BRADFORD WHITE PAPER

Quiet as a house

A guide to internal acoustics for comfort, health and wellbeing

INTRODUCTION

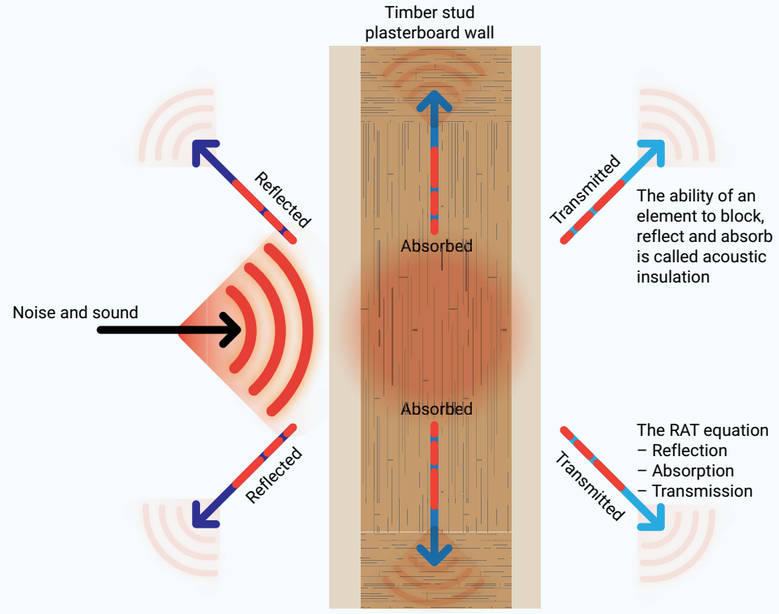
The internal acoustics of residential houses are often overlooked in modern building design and construction. At a regulatory level, Australian building codes and regulations do not include provisions for internal acoustic insulation in residential houses.

In addition, homeowners tend to prioritise functionality and aesthetics over acoustic comfort. Overlooking internal acoustics during these early stages can lead to a range of problems for homeowners. Poor acoustic design leads to regular noise disruptions as well as physical and mental health issues over time. Installing acoustic insulation in internal walls after the home has been completed can be difficult and expensive, adding further stress. A thorough understanding of the factors contributing to excessive sound transfer, is valuable to architects, builders and homeowners.

In this whitepaper, we look at the impact of poor internal acoustic design and highlight the importance of specifying acoustic solutions in the early stages of home building projects. We also examine how internal wall systems can incorporate high-density acoustic insulation in conjunction with acoustic-rated plasterboard to effectively reduce sound transfer between rooms.

Introduction to internal acoustics

Behaviour of Sound



Sound Transmission and Reverberation
When discussing internal acoustic design, it is important to highlight the difference between sound transmission and reverberation. Transmission refers to sound that passes through and between materials, typically walls and floors. Reverberation is the sound that reflects or echoes within an indoor space.

Noise Sources
There are a range of noise sources found within a modern home. Typical noise sources include televisions, gaming consoles and the sound caused by occupant activity (e.g. from speech or movement). Other sources include laundry and kitchen appliances, as well as recreational areas and media rooms. The popularity of hardwood floors is also a contributing factor, as they tend to create higher volumes of noise (e.g. from the impact of feet and chair legs) than soft-surface flooring.

Factors Affecting Internal Acoustics
The characteristics of a home and its interior spaces can impact internal noise levels. Home acoustics can be influenced by the geometry and volume of a space, the types and volume of sounds in that space, and the characteristics of surfaces enclosing and within the space.[1]

The characteristics of the walls and floors separating interior spaces play a significant role in home acoustics.[2] In many new residential homes, the trend has been towards using lighter construction materials and internal wall systems that do not contain acoustic insulation. Hollow internal walls allow even moderate sound to pass readily through, contributing to a poor acoustic environment.[3]

A standard internal wall that separates two rooms will normally be constructed with a timber or metal frame and 10mm standard plasterboard on each side. When this type of lightweight internal wall is left empty (i.e. without acoustic insulation) it can become a vulnerable part of the construction. If rooms that require controlled levels of sound, such as bedrooms and studies, are adjacent to high volume areas such as kitchens or living rooms, sound will carry through causing noise disruptions. Bare floorboards have similarly poor acoustic performance and have the added issue of dealing with impact sound (e.g. from feet or furniture impacting the floor).

Approaches to Acoustic Control
There are two primary approaches to control sound in interior spaces:

- Sound insulation (also referred to as “acoustic insulation”). Acoustic insulation is the use of dense materials to interrupt sound transmission paths to control noise levels. This type of control is typically incorporated in internal wall systems and therefore is ideally considered during the design and construction process.
- Sound absorption. This type of control relies on the “loss of sound energy when sound waves come into contact with an absorbent material”.[4] Sound absorption can usually be addressed post construction using soft furnishings, window coverings, floor coverings or even decorative acoustic tiles.

