# Enhancing Acoustic Performance with appropriate Glass

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Managing committee FOSG and Chairman GSC Glass Ltd.

# Noise

- Modern living & growing technology creates noise / sound
- Sound can distract attention, disturb sleep & create anxiety
- Prolonged exposure to high level of sound can impair hearing permanently
- Acoustic control is keeping noise levels within reasonable limits…

# Sound and Noise

- Sound is a vibration that propagates as a wave of pressure and displacement, through a medium such as air or water and can be heard when they reach a person's ear.

- Noise is a sound that is unwanted because it is unpleasant, loud, or interferes with hearing…

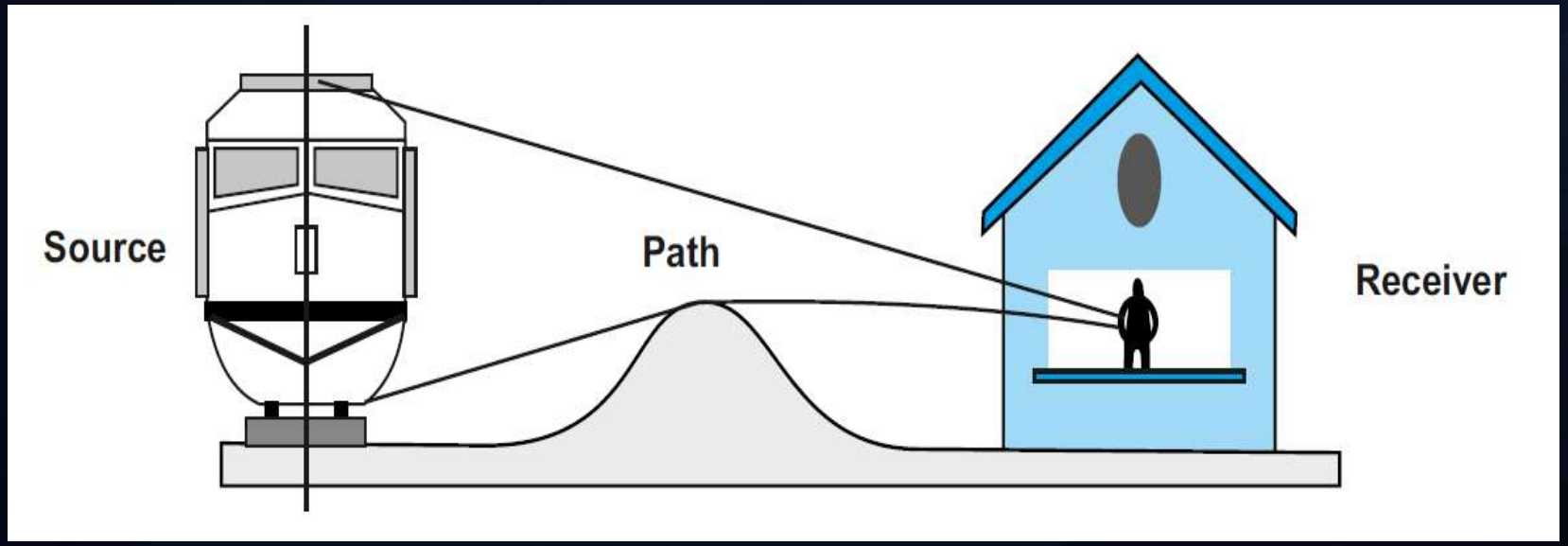
# Music

Vibration

# Noise

Vibration

# Key Elements



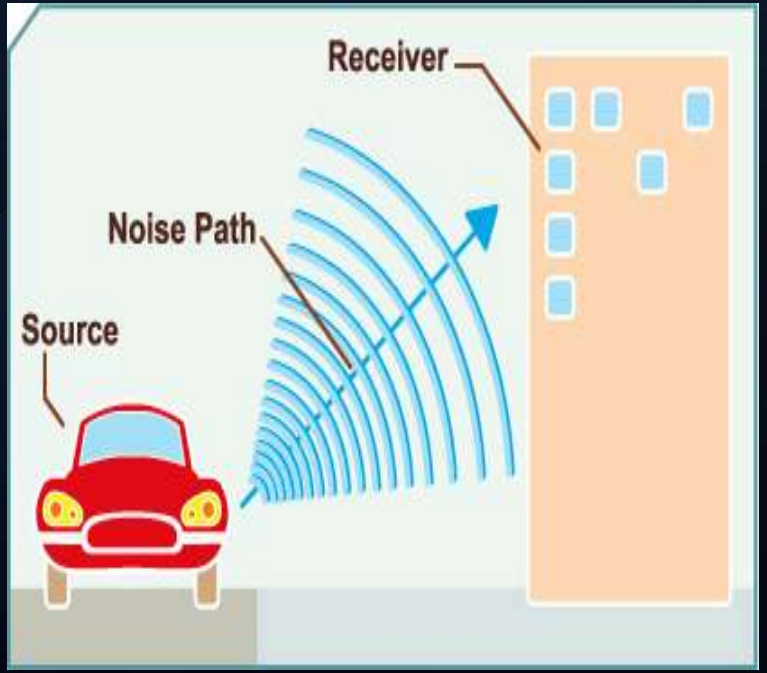

Source: when there is no source, there is Obviously no sound

Path: Through which sound travels from source to receiver

Receiver: The human ear *and* *other surrounding materials.*

# How does noise become a problem?

- A noise problem starts with a noise source such as a stream of traffic or any other source is very high.
- The noise is transmitted through a path and then arrives at the receiver.
- The noise will be perceived as a problem when the noise is so high as to be a nuisance to the receiver…



$$L_P = 10 \cdot \log \frac{\Sigma p_i^{\,2}}{p_0^2}$$

- $L_p$ : Level of the sound pressure (dB)
- Pi : Sound pressure (Pa)
- $P_0$: Reference level (Pa)
- (hearing level: 0.00002 Pa)

$$L = 10 \log_{10} \left( \sum_{i=1}^{n} 10^{(Li / 10)} \right)$$

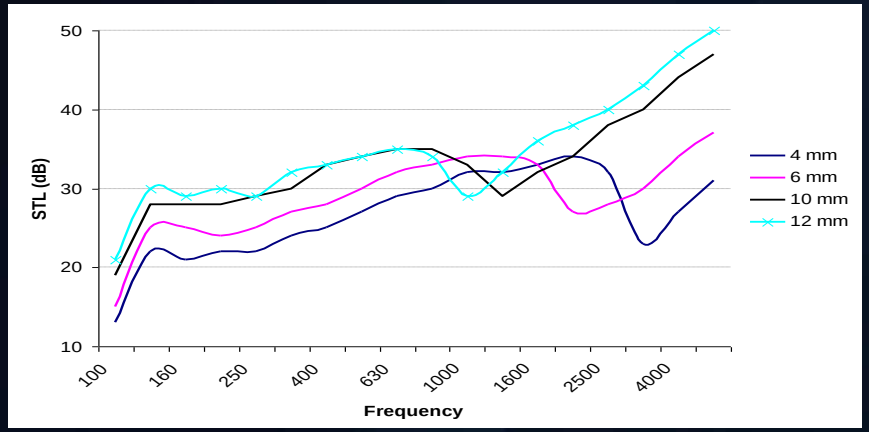
- Adding three levels 94.0 + 96.0 + 98.0:
  $L = 10 \log_{10} ( 10^{9.4} + 10^{9.6} + 10^{9.8}) = 101.1$ dB

