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DESIGN CHART OF SOUND INSULATION FOR MULTIPLE PANELS

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Abstract

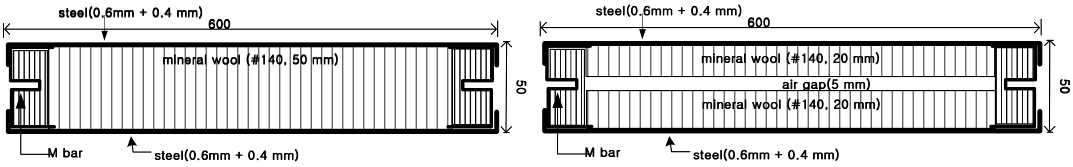
The present paper is aimed at a design method in a form of design chart that can be used for sound insulation of sandwich panels. The design chart is based on two independent variables, Young's modulus of core and thickness of skin plate, resulting in tune of dilatational frequency and then STC(Sound transmission Class). Based on this chart, we can draw a conclusion that lowering Young's modulus of core material is very important in order to increase STC. It is experimentally well verified that adoption of air gap to lower Young's modulus of core gives to enhance more than 10 dB in STC value.

1. INTRODUCTION

Of great interest is to increase sound insulation performance with keeping or lowering the weight in design of partitioning walls as shown in Fig. 1 which are commonly used in the ship. To do this, a design chart of sound insulation was made. In this chart, the dependent variable is selected to dilatational frequency f_d, so-called mass-spring-mass resonant frequency, because it plays a turning point on rapid increment of sound insulation in sandwich panels as illustrated in Fig. 2. The dilatational frequency [1] will be approximately given in Eq. (1),

$$f_d \cong \frac{1}{2\pi}\sqrt{\frac{2E_c}{d(m_1+\rho_c d/6)}}, \tag{1}$$

where E_c (N/m^2), ρ_c (kg/m^3) and d (m) are Young's modulus, density and thickness of core material, respectively and m_1 (kg/m^2) is surface density of skin plate. Of four design variables, E_c and m_1 can be changeable in practice since the others have serious restrictions such as fire receptivity and standard size.



(a) without air gap (b) with air gap(5mm)

Figure 1. Cross section views of sandwich panels with and without air gap.

