

## INSULATION INSTALLATION

### Installing insulation

#### **Installation guidelines**

It is vital that insulation is installed with careful attention to detail, as incorrect or inappropriate installation will significantly decrease performance. For instance, failure to butt all ends and edges of batts to give a snug fit could result in 5% of the ceiling area not being covered, losing up to 50% of the potential insulation benefits.

#### **Relevant standards for installation**

Various Australian Standards and national codes of practice cover the installation of insulation products with key standards set out below.

Bulk insulation must be installed in compliance with *AS3999: Thermal insulation of dwellings—Bulk insulation—Installation requirements*.

Reflective foil insulation must be installed in compliance with *AS1904: Code of practice for installation of reflective foil laminate in buildings*.

All electrical wiring encased in insulation must conform to *AS3000: Electrical installations—buildings, structures and premises*. In existing dwellings, which may not conform to this standard, spacers must be installed to ensure that wiring is not in contact with the insulation (refer AS3999).

It is best to keep wiring clear of insulation, e.g. run wiring on top of ceiling joists.

Installation safety when installing mineral wool (glasswool and rockwool), insulation should comply with Work Safe Australia's *National code of practice for safe use of synthetic mineral fibres (1990)*.

#### **Principles of installation**

The following installation principles will ensure the best possible performance from insulation.

- > Avoid gaps in insulation
- > Do not compress bulk insulation
- > Eliminate thermal bridges

- > Allow clearance around appliances and fittings
- > Protect insulation from contact with moisture
- > Provide a sealed air space with reflective insulation
- > Provide vapour and moisture barriers to prevent condensation
- > Eliminate thermal bridges

SITUATION	TECHNIQUE
Gaps where insulation not installed	Fit batts snugly leaving no gaps around ducts and pipes
Gaps between pieces of insulation	Make sure corners, junctions of wall, floor and ceiling are fully covered
Compression of bulk insulation	Retain maximum thickness, allow to fully expand
Structural framing—metal, timber	Isolate metal framing from contact with cladding, or increase level of added insulation. Isolate timber framing from contact with cladding in alpine areas
Metal window frames	Insulate window frames or install windows with thermal breaks

Table 7.6: Some installation techniques to improve thermal performance

#### **Clearance around appliances and fittings**

Some appliances and fittings, such as recessed downlights and heater flues, require free space around them for the dissipation of heat, to reduce fire hazard. Insulation should not be placed against these fixtures. Regulations and manufacturers' recommendations should always be checked before installing insulation. Table 7.7 on the following page sets out some common installation clearances.

ITEMS TO BE CLEARED	TECHNIQUE
Recessed downlights	Minimum clearance of 25 mm
Flues and exhaust fans	Minimum clearance of 90 mm
Loose fill insulation material	Use barriers to restrain and ensure adequate clearance
Electrical wiring (existing home)	Check by electrician before installing insulation. Keep wiring clear of insulation. Restrain loose fill material by spacers

Table 7.7: Insulation clearance requirements

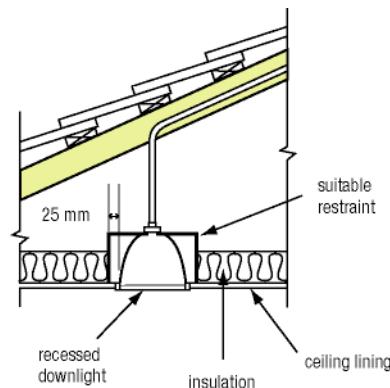


Fig 7.12: Insulation clearance around recessed downlights

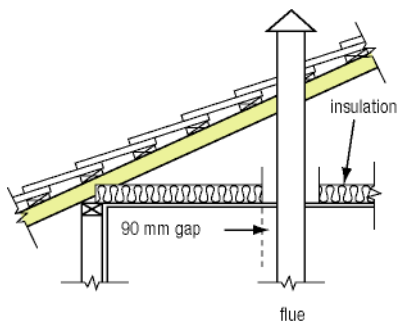


Fig 7.10: Insulation clearance around flues

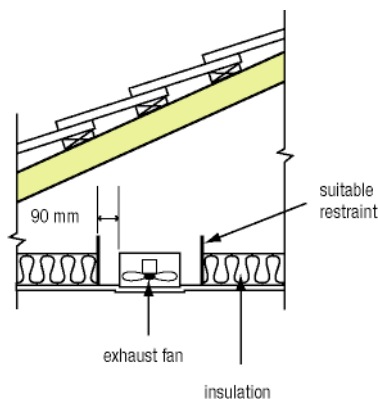


Fig 7.11: Insulation clearance around exhaust fans

### Condensation

Air always contains a certain amount of water vapour. This vapour can originate from many sources around the home—respiration, cooking, bathrooms and laundries, indoor plants, LPG gas heaters and so on. When moist air is cooled below its dewpoint (i.e. cooled to a temperature at which it cannot contain all the water originally present), and if the cooling is caused by contact with a colder surface, the vapour changes to liquid droplets on that surface. This phenomenon is called condensation.

