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DEVELOPMENT OF MEASURING DEVICE OF ACOUSTIC CHARACTERISTIC FOR SOUND ABSORBER AND SOUND BARRIER

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ABSTRACT
To measure the characteristic of acoustic material such as sound absorber and sound barrier, a simple device has been developed instead of using reverberant rooms and a big size of specimen. The two-microphone random-excitation technique has been adopted to separate the incident wave and reflected wave spectra in a duct. The test result using the device has been compared with the experimental data of the reverberant room method showing its efficiency.

1 - INTRODUCTION

Adoption of reverberant room has been popular to measure absorption ratio or transmission loss of acoustic material. However, usage of reverberant room could not provide satisfying result in efficiency and convenience. Although its method has been well-established estimating characteristics of acoustic material, it requires long period of preparation time of test and large size of specimen. Therefore, sometimes, it can never be estimated using the reverberant room if the specimen is small or irregular shape. Another possible way to measure the acoustic characteristic of the acoustic material is application of plane wave theory.

With the help of the plane wave theory, the absorption ratio has been measured using the Impedance Tube of B&K Co. But, it could not provide the function measuring the characteristic of sound barrier. Even it can be utilized only to measure the absorption ratio not the transmission loss of acoustic material, it has been widely used since its convenience due to plane wave theory. It, however, has been mentioned for reliability of its test result since its measuring method has been based normal incident wave upon the specimen in tube in contrast to the method of reverberant room. During measuring the absorption ratio or the transmission loss of the acoustic material in reverberant room, the acoustic wave from sound source propagates randomly into the specimen. In real world, of course, the acoustic material is exposed on random incident of acoustic wave. Therefore, whenever the absorption ratio of acoustic material has been measured using the Impedance Tube, the difference of test result from the result using the reverberant room has been discussed for its reliability continuously. Even though the test result using the plane wave theory is not coincide with the phenomenon of the real world, it has been used usefully to develop better acoustic material.

2 - MEASURING DEVICE

By now, adoption of reverberant room or usage of the Impedance Tube was possible way to measure absorption ratio of acoustic material. However, the method of reverberant room requires construction of reverberant room, expensive equipments and an acoustic engineer. Although the Impedance Tube is convenient device comparing with the method of reverberant room, it also requires other extra equipments such as FFT analyzer etc. and an acoustic engineer. Normally, it is hard to equip complete test set such as FFT analyzer, function generator and sensors etc. only for acoustic material measurement. Furthermore, hiring an acoustic engineer only for acoustic material measurement brings a burden to an

acoustic material maker. The measuring device introduced in this article will meet the requirements of the acoustic material maker. The measuring device called the Acoustic Duct is developed to measure the absorption ratio and the transmission loss of the acoustic material based on plane wave theory. It is the most important thing to measure the transmission loss of sound barrier with the device. Since the device is developed to analyze using normal incident wave, of course, the test result does not coincide with the result of the method of reverberant room. However, the test result from the Acoustic Duct follows similar trend of the test result of the of reverberant room. The difference of both method due to the difference between normal incident wave and random incident wave effects. As we know, we need a large size of specimen, test equipments and the reverberant room to measure the transmission loss of the acoustic material simulating random incident wave effect. Because of these reasons, we can hardly get the transmission loss of acoustic material during developing acoustic material. Although the Acoustic Duct simulates normal incident wave effect on the acoustic material during measuring the transmission loss, if it can be utilized during developing sound barriers, it will provide useful test data for better sound barriers. Furthermore, if it does not require any other special device and the acoustic engineer except itself, it will be useful device to acoustic material makers.
Fig. 1 shows the photograph of the Acoustic Duct. As shown in Fig. 1 the computer system contains signal generator, data acquisition, FFT process, calculation and post process.

Figure 1: Photograph of the acoustic duct.

If auto-spectral density of the incident wave is S_A and auto-spectral density of the reflected wave is S_B, the absorption ratio is calculated as

$$\text{Absorption Ratio} = 1 - \frac{S_B}{S_A}$$

If auto-spectral density of the incident wave before soundproof material is S_A and auto-spectral density of the transmitted wave after soundproof material is S_T, the transmission loss of acoustic material can be calculated as

$$\text{Transmission Loss} = 10\log\left(\frac{S_T}{S_A}\right)$$

Both methods coincide well as shown in Fig. 2.
As shown in Fig. 3, the test result does not coincide well comparing with both methods. However, the result from the Acoustic Duct shows similar trend as the result from the reverberant room.

3 - CONCLUSION

The measuring device for measurement of the absorption ratio and the transmission loss of an acoustic material has been developed based on plane wave theory. Test result from the device coincides with test result of the Impedance Tube for the absorption ratio of acoustic material. Test result from the

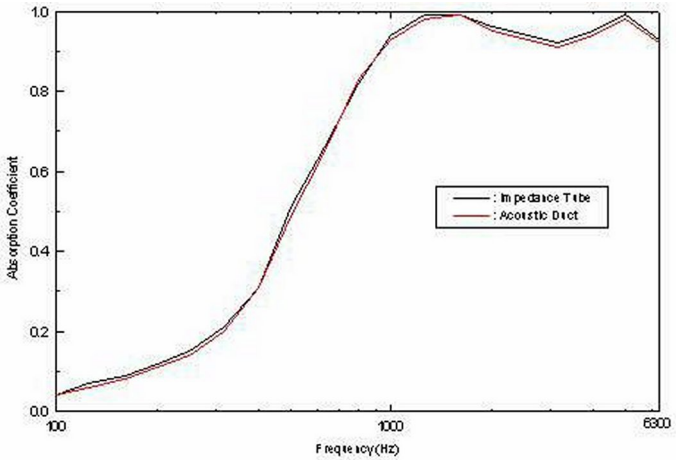

Figure 2: Comparison of absorption ratio of acoustic material between the impedance tube and the acoustic duct.

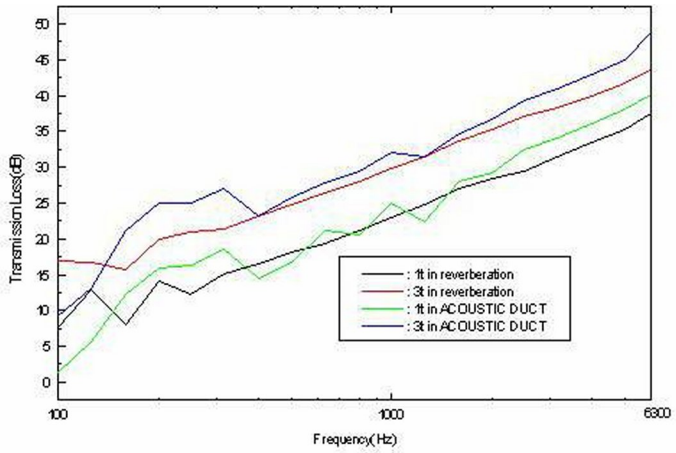

Figure 3: Comparison of transmission loss of acoustic material between the reverberant room and the acoustic duct.

device follows similar trend of the result of the reverberant room. Therefore, the device can be utilized to compare the transmission loss of the acoustic material relatively.

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