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R-values for Timber-framed Building Elements

WoodSolutions is an industry initiative designed to provide independent, non-proprietary information about timber and wood products to professionals and companies involved in building design and construction.

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Cover image courtesy of CSR Bradford

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Abbreviations

RFL Reflective Foil Laminate
TCRI Thermo-Cellular Reflective Insulation
BBM Breathable Building Membrane
BCA Building Code of Australia

Introduction

This publication provides authoritative estimates of the R-value of common building construction elements incorporating timber-framed construction. These may be required to satisfy minimum energy efficiency standards introduced by building regulatory authorities throughout Australia. The R-values have been calculated using two computer programs Rvalues5.for (walls and roof/ceilings) and FlorsU2.for (floors). These programs include an iterative calculation of the thermal resistance of all components, including air gaps and spaces, to produce accurate values for the assumed external and internal temperature conditions. The various assumptions inherent in the calculations are explained in this publication. It should be noted that any variation to these variables may result in a different R-value for the element.

The Building Code of Australia (BCA 2011) increased the energy efficiency requirements to a so called 6 Star energy rating or equivalent for new residential buildings, and as well introduces a significant increase in the energy efficiency provisions for all new commercial buildings. These changes have seen the need to increase the level of thermal insulation in all building elements. With this in mind, this edition (Edition 3.0) of the R-values for Timber-framed Building Elements builds upon the systems detailed in Version 2.1 and provides for higher levels of insulation.

Notes on the Calculation of R-values

The R-value of a building element is the TOTAL THERMAL RESISTANCE (RT) including surface thermal resistances between the air on either side of a building element. The total thermal resistance of a planar building element consisting of layers perpendicular to the heat flow is calculated using the expression:

$$RT = Rsi + R1 + R2 + \ldots\ldots + Rn + Rse$$

Where: RT is the total resistance;

Rsi is the internal surface resistance;

R1, R2, ...Rn are the thermal resistances of each layer, including bridged layers; and

Rse is the external surface resistance.

Surface resistance values adopted in the calculations are given in Table 1.

The thermal resistance of an element that is not continuous but is bridged by timber frames is determined by the method given in NZS 4214: Methods of determining the total thermal resistance of parts of buildings. The average of the parallel flow and isothermal planes methods is assumed.

The thermal resistance of an air space within a building element depends on the effective emissivity of the space as well as the mean temperature and the difference in temperatures either side of the space. It follows therefore that the calculation of the R-value of a building element containing air spaces depends on the conditions assumed externally and internally. Similarly, the conductivity of bulk insulation materials will vary with the temperature of the material. These factors are taken into account when determining the R-values given for both 'Heat Flow IN' and 'Heat Flow OUT' in this publication. The external conditions take into account the equivalent increase in the air temperature due to solar radiation on the element. This sol-air increment for walls has been calculated as the average of eight wall orientations and on a horizontal plane for a roof element. For Heat Flow IN conditions, this sol-air increment is the average for the location taken over daytime hours for the hottest six months of the year. The temperatures, temperature differences and mean temperatures used in the calculations are taken from AS/NZS 4859.1:

Heat flow out: Indoors 18°C, outdoors 12°C (6°K difference), mean 15°C

Heat flow in: Indoors 24°C, outdoors 36°C (12°K difference), mean 30°C

The R-values in this publication are intended to give a good indication of the overall performance of an element in Heat Flow IN and Heat Flow OUT situations. It is important to realise that the boundary conditions (temperature and solar radiation) and other factors used in the calculation of the R-values may differ with assumptions made in other sources of data.

Changes in Edition 3.0

Version 2.1 (2007) of R-values for timber-framed building elements is updated in line with assumptions in the BCA (2011) and Australian Standard AS 4859.1 Materials for the thermal insulation of buildings Part 1: General criteria and technical provisions (2006). In some cases, this process involved changes to the values used in the calculations and, consequently, the R-values in this new edition may differ slightly from earlier versions of the document.

The most significant assumptions that are different are discussed below.

Material properties, construction and other details

Standard values for the conductivity of common building materials included in the BCA are now used in the calculations. Table 4 gives the thermal conductivity of materials used in the calculations.

Standard assumptions taken from AS 4859.1, Appendix K are now used in the calculations. These include,

- framing sizes
- soil conductivity
- internal and external temperatures
- wind speed
- emissivities

Emissivity values used in the calculations are shown in Table 3.

Resistances of air films, attic spaces, air spaces

Air film and attic space resistances specified in the BCA and AS4859.1 are used in the calculations. Table 1 shows air film resistances and Table 2 shows attic space thermal resistance values.

The thermal resistance of air spaces is calculated by the method given in Robinson and Powlitch (1954).

The air film on the lower surface of the floor is assumed to be still.

Ventilation

Ventilation assumptions for roof/attic spaces are taken from AS 4859.1.

Tiled roofs, without reflective foil or blanket type insulation, are assumed to be naturally vented. Metal roofs and tiled roofs with reflective foil or blanket type insulation are assumed to non-vented. Wall cavities are assumed to be non-vented.

Calculation method for floors

The previous calculations were based on the CIBSE Guide (1986), while the new calculations are based on the method described in the International Standard ISO 13370 Thermal performance of buildings — Heat transfer via the ground — Calculation method. The calculation of the R-value takes into account the total resistance due to conduction, convection, radiation and ventilation. The computer program, FlorsU2.for performs the required calculations. Standard input parameters adopted in the calculations are shown in Table 5.

Table 1: Thermal Resistance of Air Films (m^2K/W)

	Position of Surface	Direction of Heat Flow	Surface Emissivity	
			High Emittance	Low Emittance
Still air	Horizontal	Up	0.11	0.23
		Down	0.16	0.80
	Sloping 45°	Up	0.11	0.24
		Down	0.13	0.39
	Sloping 22.5°	Up	0.11	0.24
		Down	0.15	0.60
	Vertical	Horizontal	0.12	0.30
Moving air	Any Orientation 3.0 m/s	Any	0.04	

Source: AS 4859.1 Materials for the thermal insulation of buildings

Note: Materials with e=0.05 or less are referred to as low emittance and those with e=0.9 are high emittance.

Table 2: Thermal Resistance of Attic Spaces (m^2K/W)

Roof Space Type	Direction of Heat Flow	Surface Emissivity	
		High emittance	Low emittance surface
Non-ventilated	Up (winter) Down (summer	0.18 0.28	0.56 1.09
Natural ventilation	Up (Winter) Down (Summer	0.00 0.46	0.34 1.36

Source: AS 4859.1 Materials for the thermal insulation of buildings

Table 3: Emissivity of Materials

Material	Emissivity
Aluminum reflective foil	
No dust cover	0.03
Slight dust cover	0.03+0.05
Moderate dust cover	0.03+0.25
Aluminum foil with anti-glare treatment, building wrap (upper surface)	0.20
Breathable building membrane	0.5
Common building materials	0.90

Source: AS 4859.1 Materials for the thermal insulation of buildings

Note: Materials with e=0.05 or less are referred to as low emittance and those with e=0.9 are high emittance.

Table 4: Thermal Conductivity of Materials

Material	Material Density (kg/m^3)	Thermal Conductivity (W/m.K)
Aluminium roof sheeting	2680	210
Carpet + underlay		0.05
Cellulose fibre – loose fill (with fire retardant)		0.04
Ceramic tiles[1]		1.136
Brickwork – extruded[2]	1580	0.61
Brickwork – pressed[2]	2120	1.03
Autoclaved aerated concrete	650	0.13
Concrete or terracotta tiles	1922	0.81
Solid concrete	2400	1.44
Dense hollow concrete block, 90 mm	1650	0.75
Fibre cement sheet	1360	0.25
Glassfibre – batts[1]	12	0.044
Gypsum plasterboard	880	0.17
Lightweight concrete block:		
140 mm	1050	0.67
90mm	1360	0.55
Linoleum[1]	1300	0.22
Particle board	640	0.12
Plywood	530	0.14
Polystyrene – expanded[1]		0.039
Polystyrene – extruded[1]		0.028
Rockwool – batts[1]		0.033
Rockwool – loose fill[1]		0.040
Steel sheeting	7850	47.5
Timber framing – Kiln dried hardwood across grain	677	0.16
Timber framing – Radiata pine across grain	506	0.10
Vinyl floor tiles	2050	0.79
Weatherboards – softwood	506	0.10

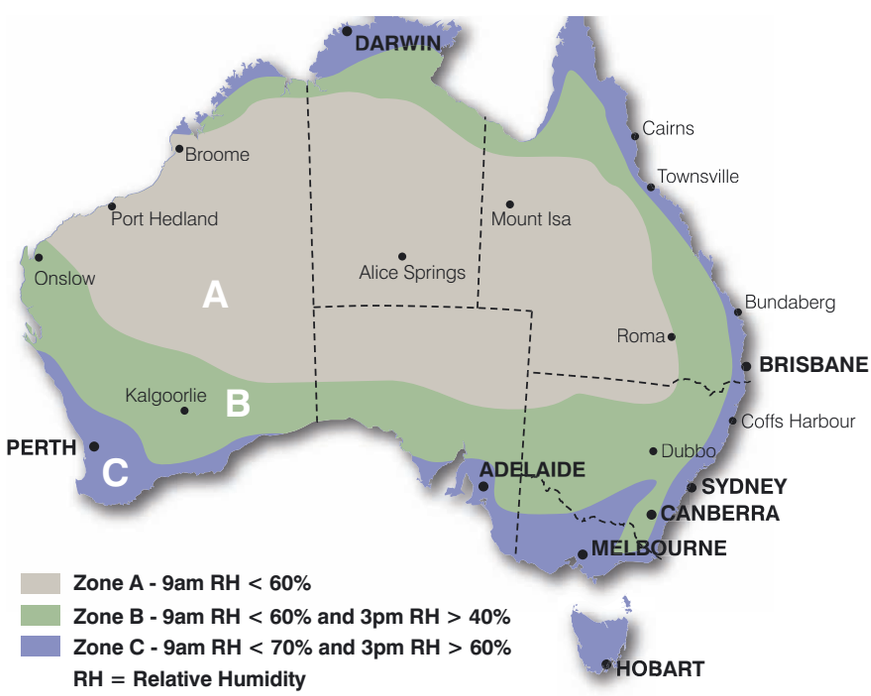
[1]Source: CSIRO (2006) AccuRate Material Properties. Melbourne: Commonwealth Scientific and Industrial Research Organisation.
[2]Source: AIRAH (2000) Handbook: Millennium Edition. Melbourne: The Australian Institute of Refrigeration, Air-Conditioning and Heating.
Note: Values for materials are from BCA (2011) unless noted.
Conductivity values given in this table are generally measured at 23°C. The conductivity of bulk insulation materials is varied as a function of the temperature of the material in accordance with AS 4859.1 Materials for the thermal insulation of buildings, Figure 2.

Table 5: Standard Values Assumed in Suspended Floor Calculations

Variable	Assumed Standard Value		
Soil - Clay **Density** **Thermal conductivity**	 1300 kg/m^3 1.5 W/m.K		
Wind speed (10 m height)	3.0 m/s		
Sub-floor ventilation **Enclosed spaces*** In accordance with BCA Part 3.4.1 and Table 3.4.1.2 (Figure 1 reproduced from BCA)	**Climatic Zone**		
	Zone A 2000 mm^2/m	Zone B 4000 mm^2/m	Zone C 6000 mm^2/m

** Enclosed sub-floor ventilation rates can be reduced if an impervious membrane is used to cover the ground (see BCA, Table 3.4.1.2)*

Figure 1: Sub-floor Climatic Zones



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Cavity Disconnected Detail

The thermal performance of timber floors in brick veneer construction can be dramatically improved by eliminating the cavity airflow path at either the roof level or floor level.

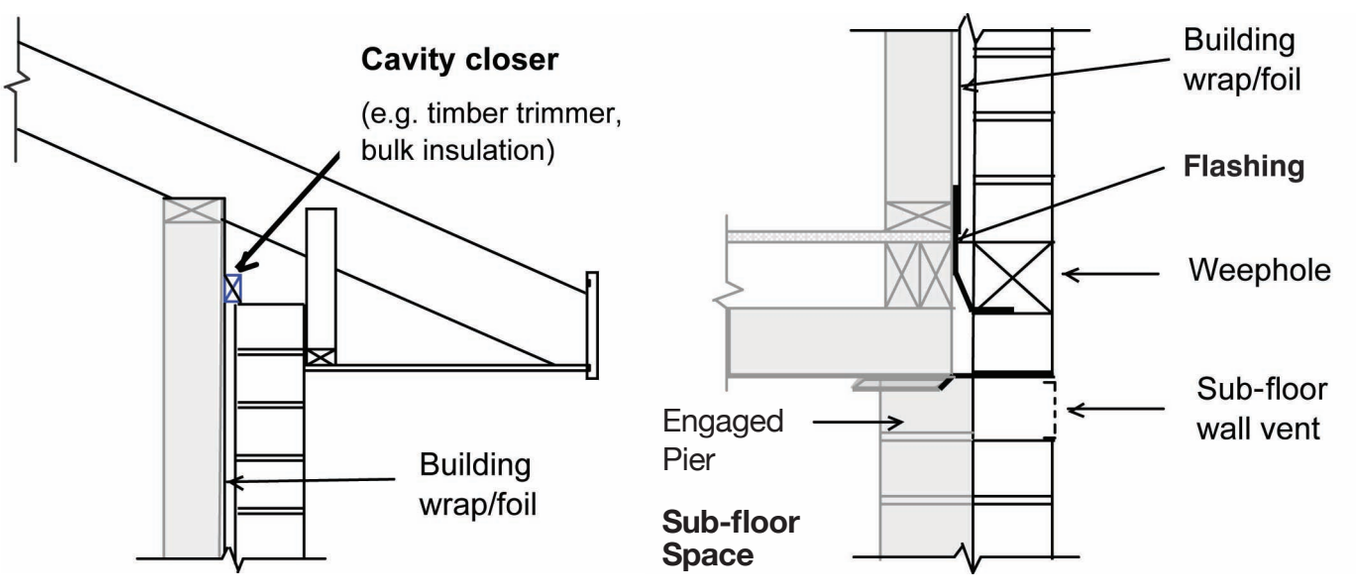
A 'flashing' across the wall cavity controls the airflow between the roof space and sub-floor, effectively disconnecting the roof space from the sub-floor space.

This change will directly improve the energy performance of a design with an enclosed sub-floor.

Make the change in either the roof (Option 1) or sub-floor area (Option 2) by taking a flashing from the brickwork to the top or bottom-plate. With the bottom-plate option you will need to insert weep holes for removing condensation – as with slab-on-ground construction.

If flashed at roof level, fold over and secure foil across the cavity gap at the top of the brickwork or fit a timber trimmer or bulk insulation across the cavity. This detail is especially effective when improving the thermal performance of an alteration or addition.

Figure 2 – Cavity Disconnection Options



Option 1 **Option 2**

Things to Consider

• The operating thickness of insulation to achieved its stated R-value varies according to a number of factors, including the type of insulation material, its density and how it is packaged. Insulation should not be compressed so that a manufacturer's specified thickness is reduced. In all cases the manufacturer's specifications should be followed. As a guide, Table 6 gives an idea of expected thickness of insulation to achieve its R-value.

