BRANZ

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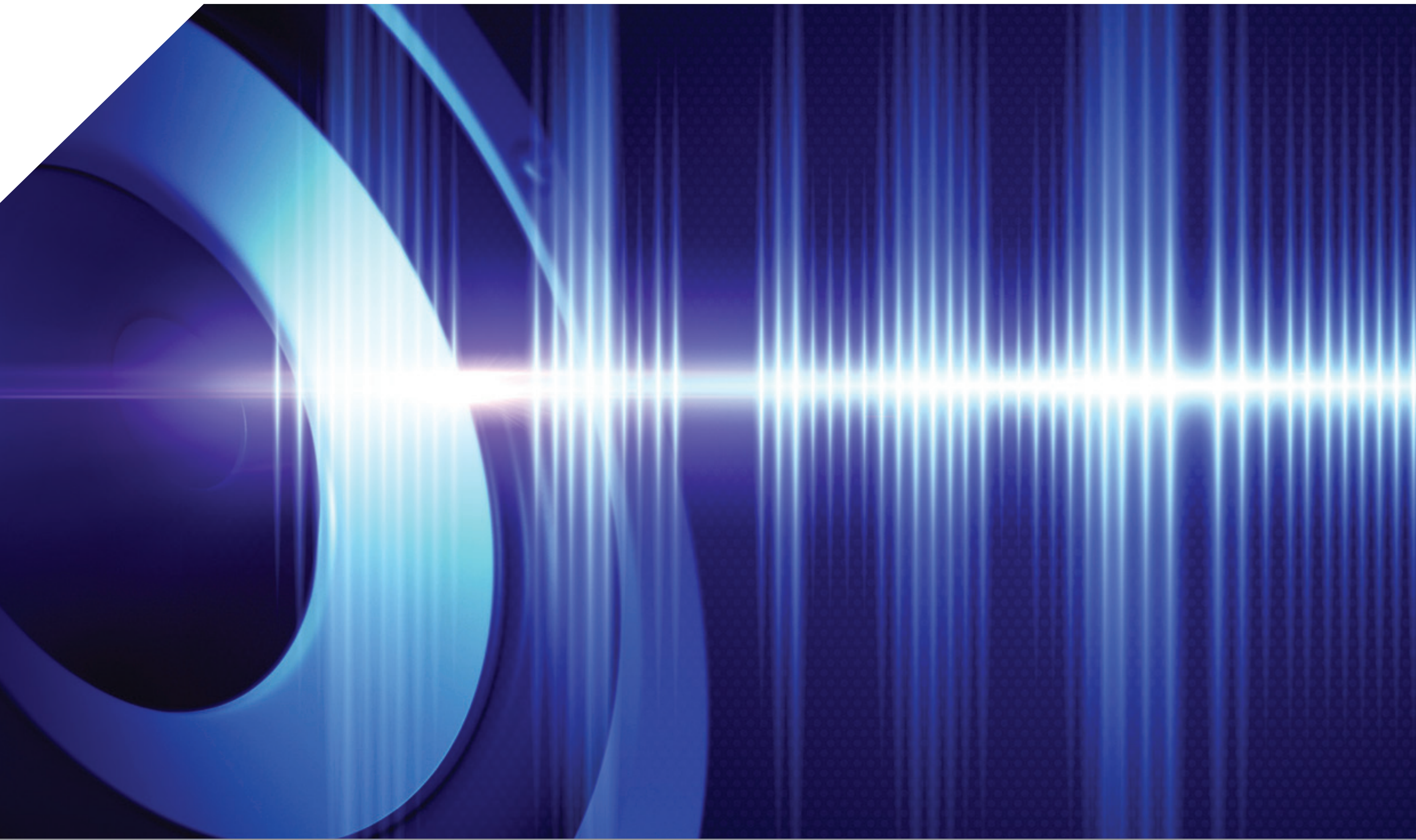
BULLETIN



ACOUSTIC DESIGN PRINCIPLES

February 2018

- The trend to inner-city living and medium-density housing places more focus on the need for acoustic privacy between individual dwelling units and between units and the outside environment.
- Acoustic insulation is also important in commercial buildings to ensure privacy for occupants.
- This bulletin explains the basics of sound insulation and New Zealand Building Code clause G6 *Airborne and impact sound*. It replaces Bulletin 426 *Achieving acoustic separation*.

