Acoustic performance

A key issue for medium-density housing is the need to design and construct walls and floors/ceilings between individual dwelling units to ensure acoustic privacy.

IN MANY AREAS of the country, urban growth and demand for housing have resulted in a move away from traditional stand-alone dwellings. This has been in favour of high-density and medium-density housing (MDH) such as townhouses, terraced units or apartments.

The trend towards inner-city multi-unit living places an increasing focus on the need to ensure acoustic privacy between individual dwelling units.

Sources of noise

There are several common sources of nuisance noise in MDH environments, particularly apartment buildings and multi-unit dwellings. These include:

- activities of other residents, such as loud conversations
- televisions and loud music (particularly bass sounds)
- plumbing systems
- heating, air-conditioning and ventilation (HVAC) systems
- building services, such as lifts
- exterior pedestrian and vehicle traffic
- foot noise from the floor above, adjacent walkways or stairways
- doors banging
- appliance noise, such as washing machines.

Acoustic ratings

There are generally two types of sound transmission to consider in MDH buildings.

- Airborne sound – noise originating in air, such as voices, music and vehicle traffic.
- Impact sound – noise originating directly on the structure by blows or vibration, such as footsteps, moving furniture or knocking plumbing.

All building elements reduce noise to some degree, but some are much more effective than others. Some are also more effective at reducing airborne noise than impact noise and vice versa.

The degree to which a building element reduces sounds as it passes through is its sound insulation characteristic.

In order to better compare building products and materials, sound insulation is generally described using a single number. There are two complementary systems in common use in New Zealand – sound transmission class (STC) and impact insulation class (IIC).

STC ratings relate to the transmission of airborne noise, and IIC ratings relate to the transmission of impact noise through floors.

These figures represent a summary of the element's acoustic performance over a range of frequencies. While the figures are very useful, it's important to remember that they do not provide a complete description of the element's performance at all frequencies.

As a general guide, the level of acoustic privacy expected by an STC rating is as follows:

- STC <30: poor sound control with little privacy.
- STC 30–40: allows normal conversations to be heard in adjacent spaces.
- STC 40–50: allows raised voices to be heard in adjacent spaces.
- STC >50: provides a reasonable acoustic privacy.

Noise performance requirements

There is a desire for amenity in MDH developments – the occupants' ability to use and relax in their home without the influence of nuisance noise. This leads to the requirement for MDH designs to include good acoustic performance.

The performance requirements of New Zealand Building Code clause G6 *Airborne and impact sound* sets minimum sound insulation requirements for dwelling units:

- STC ≥55 for inter-tenancy walls and floors.
- IIC ≥55 for inter-tenancy floors.

In addition to these design ratings, an MDH building must also achieve at least a minimum level of acoustic performance in field testing.

During field testing, the Building Code allows a 5-point leeway to take into account on-site issues such as flanking and build quality. That means MDH buildings must meet a field sound transmission class (FSTC) ≥50.

Noise-reduction strategies

Design plays a crucial role in the overall acoustic performance and privacy of an MDH development.

Acoustic design guidelines

When arranging internal spaces, simple design concepts can eliminate many noise issues.

Consider the use of each space and prioritise the level of acoustic performance of each within the dwelling. For example, position noisy living areas (living rooms, kitchens) away from noise-sensitive spaces (sleeping or study areas). Try to position low-amenity spaces (hallways and storage spaces) as a buffer between noisy and noise-sensitive areas.

There are several other simple design concepts to further limit noise:

- Separate low-rise dwelling units by using garages as a buffer.
- Avoid installing services (power outlets, plumbing fittings) on party or inter-tenancy walls.
- Treat openings (doors and windows) with perimeter seals to minimise sound leakage.
- Allow adequate wall and floor thickness to accommodate acoustically designed partitions.