Table 6: Indicative Thickness of Insulation Products to Achieve Stated R-value

Material	R-value	Thickness
Glasswool		
Ceiling Batts	R2.0	115 mm
	R3.0	165 mm
	R4.0	215 mm
	R5.0	210 mm
	R6.0	260 mm
Wall Batts	R2.0	75 mm
	R2.5	90 mm
Rockwool		
Wall batts	R2.0	75 mm
	R2.5	88 mm
	R3.0	120 mm
Polyester		
Roof batts	R2.0	90 mm
	R2.5	160 mm
	R3.0	175 mm
	R4.0	220 mm
	R4.5	225 mm
Thermal & sound wall batts	R1.5	70 mm
	R2.0	90 mm

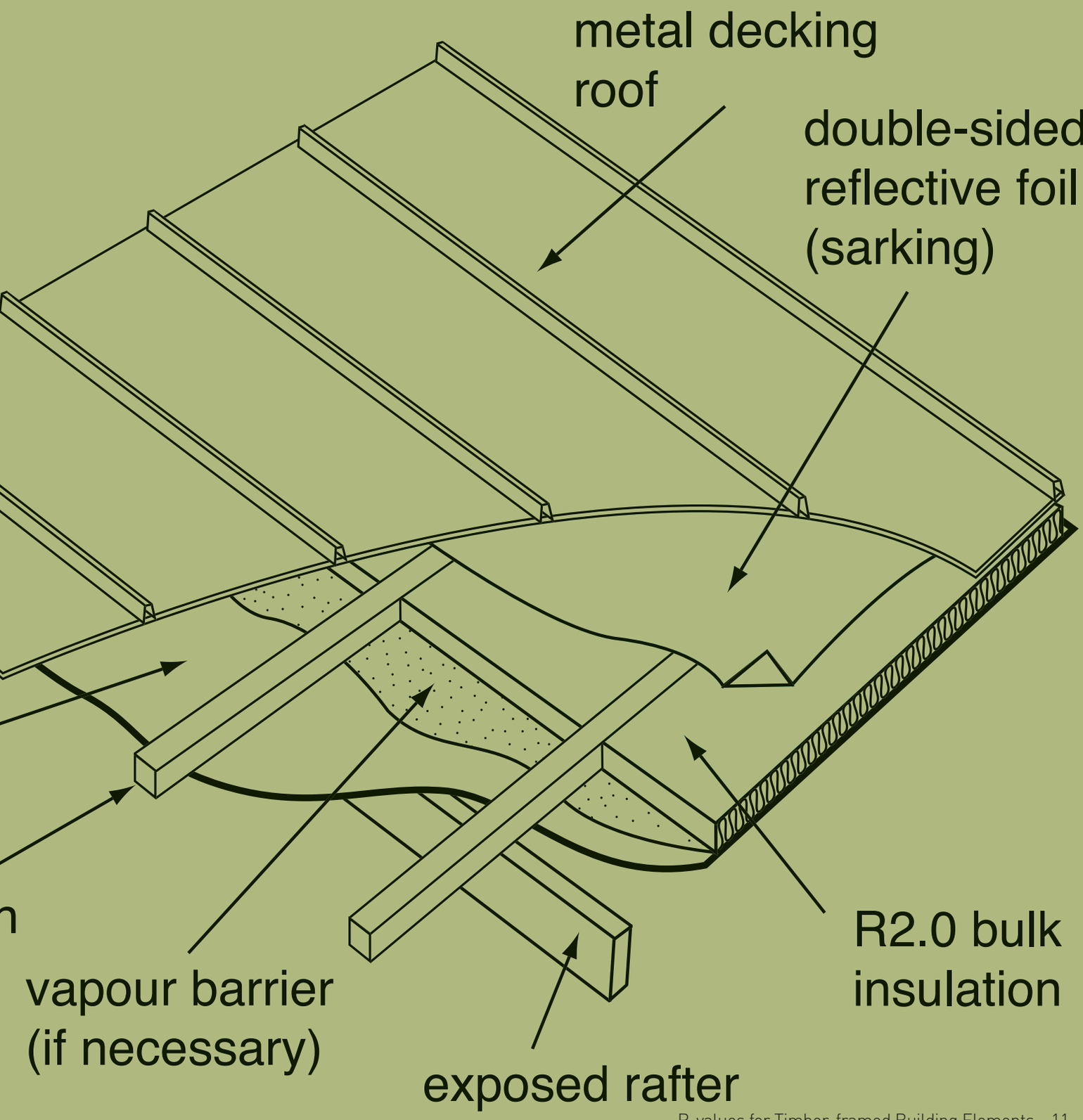
• Bulk thermal insulation may present a high hazard if it contacts potentially hot components (e.g. hot gas flue, recessed downlights) or impairs adequate air circulation around these components. Minimum clearances between the component and the insulation should be maintained as specified by the BCA or relevant Australian Standard.

• The loss of insulation due to safety clearances around flues and recessed downlights or the presence of exhaust fans must be compensated for by increasing the minimum R-value of insulation in accordance with BCA requirements.

• In certain circumstances condensation may form within a construction element. This should be carefully checked according to the location and operation of the proposed building and if necessary a vapour barrier included at an appropriate position within the element. See the BCA Condensation Handbook for more information.

Pitched Roofs

Flat Ceilings and Raked Ceilings



Explanation of Tables

For roof/ceiling elements the R-values are presented for the two directions of heat flow, **DOWN** and **UP**.

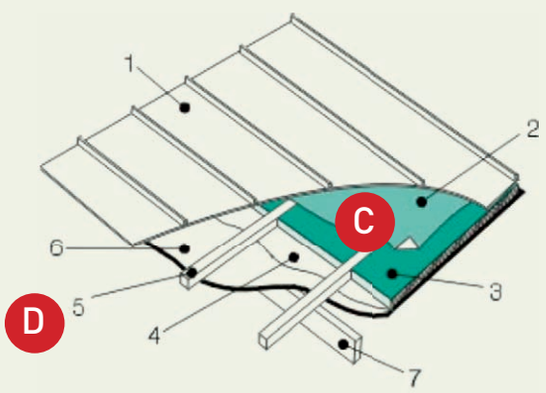
A Heat flow **DOWN** means the heat flows **into** the internal spaces of the building.

B Heat flow **UP** means the heat flows **from** the internal spaces of the building.

C RFL (2) may be corrugated or sheets fixed to joists

D Batten size (5) to be appropriate for the depth of insulation being used – refer to page 10.

R8. Metal Roof, Ceilings with Exposed Rafters, Bulk Insulation &RFL

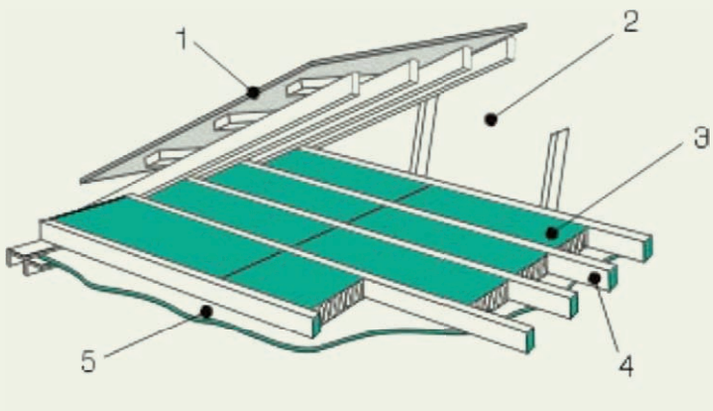


1. Metal decking
2. RFL
3. Bulk Insulation
4. Vapour barrier
5. Timber batten
6. Ceiling lining
7. Exposed rafter

Slope: 15° to 35°

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	A Heat flow DOWN (Hot weather)	B Heat flow UP (Cold weather)
R3.0 bulk insulation	2.9	3.1
R3.5 bulk insulation	3.3	3.5
R4.0 bulk insulation	3.7	3.9
R4.5 bulk insulation	4.0	4.3
R5.0 bulk insulation	4.4	4.6
R6.0 bulk insulation	5.0	5.3

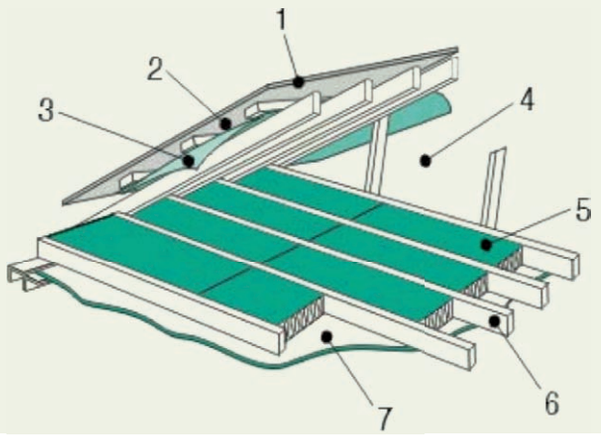
R1. Pitched Roof, Flat Ceiling, (without and with) Bulk Insulation Between Joists



1. Roof cladding
2. Attic space (non-reflective)
3. Bulk insulation
4. Timber ceiling joists
5. 10 mm Plasterboard

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
No bulk insulation		
Tiles	0.8	0.4
Metal	0.6	0.4
R3.0 bulk insulation		
Tiles	3.4	3.3
Metal	3.2	3.3
R3.5 bulk insulation		
Tiles	3.8	3.7
Metal	3.6	3.7
R4.0 bulk insulation		
Tiles	4.1	4.1
Metal	4.0	4.1
R4.5 bulk insulation		
Tiles	4.5	4.5
Metal	4.3	4.5
R5.0 bulk insulation		
Tiles	4.9	4.9
Metal	4.7	4.9
R6.0 bulk insulation		
Tiles	5.5	5.6
Metal	5.4	5.6

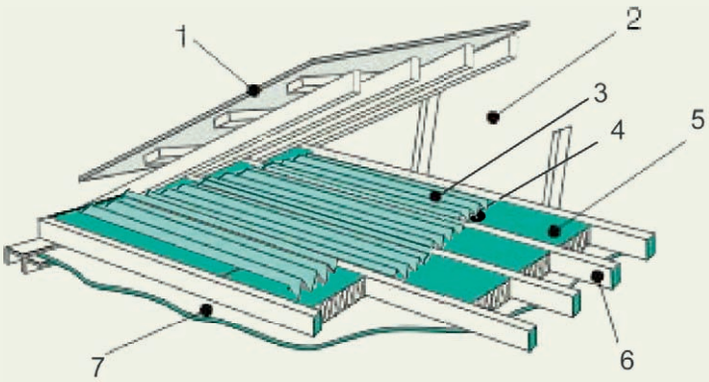
R2. Pitched Roof, Reflective Foil Laminate (RFL), Flat Ceiling, (without and with) Bulk Insulation Between Joists



1. Roof cladding
2. Airspace (non-reflective)
3. RFL
4. Attic space (reflective)
5. Bulk insulation
6. Timber ceiling joists
7. 10 mm Plasterboard

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
No bulk insulation		
Tiles	1.9	1.2
Metal	1.8	1.2
R3.0 bulk insulation		
Tiles	4.5	4.2
Metal	4.4	4.2
R3.5 bulk insulation		
Tiles	4.9	4.6
Metal	4.8	4.6
R4.0 bulk insulation		
Tiles	5.3	5.0
Metal	5.2	5.0
R4.5 bulk insulation		
Tiles	5.7	5.5
Metal	5.6	5.5
R5.0 bulk insulation		
Tiles	6.1	5.9
Metal	6.0	5.9
R6.0 bulk insulation		
Tiles	6.8	6.7
Metal	6.7	6.6

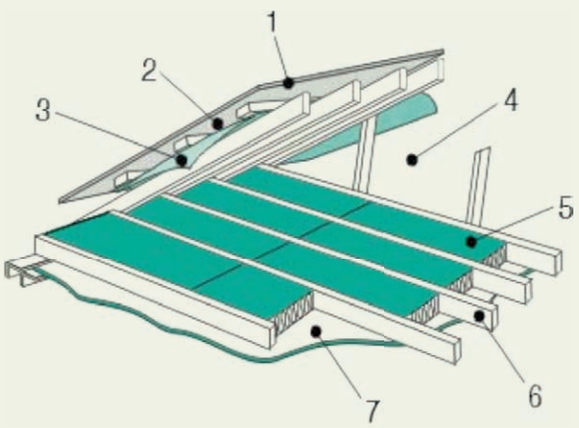
R3. Pitched Roof, Flat Ceiling, Bulk Insulation Between Joists, Concertina RFL on Top of Bulk Insulation



1. Roof cladding
2. Attic space (semi-reflective)
3. Concertina RFL
4. Air space (reflective)
5. Bulk insulation
6. Timber ceiling joists
7. 10mm Plasterboard

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
R3.0 bulk insulation		
Tiles	4.2	3.9
Metal	4.1	3.9
R3.5 bulk insulation		
Tiles	4.6	4.4
Metal	4.4	4.4
R4.0 bulk insulation		
Tiles	5.0	4.8
Metal	4.8	4.8
R4.5 bulk insulation		
Tiles	5.4	5.2
Metal	5.2	5.2
R5.0 bulk insulation		
Tiles	5.7	5.6
Metal	5.6	5.6
R6.0 bulk insulation		
Tiles	6.4	6.4
Metal	6.3	6.4

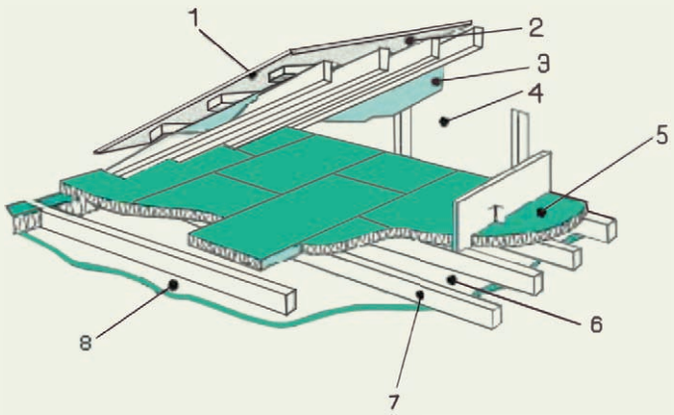
R4. Pitched Roof, Thermo-Cellular Reflective Insulation, Flat Ceiling, (without and with) Bulk Insulation Between Joists



1. Roof cladding
2. Airspace (non-reflective)
3. Thermo-cellular reflective insulation
4. Attic space (reflective)
5. Bulk insulation
6. Timber ceiling joists
7. 10 mm Plasterboard

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
No bulk insulation		
Tiles	2.1	1.4
Metal	2.0	1.3
R3.0 bulk insulation		
Tiles	4.6	4.3
Metal	4.6	4.2
R3.5 bulk insulation		
Tiles	5.0	4.7
Metal	5.0	4.7
R4.0 bulk insulation		
Tiles	5.4	5.1
Metal	5.3	5.1
R4.5 bulk insulation		
Tiles	5.7	5.5
Metal	5.7	5.5
R5.0 bulk insulation		
Tiles	6.1	5.9
Metal	6.1	5.9
R6.0 bulk insulation		
Tiles	6.8	6.7
Metal	6.8	6.7

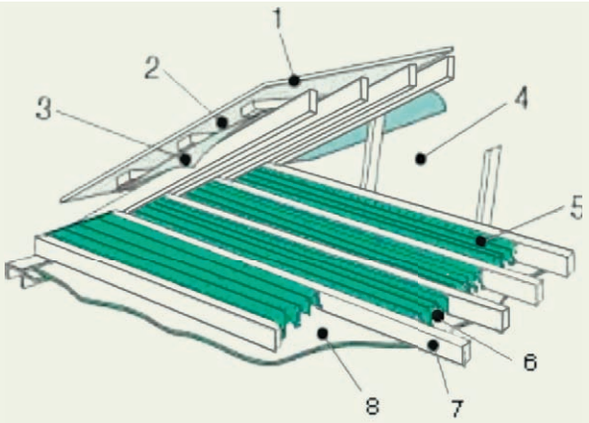
R5. Pitched Roof, Flat Ceiling, Rigid Bulk Insulation over Joists



1. Roof cladding
2. Airspace (non-reflective)
3. RFL
4. Attic space (reflective)
5. Bulk insulation
6. Airspace (non-reflective)
7. Timber ceiling joists
8. 10 mm Plasterboard

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
R3.0 bulk insulation		
Tiles	5.0	4.5
Metal	5.0	4.5
R3.5 bulk insulation		
Tiles	5.5	5.1
Metal	5.5	5.1
R4.0 bulk insulation		
Tiles	6.0	5.6
Metal	6.0	5.6
R4.5 bulk insulation		
Tiles	6.5	6.1
Metal	6.5	6.1
R5.0 bulk insulation		
Tiles	7.0	6.6
Metal	7.0	6.6
R6.0 bulk insulation		
Tiles	8.0	7.7
Metal	8.0	7.7

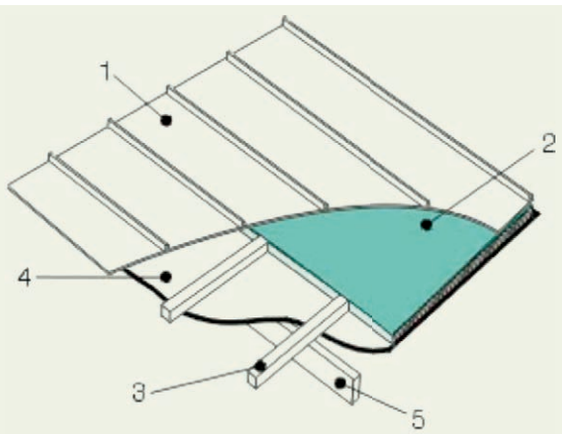
R6. Pitched Roof, Flat Ceiling, Concertina Rfl Between Joists



1. Roof cladding
2. Airspace (non-reflective)
3. RFL
4. Attic space (reflective)
5. Concertina RFL
6. Airspace (reflective)
7. Timber ceiling joists
8. 10 mm Plasterboard

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
One layer of foil batts		
Tiles	3.0	1.8
Metal	2.9	1.7
Two layers foil batts at right angles		
Tiles	4.1	2.4
Metal	4.1	2.3

R7. Metal Roof, Ceilings with Exposed Rafters, Foil-Backed Blanket or Thermo-Cellular Reflective Insulation



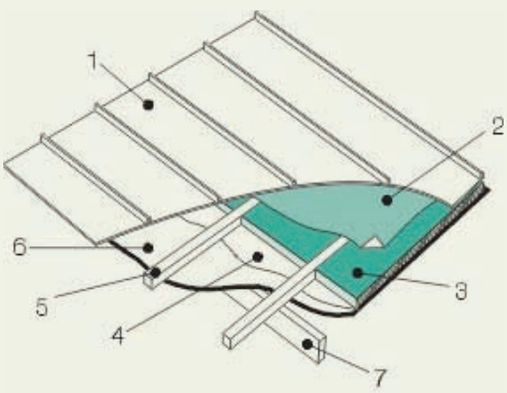
1. Metal decking
2. Foil-backed blanket or thermo-cellular reflective insulation (TCRI) (reflective foil DOWN)
3. Timber battens*
4. Plasterboard
5. Exposed rafter

Slope: 15° to 35°

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
TCRI	1.2	0.9
R2.0 insulating blanket	2.1	2.3
R2.5 insulating blanket	2.6	2.7
R3.0 insulating blanket	3.0	3.2

* Batten size to be appropriate for the depth of insulation being used – refer **Things to Consider** (page 10).

