

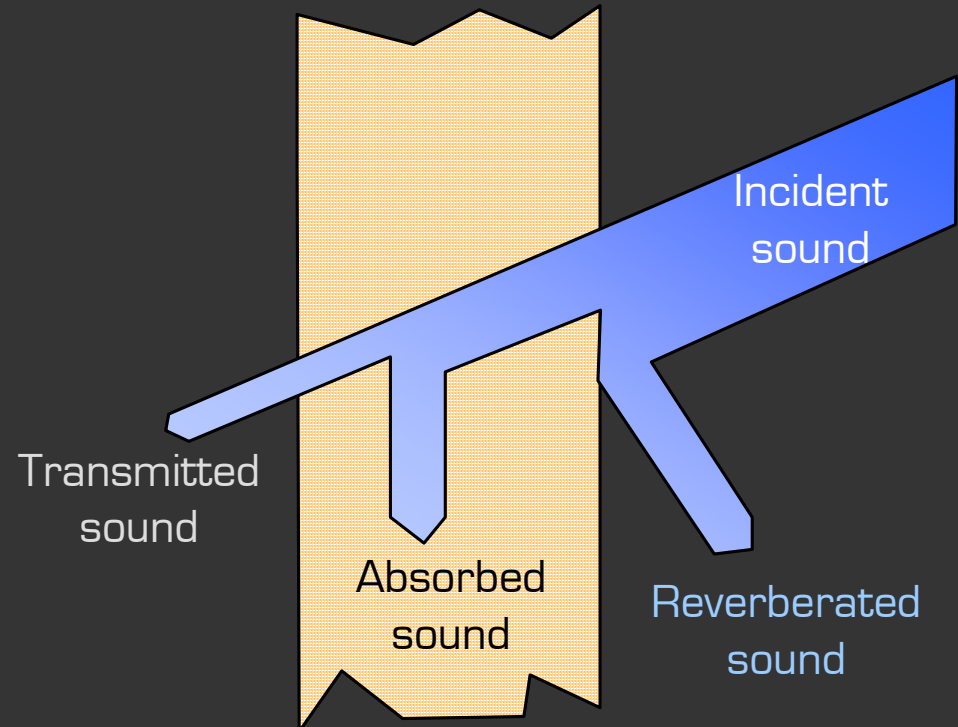
Noise control

▶ Sound components

- reflected (reverberated) ρ
- absorbed α
- transmitted τ

▶ Transmission loss TL

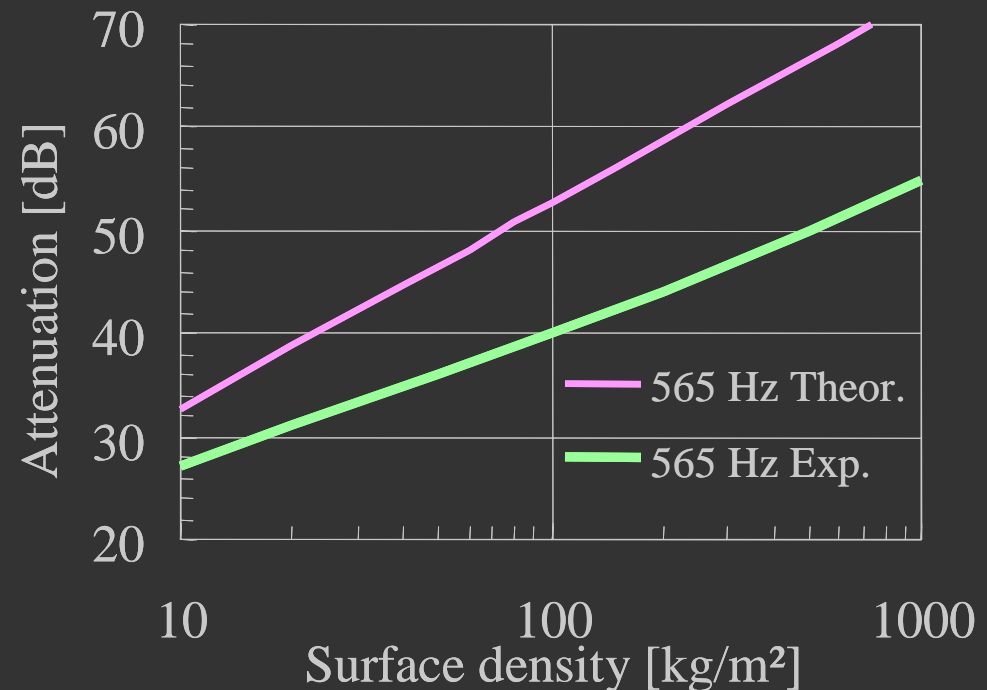
$$TL = 10 \text{ Log}(1/\tau) = -10 \text{ Log } \tau$$



Noise control

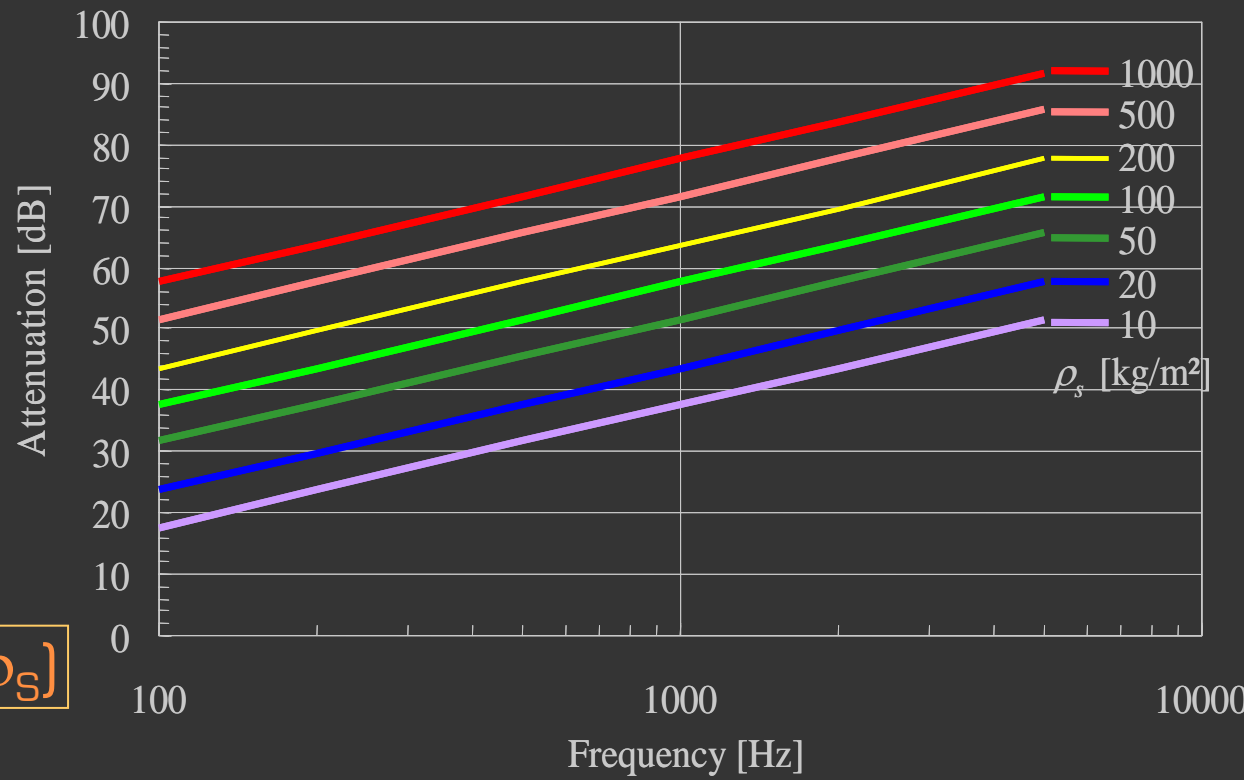
► Mass law (Berger's law)

- theory: doubling of surface density ρ_S [kg/m²] \rightarrow - 6 dB
i.e. $TL \propto 20 \text{ Log } \rho_S$
- practice: - 5 dB
i.e. $TL \propto 17 \text{ Log } \rho_S$



Noise control

- ▶ Mass law (Berger's law)
- ▶ Frequency law
 - doubling of frequency f [Hz] \rightarrow - 6 dB
 - i.e. $TL \propto 20 \text{ Log } f$

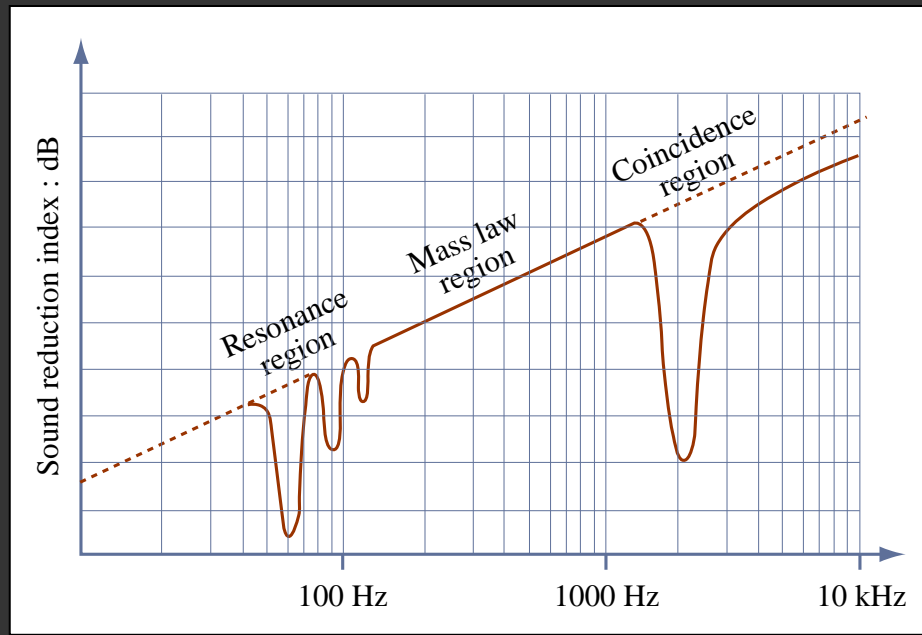


$$TL \approx 20 \text{ Log } (0.08 f \rho_s)$$

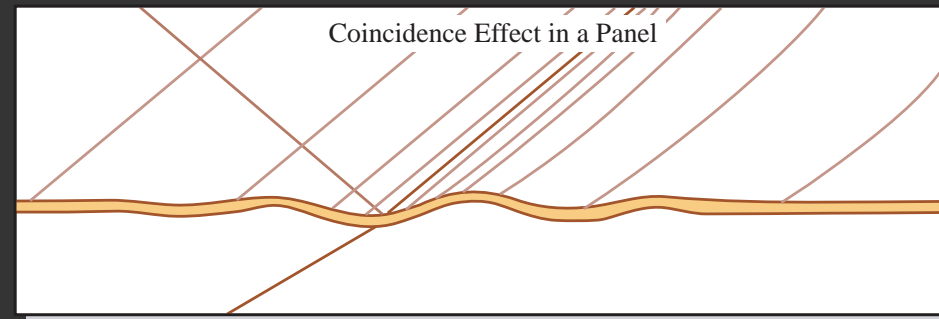
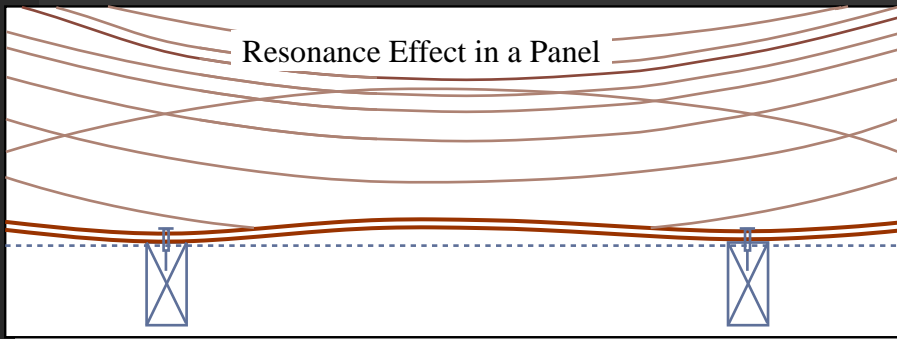
Noise control

► For low and high frequencies:

- resonance
- coincidence



Images by MIT OCW.

