5.8 Mortar

The performance of mortar is dependent on its composition. For brick facings, the mortar is not expected to bare the weight of the bricks, and so this mostly affects the mortar's durability. The various deemed-to-conform compositions of M3 and M4 mortar used for pointing is set out in Table 6 (as per AS 3700 Table 11.1).

Table 6: Deemed-to-Conform Mortar Compositions

Mortar Class	Cement (GB/GP)	Building Lime	Sand	Water Thickener[3]
M3	1 1	1 0	6 5	Optional Yes
M4	1 1 1	0.5 0 0-0.25	4.5 4 3	Optional Yes Optional

1. Mortar mixes are designated by the proportions of their ingredients following an initial letter, the chief cementing agent being given as unity (e.g. C1:L0.5:S4.5).
2. Volumes refer to materials in the dense-packed condition.
3. The water thickener referred to in this Table is cellulose based. The particular cellulose-based product used shall be suitable for this application and used in accordance with the manufacturer's or supplier's instructions.

Sands should be free of impurities including organic matter and salts. Well-graded sands containing a range of particle sizes are recommended by Young[28] to increase the water retentivity of the mortar, as this reduces the void ratio resulting in a better flow of mortar through the pointing gun or grout bag. Leaner mortar, such as that made with washed sand or sands with uniform grain size, has a lower water retention and so the water seeps out under pressure leaving compressed sand inside the gun or bag.

Adding more water to increase workability will reduce the strength and increase the shrinkage of the mortar. This will result in cracking due to shrinkage. For adequate mortar workability, the addition of hydrated lime and proper mixing is all that is needed, however additives (such as cellulose-based water thickeners) can be added for additional rheological benefits. The resultant mortar should have no free water on its surface and be able to form peaks that are stiff enough to hold their shape.

The appropriate mix used needs to be compliant with the AS 3700 durability requirements for grout and mortar as per Table 5.1. This requires M4 mortar when:

- within 100 m of a non-surf coast,
- within 1 km of a surf coast, and
- within 1 km of major industrial complexes producing significant acidic pollution.

The minimum recommended mortar class for any other brick cladding system is M3. Proprietary pre-bagged mortars are available that comply to certain mortar class compositions which can be used for brick cladding systems.

Powdered or liquid pigments may also be added to the mortar when a different colour is required. Care should be taken with mortar selection to reduce the likelihood of efflorescence occurring. This can occur due to salts present in the sand used in the mortar mix. See the Think Brick Australia *Efflorescence*[27] factsheet on how to minimise the potential for efflorescence.

5.9 Sealants

Flexible sealants are required at all movement joints which are to be installed as per Section 6.6. This is to prevent water penetrating the system while also allowing movement due to expansion and between different system components. This should be a proprietary silicone or butyl-based sealant that has the appropriate fire rating if required.

Sealants with the highest expansion and compression abilities are the most effective for use in movement joints. Check with the sealant manufacturer prior to using the product to check its suitability. They should, at minimum, be able to expand and contract by ± 25 per cent.

5.10 Weep Holes

Weep holes are to be free of mortar and any other material that will prevent their proper function as per AS 3700. A weep hole screen can be used at weep holes to prevent vermin entering the façade system.

In bushfire-prone areas, all weep holes should be screened as per AS 3959 *Construction of buildings in bushfire-prone areas*[29]. Weep holes in sills of windows and doors are exempt from screening because they do not provide a direct passage for embers to the interior of the building or building cavity.

Weep hole screens are to be made of corrosion-resistant steel, bronze or aluminium. The maximum allowable aperture size for a weep hole screen used in bushfire-prone areas is 2 mm.

5.11 Weatherproofing

As bricks themselves do not act as a waterproof layer, the substructure underneath must be weatherproof to prevent water from damaging the internal frame. All membranes should comply to AS 4654.1 *Waterproofing membranes for external above-ground use, Part 1: Materials*[30].