R8. Metal Roof, Ceilings with Exposed Rafters, Bulk Insulation and RFL



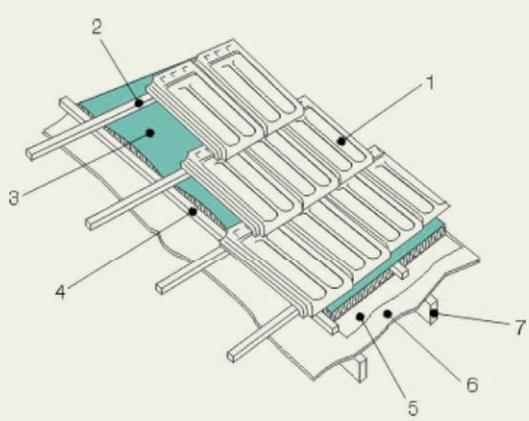
1. Metal decking
2. RFL
3. Bulk Insulation
4. Vapour barrier
5. Timber batten
6. Ceiling lining
7. Exposed rafter

Slope: 15° to 35°

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
R3.0 bulk insulation	2.9	3.1
R3.5 bulk insulation	3.3	3.5
R4.0 bulk insulation	3.7	3.9
R4.5 bulk insulation	4.0	4.3
R5.0 bulk insulation	4.4	4.6
R6.0 bulk insulation	5.0	5.3

* Batten size to be appropriate for the depth of insulation being used –refer **Things to Consider** (page 10).

R9. Tiled Roof, Ceilings with Exposed Rafters, Bulk Insulation



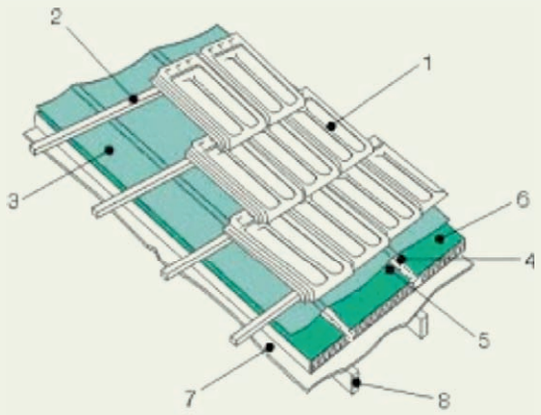
1. Tiles
2. Timber tile battens
3. RFL
4. Bulk insulation
5. Counter battens
6. Breathable building membrane
7. Plasterboard
8. Exposed rafter

Slope: 15° to 35°

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
R3.0 bulk insulation	3.0	3.2
R3.5 bulk insulation	3.4	3.7
R4.0 bulk insulation	3.7	3.9
R4.5 bulk insulation	4.0	4.3
R5.0 bulk insulation	4.5	4.8
R6.0 bulk insulation	5.1	5.5

* Batten size to be appropriate for the depth of insulation being used – refer **Things to Consider** (page 10).

R10. Tiled Roof, Ceilings with Exposed Rafters, Foil-Backed Polystyrene Board Insulation



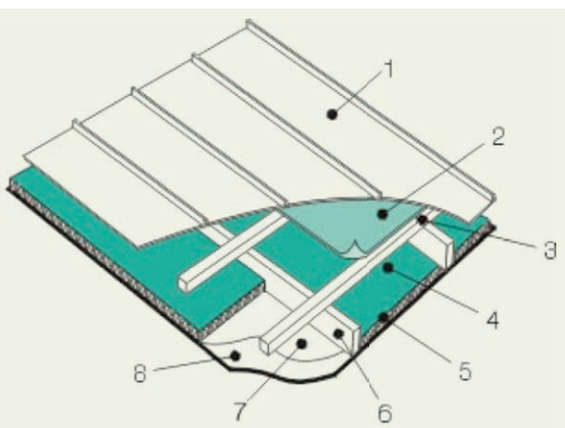
1. Tiles
2. Timber tile battens
3. Airspace (non-reflective)
4. RFL
5. Counter battens*
6. Reflective airspace
7. Polystyrene board
8. 10 mm Plasterboard
9. Exposed rafter

Slope: 15° to 35°

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
Expanded polystyrene		
7 5mm	3.4	3.1
100 mm	3.9	3.7
Extruded polystyrene		
75 mm	4.0	3.7
100 mm	4.7	4.4

* Counter batten size to be appropriate for the depth of insulation being used – refer **Things to Consider** (page 10).

R11. Metal Roof, Raked Ceiling with Concealed Rafter, RFL, (without and with) Bulk Insulation



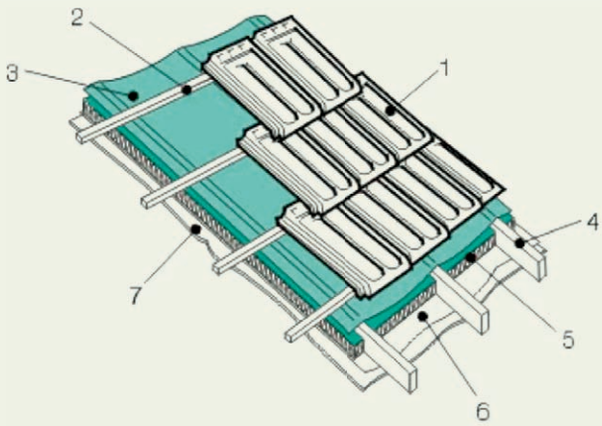
1. Metal roofing
2.RFL
3. Timber roofing batten
4. Airspace (Reflective)
5. Bulk insulation
6. Timber rafter*
7. Vapour barrier
8. 10 mm Plasterboard

Slope: 15° to 35°

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
No bulk insulation	1.5	1.3
R3.0 bulk insulation	4.1	4.1
R3.5 bulk insulation	4.5	4.6
R4.0 bulk insulation	5.0	5.2
R4.5 bulk insulation	5.6	5.8
R5.0 bulk insulation	6.0	6.3
R6.0 bulk insulation	6.8	7.1

* Rafter size to be appropriate for the depth of insulation being used – refer **Things to Consider** (page 10).

R12. Tile Roof, Raked Ceiling with Concealed Rafter, Bulk Insulation



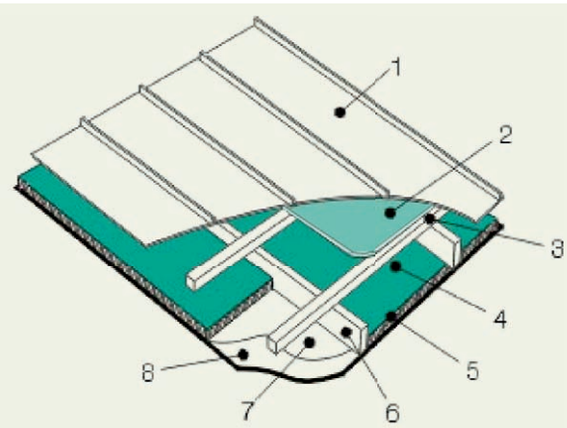
1. Tiles
2. Timber tile batten
3. RFL
4. Timber rafter*
5. Bulk insulation
6. Vapour barrier
7. 10 mm Plasterboard

Slope: 15° to 35°

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
R3.0 bulk insulation	3.7	3.9
R3.5 bulk insulation	4.1	4.3
R4.0 bulk insulation	4.7	4.9
R4.5 bulk insulation	5.1	5.4
R5.0 bulk insulation	5.6	5.9
R6.0 bulk insulation	6.3	6.8

* Rafter size to be appropriate for the depth of insulation being used – refer **Things to Consider** (page 10).

R13. Metal Roof, Raked Ceiling With Concealed Rafter, Thermo-Cellular Reflective Insulation, (Without And With) Bulk Insulation



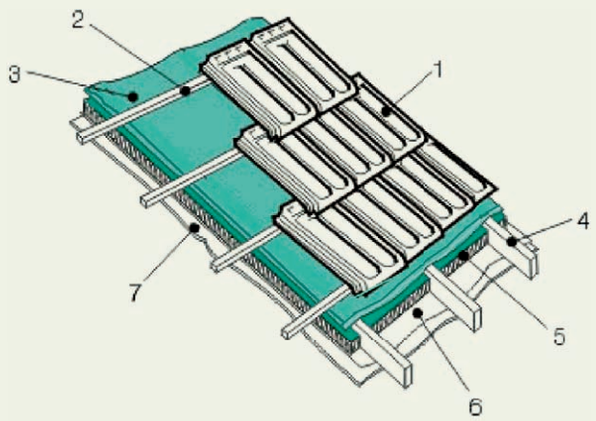
1. Metal roofing
2. Thermo-cellular reflective insulation
3. Timber roofing batten
4. 35 mm Airspace (Reflective)
5. Bulk insulation
6. Timber rafter
7. Vapour barrier
8. 10 mm Plasterboard

Slope: 15° to 35°

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
No bulk insulation	1.3	1.0
R3.0 bulk insulation	4.2	4.2
R3.5 bulk insulation	4.6	4.7
R4.0 bulk insulation	4.9	5.0
R4.5 bulk insulation	5.4	5.6
R5.0 bulk insulation	5.8	6.0
R6.0 bulk insulation	6.7	6.9

* Rafter size to be appropriate for the depth of insulation being used – refer **Things to Consider** (page 10).

R14. Tile Roof, Raked Ceiling with Concealed Rafter, Thermo-Cellular Reflective Insulation, (without and with) Bulk Insulation



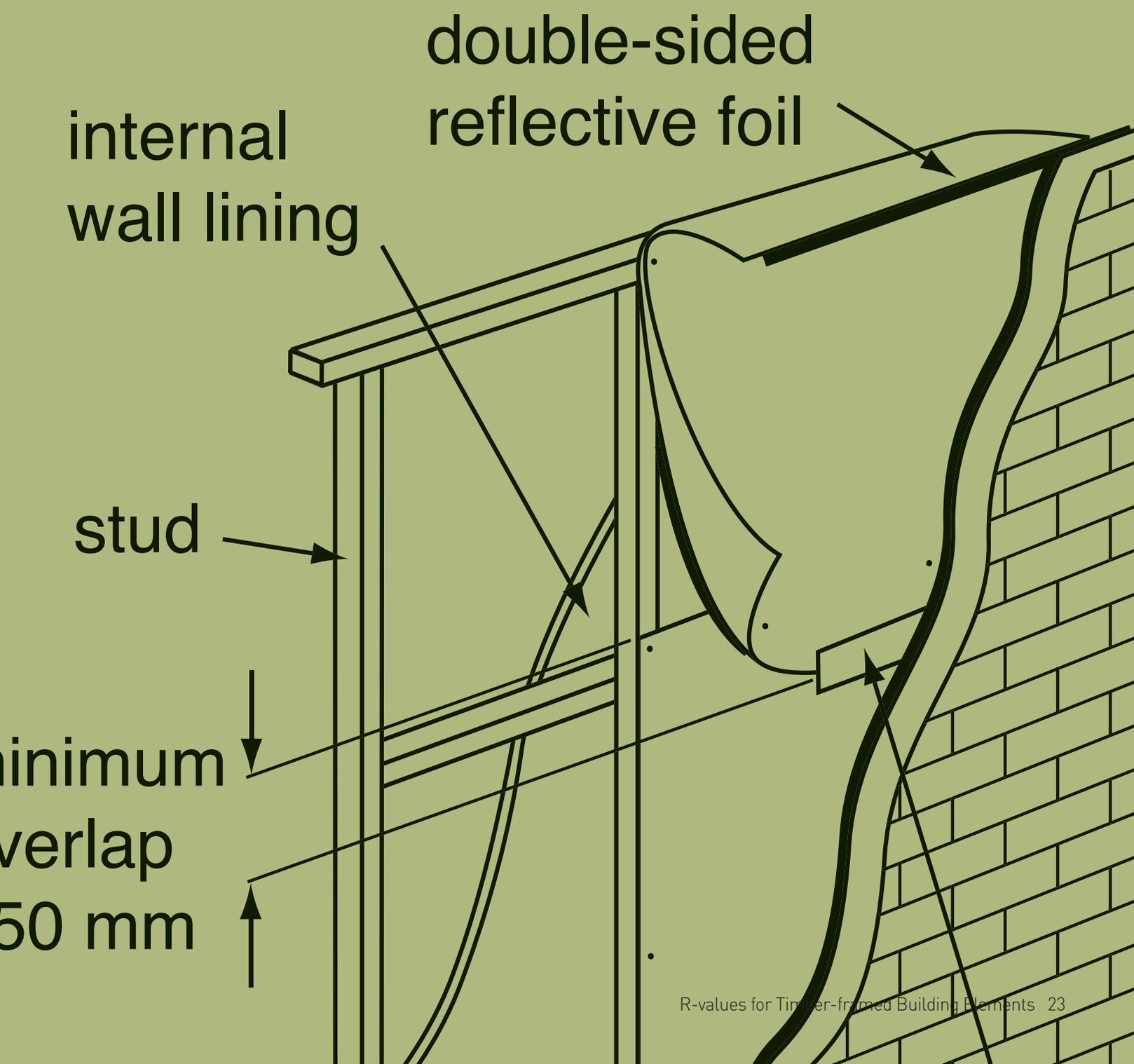
1. Tiles
2. Timber tile batten
3 Thermo-cellular reflective insulation
4. Timber rafter
5. Bulk insulation
6. Vapour barrier
7. 10 mm Plasterboard

Slope: 15° to 35°

Insulation Type	Total R-value for roof/ceiling (m^2K/W)	
	Heat flow DOWN	Heat flow UP
No bulk insulation	1.8	1.5
R3.0 bulk insulation	4.6	4.5
R3.5 bulk insulation	5.0	5.1
R4.0 bulk insulation	5.5	5.6
R4.5 bulk insulation	6.0	6.1
R5.0 bulk insulation	6.4	6.5
R6.0 bulk insulation	7.2	7.4

* Rafter size to be appropriate for the depth of insulation being used – refer **Things to Consider** (page 10).

Timber Framed Walls



Explanation of Tables

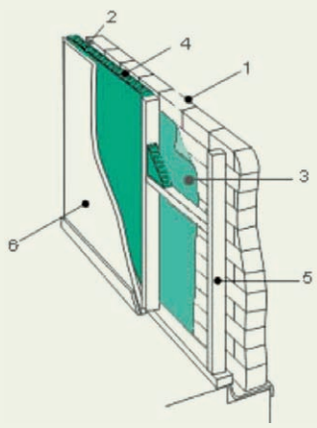
For wall elements the R-values are presented for the two directions of heat flow, **IN** and **OUT**.

