

SOUND INSULATION FOR EXTERIOR WALLS AND FACADE SYSTEMS

The sound insulation of exterior walls and roof-ceiling systems refers to their ability to reduce external noise entering your residence.

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

Key Issues and Considerations

When designing or modifying an external wall or roof-ceiling system, the work must comply with the Building Code of Australia and consideration should be given to any required reduction of outside noise. Construction that reduces the ingress of external noise must be designed to ensure that it is integral with all other Building Rules requirements such as energy efficiency.

Noise and Insulation

The wide range of activity in the inner City generates higher levels of external noise than in suburban areas. Noise from activity such as traffic, people on the street, operational commercial sites and waste collection can adversely affect the amenity of those living in the City. As low frequency noise is particularly invasive, reducing the impact of noise from truck engines, buses, music etc. may need to be considered. To effectively lower the amount of external noise that enters a building and subsequently maintain the amenity of an inner city residence, particular attention to the construction detail of the external facade (including the roof) is required.

Additionally, aircraft noise may be a problem in Adelaide as there are flight paths directly over the City. To reduce this noise, the roof-ceiling system of a residence should be acoustically enhanced with insulation and also be constructed to ensure poor construction techniques do not allow unwanted sound entering the building.



Normally, the number, size, location and selected materials of the windows, doors and openings will control external noise ingress into a residence, and the influence of the openings should be determined prior to any proposed upgrading of the exterior walls and the roof-ceiling system.

The Building Code of Australia (BCA) currently only sets minimum standards for internal sound insulation between sole occupancy units and does not address sound insulation from external noise sources. Accordingly, it is important to consider your expectations regarding noise when deciding appropriate wall and roof-ceiling constructions for your residence.

Generally, walls and roof-ceilings with a sound rating higher than R_w 45 are sufficient to control general external noise; however a number of factors can influence this rating including the levels of background noise and the expectations of the building occupier/s.

The ability of a building element to reduce noise is dependent on the following elements:

- type of construction;
- materials; and
- insulation.

If you are considering using sound insulation to reduce external noise, it is recommended that you discuss your requirements with your architect, building designer or architect/builder or consider employing the services of an acoustic consultant to ensure the proposed changes provide significant noise reduction.

Integration with Other Building Elements and Thermal Considerations

Construction for noise reduction should be considered alongside thermal insulation requirements and the nature of the local environment.

It is important to consider the acoustic construction of other building elements connecting with a wall or roof-ceiling system. To achieve maximum performance with minimal thickness, weight and cost, close attention to design is required.

General Acoustic Design

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

- the appropriate acoustic properties of the materials selected;
- ensuring that your designer and builder pays particular attention to the general construction detailing with regard to noise reduction; and
- the appropriate level of noise reduction for your particular set of circumstances.

Materials

External Masonry Veneer Walls

The type of materials used plays a major role in the sound insulation properties of a wall.

Generally, masonry construction has better insulation capabilities for airborne noise. However, stud walls lined with acoustic rated sheeting can equal or outperform the insulation levels of masonry walls at a fraction of the weight. This will only occur if they are constructed in accordance with the appropriate acoustic construction guidelines. Some proprietary systems will achieve very high levels of sound insulation.

Blockwork Walls

Blockwork performs reliably if it is well constructed and of adequate mass or density. Plastering can improve its sound insulation which can otherwise be compromised by fissures and movement cracks.

Lightweight thermal block (Autoclaved Aerated Concrete), $350 - 700 \text{ kg/m}^3$, has poor sound insulation properties compared with other types of masonry. The best blockwork walls for acoustic design are constructed using solid concrete blocks that have a density of 2000 kg/m^3 , with no-voids and a thickness not less than 120mm.

Brickwork Walls

Brickwork is usually better than blockwork as the smaller bricks are denser with fewer internal voids. Engineered brickwork (using solid bricks and fully bedded mortar joints) can achieve a density of 2300 kg/m^3 and will be the most acoustically efficient brickwork construction.

