Development and sound absorption of interior adjustable acoustical panels

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ABSTRACT

Used the small scale listening room as the example, changed the interior sound field required to redecoration entire room also demand more construction budget; so it is important to development a product could adjustment the sound field also independent from the interior decoration.

First, analysis sound absorption, installation, specification of existing acoustics panels on the marketing. Second, based on sound absorption theory to development acoustics panels what could adjustment the reverberation time. This subject designed an acoustical panel what could change the faceplate and structure for the condition without changing interior decoration to satisfy different interior acoustical demand, also maintain independence, include PP (Perforated Panel) and GMP (Geometry Micro-perforated Panel) as acoustics panel's faceplates. The experiments followed CNS 9056 (Measurement of sound absorption in a reverberation room) to evaluated acoustics panels sound absorption performance for the effect factors between installation modes and faceplates.

The results of the measurement in the study were shown two parts. One was the influence of equivalent sound absorption area caused by acoustics panels installation modes, and the other was the influence of equivalent sound absorption area caused by changing the faceplate. Above all, the acoustics panel was suitable to adjust the reverberation time without redecorating entire room, and the adjustable interior sound field would be shown.

Keywords: Sound Absorption, acoustics panel, acoustics panels installation modes, sound absorption coefficient, equivalent sound absorption area

1. INTRODUCTION

Reverberation Time in room depends on the sound absorption of interior decoration materials to fix the room acoustics. However, the adjustment of reverberation time was difficult to achieve effectively due to high costs for entire interior decoration in order to enough acoustics improvement. For condition under limited costs, the essentiality of developing independent acoustics product out of interior decoration obviously exist.

According to past study, the absorber panel showed sound absorption in different frequencies from different distances to reflecting face; air layer with multi-layers showed better and wider range than the one with single layer; oblique micro perforated panels showed above 0.5 value of absorption coefficient with back air layer. The distance to reflecting face, amount of multi air layers, and the kinds of materials of panel are the critical factors for the independent acoustics products in space.

The study is focused on the development of adjustable acoustics panel for improvement with various room acoustics demands in different settings. Through the experiment, influences of the set of facing materials and assembling styles for room acoustics would be shown. Adjustment acoustics panels would be used in independent set or attached to the wall in effective improvement of room acoustical demands.

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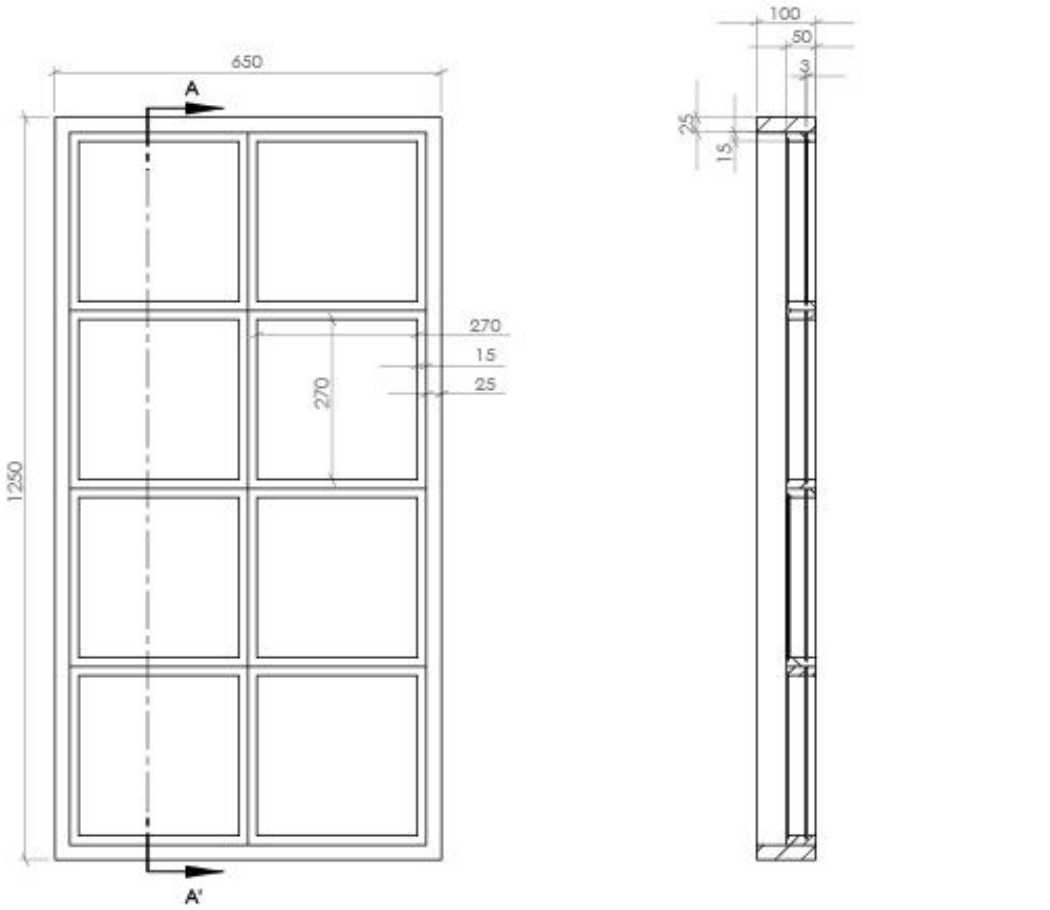
2. METHOD