A Heat flow **IN** means the heat flows **into** the internal spaces of the building (in hot weather).

B Heat flow **OUT** means the heat flows **from** the internal spaces of the building (in cold weather).

Cavities are presumed to be non-vented as per AS4859.1.

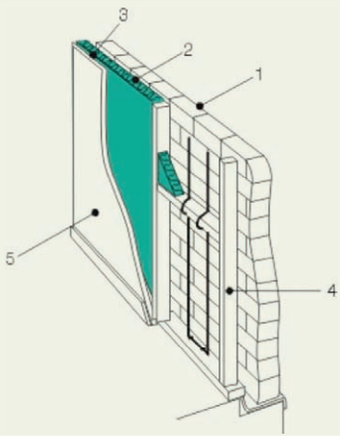
W5. Timber-framed Walls, Brick or Block Cladding, Breathable Building Membrane, R1.5 Bulk Insulation Between Studs



1. External cladding
2. Air space (non-reflective)
3. Breathable building membrane
4. R1.5 Bulk Insulation
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	A Heat flow DOWN (Hot weather)	B Heat flow UP (Cold weather)
Clay brick 110 mm		
70 mm framing	2.0	2.2
90 mm framing	2.0	2.2
Concrete brick 90 mm		
70 mm framing	2.0	2.1
90 mm framing	2.0	2.1
Aerated concrete block		
70 mm framing	2.6	2.7
90 mm framing	2.7	2.8

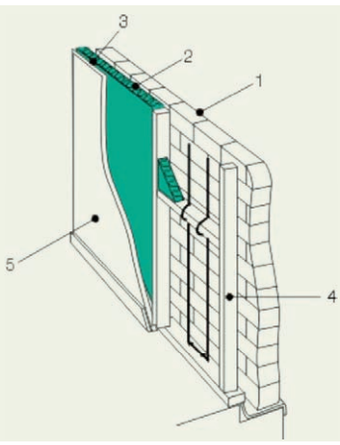
W1. Timber Framed Walls, Brick or Block Cladding, R1.5 Bulk Insulation Between Studs



1. External cladding
2. Air space (non-reflective)
3. R1.5 Bulk Insulation
4. Timber studs
5. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
70 mm framing	1.9	2.1
90 mm framing	2.0	2.1
Concrete brick 90 mm		
70 mm framing	1.9	2.0
90 mm framing	1.9	2.0
Aerated concrete block		
70 mm framing	2.5	2.7
90 mm framing	2.6	2.7

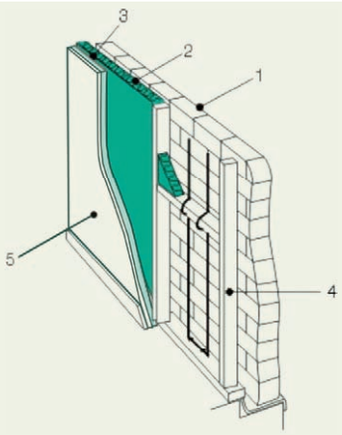
W2. Timber Framed Walls, Brick Or Block Cladding, R2.0 Bulk Insulation Between Studs



1. External cladding
2. Air space (non-reflective)
3. R2.0 Bulk Insulation
4. Timber studs
5. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
70 mm framing	2.3	2.5
90 mm framing	2.4	2.6
Concrete brick 90 mm		
70 mm framing	2.3	2.4
90 mm framing	2.3	2.5
Aerated concrete block		
70 mm framing	3.0	3.1
90 mm framing	3.0	3.1

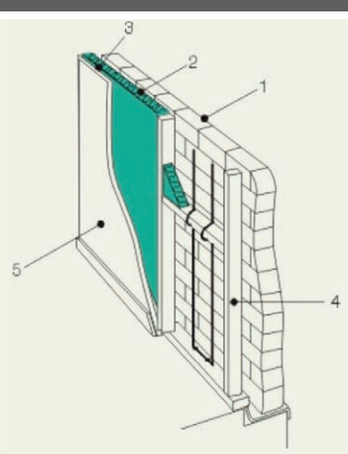
W3. Timber Framed Walls, Brick or Block Cladding, R2.0 Bulk Insulation Between Studs, Insulated Plasterboard



1. External cladding
2. Air space (non-reflective)
3. R2.0 Bulk Insulation
4. Timber studs
5. Insulated Plasterboard 35 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
70 mm framing	3.4	3.6
90 mm framing	3.5	3.7
Concrete brick 90 mm		
70 mm framing	3.4	3.6
90 mm framing	3.4	3.6
Aerated concrete block		
70 mm framing	4.0	4.2
90 mm framing	4.1	4.2

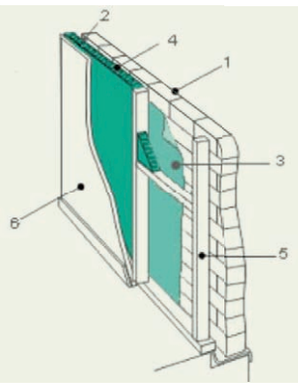
W4. Timber-framed Walls, Brick Or Block Cladding, R2.5 Bulk Insulation Between Studs



1. External cladding
2. Air space (non-reflective)
3. R2.5 Bulk Insulation
4. Timber studs
5. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
90 mm framing	2.8	3.0
Concrete brick 90 mm		
90 mm framing	2.7	2.9
Aerated concrete block		
90 mm framing	3.4	3.6

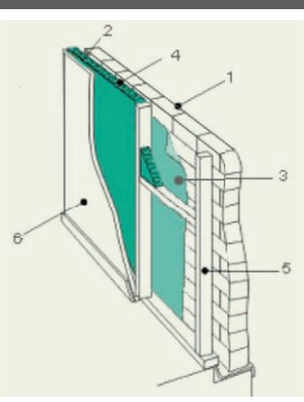
W5. Timber-framed Walls, Brick or Block Cladding, Breathable Building Membrane, R1.5 Bulk Insulation Between Studs



1. External cladding
2. Air space (non-reflective)
3. Breathable building membrane
4. R1.5 Bulk Insulation
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
70 mm framing	2.0	2.2
90 mm framing	2.0	2.2
Concrete brick 90 mm		
70 mm framing	2.0	2.1
90 mm framing	2.0	2.1
Aerated concrete block		
70 mm framing	2.6	2.7
90 mm framing	2.7	2.8

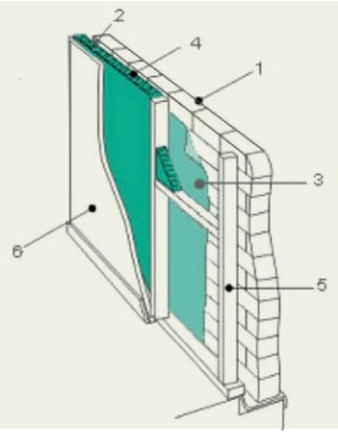
W6. Timber-framed Walls, Brick or Block Cladding, Breathable Building Membrane, R2.0 Bulk Insulation Between Studs



1. External cladding
2. Air space (non-reflective)
3. Breathable building membrane
4. R2.0 Bulk Insulation
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
70 mm framing	2.6	2.8
90 mm framing	2.6	2.8
Concrete brick 90 mm		
70 mm framing	2.5	2.7
90 mm framing	2.6	2.8
Aerated concrete block		
70 mm framing	3.2	3.4
90 mm framing	3.2	3.4

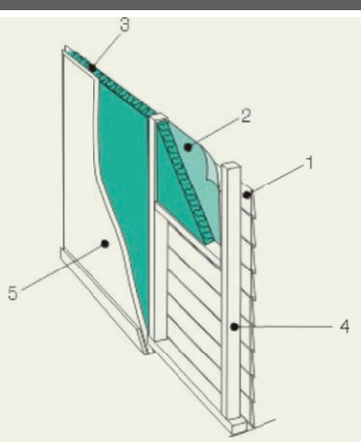
W7. Timber-framed Walls, Brick or Block Cladding, Breathable Building Membrane, R2.5 Bulk Insulation Between Studs



1. External cladding
2. Air space (non-reflective)
3. Breathable building membrane
4. R2.5 Bulk Insulation
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
90 mm framing	3.0	3.3
Concrete brick 90 mm		
90 mm framing	3.0	3.2
Aerated concrete block		
90 mm framing	3.7	3.9

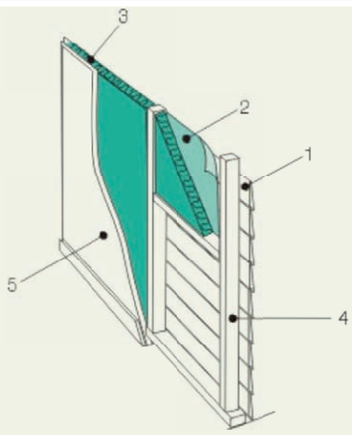
W8. Timber-framed Walls, Weatherboard, Plywood or Fibre-Cement Cladding, R1.5 Bulk Insulation



1. External cladding
2. Breathable building membrane
3. R1.5 Bulk Insulation
4. Timber Studs
5. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
70 mm framing	2.1	2.1
90 mm framing	2.2	2.3
Plywood cladding		
70 mm framing	2.0	2.0
90 mm framing	2.1	2.2
Fibre-cement cladding		
70 mm framing	1.9	2.0
90 mm framing	2.0	2.1

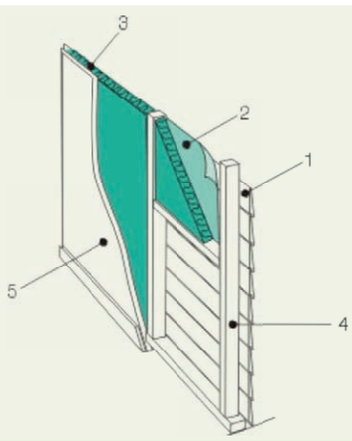
W9. Timber Framed Walls, Weatherboard, Plywood or Fibre-Cement Cladding, R2.0 Bulk Insulation



1. External cladding
2. Breathable building membrane
3. R1.5 Bulk Insulation
4. Timber Studs
5. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
70 mm framing	2.2	2.3
90 mm framing	2.2	2.4
Plywood cladding		
70 mm framing	2.1	2.2
90 mm framing	2.1	2.3
Fibre-cement cladding		
70 mm framing	2.0	2.1
90 mm framing	2.0	2.2

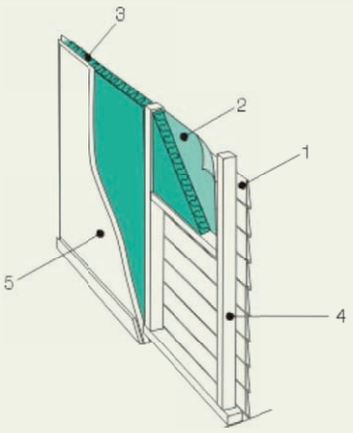
W10. Timber Framed Walls, Weatherboard, Plywood or Fibre-Cement Cladding, R2.5 Bulk Insulation



1. External cladding
2. Breathable building membrane
3. R2.5 Bulk Insulation
4. Timber Studs
5. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
90 mm framing	2.6	2.8
Plywood cladding		
90 mm framing	2.5	2.7
Fibre-cement cladding		
90 mm framing	2.4	2.6

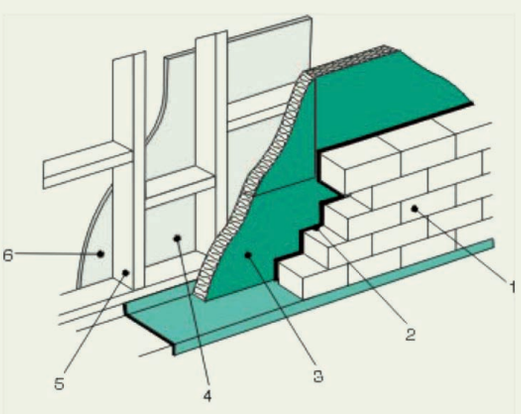
W11. Timber-framed Walls, Weatherboard, Plywood or Fibre-Cement Cladding, R3.2 Bulk Insulation



1. External cladding
2. Breathable building membrane
3. R3.2 Bulk Insulation
4. Timber Studs 120 mm
5. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
120 mm framing	3.3	3.4
Plywood cladding		
120 mm framing	3,2	3.3
Fibre-cement cladding		
120 mm framing	3.1	3.3

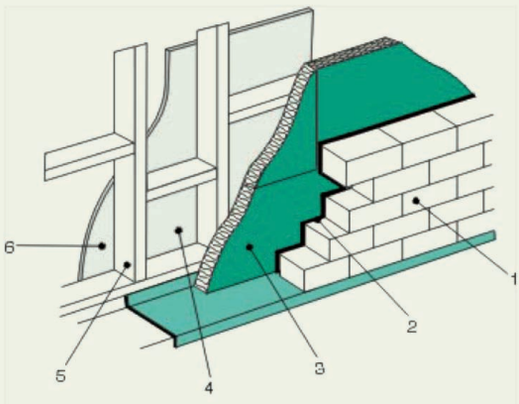
W12. Timber-framed Walls, Brick or Block Cladding, 10 mm Foil-Backed Insulation Board across Studs



1. External cladding
2. Air Space (non-reflective)
3. Insulation Board 10 mm
4. Air space (reflective)
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay brick		
70 mm framing	1.9	2.0
90 mm framing	1.9	2.0
Concrete brick		
70 mm framing	1.8	1.9
90 mm framing	1.8	1.9
Aerated concrete block		
70 mm framing	2.5	2.6
90 mm framing	2.5	2.6

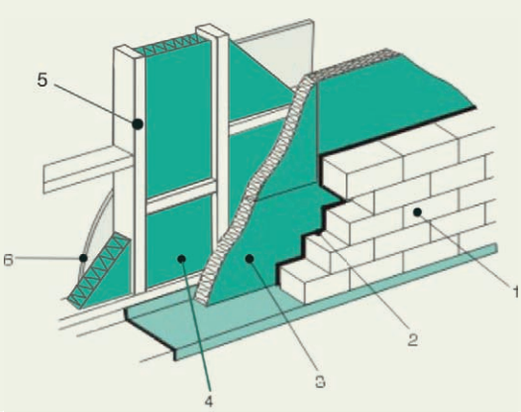
W13. Timber-framed Walls, Brick or Block Cladding, 15mm Foil-Backed Insulation Board across Studs



1. External cladding
2. Air Space (non reflective)
3. Insulation board 15 mm
4. Air space (reflective)
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Clay brick		
70 mm framing	2.1	2.2
90 mm framing	2.1	2.2
Concrete brick		
70 mm framing	2.0	2.1
90 mm framing	2.0	2.1
Aerated concrete block		
70 mm framing	2.7	2.8
90 mm framing	2.7	2.8

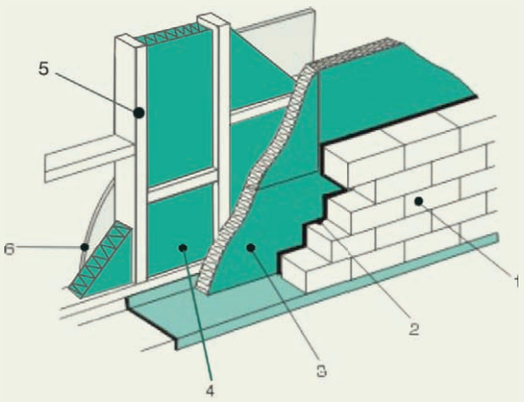
W14. Timber-framed Walls, Brick Or Block Cladding, R2.0 Bulk Insulation Between Studs, 10 mm Insulation Board Across Studs



1. External cladding
2. Air Space (non reflective)
3. Insulation Board 10 mm
4. R2.0 Bulk Insulation
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Clay brick		
70 mm framing	3.0	3.2
90 mm framing	3.1	3.3
Concrete brick		
70 mm framing	3.0	3.2
90 mm framing	3.0	3.2
Aerated concrete block		
70 mm framing	3.6	3.8
90 mm framing	3.7	3.8

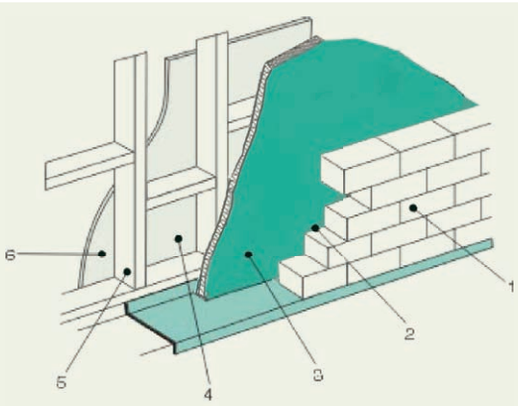
W15. Timber-framed Walls, Brick Or Block Cladding, R2.0 Bulk Insulation Between Studs, 15mm Insulation Board Across Studs



