Effect of Thickness on Noise Level and Sound Transmission Loss

Ananthshayana Mohare[1], Shanthala N L[2]

[1]PG Scholar, [2]Assistant Professor
Department of Mechanical Engineering,
Bangalore Institute of Technology, Bangalore-560004, Karnataka, India

***Abstract*: This paper is the result of investigations made on aluminium panel to understand the effect of varying thickness on sound transmission loss and noise level. Aluminium panel modeled using CATIA V5 and simulated in COMSOL to investigate the acoustic pressurized frequency –amplitude response for 8mm and 12mm aluminium panel and corresponding sound transmission loss is calculated using engineering noise control simulator (ENC).Theoretical values of sound transmission loss is compared with ENC simulator values. The observation has made that,if amplitude is more; noise is more, eventually corresponding sound transmission loss is less at given frequency and thickness.12mm aluminium panel is found to be better noise attenuation than 8mm aluminium panel which can be viewed in the result section.**

***Keywords*: acoustic pressure, sound transmission loss, amplitude, noise attenuation, panel.**

Introduction

Aluminium based metal panels have found greater applications in the field of machines, automotive and it can treated as enclosure. Owing to their lightweight and ease of availability, it can be used as noise attenuation panel in small scale industries where investment on machine is low. The machine operator usually works 8 hours per day who experiences noise constantly, the hazardous noise causes headache, fatigue on ear drum, hence it is important to reduce the noise at minimum possible value. In this paper it is advisable to reduce the noise level at design stage itself.

The one of the method is varying the thickness of enclosure panel. Vibration, which causes generation and propagation of acoustic sound waves and its interaction with panel or any structural obstacles is, refers to as statically energy analysis. These acoustic waves when interrupted by panel, sound wave's energy is reduced by the certain factor depends on the microstructure and the thickness of the panel. The effect of thickness is only influenced on low frequency range about 25 Hz to 2000 Hz [1].Increase in the thickness of the panel results in less reflection of energy and provides best absorption property.

Properties of Aluminium and Air

Requirement properties of aluminium and air are listed in table 1, to understand the effect of thickness on sound transmission loss.

Table 1- Properties of air and aluminium

PROPERTIES	VALUE	UNIT
Density of aluminium (ρ)	2700	Kg/m^3
Poisson's ratio(μ)	0.3	
Young's modulus (E)	70	Gpa
Surface density for 8mm aluminium thick(M)	21.6	Kg/m^2
Surface density for 12mm aluminium thick(M)	32.4	Kg/m^2
Density of air(ρ)	1.12	Kg/m^3
Speed of sound in air(c)	334	m/s
Impedance of air (imp)	410	Kg/sm^2

Model Definition of Panel

Aluminium rectangular panel is modeled according to the dimension 2500×1500 mm with thickness 8 and 12mm [2] as shown in the figure 1(a) and (b) respective with edges F-F-F-F boundary condition.