Note that architectural solutions often combine aspects of acoustic insulation and sound absorption to deliver effective sound reduction.

Measuring Sound Transmission
The effectiveness of a building element with respect to sound insulation can be measured by the amount of sound transmission loss that occurs through the element. This is expressed as the weighted sound reduction index (Rw), which is a number value that represents the airborne sound insulating power of a building element.[5]

In general, the higher the Rw value of a sound insulation product, the more effective it will be at soundproofing. A six-point increase in the Rw value of a wall will reduce the perceived loudness of sound passing through the wall by approximately half.[6]

Occupant Comfort, Health and Wellbeing
Acoustic comfort is one of several design elements that contribute to healthy and sustainable indoor environments. The impact of excess noise on comfort and health is well-documented.

Sleep disturbance
Persistent and excessive noise can disturb sleep, leading to increased fatigue, depressed moods and reduced well-being.[7] Secondary effects of poor sleep include an increased risk for a range of physical health issues, such as heart disease and hearing impairment, and mental health problems.[8]

The impact of poor acoustic design

Annoyance, stress and other psychological effects
Poor acoustics lead to regular noise disturbances that interrupt periods of calm, concentration and relaxation. This can contribute to heightened stress levels and increases the likelihood of "noise annoyance" (i.e. negative feelings caused by a poor acoustic environment), which has been associated with poor mental health.[9]

Research shows that excess noise can accelerate or intensify other psychological issues, including anxiety and depression, while contributing to mood changes and social conflicts.[10]

Noise interference with speech communication
Interfering noise can render speech difficult to hear and understand, leading to behavioural issues and stress.[11] Children are especially vulnerable to the effects of interfering noise in tasks involving speech perception, listening and comprehension.[12]

Reduced work performance
In addition to the psychological and physical effects of excess noise, studies show that there are adverse cognitive effects in relation to reading, attention, problem solving and memory,[13] which can impact work output and quality. This is particularly relevant to modern home design due to the rise of home studies and home office spaces.

Cost of Remediation
Implementing acoustic insulation into existing internal walls after a house has been built can be difficult and expensive on a room-by-room basis. Retrofitting acoustic installation requires cutting open internal walls, plastering and repainting. Soundproofing is typically visually unattractive if installed directly onto walls.

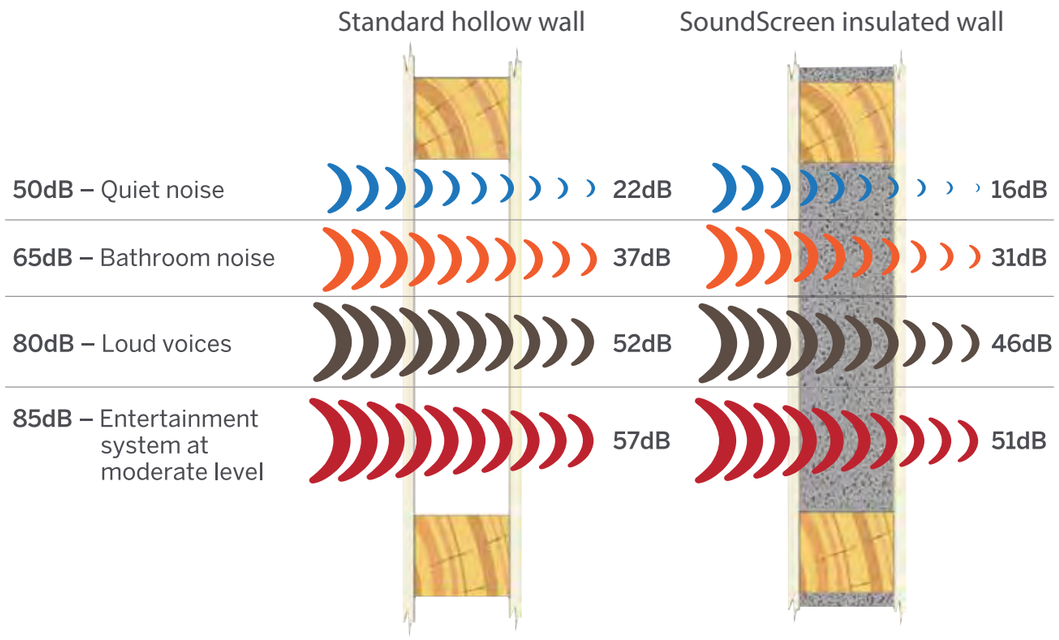
In addition, there may be a risk that existing structural elements can interfere with the retrofit. This may lead to safety risks, such as where electrical wires within a wall need to be disturbed.

