Manual 11

THINK
BRICK
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Design of Clay Masonry for Sound Insulation

We represent the clay brick and paver manufacturers of Australia. Our purpose is to make sure clay brick is recognised as the pre-eminent building material by leading architects, developers, builders and property owners. We're here to promote great home and commercial design using clay brick and pavers.

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The growth in multi-dwelling residential housing in Australia brought with it an increased demand for more effective acoustic insulation between adjoining dwellings. The weighted sound reduction index, a more sophisticated acoustic measurement, was introduced in the National Construction Code (NCC) replacing the sound transmission class. More recently this has been supplemented by correction factors for high and low frequency sounds, the latter acknowledging a major cause of complaints in multi-dwelling buildings and the potential intrusion from sound systems such as home theatres. The heavy mass of clay brick masonry is ideal for acoustic insulation, particularly for low frequency noise, and cavity masonry walls have the added benefit of isolating impact sounds. It possesses an inherent resistance to the passage of airborne sound, which makes it a superior performer in attenuating low-frequency, airborne noise caused by building mechanical systems, elevators, amplified music, traffic and aircraft. Although some alternative systems may perform as well as masonry for frequencies in the speech range, these lower mass systems have difficulty insulating against low-frequency noise. This document defines the National Construction Code (NCC) and sets out methods for compliance using popular and economic forms of clay masonry construction.

1.0 Introduction

One objective of the National Construction Code (NCC) is to ensure that the occupants of multi-dwelling residential buildings, such as villas, townhouses, units and apartments, are not subjected to excessive noise transmitted from adjoining dwellings. The weighted sound reduction index, when measured, includes two correction factors, C for high frequency noise and C_{tr} for low frequency noise emitted from items such as home theatre systems.

Correction Factor	Type of Noise Source
C	Living activities (talking, music, radio, TV) Railway traffic at high speeds Highway road traffic (>80km/h) Jet aircraft at short distance High and medium frequency factory noise
C_{tr}	Urban road traffic Railway traffic at low speeds Propeller driven aircraft Jet aircraft at large distance Low and medium frequency factory noise

The weighted sound reduction index is commonly denoted in the format R_w (C, C_{tr}). As an example, if a wall is measured as 56 (-1,-5), the value of the index when the lower frequency correction factor (C_{tr}) is applied is:

$R_w + C_{tr} = 56 + (-5)$
$R_w + C_{tr} = 51$.

2.0 Sound Insulation Definitions

2.1 Weighted sound reduction index (R_w)

Weighted sound reduction index (R_w) is a single figure used to indicate the sound insulation performance of a building element.
The higher the number, the better the performance.

R_w ratings are determined by laboratory tests of a specimen of the construction system which is fixed within a frame to form the wall between two test chambers. A high noise level is generated in one room and the difference in sound level between the source room and the receiver room represents the transmission loss through the test specimen. Measurements are conducted in one-third octave bands over all frequencies from 100 Hz to 3.15 kHz (inclusive). To determine the R_w rating of a system, the measurement results are compared with reference curves. The total of the deficiencies of the measured values below the reference curve cannot exceed 32db when they are added together.

2.2 Weighted sound reduction index plus spectrum adaptation term (R_w+ C and R_w+ C_{tr})

C and C_{tr} are correction factors used to modify the measured sound insulation (R_w). They are referred to as a spectrum adaption value and a negative number which is added to the R_w value to take into account mid- to high-frequency and low-frequency noise respectfully.

As most noise related issues involve the transmission of low frequency sound from audio equipment, the NCC's requirements for sound insulation generally include the C_{tr} term by setting a minimum R_w (airborne)+ C_{tr} (impact) value – typically 50 dB.

2.3 Discontinuous construction ($D_{nT,w}$)

Discontinuous construction ($D_{nT,w}$) is a walling system having a minimum 20 mm cavity between two separate leaves:

- For masonry, where wall ties are required to connect leaves, the ties are to be of resilient type.

- For other than masonry, there is no mechanical linkage between leaves except at the periphery.