Plasterboard Lining

The plasterboard lining for walls and ceilings improves the sound insulation. Simply increasing the thickness of the plasterboard sheet may also increase the sound insulation of the system. A further option for consideration is to use multiple layers of plasterboard thereby increasing the overall density of the wall and improving its sound insulation.

There are a number of construction considerations when increasing the thickness or using multiple layers of plasterboard such as allowing for the additional loading in ceilings and ensuring that the correct installation methods are followed.

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

Insulation

Insulation placed between the vertical members of an external stud wall or above a ceiling also plays a role in reducing sound transmission through the wall. Generally, thicker insulation will contribute to improved sound reduction although the cavity should not be bridged by the insulation. Density is also important, and fibrous materials such as glass fibre, polyester batts, and rockwool should have a minimum density of 14 kg/m³.

Increasing the size of a cavity allows thicker acoustic insulation to be installed, achieving an increased level of sound insulation, however for cavity wall construction the Building Code of Australia requires the cavity width be no greater than 65mm.

Reference to plasterboard and insulation product data will help choose proprietary insulation systems and materials to acoustically enhance walls. When choosing insulation, you must also consider the minimum thermal requirements as required by the BCA.



Installing wall and ceiling insulation
Source: Image courtesy of CertainTeed Pty Ltd

Wall Construction

The two main construction techniques for walls are cavity wall construction and single skin walling.

- Cavity wall construction

This type of construction consists of two leaves of walling separated by a cavity. The most popular forms of cavity wall construction are brick veneer and cavity masonry construction. Brick veneer is constructed with an external leaf of masonry and an internal leaf of lightweight walling such as plasterboard clad timber or steel frame. All wall construction must comply with the requirements of the Building Code of Australia.

- Single skin walling

Walling of this type may be a single leaf of masonry construction or lightweight construction. The lightweight construction will usually be a steel or timber frame with plasterboard internal wall linings and proprietary external linings that can have paint or rendered finish.

Roof - Ceiling Construction

Residential ceilings are typically a single layer (or multiple layers where high acoustic efficiency is required) of plasterboard direct fixed to the ceiling support structure with insulation in the cavity between the ceiling and the roof. Roofs are generally clad with tiles or sheet metal (such as colorbond roofing).

Air Gaps

As the air cavity between the wall leaves or the roof and ceiling increases so does the degree of noise reduction. This concept is similar with other building elements such as double glazed windows. Where double glazing is also used for thermal efficiency the size of the air cavity may be determined by the required level of thermal efficiency as increasing the cavity size decreases the thermal effectiveness of the glazing.

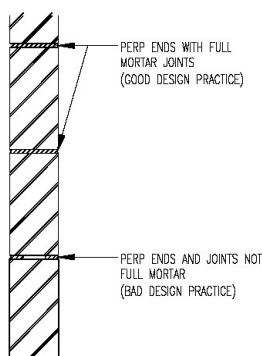
The minimum width of cavity in cavity wall construction which is acoustically beneficial is 50mm. Wider cavities will improve low frequency performance. Increasing the size of a cavity also allows thicker acoustic insulation to be installed, achieving an increased level of sound insulation. It is important to note that there is no maximum cavity width for brick veneer walling however cavity wall construction has a maximum of 65mm.

Material Thickness and Insulation

The acoustic performance can be improved by employing either thicker/heavier wall systems, or systems with larger cavities and moderate cladding thickness. To save weight, some heavy single-leaf wall systems can be replaced by lightweight construction using thinner leaves of material combined with insulation-filled cavities.

Seals and Junctions

An important feature of well constructed exterior walls and roof-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.

