

Study on the Acoustic Characteristics of Different Cavity Thickness and the Structure of Different Absorption Materials

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Abstract—In the reverberation room, the absorption coefficient is measured by the composite structure of perforated plate, perforated plate and porous sound absorbing material, and the sound absorption characteristics of perforated plate are studied. Through the analysis of the data, it is founded that: under different thickness of the cavity D, the peak value of sound absorption coefficient of perforated plate is maintained is about 0.35; the resonance frequencies of the perforated plate decreases continuously along with the increase of the thickness of the cavity D, distributed in 250 ~ 630Hz. Perforated plate with composite structures of different absorption material is under the different thickness of the cavity D, and the peak value of the absorption coefficient is maintained at 0.7~0.85; the resonance frequency of the composite structure decreases with the increase of the cavity thickness D, distributed in 200 ~ 500 Hz. The width of the absorption band has no obvious relation with the thickness of the cavity D, but it has a great relationship with the perforated plate which is added to the sound absorption material.

Keywords—composite structure; absorption coefficient; resonance frequency; sound-absorbing material

I. INTRODUCTION

Noise pollution, air pollution and water pollution are called the three major pollution. At present, noise pollution has increased seriously in our country. People who working and living in a noisy environment long hours will have a great sense of pressure and fatigue, resulting in low work efficiency and security risk. Strong noise can also damage the instruments, meters and buildings. Acoustic material and structure is one of the important means to improve the quality of indoor sound environment, and a good environment is dependent on the selection of reasonable arrangement of acoustic material and structure.

In order to achieve the best effect of the acoustic and provide the basis for structural vibration and noise reduction design. This paper will test the Sound absorption characteristic structural testing towards different thickness of cavity and additional sound absorption material structure of composite structure. Through the analysis of a lot of tests and data, it is aimed to have a wider study, especially those with good sound absorption in the low frequency band of the composite structure in which the thickness of the cavity and what additional sound-absorbing material.

II. LABORATORY EQUIPMENT, CONTENT AND DISTRIBUTION

A. Laboratory Equipment

Sound system: Adopting the type of JTS01 noise signal (filtering) Sounder, JTS022 power amplifier, JTSY non-directional sound source;

Receiving System: Using the HEAD acoustics multi-channel noise analysis systems.

B. Experiment Content

Measuring the reverberation time of sound absorption material in the reverberation chamber, according to the requirements of GB/T 20247-2006 the acoustical reverberation room acoustical measurement, the area of the experimental samples are limited in 10 ~ 12 m², samples for the aspect ratio of rectangle within 0.6~1.0. Sealing the side of sample with high reflection coefficient of the border. The distance between the samples of each side is away from the wall more than one meter, placed in the middle position of the reverberation chamber. The experiment uses wooden perforated plate whose Perforation rate is 7% (specimen 1), wooden perforation plate at a rate of 7% and 5 cm thick close behind the sound-absorbing cotton polyester fiber composite structures (specimen 2), composite structure perforation 7% of the wood behind the perforated plate and close to 5cm thick ultra-fine glass wool (specimen 3) and 7% of the perforated plate and behind wood piercing openings close to 5cm thick sound-absorbing foam cotton composite structure (specimen 4).

C. Experimental Distribution

Three microphones which is used in this experiment are arranged in the reverberation room three locations. Each microphone away from the wall is 1m, and the specimen is longer than 1 m distance. The distance between the microphone is greater than 1.5m, and distance from the sound source is greater than 2m, the height of three microphones was 1.2m, 1.6m and 1.8m. 12 surfaces body pointing in the direction of the sound source located at the corner of the reverberation chamber, setting a different location and the distance between the two position is greater than 3 m.

III. EXPERIMENTAL RESULTS AND ANALYSIS

Using the method of reverberation when analyzed the perforated plate and its composite structure under different thickness of cavity acoustic characteristics, as shown in figure 1~9.