$$NPL = L_{50} + L_{10} - L_{90} + \frac{(L_{10} - L_{90})^2}{60}$$

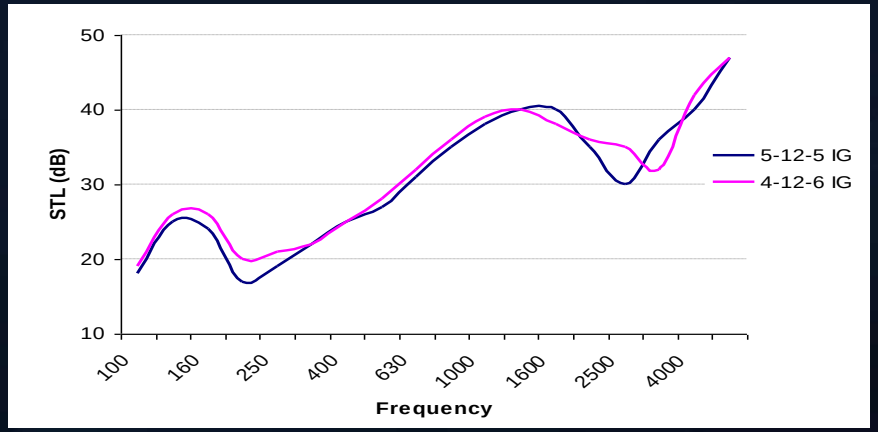
- $L_{10}$ = Level exceeded 10% of Time,
- $L_{50}$ = Level exceeded 50% of Time,
- $L_{90}$ = Level exceeded 90% of Time.

- dB(A) level exceeded 90 % of time ($L_{90}$)=30 dB
- dB(A) level exceeded 50 % of time ($L_{50}$)=20 dB
- dB(A) level exceeded 10 % of time ($L_{10}$)=10 dB
- Noise Pollution Level NPL in dB(A) = 6.6667 dB.