1. External cladding
2. Air Space (non-reflective)
3. Insulation board 15 mm
4. R2.0 Bulk Insulation
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay Brick		
70 mm framing	3.2	3.4
90 mm framing	3.3	3.4
Concrete brick		
70 mm framing	3.2	3.3
90 mm framing	3.2	3.4
Aerated concrete block		
70 mm framing	3.8	4.0
90 mm framing	3.9	4.0

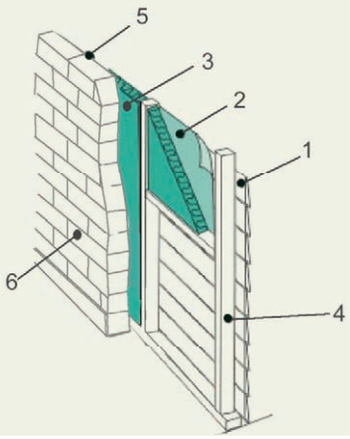
W16. Timber-framed Walls, Brick or Block Cladding Thermo Cellular Reflective Insulation across Studs



1. External cladding
2. Air Space (non-reflective)
3. Thermo-cellular reflective insulation
4. Air space (reflective)
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay brick		
70 mm framing	1.7	1.9
90 mm framing	1.6	1.7
Concrete brick		
70 mm framing	1.6	1.7
90 mm framing	1.6	1.7
Aerated concrete block		
70 mm framing	2.3	2.5
90 mm framing	2.3	2.5

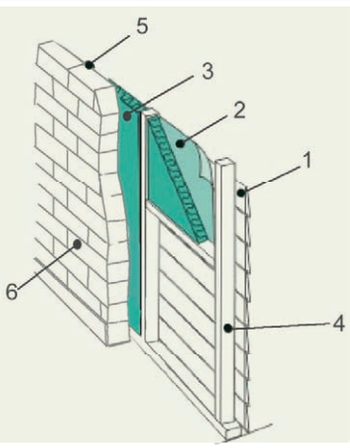
W17. Reverse Brick Veneer, Timber Cladding, R1.5 Bulk Insulation



1. External cladding
2. Breathable building membrane
3. R1.5 bulk insulation
4. Timber studs
5. Air space (non-reflective)
6. Brick internal cladding

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
70 mm framing	2.1	2.2
90 mm framing	2.0	2.1
Plywood cladding		
70 mm framing	1.8	1.9
90 mm framing	1.8	2.0
Fibre-cement cladding		
70 mm framing	1.7	1.9
90 mm framing	1.8	1.9

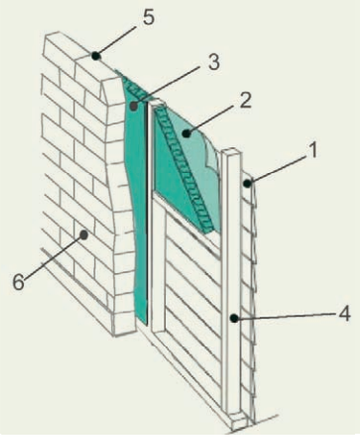
W18. Reverse Brick Veneer, Timber Cladding, R2.0 Bulk Insulation



1. External cladding
2. Breathable building membrane
3. R2.0 bulk insulation
4. Timber studs
5. Air space (non-reflective)
6. Brick internal cladding

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
70 mm framing	2.7	2.8
90 mm framing	2.8	2.8
Plywood cladding		
70 mm framing	2.6	2.7
90 mm framing	2.4	2.5
Fibre-cement cladding		
70 mm framing	2.5	2.6
90 mm framing	2.6	2.7

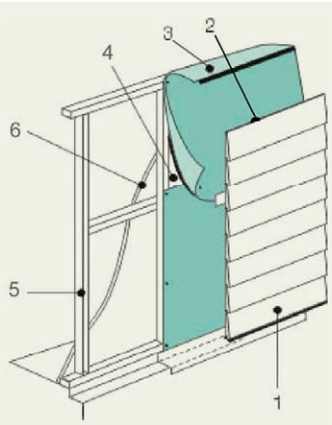
W19. Reverse Brick Veneer, Timber Cladding, R2.5 Bulk Insulation



1. External cladding
2. Breathable building membrane
3. R2.5 bulk insulation
4. Timber studs
5. Air space (non-reflective)
6. Brick internal cladding

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
90 mm framing	3.2	3.3
Plywood cladding		
90 mm framing	2.9	3.0
Fibre-cement cladding		
90 mm framing	3.0	3.1

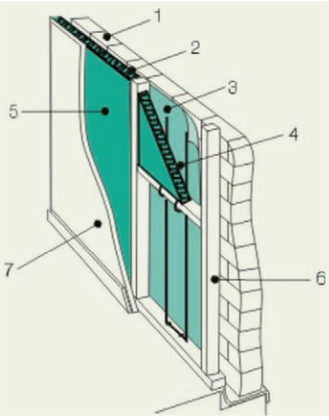
W20. Timber-framed Walls, Weatherboard, Plywood or Fibre-Cement Cladding, RFL



1. External cladding
2. Air space (Anti-glare)
3. Permeable RFL
4. Air space (Reflective)
5. Timber studs
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
70 mm framing	1.1	1.1
90 mm framing	1.1	1.2
Plywood cladding		
70 mm framing	1.0	1.0
90 mm framing	1.0	1.0
Fibre-cement cladding		
70 mm framing	0.9	0.9
90 mm framing	0.9	1.0

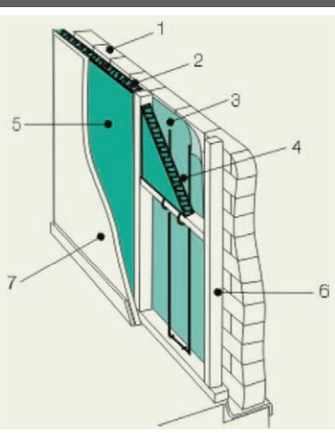
W21. Timber-framed Walls, Brick or Block Cladding, RFL on 25 mm Battens, R1.5 Bulk Insulation Between Studs



1. External cladding
2. Air space (anti-glare)
3. RFL on 25 mm battens
4. Air space (reflective)
5. R1.5 Bulk Insulation
6. Timber studs
7. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
70 mm framing	3.0	3.1
90 mm framing	3.0	3.2
Concrete brick 90 mm		
70 mm framing	2.9	3.1
90 mm framing	2.9	3.1
Aerated concrete block		
70 mm framing	3.6	3.8
90 mm framing	3.6	3.8

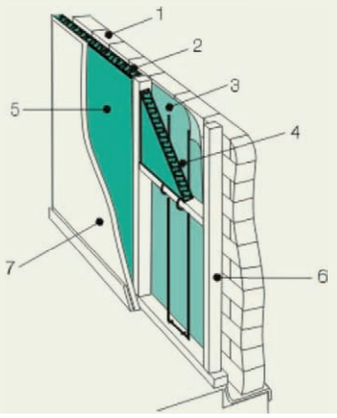
W22. Timber-framed Walls, Brick or Block Cladding, RFL on 25 mm Battens, R2.0 Bulk Insulation Between Studs



1. External cladding
2. Air space (anti-glare)
3. RFL on 25 mm battens
4. Air space (reflective)
5. R2.0 Bulk Insulation
6. Timber studs
7. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
70 mm framing	3.5	3.5
90 mm framing	3.5	3.6
Concrete brick 90mm		
70 mm framing	3.4	3.5
90 mm framing	3.4	3.6
Aerated concrete block		
70 mm framing	4.1	4.1
90 mm framing	4.1	4.2

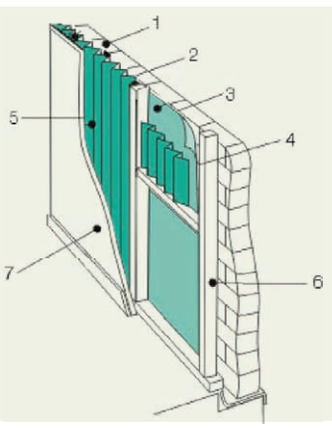
W23. Timber-framed Walls, Brick or Block Cladding, RFL on 25mm Battens, R2.5 Bulk Insulation Between Studs



1. External cladding
2. Air space (anti-glare)
3. RFL on 25 mm battens
4. Air space (reflective)
5. R2.5 Bulk Insulation
6. Timber studs
7. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
90 mm framing	3.9	4.0
Concrete brick 90 mm		
90 mm framing	3.8	3.9
Aerated concrete block		
90 mm framing	4.5	4.6

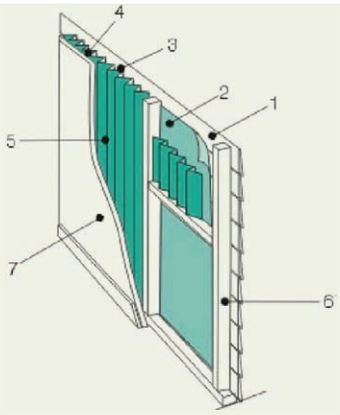
W24. Timber-framed Walls, Brick or Block Cladding, Concertina RFL Between Studs



1. External cladding
2. Air space (anti-glare)
3. Breathable building membrane
4. Air space (reflective)
5. RFL
6. Timber studs
7. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Clay brick 110 mm		
70 mm framing	2.2	2.6
90 mm framing	2.2	2.5
Concrete brick 90 mm		
70 mm framing	2.2	2.5
90 mm framing	2.1	2.4
Aerated concrete block		
70 mm framing	3.0	3.3
90 mm framing	2.9	3.2

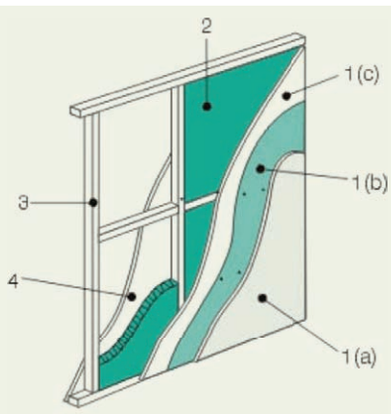
W25. Timber-framed Walls, Weatherboard or Sheet Cladding, Concertina RFL Between Studs



1. External cladding
2. Breathable building membrane
3. Air space (reflective)
4. Concertina RFL
5. Air space (reflective)
6. Timber studs
7. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard 20 mm		
70mm framing	2.0	2.1
90mm framing	2.0	2.3
Plywood cladding 12 mm		
70 mm framing	1.9	2.0
90 mm framing	1.9	2.1
Fibre-cement cladding		
70 mm framing	1.8	1.9
90 mm framing	1.8	2.0

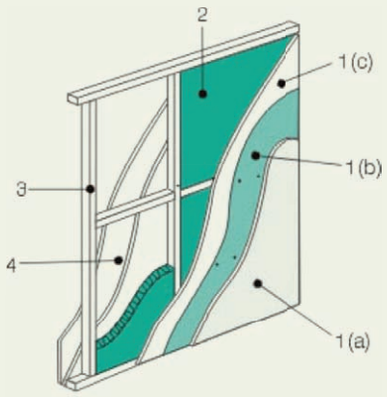
W26. MRTFC, Fire Resistance Level (FRL) 60 Mins Class 1, Bulk Insulation Between Studs



1. External cladding
(a) 6 mm fibre-cement sheet
(b) Permeable sarking or
breathable building membrane
(c) 13 mm fire-grade plasterboard
2. Bulk insulation
3. Timber studs
4. Standard plasterboard 10 mm

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
R1.5		
70 mm framing	1.8	1.9
90 mm framing	1.9	2.0
R2.0		
70 mm framing	2.2	2.3
90 mm framing	2.3	2.4
R2.5		
90 mm framing	2.6	2.7

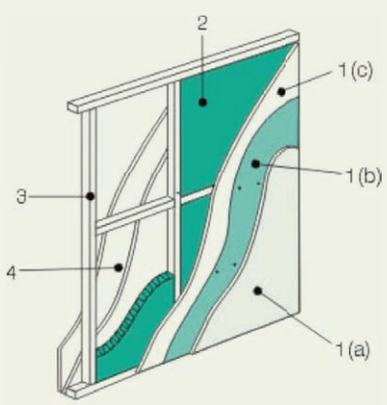
W27. MRTFC, Fire Resistance Level (FRL) 60 Mins Class 2, Bulk Insulation Between Studs



1. External cladding
(a) 6 mm fibre cement sheet
(b) Permeable sarking or breathable building membrane
(c) 13 mm fire grade plasterboard
2. Bulk insulation
3. Timber Studs
4. Internal lining:
16 mm fire-grade plasterboard;
or 6 mm fibre-cement sheet plus
13 mm fire-grade plasterboard

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
R1.5		
70 mm framing	1.8	1.9
90 mm framing	1.9	2.0
R2.0		
70 mm framing	2.2	2.3
90 mm framing	2.3	2.4
R2.5		
90 mm framing	2.6	2.7

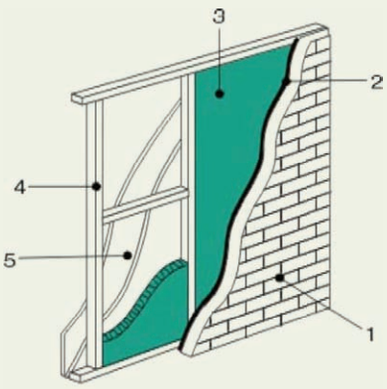
W28. MRTFC, Fire Resistance Level (FRL) 90 Mins Class 2, Bulk Insulation Between Studs



1. External cladding
(a) 12 mm plywood
(b) Permeable sarking or breathable building membrane
(c) 16mm fire grade moisture-resistant plasterboard
2. Bulk insulation
3. Timber Studs
4. Internal lining:
2/13 mm fire-grade plasterboard; or
6 mm fibre-cement sheet plus
16 mm fire-grade plasterboard

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
R1.5		
70 mm framing	2.0	2.0
90 mm framing	2.1	2.1
R2.0		
70 mm framing	2.3	2.4
90 mm framing	2.4	2.5
R2.5		
90 mm framing	2.7	2.8

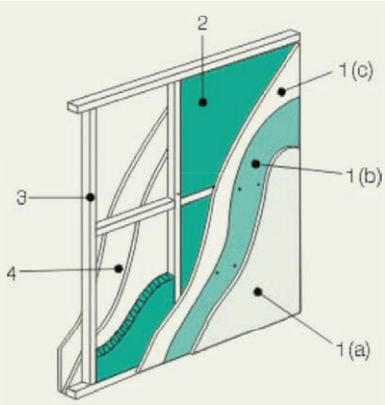
W29. MRTFC, Fire Resistance Level (FRL) 90 Mins Class 2, Bulk Insulation Between Studs



1. External cladding
(a) 12 mm plywood
(b) Permeable sarking or breathable building membrane
(c) 16 mm fire-grade, moisture-resistant plasterboard
2. Bulk insulation
3. Timber studs
4. Internal lining:
2/13mm fire-grade plasterboard; or
6mm fibre-cement sheet plus
16mm fire-grade plasterboard

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
R1.5		
70 mm framing	2.0	2.1
90 mm framing	2.1	2.1
R2.0		
70 mm framing	2.5	2.5
90 mm framing	2.5	2.6
R2.5		
90 mm framing	2.9	3.0

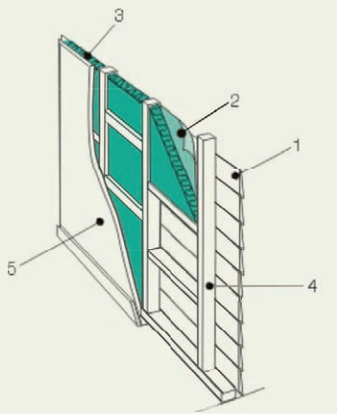
W30. MRTFC, Fire Resistance Level (FRL) 90 Mins Class 2, Bulk Insulation Between Studs



1. External cladding
(a) 6mm plywood
(b) Permeable sarking or breathable building membrane
(c) 16mm fire-grade, moisture-resistant plasterboard
2. Bulk insulation
3. Timber studs
4. Internal lining:
2/13 mm fire-grade plasterboard; or
6 mm fibre-cement sheet plus
16 mm fire-grade plasterboard

