Sound insulation of application for composite wood panel

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ABSTRACT

Glued laminated timber, also called Glulam, was applied on various building components, space products, and decoration materials. The extensively application of Glulam was attributed to its feature with durable, ease processing, attractive appearance, and sustainability. According to the feature of Glulam, in present the Glulam was frequently used to combine with multiple materials such as metal, gypsum panel, rubber, and even paper materials. The composite wood panel with multiple materials would be effective to fire prevention and sound insulation. However, the analysis of sound insulation of composite wood panel was still focused on the surface density but no more controlling factors of sound insulation for quantitative analysis. By the new technique of composite wood panel, the uncertain of quality analysis would cost wasting from repeatedly replacement during construction just because of the ineffective sound insulation analysis. This study was focused on Glulam. The composite wood panel would be combined with different material. Furthermore, it was confirmed for the influence of sound insulation with various factors, such as the location of material, rigidity, and simple mechanism. The raising surface density for the material near the median of panel section would promote the sound insulation between 500 Hz to 2000 Hz with about 5 dB. In the other side, the raising rigidity and resonance frequency for the material near the surface of panel to 7 dB. Above this study, it could extend to more analysis for composite wood panel, and would make more effective accuracy for sound insulation analysis.

Keywords: Sound Insulation, Transmission Loss, composite panel, STC

1. INTRODUCTION

Building components are applied with more various materials according to sustainability concerns. The points for these materials are focused on light weights, recyclable, flexible purposes, and high performance. Plenty kinds of materials were combined into building materials application to reach effects for shorten construction process and module production. Above these demands for building materials, the composite materials were widely used with combining two or above kinds of materials. The Glued laminated timber is one of the most popular material for this application. Glued laminated timber, also called Glulam, was applied on various building components, space products, and decoration materials. The extensively application of Glulam was attributed to its feature with durable, ease processing, attractive appearance, and sustainability. According to the feature of Glulam, in present the Glulam was frequently used to combine with multiple materials such as metal, gypsum panel, rubber, and even paper materials. The composite wood panel with multiple materials would be effective to fire prevention and sound insulation.

In the base of fire prevention with safety concerns, the sound insulation for building components is the critical performance for the space quality. The performances control on materials to entire building construction needs to executed with performance measurements in practical size and standards. Furthermore, the factors of combined components with Glulam are critical to analysis the influences of sound insulation. However, the analysis of sound insulation of composite wood panel

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was still focused on the surface density but no more controlling factors of sound insulation for quantitative analysis. By the new technique of composite wood panel, the uncertain of quality analysis would cost wasting from repeatedly replacement during construction just because of the ineffective sound insulation analysis.

This study was focused on Glulam. The composite wood panel would be combined with different material. Laboratory measurements with practical size would make confirmation for the influence of sound insulation with various factors, such as the location of material, rigidity, and simple mechanism.

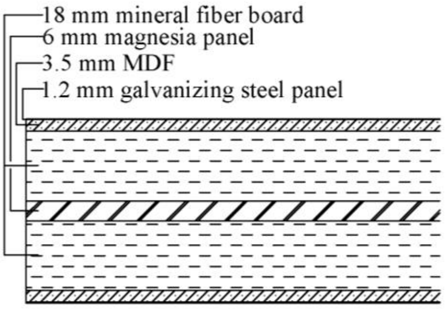
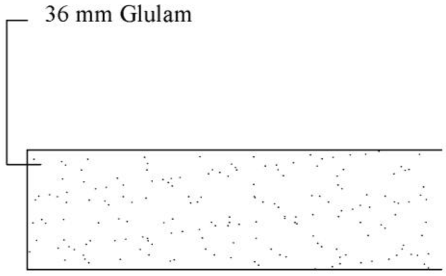
2. METHOD

The measuring method was used as laboratory measurements. Laboratory measurements were executed in the Architectural Acoustics Laboratory of NCKU Research and Development foundation (Taiwan). The measuring method followed CNS 15316 to analysis sound transmission loss and ASTM E413-10 to evaluate STC (Sound Transmission Class).

The components of composite wood panels are included of central part, base part, and facing part. By the adjustment of materials on different part application, the comparison of sound insulation index would be shown. In addition, the simple mechanism for building components was also the factor to influence the performances.

