INFORMATION SHEET
ACOUSTIC PERFORMANCE

OPTIMISING WALL PERFORMANCE

The information provided below has been taken from the New Zealand Timber Design Guide 2007, published by the Timber Industry Federation and edited by Professor A H Buchanan. To purchase a copy of the Timber Design Guide, visit www.nztif.co.nz

SOLID WALL

Sound transmission loss can be improved by increasing the mass of a partition. In practical terms, that means a doubling in the thickness of a given material for each 6 decibel (dB) increase in the transmission loss required, that is, a 10 mm panel needs to be increased to 20 mm to achieve an additional 6 dB noise reduction.

CAVITY WALL

Where high-performance, minimum-weight construction is important, the sound transmission class (STC) for most partitions can be increased for the mass per unit area (surface density) by the use of a cavity construction. A standard single-stud wall is one example of a cavity construction.

Consider a 150 mm concrete block wall that has a surface density of about 150 kg/m^2 and a typical STC that equals 43 dB. A timber stud wall constructed with 100 x 50 mm studs at 400 mm centres and clad each side with 10 mm gypsum plasterboard will give a typical STC that equals 35 dB for a surface density of about 30 kg/m^2. This demonstrates how important it is to use the correct type of construction to minimise the overall weight of a partition.

Having established that a standard timber framed wall construction will provide a transmission loss only slightly below that of a 150 mm concrete block wall, it is worth investigating methods to provide additional acoustic benefits by further modification of the wall construction.

By doubling the surface density, even for a cavity construction, the transmission loss will still tend to a 6 dB increase, so although this is not a total solution there are many instances where it will give the additional attenuation sought.

EFFECT OF INCREASING THE MASS OF A STUD FRAMED WALL

Diagram 1 shows the transmission loss for a standard 100 x 50 mm timber stud wall with one 10 mm layer of gypsum plasterboard on each side, nailed to the studs. The effect of the critical frequency is shown clearly at 4 kHz.

If the mass is doubled by adding a second 10 mm layer to each side (diagram 2), the transmission loss of the wall increases significantly as expected in the zone controlled by resonance transmission and approximates the mass law at the higher frequencies.

However, the effects of the critical frequency are still obvious and control the STC at around 4 kHz.

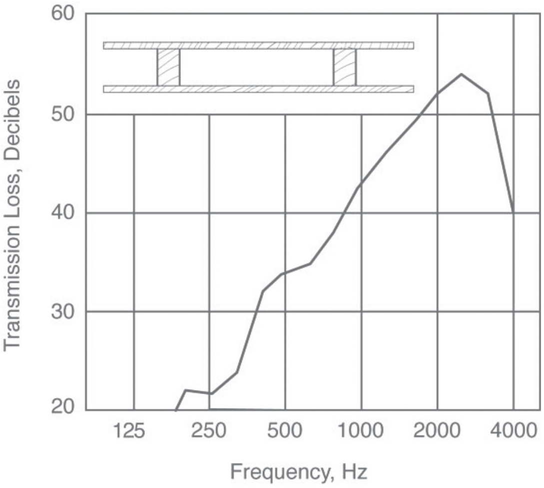
It is now clear that if significant STC benefits are to be achieved using a timber framed wall, the influence of the critical frequency will need to be reduced.

Several techniques are used to improve the acoustic performance of a wall. The most common are to install acoustic absorption, such as fibreglass batts in the cavity, isolate frames or linings from the frame, and increase the mass of linings.

Alternatively, the thickness of the material on each side of the wall can be varied so that the critical frequency of each surface panel is different, thereby reducing the overall critical frequency effect and increasing the STC rating.

