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SOUND INSULATION OF FLOORS

The sound insulation of floors refers to the ability of a floor system to reduce airborne noise entering your residence from residences above and below, and noise caused by movement such as walking from residences above. The sound insulation of floors is considered in the design of apartments, residential buildings, hotels, motels and aged care buildings. Residents in these buildings need to be insulated from the noise generating activities of adjacent residents.

The acoustic terminology used in this fact sheet is explained in *Fact Sheet 11: Acoustic Terminology*.

Key Issues and Considerations

When designing or modifying a floor, consideration should be given to airborne and impact noise insulation and integration with other building elements.

Airborne and Impact Noise Insulation

There is high density living in the inner city which results in many people living in multi-storey apartment buildings. Noise from activity in adjacent apartments can adversely affect the amenity of residents. To effectively reduce internal noise transfer from adjacent apartments and maintain the amenity of the resident it is important for the floors to be designed properly.

A well designed floor-ceiling system is required to insulate against both impact and airborne sound. Impact noise is generated by activities such as walking. The floor surface finish and overall method of construction will have an effect on impact noise transfer to apartments located below.

The Building Code of Australia (BCA) has set particular requirements for the impact and airborne sound insulation of floors. In new residential apartments the floor-ceiling systems should have been designed so that adequate airborne and impact sound insulation is provided. In older apartments, the noise insulation provided by the floor systems may not be as adequate due to variations in Building Code compliance requirements.

New residential apartment buildings are usually constructed with a minimum 150 mm concrete slab floor, with floor coverings of either carpet, acoustically installed tiles or timber flooring. This type of construction usually results in an acceptable level of airborne and impact sound insulation.

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Old buildings and converted warehouses often have lightweight timber floors and exposed beams, resulting in poor sound insulation. Problems associated with these situations include:

- poor airborne sound insulation, resulting in noise from talking, radios, televisions, telephones, doors closing, washing machines etc being audible through the ceiling and/or floor;
- poor floor impact sound insulation, resulting in noise from residents walking on timber or tiled floors being audible below; and
- poor low frequency insulation from residents walking or children running on carpeted floors, producing a thumping or booming noise in the unit below.

To reduce noise transfer through timber floors there are a number of things to consider:

- floor surface;
- insulation between floor/ceiling;
- ceiling material and thickness; and
- resilient isolation of components.

Integration with Other Building Elements and Thermal Considerations

Treatment of floor/ceiling systems to reduce noise should be considered alongside thermal insulation requirements. Keep the age of the building in mind when refurbishing as older buildings were subject to lower acoustic standards. It is also important to consider the acoustic construction of other building elements that connect to the floor-ceiling system.

General Acoustic Design

When choosing a system to reduce sound, you should consider:

- Materials;
- General construction; and
- Best practice design.

Materials

The ability of a floor to control impact sound transfer (impact sound insulation) is different from its ability to control sound passing through (airborne sound insulation).

A floor which has high mass and density and is well sealed will provide a good level of airborne sound insulation. With appropriate floor coverings and/or resilient mounting, impact sound insulation can be improved.

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Concrete Slab Floors

A standard 150 mm – 200 mm concrete slab floor will provide sufficient airborne sound insulation between two habitable spaces. *Note: it is not sufficient by itself to provide the required level of impact sound insulation.

Timber or Lightweight Floors

Timber or lightweight floors are not as good as providing airborne sound insulation as concrete slabs. However, the performance of a lightweight floor system can be improved by introducing sound absorption into cavities and by using appropriate ceiling linings.

Insulation

The airborne sound insulation of a floor-ceiling system can be improved by incorporating in the cavity between the floor and ceiling below with high grade insulation batts. Generally, thicker insulation will contribute to improved sound reduction. Density is also important, and fibrous materials such as glassfibre, polyester batts, and rockwool should have a minimum density of 14 kg/m³. When choosing insulation, you should also consider thermal requirements.

Installing wall and ceiling insulation
Source: CertainTeed Pty ltd

Plasterboard Lining

Increasing the thickness of the plasterboard lining for ceilings will also increase the airborne sound insulation of the system. The thickness of the plasterboard lining may be increased by increasing the number of layers of plasterboard used, or by simply using thicker plasterboard.

Additionally, fire-rated or sound-rated plasterboard may increase the sound insulation of a system.

*Note: where the plasterboard lining is used to provide the required airborne sound insulation, especially for timber floors, lights must be either surface mounted or acoustically rated so that they do not degrade the acoustic performance of the floor-ceiling system. Down light penetrations in the ceiling will degrade the level of airborne sound insulation achievable by the system.