1.0 INTRODUCTION

1.0.1 Practically speaking, there is no such thing as 'soundproof'. A more appropriate term is 'sound insulated', and there are a number of factors that influence how well sound insulated a room or building can be.

1.0.2 The need for good sound insulation stems from the need to be able to relax in our homes and concentrate in working environments. Common sound sources that we need to address are traffic, aircraft, HVAC (heating, ventilation and air-conditioning) systems and other equipment, plumbing and the activities of others – particularly in apartment buildings and multi-unit dwellings.

1.0.3 This bulletin provides practical advice for understanding the basics of sound insulation and gives an introduction to the New Zealand Building Code clause that regulates it, G6 *Airborne and impact sound*. However, the field of acoustic design is highly specialised, and any specific advice should be sought from a professional acoustician.

1.0.4 This bulletin updates and replaces Bulletin 426 *Achieving acoustic separation*.

2.0 NOISE

2.0.1 Noise is sound that is unwanted because it is annoying, typically because those who hear it cannot influence its source. This is because it is from an adjacent building or tenancy or from outside. Intrusive noise in general typically comes from:

- high-volume conversation
- televisions or other broadcast media
- loud music – particularly bass
- plumbing services
- building services such as lifts or air-conditioning plant
- pedestrian and vehicle traffic
- foot noise from the floor above, adjacent walkways or stairways
- doors banging
- appliance noise such as washing machines
- traffic
- aircraft
- HVAC systems and other equipment.

3.0 NEW ZEALAND BUILDING CODE

3.0.1 The minimum sound insulation requirements for dwelling units set in Building Code clause G6 are:

- an STC (sound transmission class) of at least 55 for inter-tenancy walls, floors and ceilings
- an IIC (impact insulation class) of at least 55 for inter-tenancy floors.

3.0.2 The Building Code does not specifically cover commercial buildings in terms of spaces within a tenancy. However, the following list gives context to STC ratings and the level of acoustic privacy that is provided for airborne sound:

- Less than STC 30 – poor sound control with little privacy.
- STC 30–40 – will allow conversations at normal voice levels in adjacent spaces to be heard.
- STC 40 – will allow conversations to be heard in adjacent spaces if voices are raised.
- STC 50 – provides reasonable acoustic privacy.

3.0.3 The Building Code performance requirements are based on laboratory ratings. In addition to this, an installed system must also achieve a minimum performance in the field. A 5-point relaxation is allowed to take account of on-site issues such as flanking and build quality, so the Building Code field requirements are field sound transmission class (FSTC) 50.

4.0 DEALING WITH NOISE

4.1 HOW SOUND TRAVELS

4.1.1 Sound is transmitted between spaces by the following:

- A direct path, where there is a line of sight between the sound source and the receiver. The air particles vibrate, transmitting acoustic energy (Figure 1).
- A reflected path, where the sound is reflected to the receiver via one or more solid surfaces (Figure 1).
- Structure, where the airborne sound makes an object vibrate, which then transfers the sound through it. Once through, the sound becomes airborne again but with less energy. The amount of sound energy removed by the material depends on the mass and stiffness of the material. This is how sound travels between rooms.
- A flanking path, where the sound passes or leaks around an acoustic partition (Figure 2). Flanking sound is generally unwanted because it compromises the acoustic partition's performance. Flanking paths include vibration through junctions, doors, open windows, gaps around or in a partition (such as holes cut in walls for electrical junction boxes) and HVAC ducting.

4.1.2 Audible sound travels through the air, so breaking the continuity of the path (or the line of sight from source to receiver) reduces the sound level. This is why barriers and walls effectively reduce sound. Sound will pass through even very small cracks, however. This is why an acoustic fence must have no gaps between joints or underneath, and an acoustic wall must be fully stopped and sealed around its perimeter with flexible sealant. If this is not done, a system that would otherwise comply with the Building Code may fail.