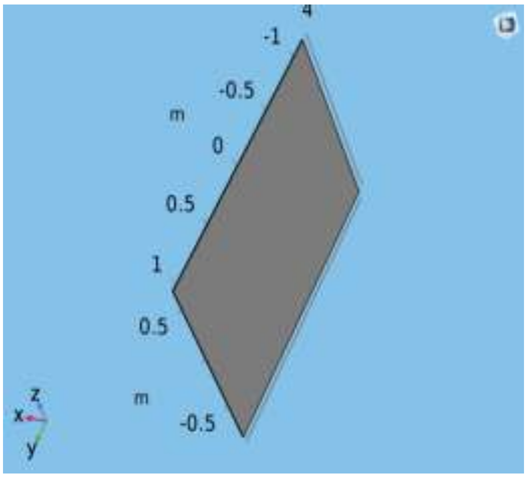

Fig 1(a)-8mm thick

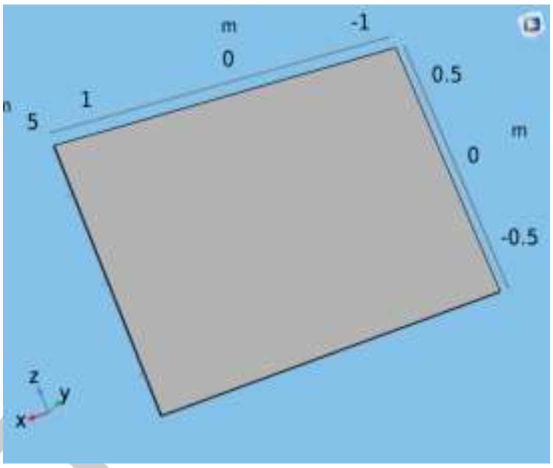

fig 1(b)-12mm thick

Results and Discussions

The Results of the work is explained in this section.Aluminium panel is subjected to the pressure 139 Pa, normal to the surface at frequency 500 Hz [3]. COMSOL simulation results for both 8mm and 12mm shown in the figure 2(a) and 2(b).

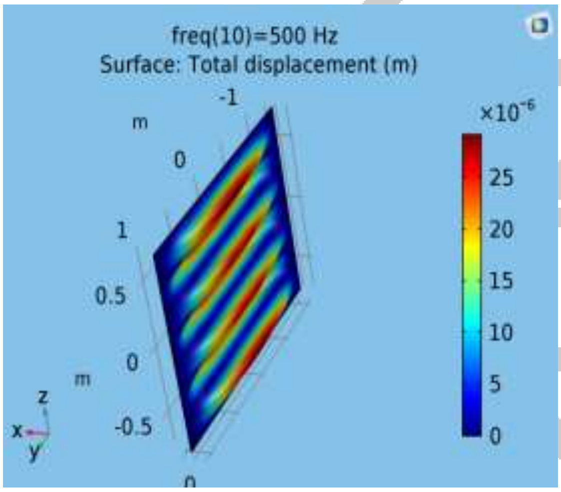

Fig 2(a)-displacement for 8mm thick

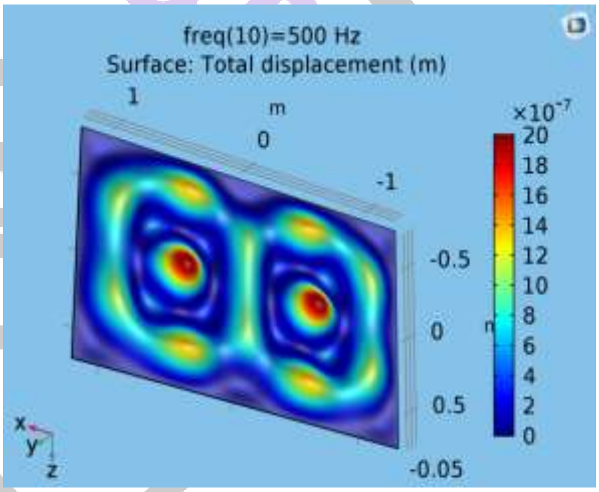

fig 2(b)-displacement for 12mm thick

Figure 2(a) and 2(b) shows that maximum displacement for 8mm and 12mm aluminium thick panel is 0.00003 mm and 0.000002 mm at 500 Hz. 12mm thick aluminium panel has smaller displacement compared to 8mm thick aluminium panel. Frequency-amplitude response is shown in the figure 3(a) and 3(b) for 8mm and 12mm thick panel respectively.