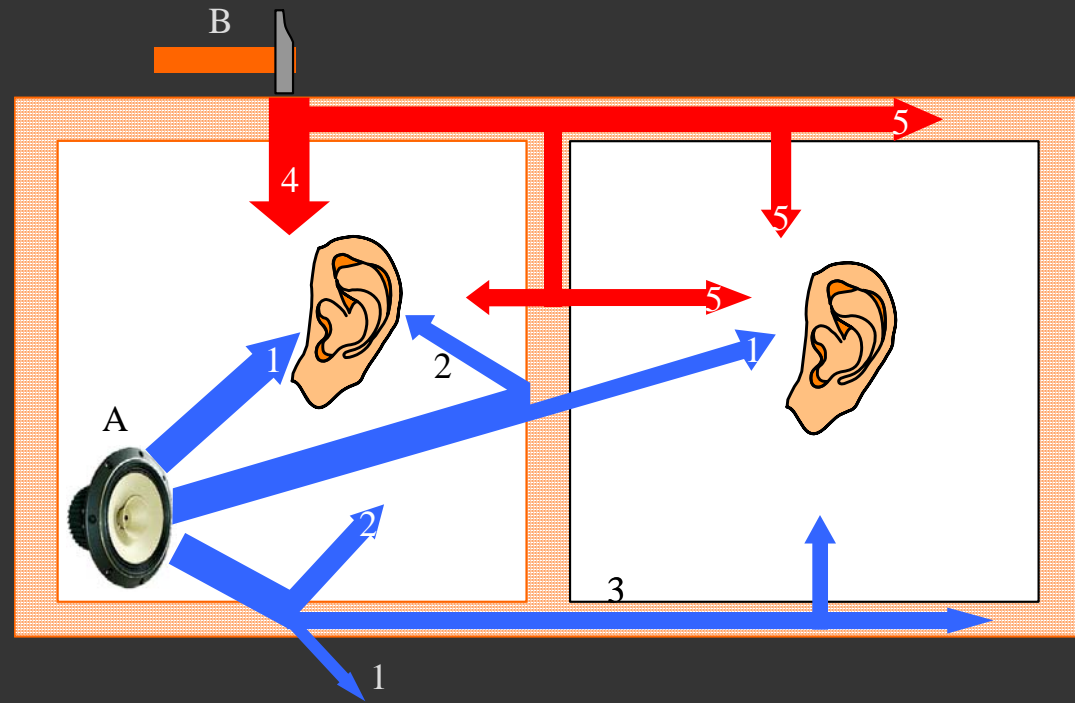


Noise control

▶ Sound paths

- 1 - direct air transmission
- 2 - reverberation
- 3 - lateral transmission of airborne sound
- 4 - re-emission of impact sound
- 5 - transmission "

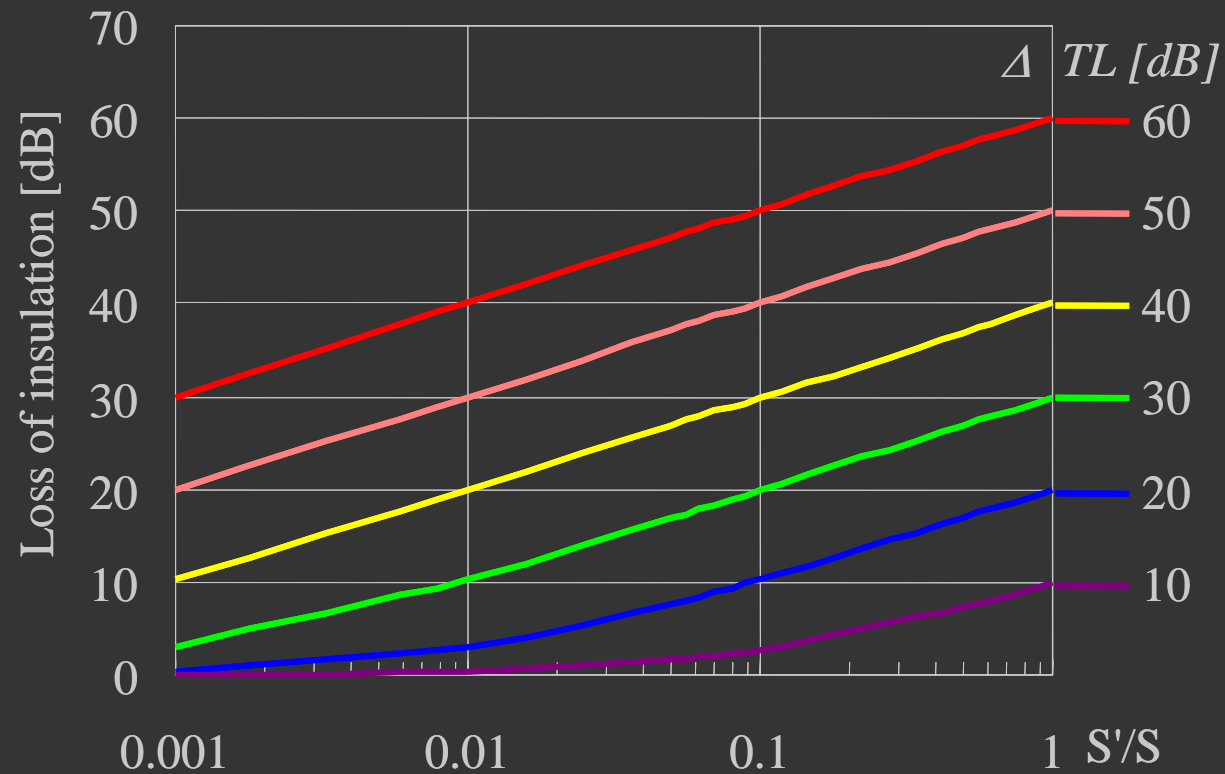
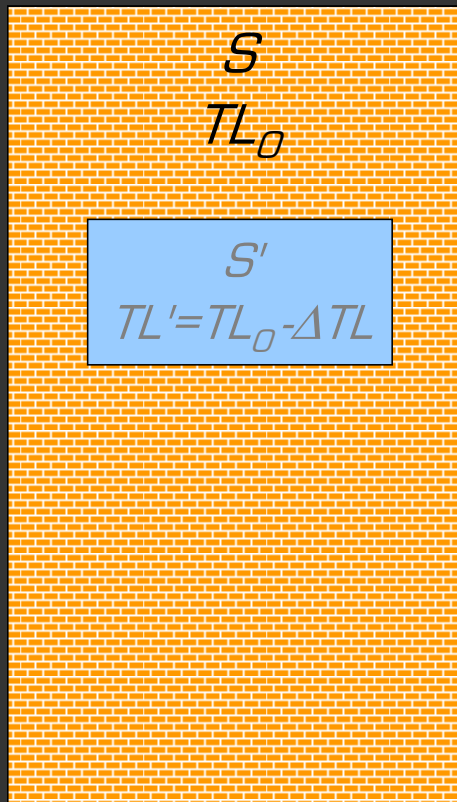
▶ Weakest path



Noise control

- ▶ Sound paths
- ▶ Weakest path

$$TL = TL_0 - 10 \log \left[1 + \frac{S'}{S} \left(10^{\frac{\Delta TL}{10}} - 1 \right) \right]$$



Noise control

▶ Planning phase

- sensitivity to noise
- noise sources
- noise insulation requirements

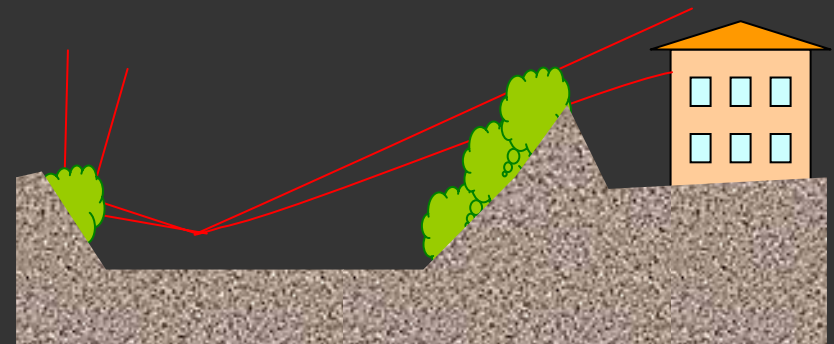
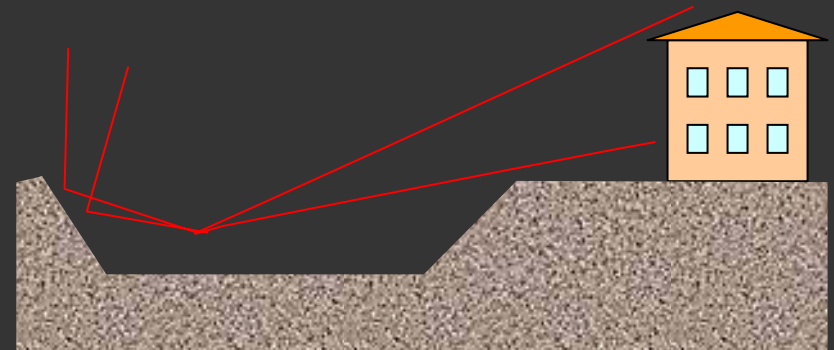
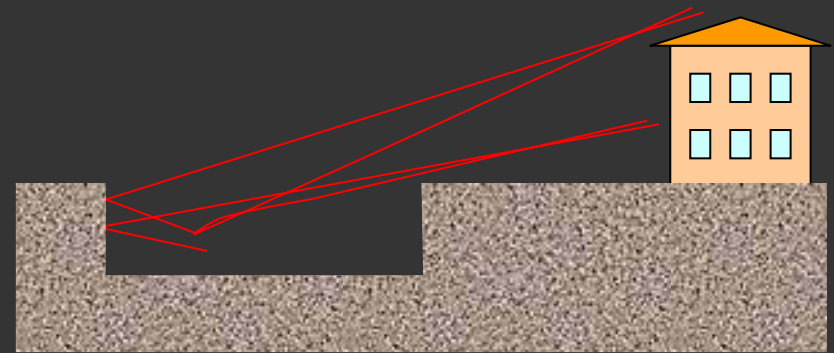
▶ Design phase

- acoustic criteria in positioning and orientation
- calm vs. noisy zones
- construction elements
- technical installations