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Floor finish
When considering the floor finish the main area of concern is impact sound transfer to the residence below.

For timber constructed floor/ceiling systems, the most significant material in impact sound insulation is the surface finish. Hard surfaces like concrete, timber or tiles are more problematic than soft finishes such as carpet because they can increase structure borne sound transference.

Carpet is one option to consider for improving the impact sound insulation of floors. Alternative hard-floor systems can also be considered with appropriate acoustic treatments. The choice of floor covering is important as part of the initial fit-out and as part of a future upgrade.

The design for both hard floor covering and carpet options should allow for:

- sufficient ceiling height to be maintained in all rooms – according to the BCA the minimum height from floor to ceiling of a habitable room is 2.4 metres; and
- maintaining relatively level floor surfaces if transitioning from carpet to other floor surfaces.

A further consideration with floor finishes is the reflected noise within a room. Smooth surfaces in a room tend to reflect high frequency noise. Surfaces such as carpet offer better absorption of sound than hard surfaces like concrete and timber, which can increase noise through reflection or reverberation. A high reverberation time can cause low speech intelligibility and high internal reverberant noise levels. A high internal reverberant noise level in one apartment will result in more noise transfer to an adjacent apartment. Therefore it is desirable to reduce reverberation by selecting absorbent floor coverings (such as carpet) or other absorbent furnishings (such as rugs or heavy drapes).

General Construction

Resilient Isolation
Generally, if carpet is used on a concrete slab floor (150 – 200 mm thick), the system will provide sufficient airborne and impact sound insulation. When hard composition flooring is used on concrete and for most timber floor systems, resilient isolation is required to have a sufficiently insulated system.

It is best to isolate the building components from one another using resilient compounds (such as rubber or silicone), or detach/decouple the construction altogether in a suspended ceiling or floating floor construction.

A floating floor system is a method of construction where the floor sits on isolating components, such as a resilient underlay, resulting in a reduction of structure-borne noise transference (improving impact sound insulation).

A suspended ceiling can also provide better reduction of structure-borne noise due to the decoupling of the construction. In these designs, the ceiling hangs from resilient hangers attached to the floor joists or concrete slab. This decouples the ceiling lining from the main floor structure which improves the impact sound insulation to the resident below. It also allows more space for services and sound insulation in the ceiling cavity.

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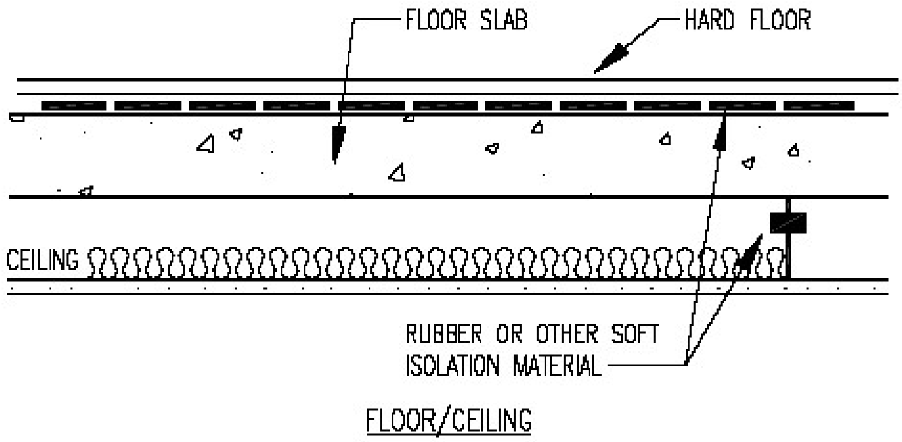

Vibration Isolation Treatment – Floor-Ceiling Construction
Source: ABCB Document: Guideline on Sound Insulation

Material Thickness and Insulation

The acoustic performance of a floor-ceiling system can be improved by employing either thicker/heavier floor constructions, or systems with larger cavities and moderate ceiling cladding thickness.

Seals and Junctions

An important feature of well constructed floor-ceiling systems is properly sealed junctions, which aid in the reduction of noise transferred via flanking paths (gaps at the edge of building elements that allow sound to travel through). Even a sound-rated system may not perform adequately, if joints and junctions are not properly sealed.

- The depth of mastic in joints should be sufficient to maintain the acoustic rating of the construction. Typically, the depth of mastic should be equal to or greater than the width of the joint. Suitable backing rods are generally required.
- Joints in dissimilar materials may open up if there is building movement. It is important that the acoustic seal in joints accommodates building movement.
- Insulation considerations should form part of the initial design. Insulation needs to be installed prior to the finishing stages.

