

Short Communication

Analysis of sound absorbing properties of different density local acoustic materials

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Grounded element, sawdust, local plaster mud and sand were mixed in various contributions by weight and their sound absorbing properties were studied and analyzed. Their absorbing properties were compared with that of panel absorbers. Results show that, these local samples give results similar to that of panel absorbers

Keywords: Sound, sawdust, absorbing, properties, sand, mud, cement

INTRODUCTION

When sound waves fall on surface or object, their energy is partially reflected and partially absorbed. The sound absorbing efficiency of the surface involved is given in terms of an absorption coefficient (Bies and Hansen, 1996; Beranek, 1960).

The absorption of a material depends on the properties of the material, the way it is positioned in a room, the shape and size of the room in which it is used, and the dimension of the material. Absorption materials play an important role in architectural recording studios, listening rooms and interior of automobiles.

Two important parameters of acoustic materials which directly relate to absorption and are also readily measurable are the coefficient of absorption and the complex acoustic impedance (Menkiti and Etinam-Umoh, 1994)

The absorption coefficients and acoustic impedance of grounded cement, sawdust, local plaster mud and sand were measured and analyzed.

MATERIALS AND METHOD

Materials

The equipment used for this study were

1. Bruel & Kjaer standing wave apparatus type 4002.
2. B & K Real-time frequency analyzer type 2133.
3. B & K frequency analyzer type 2107

4. Function/waveform generator (Hewlet Packard 33120)
5. Audio amplifier and
6. Several samples of acoustic absorbing materials (Magrab, 1975).

The acoustic absorbing materials used for this study were grounded cement, sawdust, local plaster mud and sand. They were mixed in different proportion by weight as shown below:

Sample A had the following composition by weight

Sawdust	-	¼	
Cement	-	¼	
Sand		-	¼
Local plaster mud	-	¼	

Sample B had the following composition by weight

Sawdust	-		
Cement	-		
Local plaster mud	-		

Sample C had the following composition by weight

Sawdust	-	1	
Cement	-	¼	
Sand		-	1
Local plaster mud	-	1	

Sample D

Local plaster mud and	-	½	
Cement	-	½	

Sample E

Local plaster mud alone

The mixtures were given a good mix and made into moulds of thickness 5cm. The diameters of the moulds were 10 cm and 3cm

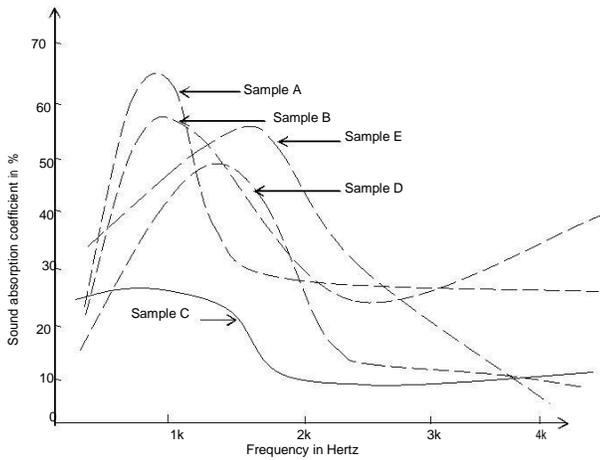


Figure1. A graph of sound absorption coefficient against frequency

for the large and small tubes of the standing were apparatus respectively.

Methods

The standing wave apparatus (Type 4002) was used for the measurements. It has a pure tune signal generator, analyzer, moving microphone, loud speaker, standing wave tube- large and small, and a metre rule.

The type used was designed for measurements of absorption coefficients and specific acoustic impedance of circular cut samples of sound absorbing materials in the frequency range 90Hz to 6.5KHz – large tube is useable in the frequency range of 90Hz to 1800Hz and the small tube for the frequency range of 800Hz to 6.5 kHz.

The material under study was placed on one end of the tube and at the other end was a sound source (loudspeaker) emitting pure tune.