However, it is important to ensure that condensation formed on the inside of the external wall is also free to escape for this same reason. This is why pliable building membranes or rigid air barriers used with thin brick cladding systems need to be deemed vapour permeable as per AS/NZS 4200.1 *Pliable building membranes and underlays, Part 1: Materials*[31]. Unless otherwise specified by the brick cladding system manufacturer, the National Construction Code (NCC)[32] requires a minimum vapour permeance for external walls to be:

- Class 3 for climate zones 4 and 5 (min. 0.1429 μg/N.s)
- Class 4 for climate zones 6, 7 and 8 (min. 1.1403 μg/N.s)

All damage or tears to the membrane should be repaired before installing the brick cladding system to ensure the membrane is able to act as required.

For all types of cladding systems, it is important to ensure that all the design considerations have been made prior to installing the system.

This is largely due to the fact that once the adhesive and/or mortar has cured, there is little flexibility to make minor amendments to the design. As a non-waterproof, non-structural, low insulating system, it is imperative that all requirements are met prior to the installation of the thin brick facings. This section accounts for the key design considerations for brick cladding systems.

6.1 Waterproofing

External walls are required to be waterproof. A waterproof layer (such as a pliable building membrane, rigid air barrier, or liquid membrane) should first be installed onto the substrate for all external brick cladding systems to ensure moisture cannot travel through the porous brick layer to the structural frame. These should be installed in accordance with AS 4654.2 *Waterproofing membranes for external above-ground use, Part 2: Design and installation*[33].

Sheet membranes are to be installed from the bottom up with the direction of lay parallel to the ground level (see Figure 6) and the above layer and ends overlapping by a minimum 150 mm (see Figure 7). These should be fixed to the framing as per AS/NZS 4200.2 *Pliable building membranes and underlays, Part 2: Installation*[34]. This requires fixing the membrane prior to the installation of brick cladding:

- for timber stud framing; mechanically at 150 mm centres.
- for steel stud framing; mechanically (with flat head screws for brick cladding systems fixed directly to the stud) at 300 mm centres unless adhered directly to the stud.
- for solid walls; using a liquid membrane

It is recommended to tape this lap where possible. For installation of brick cladding systems onto solid walls, reflective air gaps are not required.

All damage or tears to the membrane should be repaired before installing the brick cladding system to ensure the membrane is able to act as required. The membrane is to be cut where required to fit around all obstacles, openings, and penetrations in accordance with AS 4200.2 Section 4. Extra attention should be made to any 3-plane joints such as at corners of windows, doors and other openings.

For brick cladding systems on a solid substrate such as concrete or masonry, proprietary liquid membranes compliant to AS 4654.1 can be applied to the specific membrane classification relevant to the wall. These are often acrylic polymer based solutions and should be installed as per the manufacturer's instructions.

Any moisture that arises from condensation or water passing through the brick face will drain out of the cavity base flashing and weep holes. The width of this cavity is based on the size of the vertical supports or in-built panel channels and for rail systems must be of a minimum 18 mm unless otherwise tested.