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Best Practice

- A well designed floor-ceiling system will use suitably dense and thick materials. The reduction of noise will also be improved by isolating the components from one another using resilient compounds (such as rubber or silicone), or by detaching the construction altogether as in a suspended ceiling or floating floor. Proprietary systems are also available that provide increased acoustic performance. To minimise noise transfer though gaps and cracks, the design of a floor-ceiling system should consider all connected building elements.
- If you have a noise problem, achieving a useful improvement in sound insulation requires a decrease of at least five decibels (dB), preferably 10 to 15 dB. An improvement of less than 5 dB is normally not worth the additional expense as the change will only be just perceptible.
- When comparing quotations for sound insulation, look at the noise reduction performance of different options. Remember most products perform better in laboratory conditions than after installation. Ensure the specified noise reduction of the treatment is presented in decibels or a suitable acoustic measurement. Noise reduction figures presented as percentages can be misleading.

Examples of Design

This section provides examples of different acoustic treatments for improving existing floor-ceiling systems and for general floor-ceiling constructions. They are provided as examples only and are not exhaustive. City of Adelaide recommends consultation with an acoustic consultant to ensure correct design for your project.

Design Considerations

In general, the sound insulation performance of floor and ceiling elements can be improved by:

- increasing the surface mass of the material;
- the use of additional skins of material, preferably with a cavity;
- increasing the depth of cavities and thickness / density of cavity insulation;
- the use of materials with low stiffness; and
- the addition of damping, especially to thin stiff elements.

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Sound Absorption

The sound insulation of a lightweight construction can be improved by introducing sound absorbing insulation into ceiling cavities. Ceiling space insulation can also increase thermal performance.

Where absorption is already present, marginal improvements can be produced by upgrading the sound absorption material. The sound absorption performance of a material can be quantified by its noise reduction coefficient (NRC). Different materials such as glasswool, rockwool, polyester fibre, natural wool or cellulose fibre are sound absorptive. There are several proprietary ceiling systems incorporating insulating materials and offering increased noise reduction.

Sound reduction performance can be slightly improved by:

- using an insulating material with thinner fibres;
- increasing the density of, and hence the number of fibres within a given material; and
- increasing the thickness of the absorbing material itself.

In most cases the ceiling must be resiliently mounted for insulation to have acoustic benefit.

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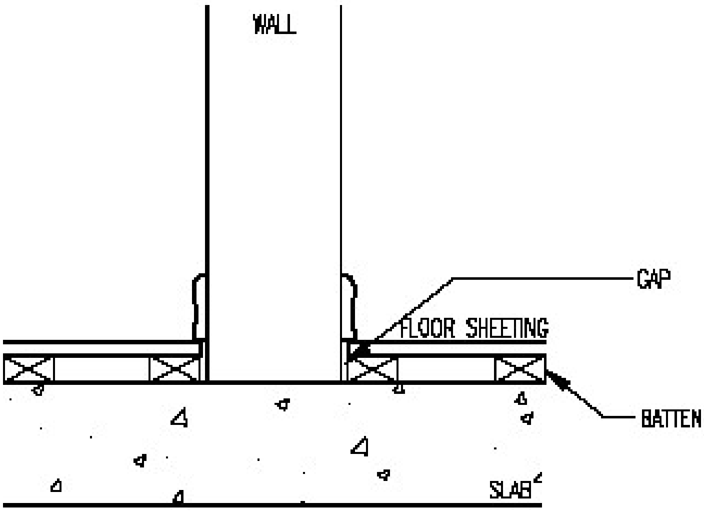
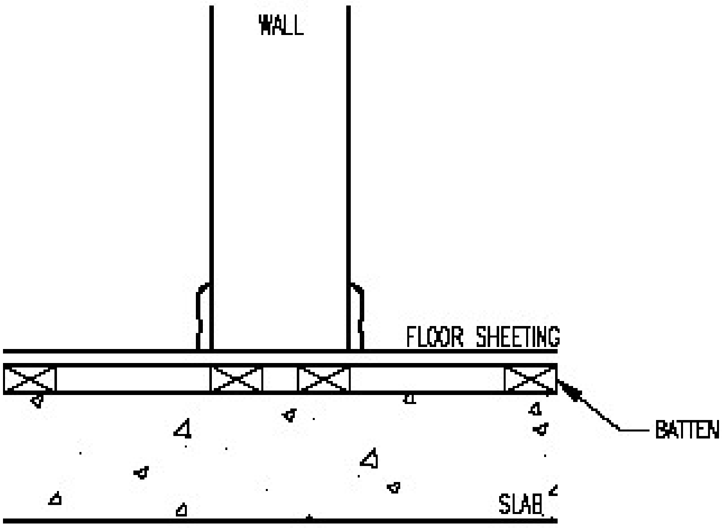
Resilient Isolation