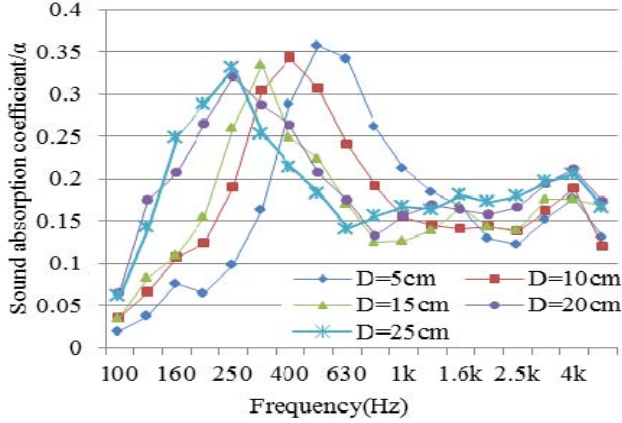


FIGURE I. SOUND ABSORPTION SPECTRUM OF SPECIMEN 1 WITH DIFFERENT CAVITY THICKNESS

Analysis of the absorption spectrum of specimen 1 in different cavity thickness in Fig 1, we can know a perforated plate under different cavity depth, the peak value of the absorption coefficient without significant changes, maximum absorption coefficient increases as the thickness of the cavity increased roughly decrease, but the change was not obvious, at about 0.35. With the increase of the thickness of the cavity D , resonance frequency has an obvious decreasing trend. Resonance principles show that when its cavity thickness increasing, the resonance frequency decreases [1]; The resonance frequency of the perforated plate is focused on the 250 ~ 630 Hz. The absorption coefficient reaches the peak at the resonance frequency. When the absorption coefficient reaches its peak, the absorption coefficient decreases with the increase of frequency, and finally tends to be stable. Analysis of the reason, the natural frequencies of the perforated plate structure are consistent with the frequency of the sound waves, acoustic resonance, the largest amplitude as well as air viscosity, so that the absorption coefficient in the frequency domain is the largest [2]. Sound absorption characteristics of perforated plate, therefore, presents the absorption peak phenomenon, namely the absorption coefficient at a particular frequency reaches its maximum, near to leave the frequency of sound absorption coefficient decreases gradually. Based on the half maximum of the sound absorption coefficient of the perforated plate structure of sound absorption to define the acoustic absorption band width, with the increase of the thickness of the cavity D , perforation plate absorption band width is almost unchanged. Analysis its reason, the band width of perforated plate is determined by the ratio of the acoustic impedance and the ratio of the perforated plate, and the band width of the same perforated panel is not changed with the changing of the cavity thickness D .

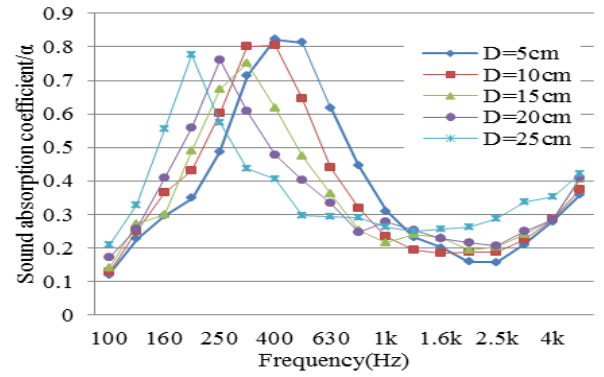


FIGURE II. SOUND ABSORPTION SPECTRUM OF SPECIMEN 2 WITH DIFFERENT CAVITY THICKNESS

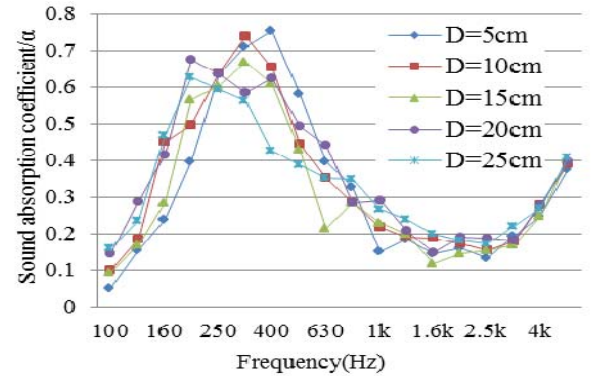


FIGURE III. SOUND ABSORPTION SPECTRUM OF SPECIMEN 3 WITH DIFFERENT CAVITY THICKNESS

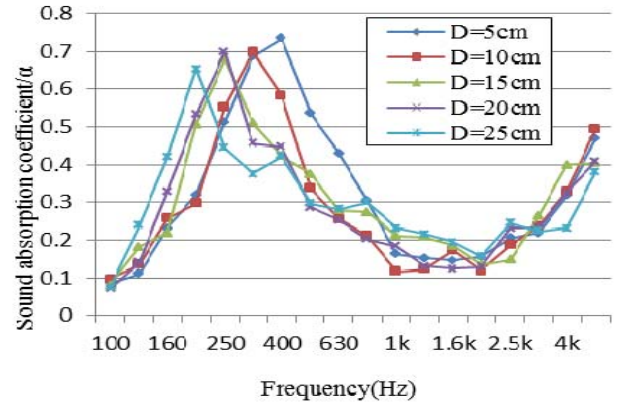


FIGURE IV. SOUND ABSORPTION SPECTRUM OF SPECIMEN 4 WITH DIFFERENT CAVITY THICKNESS

Analysis of the absorption spectrum of different specimen in different cavity thickness in Fig 2~4. when the same perforation plate is close to the same porous sound absorption material, the peak value of the absorption coefficient is not obvious changed under different cavity thickness, and the peak value of the sample 2 is about 0.8, while the peak value of the absorption coefficient of 2 and 3 is about 0.7. Analyzing the reasons, different porous absorbing material behind of it has different absorption characteristics, resulting that the test piece 2, 3 and 4 in the peak of the absorption coefficient is