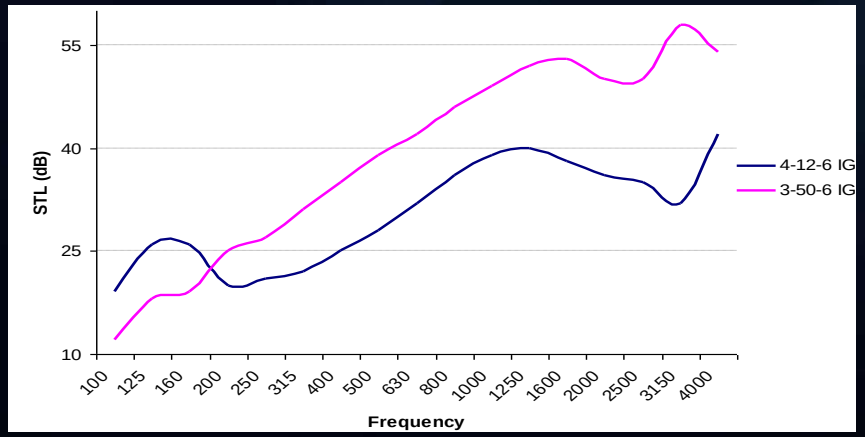
## Usage of Thicker Glass



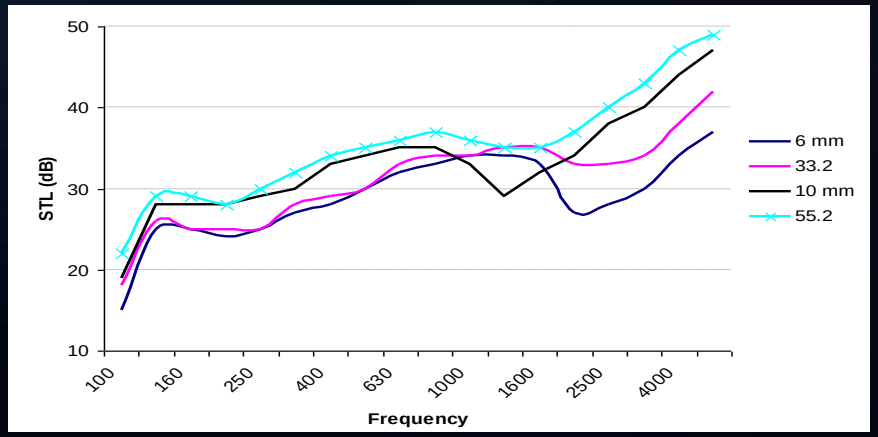

## Asymmetrical Double Glazing



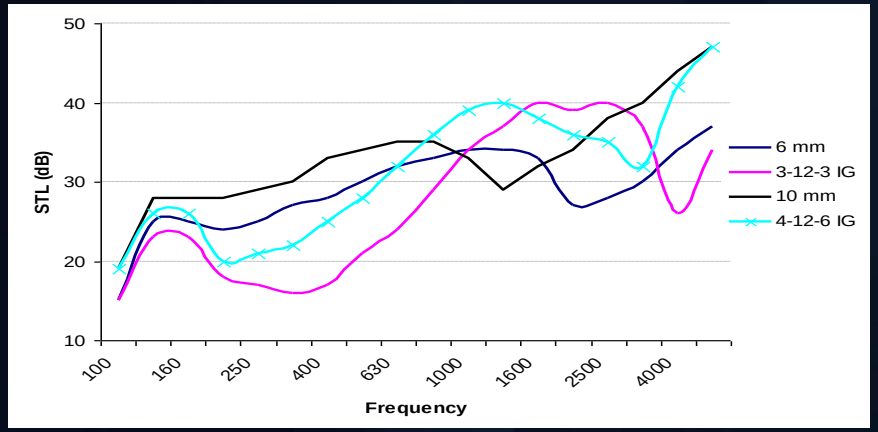

## Increasing Air Gap between IG units



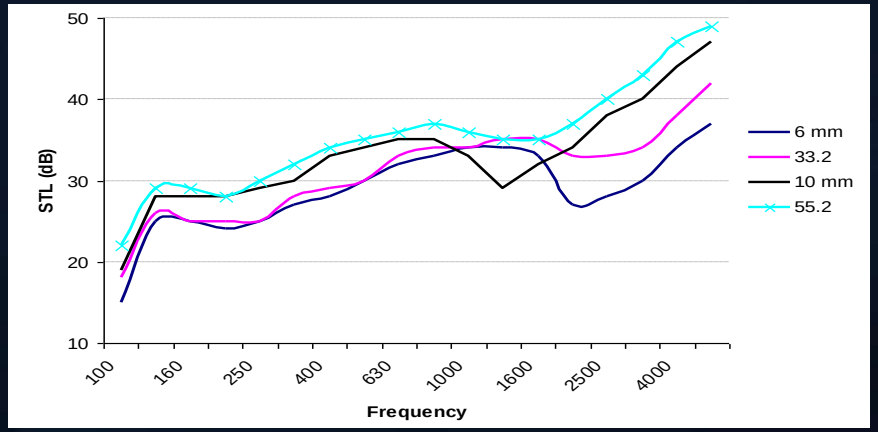

## Laminated Glass



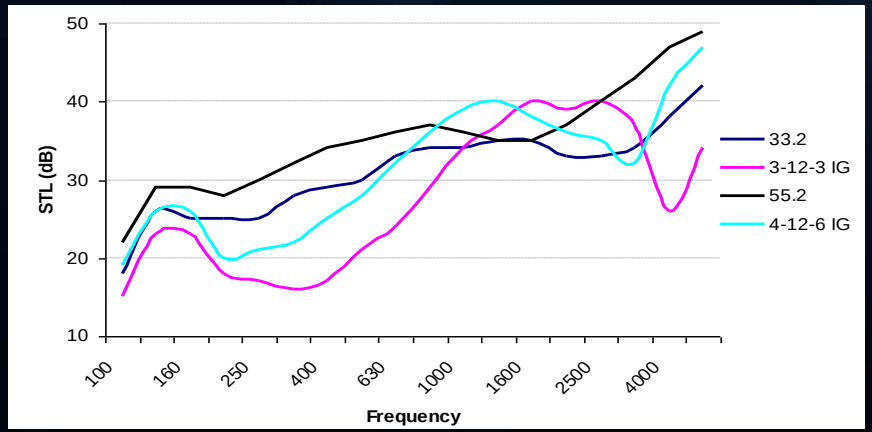
## Insulated Glass Vs. Thicker Glass



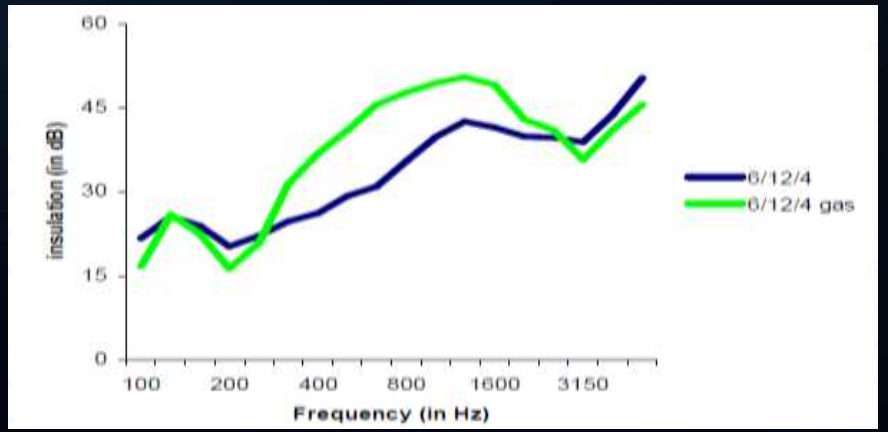

## Laminated Glass Vs. Thicker Glass




## Laminated Glass Vs. Insulated Glass




## Using Gas in place of air-gap



Let us Keep it

Simple and Basic

# Loudness

- Loudness, or intensity of a sound is commonly measured in Decibels or dB
- 1 decibel = 1/10 of 1 bel
- It is a Logarithmic scale. Like ‘Richter scale’ for earthquakes
- An earthquake of intensity 6.0 is mild whereas 9.0 is ??
- A small increase in dB means substantial increment in loudness
- 2 trumpets each producing a level of 80 dB together produce 83 dB, and not 160 dB…

# Understanding the Logarithmic Scale

**70 dB**

**X 2**

**73 dB**

# Understanding the Logarithmic Scale

**30 dB**

**X 4**

**36 dB**

# Understanding the Logarithmic Scale

**40 dB**

**x 10**

**50 dB**

# Understanding the Logarithmic Scale

**70 dB + 80 dB**

**= 80.4 dB**

# Understanding the Logarithmic Scale

**60 dB** **+** **90 dB**

**= 90.04 dB**

# Human Ear & Acoustic Insulation

**-1 dB:**
**Not Audible**

**-3 dB:**
**Noticeable**

**-5 dB:**
**Important**

**-10 dB: Sound**
**Reduced by 50%**

**-20 dB: Sound**
**Reduced by 75%**

**-30 dB: Sound**
**Reduced by 87.5%**

**-40 dB: Sound**
**Reduced by 94.25%**

# Quality or Type of Sound

- Sound arises from molecules vibrating in a gas, liquid or solid.
- The number of vibrations or sound waves emitted per second is known as the frequency and is expressed in Hertz (Hz)..

# Low and High frequency Sounds

- Low-frequency are base sounds: Music drums, lower notes in music
- Mid frequency sounds: Human conversation, Traffic noise, normal horn
- High-frequency are shrill or sharp sounds:  whistle, a bird chirping, pressure horn
- Each glass thickness has a critical frequency at which its sound reduction value is low.
- It is more difficult to provide effective acoustic insulation for facades subjected to high-intensity but low-frequency noise (such as road traffic)…

# Sound Travel

- Sound arises from molecules vibrating in a gas, liquid or solid.
- Medium of travel is important
- The transfer of sound is different in different mediums
- Sound does not travel through Vacuum…

No Medium
No Sound

# Noise sources and Loudness

| SOUND | dB | LOUDNESS |
|---|---|---|
| Space Shuttle | **188** | Dangerously loud |

Space Shuttle at take off

# Noise sources and Loudness

| SOUND | dB | LOUDNESS |
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| Space Shuttle | **188** | Dangerously loud |
| Jet Engine | **150** | Painfully loud |

Jet Engine at take off

# Noise sources and Loudness

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| Low Caliber Rifle | **140** | Painfully loud |

