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BEHAVIOUR OF ACOUSTICAL PLATES MADE OF EXPANDED PERLITE IN MOIST ENVIRONMENTS

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ABSTRACT

A number of plates made of perlite were prepared. Plates were moisturized at different levels. Their absorption coefficients were measured by the "two-microphone impedance tube" method. Experimental results were introduced and the moisture effects on acoustical properties of plates made of perlite were discussed.

1. INTRODUCTION

Perlite, which is a siliceous volcanic rock, expands ten to thirty times to its original volume when heated up to 700-1200 °C. Expanded perlite is a porous, lightweight, fire resistant and moisture retaining material. Expanded perlite, with its open porous structure, is very suitable as a sound absorbing material. However, moisture retaining properties of perlite restrict its usage.

There have been much research on acoustical plates made of perlite. These works were directed to preventing perlite grains from moisture. The materials used for this are bitumen, silicate, synthetic resin, etc. The effect of moisture on the acoustical properties has not been dealt with in literature.

The knowledge of the moisture effects on acoustical properties is necessary to make possible usage of materials in high level humid spaces, like swimming pools, etc. Fibrous materials have proved to be good sound absorbing materials but have no durability against moisture. This behaviour restricts the usage of fiber materials in moist environments.

Expanded perlite can contain moisture but this does not corrupt its structure. This study aims to determine sound absorbing properties of plates made of perlite in moist environments.

2. MEASUREMENT OF THE ABSORPTION COEFFICIENT OF THE MATERIAL MADE OF PERLITE IN MOIST ENVIRONMENT

Specimens used are commercially available perlite renderings. These materials contain perlite, cement and water. Their mixing ratio are given in Table.1. Three different conditions were chosen. These are dry, wet and 50 % humid conditions. Dry condition was obtained by heating the specimens in a furnace 105 ° C until there is no change in their weight, wet condition was obtained by saturating the specimens with water. The 50 % humid condition was obtained by keeping specimens in a climate chamber at 50 % relative humidity until there is no change in weight.

Mixing Ratio	Thickness, m	Average Density, kg/ m^3
1.3 m^3 Expanded Perlite 200 kg Cement 400 lt. Water	0.03	$8{,}6 \times 10^{-4}$

Table 1. Mixing ratio of the aggregates of specimens used in the experiment.

It is necessary to make rapid measurements without changing the conditions of the specimens. Thus, "two-microphone impedance tube" method under computer control was employed [1]. 1/3 octave band absorption coefficients of the specimens were measured between 125 ~ 2000 Hz frequencies. The transfer response of microphones was obtained at each frequency, then reflection coefficients and absorption coefficients were calculated by the following equations, respectively.

$$r = (H.e^{ikd} - 1) / (1 - H.e^{-ikd})$$
$$\alpha = 1 - |r|^2$$
$$k = 2\pi / \lambda$$

d = Distance between microphones
H = Transfer response between microphones
r = Reflection coefficient
α = Absorption coefficient

Each measurement of a specimen took less than two minutes by the use of a computer. Thus the stability of the conditions were guaranteed. Five specimens were prepared for each humid condition. The standard error was checked.

Experimental results are given in Table.2. A decrease in the sound absorption coefficients was observed as the humidity increased. Values

of dry and 50 % humid conditions are very close to each other. But in the wet condition, specimens behaved as a full sound reflector. Hence, further research is needed for the range of 50 - 95 % humid conditions.

Frequenc y Hz	Dry Condition	50 % Humid Condition	Wet Condition
125	0.11	0.13	0.03
160	0.06	0.07	0.12
200	0.07	0.03	0.02
250	0.11	0.10	0.02
315	0.15	0.12	0.04
400	0.21	0.16	0.03
500	0.23	0.19	0.01
630	0.30	0.20	0.03
800	0.25	0.22	0.05
1000	0.25	0.23	0.05
1250	0.04	0.04	0.03
1600	0.07	0.14	0.03
2000	0.14	0.13	0.09

Table. 2. Experimental results

Since the specimens made of perlite given at Table.1 are crumbly, the deformations on their surfaces caused some deviations in absorption coefficients. Especially wet specimens were more easily crumbled.

3. CONCLUSIONS

In this study, it is determined that sound absorbing properties of materials made of perlite are effected from moist environments. Especially the wet materials showed to be more reflective. In order to utilize these materials at high level humid spaces, such as swimming pools, the knowledge of sound absorbing properties at high humid levels is essential. Further research was planned to improve the plates made of expanded perlite without losing sound absorbing properties.

This study will continue and the results will be given during the presentation.

Reference

[1] ' Standard Test Method for Impedance and Absorption of Acoustical Materials Using a Tube, Two Microphones, and a Digital Frequency Analysis System ' , ASTM, E 1050 - 90