The developing basis for the limit of adjustment acoustics panel construction in this study is focused on the sound absorption theories of panel, perforated panel, and oblique micro panel construction. The measurement of sound absorption would be used the laboratory measurement through CNS 9056 "acoustics – measurement of sound absorption in a reverberation room". The sound absorption performances of practical would be obtained similarly through this way.

3. OBJECTS

The definition of adjustment acoustics panel is the flat piece objects with function of room acoustics adjustment. The kinds of adjustment acoustics panels are also include absorbing panel, noise reduction panel, reflecting panel, and scattering panel. The main function of adjustment acoustics panel in this study was focused on the sound absorption. The factors for specific frequencies adjustment are kinds of materials of facing panel and back panel, and the distance to the back wall.

Adjustment acoustics panel in this study is combination of 8 pieces units with 300mm × 300mm, and additional frame with 1250mm × 650mm for different setting of adjustment acoustics panel.



adjustment acoustics panel with scale 1:10 section AA' with scale 1:10 unit (mm)

Figure 1 –detail construction of adjustment acoustics panel

4. ANALYSIS

The setting with oblique micro perforated panel as facing and back panel, and 3 centimeter air layer showed sound absorption coefficient as figure 2. This setting reveals high sound absorption in middle and high frequencies. In the setting with frame attaching to the wall and distances to wall as 7 centimeters, the sound absorption would reach to 0.67 square meters per piece from 250 Hz above. In the independent setting, the sound absorption would reach to 0.95 square meters per piece in 2500 Hz. The independent setting and setting with frame attaching to the wall as 7 centimeters to wall would reach enough sound absorption effects for adjusting sound source in the middle, high, or wider range frequencies.