Wall Material	Total R-value for wall system (m²K/W)	
	Heat flow IN	Heat flow OUT
R1.5		
70 mm framing	1.9	2.0
90 mm framing	2.0	2.1
R2.0		
70 mm framing	2.2	2.3
90 mm framing	2.3	2.4
R2.5		
90 mm framing	2.7	2.8

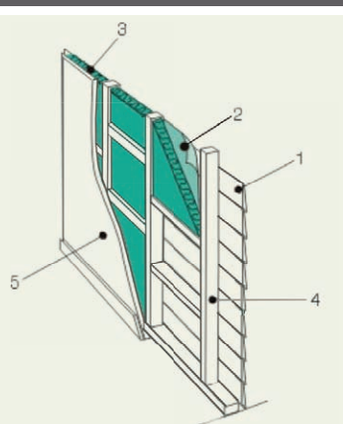
W31. Timbe-framed Walls, Weatherboard, Plywood or Fibre-cement Cladding, Staggered Studs 120 mm Top/Bottom Plate, R3.0 Bulk Insulation



1. External cladding
2. Breathable building membrane
3. R3.0 Bulk Insulation
4. Timber studs
5. Vapour barrier (as required)
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
70 mm framing	3.2	3.3
90 mm framing	3.1	3.3
Plywood cladding		
70 mm framing	3.1	3.2
90 mm framing	3.0	3.2
Fibre-cement cladding		
70 mm framing	3.0	3.2
90 mm framing	2.9	3.1

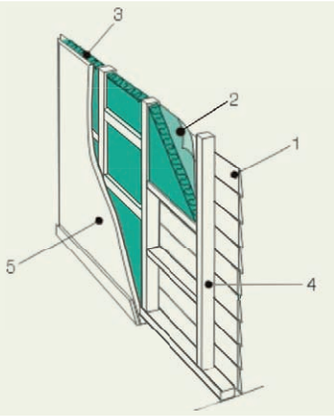
W32. Timber-framed Walls, Weatherboard, Plywood or Fibre-cement Cladding, Staggered Studs 120 mm Top/Bottom Plate, R3.2 Bulk Insulation



1. External cladding
2. Breathable building membrane
3. R3.2 Bulk Insulation
4. Timber studs
5. Vapour barrier (as required)
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
70 mm framing	3.3	3.5
90 mm framing	3.2	3.4
Plywood cladding		
70 mm framing	3.2	3.4
90 mm framing	3.1	3.3
Fibre-cement cladding		
70 mm framing	3.1	3.4
90 mm framing	3.1	3.3

W33. Timber-framed Walls, Weatherboard, Plywood or Fibre-Cement Cladding, Staggered Studs 120 mm Top/Bottom Plate, R3.5 Bulk Insulation

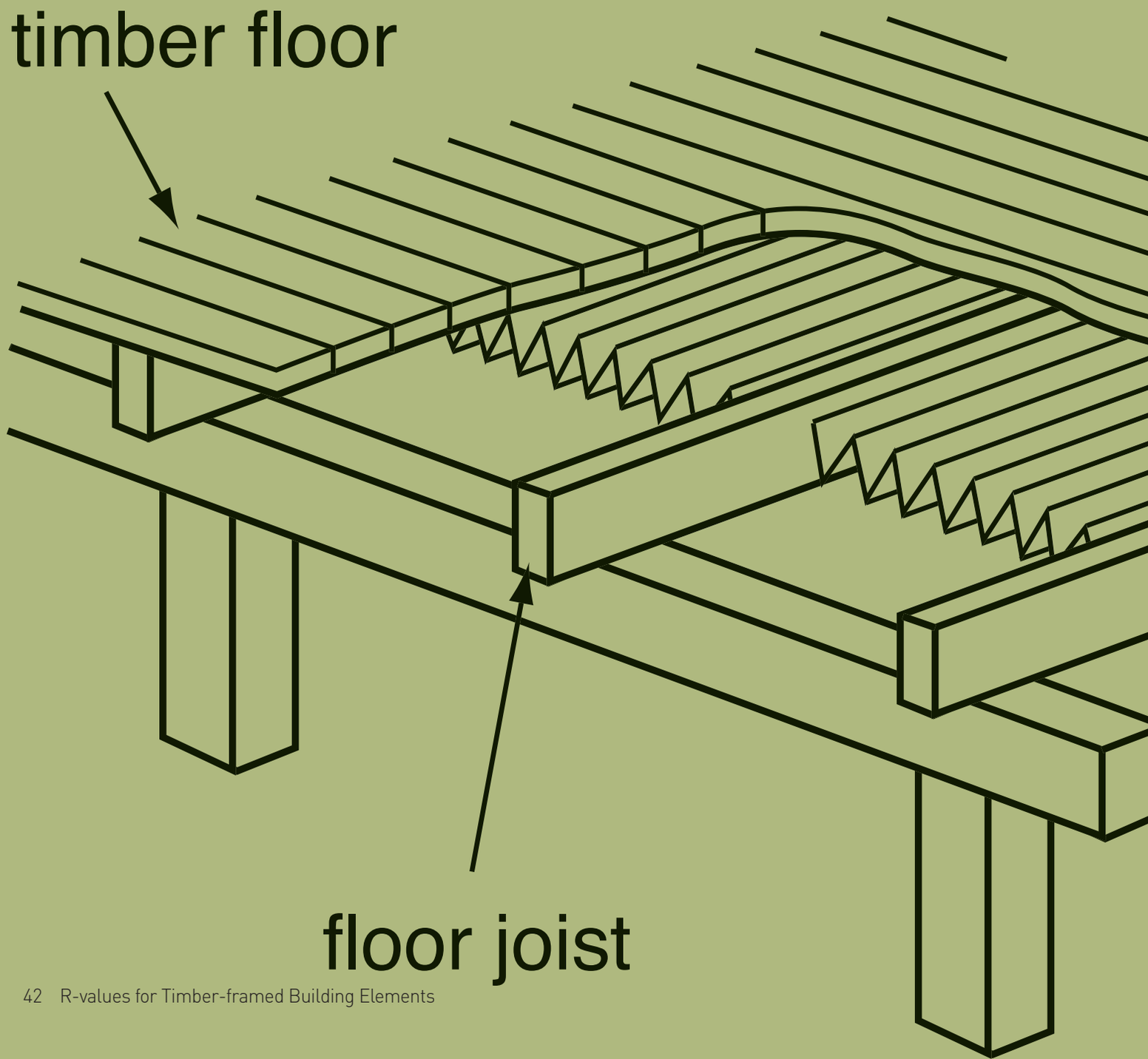


1. External cladding
2. Breathable building membrane
3. R3.5 Bulk Insulation
4. Timber Studs
5. Vapour barrier (as required)
6. Plasterboard 10 mm

Wall Material	Total R-value for wall system (m^2K/W)	
	Heat flow IN	Heat flow OUT
Weatherboard		
70 mm framing	3.5	3.7
90 mm framing	3.4	3.6
Plywood cladding		
70 mm framing	3.4	3.6
90 mm framing	3.3	3.6
Fibre-cement cladding		
70 mm framing	3.3	3.6
90 mm framing	3.3	3.5

Suspended Timber Floors

No Sub-Floor Walls



Explanation of Tables

Suspended Timber Floors, No Sub-floor Walls

R-values of suspended floor elements are calculated in accordance with AS 4859.1 and ISO 13770. Values are given for heat flow DOWN and UP and two sub-floor heights. It should be noted that conditions different to the assumptions used in the calculations would result in different R-values.

When the ground surface is sloping use the average under-floor height. For intermediate heights interpolate R-value between 0.6 m and 2.4 m.

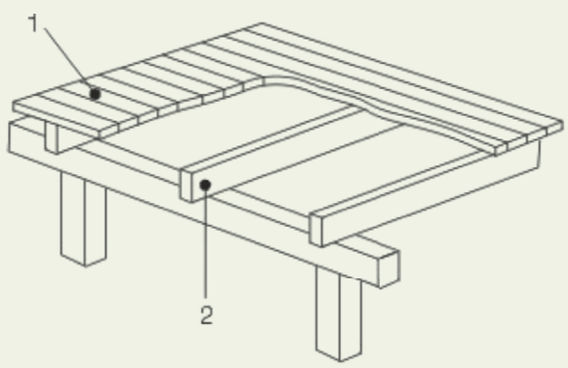
A Heat flow **DOWN** means the heat flows **from** the internal spaces of the building (in cold weather).

B Heat flow **UP** means the heat flows **into** the internal spaces of the building (in hot weather).

Joists at 450 mm or 600 mm centres.

RFL may be corrugated as shown or sheets fixed to joists.

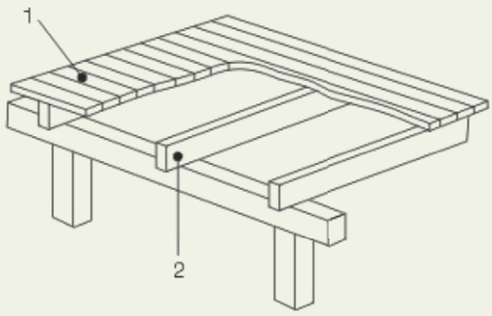
F1. Bare Timber, No Sub-Floor Walls



1. 19 mm timber floor
2. Timber floor joist

Floor Material	Total R-value for floor system (m^2K/W)	
	A Heat flow DOWN	B Heat flow UP
Softwood		
0.6 m height	0.54	0.43
2.4 m height	0.54	0.42
Particleboard		
0.6 m height	0.51	0.39
2.4 m height	0.51	0.39
Hardwood		
0.6 m height	0.47	0.35
2.4 m height	0.47	0.35
Foil-backed particleboard		
0.6 m height	1.12	0.52
2.4 m height	1.12	0.52

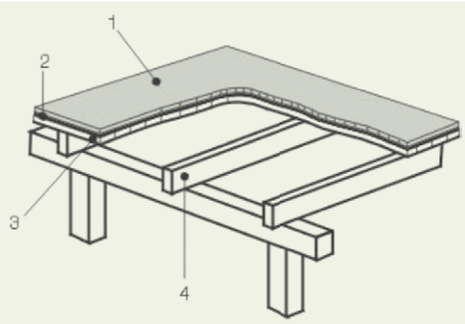
F1. Bare Timber, No Sub-floor Walls



1. 19 mm timber floor
2. Timber floor joist

Floor Material	Total R-value for floor system (m^2K/W)	
	Heat flow DOWN	Heat flow UP
Softwood		
0.6 m height	0.54	0.43
2.4 m height	0.54	0.42
Particleboard		
0.6 m height	0.51	0.39
2.4 m height	0.51	0.39
Hardwood		
0.6 m height	0.47	0.35
2.4 m height	0.47	0.35
Foil-backed particleboard		
0.6 m height	1.12	0.52
2.4 m height	1.12	0.52

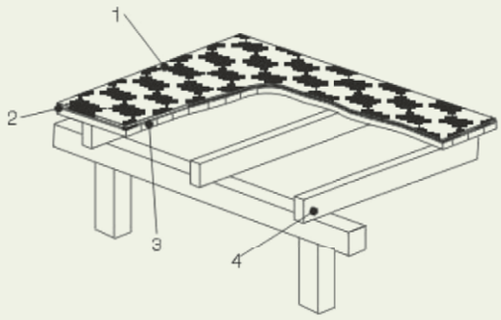
F2. Carpeted Timber, No Sub-floor Walls



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Timber floor joist

Floor Material	Total R-value for floor system (m^2K/W)	
	Heat flow DOWN	Heat flow UP
Softwood		
0.6 m height	0.95	0.83
2.4 m height	0.95	0.83
Particleboard		
0.6 m height	0.92	0.80
2.4 m height	0.91	0.80
Hardwood		
0.6 m height	0.88	0.76
2.4 m height	0.87	0.76
Foil-backed particleboard		
0.6 m height	1.52	0.92
2.4 m height	1.52	0.92

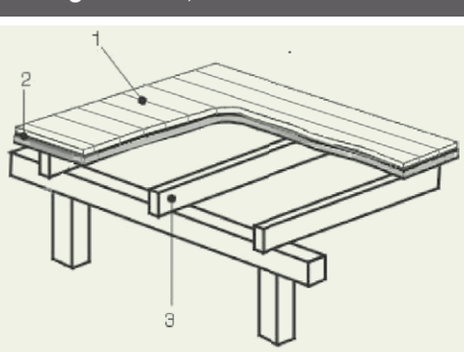
F3. Bare Timber, No Sub-floor Walls



1. Tiles
2. Tile underlay
3. 19 mm timber floor
4. Timber floor joist

Floor Material	Total R-value for floor system (m²K/W)	
	Heat flow DOWN	Heat flow UP
Ceramic tiles (vinyl)		
softwood	0.55	0.44
particleboard	0.52	0.40
hardwood	0.48	0.36
foil-backed particleboard	1.13	0.53
Cork tiles		
softwood	0.62	0.50
particleboard	0.59	0.47
hardwood	0.54	0.43
foil-backed particleboard	1.20	0.59
Linoleum		
softwood	0.57	0.45
particleboard	0.54	0.42
hardwood	0.50	0.38
foil-backed particleboard	1.15	0.55

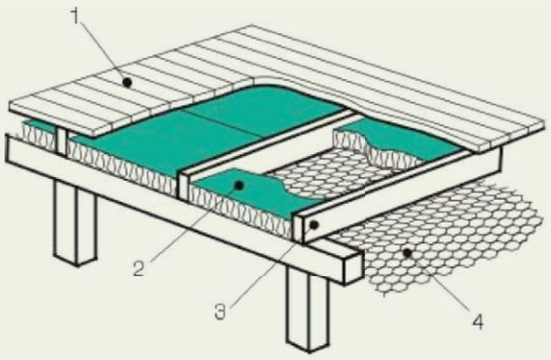
F4. Floating Timber, No Sub-floor Walls



1. 12 mm floating timber
2. 19 mm particleboard/plywood
3. Timber floor joist

Floor Material	Total R-value for floor system (m²K/W)	
	Heat flow DOWN	Heat flow UP
Plywood		
0.6 m height	0.59	0.47
2.4 m height	0.59	0.47
Particleboard		
0.6 m height	0.61	0.50
2.4 m height	0.61	0.49
Foil-backed particleboard		
0.6 m height	1.22	0.62
2.4 m height	1.22	0.62

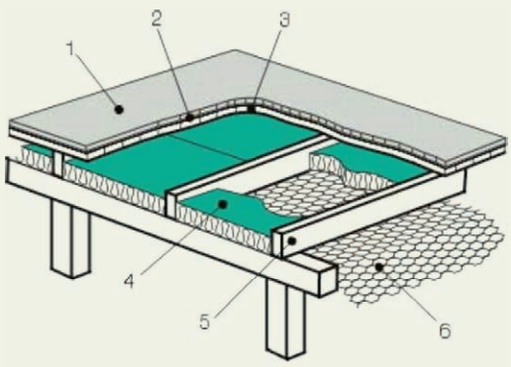
F5. Bare Timber, No Sub-floor Walls, Bulk Insulation Between Joists



1. 19 mm timber floor
2. Air space
3. Bulk insulation
4. Timber floor joist
5. Mesh

Floor Material	Total R-value for floor system (m^2K/W)	
	Heat flow DOWN	Heat flow UP
Softwood		
R1.5 (90 mm joists)	2.03	1.89
R2.0 (90 mm joists)	2.40	2.26
R2.5 (90 mm joists)	2.72	2.57
R3.0 (120 mm joists)	3.19	3.04
Particleboard		
R1.5 (90 mm joists)	2.00	1.86
R2.0 (90 mm joists)	2.37	2.22
R2.5 (90 mm joists)	2.68	2.53
R3.0 (120 mm joists)	3.15	3.00
Hardwood		
R1.5 (90 mm joists)	1.96	1.82
R2.0 (90 mm joists)	2.32	2.18
R2.5 (90 mm joists)	2.63	2.48
R3.0 (120 mm joists)	3.10	2.95