Low Caliber Rifle

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Pneumatic Drill

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| Diesel Generator,diesel pump set | **100-90** | Very loud |

Diesel Generator, diesel pump set

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| Heavy Traffic | **90** | Very loud |

Heavy Traffic

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| Heavy Traffic | **90** | Very loud |
| Loud Music | **90** | Very loud |

Loud Music

# Noise sources and Loudness

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| Noisy Factory | **90** | Very loud |

Noisy Factory

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| Vacuum Cleaner/ home appliances | **80-90** | Very loud |

Vacuum Cleaner/ home appliances

# Noise sources and Loudness

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| Average Street Noise | **70** | Moderate |

Average Street Noise

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| Average TV at 1 m | **65** | Moderate |

Average TV at 1 m

# Noise sources and Loudness

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| Heavy Traffic | **90** | Very loud |
| Loud Music | **90** | Very loud |
| Noisy Factory | **90** | Very loud |
| Vacuum Cleaner/ home appliances | **80-90** | Very loud |
| Average Street Noise | **70** | Moderate |
| Average TV at 1 m | **65** | Moderate |
| Average Office Noise… | **60** | Moderate |

Average Office Noise

# Desired levels

| ACTIVITY AREA | GOOD (dB) | REASONABLE (dB) |
|---|---|---|
| Residential at night | **30** | **40** |
| Bedroom at night | **25** | **30** |
| Class room | **35** | **45** |
| Commercial offices | **40** | **50** |
| Restaurant | **40** | **50** |
| Theatre… | **25** | **30** |

# Reduction of Noise at source itself


Using Diesel generator set with sound reducing enclosures.

# Silencer on a gun

# Silencer on a motorcycle

# Insulating the noisy areas like Discotheque in a Hotel

To prevent noise from going out to adjoining areas

Insulating the building or working areas from outside noise

The surroundings materials to be sound absorbing

# Sound Reduction Class or **STC**

| STC | What can be heard |
|---|---|
| **25** | Normal speech can be understood quite easily and distinctly through wall |
| **30** | Loud speech can be understood fairly well, normal speech heard but not understood |
| **35** | Loud speech audible but not intelligible |
| **40** | Onset of “privacy” |
| **42** | Loud speech audible as a murmur |
| **45** | Loud speech not audible; 90% of statistical population not annoyed |
| **50** | Very loud sounds such as musical instruments or a stereo can be faintly heard; 99% of population not annoyed |
| **60*** | Superior soundproofing; most sounds inaudible.. |

# Glass and sound reduction

- Using Thicker glass
- Laminated glass
- Acoustic PVB
- Non symmetric combinations
- Increase Gap in DGU
- Fill Gas in DGU..