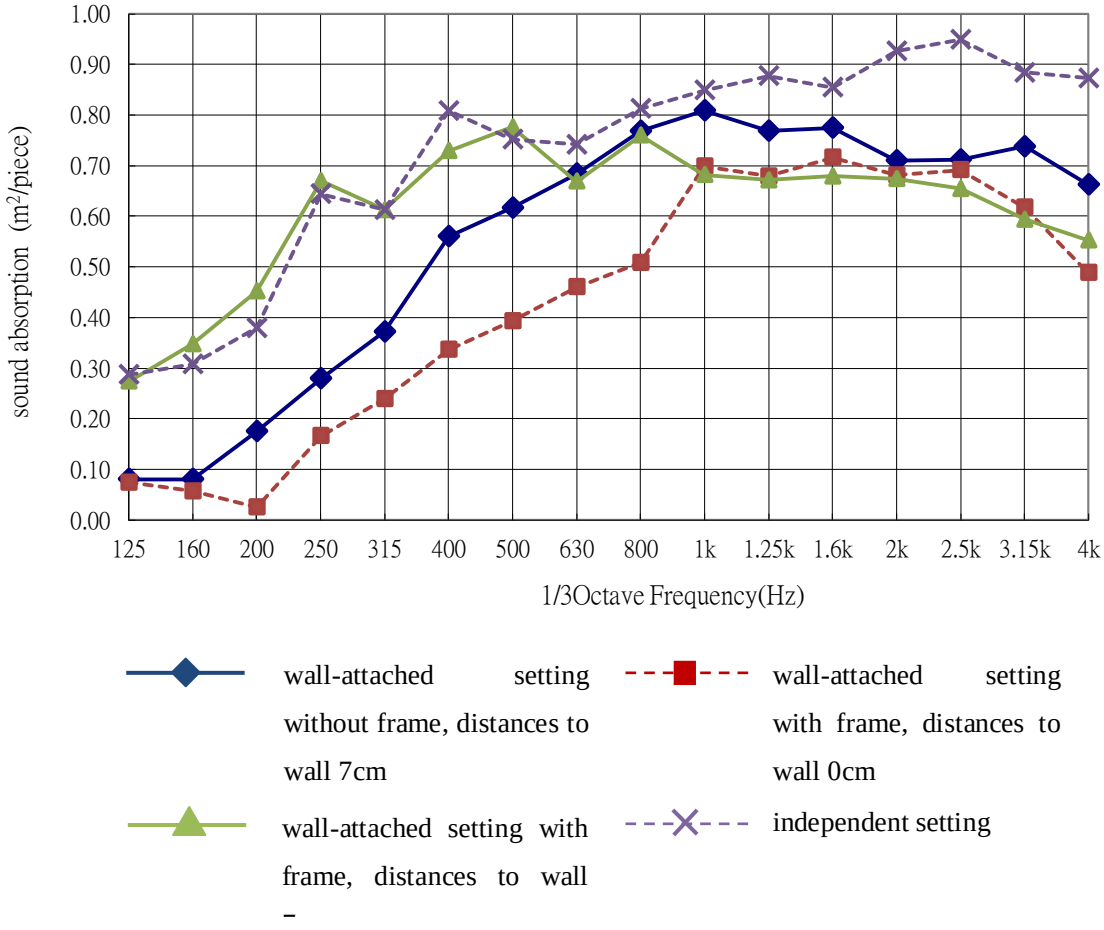


Figure 2 –Sound absorption comparison of the setting with oblique micro perforated panel as facing and back panel, and 3 centimeter air layer

The setting with oblique micro perforated panel as facing, perforated steel panel as back panel, and 3 centimeter air layer showed sound absorption coefficient as figure 3. Comparing to the effect of setting with oblique micro perforated panel, this setting reveals obvious sound absorption effect in specific frequencies, and especially in the setting with distances to wall as 7 centimeters the sound absorption effect in 500 to 1000 Hz is obvious.

In the setting with frame attaching to the wall, the sound absorption would reach to above 0.6 square meters per piece in 315 to 1000 Hz. In the independent setting, the sound absorption would reach to 0.6 square meters per piece from 250 Hz above. The independent setting and setting with frame attaching to the wall as 7 centimeters to wall would reduce sound absorption effects in high frequencies, and the reduction effects would more obvious with the increasing of amount and depth of multi air layers. This setting would fit to specific sound source adjustment.