4.2 MANUFACTURERS' LITERATURE

4.2.1 Manufacturers typically produce literature that outlines specific wall and floor constructions that have been tested by independent laboratories to confirm

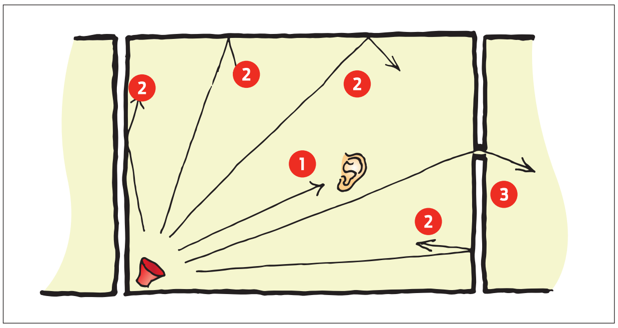


Figure 1. Sound transmission paths.

1 Direct path from source 2 Reflected sound 3 Diffracted sound

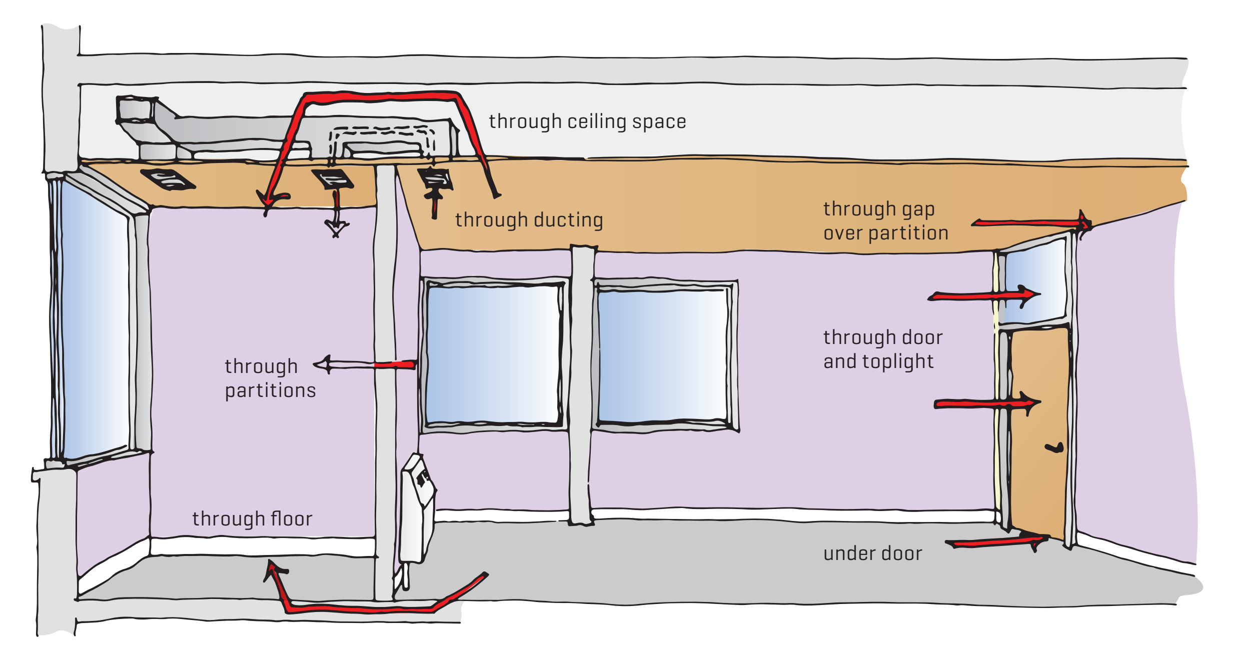


Figure 2. Sound transmission/flanking paths.

their claimed level of acoustic insulation. An acoustic rating is given to a particular system with the specific materials detailed by the manufacturer. Be careful about substituting components because it could reduce the level of acoustic insulation achieved.