→ e.g. cavities in walls, no connection between window layers

Noise control

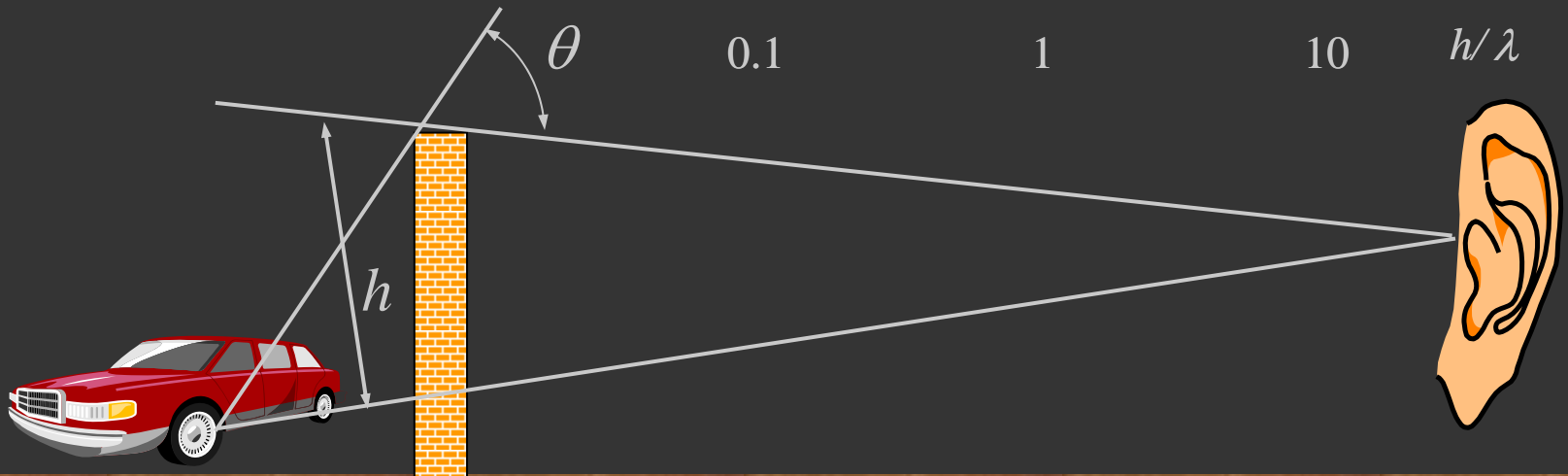
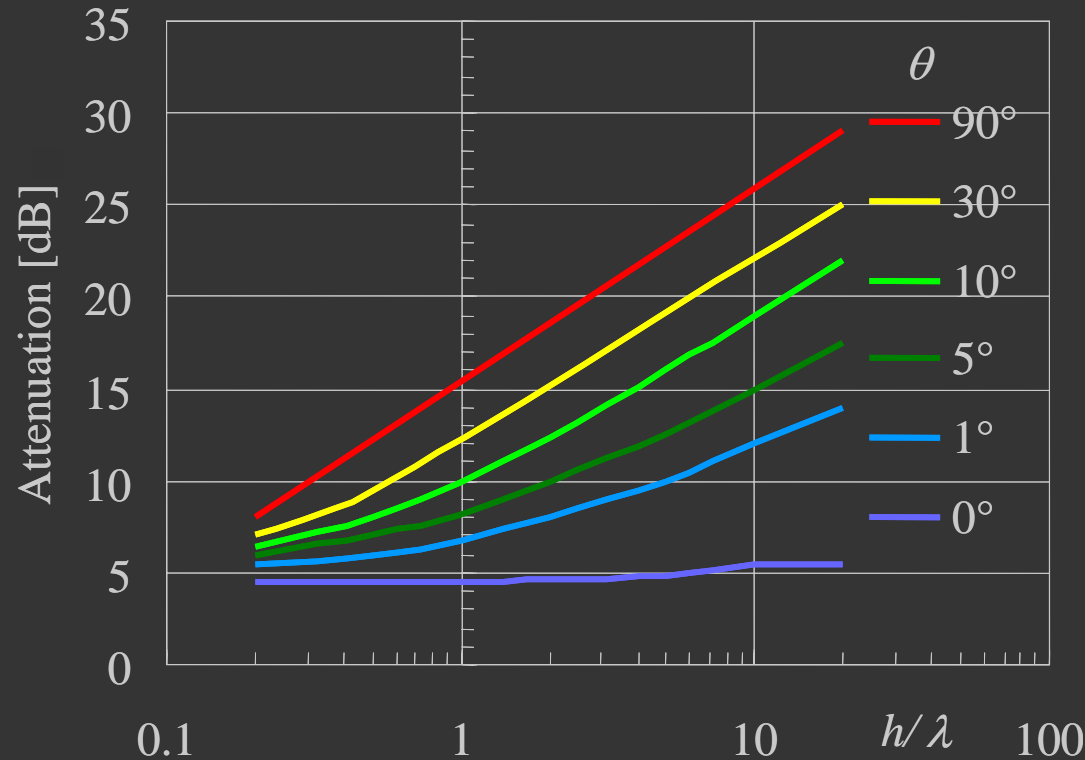
► Environmental noise



Noise control

► Environmental noise

- Anti-noise barriers
 - of "infinite" length

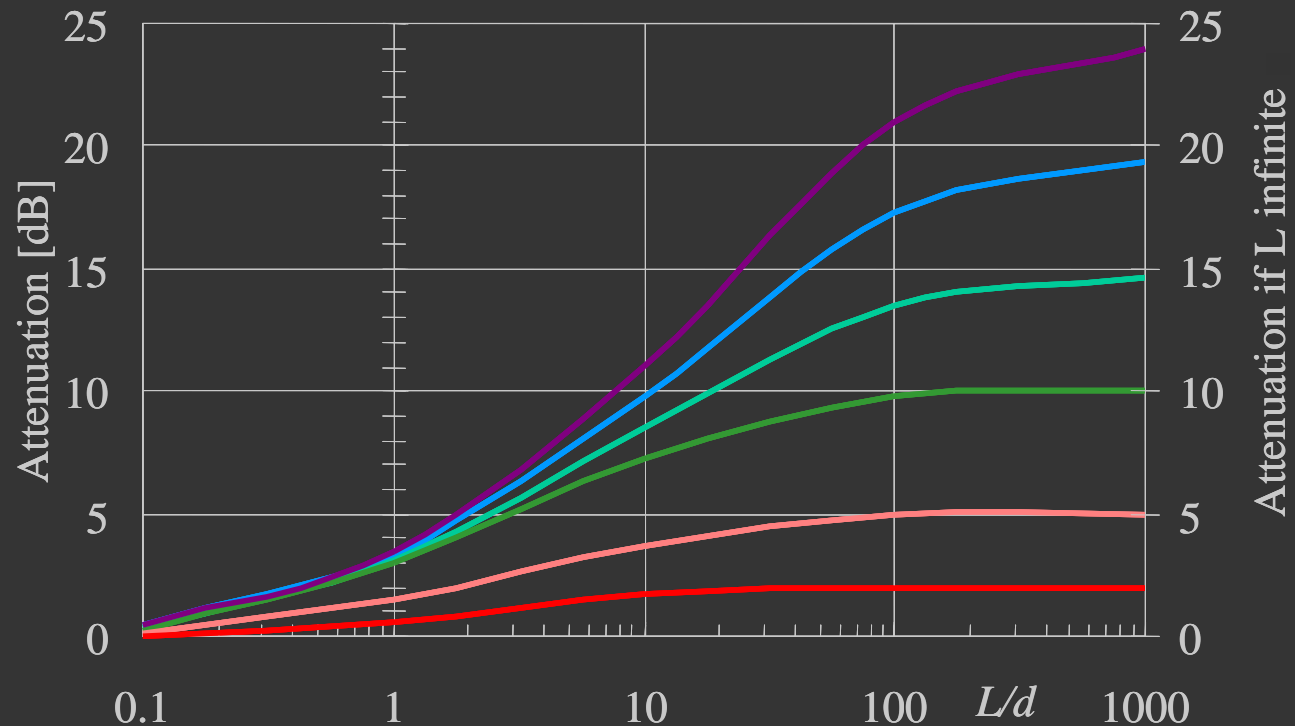
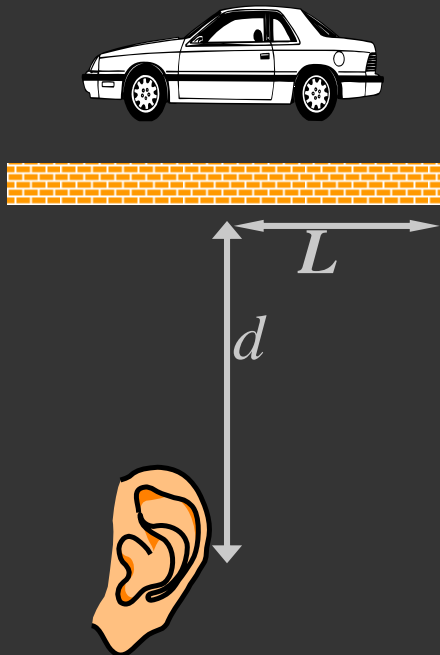


Noise control

► Environmental noise

■ Anti-noise barriers

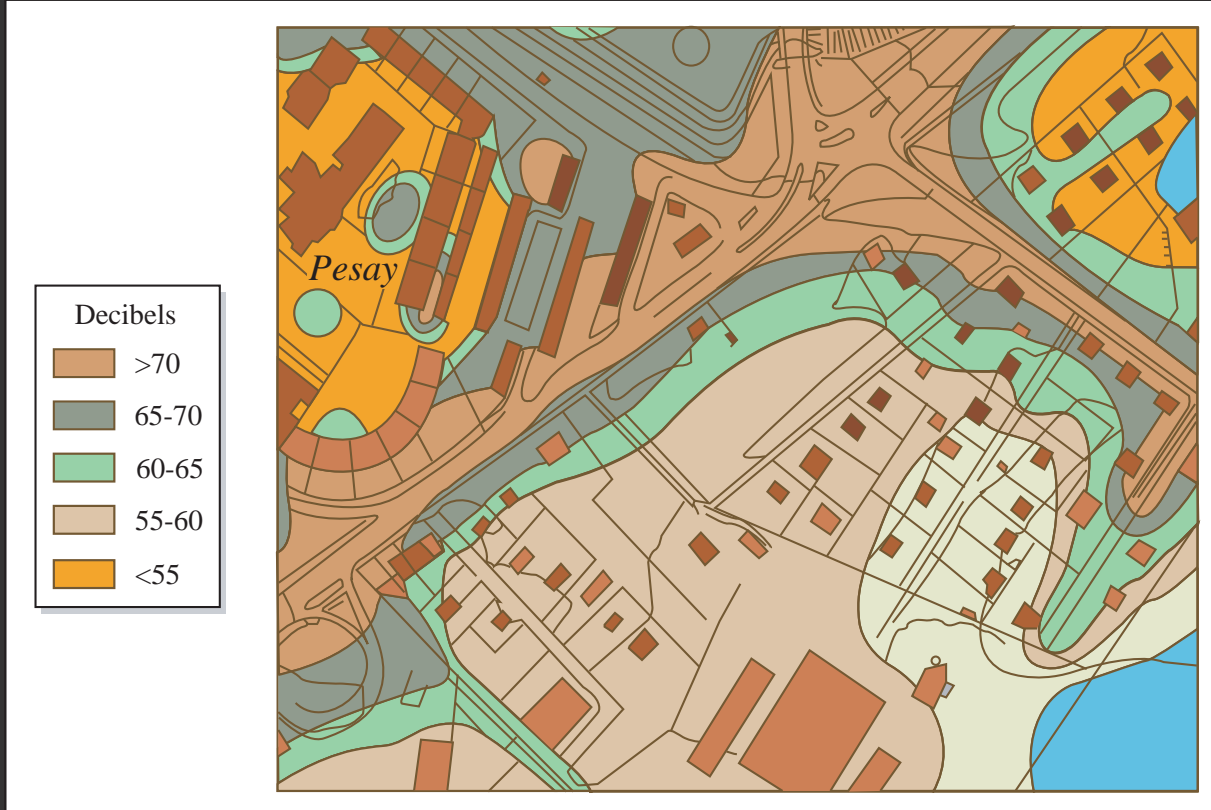
- of "infinite" length
- of finite length L