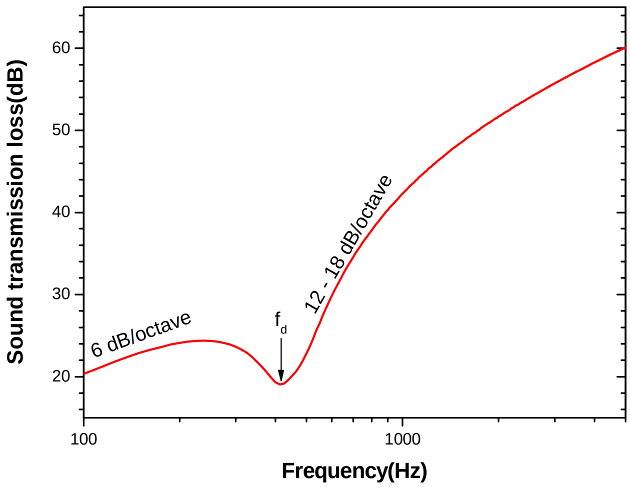


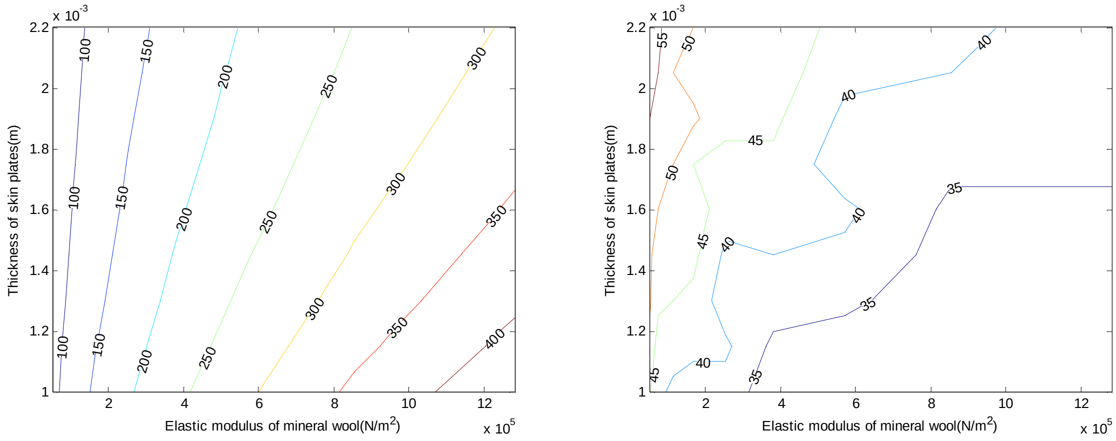
Figure 2. Typical characteristics of sound insulation in the sandwich panel.

2. DEVEOPMENT OF DESIGN CHART OF SOUND INSULATION

Design chart for a sandwich panel as sketched in Fig. 1 was made with two independent variables, E_c and t (thickness of the skin plate). Here, prediction was based on sandwich model[1]. Fig. 3 shows variations of dilatational frequency f_d and STC(Sound Transmission Class) with E_c and t. Based on this chart, we can draw a conclusion that lowering Young's modulus of core material is very important in order to increase STC. Experimental verification was conducted for two specimens as shown in Fig. 1. Fig. 4 shows comparison between two specimens. f_d of the specimen without air gap occurs at 1 kHz which means that E_c of mineral wool will be about 1e7(N/m^2) from Eq.(1). Meanwhile, in the case of with air gap, f_d occurs at 80 Hz. This is in part because air gap acts like a softener to significantly lower E_c from 1e7 to 1e4 (N/m^2). As a result, air gap as a softener yields to enhance more than 10 dB in STC.

3. SUMMARY

The design chart is made for sound insulation design of sandwich panels by using two independent variables, Young's modulus of core and thickness of skin plate, resulting in tune of dilatational frequency. Based on this chart, we can draw a conclusion that lowering Young's modulus of core material is very important in order to increase STC.



(a) Dilatational frequency (b) STC(Sound Transmission Class)

Figure 3. Design chart of sound insulation in a sandwich panel.

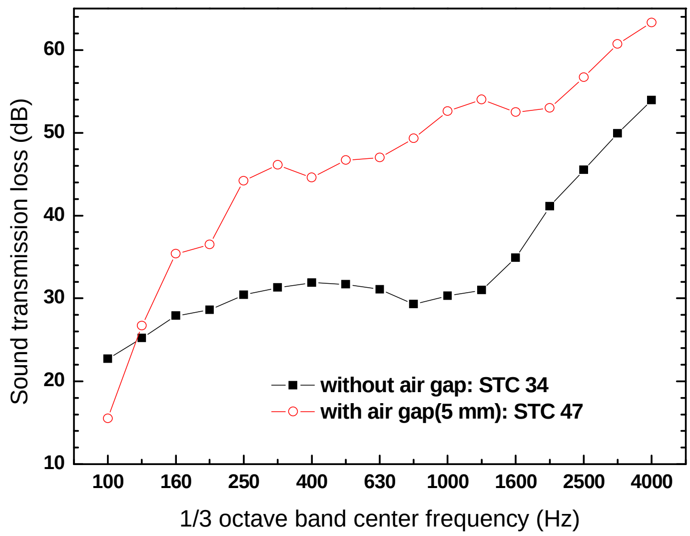


Figure 4. Comparison of sound insulation between with air gap and without air gap.

ACKNOWLEDGEMENTS

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[1] C. L. Dym and D. C. Lang, "Transmission loss of damped asymmetric sandwich panels with orthotropic cores," JSV **88**, 299-319 (1983).