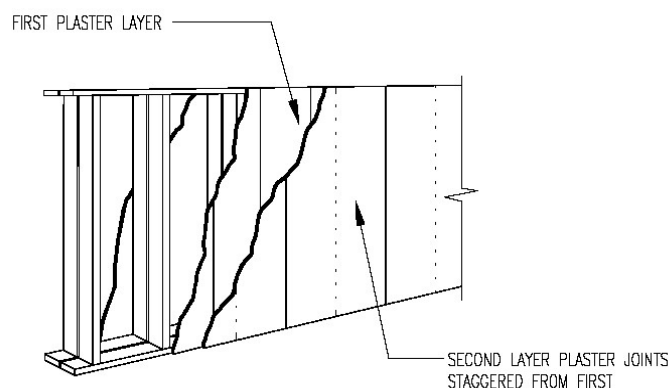


Treatment of joints - Masonry Walls
Source: ABCB Document: Guideline on Sound Insulation

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- Full-mortar joints should be used when a sound-rated masonry wall system is used.
- 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.
- Sheeting joints in dry wall/masonry combination systems should be staggered. Where multiple layers of material are used on walls, the joints should not overlap.



Optimum Joint Configuration - Dry Wall Sheeting
Source: ABCB Document: Guideline on Sound Insulation

Best Practice

- A well designed wall will use suitably dense and thick materials. An appropriate air gap and internal sound absorption will also assist in the reduction of noise. To minimise noise transfer, the design of a wall or roof-ceiling system should consider all connected building elements and the appropriate sealing of joints.
- 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.

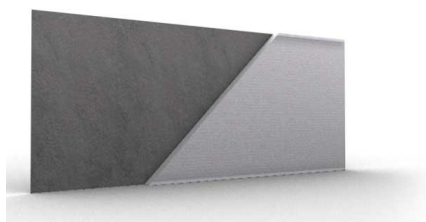
Examples of Design

This section provides examples of different acoustic treatments for exterior walls. They are provided as examples only and are not exhaustive. Consultation with an acoustic consultant is recommended to ensure correct design for your project.

Single Leaf Masonry Wall

- 190mm concrete block; and
- one layer of 10mm plasterboard attached to the inside face of the concrete block.

This type of construction is usually sufficient for residences where there is minimal external noise as this type of exterior wall generally does not have good airborne sound insulation (R_w 45). The acoustic performance of the wall can be improved by the addition of thicker plasterboard, gypsum lining, or an insulated stud wall built on the inside of the facade.

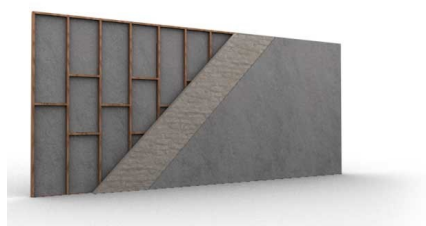


Source: image courtesy of City of Melbourne's City Sounds2 Noise Fact Sheets.

Brick Veneer Wall

- 110mm clay brick masonry;
- 70mm x 35mm timber studs at 600mm centres with an air gap greater than 20mm to the internal side of wall framing;
- 50mm mineral insulation between studs with a minimum density of 14 kg/m³; and
- One layer of 13mm plasterboard attached to the studs.

A correctly constructed typical brick veneer with good insulation should provide adequate reduction of airborne noise (R_w 55 – 60). Increased sound insulation can be achieved by the addition of thicker plasterboard or gypsum lining.



Source: Image courtesy of City of Melbourne's City Sounds2 Noise Fact Sheets.

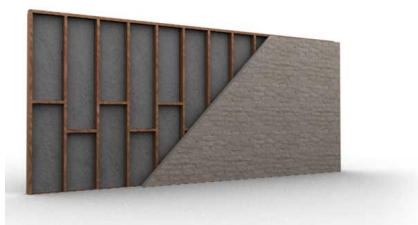
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Pre-cast Concrete Veneer Wall