Noise control

► Environmental noise

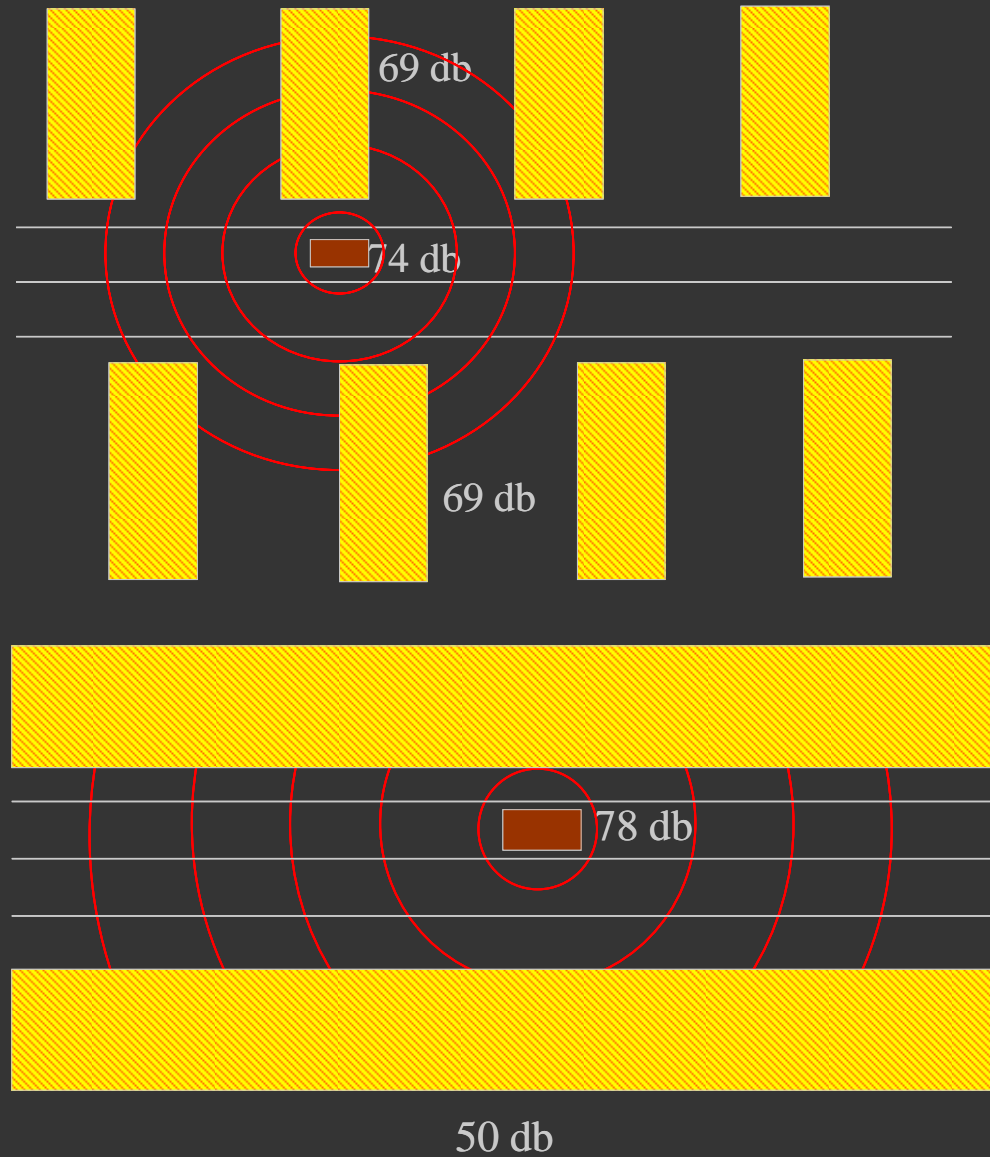
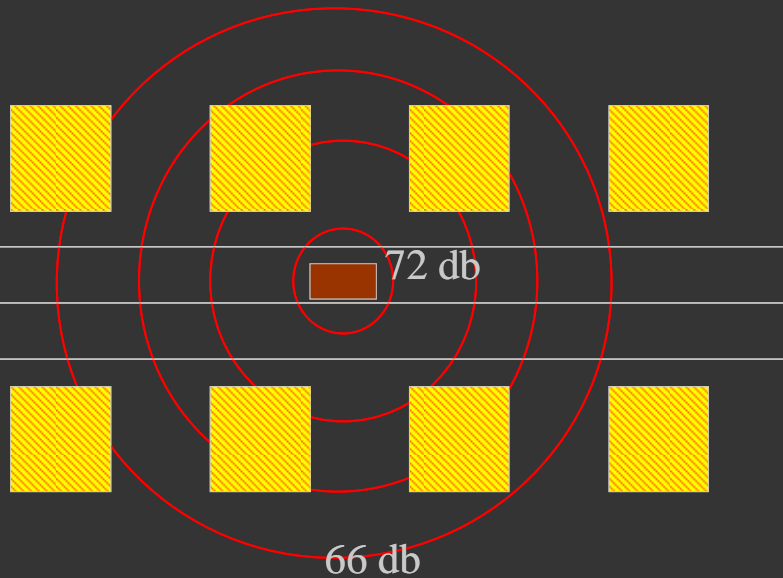
- Anti-noise barriers
- Acoustic urbanism



Noise control

► Environmental noise

- Anti-noise barriers
- Acoustic urbanism



Noise control

► Environmental noise

- Anti-noise barriers
- Acoustic urbanism

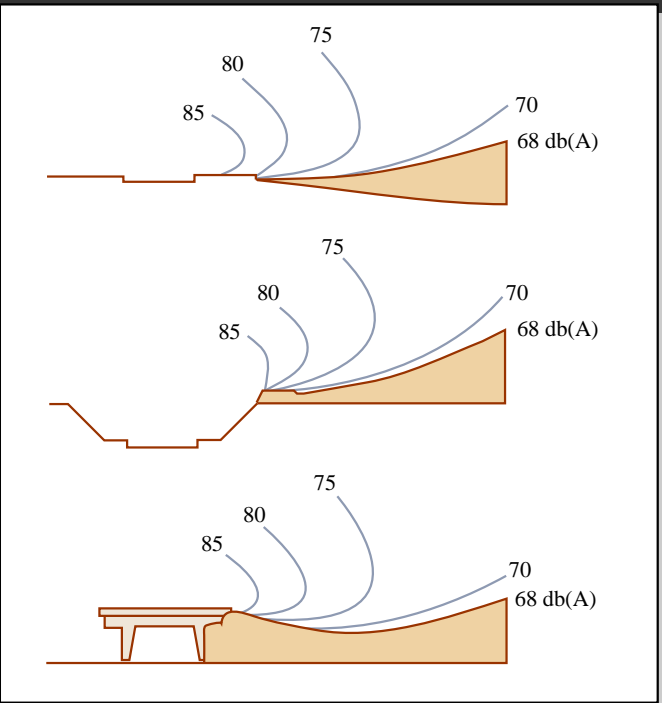


Image by MIT OCW.

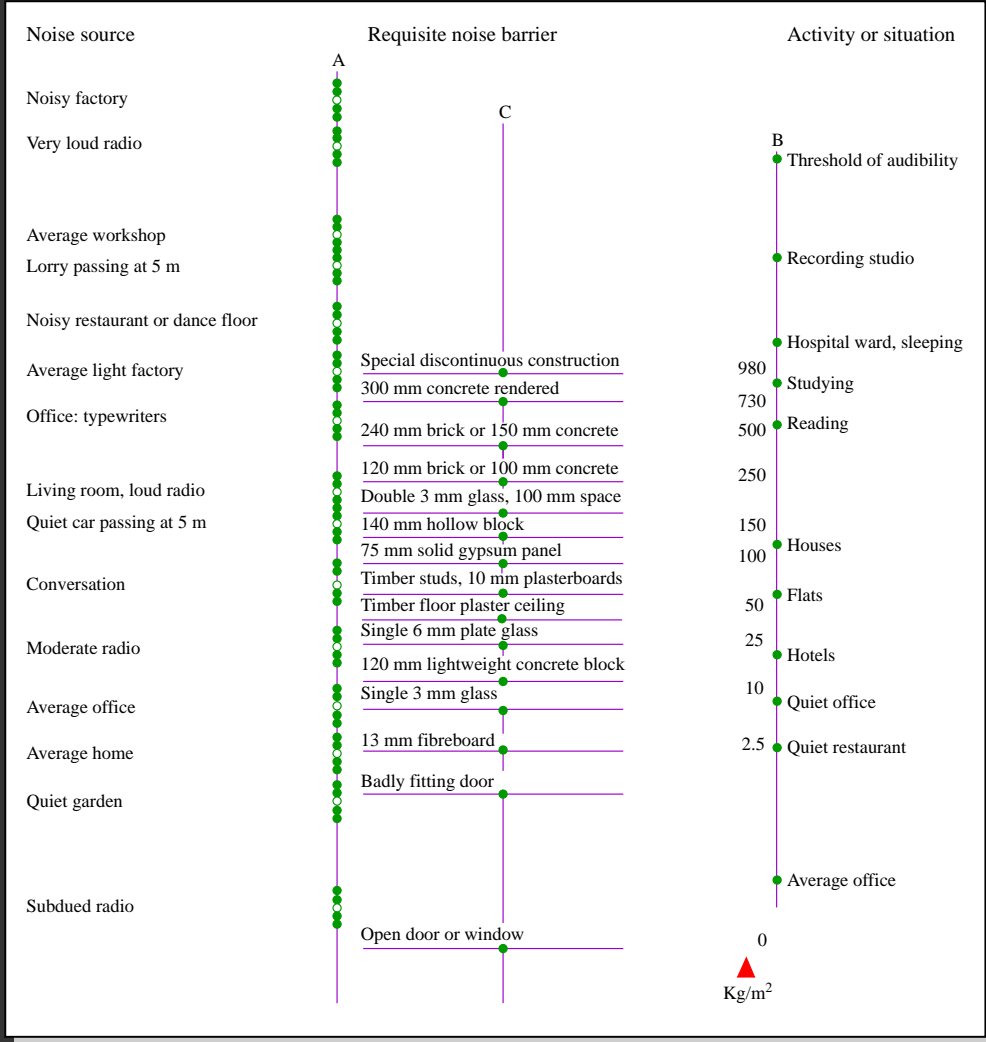
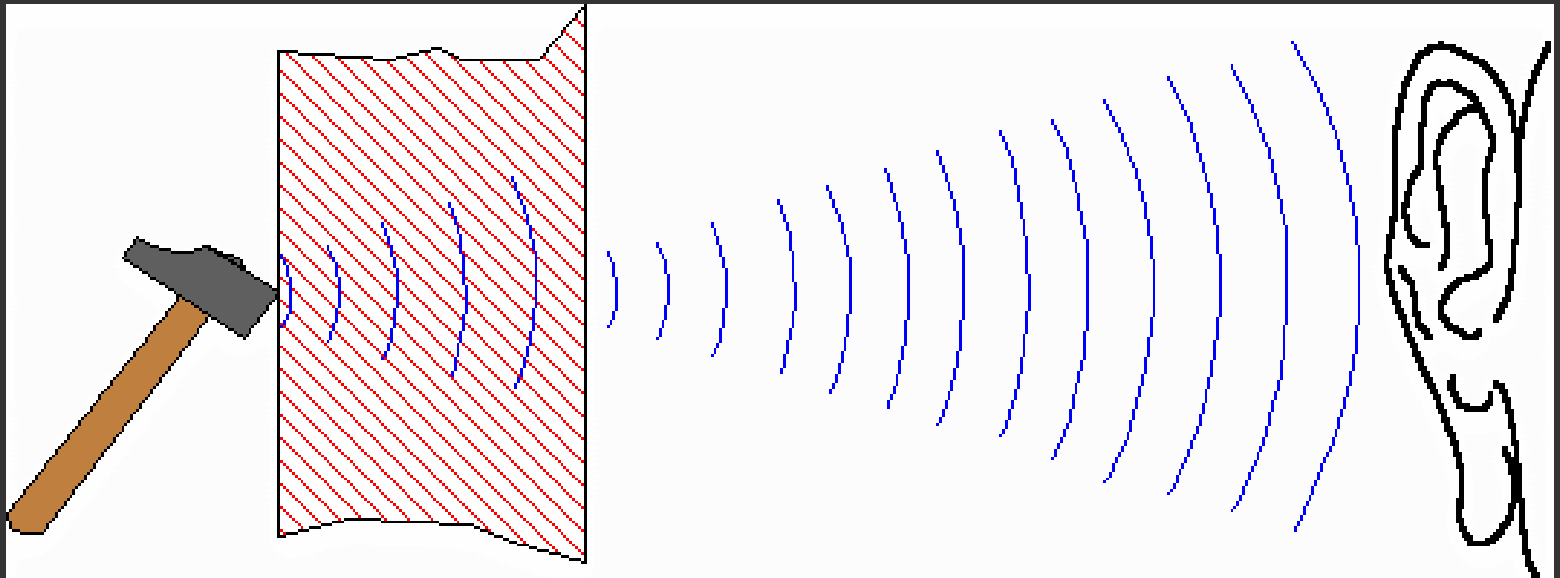


Image by MIT OCW.