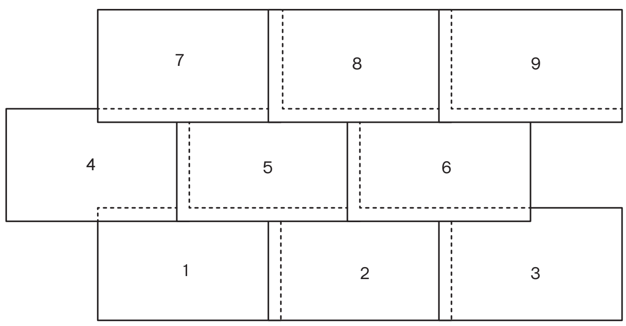

Figure 6: Sheet Membrane Installation Order

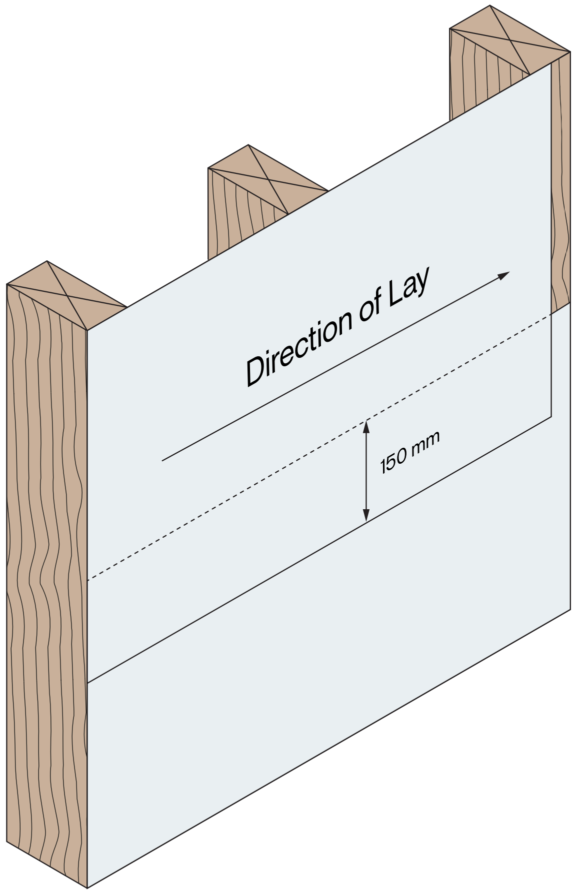

Figure 7: Waterproof Membrane Installation Overlap

6.2 Foundations

The NCC Volume Two specifies that the minimum clearance from the bottom of the brick cladding wall to the finished ground level must be at least:

- 100 mm in low rainfall intensity areas or sandy, well-drained areas.
- 50 mm above impermeable (paved or concretes) areas that slope away from the building.
- 150 mm in any other case.

This guidance can be used when detailing flashings in buildings that would otherwise be covered by the NCC Volume One. Where brick cladding terminates (including suspended slabs and the like), it should be detailed such that moisture can be redirected effectively away from the brickwork. This may include extending the brick cladding below the bearer or lowest horizontal part of a suspended floor framing.

6.3 Flashings

The flashing for brick cladding systems should be designed in a way such that it can collect water drained from the cavity within the system and direct it out of the wall through weepholes. The material should be designed as per Section 5.4 of this manual. All flashings are to be fixed directly to the substrate and should be installed to form a continuous barrier at:

- The base of the cladding,
- Horizontal control joints,
- Wall to roof intersections, and
- Window heads, jambs and sills.

Flashings should be fixed at 600 mm centres. Joins between flashings must overlap by at least 75 mm in the direction of flow and be securely fastened at intervals of not more than 40 mm with sealant installed between the laps. The waterproof membrane should also be installed such that it laps the flashings in the direction of flow.

The flashing should extend to the exterior wall surface or beyond, with the back edge turned up at least 150 mm vertically. Extending flashings beyond the face of the brick cladding to form a drip edge is recommended. When such drip edge is not used, the flashings should stop (or be cut) flush with the face of the wall.

Flashings at openings should extend at least 110 mm beyond the reveals on each end where practicable and drain to the outside face of the cladding. The top of an opening (such as a window or doorway) does not need to be flashed if it is adequately protected by an eave of a width more than 3 times the height of the cladding above the opening (see Figure 8).

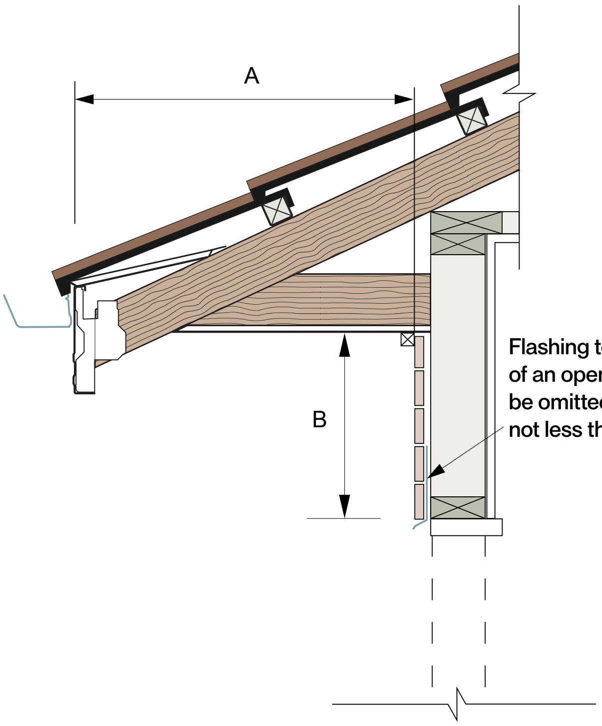

Figure 8: Weather Protection of Openings

6.4 Parapet Cappings

When a parapet wall is to be designed, the brick cladding system must be attached to a supporting substrate and have a parapet capping over it to protect the cavity and divert water away from the wall. This must be of a material as per Section 5.4 of this manual and designed to extend no less than 50 mm down the sides of the parapet.

