# R-VALUE

Thermal Resistance and NCC Requirements

## THERMAL RESISTANCE

The R-value (or thermal resistance value) is a measure of a material's ability to resist heat flow through conduction. It is defined as the ratio of the temperature difference across a material to the rate of heat transfer per unit area and is typically expressed in units of $m^2K/W$, calculated by dividing a material's thickness by its thermal conductivity. A higher R-value indicates greater insulating capabilities, meaning the material is more resistant to the passage of heat.

The total thermal resistance of a building element or system (such as a wall) can be calculated by summing the R-values of its individual layers including any building material, insulating material, airspace, thermal bridging and associated surface resistances. However, R-value does not account for other important aspects of thermal performance such as thermal mass, air infiltration or radiant heat transfer, and must be considered as part of a broader analysis of a building's energy efficiency.

## THERMAL TRANSMISSION

The term which describes the ease with which heat moves through a wall is thermal transmission, known simply as the U-value. It allows for the effect of any airspaces, thermal bridging and associated surface resistances. This is calculated to be the inverse of the total R-value such that a lower U-value demonstrates better thermal performance, expressed in $Wm^{-2}K^{-1}$.

A U-value of less than 1.3 is appropriate for temperate Australia and insulation in full brick construction is an unwarranted cost. In most areas of Australia, cavity brick walls built on a slab are exempt from the requirement for all new houses to have wall insulation. This exemption recognises the inherent thermal properties of full brick construction.

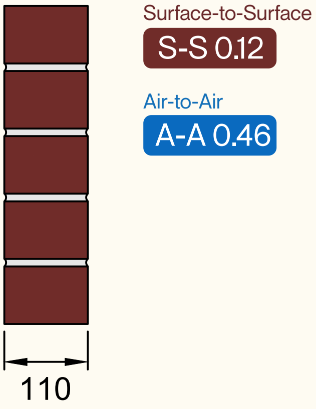
## R-VALUE OF BRICKS

Research by the University of Newcastle has shown that thermal mass (the principal property provided by clay bricks to improve thermal performance) is critical to improving energy efficiency and that there are limitations in relying solely on R-Values. Part of this research was to test the R-Values of different clay bricks and compare them to their mass, as shown in Table 1.

Furthermore, the R-Values of different walling systems were calculated as shown for single skin masonry (equal to the R-Value of bricks) in Figure 2. It shows the surface-to-surface (S-S) and the air-to-air (A-A) R-Value. More walling systems can be found on the next page.

**Table 1:** Brick Mass & R-Values

| Brick Mass (kg) | R-Value ($m^2K/W$) |
|---|---|
| 2.50 | 0.22 |
| 2.75 | 0.20 |
| 3.00 | 0.18 |
| 3.25 | 0.17 |
| 3.50 | 0.16 |
| 3.75 | 0.14 |
| 4.00 | 0.13 |
| 4.25 | 0.12 |



Single Skin
110mm dry-pressed units

**Figure 2:** Surface-to-Surface (S-S) and Air-to-Air (A-A) R-Values of a Single Skin Masonry Wall

## NCC REQUIREMENTS

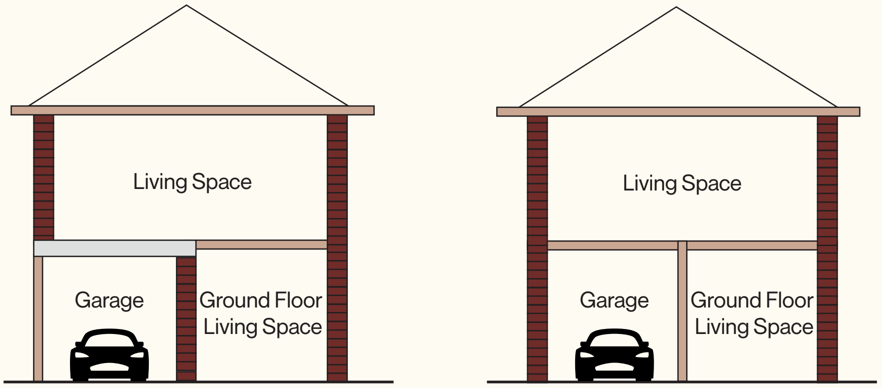
The requirements under the NCC can be found in:

- NCC 2022 ABCB Housing Provisions Part 13.2.5 (for residential buildings),
- NCC 2022 Volume One Part J4D6 (for all other building classes), and
- NCC 2022 Volume One Specification 38 (for calculations)

For residential buildings, a garage attached to a house must (see Figure 1):

a) be separated from the living spaces with the required level of thermal performance, or

b) have an external walls that achieve the required thermal performance for a the living spaces.



OPTION (a) - Elevation

OPTION (b) - Elevation

**Figure 1:** R-Value Requirements for Class 1 to Class 10 Buildings

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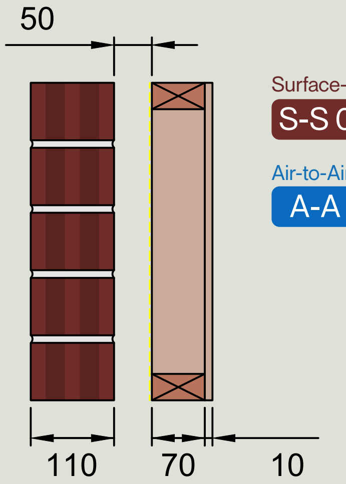
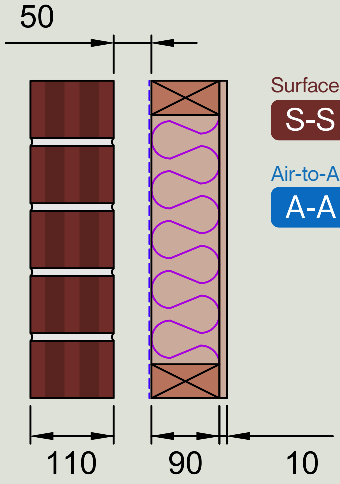
## BRICK VENEER SYSTEMS



Surface-to-Surface
S-S 0.83

Air-to-Air
A-A 1.14

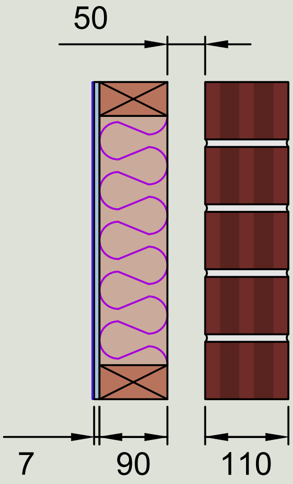
**Brick Veneer**
Extruded units + air cavity + pine studs at 600 mm centres with reflective foil insulation + plasterboard lining



Surface-to-Surface
S-S 1.53

Air-to-Air
A-A 1.87

**Insulated Brick Veneer**
Extruded units + air cavity + pine studs with low glare wall wrap + R1.5 glass wool insulation + plasterboard

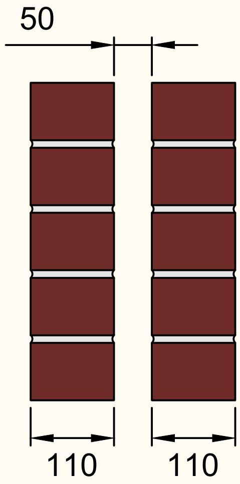


Surface-to-Surface
S-S 1.57

Air-to-Air
A-A 1.93

**Reverse Brick Veneer**
GranoSkin finish on blueboard + pine studs at 600 mm centres with R1.5 glass wool insulation + extruded units