Designing for acoustic comfort

High-density acoustic wall insulation
A key component of achieving acoustic comfort in a home is minimising sound transfer throughout the building. High-density acoustic insulation batts, such as CSR Bradford's SoundScreen, can be installed in internal walls and between floors to reduce sound transfer between rooms. These products work by absorbing the sound that would otherwise travel through the air pockets between framing and other structural elements.

As a baseline, the Rw rating of a standard internal wall (10mm standard plasterboard on each side of a 90mm stud without acoustic insulation) is Rw28. The addition of Bradford SoundScreen into a standard internal wall can increase the Rw rating by six points, which halves the perceived volume of sound passing through it. When you consider the benefits of including high-density acoustic insulation batts in a standard internal wall, architects and designers should consider this as a fundamental inclusion in all internal walls.

High-density acoustic insulation batts have other practical advantages over other acoustic solutions. For example, as an acoustic control solution they are relatively inexpensive. A builder would typically charge approximately $400AUD for an average bedroom to include Bradford SoundScreen. Some builders offer low-cost wall upgrades (including acoustic insulation) during construction of a home. Given its high levels of acoustic performance, the low cost of high-density acoustic insulation batts provides an exceptional return on investment.



Acoustic-rated plasterboard

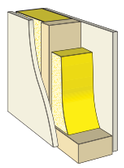
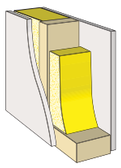
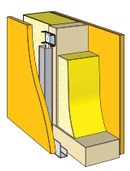
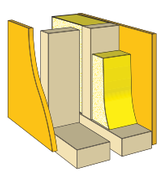
Acoustic performance can be further enhanced by specifying acoustic-rated gypsum plasterboard. Acoustic-rated plasterboard that is specifically designed to reduce sound transmission provides an additional barrier to prevent sound from moving to adjoining rooms.

By adding Bradford SoundScreen into internal walls and changing the standard 10mm plasterboard to Gyprock Superchek, a market-leading acoustic-rated plasterboard, the Rw rating of the wall system increases by a total of 14 points to Rw42 (six points from the high-density batts and eight points from the acoustic-rated plasterboard). This would be the ideal cost-effective acoustic control solution for a single 90mm internal stud wall.

To further improve the Rw rating in special areas of the house, higher performing systems can be specified. For example, Gyprock Superchek 10mm can be upgraded to 13mm, and combined with resilient acoustic mounts, furring channels, and Bradford SoundScreen, to boost the performance of a wall system to Rw54.

Another option is to design a double-stud system comprising of two rows of 90mm studs with a 20mm minimum gap between them and adding Bradford SoundScreen with 13mm Gyprock Soundchek. This type of system with Bradford SoundScreen can achieve an Rw rating of Rw60.

Working closely with leading manufacturers and suppliers of acoustic solutions can help determine the ideal configuration of plasterboard, insulation and wall framing for any given home.

SYSTEM OPTIONS			ACOUSTIC OPINION: PKA Predictor V16				
FRL Report/Opinion	SYSTEM N°	WALL LININGS	STUD DEPTH mm	70	90	120	140
			CAVITY INFILL	Rw / Rw+Ctr			
– / – / –	**CSR2009** 	BOTH SIDES • 1 x 10mm Gyprock Plus Plasterboard.	(a) Nil	27/19	28/21	31/24	31/24
			(b) 75 Gold Batts 1.5	32/22	33/24	36/27	36/27
			(c) 70 Soundscreen 2.0	33/23	34/25	37/28	36/27
			Wall Thickness mm	90	110	140	160
– / – / –	**CSR2024** 	BOTH SIDES • 1 x 10mm Gyprock Superchek Plasterboard.	(a) Nil	34/27	36/29	37/30	38/31
			(b) 75 Gold Batts 1.5	39/30	41/32	42/33	43/34
			(c) 70 Soundscreen 2.0	40/31	42/33	43/34	43/34
			(d) MSB3 Polyester	37/29	39/31	40/32	40/32
			Wall Thickness mm	90	110	140	160
– / – / –	**CSR2135** 	BOTH SIDES • 1 x 13mm Gyprock Superchek Plasterboard.	(a) Nil	42/35	44/38	45/39	46/40
			(b) 75 Gold Batts 1.5	50/41	52/44	53/45	53/45
			(c) 70 Soundscreen 2.0	52/42	54/45	54/45	55/46
			(d) MSB3 Polyester	46/38	48/41	48/41	49/42
			Minimum Wall Thickness mm	124	144	174	194
– / – / –	**CSR2136** 	BOTH SIDES • 1 x 13mm Gyprock Superchek Plasterboard.	(a) Nil	44/38	46/40	47/41	48/42
			(b) 75 Gold Batts 1.5	55/47	57/49	58/**50**	59/**51**
			(c) 70 Soundscreen 2.0	58/48	60/**50**	61/**51**	62/**52**
			(d) MSB3 Polyester	50/44	52/46	53/47	54/48
			Minimum Wall Thickness mm	186	226	286	326

Designing for acoustic comfort

Bradford SoundScreen™

Delivering tried-and-tested performance, SoundScreen is Australia's most trusted high-density acoustic insulation product and is specifically engineered for superior acoustic performance in residential applications. Manufactured in Australia by Bradford, SoundScreen is predominantly made from recycled glass. Recycling glass results in reduced landfill waste, reduced CO2 emissions and promotes the conservation of raw materials; contributing to improved environmental and sustainability outcomes.

