How Walls and Ceilings Resist Sound in Multi-Residential Buildings

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INTRODUCTION

Noise exposure has a profound impact on health and well-being, and with Australia's cities becoming increasingly noisier, addressing acoustic concerns in residential design is more critical than ever. This challenge is especially prominent in multi-residential developments, where many housing units are concentrated within a small area, amplifying noise from both external and internal sources.

Walls and ceilings are particularly important in controlling sound in multi-residential buildings because they act as primary barriers between living spaces, both within individual units and between neighbouring units. Sound travels easily through poorly designed or inadequately insulated walls and ceilings, leading to issues such as noise from neighbouring apartments, footfalls from above, or disturbances from communal areas.

By carefully considering wall and ceiling design, among other considerations, designers can improve acoustic comfort. This whitepaper examines the challenges and solutions for achieving effective acoustics in multi-residential buildings, with a focus on how walls and ceilings can resist sound transmission between units.

USEFUL TERMS AND CONCEPTS

Airborne vs. impact noise

Airborne noise refers to sound that travels through the air, reaching your ears without direct contact with a surface. Common examples include voices, music, or the sound of traffic.

Impact noise, on the other hand, occurs when an object physically strikes a surface, causing vibrations to travel through the building's structure. Sounds that occur when solid objects come into direct contact with floors, walls, or ceilings, such as footsteps, banging doors, or moving furniture, fall into this category.

Ceiling Attenuation Class

Ceiling Attenuation Class (CAC) is a rating used to assess how well a ceiling system can block airborne sound from passing between neighbouring rooms that share the same air plenum. Essentially, it measures the ceiling's ability to act as a sound barrier. A higher CAC rating indicates better performance in preventing sound transmission.

Ln,w

The term used to describe the impact sound insulation of a floor is the "weighted normalised impact sound pressure level" (Ln,w). A lower Ln,w value indicates better impact sound insulation performance for the flooring system.

Noise reduction coefficient

Noise Reduction Coefficient (NRC) is a measure of how well a material can absorb sound, helping to reduce noise levels by preventing sound from bouncing off surfaces. NRC values are based on the material's ability to absorb sound across four different frequencies—250, 500, 1,000, and 2,000 Hz. NRC values range from 0, indicating the material reflects all sound, to 1.00, meaning the material absorbs all sound. Essentially, a higher NRC means the material is better at absorbing sound rather than reflecting it.

Rw

Rw, or the weighted sound reduction index, is a measure used to evaluate how effectively a building element, such as a wall, ceiling, floor, window, or door, can block airborne sound. This value is determined in a controlled laboratory setting and indicates the sound insulation performance of the element. The higher the Rw rating, the better the material is at preventing sound from passing through it.

Rw+Ctr

Rw+Ctr represents the Rw value adjusted by a correction factor, Ctr, which accounts for low-frequency sounds. Since low-frequency noises—like those from traffic, aircraft, surround sound systems, and home entertainment systems—have become more common, this adjustment is important for accurately assessing how well a building element can block these types of sounds. The Ctr factor is typically negative, meaning it reduces the overall sound insulation rating to reflect the element's performance against low-frequency noise.

Minimising noise transmission between living spaces is essential for maintaining comfort and privacy.

SOURCES OF NOISE IN MULTI-RESIDENTIAL BUILDINGS

External noise intrusion

This refers to sounds from outside a building, such as traffic, construction, or nearby activities, that enter the building and disturb the indoor environment. Effective insulation and acoustic design are essential to minimise the impact of this noise on occupants' comfort.

Internal building services

These are the operational systems within a building, such as plumbing, heating, ventilation, and air conditioning, which can produce noise. If not well-designed or maintained, these systems can cause disturbances by generating constant background noise or vibrations.

Residential activities

These are everyday sounds created by occupants within a home, such as conversations, music, or the noise from appliances and household tasks. In multi-residential buildings, these noises can travel through walls, floors, or ceilings, affecting neighbours if proper acoustic measures are not implemented.

Structure-borne noise

This type of noise is caused by vibrations travelling through the building's structure, typically from impacts like footsteps, moving furniture, or mechanical equipment. It can easily spread through walls, floors, and ceilings if not properly controlled with soundproofing or isolation techniques.

NCC REQUIREMENTS AND OTHER GUIDELINES

In Australia, acoustic performance in Class 2 multi-residential homes is governed by a range of regulations and guidelines. The National Construction Code (NCC) includes specific provisions aimed at controlling sound transmission between dwellings to ensure acoustic comfort for occupants.

