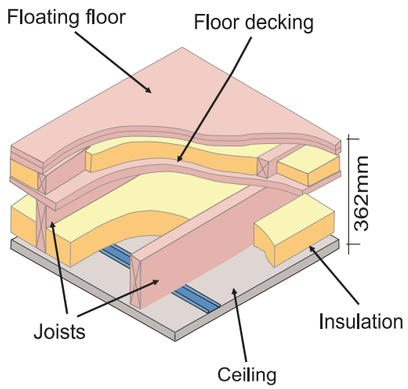
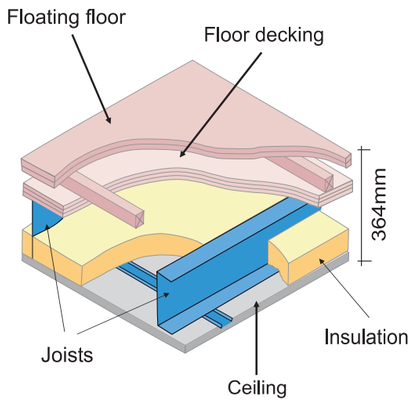
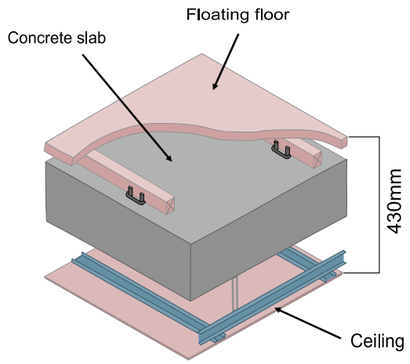
- **Separating floors**
  - Light steel framing with a minimum of 225mm deep steel joists with no less than 100mm thick mineral wool quilt insulation (density of 10 to 36 kg/m³) between joists. Floating floor consisting of 18 to 22mm flooring board on battens with a 70mm void above 22mm thick wood-based board with a minimum density of 600 kg/m³ fixed to the joists. Minimum of two layers of 12.5mm thick gypsum-based ceiling board (24 kg/m²) on resilient bars fixed to the underside of the joists. Overall depth 364mm



  - Minimum of 220mm deep solid timber joists at a maximum of 400mm cross-centres with no less than 100mm thick mineral wool quilt insulation (density of 10 to 36 kg/m³) between joists. Floating floor applied on top of a minimum of 11mm thick wood-based board with a minimum density of 600 kg/m³ fixed to the joists. Floating floor consisting of 18 to 22mm flooring board on battens with a 70mm void above 25mm thick mineral fibre. Minimum of two layers of 12.5mm thick gypsum-based ceiling board (24 kg/m²) on resilient bars fixed to the underside of the joists. Overall depth 362mm



  - Minimum of 250mm in situ concrete floor slab (density of 2400 kg/m³) with no less than 40mm screed applied directly to the top of the slab (with a minimum mass of 80 kg/m²). Floating floor applied to top of screed consisting of 18 to 22mm flooring board on 30mm mineral batt insulation (minimum 140 kg/m³). One layer of 12.5mm thick gypsum-based ceiling board (8 kg/m²) suspended from timber or metal ceiling system with a minimum 75mm ceiling void. Overall depth 430mm



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Acoustics

Sound is produced when objects vibrate in air. The movement causes air particles to vibrate giving rise to rapid pressure fluctuations that are detected by the ear. Two important characteristics of sound which humans can detect are:

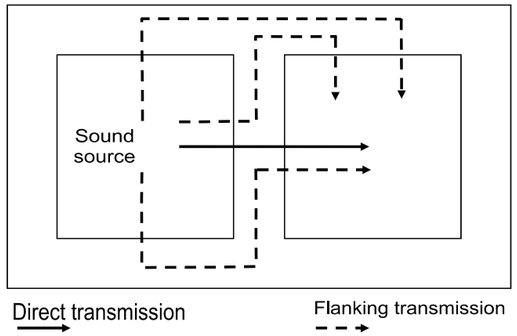
- The level or loudness.
- The pitch or frequency.

Sound levels and sound insulation (i.e. attenuation) values are expressed in decibels (dB), whilst frequency is expressed in Hertz (Hz). In the case of sound levels, the decibel rating is a representation of the volume of the sound; whilst, in the case of sound insulation values, it is a measure of the amount by which sound transmitted from one room to another is reduced by the separating construction.

There are two types of sound that should be considered in the acoustic design of buildings:

- Airborne sound.
- Impact sound.

Airborne sound insulation is important for both walls and floors. The measure that is in most use internationally is defined by ISO 10140-1[1] as the weighted standardised level difference $D_{n,Tw}$; the higher the value of $D_{n,Tw}$, the better the performance. Impact insulation is defined by the standardised impact sound pressure level $L'_{n,Tw}$, which is generally only relevant to floors; the lower the value of $L'_{n,Tw}$, the better the performance.



Transmission of Sound

Where rooms are separated from one another, sound can travel by two routes: directly through the separating structure, which is known as *direct transmission*, and around the separating structure through adjacent building elements, which is called *flanking transmission*. These routes are indicated in the figure above. Sound insulation for both routes is controlled by the following three characteristics:

1. Mass

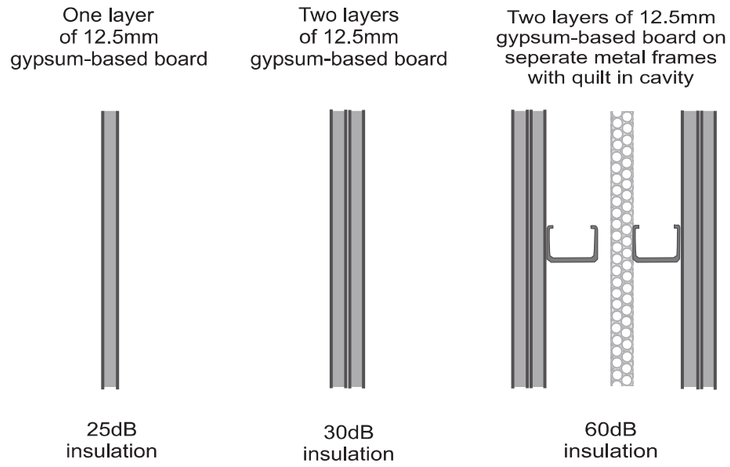
Transmission of airborne sound will obey what is known as the *mass law*. In principle, the law suggests that the sound insulation of a solid element will increase by approximately 5 dB per doubling of mass. The mass law is applicable between 10 kg/m² and 1000 kg/m². However, this is

[1] ISO 10140-1, Acoustics -Laboratory measurement of sound insulation of building elements - Part 1: Application rules for specific products, International Organization for Standardization (ISO), Geneva, Switzerland, 2010

only applicable to solid elements and is insufficient in itself to satisfy modern sound insulation requirements.

2. Isolation

Lightweight framed construction achieves far better standards of airborne sound insulation than the mass law would suggest because of the presence of a cavity, which results in a degree of isolation between the various layers of the construction. It has been demonstrated[2] that the sound insulation of individual elements within a double skin partition tend to combine together in a simple cumulative linear relationship. As a consequence of this, two comparatively lightweight partitions of 25 to 30 dB sound reduction can be combined to give an acoustically enhanced partition with a 50 to 60 dB sound reduction; however, the mass law alone would have suggested only a 5 dB improvement. This performance is shown graphically in the figure below (the width of the cavity between separate layers is important to the acoustic performance of a wall, and the cavity width should be at least 40mm).



Sound insulation by layers

3. Sealing

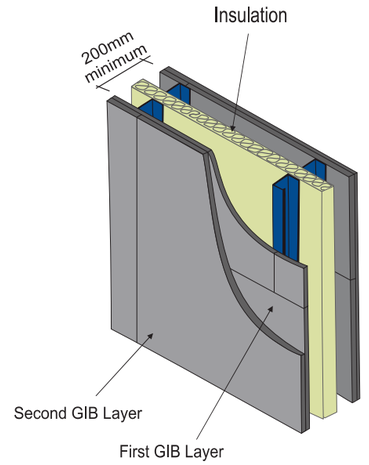
It is important to provide adequate sealing around floors and partitions because even a small gap can lead to a marked deterioration in acoustic performance. Joints between walls as well as between walls and ceilings should be sealed with tape or caulked with sealant.

Acoustic performance in residential construction depends not only on the integrity of detailed design, but also significantly on the quality of construction. Recognising this, the UK has adopted a series of Robust Details[3], which have been proved by tests to be capable of consistently exceeding the performance standards given within the building regulations. As the only other alternative in the UK is to undertake pre-completion testing, the steel, timber, concrete and masonry industries have been quick to develop Robust Details for their systems. Designers have benefited from the publication of Robust Details in that it has permitted direct comparisons to be made between different construction methods. In the context of light steel framing, Robust Details have shown the following equivalence in performance for direct sound transmission:

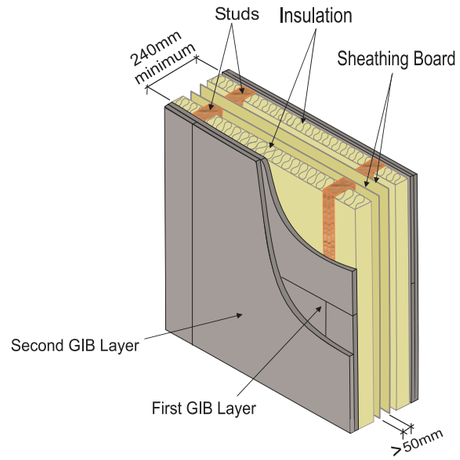
[2] Way, A.G.J. & Couchman, G.H. Acoustic detailing for steel construction, SCI P372, Steel Construction Institute, Ascot, UK
[3] *www.robustdetails.com* , accessed April 2013

- **Separating walls**

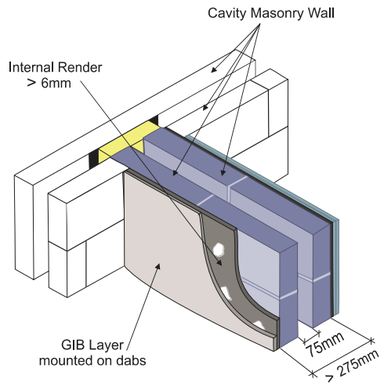
  - Light steel framing with two rows of studs separated by a minimum of 50mm mineral wool insulation batts (density between 33 to 60 kg/m³) covered by no less than two layers of gypsum based board (with a minimum mass of 22 kg/m²) to provide the finished surface. Overall wall thickness of 250mm.



  - Two rows of timber studs separated by a cavity with a minimum of 60mm thick mineral wool insulation between stud centres (density of 10 to 60 kg/m³) covered by no less than two layers of gypsum-based board (with a minimum mass of 22 kg/m²) to provide the finished surface. Overall wall thickness of 290mm.



  - Minimum of two 100mm wide dense aggregate masonry leafs (density of 1850 to 2300 kg/m³) separated by a 75mm cavity. Finished surface consists one layer of 12.5mm gypsum-based board (with a minimum mass of 8 kg/m²) mounted on dabs on top of a nominal 8mm render applied to the face of the masonry leafs. Overall wall thickness of 315mm.



[5] Building Research Establishment, Energy efficiency in new housing. Lower energy design for housing associations, Good Practice Guide 79, 1993