3.0 Types of Noise

3.1 Airborne noise

Airborne noise comes from common sound sources such as voices, TVs and radios. The noise performance of a building system is called the Weighted Sound Reduction Index (R_w). The higher the R_w the better the system is at isolating airborne noise.

The greater the mass of the wall or floor, the more difficult it is to set up vibrations in it, and hence more difficult to transfer sound from one side to the other. Brick walls perform well in reducing the transmission of airborne sounds due to their mass.

A change of 3 R_w (or dB) in the sound level means a doubling or halving of the sound energy. As the human ear does not perceive sound in a linear way, a 3dB change is barely perceptible. The table below shows the subjective perception of sound energy.

Reduction in dB	%	Reduction in Sound Energy Subjective Perception
3	50	Barely perceptible
4-5	70	Significant
6	75	Sound appears to be reduced by about ¼
7-9	87	Major reduction
10	90	Sound appears to be less than half original

The table below outlines what this means in practice for building elements.

R_w	Effect on Speech Perception
25	Normal speech can be heard easily
30	Loud speech can be heard easily
35	Loud speech can be heard but not understood
42	Loud speech heard as murmur
45	Must strain to hear loud speech
48	Loud speech can be barely heard
53	Loud speech can be barely heard

3.2 Structure-borne noise

Structure-borne noise, also called impact noise, is produced when part of the building fabric is directly or indirectly impacted. Energy passes through the building structure and creates noise in nearby rooms. Examples are heavy footsteps (particularly on bare timber or tile floors), banging doors, scraping furniture, vibrations from loud music, and plumbing noise. The Impact Insulation Class (IIC) is used to rate the impact noise insulation of floors.

IIC	
45	People walking around are clearly audible
50	People walking around are audible and noticeable
55	People walking around audible but acceptable
62	Walking heard as low frequency thump
70	Heavy walking heard as low frequency thump

4.0 NCC requirements

Where walls and separate sole-occupancy units, their acoustic performance should ensure that sound from one dwelling does not result in ambient sound levels in the adjoining dwelling that exceed the values regarded as providing a satisfactory working, living or sleeping environment.

NCC determines the classification of a building or part of a building by the purpose for which it is designed, constructed or adapted to be used. The following classes are applied to sound insulation provisions.

> Class 1 – one or more buildings which in association constitute –
>
> > Class 1a – a single dwelling being either a detached house or one of a group of two or more attached dwellings separated by a fire-resisting wall.
> >
> > Class 1b – a boarding house, guest house, hostel or the like for no more than 12 persons, with a total area of all floors not exceeding 300 m² measured over the enclosing walls of the Class 1b; or no less than 4 single dwellings located on one allotment and used for short-term holiday accommodation which are not located above or below another dwelling or another Class of building other than a private garage.
>
> Class 2 – a building containing two or more sole-occupancy units each being a separate dwelling.
>
> Class 3 – a residential building, other than a building of Classes 1 or 2, which is a common place of long term or transient living for a number of unrelated persons w(e.g. hostel, hotel, boarding house).
>
> Class 9c – an aged care building.

For Class 1, the intent of the NCC sound provisions is to safeguard occupants from illness or loss of amenity as a result of undue sound being transmitted between adjoining dwellings.

(National Construction Code Series Volume Two Part 3.8.6)

For Class 2, 3 and 9c, the intent of the NCC sound provisions is to minimise noise transmitted:

• between adjoining sole-occupancy units; and

• from common spaces to sole-occupancy units; and

• from parts of different classification to sole-occupancy units.