Parapet cappings must be fixed using compatible self-drilling screws or rivets with rubber washers at 500 mm centres. They should not be fixed or penetrated at the top unless where at a joint or corner. Joins between parapet cappings must overlap by at least 50 mm in the direction of flow and be securely fastened at intervals of not more than 40 mm with sealant installed between the laps.

The waterproof membrane should be installed as a vapour permeable sarking beneath the parapet capping. This is to be installed on the elements considered to be external wall which should extend to the top and back of the parapet. This should be fixed to the supporting structure at no more than 300 mm centres with a minimum 150 mm overlap between sheets taped together. A gap should be provided between the membrane and the parapet capping to help control condensation.

6.5 Deflection

For adhered thin brick facings with a masonry or concrete substrate, deflection is not as much of a concern because the flexural stiffness of the bricks is similar to that of the substrate. When applied on timber or steel stud framing, out-of-plane deflection should be considered because the stiffness of the thin brick facings can be substantially greater than the stud framing. Substrate deflection under all live, dead, and impact actions for adhered thin brick facings should not exceed L/360 as per AS 3958 Section 4.1.2.

For mechanically engaged systems, deflection limits are specific to the capacities of each system type and manufacturer, and so the maximum deflection tested by the manufacturer should be checked before building the substrate. Where a test report is not available, a maximum deflection of L/500 should be applied based on the principles set out in AS 3700 Section 2.7. This should also be considered when determining the appropriate spans and geometry for the substrate.

6.6 Control Joints

Existing movement joints (also known as expansion joints or control joints) in the substrate or supporting structure must be carried through to the facings and should conform to architectural details and structural requirements. Thin brick facings and respective supporting components should not be installed over existing substrate control joints. Appropriate locations for control joints include between sections of rail or panel, framing, doors, abutments, and penetrations.

Vertical and horizontal movement joints in the substrate or supporting structure should be considered prior to installing the brick cladding system as they must line up with the movement joints in the brick cladding façade. All joints should be straight (not toothed), free of mortar and should extend to the full height or length of the masonry.

Control joint spacing should be designed in accordance with AS 3700 Section 4.8 which specifies that the joint should not close by more than 15 mm. It also specifies that the thickness of control joints should be designed so that it does not become less than 5 mm wide or exceed 10 mm more than the design joint thickness (see Figure 9). For typical 10 mm mortar joints, as bricks expand over time, a 15-20 mm control joint is recommended to allow for a 10 mm joint reduction due to expansion.

Allowances for the material expansion (e_m), thermal expansion, and shrinkage of concrete substrates (if applicable) should be considered when designing joint spacing and thickness. Different systems and products may have different expansion values, and so the manufacturer should be consulted before determining the maximum control joint spacing.

Where a control joint is incorporated, the joint is deemed to be a structural end. Rails and panels on either side of a control joint should not be fixed to the same substrate as they should be free to move and expand independently. Where brick cladding systems are abutted to traditional brickwork or other materials different to the system, a control joint must be used at the junction.

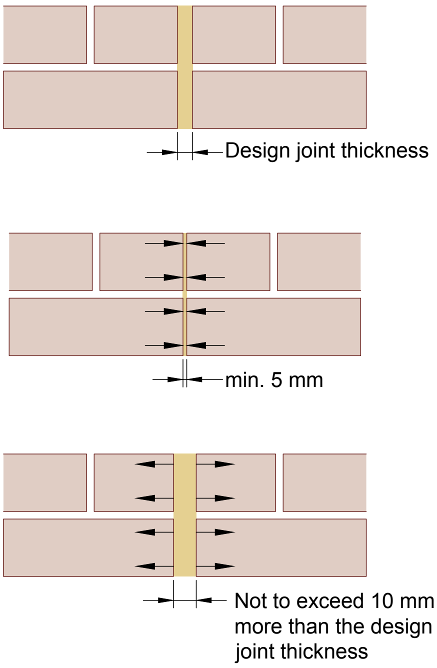

Figure 9: Allowable Control Joint Dimensions

6.7 Fire Considerations

All components of brick cladding systems should be made from non-combustible materials as per Section 5.3, and should not contribute to the spread of fire. This means that they can be used in areas with a maximum Bushfire Attack Level 19 (BAL-19) as per AS 3959 *Construction of buildings in bushfire-prone areas*[29].