Condensation is more likely to occur:

- > where there is a low ventilation rate within the walls or roof space, insufficient to remove water vapour (e.g. cathedral and flat roof ceilings);
- > where daytime temperatures do not exceed 5°C (e.g. in alpine areas in winter); and
- > where high amounts of water vapour are generated internally but not mechanically exhausted.

### Condensation on interior surfaces

Insulation, correctly installed, can keep the interior surface temperature of ceilings and external walls above the dewpoint, preventing condensation on these surfaces. Condensation control involves preventing moist air from coming into contact with

cold surfaces below the dewpoint of the air by one or more of the following means:

- > removing moisture-laden air by controllable ventilation or exhaust fans;
- > insulating to keep ceiling and wall temperatures above dewpoint, and to reduce the difference between room temperature and surface temperatures; and
- > background heating to prevent interior surfaces from cooling below the dewpoint.

**Interstitial condensation**

In cold conditions, condensation may occur within the roof space (especially where metal deck roofs are used) or walls and within the insulation itself. Exhausting moist air into the roof space or wall cavity may also cause condensation. Such condensation is known as interstitial condensation. It can cause mould, mildew and rotting of building components. In addition, the effectiveness of insulation is significantly reduced when it contains water.

Condensation is a particular hazard in cathedral and flat roof systems where the low ventilation rate within the roof space may be insufficient to remove water vapour contained in the air, or condensed upon or within building components.

These problems can be avoided by either providing sufficient ventilation within the wall or roof space to remove water vapour, or by installing vapour barriers such as reflective foil on the warm side of insulation. This prevents water vapour from contacting cool surfaces within the walls or roof structure.

Exhaust fans in buildings with metal deck or tiled roofs with sarking (reflective foil installed under roofing material for weatherproofing) must be ducted to the atmosphere.

**Protect insulation from contact with moisture**

Masonry walls are not waterproof. In both brick veneer and double-brick wall construction a cavity between the external masonry wall and the internal lining keeps the internal lining dry. Moisture on the internal face of the external masonry wall can drain away through weepholes or evaporate into the cavity. Table 7.8 sets out techniques to prevent the insulation from absorbing moisture from the external leaf and losing effectiveness.

SITUATION	TECHNIQUE
Brick veneer construction	Restrain bulk insulation within the frame. Reflective foil laminate, polypropylene lashing, nylon cord, galvanised wire or building paper can be used to keep bulk insulation in place
Cavity masonry walls	Restrain bulk insulation to maintain at least 30 mm cavity
Existing wall cavities	Use 'cavity fill' water-repellent loose-fill granular rockwool insulation. Contains water-repelling agent to prevent absorption of moisture. Not allowed by some building authorities because of concern over moisture penetration

Table 7.8: Keeping insulation dry in wall cavities

**Provide a sealed air space with reflective insulation**

Reflective insulation adjacent to a solid surface without an airspace, has no insulative value and acts only as a vapour barrier. To add thermal resistance, reflective insulation must face a sealed air space (see figure 7.13).

To maximise the effectiveness of reflective foil:

- > maintain a sealed air space of at least 25 mm;
- > eliminate air movement between air spaces on either side of the foil;
- > overlap sheets by 150 mm and tape over joints; seal any gaps;

- > use face-of-wall brick ties instead of ties which penetrate the foil; and
- > reflective surfaces should be kept clean and dust free, vertical installation is best for this.

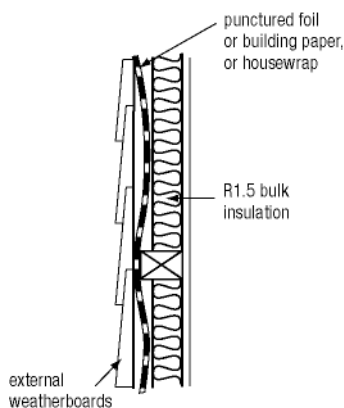


Figure 7.13: Reflective insulation with sealed air space (weatherboard wall)

### **Provide barriers to prevent condensation**

Condensation in bulk insulation reduces its insulating properties significantly. Vapour barriers stop the transmission of water vapour generated inside the home, through the building elements and into the building structure.