different. With the increase of the thickness of the cavity D, the resonance frequencies of the perforated plate composite structure decreases continuously. Resonance principles show that with the increase of the thickness of the cavity D, resonant frequency decreases. The resonance frequencies of the perforated plate combination resonance structure concentrated in 200 ~ 500 hz. The absorption coefficient of the perforated plate and the porous absorption material is relatively stable, and the absorption coefficient is about 0.2, and the absorption coefficient tends to rise in 3150~5000Hz, but the high frequency sound absorption performance is not ideal in general. Analysis its reason, perforated plate perforation ratio is small, a large part of the sound energy is reflected by the perforated plate, and in between 3150~5000Hz, the sound absorption coefficient increased due to the porous sound-absorbing material in the high frequency of sound absorption performance is better.

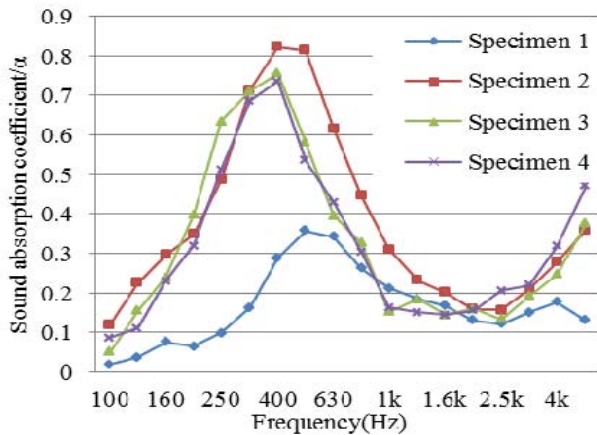


FIGURE V. THE ABSORPTION SPECTRUM OF DIFFERENT SPECIMEN UNDER THE CAVITY THICKNESS 5 CM

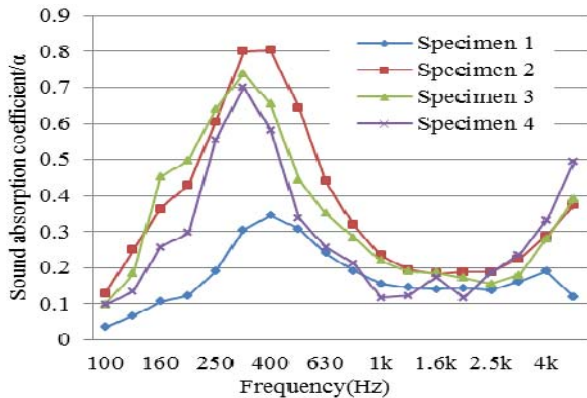


FIGURE VI. THE ABSORPTION SPECTRUM OF DIFFERENT SPECIMEN UNDER THE CAVITY THICKNESS 10 CM

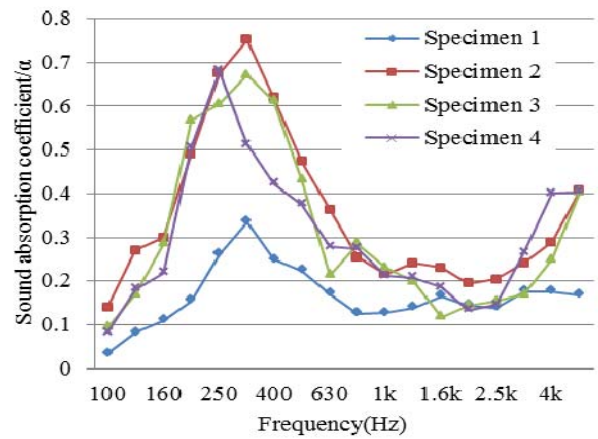


FIGURE VII. THE ABSORPTION SPECTRUM OF DIFFERENT SPECIMEN UNDER THE CAVITY THICKNESS 15 CM

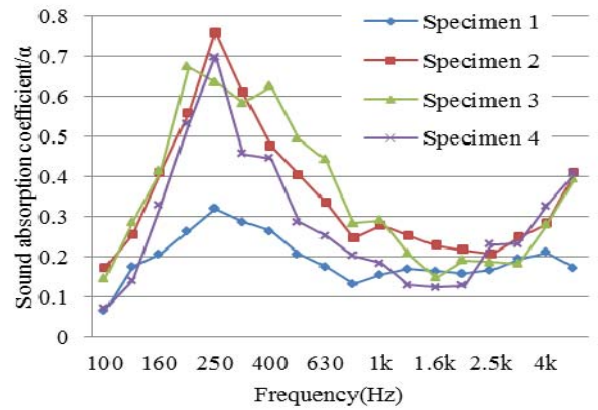


FIGURE VIII. THE ABSORPTION SPECTRUM OF DIFFERENT SPECIMEN UNDER THE CAVITY THICKNESS 20 CM

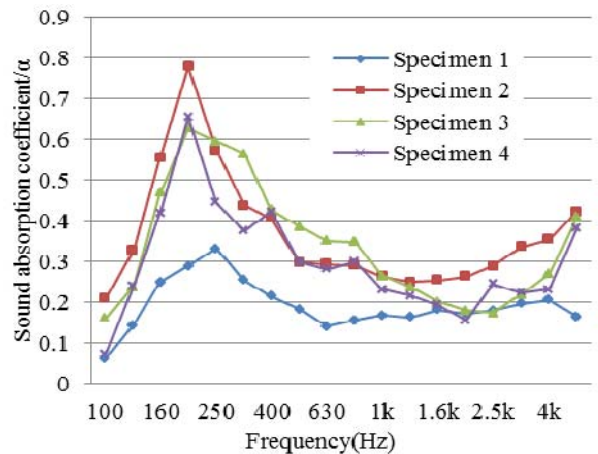


FIGURE IX. THE ABSORPTION SPECTRUM OF DIFFERENT SPECIMEN UNDER THE CAVITY THICKNESS 25 CM

Analysis diagram 5~9 of different specimen under the same cavity thickness of absorption spectrum. We can know that in the same cavity thickness, behind the perforated plate close to 5 cm of porous sound absorbing material combination mechanism of resonance frequency is smaller than the

resonance frequencies of the perforated plate, and additional behind different sound-absorbing material has little effects on the resonant frequency of the perforated plate composite structure. Analysis of the reasons behind the perforated plate when attached different porous sound-absorbing material, the effective length of the composite structure of perforated plate is larger than that of perforated plate, which is $0.4d$. Resonance principles show that the effective length of the neck is increased and the resonance frequency is decreased. At the resonance frequency, the sound absorption coefficient of perforated plate is much smaller than that of the composite structure of perforated plate. The reason is that the sound absorption performance of perforated plate is very small, which is due to the viscous effect of the air entering into the hole, and the majority of the acoustic energy is reflected back from the