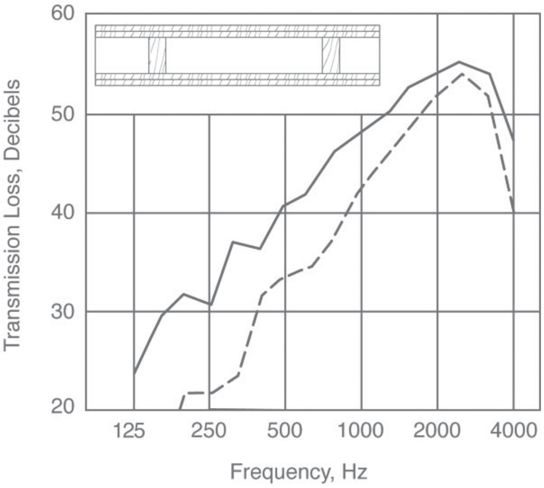
If the cavity size is increased there will be an increase in the STC, although the critical frequency will have a more significant influence on the final STC value.

Diagram 1: Transmission loss for a timber stud wall using one layer of gypsum plasterboard



Notes: STC = 35 dB. $R_w(C;C_{tr})$=35(-2,-6) dB. One layer of 10 mm gypsum plasterboard nailed to each face of 100 x 50 mm timber studs at 400 mm centres.

Diagram 2: Transmission loss for a timber stud wall using two layers of gypsum plasterboard

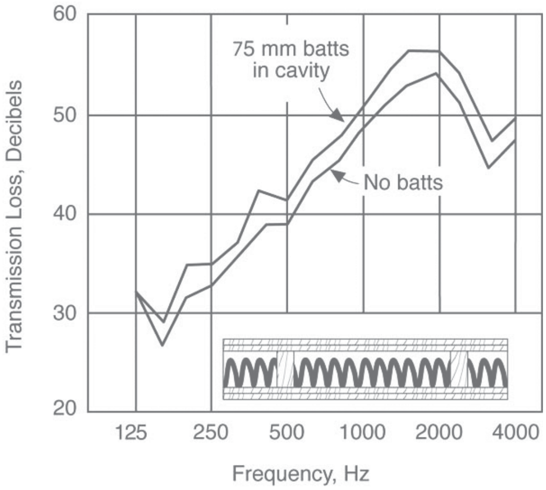


Notes: STC = 44 dB. $R_w(C;C_{tr})$ = 44 (-1,-6) dB. Two layers of 10 mm gypsum plasterboard nailed to each face of 100 x 50 mm timber studs. (The dotted line is the curve from Diagram 8.)

ACOUSTIC ABSORPTION MATERIAL

Diagram 3 shows the transmission loss of a 100 x 50 mm timber stud wall lined on both sides with two layers of 13 mm gypsum plasterboard. Included in the cavity are 75 mm batts to reduce the cavity resonance, which results in the STC improving by 2 dB. The effect of cavity infill will be pronounced (up to 8 dB) when frames are separated and the direct transmission path through the single stud is eliminated.

Diagram 3: Transmission loss for a timber stud wall using absorption materials

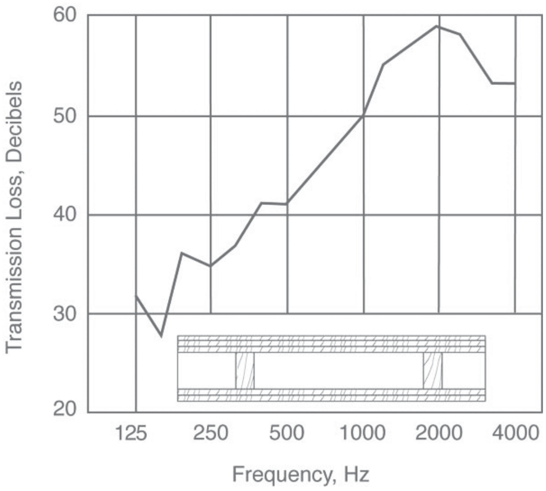


Notes: Two layers of 13 mm gypsum plasterboard nailed to each face 100 x 50 mm timber studs. With batts in the cavity, STC = 46 dB, $R_w(C;C_{tr})$=46(-1,-6) dB. With no batts in the cavity, STC = 44 dB, $R_w(C;C_{tr})$=44(-1,-6) dB.