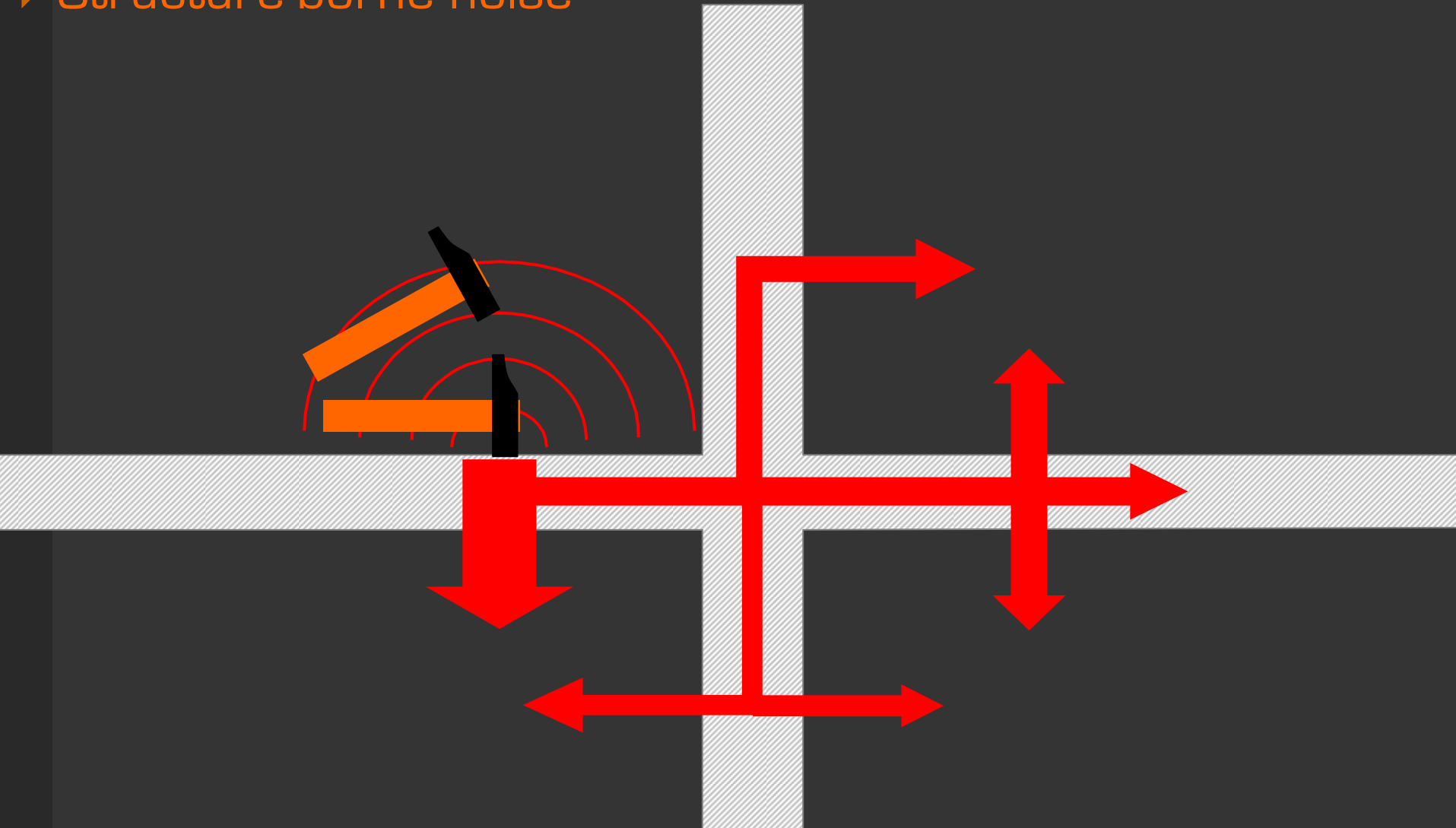
Noise control

▶ Structure-borne noise



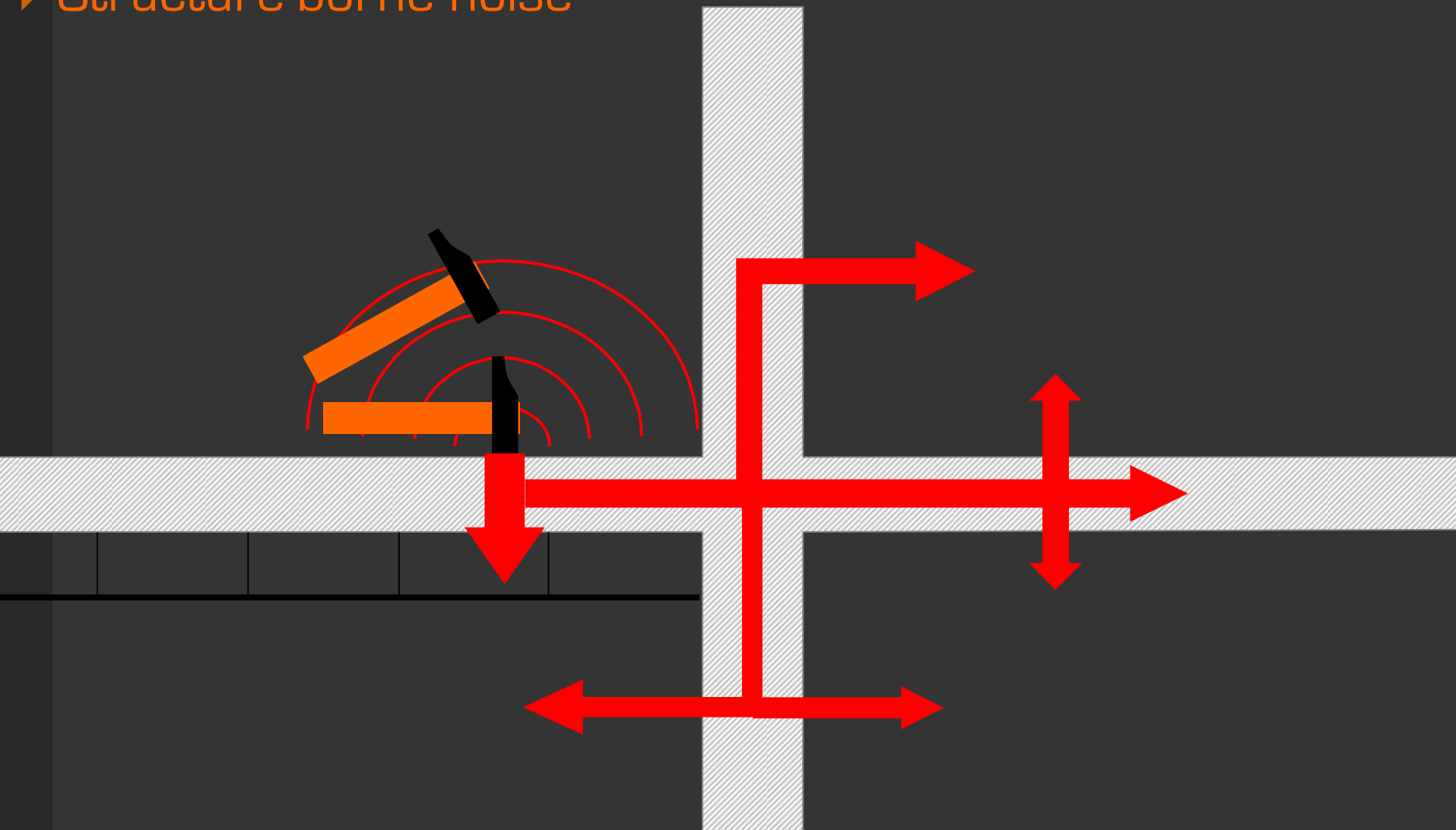
Noise control

▶ Structure-borne noise



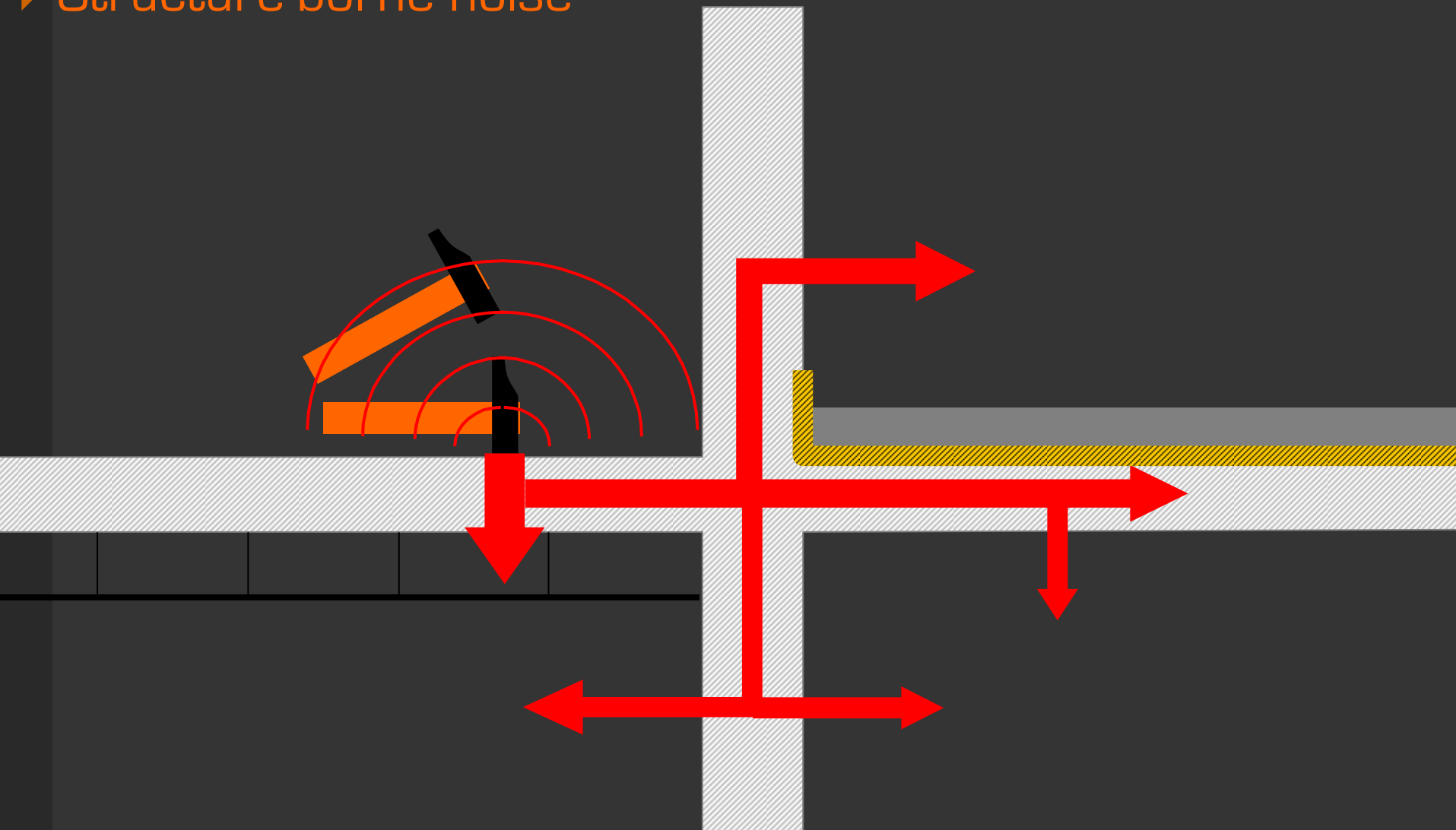
Noise control

▶ Structure-borne noise



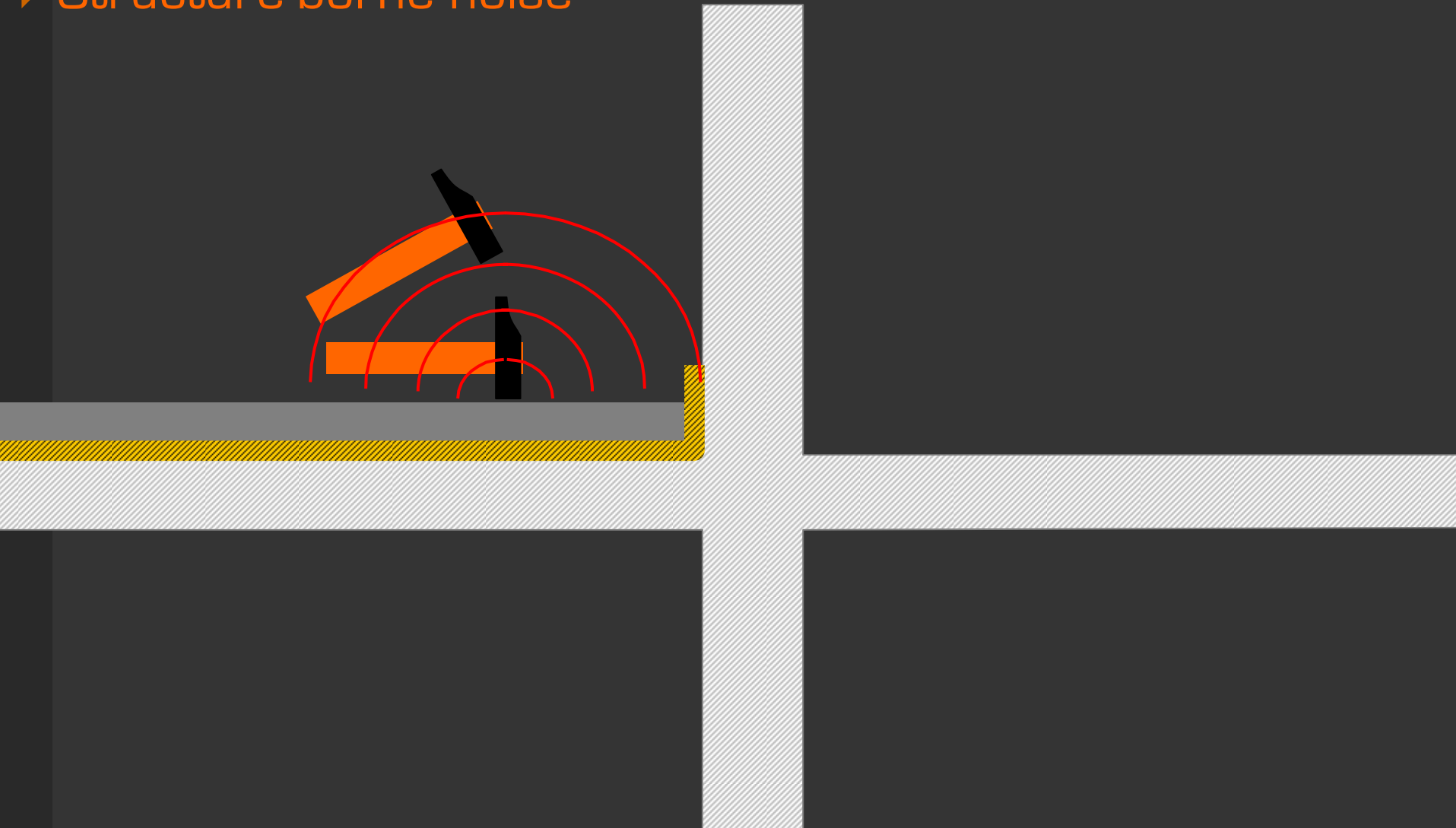
Noise control

