A GUIDE TO OFFICE ACOUSTICS

Key learning points

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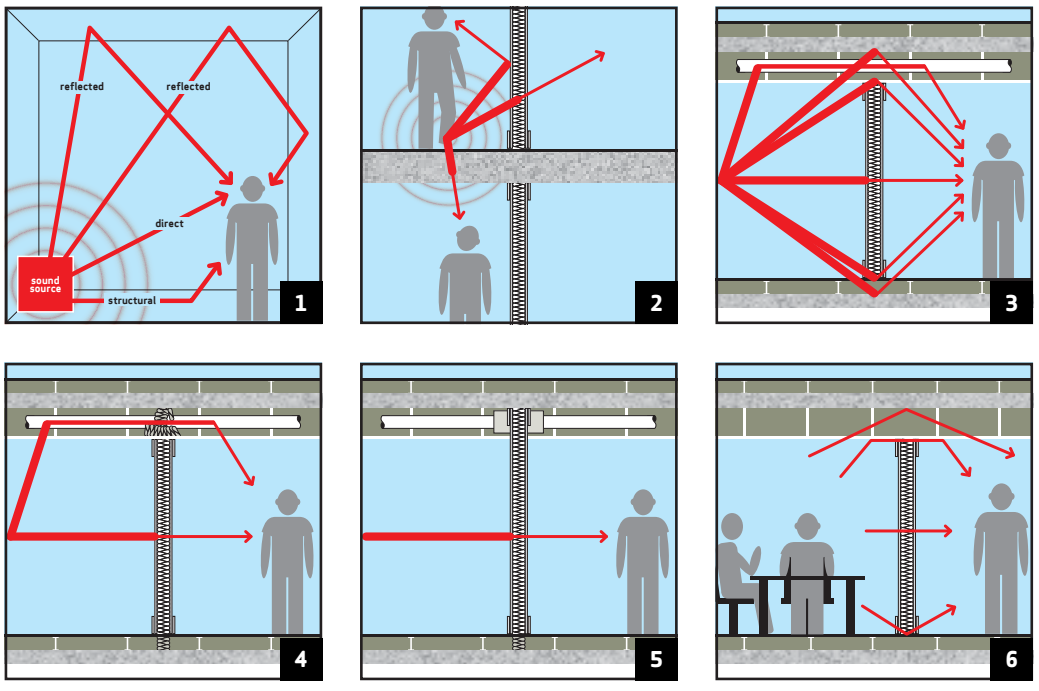


Basic acoustics

- Good acoustics are essential to productivity and creativity in the workplace. Indeed they can be key to the success of a building.
- Acoustic problems and disturbance in a room are often derived from either long reverberation times, which give a room an echoey feel or from noises outside the room and poor sound insulation.
- Sound is a series of waves or pressure fluctuations, which start with an object vibrating. It moves or propagates in the air from its source at about 1,200km/h or 786mph.
- As it travels the sound dissipates. If it hits a hard surface it can reflect (see illustration 1) the reflection can lead to a build-up of sound energy. If it hits a soft surface some of the energy can be absorbed. As the sound encounters objects such as walls the energy passing through them is reduced.
- When sound travels through air it is described as airborne; when it moves through a solid it is termed structure borne (see illustration 2).
- Sound is measured in terms of the frequency of the wave, expressed in hertz (Hz), and the wavelength and pressure level, expressed in decibels (dB).
- Decibels are a logarithmic scale, and are best described using typical noises: shouting (80dBA), a pneumatic drill (100dBA). Sound levels above 120dBA would be the threshold for pain in most humans. We perceive an increase of 10dBA as a doubling of sound.
- Reduction figures of 10dB are describing a perceived reduction of 50% or 20dB being a reduction of 75%. Humans can detect a difference of about 3dB.
- To communicate effectively, normal speech needs to be between 10dB and 15dB above the background noise level.