4.3 TYPICAL STC PERFORMANCE RATINGS

4.3.1 Always refer to independent acoustic test results provided by the manufacturer. Typical STC ratings expected from wall elements are given in Table 1.

4.3.2 Typical impact insulation ratings that can be expected for floor systems are given in Table 2.

4.4 BASIC PRINCIPLES OF REDUCING SOUND TRANSMISSION

4.4.1 Sound transmission through built elements can be further reduced by:

- decoupling or separating each side of the construction from the other – for example, through using a staggered-stud system (Figure 3), a double-stud system where two frames are constructed separately (Figure 4) or a resilient mount system (Figure 5)
- adding mass by using heavier materials or multiple layers of lighter materials
- reducing stiffness by using flexible components such as resilient rubber mounting systems
- avoiding stiff lightweight materials
- adding cushioning or damping to floor systems to improve impact insulation.

Table 1. STC ratings of some typical wall constructions.

Wall lining – side 1	Framing	Wall lining – side 2	Cavity infill	STC rating
10 mm plasterboard	90 x 45 mm timber[1]	10 mm plasterboard	None	33
10 mm plasterboard	90 x 45 mm timber	10 mm plasterboard	90 mm sound insulation material	36
150 mm concrete OR 190 mm solid filled concrete masonry	–	–	–	55
2 x layers 13 mm plasterboard	90 x 45 mm timber with resilient rubber mounting system	1 x layer 13 mm plasterboard	90 mm sound insulation material	56
10 mm plasterboard	190 mm solid filled concrete masonry with 45 mm strapping either side	10 mm plasterboard	40 mm sound insulation material	62[2]
2 x layers 13 mm plasterboard	2 x 90 x 45 mm double timber stud (separate frames)	2 x layers 13 mm plasterboard	2 x 90 mm sound insulation material	64

1. Steel stud systems tend to perform 1–2 points better than equivalent timber stud systems.

2. Strapping and lining masonry systems must be done carefully, otherwise matched resonance can reduce rather than increase the performance of the masonry alone. To avoid problems, strapping must be a minimum of 45 mm deep and spaced 600 mm apart, and the cavity must be filled with insulation.

Table 2. Typical impact insulation ratings for various types of floor construction.

Floor covering	Floor structure	Ceiling	Cavity infill	IIC rating
None	150 mm concrete	None	None	28
None	120 mm concrete	13 mm plasterboard on hangers, 300 mm ceiling void	130 mm sound insulation material	43
Vinyl or tiles on high-performance acoustic underlay	120 mm concrete	13 mm plasterboard on hangers, 300 mm ceiling void	130 mm sound insulation material	55[1]
Floating floor (20 mm wood-based flooring on 45 x 45 mm battens on resilient pads with no rigid connections to underlying structure) and 130 mm sound insulation material in ceiling cavity	20 mm wood-based flooring on 240 mm joists	13 mm plasterboard suspended from resilient rubber hanging system and furring channels	40 mm sound insulation material under floating floor	55[2]

1. The performance of underlays can vary widely. Select systems that have been independently verified and tested to demonstrate performance as part of a compliant floor system.

2. Floating floor systems are required to enable lightweight floor systems to achieve Building Code compliance without carpet. Select systems that have been independently verified and tested.

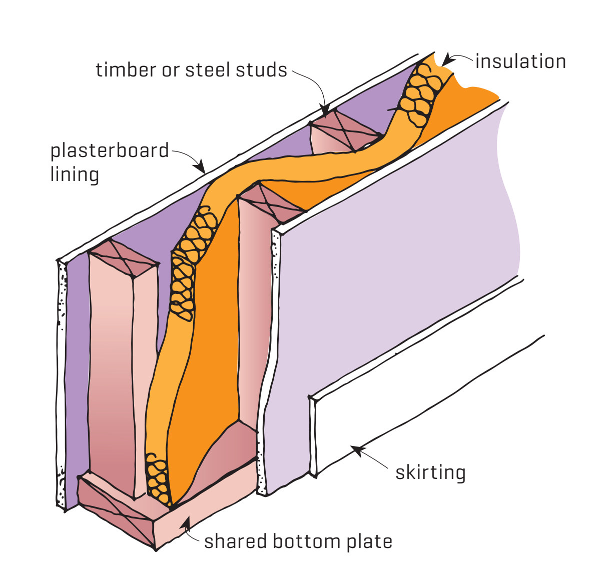


Figure 3. Staggered-stud construction.