▶ Structure-borne noise



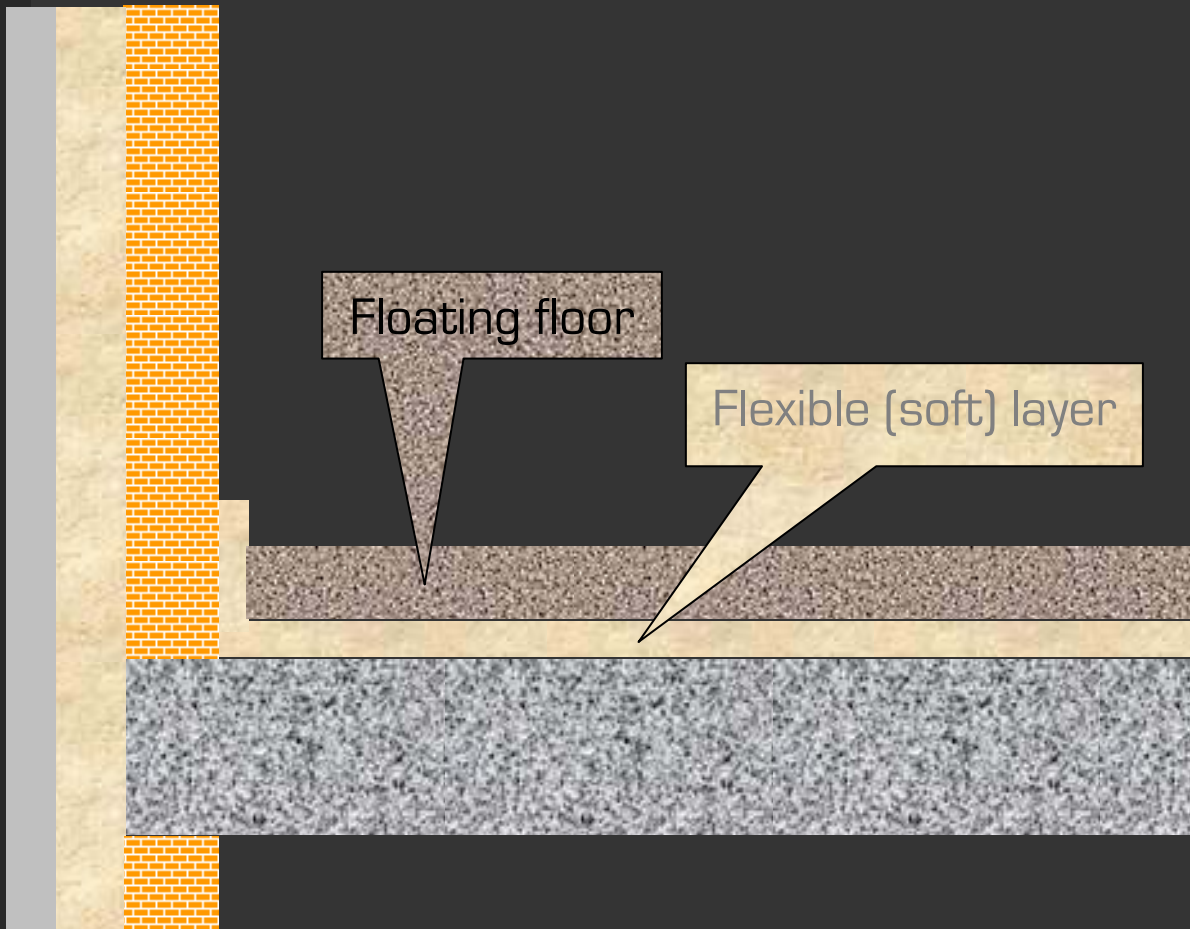
Noise control

▶ Structure-borne noise



Noise control

► Structure-borne noise



Noise control

► Sound source in room

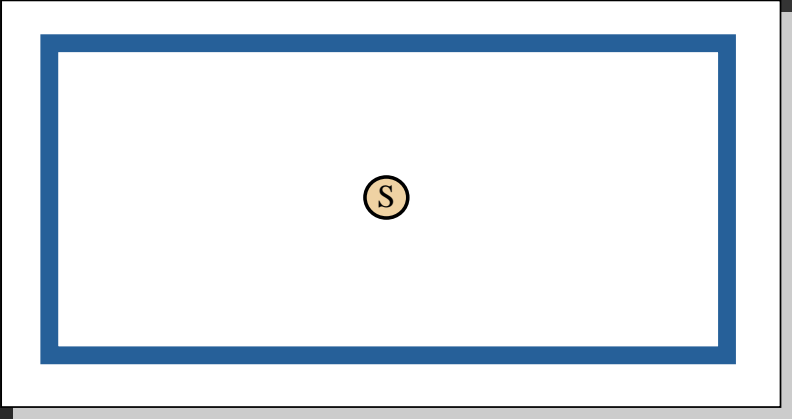
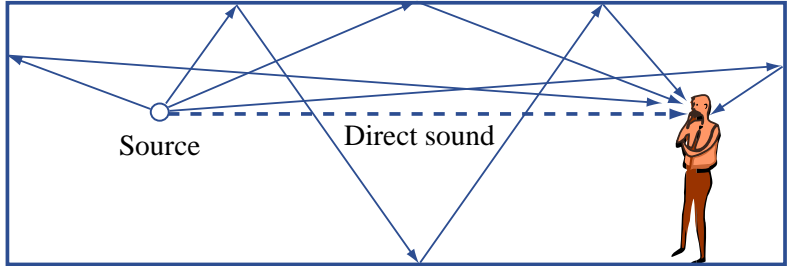


Image by MIT OCW.



