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MEDIUM-DENSITY HOUSING #5

Acoustic performance

Noise is too often a problem in medium-density housing (MDH). Achieving good acoustic privacy between dwellings takes careful planning and design early in the project and follow-through in the whole construction process.

INCREASING HOUSING DENSITY brings more noise-related issues. In one Wellington survey, apartment dwellers rated noise as the least-liked aspect of apartment living. Elsewhere, council officers report inter-tenancy noise as a rising source of noise complaints. There is evidence that developers or designers don't place a priority on acoustic performance, don't budget appropriately for it and don't consider it early enough in the project.

The whole building design impacts on its acoustics. The best and most cost-effective approach is to address acoustics at the same time as structure and fire protection, internal comfort (air quality, temperature and moisture control, natural light), energy efficiency and even aesthetics.

Not considering acoustics early can be expensive – if it is found later in a project that an inter-tenancy wall or floor needs a greater depth or alternative construction to meet sound insulation requirements, costs and timeframes can blow out. Fixing a problem down the track generally costs more than designing good acoustic performance in the first place.

Professional advice is a good idea for MDH, using an independent acoustical consultant or experts in a project's architectural or engineering firm.

A good result also requires on-site follow-through to avoid contractor/installer errors such as installing a duct through a completed acoustic separation.

Sources of noise

There are many potential sources of nuisance noise in MDH environments, including:

- other residents' activities – conversations, televisions and music (particularly bass sounds), appliances such as washing machines, doors banging and foot noise
- building services – lifts, plumbing, heating, air conditioning and ventilation systems
- external noise.

Acoustic ratings

There are two key types of sound transmission:

- Airborne sound – such as voices, music and vehicle traffic.
- Impact sound – noise through the structure from blows or vibrations, such as footsteps, moving furniture or knocking plumbing.

Sound can travel directly or through flanking paths, where sound reaches the receiver without travelling directly through any separating element (Figure 1). Examples of flanking paths are sounds carried via a duct, common ceiling space or floor slab.

All building elements reduce noise, some more effectively than others. Some are more effective at reducing airborne noise than impact noise and vice versa.

Two noise-reduction measures are commonly used in New Zealand. Sound transmission class (STC), relating to airborne

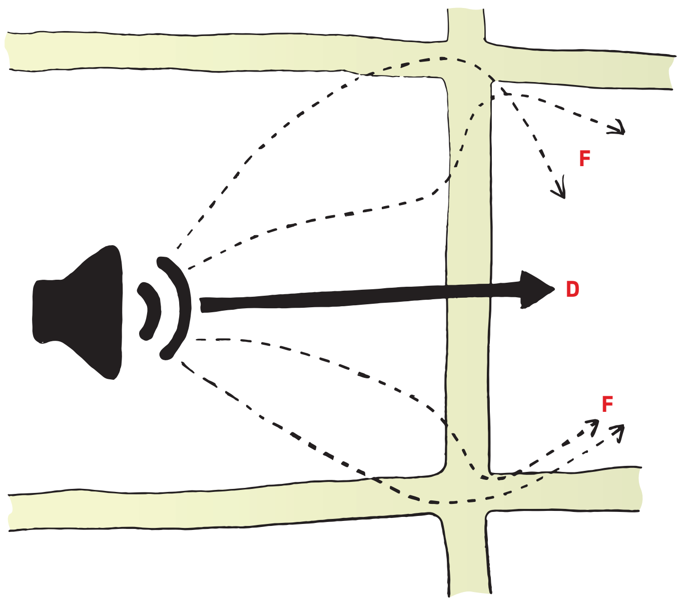

Figure 1. Sound can travel directly through the air or through a building element (D) or through a flanking path (F).

noise, is essentially the noise reduction in decibels (dB) that a wall or floor provides. If a wall has an STC rating of 55, a 75 dB sound on one side is reduced to 20 dB on the other side. The other measure is impact insulation class (IIC), which gives the decibels resisted in the transmission of impact noise.

These figures do not provide a complete description at all frequencies. A light timber-framed wall and a concrete wall may both have the same STC rating, but the timber wall may not block low frequencies as well as the concrete wall and the concrete wall may not block high frequencies as well as the timber wall.

As a general guide, levels of acoustic privacy are:

- STC <30 – poor sound control, little privacy
- STC 30–40 – normal conversations can be heard in adjacent spaces
- STC 40–50 – raised voices can be heard in adjacent spaces
- STC >50 – reasonable acoustic privacy
- STC 60+ – good acoustic privacy.

Noise performance minimum requirements

New Zealand Building Code clause G6 *Airborne and impact sound* sets minimum sound insulation requirements for inter-tenancy walls and floors of connected dwellings:

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

An MDH building must also achieve at least a minimum level of acoustic performance in field testing. The Building Code allows a 5-point leeway for on-site issues such as flanking and build quality. That means MDH buildings must meet a field sound transmission class (FSTC) of ≥50.