Other basic rules can mitigate noise from external sources:

- Site the building as far as possible from the noise sources.
- Use the building layout to position sensitive spaces away from noise sources.
- Decouple or separate each side of the construction from each other. For example, use a double-stud system (where two frames are constructed separately) or a resilient mount system.
- Avoid or minimise windows and doors that face noise sources.
- Provide quality perimeter seals on windows and external doors.
- Use landscape features, ancillary buildings or acoustic walls to break line-of-sight sound paths from the source to receiver.

Limiting noise from services

Building services are some of the most common sources of nuisance noise in MDH buildings. Keep the following in mind to reduce noise from services:

- Choose appliances and equipment for their quietness (supported by independent testing).
- Mount equipment on resilient or isolation mounts.
- Use flexible connectors at the junctions between fixed equipment and pipes and ducts.
- Design and construct ductwork using simple layouts, silencers, smooth joints and transitions, long radius turns and calming chambers.
- Use fans and impeller designs that are quiet and operate at low speed.

The following also apply to plumbing services:

- Isolate plumbing fittings and pipes from the structure and fix pipes with resilient pipe clamps to reduce structure-borne noise.
- Use copper and cast iron pipes for waste and flexible plastic pipes for water supplies.
- Minimise the number of elbows, take-off points and wingbacks in the system.
- Use a single long drop for vertical stacks or discharge pipes.

Performance of building elements

The MDH designer should consider a range of factors when selecting, installing or detailing noise control systems in wall, floor and ceiling assemblies.

Materials selection

As a general rule, reducing sound transmission requires greater mass or larger separation of elements. When the separation is fixed, the designer can increase mass by:

- using a thicker version of the same material
- specifying a denser material that will have a greater mass for the same volume.

When selecting materials to reduce sound transmission, consider the following:

- Use thicker or higher-density building materials, such as 13 mm instead of 10 mm plasterboard.
- Use heavier materials such as concrete or concrete masonry, where practicable.
- Reduce stiffness by using flexible components such as resilient rubber mounts. Avoid stiff, lightweight materials such as polystyrene.
- Use solid-core doors with perimeter seals or proprietary acoustic doors.
- Add underlay and carpet to floor surfaces (this typically improves IIC ≥10).
- Specify soft-close cupboards and drawers in kitchens to reduce impact transfer through walls.
- Add cushioning or damping to floor systems to improve impact insulation.

Above all, always keep to the design specification for building elements that contribute to the sound insulation, particularly for inter-tenancy walls. Variation or substitution of components should only be carried out with the approval of the supplier of the acoustic system, as the change can compromise acoustic performance.

Typical ratings

The following tables indicate the typical acoustic performance of wall and floor elements used in MDH buildings. Always refer to the manufacturer's guidelines and independent test results for actual acoustic performance figures.

Table 1 Typical acoustic transmission performance of generic wall elements.				
Wall lining – side 1	**Framing**	**Wall lining – side 2**	**Cavity infill**	**STC**
10 mm plasterboard	90 × 45 mm timber	10 mm plasterboard	None	33
10 mm plasterboard	90 × 45 mm timber	10 mm plasterboard	90 mm blanket	36
150 mm concrete	-	-	-	55
190 mm solid (all cells filled) concrete masonry	-	-	-	55
2 × 13 mm plasterboard	90 × 45 mm timber with resilient rubber mounting system	1 × 13 mm plasterboard	90 mm blanket	56
10 mm plasterboard	190 mm solid filled concrete masonry (strapped)	10 mm plasterboard	40 mm blanket	62
2 × 13 mm plasterboard	2 × 90 × 45 mm double timber stud (separate frames)	2 × 13 mm plasterboard	2 × 90 mm blanket	64

Table 2 Typical acoustic insulation performance of floor elements.				
Floor covering	**Floor structure**	**Ceiling structure**	**Cavity infill**	**IIC**
None	150 mm concrete	-	-	28
None	120 mm concrete	13 mm plasterboard on hangers	130 mm blanket	43
Vinyl/tiles on acoustic underlay	120 mm concrete	13 mm plasterboard on hangers	130 mm blanket	55
Floating floor	20 mm plywood	13 mm plasterboard on resilient hangers	40 mm blanket (floor) and 130 mm blanket (ceiling)	55

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