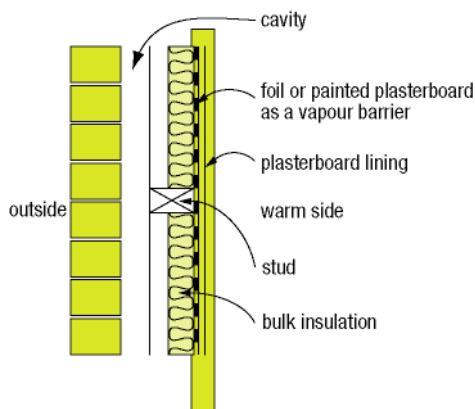


Figure 7.14: Place vapour barrier on the warm side of insulation (brick veneer wall)

A vapour barrier installed on the warm side of insulation will prevent moist air from contacting a

cold surface (see figure 7.14). The vapour barrier should be continuous, with no breaks. Vapour barriers include well-maintained painted surfaces, polythene sheeting and aluminium foil. If aluminium foil is required to act as both thermal insulation and a vapour barrier, ensure that a still airspace is provided.

Painted surfaces generally provide adequate protection from condensation in Victorian climates. Moisture barriers stop the transmission of water from outside the home entering through the building elements. Sarking may be installed directly under roofing material to act primarily as a moisture barrier. It is usually made of reflective foil laminate (which adds to the insulation effect), or other waterproof material.

### **Health and safety**

#### **Glasswool, rockwool and cellulose fibre**

Claims have been made regarding exposure to glasswool and rockwool as an apparent ongoing health risk, particularly in reference to cancer. However, continuing medical research has failed to find any evidence to support these claims. In 1994, The Institute of Respiratory Medicine Royal Prince Alfred Hospital, NSW, investigated the Respiratory Health of Australian Glasswool and Rockwool Manufacturing Industry, for the Insulation Wools Research Advisory Board. They found no evidence of occupational asthma, pulmonary fibrosis or lung cancer.

The main risk associated with glasswool and rockwool is short-term irritation to skin, eyes, nose and throat. This reaction is a physical reaction, not an allergic reaction. Cellulose fibre may cause minor eye and respiratory irritation when handled. For most people, the irritation quickly disappears. Once installed, the insulation should present no further problems. However additional weatherstripping should be installed around access holes and ceiling cracks.

The irritation caused by these fibres can generally be avoided by:

- > minimising dust release when opening insulation wrapping;
- > wearing long-sleeved, loose-fitting clothing and gloves during installation;
- > wearing goggles and head covering, especially when installing insulation overhead;
- > wearing a half-face (Class L or M) disposable respirator during work in enclosed or poorly-ventilated spaces;
- > washing skin with warm, soapy water following installation; and
- washing protective clothing separately.

#### Reflective foil

Reflective foil can cause dangerous glare and even sunburn if installed outdoors. Anti-glare products should be selected if installed in sunlight and adequate eye protection should be worn.

### Installation options

#### Ceiling installation

The following details illustrate ways of achieving an overall minimum insulation level of at least R2.2 for a variety of ceiling and roof types for Victoria.

#### Flat ceilings with pitched roofs

This is the most common form of ceiling and the easiest to insulate.

#### Bulk insulation between ceiling joists

The use of only bulk insulation between joists is shown in figure 7.15. With added R2.5 bulk insulation, the overall R value is 2.2. This can be increased to 2.7 by using R3.0 or higher.

#### Bulk insulation and reflective foil between ceiling joists

The use of bulk insulation between ceiling joists as well as reflective foil directly under the roof is shown in figure 7.16. The use of double-sided reflective foil placed directly under the roof improves summer and winter performance and

provides a moisture barrier (sarking). Foil alone has an overall R value of approximately 0.5 and must be supplemented by other insulation to satisfy the minimum insulation level. With added R2.0 bulk insulation, the overall value is R2.3. This can be increased to R2.7 by using R2.5 or greater.