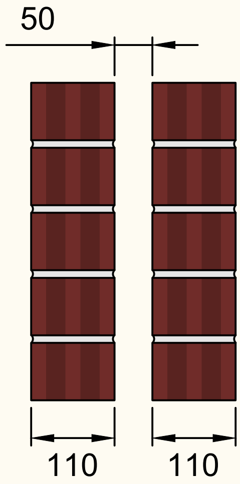
## CAVITY BRICK SYSTEMS



Surface-to-Surface
S-S 0.37

Air-to-Air
A-A 0.68

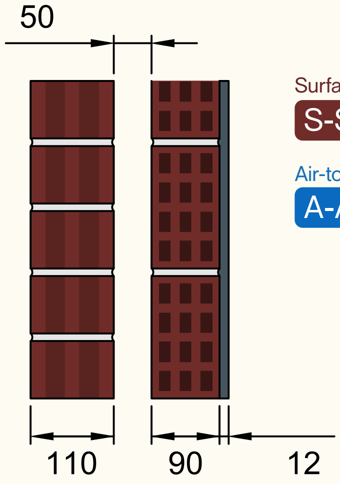
**Cavity Brick (dry pressed)**
110 mm dry-pressed units
+ 50 mm air cavity
+ 110 mm dry-pressed units



Surface-to-Surface
S-S 0.43

Air-to-Air
A-A 0.77

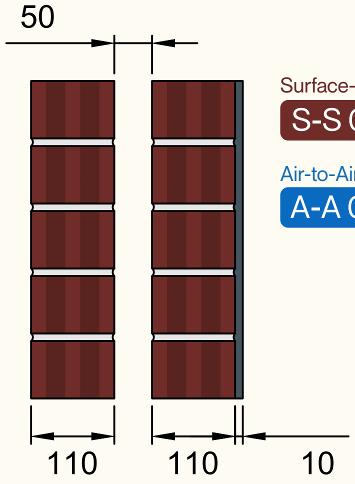
**Cavity Brick (extruded)**
110 mm extruded units
+ 50 mm air cavity
+ 110 mm extruded units



Surface-to-Surface
S-S 0.49

Air-to-Air
A-A 0.82

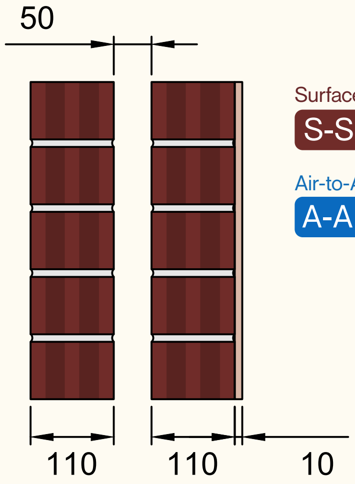
**Rendered Cavity Wall (WA)**
110 mm extruded units + 50 mm air cavity + 90 mm horizontally cored (WA) units + 12 mm render



Surface-to-Surface
S-S 0.44

Air-to-Air
A-A 0.77

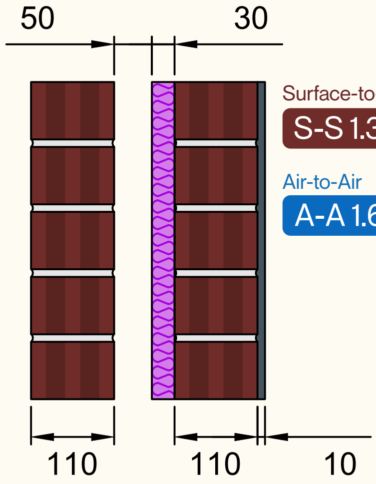
**Cavity Brick (extruded)**
110 mm extruded units + 50 mm air cavity + 110 mm extruded units + 10 mm render



Surface-to-Surface
S-S 0.55

Air-to-Air
A-A 0.89

**Rendered Cavity Wall (WA)**
110 mm extruded units + 50 mm air cavity + 110 mm extruded units + 10 mm plasterboard glued at 600 mm centres



Surface-to-Surface
S-S 1.30

Air-to-Air
A-A 1.62

**Insulated Cavity Wall**
110 mm extruded units + 50 mm air cavity + 30 mm rigid board insulation + 110 mm extruded units + 10 mm render

All measurements in millimeters (mm).