# Insulating Glass or DGU

- Is not a Vacuum Glass. It has air or Gas between two panes
- A normal Insulated Glass does not help in sound insulation
- 6+12+6mm assembly will be same as 12mm single
- Dissimilar Panes like 6+12+8 will help to some extent
- Increasing the Air Gap will help but cannot go beyond a point
- Filling with some special gases like Krypton or Xenon (not Argon) will help marginally…

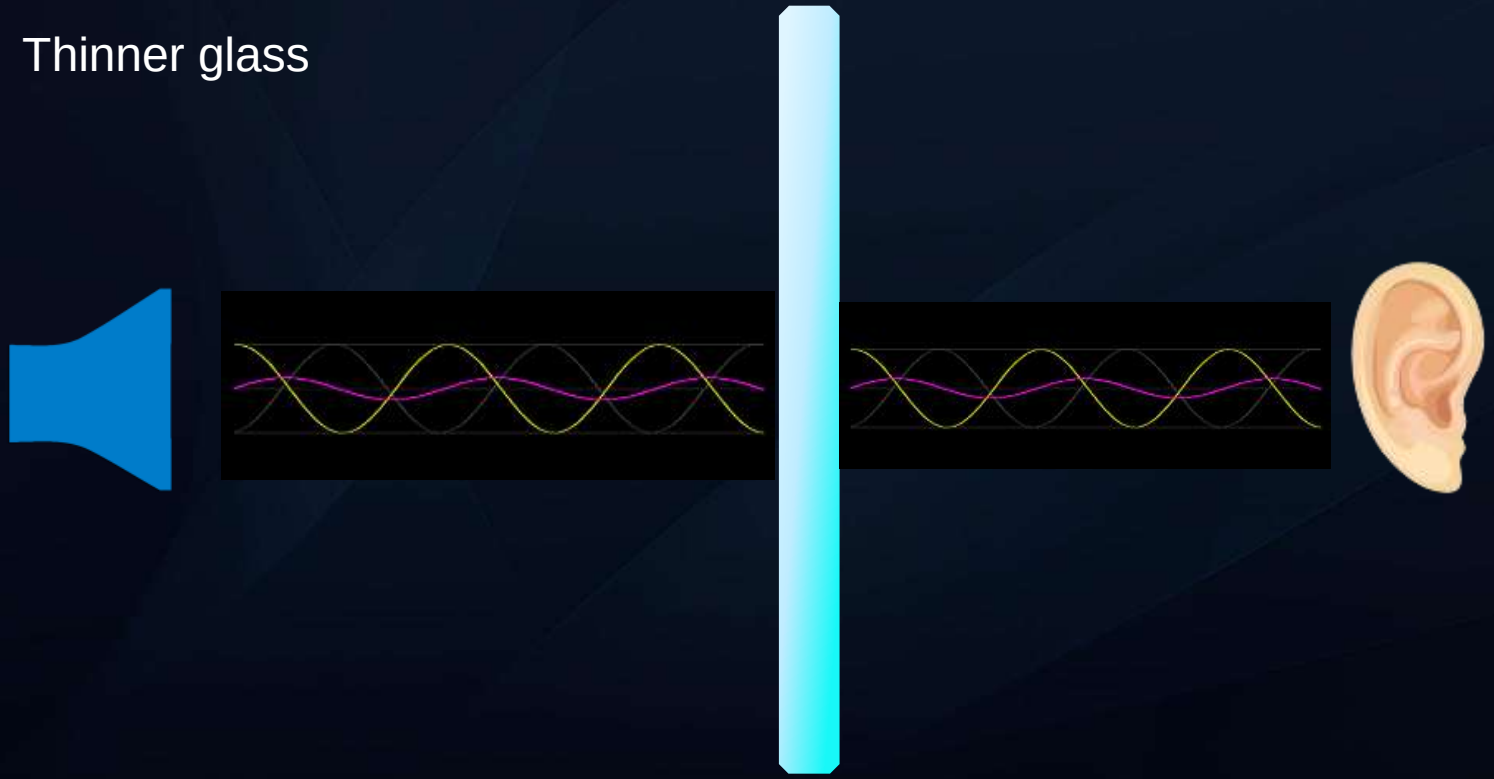
# Laminated Glass is best

- The PVB interlayer provides a dampening effect
- Reduces vibration by absorbing the sound waves
- Superior sound insulation in higher frequency range also
- Increasing the thickness of interlayer has marginal effect
- Outer glass has to be thinnest and Inner glass to be thickest
- Using one pane in DGU enhances the performance
- Both panes laminated will further enhance the sound insulation
- Acoustic PVB’s will further reduce by 2-3 dB…

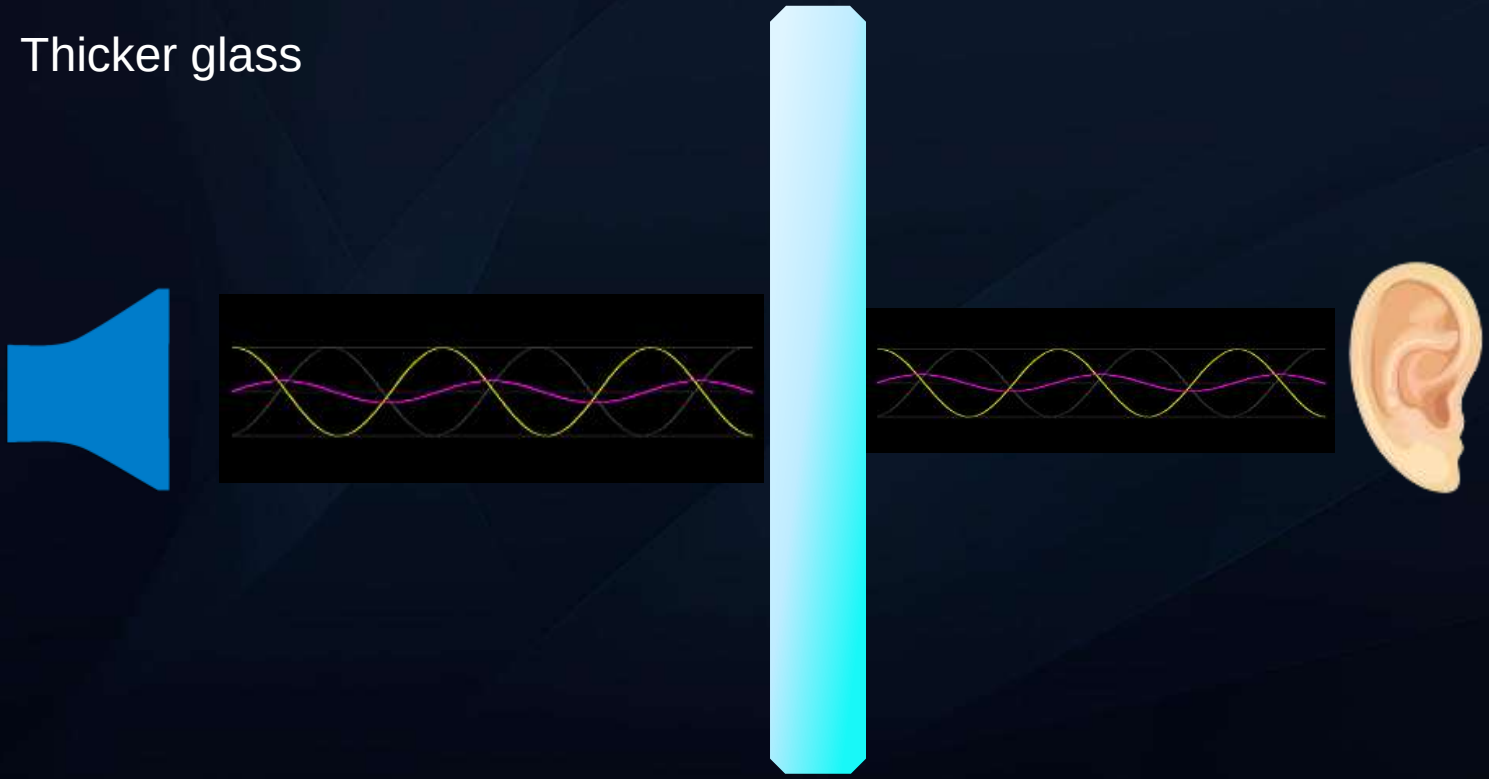
# Factors not effecting Sound Insulation