Problems have been reported with inter-tenancy noise even in Code-compliant buildings. Designers can take a Code-plus approach and design better than the minimum level legally permissible. STC 60+ provides good acoustic privacy.

Clause G6 was introduced in 1992 and last amended in 1995 – it has remained unchanged for 25 years. It does not require acoustic privacy for external walls and windows where adjacent dwellings are not connected, regardless of how close they are. In the absence of updated government guidance, there is a heightened responsibility on MDH developers and designers.

Many local authority district plans have rules around noise at a residential boundary. Some require exterior acoustic insulation in city centre MDH buildings to protect occupants from street noise.

Noise-reduction strategies

Acoustic considerations are often not included early enough in design to allow effective integration with other requirements. Siting, whole-building design and construction can all have a big impact on whether or not noise will be a problem.

Acoustic design guidelines

Basic design rules:

- Position noisy areas (living rooms, kitchens) away from sleeping and study areas.
- Position low-amenity spaces (hallways, storage spaces) as a buffer.
- Separate dwelling units by using garages as a buffer.
- Avoid installing services such as plumbing fittings on inter-tenancy walls.
- Avoid running plumbing services from one unit through the ceiling of the unit below.
- Specify perimeter seals on doors and windows.
- Add sound insulation, separate or stagger stud construction or use a proprietary acoustic-rated wall construction system in lightweight framing. Insulation in a wall or floor/ceiling cavity will improve the STC rating by around 4–6 dB. (A 10 dB reduction is roughly equivalent to halving the perceived loudness of sound over a range of low frequencies.)
- Allow adequate wall and floor thickness to accommodate acoustically designed partitions.

Methods to reduce external noise:

- Site the building as far as possible from the noise sources.
- In building layout, position sensitive spaces away from noise sources.
- Avoid or minimise windows and doors that face noise sources.
- Specify quality perimeter seals on windows and external doors.
- Break line-of-sight sound paths with ancillary buildings or acoustic walls.

Limiting noise from services

Building services are a common source of nuisance noise in MDH buildings:

- Choose quieter appliances and equipment (supported by independent testing).
- Mount equipment on resilient or isolation mounts.
- Use flexible connectors at junctions between fixed equipment and pipes and ducts.
- Design/install ductwork with simple layouts, silencers, smooth joints, long radius turns and calming chambers.
- Specify fans that are quiet and operate at low speed.

Construction techniques for plumbing services:

- Isolate plumbing fittings and pipes from the structure and fix pipes with resilient clamps.
- 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.
- Use a single long drop for vertical stacks or discharge pipes.

Performance of building elements

Materials selection

Reducing sound transmission generally requires greater mass or separation of elements:

- Use thicker/denser material, such as 13 mm plasterboard instead of 10 mm.
- Specify materials with higher mass, such as concrete or concrete masonry construction. Doubling the mass of a wall increases the STC rating by around 5–6 dB. Medium-weight steel/concrete composite flooring systems are common for apartment buildings but tend to have poorer acoustic performance than heavier concrete systems due to reduced mass, increased stiffness and an unbroken composite nature.
- Timber floors can contribute to noise transfer in multi-level buildings.
- Reduce stiffness by using flexible components such as resilient rubber mounts.
- Use solid-core doors with perimeter seals or proprietary acoustic doors.
- Add underlay and carpet to floor surfaces (this typically improves IIC by ≥10).
- Specify soft-close drawers and cupboards doors in kitchens.
- Add cushioning or damping to floor systems.

Keep to the design specification for elements that contribute to sound insulation, particularly for inter-tenancy walls. Variation or substitution of components can compromise acoustic performance.

Typical ratings

Tables 1 and 2 indicate the typical acoustic performance of wall and floor elements in MDH buildings. See manufacturers' guidelines and independent tests for actual performance figures.

Issues around acoustics in MDH

Industry surveys have uncovered problems around MDH acoustics but also possible solutions.

One survey of 279 council, government, professional and building industry practitioners found that 42% had encountered problems around acoustics in the design or consenting process. This was the third-biggest issue after fire design and car parking.

Another survey (covering the same groups, with 414 completed responses) found that 55% of respondents felt that minimum performance levels in clause G6 should be raised and/or additional areas included. Fewer than 2% felt the current standards are too high.

Suggested areas for improvement:

- Raise baseline knowledge across the industry – both industry practitioners and consenting officers need upskilling.
- Develop New Zealand-specific, independent information to complement proprietary product information. Develop more information on whole-building construction options and designs or systems that address multiple requirements at once or at least better information on integrating the many different requirements.
- Improve the regulations around building acoustics. Expand Acceptable Solution G6/AS1 to address issues such as noisy plumbing.
- Find what occupants want and their experience with acoustics in existing MDH buildings.

More information

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Table 1. Typical acoustic transmission performance of 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 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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