Including SoundScreen in interior walls can greatly reduce the transmission of noise between rooms, enhancing peace, comfort and wellbeing. A wall system including SoundScreen can absorb as much as 75% of sound to effectively reduce noise to acceptable levels. Replacing the standard plasterboard with Gyprock Soundchek™, an acoustic-rated plasterboard, can result in even greater noise reductions.

SoundScreen is a grey colour to make it easy to identify on site and comes in a range of thicknesses and widths to suit both timber and steel wall studs and ceiling joists.

SoundScreen is low allergen and will not shrink, mould, rot or deteriorate. When installed in accordance with their directions, Bradford insulation products are guaranteed for at least 70 years. SoundScreen is also approved by the National Asthma Council's Sensitive Choice® program, making it ideal for the homes of asthma and allergy sufferers.[14]

Performance Testing

SoundScreen is tested for sound absorption in accordance with AS/ISO 354-2006 and NRC (Noise Reduction Coefficient) rated in accordance with ASTM C423-90A. The sound absorption coefficient as per AS ISO 11654-1997 is: = 1.00

SoundScreen has also been tested for fire hazard properties in accordance with AS/NZS 1530 Part 3-1999 with ratings of 0 for ignitability, spread of flame and heat evolved, and 0-1 for smoke developed. This product is non-combustible when tested to AS/NZS 1530 Part 1-1994.

CSR Bradford

Across Australia and New Zealand, CSR Building Products is the name behind some of the market's most trusted and recognised brand names for residential and commercial construction, including Bradford insulation and Gyprock plasterboard.

Established in 1934, Bradford Insulation is a leading manufacturer of premium energy-saving insulation products for domestic, commercial and industrial applications. The company's high quality products are supported by a highly-trained and experienced team with world class engineering knowledge, and research and development, technical and customer service skills. The Bradford team supports an extensive manufacturing and distribution network across Australia and New Zealand.

Bradford has been making insulation in Australia for over 80 years and remains embedded within local communities, employing over 500 people across four manufacturing plants.

References

1 Designing Buildings Ltd. "Building acoustics." Designing Buildings Wiki. https://www.designingbuildings.co.uk/wiki/Building_acoustics (accessed 18 December 2019).

2 Ibid.

3 Australian Government. "Noise Control." YourHome. http://www.yourhome.gov.au/housing/noise-control (accessed 18 December 2019).

4 Above n 1.

5 Owners Corporation Network of Australia Ltd. "2.4 How is sound measured?" Owners Corporation Network. https://www.ocn.org.au/book/export/html/1385 (accessed 11 January 2020).

6 Ibid.

7 World Health Organization. "Adverse Health Effects Of Noise." WHO. https://www.who.int/docstore/peh/noise/Comnoise-3.pdf (accessed 18 December 2019).

8 Wang, Chen, Yuenxun Si, Hamzah Abdul-Rahman and Lincoln C Wood. "Noise Annoyance and Loudness: Acoustic Performance of Residential Buildings in Tropics." Building Services Engineering Research and Technology Vol. 36, Issue 6 (2015): 680-700.

9 Hammersen, Friederike, Hildegard Niemann and Jens Hoebel. "Environmental Noise Annoyance and Mental Health in Adults: Findings from the Cross-Sectional German Health Update (GEDA) Study 2012." International Journal of Environmental Research and Public Health Vol. 13, No. 10 (2016): 954.

10 Above n 6.

11 Ibid.

12 Wang, Lily M. "The impact of building acoustics on speech comprehension and student achievement." In Internoise 2014: 43rd International Congress on Noise Control Engineering. Melbourne: Australian Acoustical Society, 2014.

13 Ibid.

14 National Asthma Council Australia. "Bradford Insulation." Sensitive Choice. https://www.sensitivechoice.com/product/bradford-insulation (accessed 11 January 2020).

As experts in the field of insulation for acoustic, thermal, fire and moisture management, the Bradford team is available for advice and technical support for architects, designers and builders looking to incorporate best-practice insulation design.

As the experts in building science for insulation, the Bradford team can assist with:

- project-specific support
- value engineering challenges
- specification documentation
- system design detailing
- product installation and certification

Call our team on **1800 354 044**
or visit **www.csrbradford.com.au**

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