Key Performance Requirements include:

- F7P1 addresses sound transmission through floors; and
- F7P2 focuses on sound transmission through walls.

Verification Methods offer a performance-based pathway to meet acoustic requirements. The relevant provisions are:

- F7V1 for sound transmission through floors; and
- F7V2 for sound transmission through walls.

Deemed-to-Satisfy (DtS) provisions in the NCC provide a set of specific guidelines that, if followed, ensure compliance with building standards. The relevant DtS provisions that satisfy F7P1 to F7P4 are set out in F7D2 to F7D8.

The DtS provisions reference Specifications 28 and 29. Specification 28 lists the weighted sound reduction index Rw for some common forms of construction. Specification 29 describes a testing method to determine the comparative resistance of walls to the transmission of impact sound.

In addition to the NCC, other relevant standards and guidelines include the Association of Australasian Acoustical Consultants' Guideline for Apartment and Townhouse Acoustic Rating, local planning regulations, and AS/NZS 2107:2000, which provides recommendations on sound levels and reverberation times in buildings. Together, these documents help designers and specifiers ensure that multi-residential homes achieve appropriate levels of acoustic performance.

HOW WALLS AND CEILINGS RESIST SOUND

Walls and ceilings control sound using three key principles: sound absorption, sound insulation, and sound isolation.

Sound absorption refers to when materials within a building element, like acoustic panels or insulation batts, absorb sound waves and convert them into heat. This reduces the amount of sound that reverberates inside internal cavities and spaces, which lessens echo and improves sound clarity. A common measure for sound absorption is the NRC value.

Sound insulation refers to the ability of walls and ceilings to block sound from passing through them. This is crucial for preventing noise from spreading between apartments in multi-residential buildings. Sound-insulating materials and construction techniques, such as adding mass to walls or creating air gaps, work to limit the amount of airborne noise that can pass through building elements. High levels of sound insulation also ensure that external noise sources, like traffic, are less likely to disrupt indoor living spaces.

Sound isolation is the physical separation of building elements to prevent noise from transferring between spaces. This can be accomplished by decoupling floors, walls, or ceilings, which means that the structure is built to break the direct path of sound waves. Decoupling techniques, such as the use of resilient channels and double-stud walls, isolate sound and prevent it from reverberating into nearby areas. These techniques are particularly effective at controlling impact noise, which can travel easily through connected building elements.

DESIGN CONSIDERATIONS

Walls

Minimising noise transmission between living spaces is essential for maintaining comfort and privacy. To achieve this, it is important to use NCC-compliant, laboratory-tested systems and to verify their performance with valid test certificates and guidelines from suppliers. Materials should be chosen based on their proven ability to reduce sound transfer while meeting regulatory standards. Proper selection ensures that walls meet both sound insulation requirements and other performance requirements, like fire safety.

Thicker or heavier walls generally provide better sound insulation, but this must be balanced with the need to keep construction efficient and cost-effective. The acoustic performance of wall systems can typically be enhanced by using either thicker or heavier walls or by incorporating systems with larger cavities and moderately thick cladding.[1] Party walls need sufficient width and depth to accommodate the materials and techniques used for sound insulation.

"Discontinuous construction" refers to building techniques that reduce sound transmission by separating building elements. It is often required in certain areas by the NCC to meet specific acoustic performance standards, particularly in multi-residential buildings or where sound insulation between adjoining spaces is critical.

Clear design instructions should be provided for junctions where walls, floors, and ceilings meet, as these areas can be weak points for sound leakage if not properly addressed. Additionally, the specification of impact-rated walls in high-noise areas, such as around elevators or staircases, helps to further reduce sound transmission in sensitive zones.

Other key considerations include:

- select reliable wall systems that are easy to build and dependable;
- ensure walls are constructed to the same standard as in laboratory testing to maintain acoustic ratings;
- maintain discontinuities in walls, floors, and ceilings;
- use acoustic-grade insulation in sound-rated walls and ceilings;
- specify durable acoustic seals that last throughout the building's life;
- avoid material substitution without proper testing and documentation;
- avoid fixing together parts of sound-rated walls or ceilings;
- ensure wall designs comply with other NCC requirements, such as fire and structural safety; and
- properly treat areas around sound-rated doors.