The transference of structure-borne or impact sound can be reduced by increasing the vibration isolation in a system. This can be done by:

- using a suitably soft connecting material such as rubber, neoprene or isolation springs between the building elements;
- increasing the size of the air gap or cavity between the panels; and
- introducing vibration isolated floors to adjacent rooms located on a common slab.



Floor Lateral Vibration Isolation – Good Design Practice – Floors in adjacent rooms isolated
Source: ABCB Document Guideline on Sound Insulation



Floor Lateral Vibration Isolation – Bad Design Practice – Common floor between adjacent rooms
Source: ABCB Document: Guideline on Sound Insulation

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Different Acoustic Treatments

The following acoustic treatments represent three different levels of acoustic design. They are provided as an example only and are by no means exhaustive. City of Adelaide recommends consultation with an acoustic consultant to ensure correct design for your project.

Minimal Timber Construction

- 19 mm tongued and grooved boards over 175 mm x 50 mm timber joists; and
- 75 mm mineral insulation with a density of 11 kg/m^3 laid between joists
- 10 mm plasterboard ceiling fixed to underside of joists.

This example is indicative of timber construction with minimal thought given to sound insulation or absorption, and is similar to that found in converted warehouses and terrace type dwellings. The construction does not meet BCA 1996 or 2004 requirements.

Footfall noise is both transferred and reverberated due to the hard surface finish and continuous construction. It is possible to increase the impact insulation in a number of ways including carpeting the floor surface or using other soft finishes such as cork. In conjunction with carpet, soft furnishings such as drapes can help absorb sound generated within a space.

Standard Reinforced Concrete Construction– Standard Treatment

- 150 mm reinforced concrete slab;
- 28 mm furring channels and isolation mounts fixed to underside of slab at 600 mm centres;
- 65 mm polyester insulation fixed between furring channels; and
- 13 mm plasterboard to underside of furring channels.

This method of concrete construction is an example of the minimum construction required BCA requirements for sound insulation for floors between dwellings.

It can provide impact sound insulation of $L_{nw}+C_{tr} \le 62$ and airborne sound insulation of $R_w+C_{tr} \ge 50$. This design takes into account bass frequencies generated by stereos and home theatre systems. It is possible to increase the impact insulation in a number of ways including carpeting the floor surface or using other soft finishes such as cork.

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Standard Reinforced Concrete Construction – Improved Treatment

- 200 mm reinforced concrete slab with carpet on underlay.

This method of concrete construction is also an example of the minimum construction required to comply with the BCA requirements for sound insulation for floors between dwellings. By installing a ceiling with insulation in the ceiling cavity, it is possible to increase both the airborne and impact noise insulation of the system.

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Challenges

Challenges to good acoustic design of floor/ceiling systems can arise from renovation works and flanking paths.

Renovation

Refurbishments have the potential to severely compromise the acoustic performance of a building. Old buildings and converted warehouses often have lightweight timber floors and exposed beams, resulting in poor sound control.

When designing a floor system that uses carpet for noise reduction, consider the possibility of future renovation works. Where carpet is replaced by hard floor finishes during renovation works, the impact isolation performance of the floor will invariably be reduced. The reduction could be as high as 25 to 30 dB.

This level of reduction is difficult to recover and the use of resiliently suspended ceilings becomes an important part of any design solution. However, a ceiling of this type would need to be installed at the time of construction as there is no guarantee of access to the unit underneath for retrofit later.

Even with the addition of a resiliently suspended ceiling, the floor-ceiling system may still be 15 to 20 dB lower than the original carpet design.

When renovation is a future possibility, it is advisable to ensure sufficient detail is readily available to future occupants via the body corporate for floor, ceiling and wall modifications.

Flanking Paths - Sealing Gaps

Flanking is the transfer of noise through paths around a building element, rather than through the element directly. Flanking can describe the transfer of noise through gaps and cracks in a building element, or via incorrectly sealed junctions between two materials.

These noise flanking paths can defeat noise reduction techniques. It is essential to consider the design of junctions, including internal detail. Common flanking paths arise because of poor design, when the junction of building elements is inadequately detailed.