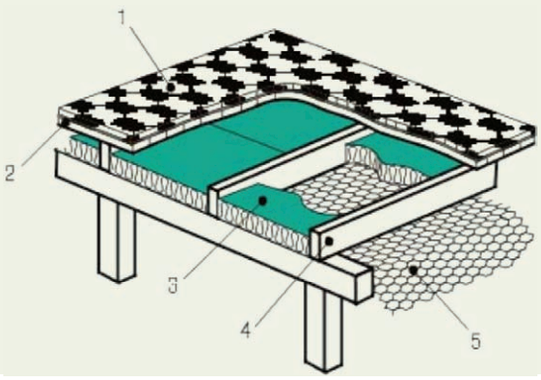
F6. Carpeted Timber, No Sub-floor Walls, Bulk Insulation Between Joists



1. 19 mm timber floor
2. Air space
3. Bulk insulation
4. Timber floor joist
5. Mesh

Floor Material	Total R-value for floor system (m^2K/W)	
	Heat flow DOWN	Heat flow UP
Softwood		
R1.5 (90 mm joists)	2.46	2.32
R2.0 (90 mm joists)	2.84	2.71
R2.5 (90 mm joists)	3.18	3.04
R3.0 (120 mm joists)	3.65	3.1
Particleboard		
R1.5 (90 mm joists)	2.42	2.29
R2.0 (90 mm joists)	2.81	2.67
R2.5 (90 mm joists)	3.14	3.01
R3.0 (120 mm joists)	3.62	3.48
Hardwood		
R1.5 (90 mm joists)	2.38	2.25
R2.0 (90 mm joists)	2.76	2.63
R2.5 (90 mm joists)	3.10	2.96
R3.0 (120 mm joists)	3.57	3.43

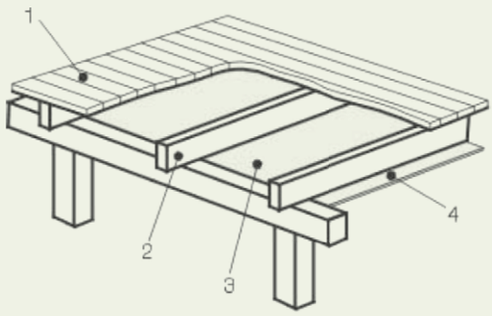
F7. Tiled Timber, No Sub-floor Walls, Bulk Insulation Between Joists



1. 6 mm tiles
2. 19 mm timber floor
3. Air space
4. Bulk insulation
5. Timber floor joist
6. Mesh

Floor Material	Total R-value for floor system (m^2K/W)	
	Heat flow DOWN	Heat flow UP
Softwood		
R1.5 (90 mm joists)	2.05	1.91
R2.0 (90 mm joists)	2.41	2.27
R2.5 (90 mm joists)	2.73	2.58
R3.0 (120 mm joists)	3.20	3.05
Particleboard		
R1.5 (90 mm joists)	2.01	1.88
R2.0 (90 mm joists)	2.38	2.23
R2.5 (90 mm joists)	2.69	2.55
R3.0 (120 mm joists)	3.16	3.01
Hardwood		
R1.5 (90 mm joists)	1.97	1.83
R2.0 (90 mm joists)	2.33	2.19
R2.5 (90 mm joists)	2.64	2.50
R3.0 (120 mm joists)	3.11	2.96

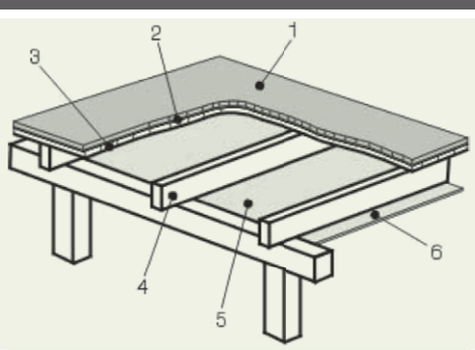
F8. Bare Timber, No Sub-floor Walls, Plywood Under Joists



1. 19 mm timber floor
2. Timber floor joist
3. Air space (non-reflective)
4. Underlining

Floor Material	Total R-value for floor system (m²K/W)	
	Heat flow DOWN	Heat flow UP
Softwood		
0.6 m height	0.75	0.58
2.4 m height	0.74	0.58
Particleboard		
0.6 m height	0.72	0.55
2.4 m height	0.71	0.55
Hardwood		
0.6 m height	0.67	0.51
2.4 m height	0.68	0.51
Foil-backed particleboard		
0.6 m height	2.06	0.9
2.4 m height	2.06	0.9

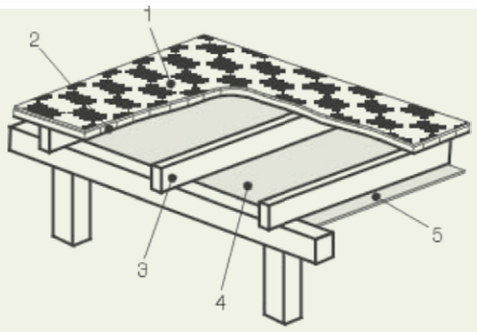
F9. Carpeted Timber, No Sub-floor Walls, Plywood Under Joists



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Timber floor joist
5. Air space (non-reflective)
6. Underlining

Floor Material	Total R-value for floor system (m²K/W)	
	Heat flow DOWN	Heat flow UP
Softwood		
0.6 m height	1.15	0.99
2.4 m height	1.15	0.99
Particleboard		
0.6 m height	1.12	0.96
2.4 m height	1.12	0.95
Hardwood		
0.6 m height	1.08	0.92
2.4 m height	1.08	0.91
Foil-backed particleboard		
0.6 m height	2.50	1.33
2.4 m height	2.50	1.33

F10. Tiled Timber, No Sub-floor Walls, Plywood Under Joists

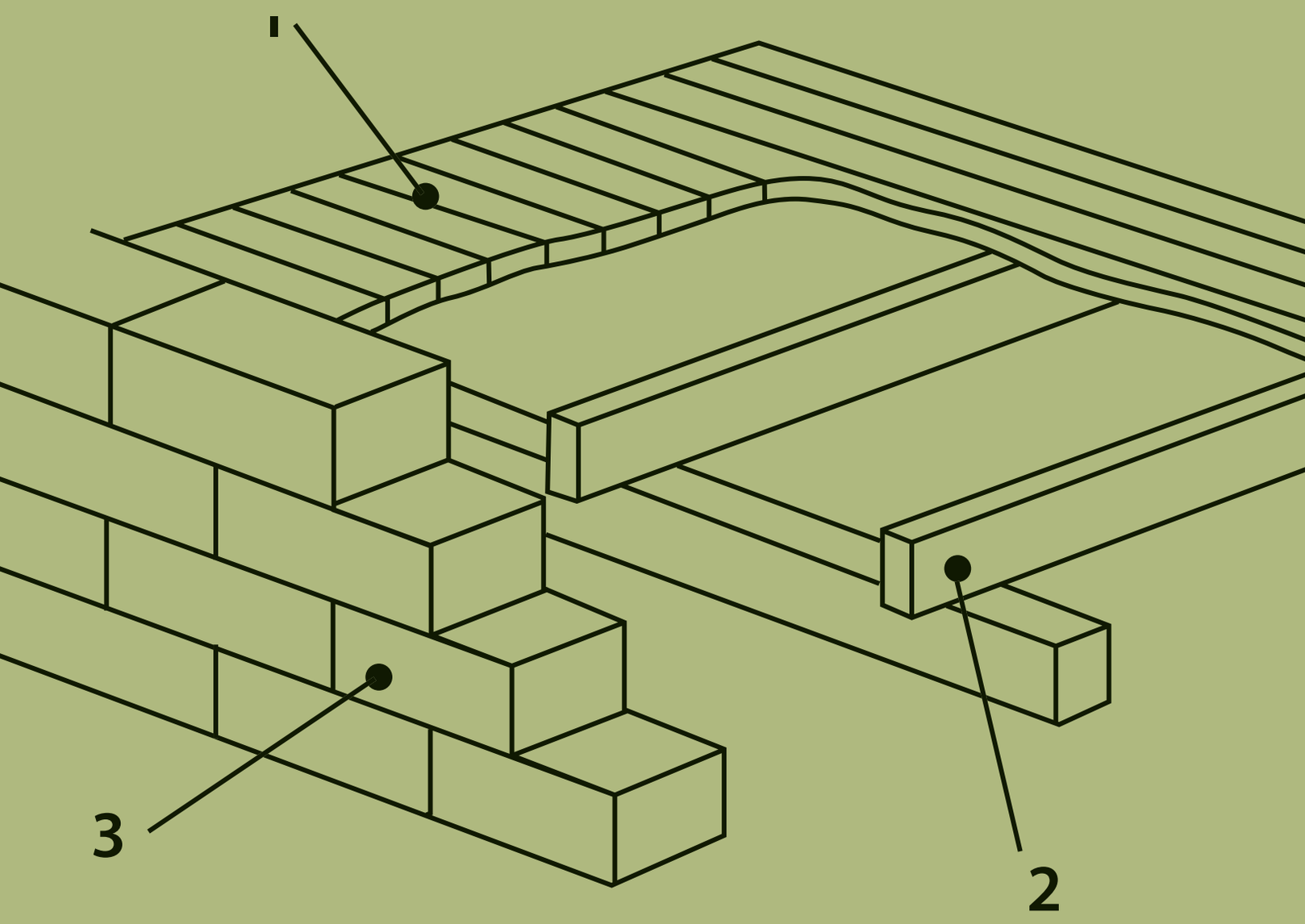


1. 6 mm tiles
2. 19 mm timber floor
3. Timber floor joist
4. Air space (non-reflective)
5. Underlining

Floor Material	Total R-value for floor system (m^2K/W)	
	Heat flow DOWN	Heat flow UP
Softwood		
0.6 m height	0.76	0.59
2.4 m height	0.76	0.59
Particleboard		
0.6 m height	0.73	0.56
2.4 m height	0.72	0.56
Hardwood		
0.6 m height	0.69	0.52
2.4 m height	0.68	0.52
Foil-backed particleboard		
0.6 m height	2.08	0.91
2.4 m height	2.08	0.91

Suspended Timber Floors

Enclosed Sub-Floor, Cavity Disconnected



Explanation of Tables

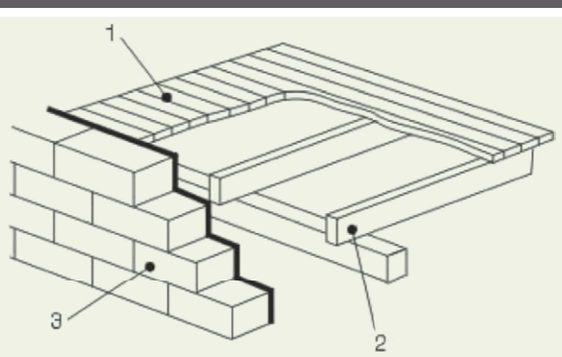
Suspended Timber Floors, Enclosed sub-floor

R-values of suspended floor elements are calculated in accordance with AS 4859.1 and ISO 13770. Values are given for heat flow DOWN and UP that correspond to open and enclosed sub-floors with three ventilation conditions (see BCA, Table 3.4.1.2), two sub-floor heights. A clay soil is assumed for all calculations. It should be noted that conditions different to the assumptions used in the calculations may result in different R-values.

Notes:

1. When the ground surface is sloping use the average under-floor height. For intermediate heights interpolate R-value between 0.6 m and 2.4 m.
2. Zone 1, Zone 2 and Zone 3 refer to sub-floor ventilations rates from BCA Part 3.4.1.
3. **A** Sub-Floor Ventilation [Zone A, Zone B, Zone C]. Heat flow **DOWN** means the heat flows **from** the internal spaces of the building (in cold weather).
4. **B** Sub-Floor Ventilation [Zone A, Zone B, Zone C]. Heat flow **UP** means the heat flows **into** the internal spaces of the building (in hot weather).
5. Joists at 450 mm or 600 mm centres.
6. RFL may be corrugated as shown or sheets fixed to joists.
7. Calculations are based sub-floor walls of single brick. Sub-floor walls of other materials will affect the Total R-value.
8. **CAVITY CONNECTED** refers to situations where air flow is possible from the sub-floor through the wall cavity.
9. **CAVITY DISCONNECTED OR TIMBER FRAME** refers to situations where air flow from sub-floor to the roof via a wall cavity is prevented. This is achieved by cavity flashing or similar (see Figure 2 (page 9) – Cavity Disconnection Options) OR where the construction is of timber frame with lightweight cladding such as weatherboards or fibre-cement

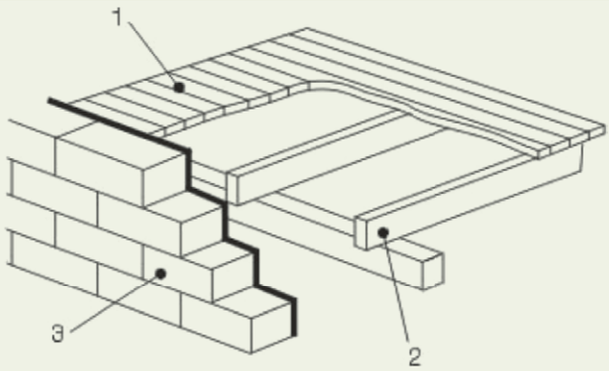
F11. Bare Timber, No Sub-Floor Walls



1. 19 mm timber floor
2. Timber floor joist
3. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	A Heat flow DOWN			B Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	0.75	0.75	0.74	0.63	0.63	0.63
2.4 m height	0.68	0.68	0.67	0.56	0.56	0.56
Particleboard						
0.6 m height	0.72	0.72	0.71	0.61	0.60	0.59
2.4 m height	0.65	0.64	0.64	0.53	0.53	0.52
Hardwood						
0.6 m height	0.68	0.68	0.67	0.57	0.56	0.55
2.4 m height	0.61	0.60	0.60	0.49	0.49	0.48

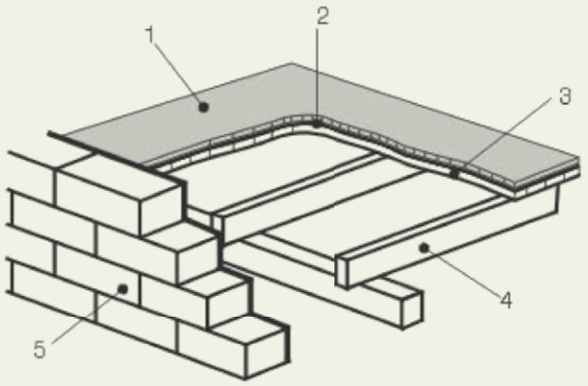
F11. Bare Timber, No Sub-floor Walls



1. 19mm timber floor
2. Timber floor joist
3. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	0.75	0.75	0.74	0.63	0.63	0.63
2.4 m height	0.68	0.68	0.67	0.56	0.56	0.56
Particleboard						
0.6 m height	0.72	0.72	0.71	0.61	0.60	0.59
2.4 m height	0.65	0.64	0.64	0.53	0.53	0.52
Hardwood						
0.6 m height	0.68	0.68	0.67	0.57	0.56	0.55
2.4 m height	0.61	0.60	0.60	0.49	0.49	0.48
Foil-backed particleboard						
0.6 m height	1.81	1.74	1.69	1.18	1.11	1.06
2.4 m height	1.42	1.42	1.39	0.81	0.79	0.78

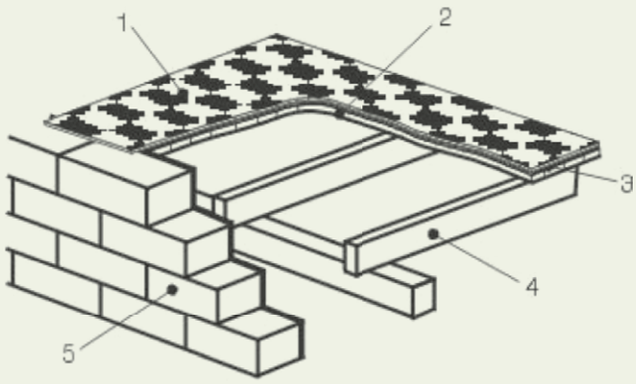
F12. Carpeted Timber, Sub-floor Walls, Cavity Disconnected or Timber Frame



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	1.67	1.60	1.50	1.54	1.47	1.37
2.4 m height	1.23	1.22	1.21	1.12	1.10	1.09
Particleboard						
0.6 m height	1.64	1.57	1.47	1.51	1.43	1.38
2.4 m height	1.20	1.19	1.17	1.08	1.06	1.06
Hardwood						
0.6 m height	1.60	1.53	1.43	1.47	1.39	1.30
2.4 m height	1.16	1.15	1.13	1.04	1.02	1.02
Foil-backed particleboard						
0.6 m height	2.21	2.14	2.09	1.58	1.52	1.47
2.4 m height	1.82	1.81	1.79	1.21	1.20	1.19

