論 文 の 内 容 の 要 旨

論 文 題 目　Study on sound insulation characteristics of double-layer wall using vibration absorbers
（動吸振器を用いた二重壁構造の遮音特性に関する研究）

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The Drywall (also called plaster board, gypsum board, or LAGYP) is widely used in architecture. The advantages are light weight, low cost and convenient for construction. The light weight property of the drywall is easy for conveyance and suitable for the earthquake-proof buildings, especially the tower buildings. In Japan, the drywall is used for saving the building cost in the detached house and is also used for the party wall in the apartments and mansions. However, the drywall was not applied popularly because of the humid climate in Taiwan. But recently, it is commonly used for earthquake-proof designs due to the increase of the tower buildings .

There is one disadvantage of the drywall which is the low sound insulation performance. The problem is serious when using the drywall as the party wall because of the lightweight. In Taiwan, the standards or legalizations of the sound insulation of the party wall have yet to establish perfectly. It is hard for the customers to know the sound insulation performance of the drywall before purchasing an apartment.

When a dispute with the noise problem due to the low sound insulation performance occurs, the builders increase the thickness of the drywall or plus an additional dry wall to construct a double-layer wall (DLW). In the view point of the sound insulation characteristics, the double-layer wall is better than the other structure if they cost the same construction space. Therefore the double-layer wall are widely used in the studios, rehearsal rooms or acoustics laboratories where the high sound insulation characteristics is demanded. In addition, the double-layer wall is also used to control the noise from the vehicles, trains, or home appliances in mechanical engineering.

The high sound insulation characteristics of the double-layer wall are due to separated walls to isolate the sound and vibration transmission. In spite of that, the air in the structure works like a spring and a resonance problem exists in the mass-spring-mass structure. When the structure encounters an incident sound with a specific frequency, the violent vibration of the walls occurs and the sound transmits through the walls totally. This phenomenon is called “mass-air-mass (MAM) resonance” and it causes the deterioration of the sound insulation characteristics of the double-layer wall.

For the controlling the vibration of the walls, the vibration absorber (or dynamic vibration absorber) is an efficient device.

In mechanical engineering, the unnecessary vibration can be controlled by the vibration absorber when the engine of a car runs. As the same principle, the vibration absorber is also applied in the home appliances such as washing machines, refrigerators and so on. In the optical drive, the vibration absorber is attached on the motor to reduce the vibration at the operation frequency in order to raise the precision of reading and writing.

The method of applying the vibration absorber to control the vibration is that adjusting the natural frequency of the vibration absorber equal to the problem frequency of the target system. However, this method causes the other vibrations occur at lower and higher frequencies than the problem frequency. Therefore, the vibration absorber is usually designed to make the other vibrations excited at the frequency which is out of the operation frequency range or out of the human perception frequency.

The main objective of the present thesis is to provide a simple structure vibration absorber to see the effect on the sound insulation characteristics of the double-layer wall. The targets to be controlled by the vibration absorber include the double-layer wall applied in architecture and mechanical engineering.

On the basis of the previous studies, the applications of the vibration absorber can raise the sound insulation performance at the MAM resonance frequency band but made the performance worse at the other frequency bands. Therefore, finding a solution to deal with the issue is also an important target.

Besides to provide an available vibration absorber, the thesis indicates the way to use the vibration absorber and shows the mechanism of the vibration absorber in the double-layer wall by comparing the various conditions. The comparisons are conducted by theoretical analysis, numerical analysis, and scale model experiments.

The structure of the thesis is as follows. Chapter 2 introduces the previous studies about the improvement of the sound insulation characteristics of double-layer wall and the application of the vibration absorber. On the basis of these literatures, the characteristics of the different applications can tell the problem and the explanation for examining the sound insulation characteristics when applying a new solution. They can also be the references for designing a vibration absorber.

Chapter 3 shows a one-dimensional theoretical analysis of the double-layer wall with the vibration absorber. A MKC (M: mass, K: spring and C: damper) system is used to describe the double-layer wall and to indicate the difference of the sound insulation characteristics between the double-layer wall with and without the vibration absorber. Also the parametric study on the properties of the vibration absorber and the investigations of the location side of the vibration absorber are proceeded for the application in practice.

Chapter 4 explains the two-dimensional numerical analysis by the finite-difference time-domain method (FDTD method). The analysis is developed to mainly verify the mechanism of the vibration absorber how to affect the sound insulation characteristics of the double-layer wall. Moreover, the effects of the location side of the vibration absorbers and that of the distribution patterns of the vibration absorbers on the sound insulation performance of the double-layer wall are verified in the chapter.

Chapter 5 introduces the scale model experiments. By obeying the similarity rules, the double-layer wall is established at the opening of the reverberation chamber and its sound insulation characteristics are measured by the sound intensity method. This chapter shows the properties of the materials measured for making a vibration absorber and also presents the design process. The correlation with the sound insulation characteristics and the various conditions of the vibration absorbers such as the number, the patterns, the location and the composition are investigated to provide a guideline to apply the vibration absorber and know the mechanism.

Chapter 6 provides the conclusions of the works and suggests the future work related to the findings in the thesis.

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