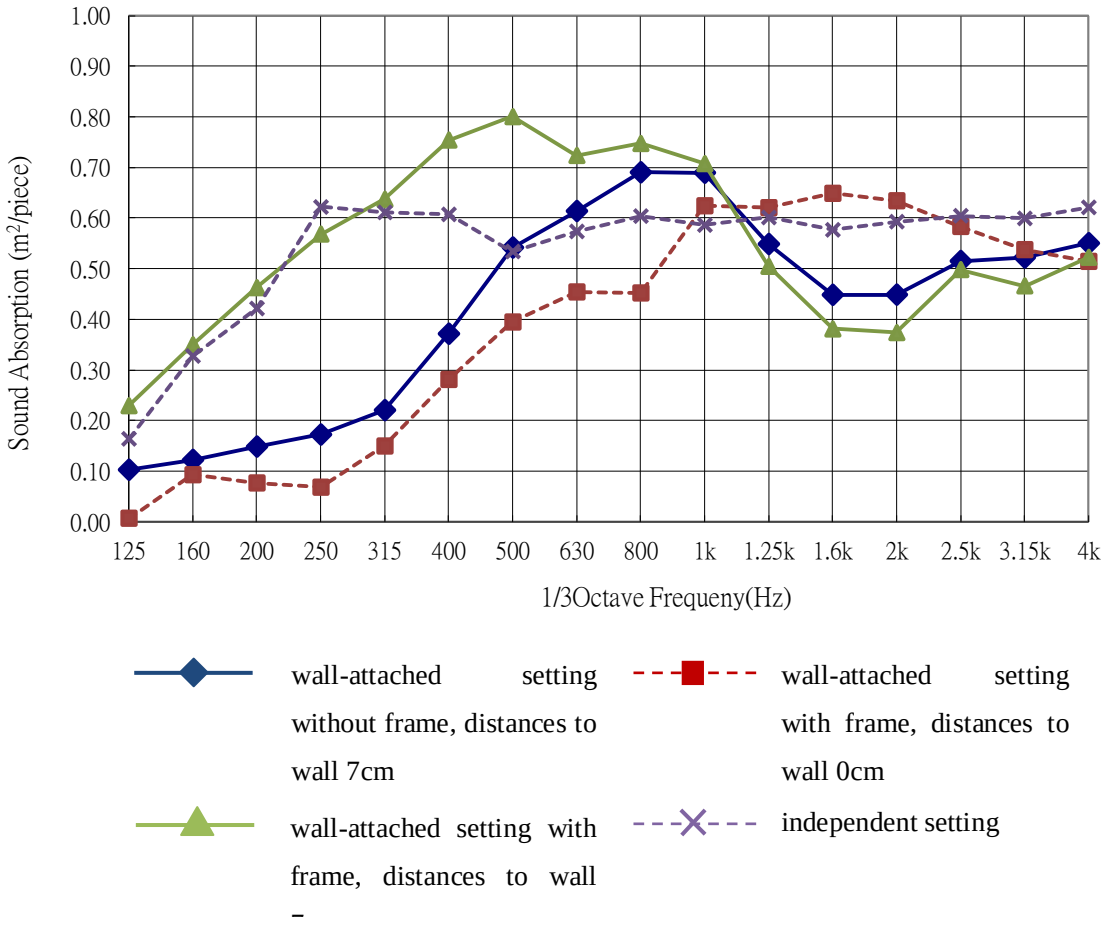
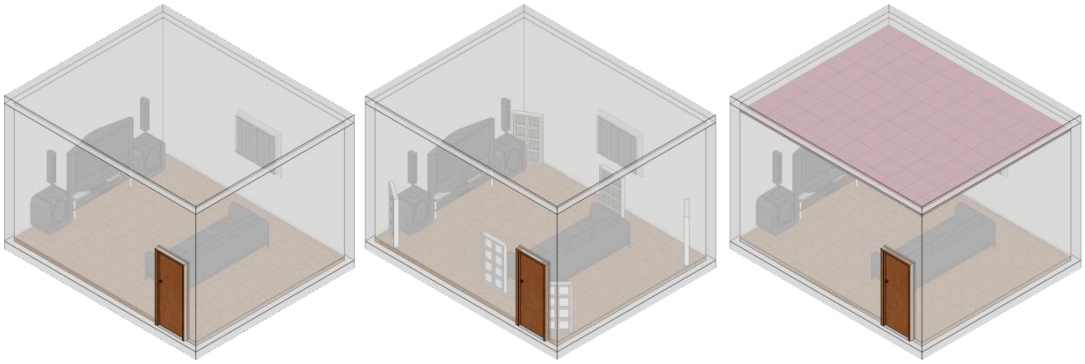