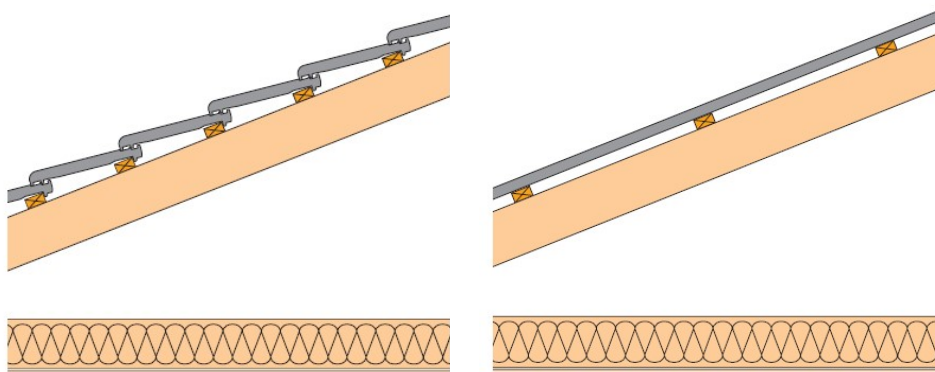
- 125mm concrete panel;
- 120mm timber or steel studs at 600mm centres with air gap > 20mm on internal side of wall framing;
- 100mm polyester insulation with a minimum density of 14 kg/m³ between studs; and
- One layer of 16mm fire-rated plasterboard attached to studs.

This type of wall construction provides very good sound insulation. The width, materials and discontinuous construction provide a good level of sound insulation against airborne noise (R_w 60 – 65) and bass frequencies generated by traffic movement. Proprietary wall systems are available that can achieve increased levels of sound insulation with lesser wall width.



Source: Image courtesy of City of Melbourne's City Sounds2 Noise Fact Sheets.

Ceiling Direct Fixed to Ceiling Joists



Ceilings under tile / metal deck roof - Ceiling direct fixed
Source: Boral Selector - Plasterboard Systems

The R_w rating varies from 42 to 53 depending on the roof construction and the thickness and number of layers of plasterboard.

For ceilings under tile roof:

- one layer of 13mm thick plasterboard will give R_w 43 and $R_w + C_{tr}$ 37; and
- three layers of 16mm fire-rated plasterboard will give R_w 53 and $R_w + C_{tr}$ 47.

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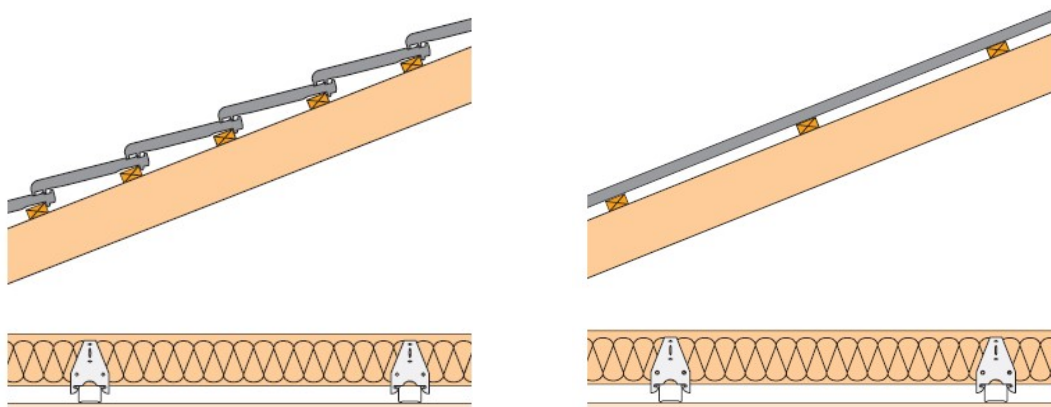
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For ceilings under metal deck roof:

- one layer of 13mm thick plasterboard will give R_w 42 and $R_w + C_{tr}$ 35; and
- three layers of 16mm fire-rated plasterboard will give R_w 52 and $R_w + C_{tr}$ 45.

To achieve the above mentioned R_w ratings the insulation above the ceiling is to be R2.5 glasswool ceiling batts or acoustically equivalent.