- Tint / Color of glass
- Coatings (Reflective / Low-e) on glass
- Position of glass
- Tempering
- Annealed glass of a particular company…

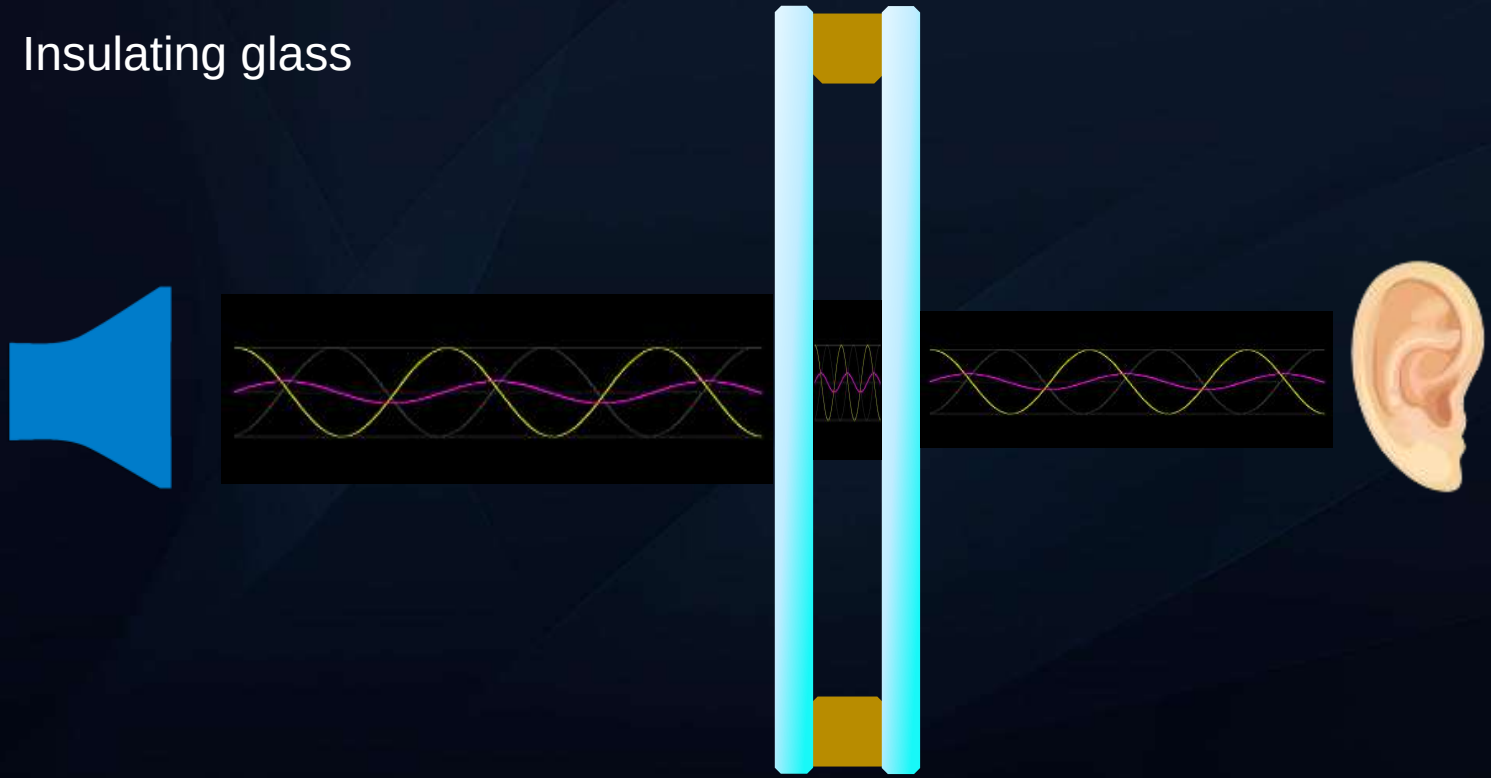
Thinner glass



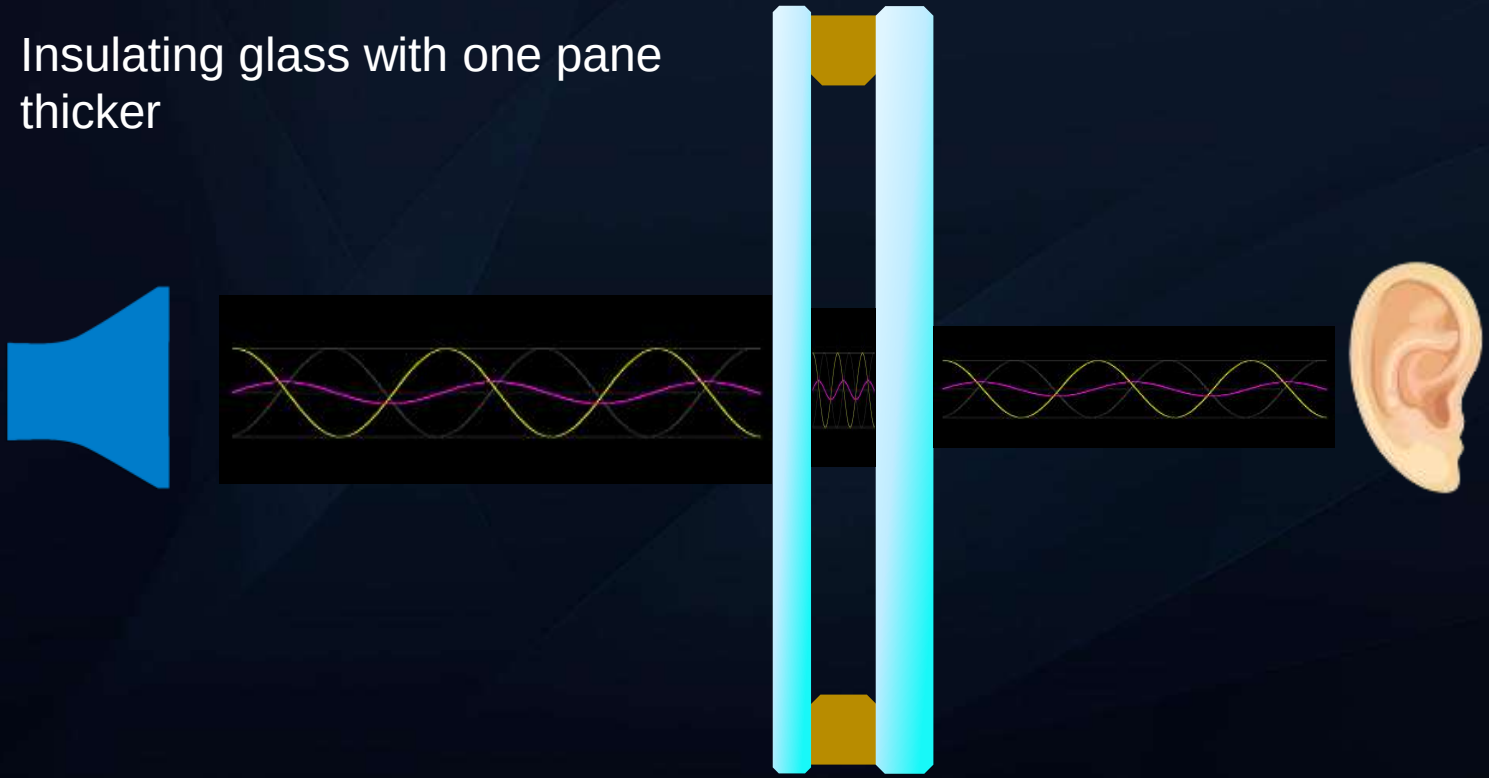