Acoustic control

- Sound can be controlled in three distinct ways:
  - Absorption, which deals with reverberation within the space.
  - Insulation (attenuation), which deals with the control of sound from one space to another.
  - Diffusion, which scatters the sound.
- Sound reflects in a similar way to light.
- The acoustic quality of a room can be expressed by measuring the reverberation time (RT). If a room has a long reverberation time, one spoken word does not have time to die out before the next reaches the listener.
- In order to reduce reverberation times, sound absorbing products such as ceilings, rafts, wall panels, carpets and free standing structures can be introduced.
- The sound absorption coefficients of a particular material are expressed as α_w – 0.0 being no absorbency and 1.0 being 100%. For ease of comparison, manufacturers categorise products using five performance bands, A to E, where A denotes the highest absorption.
- A products sound insulation performance is expressed as a weighted sound reduction index described as R_w in accordance with BS EN ISO 717-1: 1997. See table 3 for typical performance of partitions.
- If office background noise is too high, productivity is likely to suffer. If background noise is too low, privacy can suffer.
- Research has shown that ceilings have the biggest impact on the acoustic quality of open plan offices.
- The sound insulation performance of the ceiling (see table 1) may be compromised when it is penetrated by lighting fixtures and ventilation ducting grilles (see illustration 3).
- Sound can also be transmitted through building elements, this is known as flanking which can be defined as sound travelling around a sound resisting element (see illustration 3).
- When installing acoustic performance partitioning it should be made as airtight as possible (see illustration 5).
- Wall sockets should not be installed back to back.

Design considerations

- When selecting the performance rating of a partition, background noise levels need to be taken into account. BS 8233: 1999 encourages the principle of acoustic zoning, using the concepts of intrusive noise and privacy factors. Background sound can provide vital masking.
- The cumulative effect of different building elements will affect the overall room to room performance (see illustration 6).
- The speech privacy potential (SPP) combines the partition sound insulation performance expressed in terms of installed D_w with the background noise level in the receiving room expressed in terms of dBA. The higher the resulting SPP, the higher the level of privacy between the rooms (see tables 2 and 4).
- Speech intelligibility defines the degree of privacy in a space. The higher the intelligibility, the better for promoting communication in a space; the lower it is, the better for privacy. Intelligibility is affected by the background noise level and reverberant characteristics of a space.

Table 4

Privacy rating	Speech privacy
High	85
Raised voices are barely audible and unintelligible.	
Good	75
Normal speech is barely audible, raised voices are mostly unintelligible.	
Basic	65
Normal speech can be overheard some of the time, raised voices can be heard.	
Poor	<65
Normal speech can be heard most of the time.	

Table 1 - Typical performance matrix for ceilings by type.