DIFFERENT LINING THICKNESS

Diagram 4 shows the effect of adding one 10 mm layer of gypsum plasterboard to one side of the wall giving two layers of 13 mm gypsum plasterboard on one side and two layers of 13 mm plus one layer of 10 mm on the other. There is a typical benefit of 2 dB over most of the frequency range, with a significant 6 dB improvement at 4 kHz (the effect of doubling the mass at this frequency) as a result of reducing the coincidence dip effect. The STC rating has now improved from 44 to 46 dB.

Diagram 4: Transmission loss for a timber stud wall using different lining thicknesses

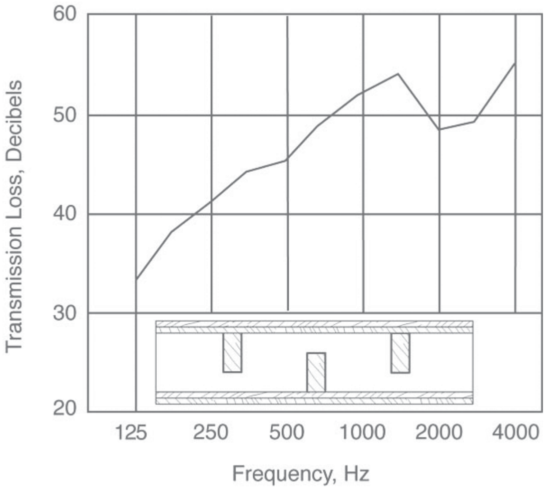


Notes: STC = 46 dB. Two layers of 13 mm gypsum plasterboard nailed to each face, with an additional layer of 10 mm gypsum plasterboard on one face; 100 x 5 mm timber studs at 400 mm centres.

STAGGERED STUDS

Diagram 5 shows the transmission loss for a timber framed wall consisting of 150 x 50 mm top and bottom plates, with 100 x 50 mm staggered studs spaced at 400 mm centres. Because both sides are lined with two layers of 13 mm gypsum plasterboard, the critical frequency is at approximately 2 kHz, with an STC of 51 dB. This design can be upgraded by varying the lining thicknesses as discussed above.

Diagram 5: Transmission loss for a timber stud wall using staggered studs



Notes: STC = 51 dB. Two layers of 13 mm gypsum plasterboard nailed to each face of staggered 100 x 50 mm timber studs on 150 x 50 mm timber plates.

DOUBLE STUDS

A wall assembled using staggered studs will compromise transmission loss because sound will travel along the studs on one side of the wall through the common plates and along the stud connected to the other side of the wall. The transmission loss of such a wall can be significantly improved by having two completely separate wall frames with a small gap between – a double-stud wall.

The STC and Weighted Sound Reduction Index *(R_w)* values of a double-stud wall can be 10 dB greater than an otherwise similarly staggered stud wall. Care must be taken to ensure the proper structural performance of such a system while avoiding unnecessary connections between the frames. Resilient frame ties are available from manufacturers to help achieve the required structural performance while maximising the transmission loss of such a wall.

RESILIENT CHANNELS

Resilient channels can be used where increased noise control is required for timber framed walls. These channels assist in reducing the critical frequency by minimising the vibration transfer of noise through the wall.

An example of such a wall is shown in diagram 6, which consists of 100 x 50 mm timber studs with two layers of 13 mm gypsum plasterboard fixed to resilient channels on one side, 75 mm batts in the cavity and one layer of 13 mm board on the other side. The STC of this wall is 50 dB. Diagram 7 shows a cross section of a resilient channel incorporated into a wall assembly.