(National Construction Code Series Volume One Part F5)

5.0 Methods of Compliance

The following are methods available for complying with the provisions of the NCC. Compliance with the NCC's performance requirements can only be achieved by:

a)   complying with the *Deemed-to-Satisfy Provisions*

b)   formulating an alternative solution to the *Deemed-to-Satisfy Provisions*

Any alternative solutions must be assessed to demonstrate that the performance requirements have been met. The assessment methods include:

i)   **Documentary evidence** – Testing by a registered testing authority, for example the National Building Technology Centre (NBTC), CSIRO or an authority registered by the National Association of Testing Authorities (NATA).

ii)   **Verification** – Field measurement to demonstrate that the weighted standardised level difference with spectrum adaptation term, $D_{nT,w} + C_{tr}$ is not less than 45 when determined by AS/NZS 1276.1. (This does not apply in Qld, NT and WA.)

iii)   **Comparison** with deemed-to-satisfy provisions.

iv)   **Expert** judgement.

5.1 NCC requirements for Class 1 buildings (NSW, Qld, SA, Tas, Vic, WA)

In Class 1 buildings common walls are required to have a $R_w + C_{tr}$ of not less than 50, and where the wall separates a habitable room (bedroom, living, dining) in one unit from a wet area (bathroom, kitchen, toilet, laundry) in another unit, the wall must be of discontinuous construction as well.

Separating wall (containing a duct, soil, waste, water supply pipe or storm water pipe) adjacent to a habitable room other than a kitchen is required to have a $R_w + C_{tr}$ not less than 40. This must be reduced to a $R_w + C_{tr}$ not less than 25 if the adjoining room is kitchen.

Note: Discontinuous construction means a wall system having a minimum 20 mm cavity between two separate leaves. For masonry, where wall ties are required to connect leaves, the ties are of the resilient type.
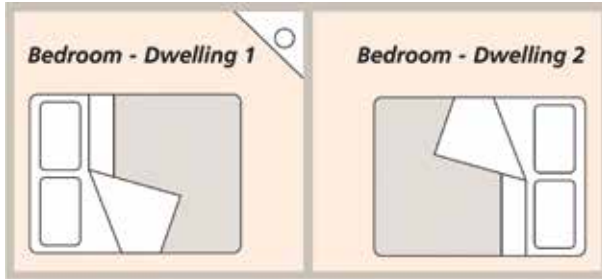
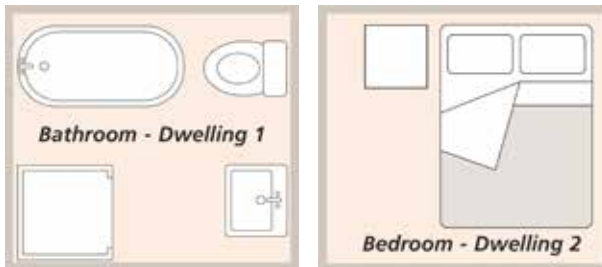**Figure 1 Habitable–habitable areas in buildings require $R_w + C_{tr} \geq 50$**

Figure 2 Habitable-wet areas in buildings require $R_w + C_{tr} \geq 50$ and discontinuous construction

5.2 NCC requirements for Class 1 buildings (NT)

A separating wall between two or more Class 1 buildings must achieve the weighted sound reduction index (R_w) and impact sound resistance required in section 5.1 of this manual.

A wall separating two habitable rooms in adjoining units in Class 1 building must have an R_w of not less than 45, whereas a wall separating a habitable room from a wet area requires an R_w of not less than 50 with satisfactory impact resistance. Adequate impact sound insulation is achieved if the performance of the test specimen is equivalent to, or better than, the performance of a cavity brick construction of two leaves of 90 mm bricks with 40 mm cavity under the same test conditions.
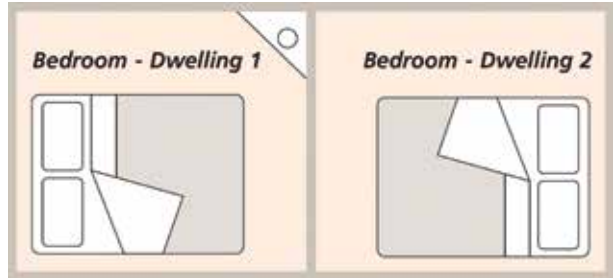
Figure 3 Habitable–habitable areas in buildings require $R_w \geq 45$