A. Page, B. Moghtaderi, D. Alterman, & S. Hands. (2011). *A Study of the Thermal Performance of Australian Housing*, The University of Newcastle.

# THERMAL MASS

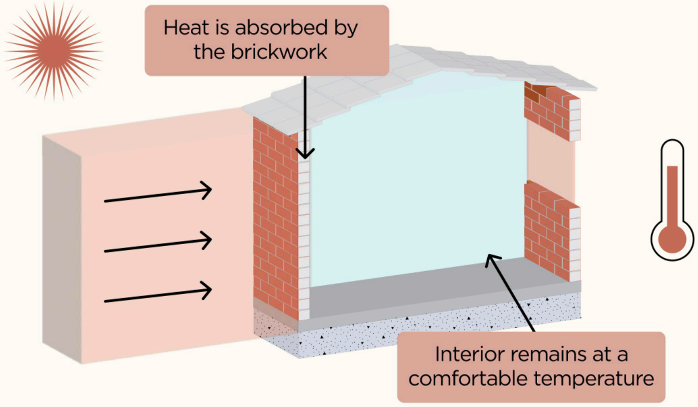
R-value is a standard measure used to quantify a material's resistance to conductive heat flow (i.e. insulating capability), however it does not account for the thermal dynamics of materials with high thermal mass. Bricks, while possessing a comparatively low R-value relative to conventional insulating materials, have significant thermal mass, which means they are effective at absorbing, storing and gradually releasing heat over extended periods. This capacity to moderate temperature fluctuations can enhance thermal performance, particularly in climates with severe diurnal temperature variations.

During periods of high external temperatures, bricks absorb heat and delay its transmission into the interior space, thereby reducing peak heat loads. Conversely, as external temperatures decline, the stored heat is slowly released, contributing to indoor thermal stability. Although bricks do not offer substantial resistance to heat flow on their own, their thermal mass can complement insulation systems by dampening temperature extremes, lowering reliance on heating and cooling, and improving overall energy efficiency in building envelopes.

The combined use of thermal mass and insulation is essential for optimising building performance. In colder climates, thermal mass must be carefully integrated with insulation to prevent unwanted heat loss, while in warmer regions, strategic placement of thermal mass within the building envelope can assist in delaying and reducing internal temperature rises. Orientation, shading, ventilation and the positioning of thermal mass materials such as brick must all be considered during the design process to ensure the desired thermal response is achieved.

While R-value remains a critical metric for assessing insulation, a comprehensive understanding of thermal performance requires consideration of both resistance and storage properties. When used appropriately within a passive design framework, materials with high thermal mass (such as bricks) can make a valuable contribution to sustainable and energy efficient construction.

DAY



NIGHT

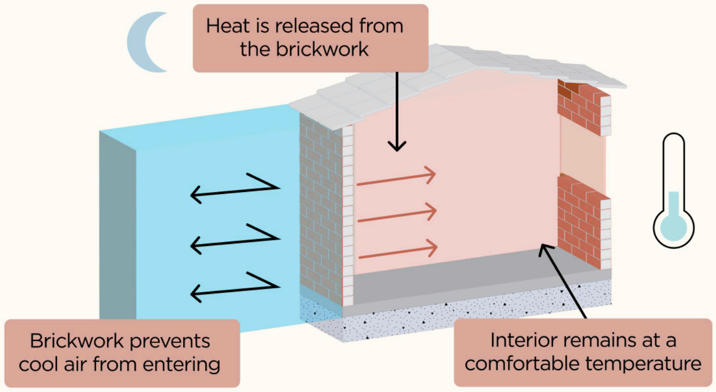


**Figure 3:** Effect of Thermal Mass on Thermal Performance in Winter and Summer