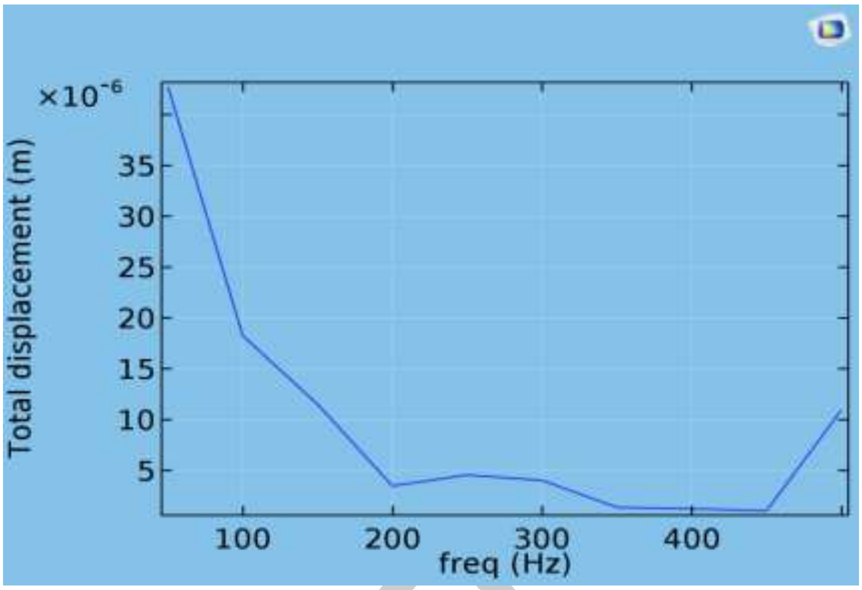

Figure 3(a) frequency-amplitude for 8mm thick panel

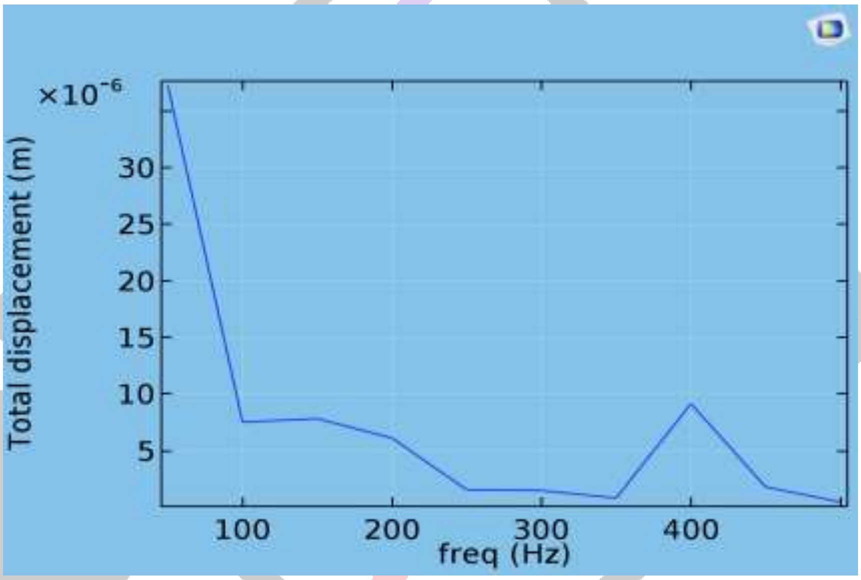

Figure 3(a) frequency-amplitude for 12mm thick panel

Figure 3(b) shows that amplitude is 0.000037 m for 12mm aluminium thick panel which is lower than that of the 8mm aluminium thick panel shown in the figure 3(a).Noise is always determined by the amplitude of the vibration. The larger the amplitude, higher is the noise level. Consequently Sound transmission loss in panel is lower for higher amplitude. Hence 12mm aluminium panel has more noise attenuation property which is thicker than 8mm aluminium panel.

Sound transmission loss

Engineering noise control simulator gave the results of sound transmission loss in decibels (dB) for both 8mm and 12mm aluminium thick panel. Sound transmission loss v/s frequency plot is shown in the figure 4(a) for 8mm aluminium panel and 4(b) for 12mm aluminium panel.