Thicker glass



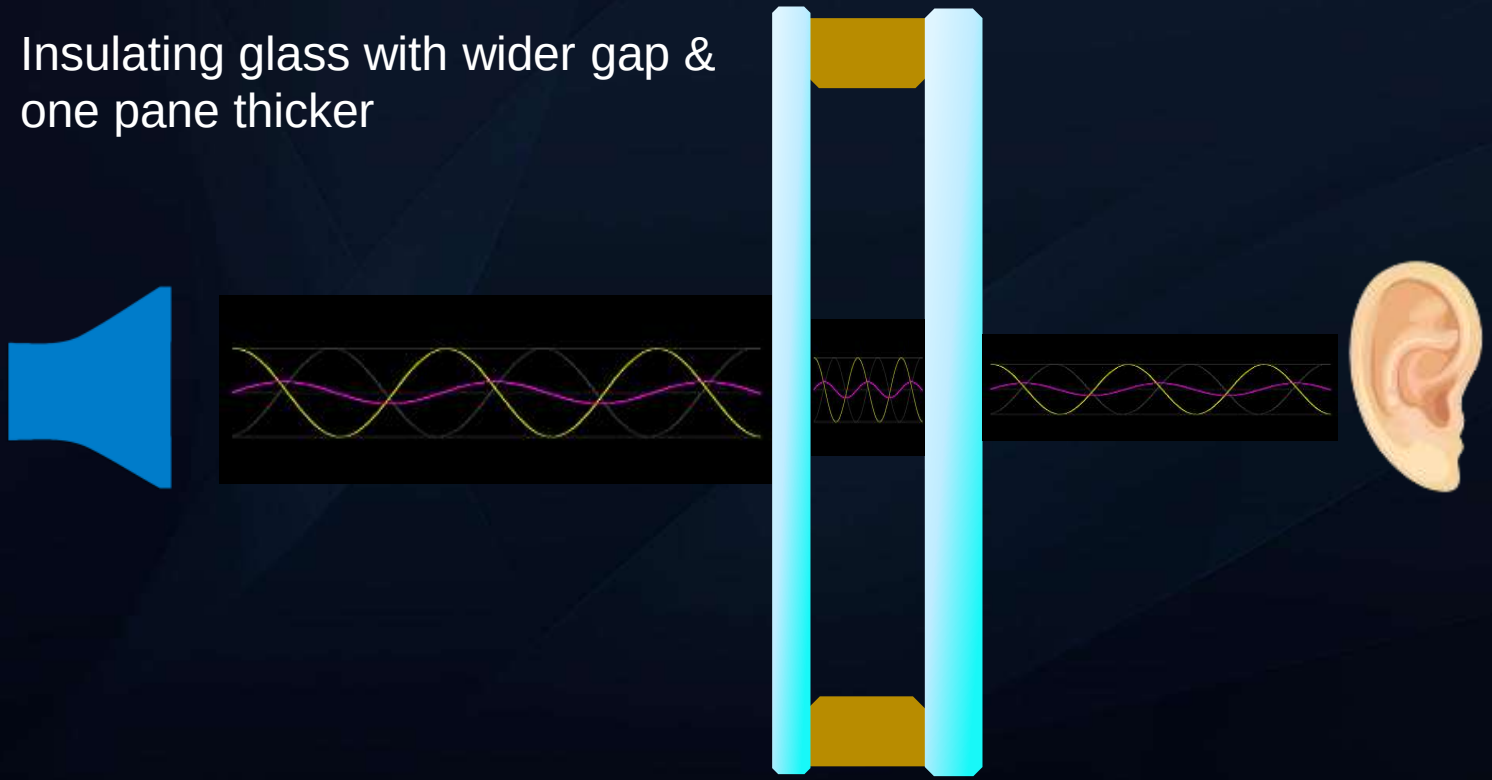
Insulating glass



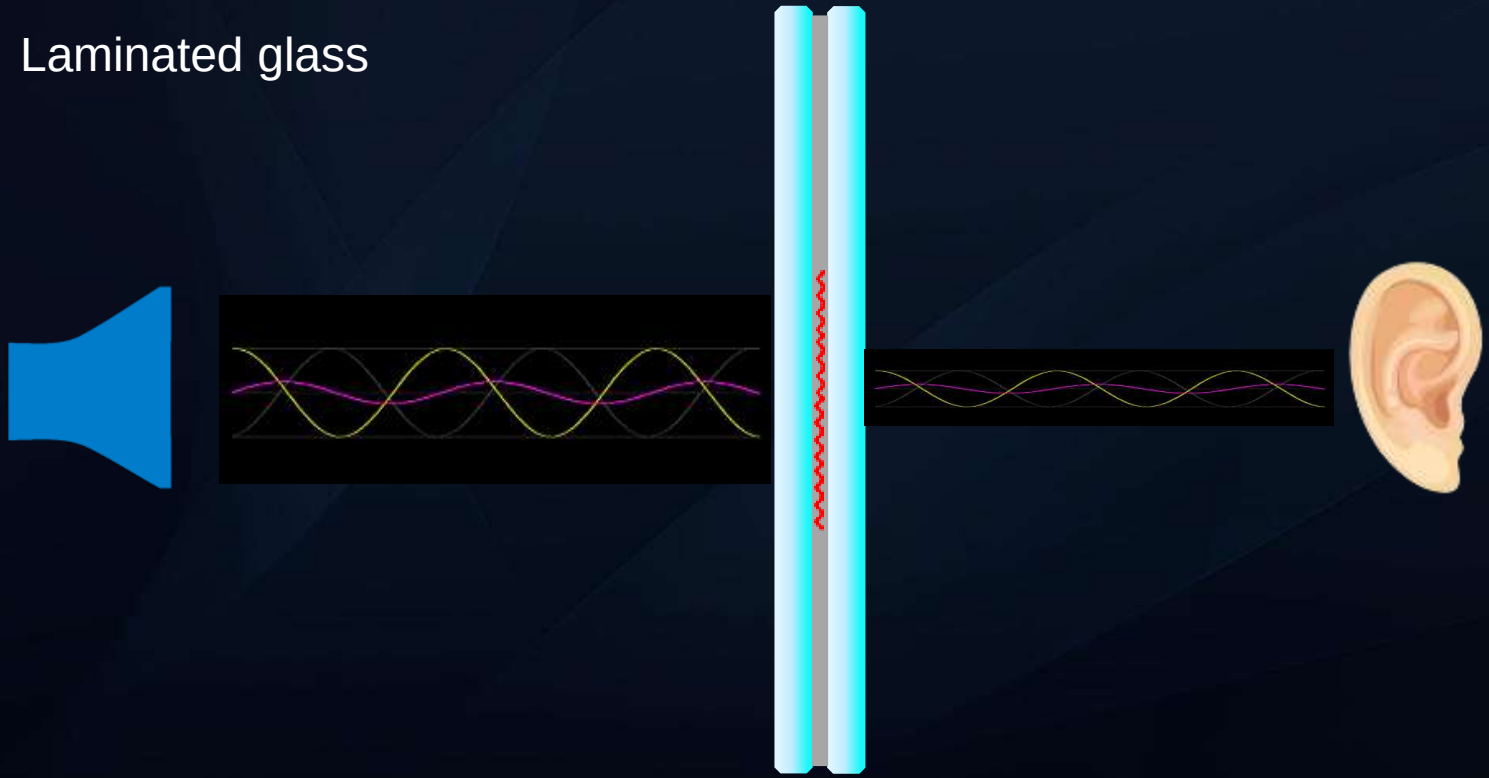
Insulating glass with one pane thicker



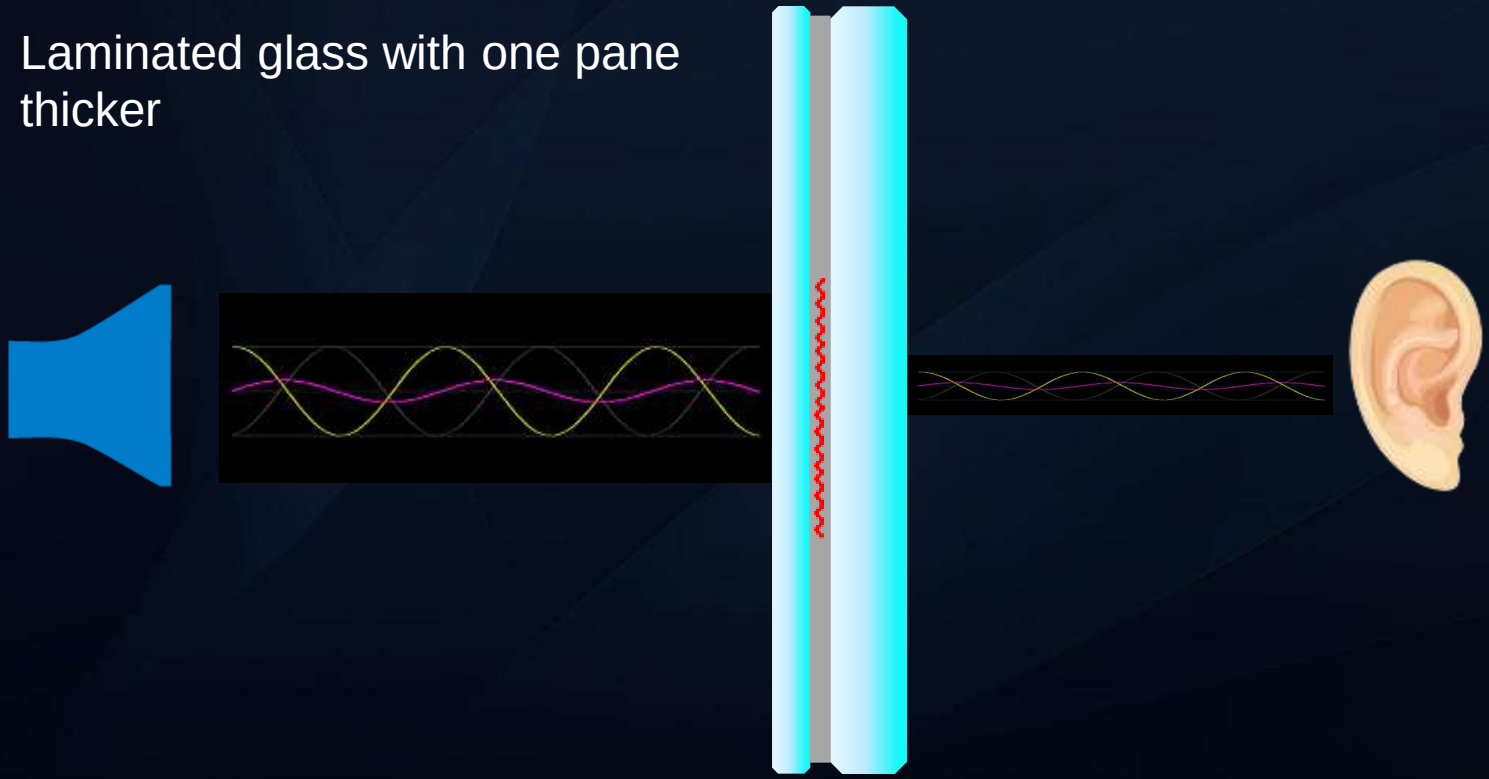
Insulating glass with wider gap & one pane thicker



