While the absorption of porous materials is biased towards the high frequencies, unless a very thin membrane such as a stretched skin is used, panel absorbers offer useful complimentary low frequency absorption.

Helmholtz Resonators

Helmholz resonators are like bottles with a cavity and a neck. The sound wave causes the plug of air in the neck to vibrate, the air in the cavity undergoing periodic compression and rarefraction. The friction new to the increased motion of the air particles in the neck and the neck itself causes absorption the sound absorption is highly tuned to the resonant frequency given by:

$f = c/2\pi\{S/lV\}^{1/2}$ where

c = velocity of sound(m/s)
S = cross sectional area or neck (m^2)
l = length of neck (m)
V = volume of cavity (m^3)

There is limited use for an absorber with such fine tuning (taking out particular tonal sounds in ducts and artificial reverberation systems) but if the resonator is filled with absorber the absorption at resonance is reduced (and there is a slight change to resonant frequency) but the absorption is spread over a much larger range.

Some acoustic panels are hybrids between Helmholtz absorbers and porous absorbers, placing a perforated sheet over a layer of porous materials. If the perforations exceed 25% the covering panel can be ignored but with a lower percentage perforation a resonance frequency will occur, the net result normally being to increase the low /mid frequency absorption and reduce the high frequency absorption.

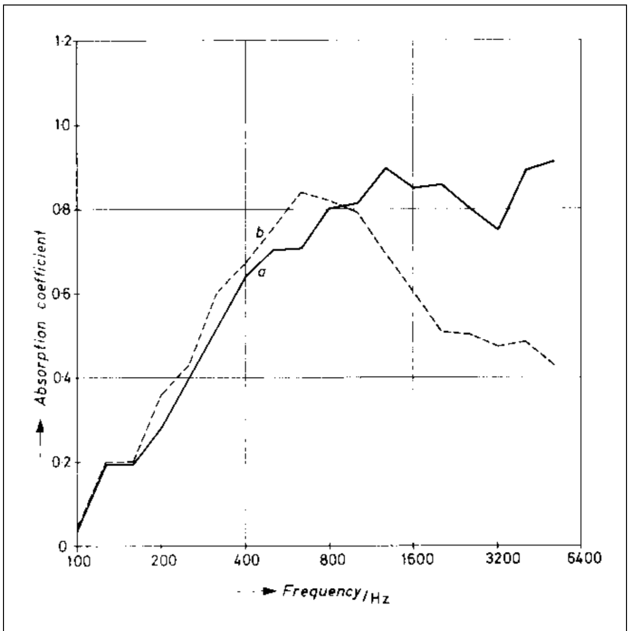

Fig 9 (Source ref 4) Absorption Coefficient of 50 mm glass wool, mounted immediately on concrete a) uncovered, b) covered by a panel of 5mm thickness, perforated at 14%.

Room Sound Level

According to traditional theory, which assumes that the ratios of the room dimensions are not too dissimilar, the total sound level within a room is due to the direct sound from the source which depends on distance and the reverberant sound which is constant throughout the room.

To determine the room sound level we need to know how much sound power is being put into the room. Sound power is measured in Watts and the corresponding sound power level is given by the expression:

$L_w = 10 \log(W/W_0)$

where L_w is the sound power level (dB)
and W is the sound power (Watts)
and W_0 is a reference sound power taken as 10^{-12} Watts

Direct Field

If we assume that a source of sound power,W, radiates omnidirectionally then :

$I = W/4\pi r2$

where r is the distance from the source. Introducing the term directivity factor,Q, (p^2_θ/p^2_{mean}), where θ is the angle at which we are measuring the directivity then:

$I = QW/4\pi r2$

For example, an air supply grille in a wall would have approx Q = 2 for all angles.

In a free field (no reflecting surfaces)

$L_p = L_i = 10 \log(QW/4\pi r2)$

Reverberant field

The reverberant field will be created by that part of the sound power left after the first reflection:

i.e. $W_{R1} = W(1 - \alpha)$ after the first reflection. where α is the mean absorption coefficient and W_{R1} is the sound power entering the reverberant field.
If we then include the sound power left after all the subsequent reflections

$W_R = W (1 - \alpha)/\alpha$ where W_R is the total sound power in the reverberant field