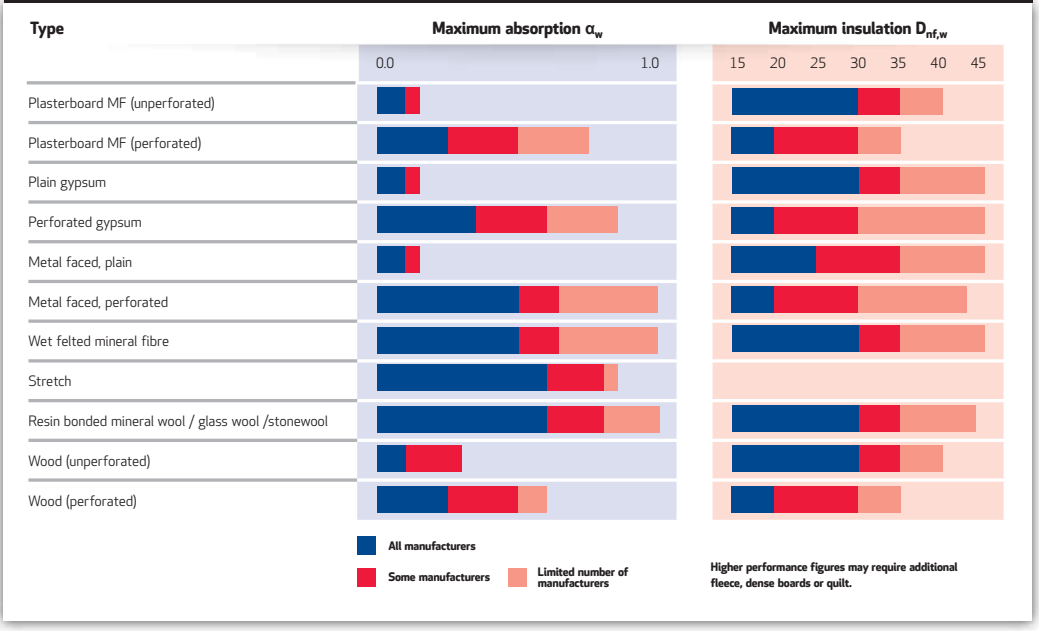
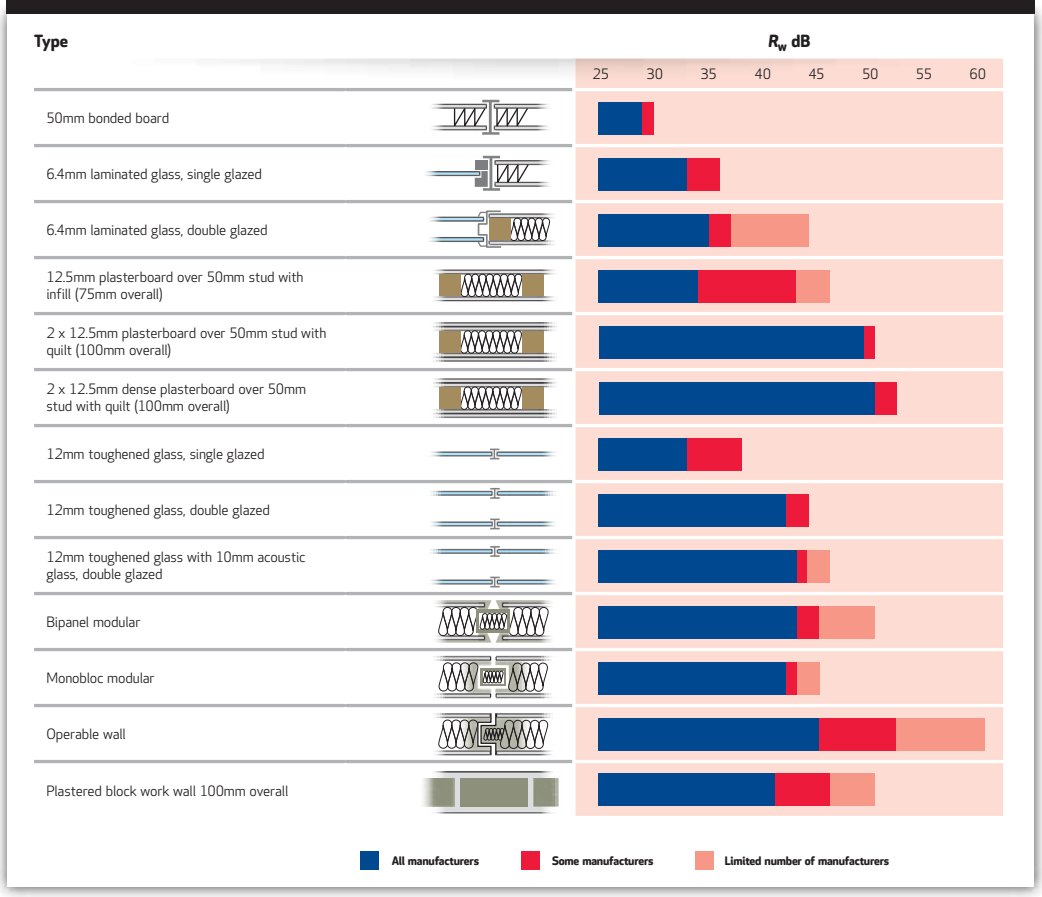


Table 2 - Privacy of speech (loud speech level) from the next office, depending on weighted sound level difference and background noise level in receiving room (assuming full-height partitions).