4.5 DESIGNING FOR ACOUSTIC PRIVACY

4.5.1 The layout of spaces in buildings is an important factor to consider when designing for acoustic separation or privacy. Simple design rules when arranging spaces include the following:

- Consider the use of the space, and prioritise the level of performance required for spaces within buildings. For example, position noisy living areas (living rooms, kitchens) away from noise-sensitive spaces (sleeping or study areas). Low-amenity spaces such as hallways, closets and bathrooms can be positioned to act as a buffer between noisy and noise-sensitive areas.
- Separate dwelling units by using garages as a buffer.
- Do not locate services (power outlets, plumbing fittings) on party or inter-tenancy walls. (Not having power outlets here may also discourage occupants from hanging televisions and loudspeakers on these walls, thus avoiding vibration transfer into the walls.)
- Specify that openings such as doors and windows be treated with perimeter seals to minimise sound leakage paths.

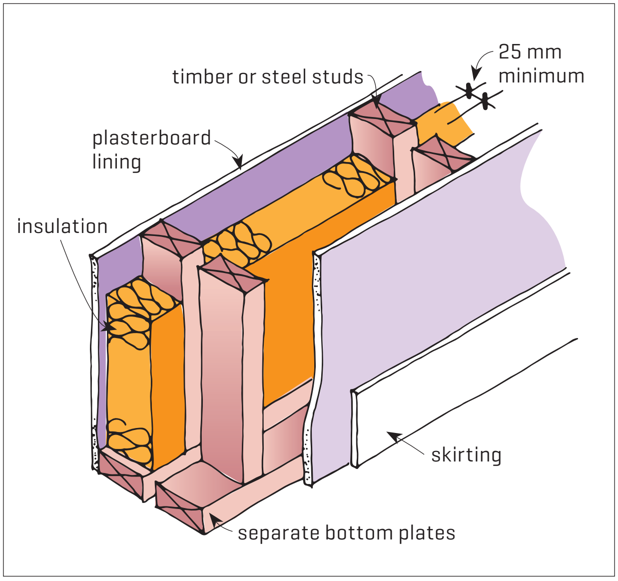


Figure 4. Double-stud construction.

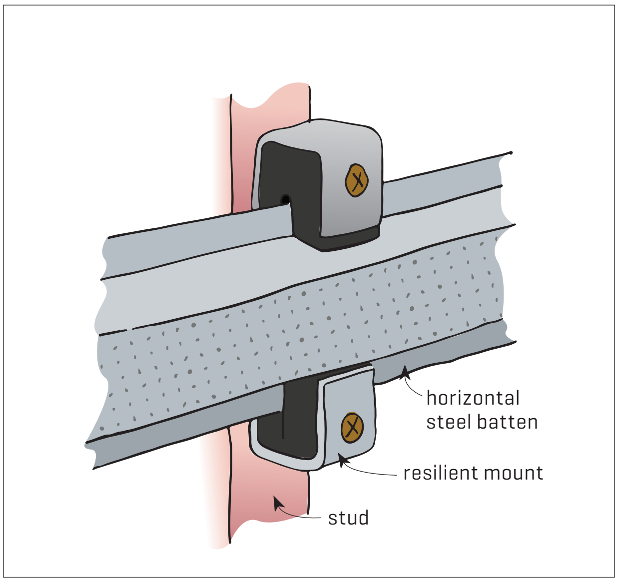


Figure 5. Detail of resilient rail mount.

- Allow adequate wall/floor thickness to accommodate acoustically designed partitions.