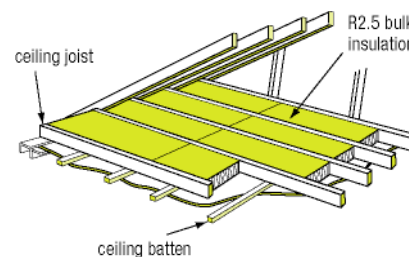


Figure 7.15: Bulk insulation between joists (overall R value 2.2)

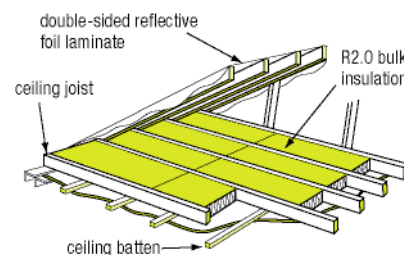


Figure 7.16: Bulk insulation between ceiling joists and reflective foil under roof (overall R value 2.3)

#### Ceilings with exposed rafters

These roofs include sloping ceilings, cathedral ceilings, vaulted ceilings, flat and skillion roofs. Ceilings with exposed rafters require insulation to be installed during construction, as it cannot be accessed later. Roof space can be very limited in these situations. Note that 100–125 mm batten height is needed to avoid compression of R2.5 bulk insulation. For this reason consider materials that offer the same R value with less thickness, e.g. extruded or expanded polystyrene boards.

These roofs are more susceptible to problems of condensation due to the low ventilation rate in the roof space, so a vapour barrier installed directly above the ceiling lining may be a useful inclusion.

### *Bulk insulation and vapour barrier between battens*

A metal deck roof with bulk insulation between battens with a vapour barrier is shown in figure 7.17. With added R2.5 bulk insulation, the overall value is R2.2. The overall R value can be increased to 2.7 by using R3.0 bulk insulation. An alternative solution is to use 50 mm extruded polystyrene boards laid above the ceiling lining requiring no vapour barrier and providing an overall R value of 2.3.

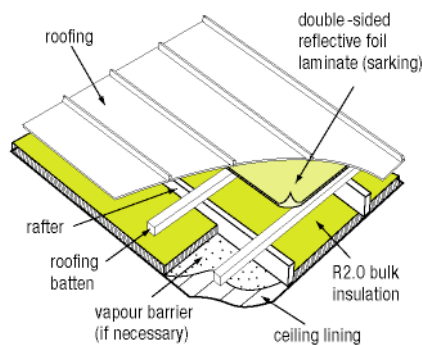


Figure 7.17: Bulk insulation between battens and vapour barrier under metal roof (overall R value 2.2)

### *Bulk insulation blanket over battens*

A metal deck roof with bulk and reflective insulation is shown in figure 7.18. With added R2.5 foil backed batts or blankets, the overall R value is 2.2. Compression of bulk insulation reduces its effectiveness. An alternative solution is to use 25 mm expanded polystyrene foil boards installed

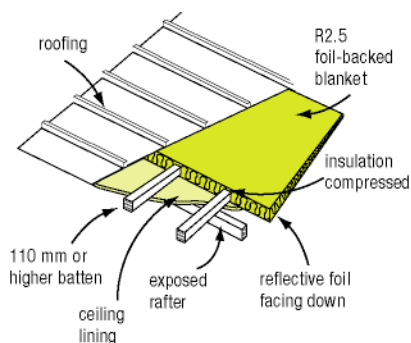


Figure 7.18: Foil backed bulk insulation over battens under metal roof (overall R value at least 2.2)

between the ceiling and metal deck roof, with a 25 mm air space above and below. This would provide an approximate overall R value of 2.2.

### *Bulk insulation and reflective foil between counter battens under tiled roof*

A tiled roof with bulk and reflective insulation is shown in figure 7.19. With added R2.5 bulk insulation and reflective foil, the overall R value is at least 2.2. This can be increased to 2.7 by using R3.0 batts, requiring a minimum batten depth of 125 mm.

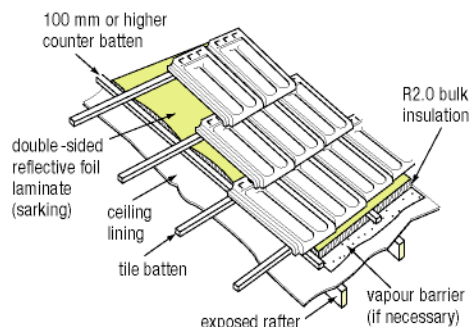


Figure 7.19: Bulk insulation and reflective foil between counter battens under tiled roof (overall R value at least 2.2)

### **Ceilings with concealed rafters**

Such roofs include sloping ceilings, cathedral ceilings, vaulted ceilings, flat and skillion roofs. Bulk insulation may be placed between rafters, and moisture problems avoided by placing a vapour barrier directly above the ceiling lining. Extruded polystyrene products do not require a vapour barrier.