Ceiling Fixed on Furring Channels



Ceilings under tile / metal deck roof - Ceiling fixed on furring channels
Source: Boral Selector - Plasterboard Systems

The R_w rating varies from 44 to 55 depending on the roof construction and the thickness and number of layers of plasterboard.

For ceilings under tile roof:

- one layer of 13mm thick plasterboard will give R_w 45 and $R_w + C_{tr}$ 39; and
- three layers of 16mm fire-rated plasterboard will give R_w 55 and $R_w + C_{tr}$ 49.

For ceilings under metal deck roof:

- one layer of 13mm thick plasterboard will give R_w 44 and $R_w + C_{tr}$ 37; and
- three layers of 16mm fire-rated plasterboard will give R_w 54 and $R_w + C_{tr}$ 47.

To achieve the above ratings the insulation above the ceiling is to be a minimum R2.5 glasswool ceiling batts or acoustically equivalent.

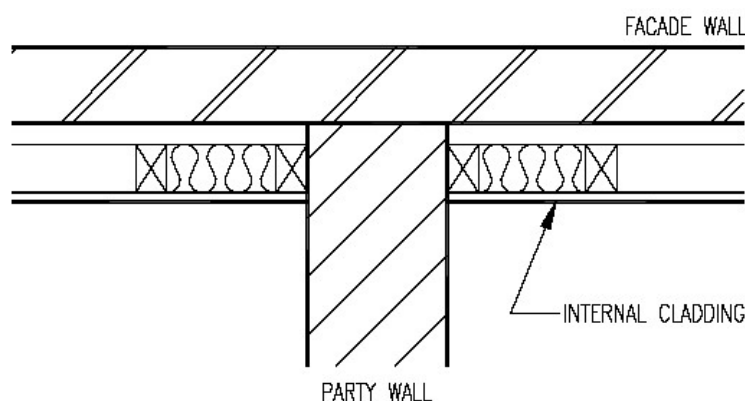
Challenges

Challenges to good acoustic design of external walls or roof-ceiling systems can arise from noise transferred via flanking paths. It is important to minimise flanking through services and penetrations.

Flanking Paths

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.

Where external wall flanking control measures are proposed (as per diagram below) it is important to maintain the weatherproofing of the external wall.



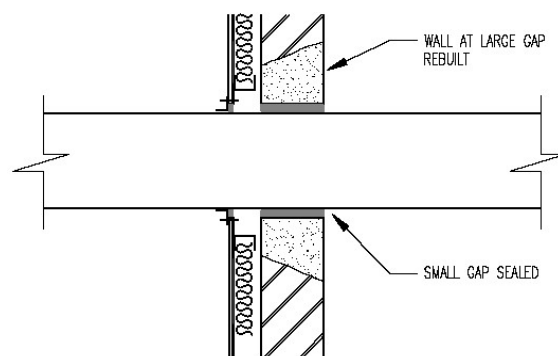
External Wall Flanking Control - Good Design Practice
Source: ABCB Document: Guideline on Sound Insulation

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

Services and Penetrations

Design of a wall or roof - ceiling system should consider services and penetrations from other building elements. Penetrations in a system can compromise its acoustic performance and will require extra consideration. For external walls it is also important not to chase services into masonry or concrete walls.

- All penetrations in sound-rated building elements should be neatly cut or drilled. Avoid excessively sized penetrations.
- The wall around any large penetration should be rebuilt with the same material. Small residual gaps at penetrations can be sealed with suitable mastic.
- The normal tolerance in building construction should be considered when installing penetrations, and at wall/floor junctions. Revised detailing is needed where residual gaps are too large to allow effective sealing with mastic.
- Gaps around all penetrations in sound-rated walls or ceilings should be treated and sealed to maintain acoustic ratings.
- Sealing should be effective, resilient, resistant to the surrounding environment, and designed to last for the life of the building.



Treatment of Gaps and Penetrations
Source: ABCB Document: Guideline on Sound Insulation

- Insulation should be evenly spaced throughout the entire cavity where needed.

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

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

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

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Contact Us

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

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