The loudspeaker is a moving coil type, and the microphone, to which a probe is attached, lay in an elastic mounting well insulated from airborne noise and impact sound or vibration (Magrab 1975)

When sound wave, incident normally on the surface is reflected, the incident and the reflected waves reinforce to form a standing wave pattern, where the maxima is (A + B) and minima is (A – B) can be calculated.

Standing wave ratio is the ratio of pressure maximum to pressure minimum

$$SWR = \frac{A + B}{A - B} \tag{1}$$

Also measured was the distance from the faces of the samples to the first pressure minima, d_{min} . The sound reflection coefficient is given by

$$R = \frac{B}{A} = \frac{SWR - 1}{SWR + 1} \tag{2}$$

The sound power absorption coefficient for each test sample at a given frequency was calculated from

$$R = \frac{(SWR - 1)^2}{(SWR + 1)^2} \tag{3}$$

The complex acoustic impedance was calculated using

$$Z = cs \frac{A + B}{A - B} = cs \frac{1 + \frac{B}{A}}{1 - \frac{B}{A}}$$

where ρ = density
 c = speed of sound in air
 s = cross sectional area of the sample

RESULTS

The quantities, SWR and d_{min} were tabulated and plotted as functions of frequency for the front and back of each sample. A smooth curve was drawn through the points in each case – to reduce the exaggeration of errors (Bruel and Kjaer,1967)Then, from the graphs, standing wave ratios and d_{min} values were extracted and used to calculate both the absorption coefficients and the complex acoustic impedances at the corresponding frequencies.

Using the data, the graphs of the variation of absorption coefficient and complex acoustic impedances with frequency were plotted. These graphs are shown in Figures 1 and 2 respectively.In each graph, the numbering is the same as in the samples.

DISCUSSION

It can be seen from the graphs that the absorption coefficient for each sample rises slightly to a maximum point before decreasing, as the frequency increases.

Samples A, B and C had their peaks at around 0.5kHz while samples D and E had theirs at about 1 kHz.

Samples E (local plaster mud along) and D (local plaster mud mixed in the same proportion with cement) had wider range of absorption than other samples.

This shows that local plaster mud and a mixture of local plaster mud with cement can be effectively employed as a general purpose absorbent.

This finding explains why local mud houses in most African villages serve as a haven from introducing noise.

Graphs of complex acoustic impedances against frequency show that the impedance reduces as frequency increases until they reach the minimum value, after which they start to increase steadily.This agrees with earlier findings (Menkiti and Etinam -Umoh,1994)