### *Bulk insulation between rafters and vapour barrier*

A metal deck roof with air space, bulk insulation and a vapour barrier beneath is shown in figure 7.20. With added R2.5 bulk insulation, the overall R value is 2.2. This can be increased to 2.7 by using R3.0 or higher batts, requiring a minimum rafter depth of 125 mm.

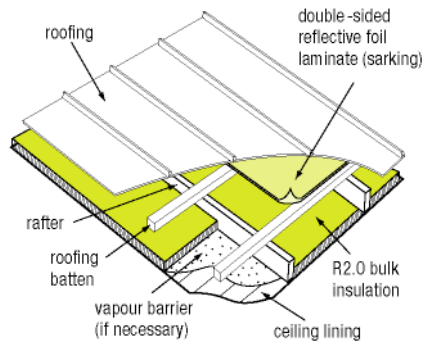


Figure 7.20: Bulk insulation between rafters and vapour barrier under metal roof (overall R value 2.2)

#### *Bulk insulation between rafters and vapour barrier*

A tiled roof with bulk insulation and a vapour barrier beneath is shown in figure 7.21. Note that sarking is used below the tiles as a moisture barrier. With added R2.5 bulk insulation, the overall R value is at least 2.2. This can be increased to 2.7 by using R3.0 or higher batts, requiring a minimum rafter depth of 125 mm.

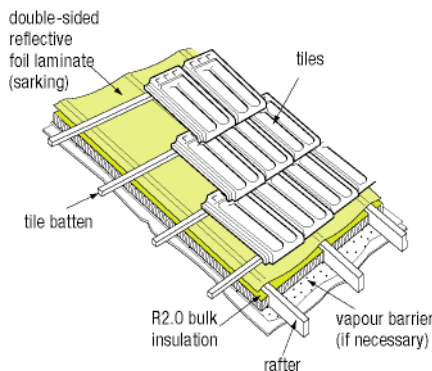


Figure 7.21: Bulk insulation between rafters and vapour barrier under tiled roof (overall R value 2.2)

#### **External wall Installation**

The following notes provide information on correctly installing wall insulation and illustrate ways of achieving at least an overall minimum insulation level of R1.3 for a variety of external wall construction types (refer to the *Insulation types* fact sheet for minimum insulation level for Victoria).

#### **Existing walls**

For existing housing, wall insulation can be installed by removing internal or external linings to access the cavity, and then replacing the linings. Alternatively wall cavities can be filled with granulated rockwool, if permitted by local building regulations. It is costly to insulate existing walls and often difficult to access the cavity. In these circumstances the insulation installation cost may be better invested in extra ceiling or floor insulation, or other energy saving measures.

#### **Wall sections with a roof space**

It is essential to insulate vertical wall sections within the roof space above ceilings of different heights, as these can be a major source of heat loss. These sections should be insulated to the same level as the ceiling (see figure 7.22).

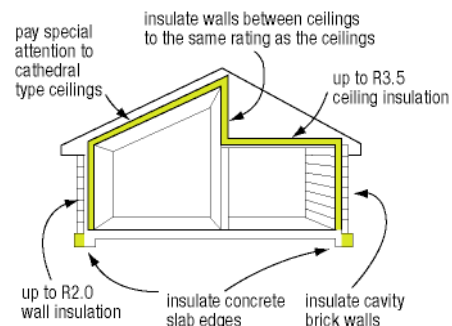


Figure 7.22: Insulate vertical wall sections between ceilings of different heights

#### **Vapour barriers**

Where there is a risk of condensation, install reflective foil or polythene sheets on the warm side of wall insulation to act as a vapour barrier. Well-maintained painted or foil-backed plasterboard also act as vapour barriers (see figure 7.15).

#### **Framed walls: Brick veneer and weatherboard**

Reflective foil should be installed on the outside of wall studs, creating a still air layer on either side of the foil. The material must be continuous, and any holes, tears or joins in the foil must be taped over.

For weatherboard or cladding construction (where the outer skin is in contact with the timber framing), the foil should be dished between the studs to create still air pockets on both sides. Perforated or 'breather' foil should be used with weatherboard walls, as it allows the timber to breathe and prevents warping.

#### *Framed walls with reflective foil laminate*

By installing double-sided reflective foil on the outside of the framed walls (studs), achieves an overall R value of 1.3. This can be increased to R1.8 if combined with concertina-style reflective foil stapled between the studs as well (leaving at least 25 mm air space between them). The use of reflective foil over framing is shown in figure 7.23. Suitable materials are double-sided reflective foil laminate and reflective building paper.