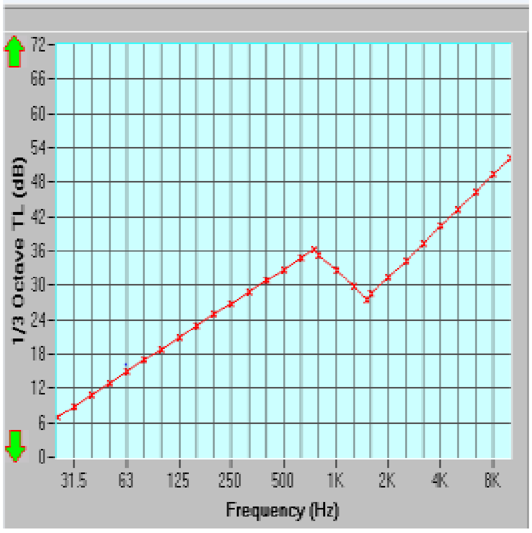

Fig 4(a) 8mm thick, STL

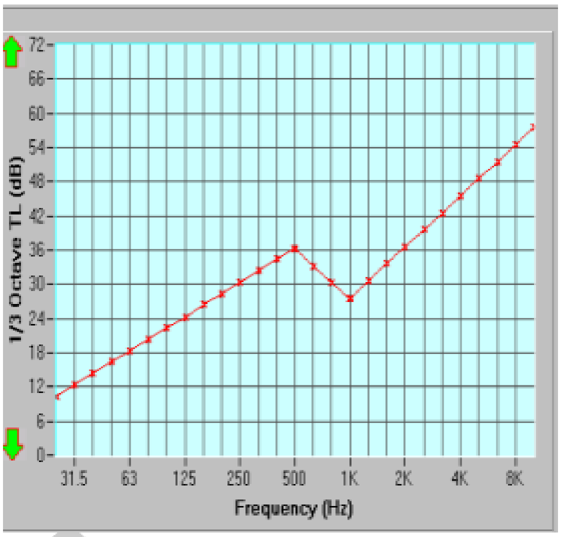

fig 4(b) 12mm thick, STL

From the figure 4(a) and 4(b) it is observed that, sound transmission loss in 12mm thick aluminium panel is more comparatively 8mm thick aluminium panel.

Theoretical Approach

Theoretical calculation is made to support the ENC simulator [4].The following calculation is made for 8mm and 12mm aluminium panel.

i) 8mm aluminium panel at 31.5 Hz

$$\text{STL} = 20\ \text{Log}\ \left(\frac{\pi\times\rho\times h\times f}{\text{imp}}\right) - 5.5$$

$$=20\ \text{Log}\ \left(\frac{\pi\times 2700\times 0.008\times 31.5}{410}\right)\text{-}5.5$$

= 8.84 dB

ii)12mm aluminium panel at 31.5

$$= 20\ \text{Log}\ \left(\frac{\pi\times 2700\times 12\times 31.5}{410\times 1000}\right)\text{-}5.5$$

= 12.36 dB

The table 2 represents the comparison of 8mm and 12mm aluminium panel for sound transmission loss.

Table-2 comparison of 8mm and 12mm aluminium panel

Frequency (dB)	**ENC transmission loss (dB)**	**Theoretical transmission loss (dB)**	**Percentage of error %**
Sound transmission loss for 8mm thick aluminium panel			
31.5	8.5	8.84	3.846
250	26.5	26.83	1.2
500	32.5	32.85	2.28
Sound transmission loss for 12mm thick aluminium panel			
125	12.1	12.36	2.10
250	30	30.35	1.28
500	34.4	36.3	5.23

Amplitude is the characteristics of sound.12mm thick panel have less amplitude response and hence sound transmission loss is more in that panel. Hence from previous studies the larger thickness of the panel, the more will be noise reduction.

Conclusion

This paper brings the information about effect of thickness on noise level. It is understood that 12mm aluminium panel has more noise attenuation compared to 8mm thick aluminium panel. Amplitude-frequency response for 12mm and 8mm is simulated. It is understood that, 12mm aluminium panel has less amplitude, hence noise level is less, and eventually sound transmission loss is more, hence it is concluded that larger the thickness, more loss of sound energy.

References

[1] 'Characteristics of Noise Absorption Material' by S Amares et al 2017 J
[2] 'AAA special machine manual' by S.Arivalgan.
[3] www.COMSOLWEBINARS.com
[4] 'Noise and vibration control' by M L Munjal.