Floors and ceilings

To comply with NCC acoustic provisions, both floors and ceilings may need to be sound-rated to effectively reduce airborne and impact noise. Careful selection of materials and construction techniques, such as incorporating acoustic insulation between floors and ceilings, is essential to meet these performance standards.

Carpets and underlays are commonly used in floor designs to help meet acoustic requirements, as they effectively dampen impact noise like footsteps. Hard flooring, on the other hand, increases the risk of noise transmission, particularly impact sound. Therefore, if hard flooring is desired, alternative impact-rated flooring systems should be considered to maintain compliance. Additionally, floorboards should be installed with breaks under party walls to isolate units from one another and prevent structure-borne noise from travelling across floors.

For ceilings, sound-rated designs must address potential weak points caused by penetrations like downlights or ventilation grilles, which can allow noise to pass through. Ensuring these elements are properly sealed and treated with acoustic solutions will help minimise noise intrusion. Combining sound-rated ceilings with well-designed floors creates a robust barrier that significantly reduces noise transmission.

Materials

Effective sound control in walls and ceilings often relies on the careful selection of materials. Common sound absorbers include glass wool, rock wool, polyester fibre, natural wool, and cellulose fibre, all of which help reduce noise by absorbing sound waves. Increasing the mass of building elements, either by adding extra layers or using denser materials, is another way to improve sound insulation.

Lightweight building elements, such as partitions, can benefit from introducing sound-absorbing materials into cavities to improve overall insulation. Specialty lining materials, such as acoustic plasterboard, are also available for spaces requiring enhanced acoustic performance. When combined with proper insulation and studs, these materials can significantly reduce sound transmission through walls and ceilings, ensuring a quieter and more comfortable environment in multi-residential buildings.

Addressing sound leakage

Sound can inadvertently enter spaces through penetrations, cracks and gaps and around the edges of building elements. These "flanking paths," as these noise paths are often called, contribute significantly to poor sound control.

All windows and doors should have acoustic seals around the perimeter; however, these seals will only work as intended if they are installed correctly. Seals should be chosen for their longevity, ease of use, low maintenance requirements, and performance.

A wall or ceiling system's design should account for any penetrations and services. Every penetration made in acoustic-rated building elements needs to be carefully drilled or cut. It is good practice to avoid excessively large penetrations. Make sure that all penetrations, joints, and junctions are sealed airtight with a flexible caulking compound to minimise noise transfer via flanking paths.

ACOUSTIC SOLUTIONS FOR MULTI-RESIDENTIAL BUILDINGS

Gyprock offers a range of acoustic systems tailored to help specifiers and builders confidently meet the NCC requirements for sound control in multi-residential buildings. Their acoustic plasterboard products, such as Soundchek™ and Gyprock HD, are designed to minimise sound transfer between units and across different levels of an apartment or multi-residential complex. When used with acoustic insulation, these products are ideal for creating quiet spaces, especially around bedrooms, studies, or entertainment areas in multi-residential developments.

For areas requiring enhanced sound control, Gyprock's Perforated Plasterboard can be used in spaces like common rooms or recreational areas. The perforations, combined with insulation, reduce echo and reverberation, contributing to a more comfortable environment for residents. In larger multi-residential and commercial applications, products like Soundchek™, Fyrchek™, Fyrchek™ MR, Gyprock HD and EC08™ Complete offer superior sound absorption for walls and ceilings, reducing noise transfer between apartments, offices, or communal spaces. These solutions also help control reverberation, improving acoustic comfort in shared areas such as foyers and gyms.

For more demanding applications, EC08™ Extreme is engineered to meet rigorous performance standards, providing exceptional sound control while withstanding high-impact environments.

To further optimise acoustic performance, these plasterboard products can be paired with the Rondo QUIET STUD® Acoustic Wall System, which enhances noise reduction in inter-tenancy walls and other areas requiring heightened acoustic performance. For ceiling applications, Rondo Resilient Acoustic Mounts combined with the Rondo KEY-LOCK® Concealed Suspended Ceiling System offer an effective solution for minimising sound transmission.

Walls and ceilings control sound using three key principles: sound absorption, sound insulation, and sound isolation.

REFERENCES

[1] Australian Building Codes Board. “Sound transmission and insulation in buildings.” ABCB. https://www.abcb.gov.au/sites/default/files/resources/2021/Handbook_Sound_Transmission_and_Insulation_in_Buildings.pdf (accessed 24 September 2024).

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