Figure 4 Habitable-wet areas in buildings require $R_w \geq 50$ + impact

5.3 NCC requirements for Class 2 and 3 buildings (All States and Territories)

Class 2 or 3 buildings are required to have walls separating sole occupancy units of $R_w + C_{tr}$ of not less than 50 and where the wall separates a habitable room in one unit from a wet area in another unit it must be of discontinuous construction. Also where a wall in a Class 2 or 3 building separates a unit from a plant room, lift shaft, stairwell or public area it must have an R_w of not less than 50 and be of discontinuous construction when that wall separates a habitable room in one unit from a plant room or lift shaft.
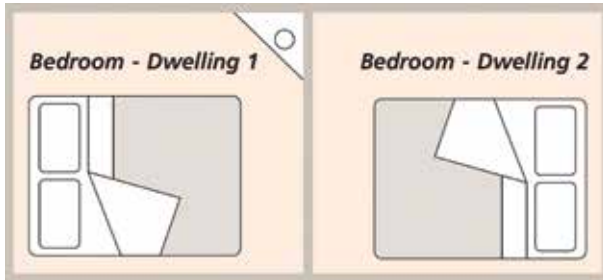
Figure 5 Habitable–habitable areas in buildings require $R_w + C_{tr} \geq 50$

Figure 6 Habitable-wet areas in buildings require $R_w \geq 50$ and discontinuous construction

5.4 NCC requirements for Class 9c buildings (All States and Territories)

For Class 9c buildings walls separating sole occupancy units or a sole occupancy unit from a kitchen, bathroom, laundry, plant or utilities room must have an R_w of not less than 45. Also walls separating a sole occupancy unit from a kitchen or laundry must have satisfactory impact sound resistance. Adequate impact sound insulation is achieved if the performance of the test specimen is equivalent to, or better than, the performance of a cavity brick construction of two leaves of 90 mm bricks under the same test conditions. Special attention must be paid to the junction of sound insulated walls with perimeter walls, floors and roofs. This is detailed in the NCC.

6.0 NCC Deemed-to-Satisfy Wall Systems for ACT, NSW, Qld, SA, Tas, Vic, WA

6.1 Clay brick wall systems that achieve $R_w + C_{tr} \geq 50$

6.1.1 Single leaf of 110 mm clay brick masonry with:

a) a row of 70 mm×35 mm timber studs or 64 mm steel studs at 600 mm centres, spaced 20 mm from the masonry wall; and

b) 50 mm thick mineral insulation or glass wool insulation with density of 11 kg/m³ positioned between studs; and

c) one layer of 13 mm plasterboard fixed to outside face of studs and outside face of masonry.
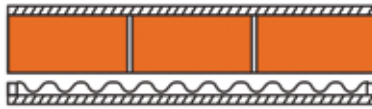
Figure 7. Single leaf brickwork, 110 mm clay bricks

6.1.2 Single leaf 90mm clay brick masonry with:

a) a row of 70 mm × 35 mm timber studs or 64 mm steel studs at 600 mm centres, spaced 20 mm from each face of the masonry wall; and

b) 50 mm thick mineral insulation or glass wool insulation with density of 11 kg/m³ positioned between studs in each row; and

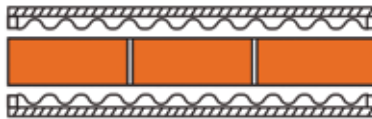c) one layer of 13 mm plasterboard fixed to studs on each outside face.

Figure 8. Single leaf brickwork, 90 mm clay bricks

6.1.3 Two leaves of 110 mm clay brick masonry with:

a)   cavity not less than 50 mm between leaves; and

b)   13 mm cement render on each outside face.