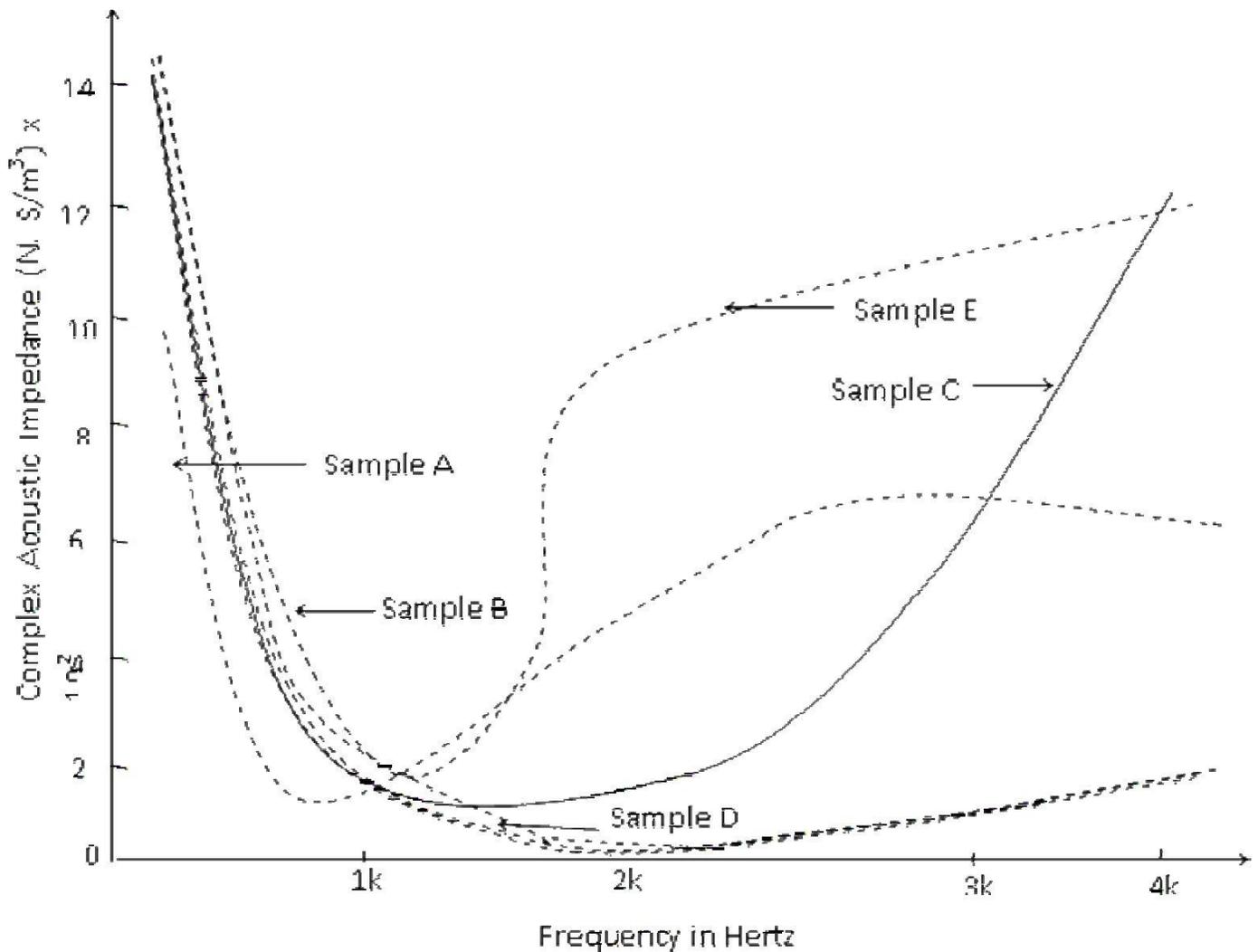


Figure 2. A graph of complex acoustic impedance against frequency

Conclusion

The absorption coefficients of all the samples examined show increases with increase in frequency, up to some maximum value, before falling with further increase in frequency. The range of useful absorption depends on the composition of the mixture. Results indicate that, of all the samples tested, local plaster mud and its mixture with cement can be effectively used as general purpose absorbent (Crocker and Price 1975; Russel 2002).

REFERENCES

- Beranek LL (1960). Noise reduction. New York:McGraw Hill
- Kinsler LE, Frey AR, Coppens, AB ,Sanders JV (1982). Fundamentals of Acoustics, Third Edition. New York :John Wiley and Sons.
- Menkiti AI ,Etinam-Umoh S(1994), Sound absorbing properties of two common Acoustic materials. J.West Afri.Sci. Assoc. 37: 49-59.
- Magrab EB (1975). Environmental Noise control.Toronto: John Wiley and Sons.
- Bruel and Kjaer (1967).Instructions and applications for standing wave apparatus type 4002 and frequency analyzer (type 2107).
- Crocker, AJ and Price, AJ (1975). Noise and noise control.Cleveland :CRC Press
- Russel DA (2002).Absorption coefficients and impedance. Web site address Accessed 20/7/2007.
- Scott, RA (1946).An apparatus for accurate measurement of the acoustic impedance of sound absorbing materials. Proc. Phy, Soc. Am.53:253-264.