Reverberant sound: Sum of an infinite number of paths

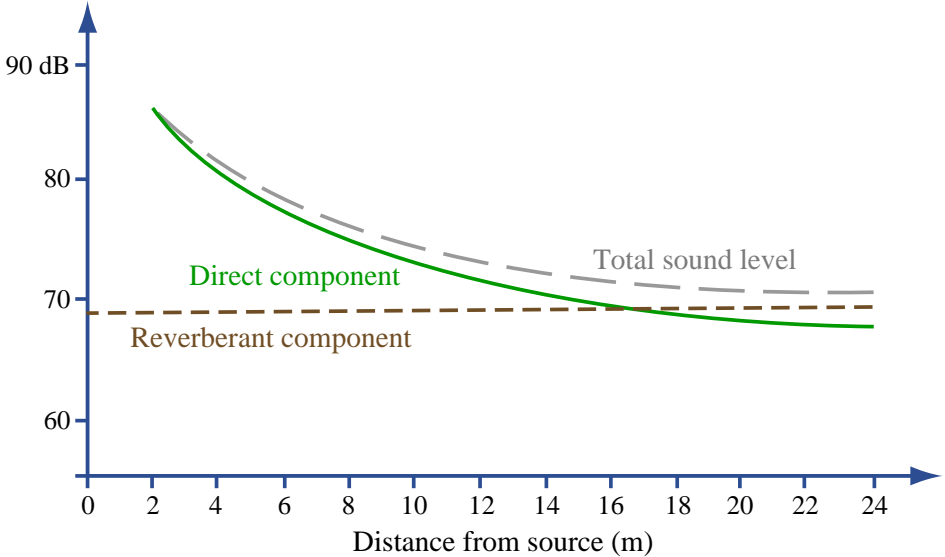
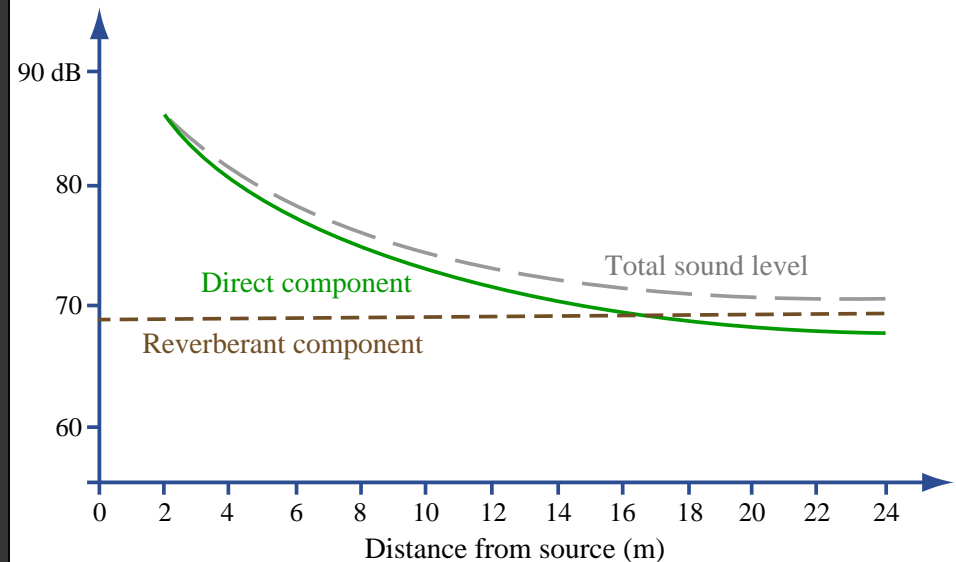
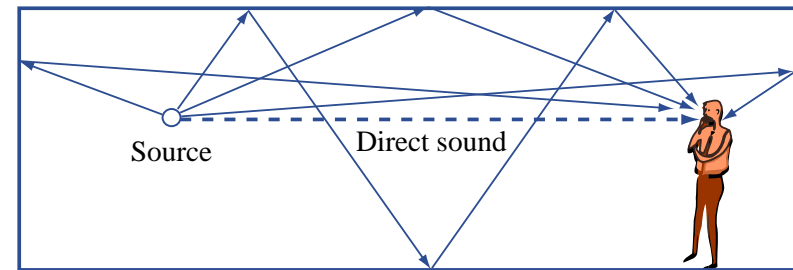


Image by MIT OCW.

Noise control

► Sound source in room

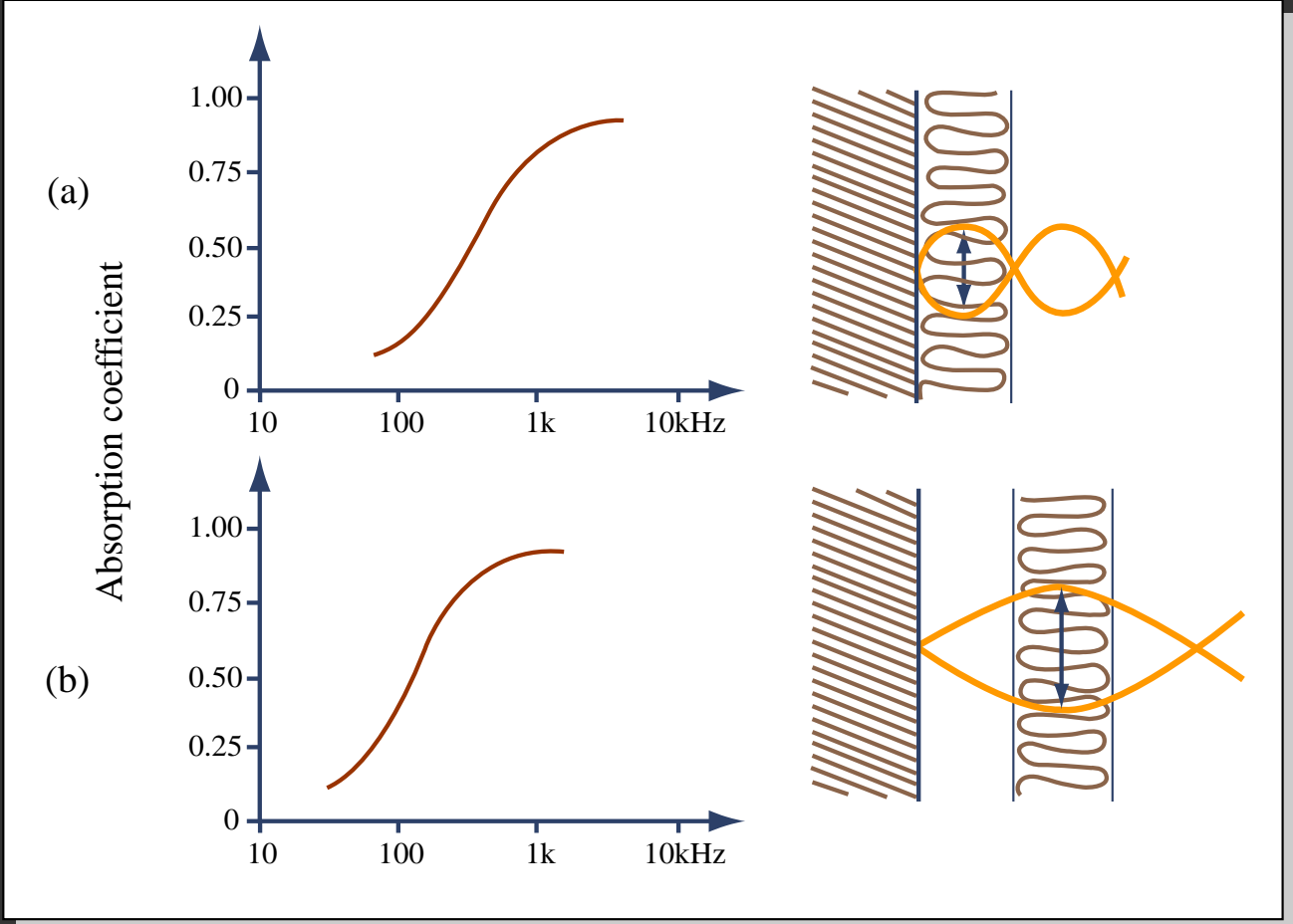
- $I_{\text{abs}} = I_{\text{inc}} \cdot \alpha_s$
- $P_{\text{abs}} = I_{\perp} \cdot A = I_{\perp} \cdot \alpha_s \cdot S$
- $I_{\perp} = \frac{1}{4} I_{\text{stat}}$
- L_{stat}