However, where testing has been conducted to AS 1530.8.1 *Methods for fire tests on building materials, components and structures, Part 8.1: Tests on elements of construction for buildings exposed to simulated bushfire attack - Radiant heat and small flaming sources*[35] or AS 1530.8.2 *Methods for fire tests on building materials, components and structures, Part 8.2: Tests on elements of construction for buildings exposed to simulated bushfire attack - Large flaming sources*[36], the systems may comply up to BAL-40 or BAL-FZ respectively.

Alternatively, if a system has been tested to AS 1530.4 and achieves a Fire Resistance Level (FRL) of at least -/30/30, it will be compliant for walls of BAL-FZ.

6.8 Thermal Considerations

Thermal bridging allow heat to travel freely through walls which can negatively impact its thermal properties and cause additional unwanted condensation. A wall's resistance to this transfer is referred to as the total R-Value (in m^2K/W), which describes its thermal resistance/transmittance (i.e. the ability of heat to transfer through a system). Each component of a wall has its own value which is calculated using AS 4859.2 *Thermal insulation materials for buildings, Part 2: Design*[37].

As metal is a strong conductor, where external metal members (such as a rail or panel) are in contact with structural components a thermal break is needed. This is an element with low thermal transmittance located such to interrupt the heat flow path through elements with high thermal transmittance. An example of where this is to be included can be seen in Figure 10.

The NCC Volume Two Section 13.2.5(5) states that an external steel stud-framed wall must have a thermal break, consisting of a material with an R-Value of not less than 0.2, installed at all points of contact between the external cladding and the metal frame. This applies to all steel stud-framed walls cladded with metal rails, panels or top hats fixed directly to the frame.

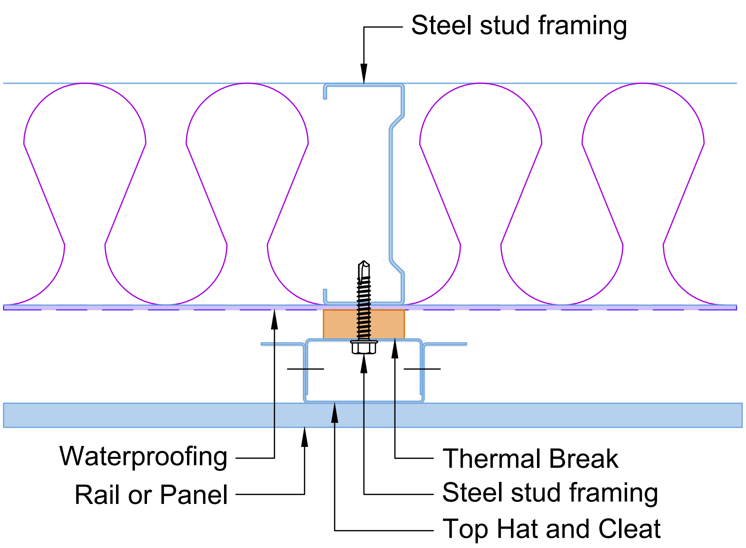

Figure 10: Thermal Break Example

6.9 Insulation

The R-value for thin bricks (R < 0.05) and their rails/panels and other supporting materials are significantly small (total R-Value < 0.2). This is why the supporting wall should be insulated adequately to achieve the required overall insulation. For this reason, the total R-value for external wall systems using rail systems is generally calculated in accordance with AS/NZS 4859.2 ignoring the system and cavity, unless otherwise tested to AS/NZS 4859.1 *Materials for the thermal insulation of buildings, Part 1: General criteria and technical provisions*[38].