smooth rigid wall, so that the sound absorption performance is poor. The sound absorption performance of the perforated plate composite structure is better because of the viscous effect of the air, perforated plate and porous sound-absorbing material stick on the surface of the junction energy, and the energy dissipation of the fiber grid structure of porous sound absorption material in three aspects. So the absorption coefficient of the composite structure of the perforated plate is much larger than that of the perforated plate at the resonance frequency[3]. In the same cavity thickness, the resonance absorption band width of the perforated plate composite structure is wider than that of the perforated plate. Mainly because of the perforated plate is close to the porous absorption material can increase the resonance absorption structure of the damping characteristics, broaden the resonance absorption band width.

IV. CONCLUSION

under the same perforation plate, the peak value of the absorption coefficient has no obvious change at different cavity depths, and it is maintained at about 0.35. As the increasing of the thickness of the cavity, the resonant frequency of the D is obviously decreased, distributed in 250~630Hz; but the perforated plate absorption band width is almost unchanged.

The same porous sound absorbing material which is close to the same perforation plate, the peak value of the absorption coefficient is not obvious changed under different cavity thickness, and maintained at 0.7~0.85. With the increase of the thickness of the cavity D, the resonance frequencies of the perforated plate composite structure constantly decreases, and the resonance frequency is concentrated in the 200 ~ 500 Hz, and the combination of the perforated plate with the middle and low frequency section has a better absorption characteristic.

The absorption coefficient of the composite structure of perforated plate and porous sound absorbing material is relatively stable, about 0.2; and between 3150~5000Hz, the absorption coefficient tends to rise, but the overall performance in high-frequency sound absorption is poor.

Under the same cavity thickness, the resonance frequency of the composite mechanism of the porous sound absorption material is close to the 5cm of the perforated plate is smaller than that of the perforated plate, but attached to different

sound-absorbing material behind it has little effects on the resonant frequency of the perforated plate composite structure. At the resonance frequency, the sound absorption coefficient of perforated plate is much smaller than that of the composite structure of perforated plate. In the same cavity thickness, the resonance absorption band width of the perforated plate composite structure is wider than that of the perforated plate.

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