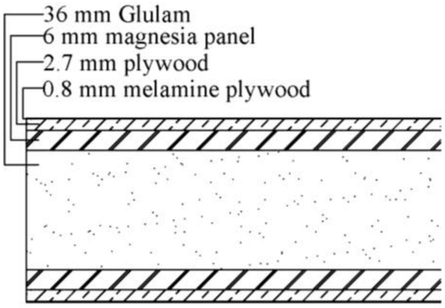
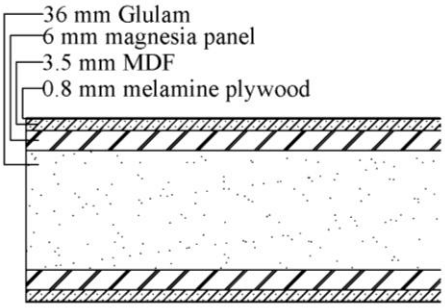
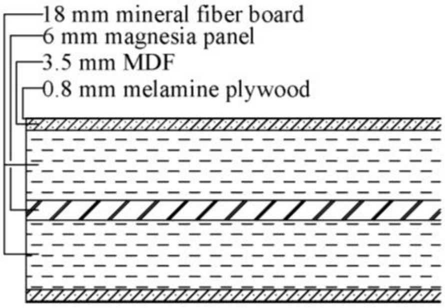
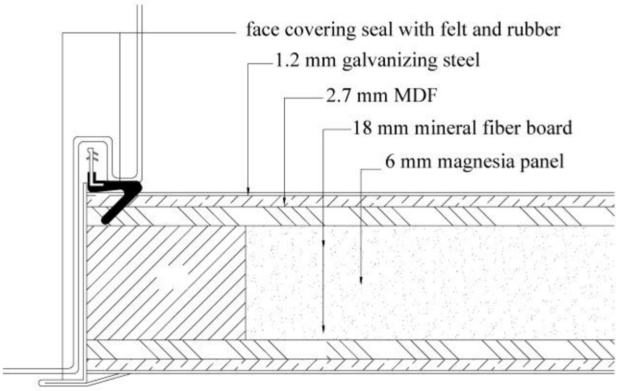
According to the factors setting, the relative materials to composite wood panel were Glulam, magnesia panel, MDF, plywood, melamine plywood, and Galvanizing steel panel. Contents of samples for the measurements are as figure 1.

Table 1 –Sample Contents

Serial No.	Contents	
TL001	1.2 mm galvanizing steel panel, 2.7 mm MDF, 18 mm mineral fiber board, 6 mm magnesia panel, 18 mm mineral fiber board, 2.7 mm MDF. 1.2 mm galvanizing steel panel	
TL002	36 mm Glulam	

(continued)

Table 1 –Sample Contents

Serial No.	Contents	
TL003	0.8 mm melamine plywood, 2.7 mm plywood, 6 mm magnesia panel, 36 mm Glulam, 6 mm magnesia panel, 2.7 mm plywood, 0.8 mm melamine plywood	
TL004	0.8 mm melamine plywood, 3.5 mm MDF, 6 mm magnesia panel, 36 mm Glulam, 6 mm magnesia panel, 3.5 mm MDF, 0.8 mm melamine plywood	
TL005	0.8 mm melamine plywood, 3.5 mm MDF, 18 mm mineral fiber board, 6 mm magnesia panel, 18 mm mineral fiber board, 3.5 mm MDF, 0.8 mm melamine plywood	
TL006	1.2 mm galvanizing steel panel, 2.7 mm MDF, 18 mm mineral fiber board, 6 mm magnesia panel, 18 mm mineral fiber board, 2.7 mm MDF. 1.2 mm galvanizing steel panel	
	Arcuate entry barrier, face covering seal with felt and rubber	

3. ANALYSIS

In one of the base part, TL (Transmission Loss) and STC of two samples have shown the difference of single central material from with base part of magnesia panel plus facing part of melamine plywood and without. In 200-500 Hz the difference would be 3 dB; in 630-1000 Hz the difference would be 5 dB; in 1250-4000 Hz the difference would be 10 dB. The results reveal the plywood and magnesia panel would effectively reduce the resonance in middle-low frequencies, and lift the TL in middle-high frequencies by surface density lifting.