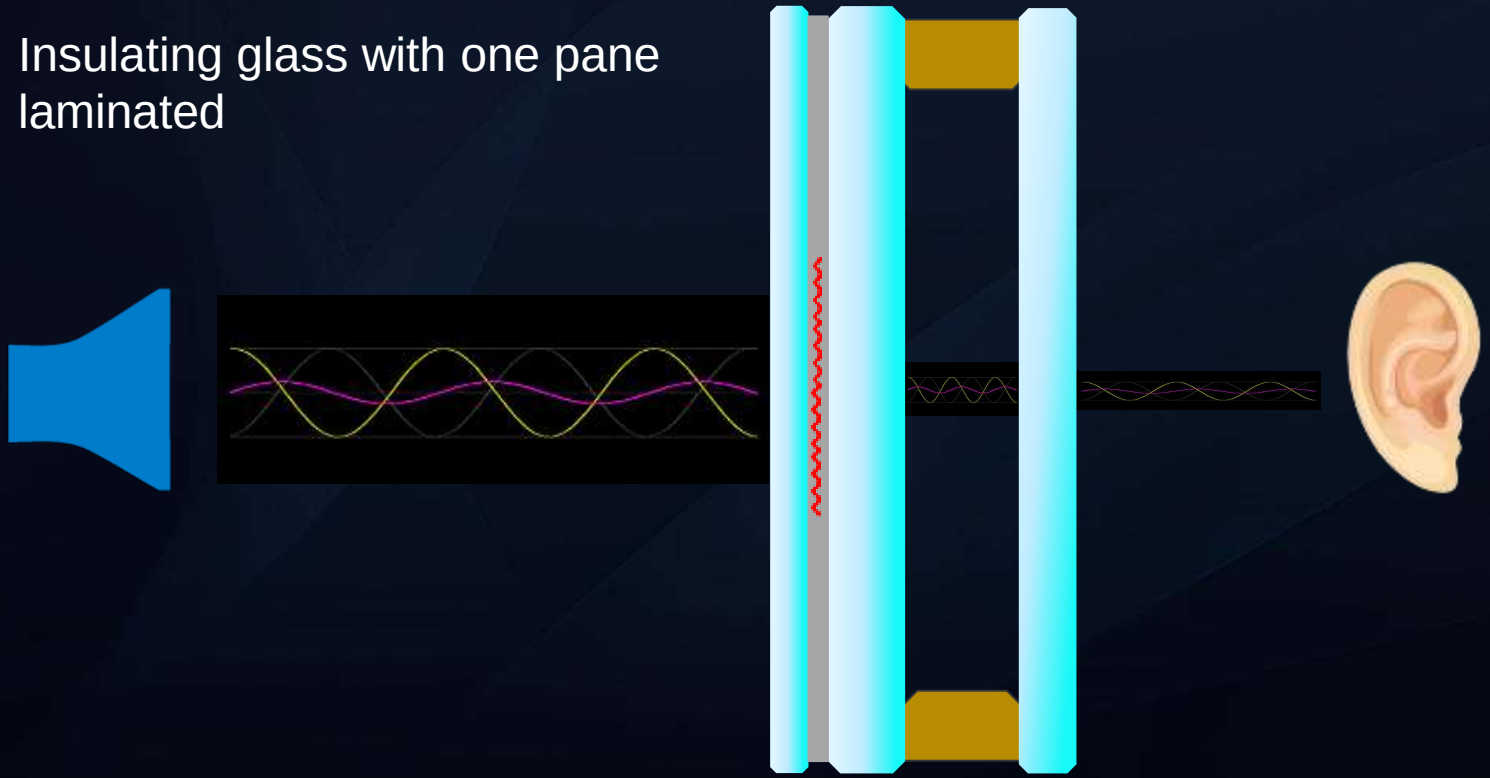
# Laminated glass



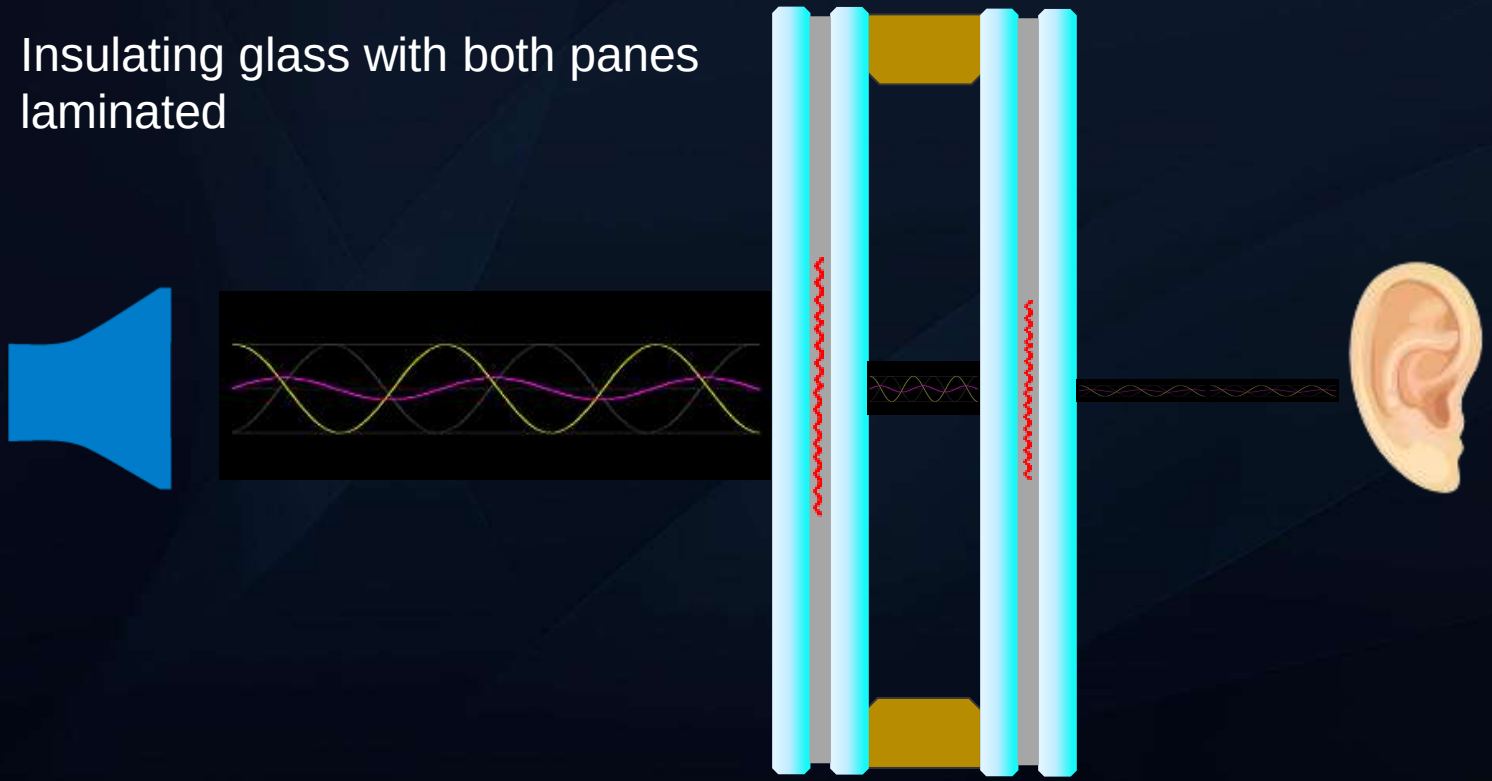
Laminated glass with one pane thicker



Insulating glass with one pane laminated



Insulating glass with both panes laminated



# Use Combination of Insulated & Laminated Glasses

| | Inside | Construction Space | Outside | STC Value | $R_w$ |
|---|---|---|---|---|---|
| Monolithic Glass | 6 mm | - | - | 31 | 32 |
| | 12 mm | - | - | 36 | 37 |
| Insulated Glass | 3 mm | 8 mm Air | 3 mm | 28 | 30 |
| | 6 mm | 12 mm Air | 6 mm | 35 | 35 |
| | 6 mm | 25 mm Air | 6 mm | 37 | 37 |
| Laminated Glass | 3 mm | 0.76 mm PVB | 3 mm | 35 | 35 |
| | 6 mm | 0.76 mm PVB | 3 mm | 36 | 36 |
| | 6 mm | 1.52 mm PVB | 3 mm | 37 | 37 |
| | 6 mm | 0.76 mm PVB | 6 mm | 38 | 38 |
| | 6 mm | 1.52 mm PVB | 6 mm | 39 | 39 |
| | 10 mm | 0.76 mm PVB | 6 mm | 40 | 40 |
| | 12 mm | 1.52 mm PVB | 6 mm | 41 | 41 |
| Laminated Insulating Glass | 6.76 mm | 12 mm Air | 6 mm | 39 | 39 |
| | 6.76 mm | 12 mm Air | 5 mm | 39 | 39 |
| | 10.76 mm | 12 mm Air | 6 mm | 40 | 40 |
| | 6.76 mm | 25 mm Air | 5 mm | 42 | 42 |
| | 6.76 mm | 12 mm Air | 6.76 mm | 43 | 43 |

# Sealing

- No matter how good the noise insulation quality of the window is, there should be no gaps or cracks around the window frame
- Doors should also have gaskets or foam tapes or soft seals
- Normal 12mm doors as mostly used: will only give a low to medium sound insulation
- The biggest challenge is to provide for ventilation for such sealed areas…

# Conclusions

- Maximum Mass: Thicker glass or combinations
- Maximum Asymmetry: Use different thicknesses and different mediums of travel
- Proper sealing but provide for ventilation
- Achieving STC 40 is easy, 45 is struggle, beyond 45 has to be double wall
- Examine noise levels and desirable levels to give optimum cost effective solution…

All this and more in this Guide from FOSG

*Acoustics page 35-43*

Available at FOSG Stand in this Hall #3

**Thank you for your attention.**