Figure 9. Rendered cavity brickwork, 110 mm clay bricks

6.1.4 Two leaves of 110 mm clay brick masonry with:

a)   cavity not less than 50 mm between leaves; and

b)   50 mm thick glass wool insulation with a density of 11 kg/m^3 or 50 mm thick polyester insulation with a density of 20 kg/m^3 in the cavity.
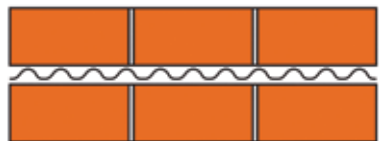

Figure 10. Insulated cavity brickwork, 110 mm clay bricks

6.2 Clay brick wall system that achieves $R_w \geq 50$ (only for class 2, 3, and 9c buildings)

Single leaf of 150 mm clay brick masonry with each face rendered 13 mm thick.

Figure 11. Rendered single leaf brickwork, 150 mm clay bricks

6.3 Clay brick wall systems that achieve $R_w + C_{tr} \geq 50$ (only for class 2, 3, and 9c buildings)

Single leaf of 220 mm clay brick masonry with each face rendered 13 mm thick.

Figure 12. Rendered single leaf brickwork, 220 mm clay bricks

6.4 Clay brick wall system that achieves $R_w \geq 45$ (only for class 2, 3, and 9c buildings)

110 mm thick brick masonry with 13 mm cement render on each face.

Figure 13. Rendered single leaf brickwork, 110 mm clay bricks

7.0 NCC deemed-to-satisfy wall systems for NT

7.1 Clay brick wall system that achieves $R_w \geq 50$ and impact

7.1.1 Two leaves of 90 mm clay brick masonry with:

a) all joint solid filled with mortar

b) minimum cavity of 40 mm

c) Leaves connected with ties in accordance with AS 3700 and AS 4773.1

Figure 14. Cavity brickwork, 90 mm clay bricks

7.1.2 Single leaf of 80 mm thick brick masonry with:

a) Both faces rendered 13 mm thick

b) 50 x 12 mm thick timber battens at less than 610mm centres fixed to each face but not recessed into the render

c) 12 mm thick softboard nailed to the battens

d) 6 mm thick medium density hardboard fixed to the softboard using adhesive.
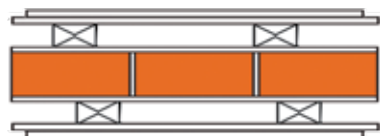
Figure 15. Single leaf brickwork, 80 mm clay bricks

7.2 Clay brick wall system that achieves $R_w \geq 45$

7.2.1 Single leaf of 110 mm clay brick masonry with:

mass per unit area ≥290 kg/m^3.

Figure 16. Single leaf brickwork, 110 mm clay bricks

7.2.2 Single leaf of 80 mm thick pressed brick with:

- 13 mm thick render on one side

- Mass per unit area of unrendered wall ≥215 kg/m^3.

Figure 17. Rendered single leaf brickwork, 80mm clay bricks

8.0 Good practice for compliance

- All clay brick wall systems should be constructed in accordance with the design drawings and the manufacturers' specification.

- All joints must be filled solid with mortar.

- Where a wall separates a habitable room in one unit from a wet area in another unit the wall must be of discontinuous construction (except for NT).

- Where for structural integrity two leaves of clay bricks are connected and used where discontinuous construction is required they must be connected using resilient ties.

- Clay brick walls must not be chased to install any services.

9.0 Exclusions from NCC requirements

For information on other clay brick walling solutions for sound insulation contact the manufacturers in your state.

The provisions in the code apply to sound insulation between dwellings as described in this document and do not address:

•   noise entering the unit from an outside source (traffic)

•   air-conditioning or other plant from within a unit

•   domestic appliance noise within a unit

•   room acoustic design for home entertainment systems

•   noise transfer within a unit.

Cover: The Wall is a two-storey luxurious home with an expansive space that accommodates for stylish, modern family living. It features an impressive two-storey brick spine block wall, which runs from the front to the back and this key feature is highlighted in every room of the home providing warmth, texture and style.

Architect & Builder: Scott Salisbury Homes

Manufacturer: Austral Bricks

Bricks used: Austral Brick - Colossus Silver brick

Photographer: Mark Zed – Aspect Photographics

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