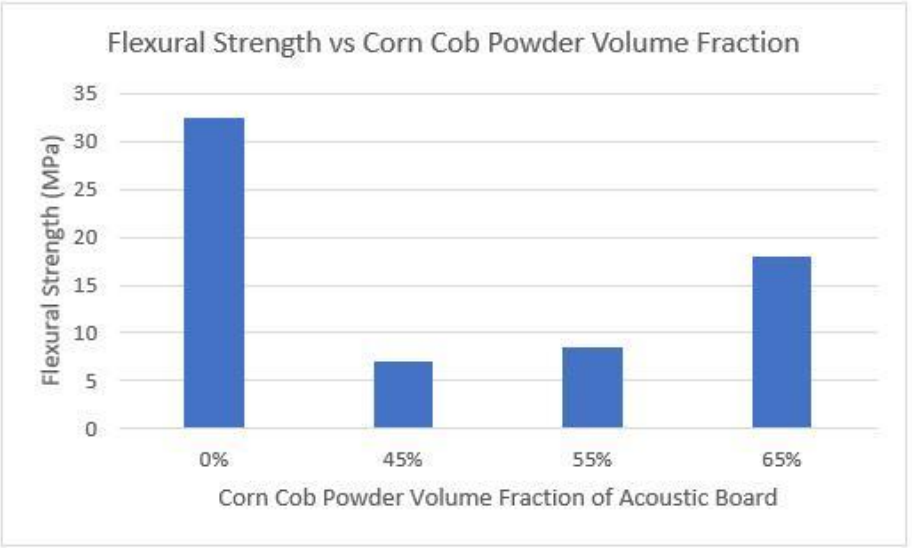

Fig. 4. Bending Test Results

Fig. 4 shows that the more corncob powder filler added, the higher the bending strength value. Lowest yield on corncob powder variation 45% with an average bending strength of 7.45 MPa and the highest yield was found in 65% corn cob powder with an average bending strength of 17.94 MPa.

Physically, the corncob component is elastic because there is a natural foam element in the core of the corncob. So the addition of volume fraction of corncob powder to a certain extent increases the bending strength of the composite.

4 Conclusions

The results of the study can be concluded that:

The addition of cob powder to the acoustic board composite material (range 0% - 65%) can increase the sound attenuation ability. The corncob powder composite material also meets the recommended value for sound absorbing materials, namely the NAC value (Noise Absorption Coefficient) greater than 0.2. The best dampening ability is found in composites reinforced with 65% corn cob powder with a Noice Absorption Coefficient (NAC) value of 0.275 at a frequency of 160 Hz.

The addition of corncob powder filler (range 0% -65%) affects the increase in the bending strength of the composite, where the highest bending strength of the composite is at a variation of 65% with a bending strength of 17.94 MPa.

References

1. Yusriani, Sahara, Lanto, M.S : Uji Sifat Mekanik Papan Komposit Berbahan Tongkol Jagung dan Serat Batang Pisang. Teknosains Journal, Vol 16, No 1 (2022).
2. Ardinal, A, Wirni, R, Haryati, N.A : Pengaruh Penambahan Limbah Tongkol Jagung untuk Pembuatan Batu Bata Ringan. Riset Industri Journal, Vol 10, No 1 (2020).
3. *Primaningtyas, W.E, Suheni, Feri Alfian Pradana, F.A* : Pengaruh Ukuran Partikel Serbuk Bonggol Jagung Terhadap Sintesis Komposit Kampas Rem Non-Asbestos. Iptek Journal, Vol 22, No 1 (2018).
4. Rifa'i, V.A, Hermansyah, Kurniwati, E : Tinjauan Hubungan Plastik Hdpe Dengan Tongkol Jagung Untuk Pembuatan Batako Komposit. Hexagon Journal, Vol 1, No 1 (2020).
5. Ibrahim, M.M, Desiasni, R, Widyawati, F : Pengaruh Volume Serbuk Terhadap Laju Penyerapan Air Pada Komposit Partikel Tongkol Jagung (Corn Cob) Dengan Matriks Epoksi. Hexagon Journal, Vol 2, No 1 (2021).