Table 2 –Sample Comparison - TL002, TL003

Factors	part	TL002	TL003
Variable	Base	None	2.7 mm plywood, 6 mm magnesia panel
	Facing	None	0.8 mm melamine plywood
fixed	Central	36 mm Glulam	

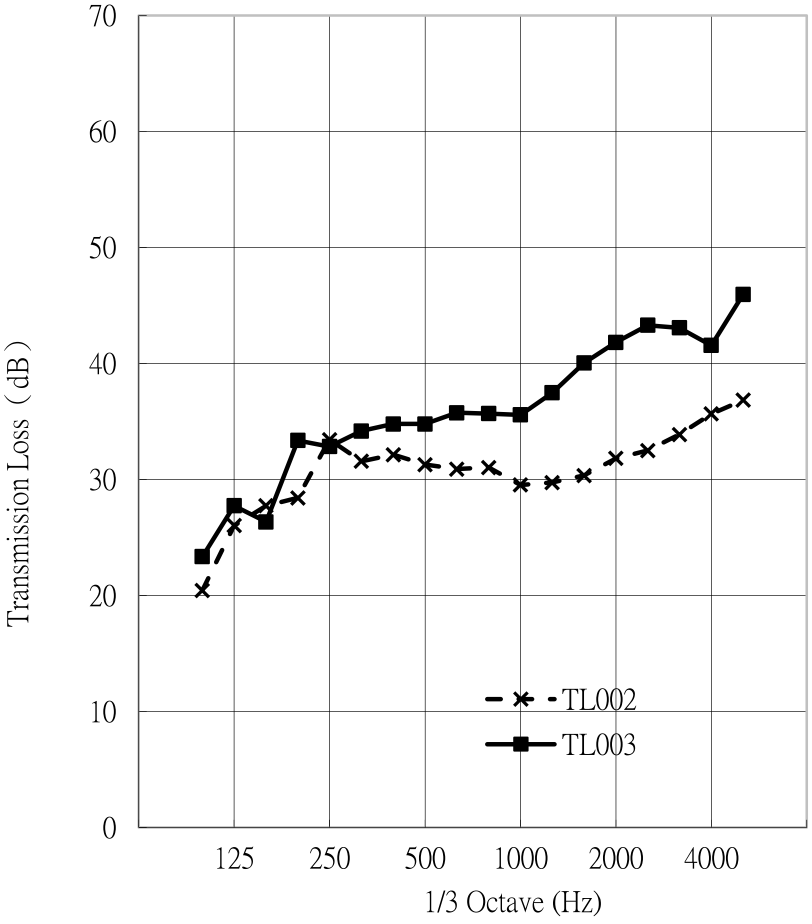


Figure 1 –Comparison of Sound Insulation - TL002, TL003

In the central part, TL (Transmission Loss) and STC of two samples have shown the difference of central material. Below 800 Hz the difference would 1 dB; in 1000 Hz and above the difference would increase with frequencies increasing, and the most difference would be 10 dB; in 4000 Hz the same coincidence effect would be shown. The results reveal the changes of central part make few influence to the rigid and resonance control in low and middle-low frequencies, and the surface density lifting of central part makes remarkable influence in middle and high frequencies.

Table 3 –Sample Comparison - TL004, TL005

Factors	part	TL004	TL005
Variable	Central	6 mm magnesia panel, 36 mm Glulam, 6 mm magnesia panel	18 mm mineral fiber board, 6 mm magnesia panel, 18 mm mineral fiber board
fixed	Facing	0.8 mm melamine plywood	
	Base	3.5 mm MDF	