In order to minimise flanking paths, the design of a floor system will need to consider detail for all connecting walls.

Sealing gaps at the perimeter of floor-ceiling systems is essential, as gaps at the junction of these building elements are a common flanking path (especially in renovated buildings). Gaps can also open up over time from building movement, limiting sound insulation.

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- Gaps at the perimeter of wall and floor-ceiling systems should be sealed and airtight, using an appropriate mastic compound.
- Robust acoustic design should be used to allow for site conditions where surfaces may not be straight, true or square. This is especially important around joints, walls, floors, ceiling junctions and penetrations
- The treatment applied to seal gaps should be sufficiently flexible to allow for building movement
- The floor-ceiling system will need to control sound and vibration travelling through timber floorboards, joists, beams, external walls or ceilings

For more information see *Fact Sheet 2: Gaps and Flanking Paths*

Other Building Considerations

You may also need to consider other building requirements in design and construction.

- Avoid potential fire hazards from acoustic treatment by ensuring that electrical wiring or lighting is not covered with acoustic insulation.
- When upgrading acoustic ratings, the additional mass of building elements should not exceed maximum acceptable structural loading.
- Consider variations in the building fit-out driven by unexpected site conditions that may require revised designs.

Acoustic Consultant

If you are considering any sound insulation, it is recommended that you verify any sound insulation specifications with your architect/builder and/or employ the services of an acoustic consultant to ensure the proposed changes provide significant noise reduction.

To contact an acoustic consultant visit the Yellow Pages Directory (under Acoustical Consultants) or for an acoustic consultant who is part of the Association of Australian Acoustical Consultants (AAAC) visit www.aaac.org.au

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Other Fact Sheets

A number of other Noise Technical Fact Sheets complement the information in this document. These can be downloaded from the City of Adelaide website: www.cityofadelaide.com.au/noise

Fact Sheet 1: Sound Insulation Guidelines

Fact Sheet 2: Gaps and Flanking Paths

Fact Sheet 3: Sound Insulation for Windows

Fact Sheet 4: Sound Insulation for Glazed Doors and Standard Doors

Fact Sheet 5: Sound Insulation for Exterior Walls and Facade Systems

Fact Sheet 6: Ventilation

Fact Sheet 7: Sound Insulation for Air Conditioners and Other External Mechanical Plant

Fact Sheet 8: Sounds in the City

Fact Sheet 9: Adelaide City Road Traffic Noise Map

Fact Sheet 10: Noise Ready Reckoner

Fact Sheet 11: Acoustic Terminology

Fact Sheet 12: Frequently Asked Questions

Fact Sheet 13: Sound Insulation for Internal/Common Walls

Fact Sheet 14: Sound Insulation of Floors

Fact Sheet 15: Mechanical Plant for Commercial Buildings

Fact Sheet 16: AAAC Star Rating

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The Building Code of Australia Compliance

The Building Code of Australia (BCA) should be consulted to ensure that any sound insulation upgrades comply with the requirements of the BCA. It should be noted that although the upgrade of a building element may be acoustically beneficial, it may not comply with the requirements of the BCA.

Australian Building Codes Board

The Noise Technical Fact Sheets contain content sourced from the Building Code of Australia and Guidelines on Sound Insulation, published by the Australian Building Codes Board (ABCB). These documents can be purchased from the ABCB website: www.abcb.gov.au

Standards

The standards which apply in the Development Plan are:

- Australian/New Zealand Standard 2107:2000 “Acoustics - Recommended design sound levels and reverberation times for building interiors”
- World Health Organisation, Guidelines For Community Noise, Edited by B Berglund et al, 1999) (http://www.who.int/docstore/peh/noise/guidelines2.html)
- Recognised liquor licensing noise limits (www.olgc.sa.gov.au). These are modified to apply within bedroom and living areas.

Contacts / Additional Information

Additional information can be obtained from:

- Australian Association of Acoustic Consultants (www.aaac.org.au)
- Australian Acoustical Society (www.acoustics.asn.au)
- Office of the Liquor and Gambling Commissioner (www.olgc.sa.gov.au)
- South Australian EPA (www.epa.sa.gov.au/noise.html)
- South Australian Police (www.sapolice.sa.gov.au)
- Yellow Pages (www.yellowpages.com.au search “acoustic”)
- Australian Window Association (www.awa.org.au)

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Acknowledgements

This project has been developed by City of Adelaide in partnership with Bassett Acoustics.

Contact Us

For further information call City of Adelaide on (08) 8203 7203 or email city@cityofadelaide.com.au

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