Intelligible	70	65
Ranging between intelligible and unintelligible	75-80	65-75
Audible but not intrusive (unintelligible)	80-90	75-85
Inaudible	90	85

Sound Insulation

The sound insulation of a single panel of material will depend on the frequency of the sound and its mass. Its insulation in practice will also depend on its fixing and very much on the quality of the workmanship.
The force on a panel due to a sound wave in air could be described by Newton's Second Law of Motion. That is force = mass x acceleration. In simplified terms the acceleration produced and consequently the acceleration given to the air molecules on the other side of the panel and the resulting sound pressure in the transmitted wave will depend on the mass of the panel. This will apply except where the panel is thin and/or flexible. In this latter case the panel will vibrate as a whole and the transmission governed by its stiffness.
A more detailed treatment is based on the principle of continuity of the pressure and particle velocity at each boundary. That is the sum of the incident and reflected pressures must be equal to the transmitted pressure and the same applies to the particle velocity. Assuming no loss of energy at each boundary, and remembering that the impedance of a material is given by the ratio of the pressure to the particle velocity, at a single boundary:

$\alpha_t = 4z_1z_2/(z_1 + z_2)^2$ If $z_2 >> z_1$ then $\alpha_t = 4z_1/z_2$

where α_t is the sound (power)transmission coefficient, z_1 is the impedance of air (415 rayls), and z_2 is the impedance of the material. Examples of impedance: concrete = 8.1×10^6 rayls, sea water = 1.54×10^6 rayls.
For a finite panel with air either side solving, the continuity equations at each boundary the sound transmission coefficient (T or α_T) is given by:

$T = 1.75 \times 10^4/m^2f^2$

Where m is the surface mass of the panel in kg/m2 and f is the frequency in Hz.

This formula is derived on the basis of normally incident plane waves and that the partition is rigid so that no other vibrations are set up. It is commonly known as the mass law. The sound transmission coefficient is more conveniently expressed in a logarithmic form as the sound reduction index:

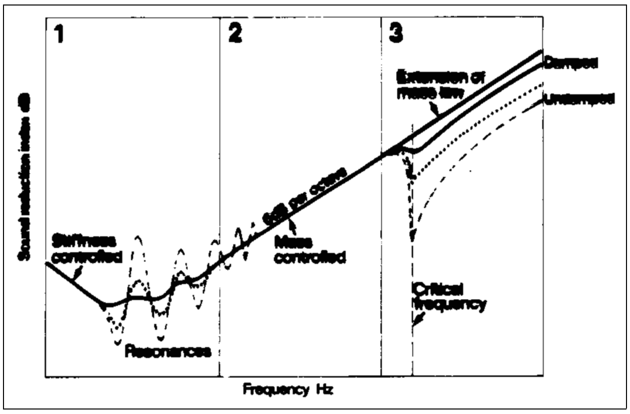
SRI = 10 log (1/T)

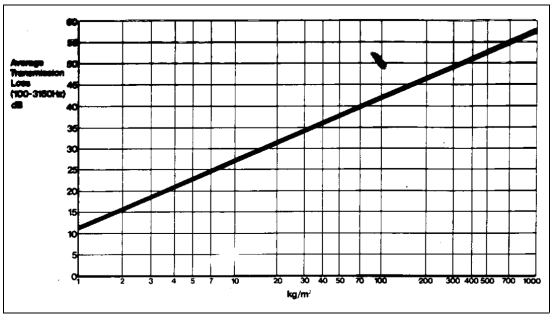
This leads to the expression SRI = -42.4 +20 log mf

This implies that there is a 6dB increase in sound insulation if either the mass or the frequency is doubled. For randomly incident sound the practical increase is nearer 4.5 or 5 dB per octave and a typical mass law expression could be:

SRI = -17 + 15 log mf

In the proceeding section we have ignored the stiffness of the panel but this becomes dominant at low frequencies. Resonances which occur at the natural vibrating frequencies of the partitions depending on the partition dimensions and fixings, and bending waves set up at higher frequencies both reduce the partition insulation below that expected from the mass law.





Figs 16 and 17 Sound Transmission of a single partition

The Coincidence Effect

Solids can transmit shear forces so that in addition to longitudinal compression waves, shear waves and bending waves can be transmitted. The phenomenon of bending waves that are set up in a partition is known as the Coincidence Effect. At grazing incidence where the wavelength of the sound in air is the same as the bending wavelength of the partition the transmission of the sound is high with consequent loss of insulation. This frequency is known as the Critical Frequency. The coincidence effect continues at higher frequencies but the loss of insulation is gradually reduced.