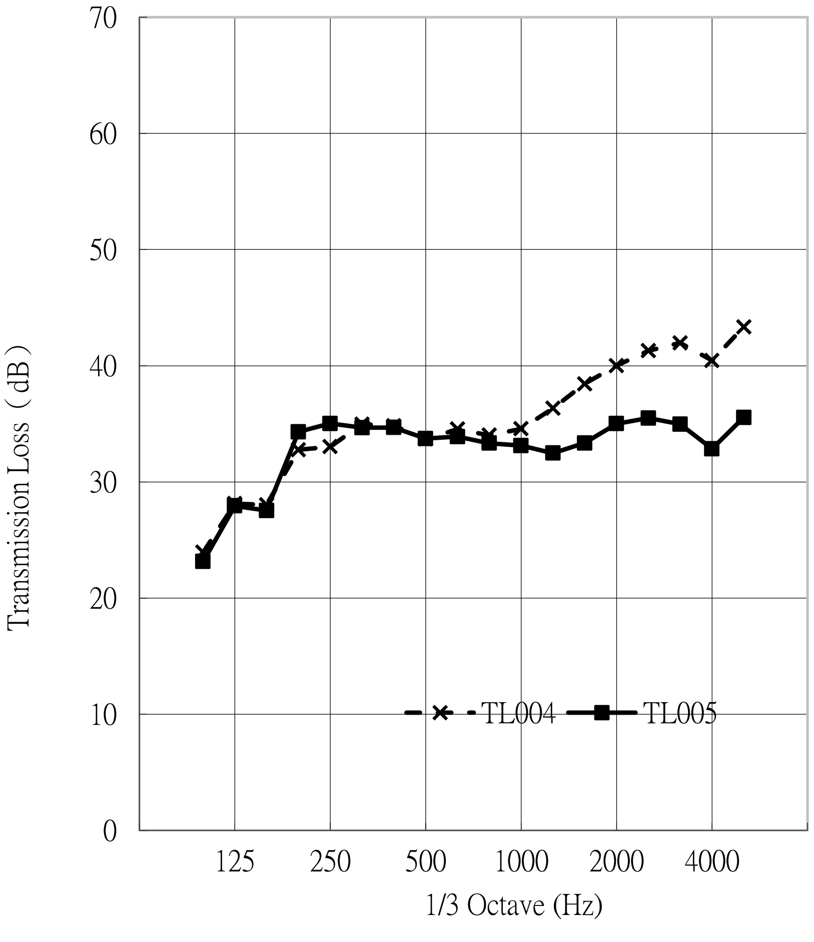


Figure 2 –Comparison of Sound Insulation - TL004, TL005

Advanced study of the base part, TL (Transmission Loss) and STC of two samples have shown the difference of base material. Above 500 Hz the difference would 1 dB; in other frequencies the difference would be less; in 4000 Hz the same coincidence effect would be shown. The results reveal the changes of base part make few influence in middle and high frequencies, and few influence for rigid and resonance control. Furthermore, the same coincidence effect in 4000 Hz were appeared from TL003, TL004, and TL005 with same facing part, and the facing part makes remarkable influence in coincidence.

Table 4 –Sample Comparison - TL003, TL004

Factors	part	TL003	TL004
Variable	Base	2.7 mm plywood	3.5 mm MDF
fixed	Facing	0.8 mm melamine plywood	
	Base	6 mm magnesia panel	
	Central	36 mm Glulam	