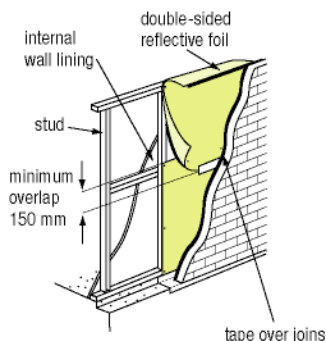


Figure 7.23: Framed walls with reflective foil (overall R value 1.3)

#### *Framed walls with reflective foil batts*

The use of reflective foil batts between framing is shown in figure 7.24. Suitable materials are concertina-style reflective foil laminate or single-cell foil batts, both stapled between the studs.

The overall R value is 1.4, and can be increased to 1.8 by using two layers of concertina batts stapled between the studs (leaving at least 25 mm air space between them), or by using double-cell foil batts stapled between the studs.

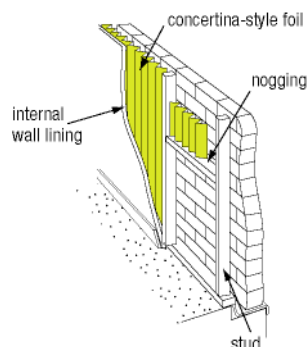


Figure 7.24: Framed walls with reflective foil batts (overall R value 1.4)

#### *Weatherboard walls with bulk insulation and reflective foil*

The use of weatherboard walls with bulk insulation is shown in figure 7.25. Weatherboards should be lined with a fire retardant building paper or perforated reflective foil attached to the outside of the frame, with R1.5 bulk insulation between the studs. The overall R value is at least 1.7 and can be increased to at least 2.2 by using batts with an R value of 2.0.

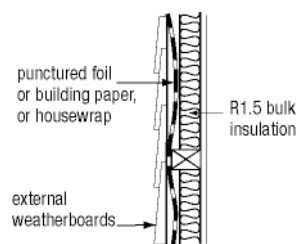


Figure 7.25: Weatherboard walls with bulk insulation and reflective foil (overall R value at least 1.7)

#### *Brick veneer walls with bulk insulation between studs*

The use of bulk insulation between studs is shown in figure 7.26. Strapping, reflective foil or building paper should be used to prevent R1.5 batts falling against the cladding or bricks and absorbing moisture from them. The overall R value is 1.7 and can be increased to 2.2 by using batts with an R value of 2.0.

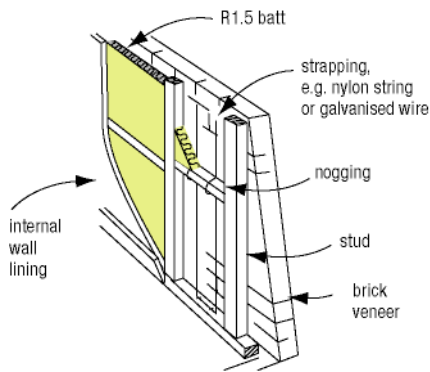


Figure 7.26: Framed walls with bulk insulation between studs (overall R value 1.7)

#### *Brick veneer walls with insulation boards across studs*

The use of bulk insulation across the outside face of studs is shown in figure 7.27. Insulating across the outside of the frame reduces thermal bridging through the frame and achieves a better overall insulation value when comparing the addition of products with equivalent R values. This method is particularly suitable for metal framing. Although other products can be used, ten millimetres of foil-faced expanded polystyrene or R1.0 extruded polystyrene boards are the most practical for this type of insulation, as they maintain a 25 mm cavity between the external cladding and the insulation. The overall R value is 1.7 and can be increased to over 2.0 by using thicker boards.

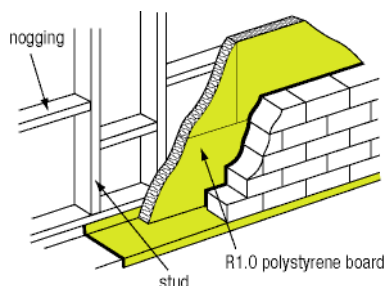


Figure 7.27: Brick veneer walls with bulk insulation across the studs (overall R value 1.7). Particularly suitable where metal framing is used

#### **Double brick cavity walls**

Insulating a double brick wall is relatively simple if insulation is installed during its construction. For established homes, existing walls can be insulated using either loose-fill cavity insulation or internal or external insulation, however it is difficult and more costly to install. Internal insulation is less effective than external insulation as it isolates the thermal mass benefits of the wall from the inside of the dwelling and reduces the internal size of the room.