Weighted sound level difference of partition, D_w	Typical construction	Privacy of speech from next room with a background level of... 25dBA	30dBA	35dBA	40dBA
32dB	8mm laminated glass	Very poor	Very poor	Poor	Poor
37dB	12mm laminated glass with acoustic interlayer	Very poor	Poor	Fair	Words intelligible but not whole sentences
42dB	100mm thick partition comprised of a single layer of plasterboard either side of a galvanised stud partition with an insulating quilt	Poor	Fair	Words intelligible but not whole sentences	Good
47dB	125mm partition comprised of two layers of plasterboard either side of galvanised stud with an insulating quilt	Fair	Words intelligible but not whole sentences	Good	Very good
52dB	155mm partition comprised of two layers of plasterboard either side of a galvanised stud with an insulating quilt	Words intelligible but not whole sentences	Good	Very good	Very good

Table 3 - Typical performance matrix for partitions by type.



FIS
Olton Bridge, 245 Warwick Road
Solihull B92 7AH

+44(0)121 707 0077
info@thefis.org
www.thefis.org

What to consider when designing and installing an office fit out.

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Type of space

Deployment considerations

Other considerations

Steps required for **sound absorption...**

Atria, open plan, rest area, restaurant etc.

Communication generally important.

Where privacy is important ensure that a speech transmission index of ≤0.4 can be achieved between adjacent areas.

The suspended ceiling will provide the greatest effect on absorption in a space.

Consider absorbent baffles on the walls or ceiling to absorb and diffuse sound.

Consider installing ceiling rafts and islands to increase absorption where exposed soffits are used.

Consider lowering the ceiling between work clusters.

Too much absorption can make a space unnaturally dead.

Too little will mean long reverberation times, leading to increased sound levels as people raise voices to be heard over sound that has not decayed.

Outset considerations common to both **sound absorption** and **sound insulation...**

Zone the space, putting areas of communication in the quietest part of the building, and areas of privacy with higher levels of background noise.

Determine the acoustic requirement of the space.

Understand the background noise of the space from all external and internal sources.

Establish suitable reverberation times and noise levels for the space (see performance criteria in the guide for reference).

The size, including height, shape and internal finishes will affect the acoustic properties of the space: ensure these are taken into account.

Consider the services of an acoustician - a list of qualified professionals is at www.ioa.org.uk and www.association-of-noise-consultants.co.uk

Remember that sound insulation affects users in adjacent spaces, while sound absorption affects the quality of the sound in the space.

Understand the effect on acoustics if an exposed soffit is used, as the lack of an absorbant ceiling could result in increased reverberant noise level or the lowering of background noise where mechanical ventilation is absent.

When looking at test data, check that the test data is still relevant, and ask to see the whole report detailing the composition and assembly of the system.

Ensure that the products are installed fully in accordance with the manufacturer's method of build.

Consider additional absorption in areas of highly reflective surfaces, such as glass or polished plaster.

Be prepared to carry out additional works to fine tune the space in use.

Steps required for **sound insualtion...**

Meeting room, conference room, cellular space etc.

Privacy generally important.

Consider planning offices and meeting areas where background sound (eg from ventilation or office activity) can mask conversation and assist in privacy.

Where communication is important ensure that a speech transmission index of ≥0.6 can be achieved within the communication zone.

Look at the sound insulation requirements separately to sound absorption, ie partitions, doors, floors.

Where privacy is important ensure that the partition can achieve the required $D_{nf,w}$ / D_w by specifying the insulating factors of all the elements separately from sound absorption.

When considering the insulating value of partitioning, understand that an onsite test $D_{nf,w}$ / D_w will be lower to the laboratory test of R_w by between 3-8dB dependant on the partition type (eg lightweight stud or blockwork).

Consider the effect of flanking paths above ceilings or building services.

Balance the benefit of flexibility afforded by installing partitioning to the underside of the suspended ceiling (with appropriate cavity barriers in place) against additional performance but with additional cost and disruption should the partition need moving.

Understand that curved meeting rooms can create an unnatural focal point for sound within the space.