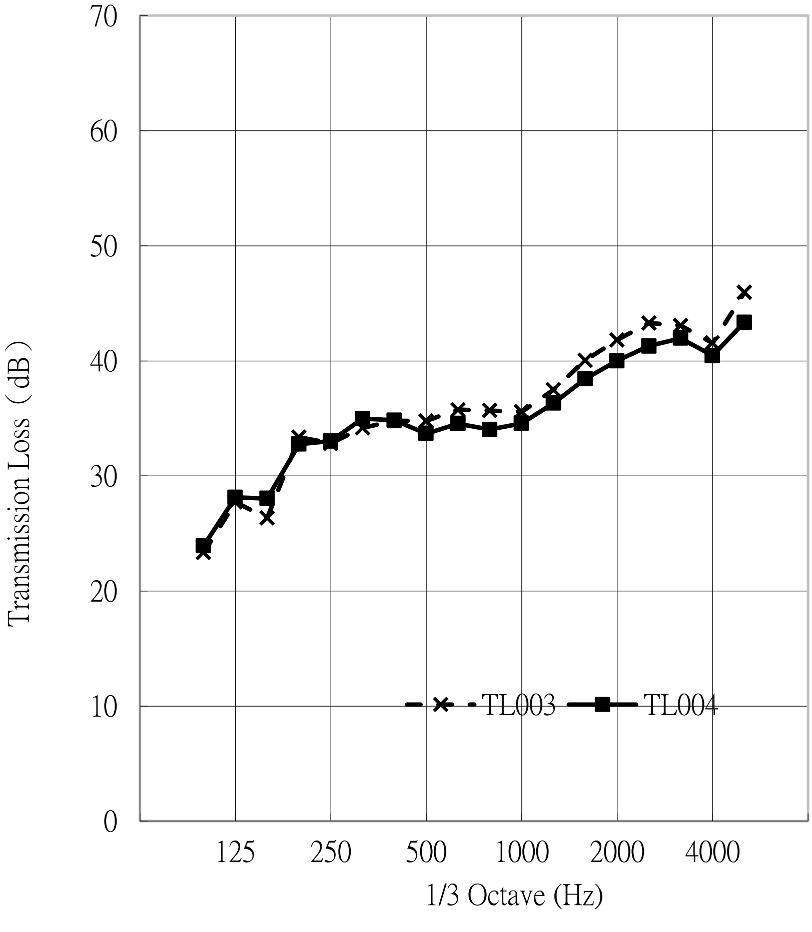


Figure 3 –Comparison of Sound Insulation - TL003, TL004

In the facing part, TL (Transmission Loss) and STC of two samples have shown the difference of facing part. In 100 to 125 Hz the difference would be 7 dB; in 250-500 Hz the difference would be 2 dB; in 4000 to 5000 Hz would be upon 10 dB. The results reveal the facing part with high rigid and surface density would makes remarkable influence in low frequencies from rigid control. In contrast, the resonance was also remarkable from the facing part changes according to the sound insulation reduction at 250, 500, 2000 Hz. In 4000 Hz the coincidence effect was also influence by the facing part changes and lift TL.

Table 5 –Sample Comparison - TL001, TL005

Factors	part	TL001	TL005
Variable	Facing	1.2 mm galvanizing steel panel	0.8 mm melamine plywood
	Base	2.7 mm MDF	3.5 mm MDF
fixed	Central	18 mm mineral fiber board, 6 mm magnesia panel, 18 mm mineral fiber board	

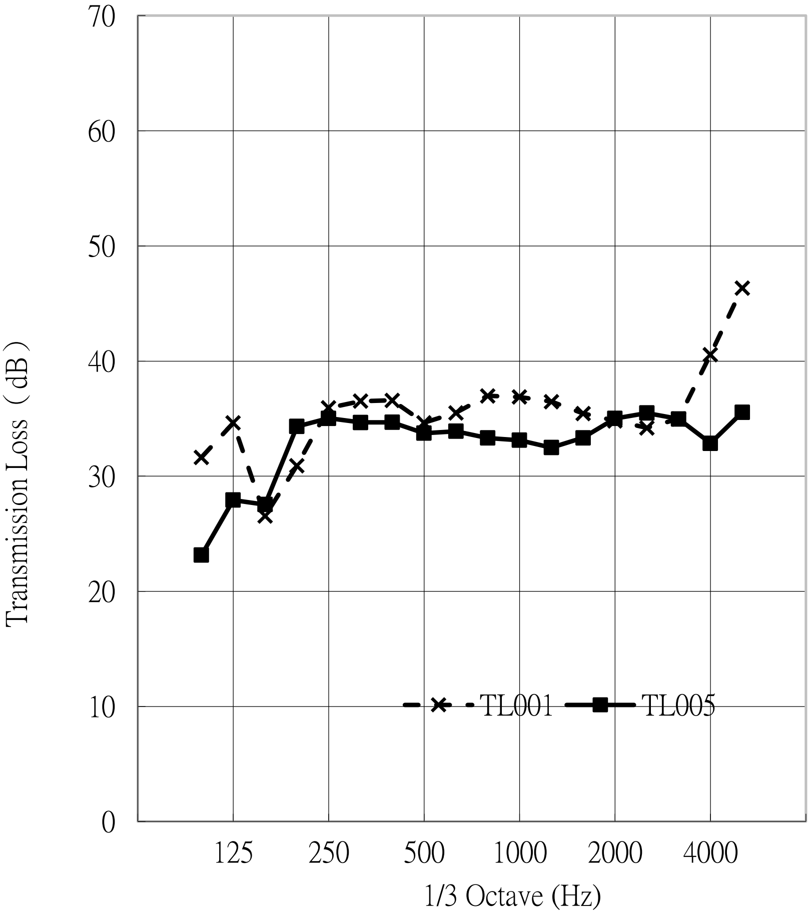


Figure 4 –Comparison of Sound Insulation - TL001, TL005

In the part with simple mechanism for building components, TL (Transmission Loss) and STC of two samples have shown the difference of results with simple mechanism. In 160 to 250 Hz the difference would be 7 dB; in 630-1600 Hz the difference would be 3 dB. The results reveal the simple mechanism with face covering seal and pre-stressing force on panel would make more rigid control in low frequencies.