#### *New cavity brick wall with insulation boards within the cavity*

The use of insulation boards in the cavity of new walls is shown in figure 7.28. The boards are pushed over the brick ties of the internal brick wall. Foil-faced expanded polystyrene (ten millimetres) or R 1.0 extruded polystyrene boards are typically used. They are self-supporting and need only small clips to keep them in place. The overall R value is at least 1.7.

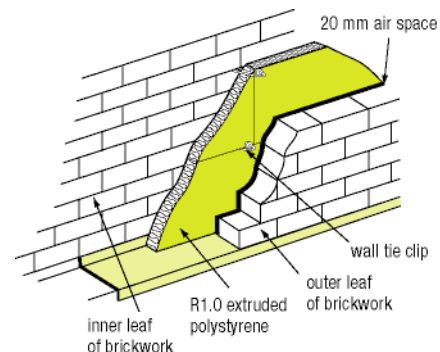


Figure 7.28: New cavity brick wall with bulk insulation within the cavity (overall R value 1.7)

#### *Existing cavity brick wall with cavity fill insulation*

The use of cavity fill insulation in an existing wall is shown in figure 7.29. Subject to local building regulations, the cavity can be filled with water-repellent loose-fill rockwool insulation. R 1.0 hydrophobic loose-fill rockwool is also suitable. The overall R value is 1.5.

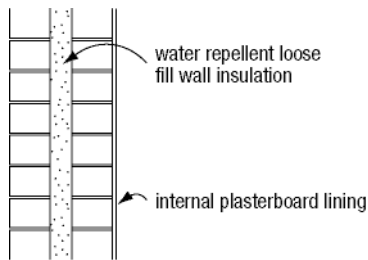


Figure 7.29: Existing cavity brick wall with cavity fill insulation (overall R value 1.5)

### Solid walls: brick, mud brick and concrete

Solid masonry walls, including concrete block, concrete panel, mud brick, pise and solid brick forms of construction without cavity and less than 180 mm thick, should have internal or external insulation applied to meet Victorian Insulation Regulations. The insulation must be protected from contact with moisture by using a moisture barrier for external insulation and a vapour barrier for internal insulation. External insulation provides the advantage of containing the thermal mass within the building envelope, and protects the wall from moisture absorption. Construction techniques and total R values depend on the product used.

Solid walls may be constructed using materials such as 200 mm thick aerated concrete that have an inherent R value and do not require additional insulation to satisfy the insulation regulations. Other products available include cement-rendered straw bales, Thermomass (two concrete panels joined together with polystyrene insulation between them), and Thermocell (polystyrene foam cell filled with concrete).

### Solid masonry wall with internal insulation

The use of internal insulation is shown in figure 7.30. Suitable materials, together with a wall lining, are R1.0 batts or polystyrene boards. If extruded polystyrene or foil-faced expanded polystyrene is used, no vapour barrier is necessary. The overall R value is at least 1.3 (dependent on wall thickness, material and insulation).

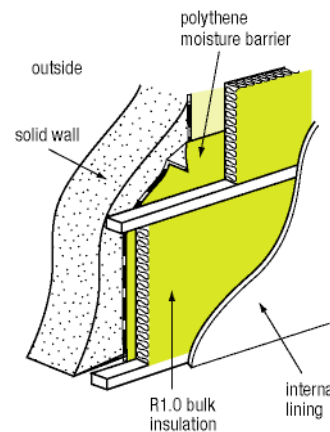


Figure 7.30: Solid masonry wall with internal insulation (overall R value 1.4)

### Solid masonry wall with external insulation

The use of external insulation is shown in figure 7.31. Suitable materials are R1.0 extruded polystyrene boards together with an external impact and weather resistant finish. The overall R value is at least 1.3 (dependent on wall thickness, material and insulation).

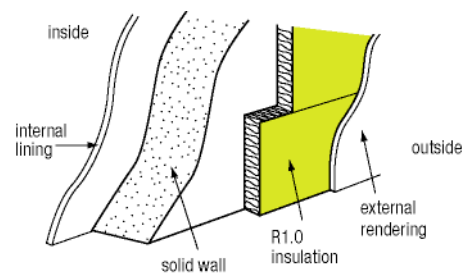


Figure 7.31: Solid masonry or concrete panel wall with external insulation (overall R value 1.4)

### Floor insulation

The following notes illustrate ways of insulating a variety of floor construction types.

Concrete slab-on-ground floors generally do not require added insulation, unless the home is constructed in an area with a high water table or where in-slab heating is installed.

The first step in reducing heat loss through a timber floor is to enclose the under-floor space,

maintaining sufficient ventilation to satisfy local building requirements to prevent rotting. Next, where appropriate, provide a good underlay and carpet. If this is not possible, under-floor insulation may be necessary. Overall R values depend on the type of sub-floor (i.e. open or enclosed).