Diagram 6: Transmission loss from using resilient channels in a wall assembly

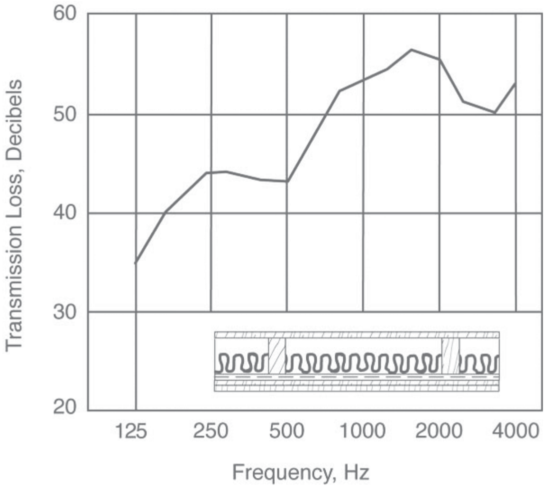
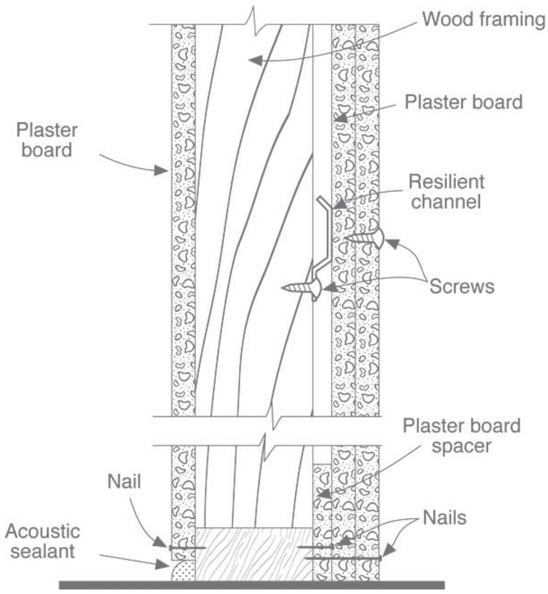


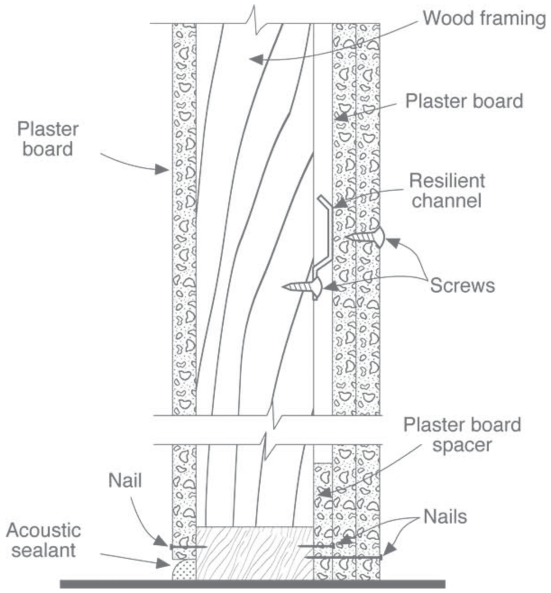
Diagram 7: Cross section of a resilient channel incorporated in a wall assembly



HOLES OR OPENINGS

The construction technique for high- performance acoustic walls is important, because the smallest hole will significantly degrade the acoustic performance of the wall. Diagram 8 shows the use of an acoustic sealant to eliminate one of the most common aspects in a design for noise control. Light switches, power points or similar should not be installed in acoustic walls unless the wall has been specifically designed to incorporate them. These elements can reduce the average transmission loss by as much as 5 to 6 A-weighted decibels (dB(A)), which has the same effect as halving the mass of the wall.

Diagram 8: Placement of acoustic sealant for eliminating holes or openings



AIRBORNE SOUND INSULATION BETWEEN ROOMS

Sound insulation and the contribution that elements make to the total sound transmitted between rooms is an important consideration in acoustic wall design.

The calculation and measurement of sound insulation between rooms is expressed in terms of sound level difference, with the variable effect of sound absorption in rooms removed or 'normalised' to a reference sound absorption value.

The International Organization for Standardization (ISO) standards express this normalised sound level difference as D_n. Sometimes D_{nT} is used; this refers to a different method of normalisation known as reverberation time standardisation. As with R_i a single figure number can be produced with a reference curve to generate the 'Weighted Sound Level Difference' $D_{n,w}$ or $D_{nT,w}$; and, as with R_w, the spectrum adaptation terms C and C_{tr} can be added to consider sound sources with different characteristics.

Total room sound insulation includes the effect of 'flanking' sound transmission, which is sound that transmits around the partitioning element by some path. An example is sound carried along an exterior wall that is common to two adjoining tenancies.