Figure 3 –Sound absorption comparison of the setting with oblique micro perforated panel as facing, perforated steel panel as back panel, and 3 centimeter air layer

To clarify the influence of reverberation time through interior absorbing ceiling and adjustment acoustics panels, the simulation space would set as 4.5×5.5×3.5 (meter) and volume as 86.6 cube meters. The simulation of reverberation time was according Sabine calculation.



(a) (b) (c)

Figure 4 –simulation room and improvements

Reverberation time in this room without ceiling or adjustment acoustics panel was too long to the purpose of audio appreciation. For the two cases of absorbing ceiling and adjustment acoustics panels as improvement, the results were as below.

In the case of absorbing ceiling as improvement method, the amount of reverberation time adjustment was 78% as the most effective method. However the method was one-off decoration construction and unable to fit different demands of reverberation time from other kinds of audio appreciation or instrument practicing.

In the case of adjustment acoustics panel with 6 pieces of independent setting as improvement method, the amount of reverberation time adjustment was 49% as the most effective method. The method was executed with 6 pieces of adjustment acoustics panel and reach the 63% improvement effect of ceiling. This method would be able to fit different demands of reverberation time from other kinds of audio appreciation or instrument practicing, and without redecoration and construction. The sound absorption could be adjusted by replacing the facing or back panel.

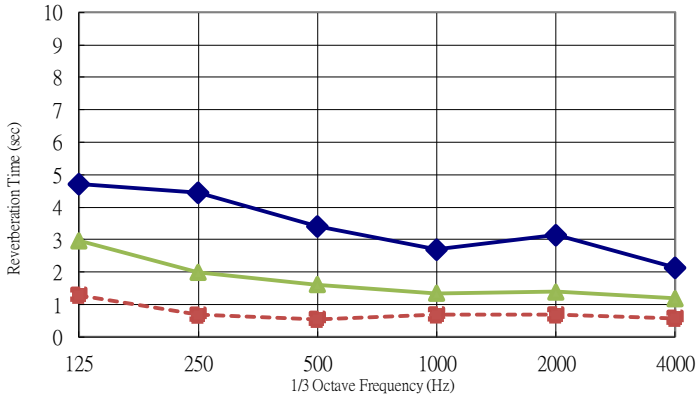


Figure 5 –Comparison of Reverberation Time Calculation

5. CONCLUSIONS

According to the cases and laboratory measurement, the adjustment acoustics panel with changeable construction would be developed. The sound absorption of adjustment panel could be adjusted from 0.5 to 0.73 square meters per piece through the assembling method, facing panel, and multi air layers setting. Furthermore, the simulation of reverberation time in room shown the remarkable reduction of reverberation time through 6 pieces of independent setting, and without the redecoration and construction.

For the acoustics adjustment of small scale listening room, adjustment acoustics panel reveals superior sound absorption and more convenience for application than absorbing ceiling.

ACKNOWLEDGEMENTS

Based on the development of adjustment acoustics panel, one of the further study would be executed in absorption control in low frequencies. In the other side of further study would be focused on more acoustics performances such as reflection and scattering.

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