4.5.2 Noise from external sound sources such as traffic can be mitigated by:
- siting the building as far as possible from the sound sources
- using the building layout to position sensitive spaces away from noise sources
- avoiding or minimising windows and/or doors facing the noise sources
- specifying quality perimeter seals to windows and external doors
- using landscape features, ancillary buildings or acoustic walls to break the line of sight from source to receiver.

4.6 MATERIAL SELECTION

4.6.1 When specifying materials to achieve sound isolation, consider:
- wall and floor systems that have been independently tested and verified
- underlay products for use with tiled, stone or timber board finished floors, ensuring they have been independently tested and verified and are installed by a suitably experienced person
- underlay and carpet to floor surfaces – this typically improves the IIC by 10+
- thicker or higher-density building materials (for example, 13 mm high-density plasterboard instead of 10 mm standard plasterboard)
- heavier materials such as concrete or masonry where practicable – doubling the mass of a single element improves its sound isolation by 6 dB

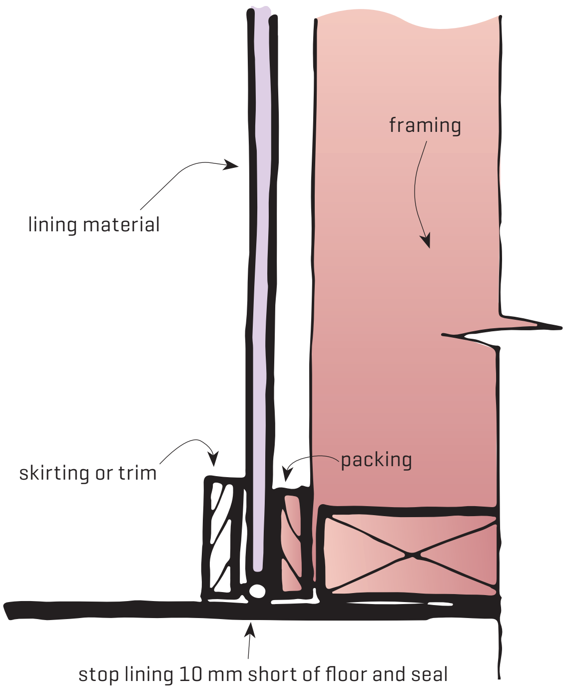


Figure 6. Sealing around edges of an acoustic partition (similar detail at top and wall end).

- solid-core doors with perimeter seals or proprietary acoustic doors
- soft-close cupboards and drawers in kitchens to reduce impact transfer through walls
- avoiding any hard connections to building fit-out elements that are likely to vibrate, such as light fittings or garage door motors
- isolating plumbing fittings and pipes from the structure.

4.7 CONSTRUCTION REQUIREMENTS

4.7.1 Other important requirements for all acoustic partitions include:
- following the specific installation or detail instructions for the acoustic separation to achieve the required performance level, even down to the specified glues, fixings or sealants
- not substituting alternative components or materials as this may reduce the rating achieved
- ensuring there is an airtight seal at junctions between elements (Figure 6).

4.8 BUILDING SERVICES

4.8.1 Building services and equipment are a common source of noise. Installations will be quieter where:
- appliances and equipment are specifically chosen for their proven quietness (supported by independent testing)
- equipment is mounted on resilient or isolation-type mounts
- flexible connectors are used at the junction between fixed equipment and piping or ducting
- ductwork is designed/constructed with simple layouts, silencers, smooth joints and transitions, long radius turns and calming chambers
- moving parts, particularly rotors and fans, are properly balanced and well maintained
- fans and impellers are designed to run at lower speeds to reduce fan tip speed – centrifugal fans are quieter than the same capacity propeller or vane axial fans.

4.8.2 For plumbing:
- use acoustic pipework – see BRANZ Appraisal listings
- fix pipes with resilient pipe clamps to reduce structure-borne noise
- copper and cast-iron stacks or discharge pipes are quieter than PVC
- flexible plastics are quieter than copper for water supply piping
- minimise the number of elbows, take-off points and wingbacks
- for vertical stacks or discharge pipes, one long drop is quieter than a number of short ones.

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