Noise control

▶ Sound absorbers

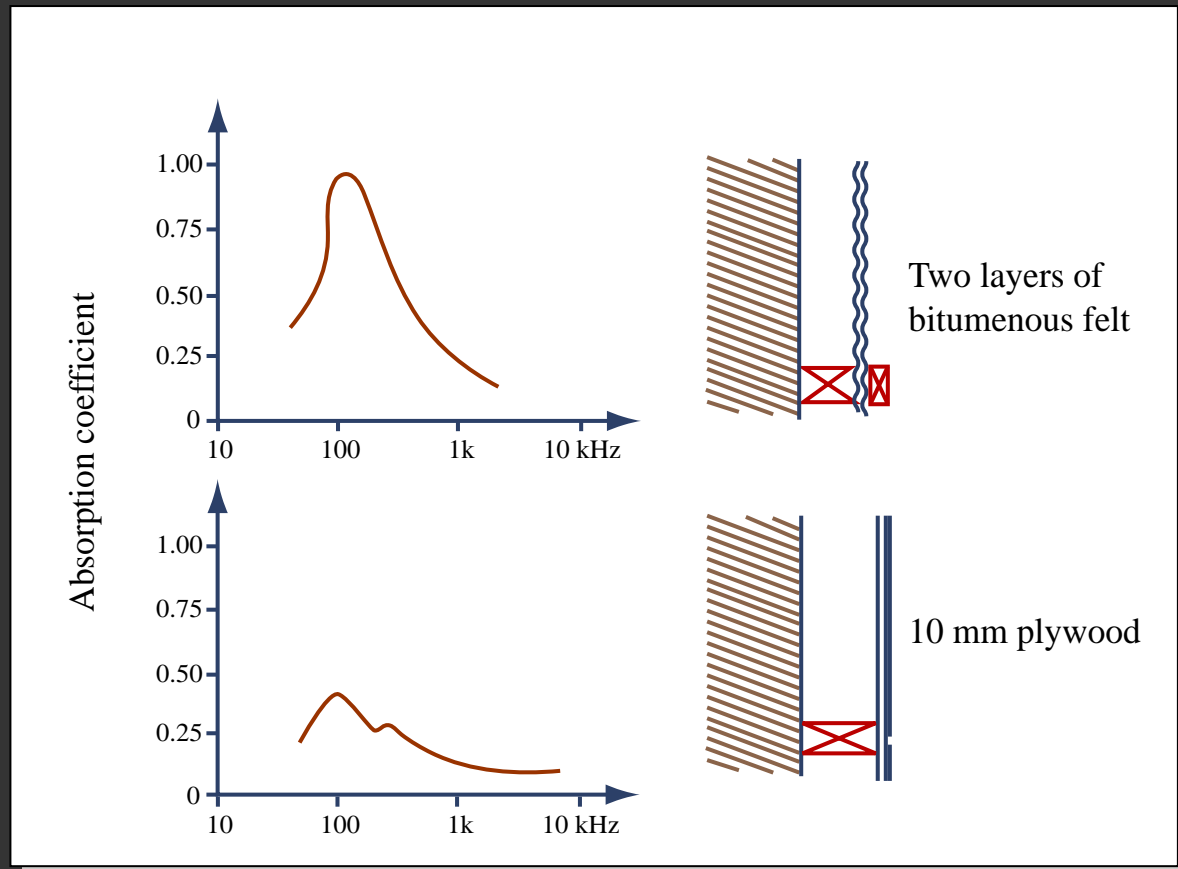
- Porous



Noise control

▶ Sound absorbers

- Porous
- Membrane



Noise control

▶ Sound absorbers

- Porous
- Membrane
- Cavity resonators

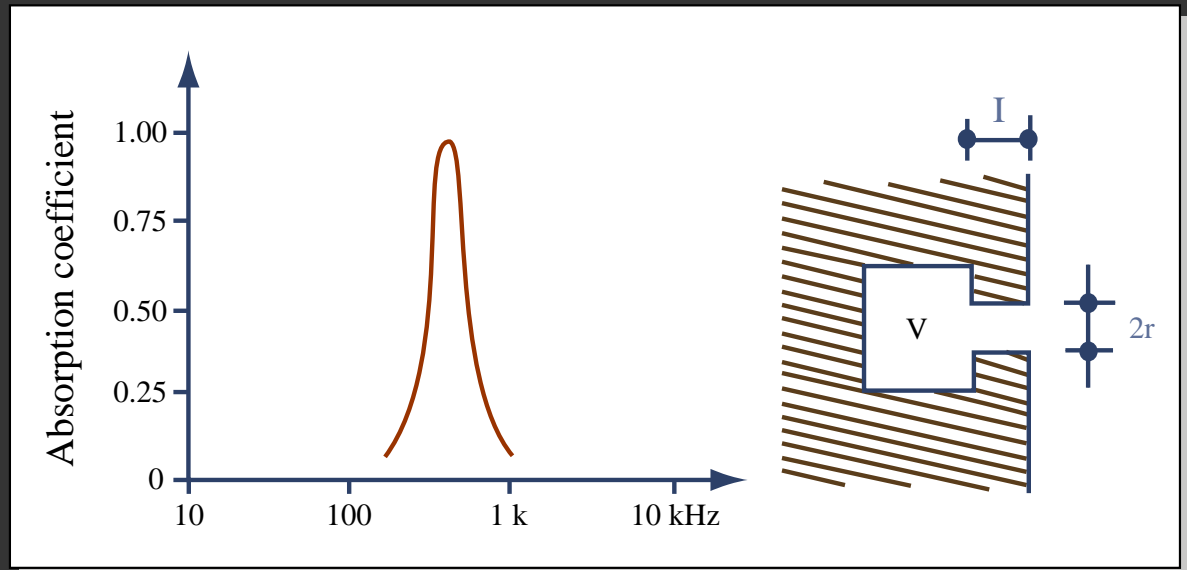
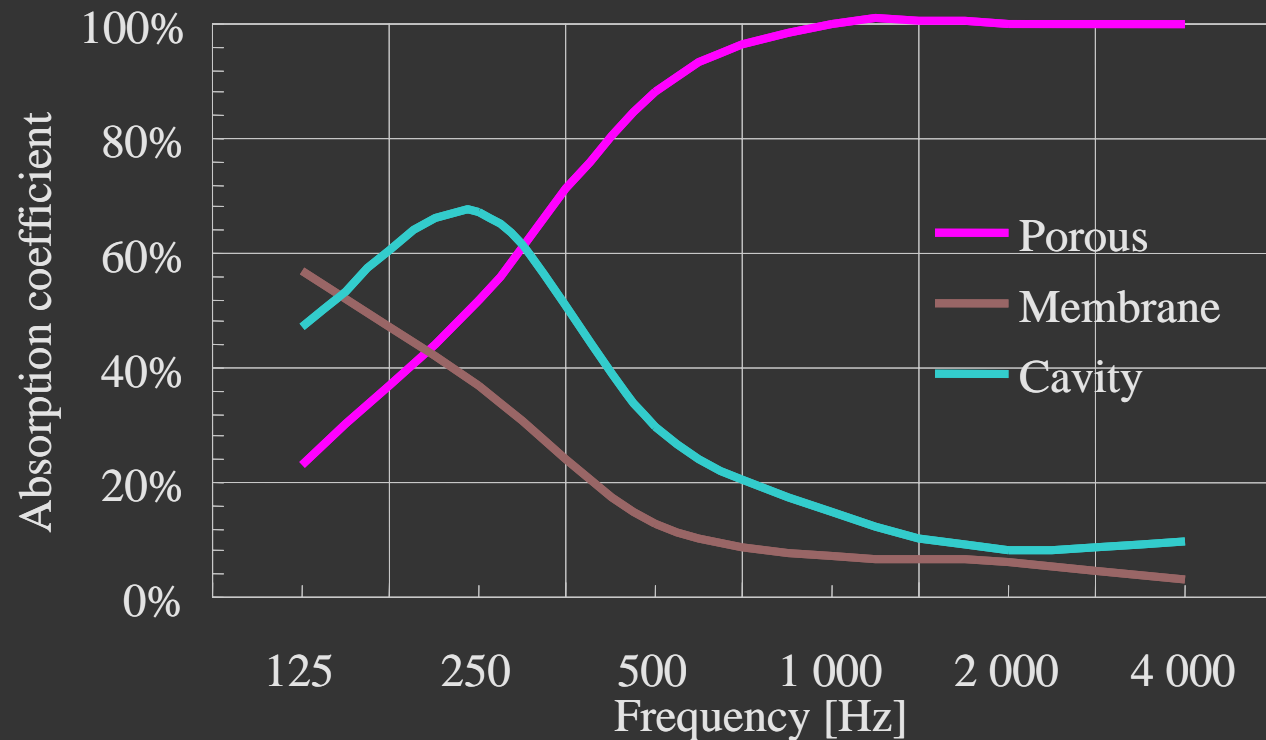


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Noise control

▶ Sound absorbers

- Porous
- Membrane
- Cavity resonators



Noise control

▶ Sound absorbers

- Porous
- Membrane
- Cavity resonators
- Perforated panels

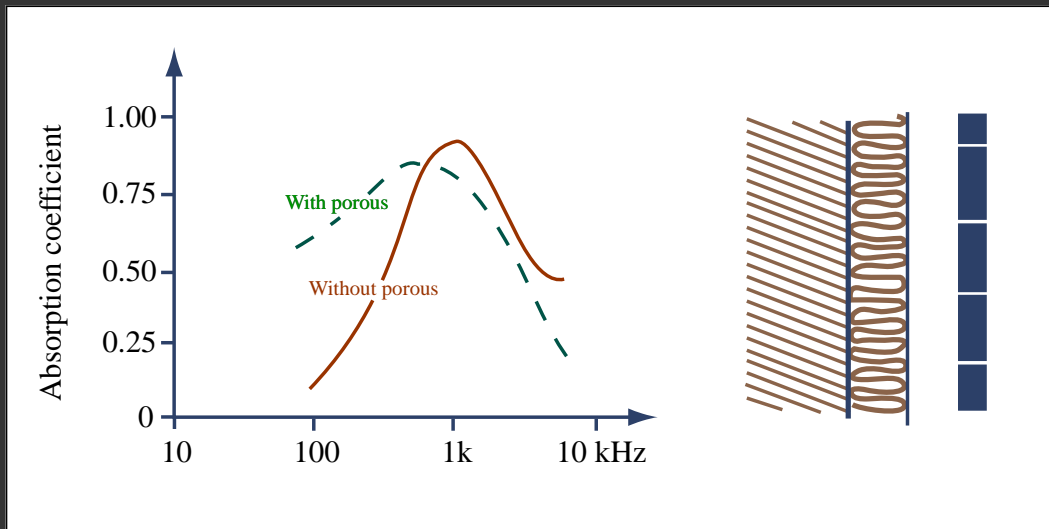


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Noise control

Absorbent baffles

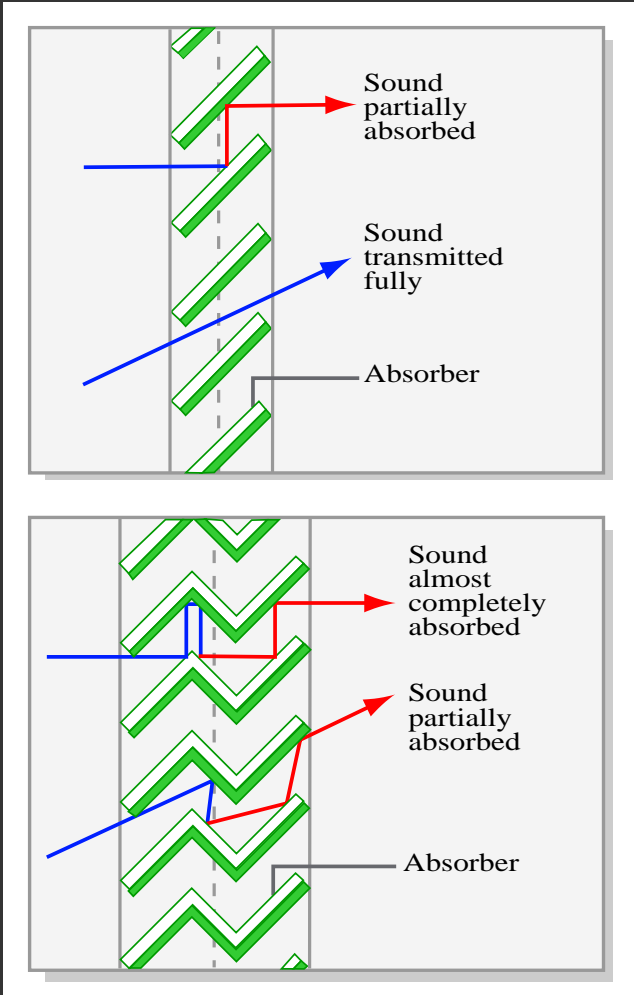


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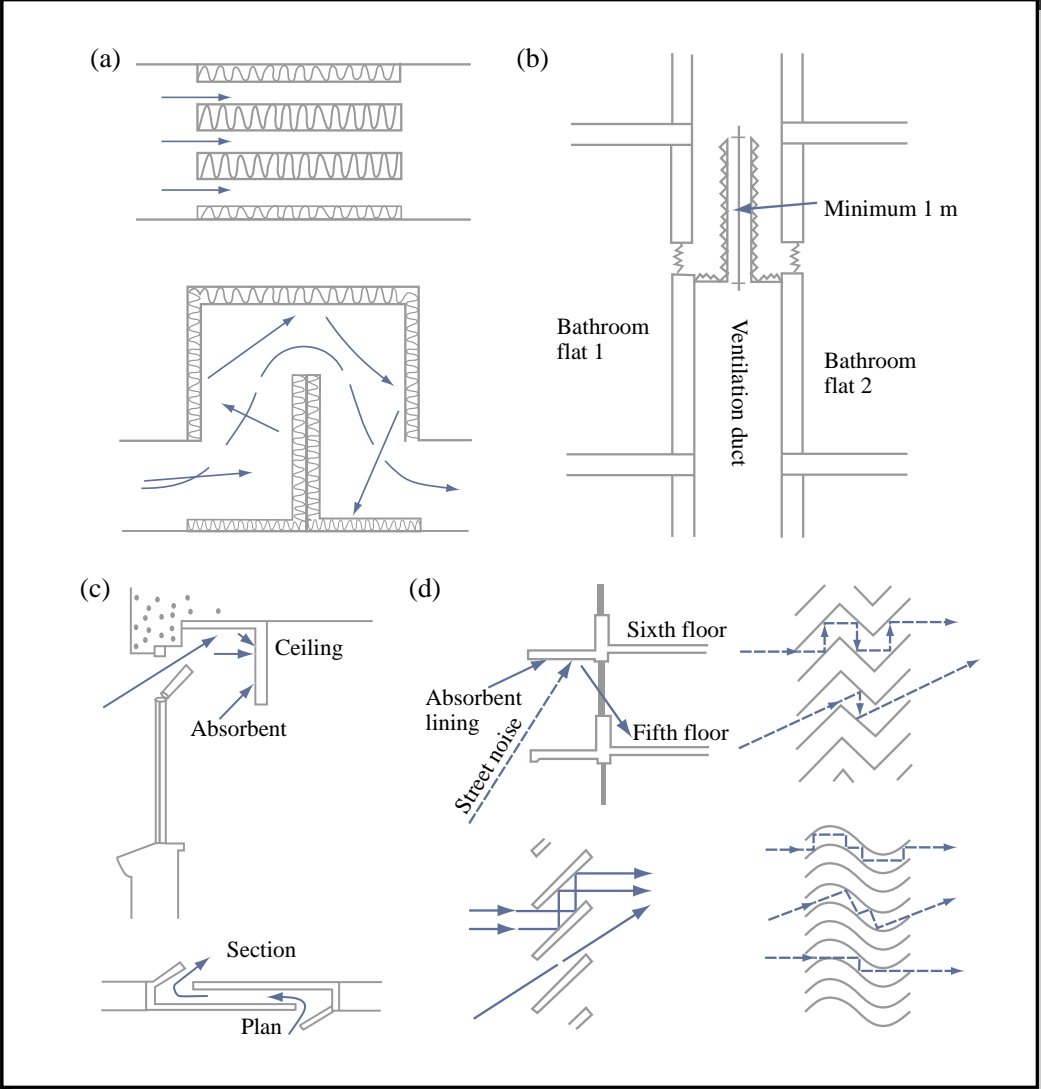


Image by MIT OCW.

Noise Control

- ▶ Reading assignment from Textbook:
 - "Introduction to Architectural Science" by Szokolay: § 3.3
- ▶ Additional readings relevant to lecture topics:
 - "How Buildings Work" by Allen: p. 132 in Chap 14