In some situations, insulation of timber or suspended slab floors may increase discomfort in summer. This can occur in regions where there is a significant hot summer season, as the opportunity for heat loss to the cool air or ground below the floor has been reduced with insulation. Therefore, it is wise to limit insulation of these floors.

### Suspended floors

#### *Suspended timber floor with reflective foil*

The use of perforated concertina-style reflective foil batts with a suspended timber floor is shown in figure 7.32. Perforated foil maintains a still layer of air under the floorboards, whilst allowing moisture to escape, preventing warping and deterioration of the flooring. The foil can be stapled between the floor joists (where concertina-style foil is used), or reflective foil laminate placed over the joists and dished between them, to provide a still air space, before the flooring is laid. The overall R value is at least 1.0.

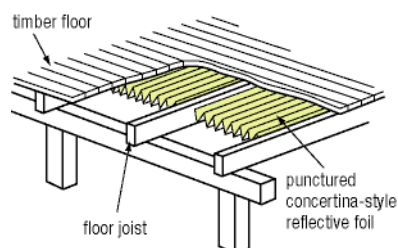


Figure 7.32: Suspended timber floor with perforated concertina-style reflective foil batts (overall R value 1.0)

#### *Suspended timber floor with bulk insulation between joists*

The use of bulk insulation between the joists of a suspended timber floor is shown in figure 7.33. Supporting mesh (non-degradable material, e.g. nylon, galvanised wire) should be laid under

the floor joists. Suitable materials for insulation are R1.0 batts or polystyrene boards. Boards can be attached to the underside of the joists using fixing spikes or long staples. The overall R value is at least 1.3.

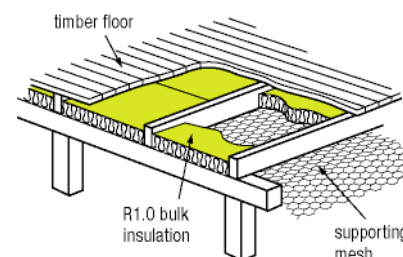


Figure 7.33: Suspended timber floor with bulk insulation between the joists and supporting mesh (overall R value at least 1.3)

#### *Suspended concrete slab with polystyrene board insulation*

The use of polystyrene boards below a suspended concrete slab is shown in figure 7.34. R1.0 expanded or extruded polystyrene boards are attached to the underside of the slab using retaining pins. Insulation is essential for heated suspended slabs. The overall R value is 1.2.

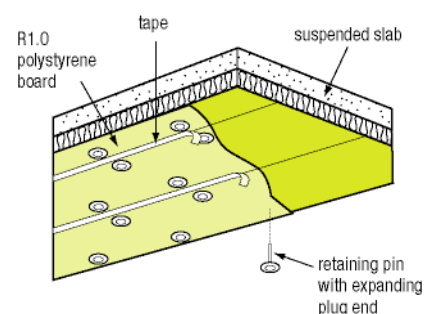


Figure 7.34: Suspended concrete slab with polystyrene board insulation (overall R value 1.2)

### Slab-on-ground floors

Edge insulation is recommended for a heated slab, or a slab-on-ground where the water table is high, as approximately 80% of heat loss from the slab occurs through the edge. For structural reasons it is not recommended that insulation be installed under concrete edge beams.

### *Heated concrete slab with edge insulation*

The use of edge insulation with a heated slab-on-ground floor is shown in figure 7.35. Insulation should be installed before the concrete is poured. Ensure that insulation forms a continuous barrier around the slab edge, with no gaps. In termite-prone areas, the slab edge needs to be visible for inspections. Contact manufacturers for specific installation details, especially with regard to placement of insulation in relation to the waterproof membrane. The only suitable materials, due to their waterproof qualities, are extruded and expanded polystyrene boards of R1.0 or higher. The overall R value is 2.2 in the insulated section only.

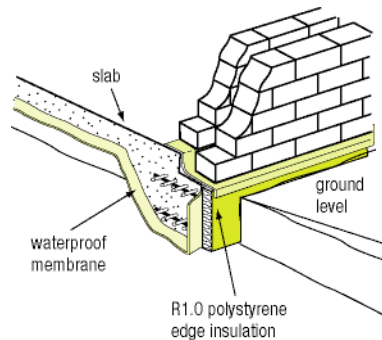


Figure 7.35: Heated concrete slab, insulated around the edge with extruded polystyrene (overall R value 2.2).