Table 6 –Sample Comparison - TL001, TL006

Factors	part	TL001	TL006
Variable	Mechanism	none	Arcuate entry barrier, face covering seal with felt and rubber
	Base	2.7 mm MDF	5 mm MDF
fixed	Facing	1.2 mm galvanizing steel panel	
	Central	18 mm mineral fiber board, 6 mm magnesia panel, 18 mm mineral fiber	

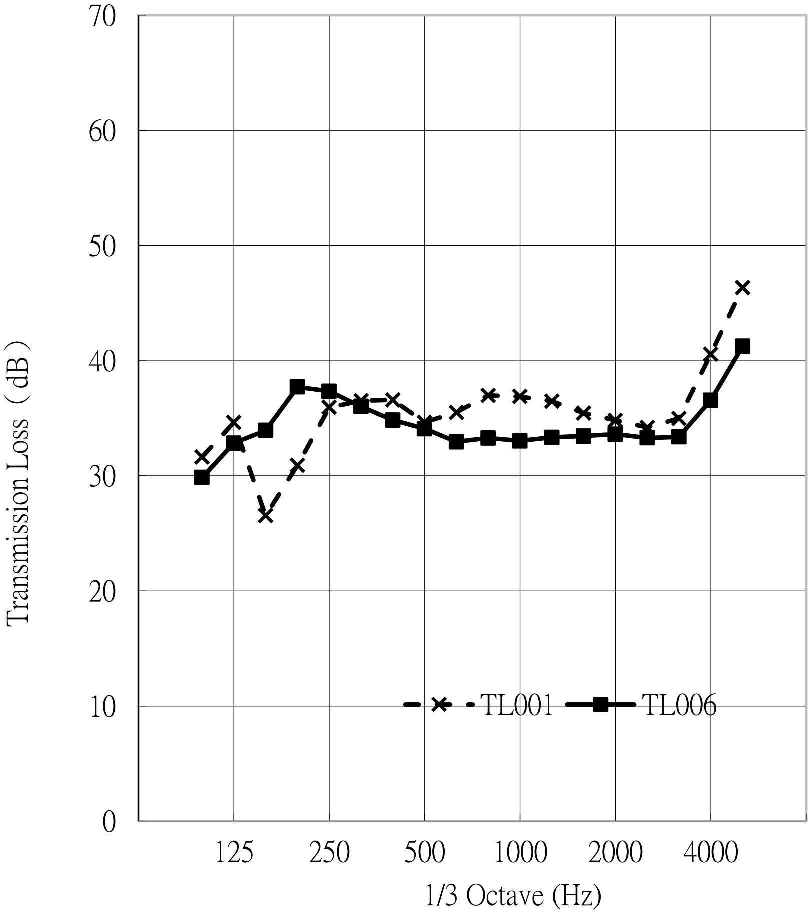


Figure 5 –Comparison of Sound Insulation - TL001, TL006

4. CONCLUSIONS

Above the measurements and factor analysis, the influence from central part, base part, facing part, and simple mechanism would be shown as below:

In the central and base part, the rigid control in low frequencies, the resonance control in middle-low frequencies, and the coincidence effects in high frequencies would be less effect. However the increasing of surface density form central part would make remarkable increasing for TL in middle frequencies.

In the facing part, the rigid control in low frequencies, the resonance control in middle-low frequencies, and the coincidence effects in high frequencies would be remarkable effect. In contrast the increasing of surface density form central part would make few changes for TL in middle frequencies.

In the simple mechanism part, the rigid control in low frequencies and the resonance control in middle-low frequencies would be remarkable influence from the pre-stressing force to edge of panel.

ACKNOWLEDGEMENTS

This study would clarify the influence from different parts of composite wood panel at initial step. The follow-up step will focus on the influence of sound insulation from frame and combining mechanism, and the prediction model of sound insulation will be set.

REFERENCES

1. CNS 15316-2010 , " acoustics - measurement of sound insulation in buildings and of building elements using sound intensity - laboratory measurements" (2010)
2. ASTM E413-10 , “Classification for Rating Sound Insulation,((2010).
3. T. R. T. Nightingaleand J. D. Quirt , “Effect of electrical outlet boxes on sound insulation of a cavity wall,”J. Acoust. Soc. Am. Volume 104, Issue 1, pp. 266-274 (1998)
4. J. A. Moore and R. H. Lyon," Sound transmission loss characteristics of sandwich panel constructions", J. Acoust. Soc. Am. 89, 777 (1991)