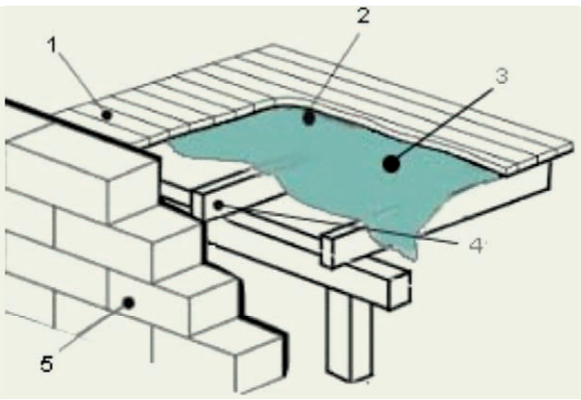
F13. Tiled Timber, Sub-floor Walls, Cavity Disconnected or Timber Frame



1. 6 mm tiles
2. 19 mm timber floor
3. Tile underlay
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	1.22	1.16	1.10	1.09	1.03	0.98
2.4 m height	0.84	0.82	0.81	0.73	0.71	0.69
Particleboard						
0.6 m height	1.19	1.13	1.07	1.06	1.00	0.94
2.4 m height	0.81	0.79	0.78	0.70	0.67	0.66
Hardwood						
0.6 m height	1.15	1.08	1.03	1.02	0.95	0.90
2.4 m height	0.77	0.75	0.74	0.65	0.64	0.62
Foil-backed particleboard						
0.6 m height	1.80	1.74	1.68	1.18	1.12	1.07
2.4 m height	1.42	1.40	1.39	0.81	0.80	0.79

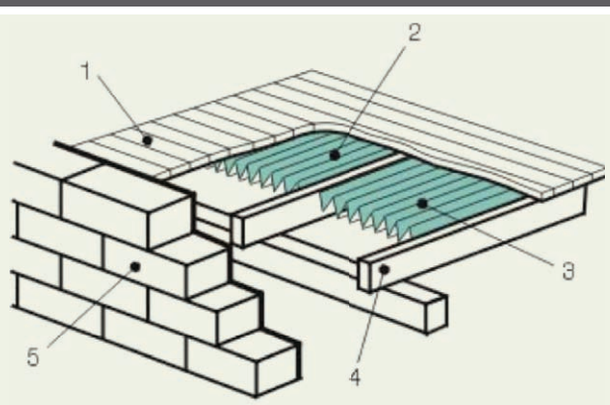
F14. Bare Timber, Sub-floor Walls, RFL Over Joists, Cavity Disconnected or Timber Frame



1. 19 mm timber floor
2. Air space (reflective)
3. RFL
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.43	2.37	2.31	1.55	1.48	1.43
2.4 m height	2.05	2.03	2.02	1.18	1.16	1.15
Particleboard						
0.6 m height	2.40	2.34	2.28	1.51	1.45	1.40
2.4 m height	2.02	2.00	1.99	1.15	1.13	1.12
Hardwood						
0.6 m height	2.36	2.29	2.24	1.48	1.41	1.36
2.4 m height	1.98	1.96	1.95	1.11	1.09	1.08

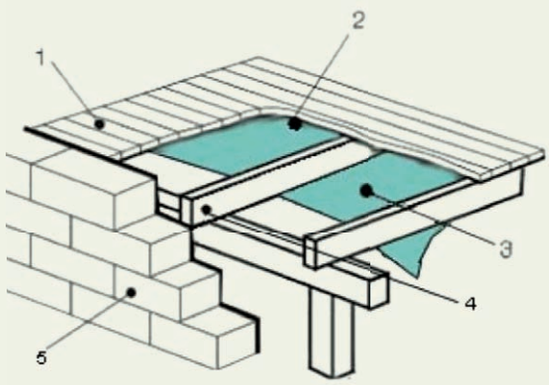
F15. Bare Timber, Sub-floor Walls, RFL Between Joists, Cavity Disconnected or Timber Frame



1. 19 mm timber floor
2. Air space (reflective)
3. RFL
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.80	2.73	2.68	1.69	1.60	1.55
2.4 m height	2.41	2.40	2.38	1.30	1.28	1.27
Particleboard						
0.6 m height	2.76	2.70	2.64	1.63	1.57	1.52
2.4 m height	2.38	2.36	2.35	1.26	1.25	1.23
Hardwood						
0.6 m height	2.72	2.65	2.00	1.59	1.52	1.47
2.4 m height	2.33	2.32	2.31	1.22	1.20	1.19

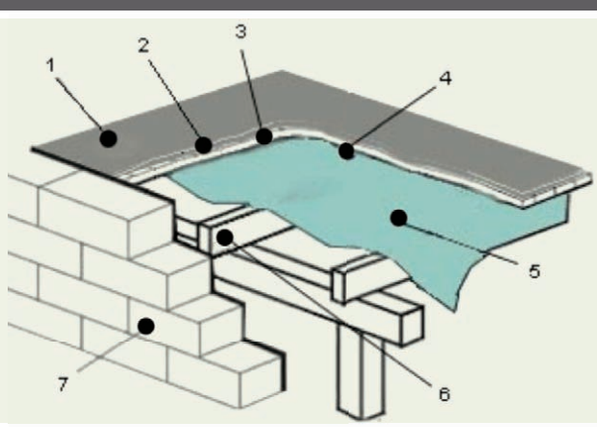
F16. Bare Timber, Sub-floor Walls, RFL Under Joists, Cavity Disconnected or Timber Frame



1. 19mm timber floor
2. Air space (reflective)
3. RFL
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.94	2.88	2.82	1.68	1.62	1.56
2.4 m height	2.56	2.4	2.53	1.31	1.29	1.28
Particleboard						
0.6 m height	2.91	2.84	2.79	1.64	1.58	1.57
2.4 m height	2.53	2.51	2.50	1.27	1.26	1.25
Hardwood						
0.6 m height	2.87	2.80	2.75	1.60	1.54	1.49
2.4 m height	2.48	2.47	2.46	1.23	1.22	1.20

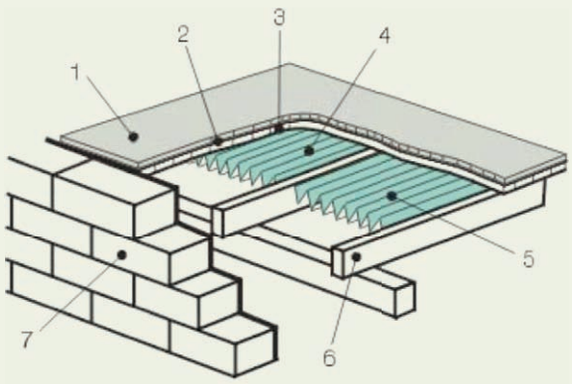
F17. Carpeted Timber, Sub-Floor Walls, RFL Over Joists, Cavity Disconnected or Timber Frame



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Air space (reflective)
5. RFL
6. Timber floor joist
7. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.84	2.78	2.72	1.95	1.88	1.83
2.4 m height	2.46	2.44	2.43	1.58	1.56	1.55
Particleboard						
0.6 m height	2.81	2.74	2.69	1.91	1.85	1.80
2.4 m height	2.43	2.41	2.40	1.54	1.53	1.52
Hardwood						
0.6 m height	2.77	2.70	2.65	1.87	1.81	1.76
2.4 m height	2.39	2.37	2.36	1.50	1.49	1.48

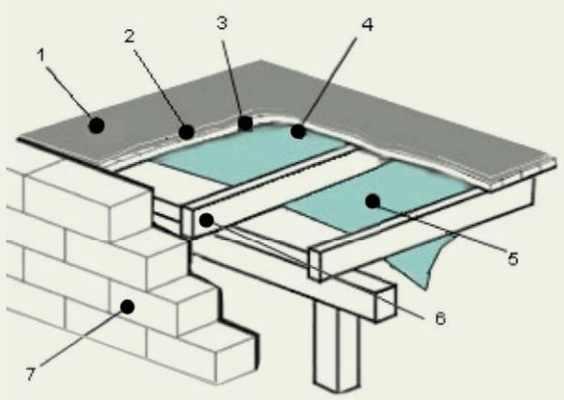
F18. Carpeted Timber, Sub-floor Walls, RFL Between Joists, Cavity Disconnected or Timber Frame



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Air space (reflective)
5. RFL
6. Timber floor joist
7. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.81	2.74	2.69	1.70	1.61	1.56
2.4 m height	2.42	2.42	2.39	1.31	1.29	1.28
Particleboard						
0.6m height	2.77	2.71	2.65	1.65	1.58	1.53
2.4 m height	2.39	2.37	2.36	1.27	1.26	1.24
Hardwood						
0.6 m height	2.73	2.67	2.01	1.60	1.53	1.48
2.4 m height	2.34	2.33	2.32	1.22	1.21	1.20

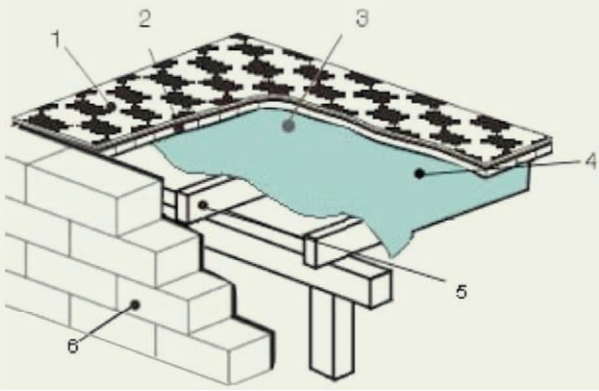
F19. Carpeted Timber, Sub-Floor Walls, RFL Under Joists, Cavity Disconnected or Timber Frame



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Air space (reflective)
5. RFL
6. Timber floor joist
7. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	3.35	3.29	3.23	2.08	2.02	1.96
2.4 m height	2.97	2.81	2.94	1.71	1.69	1.68
Particleboard						
0.6 m height	3.32	3.24	3.20	2.04	1.98	1.97
2.4 m height	2.94	2.92	2.91	1.66	1.66	1.65
Hardwood						
0.6 m height	3.28	3.21	3.16	1.99	1.94	1.89
2.4 m height	2.89	2.88	2.87	1.62	1.62	1.60

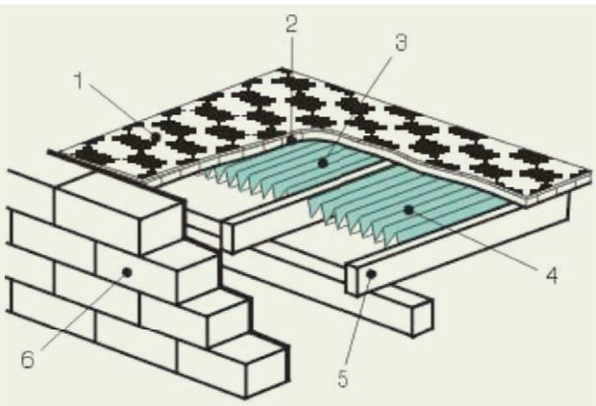
F20. Tiled Timber, Sub-floor Walls, RFL Over Joists, Cavity Disconnected or Timber Frame



1. 6 mm tiles
2. 19 mm timber floor
3. Air space (reflective)
4. RFL
5. Timber floor joist
6. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.44	2.38	2.32	1.56	1.49	1.44
2.4 m height	2.06	2.05	2.03	1.19	1.17	1.16
Particleboard						
0.6 m height	2.41	2.35	2.29	1.53	1.46	1.41
2.4 m height	2.03	2.01	2.00	1.16	1.14	1.13
Hardwood						
0.6 m height	2.37	2.31	2.25	1.49	1.42	1.371
2.4 m height	1.99	1.97	1.96	1.11	1.10	1.09

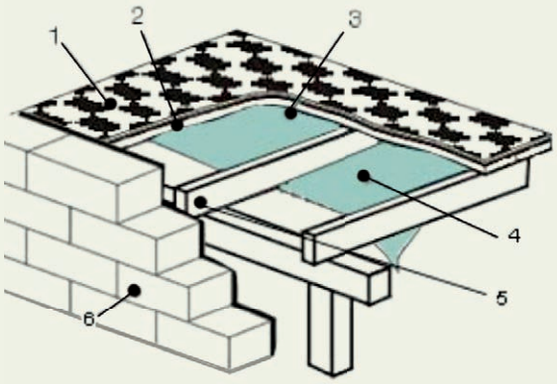
F21. Tiled Timber, Sub-floor Walls, RFL Under Joists, Cavity Disconnected or Timber Frame



1. 6 mm tiles
2. 19 mm timber floor
3. Air space (reflective)
4. RFL
5. Timber floor joist
6. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.81	2.74	2.69	1.70	1.61	1.56
2.4 m height	2.42	2.42	2.39	1.31	1.29	1.28
Particleboard						
0.6 m height	2.77	2.71	2.65	1.65	1.58	1.53
2.4 m height	2.39	2.37	2.36	1.27	1.26	1.24
Hardwood						
0.6 m height	2.73	2.67	2.01	1.60	1.53	1.48
2.4 m height	2.34	2.33	2.32	1.22	1.21	1.20

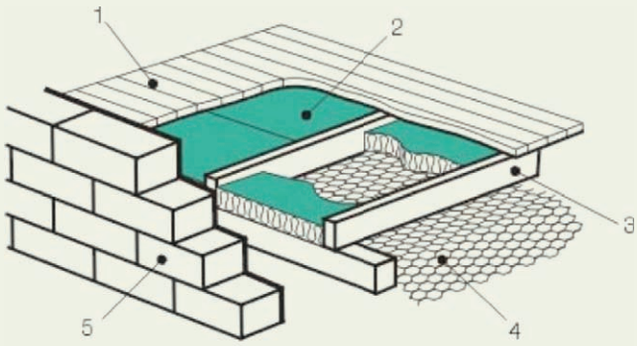
F22. Tiled Timber, Sub-floor Walls, RFL Under Joists, Cavity Disconnected or Timber Frame



1. 6 mm tiles
2. 19 mm timber floor
3. Air space (reflective)
4. RFL
5. Timber floor joist
6. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.95	2.89	2.83	1.69	1.63	1.57
2.4 m height	2.57	2.42	2.54	1.32	1.30	1.29
Particleboard						
0.6 m height	2.92	2.85	2.80	1.66	1.59	1.58
2.4 m height	2.54	2.52	2.51	1.28	1.27	1.26
Hardwood						
0.6 m height	2.88	2.82	2.76	1.61	1.55	1.50
2.4 m height	2.49	2.48	2.47	1.23	1.23	1.21

F23. Bare Timber, Sub-floor Walls, Bulk Insulation Between Joists, Cavity Disconnected or Timber Frame

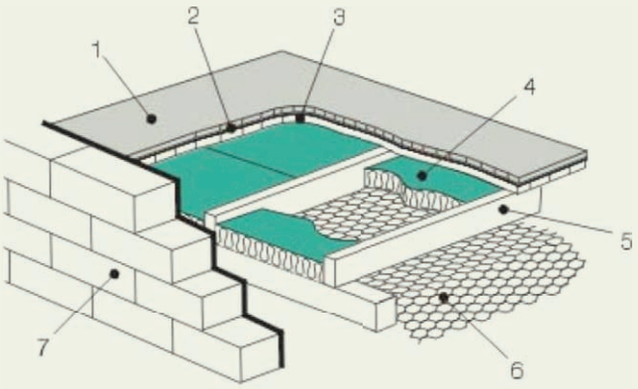


1. 19 mm timber floor
2. Bulk insulation
3. Timber floor joist
4. Mesh
5. Sub-floor wall

Height 0.6 m
Joists @450 or 600 crs
NOTE: R3.0 - 120 mm joists

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
R1.5	2.70	2.63	2.58	2.54	2.48	2.43
R2.0	2.99	2.92	2.87	2.84	2.78	2.72
R2.5	3.39	3.32	3.27	3.23	3.16	3.11
R3.0	3.86	3.79	3.74	3.69	3.63	3.58
Particleboard						
R1.5	2.66	2.60	2.54	2.66	2.45	2.40
R2.0	2.95	2.89	2.83	2.80	2.74	2.69
R2.5	3.35	3.29	3.23	3.19	3.12	3.07
R3.0	3.82	3.76	3.70	3.65	3.59	3.54
Hardwood						
R1.5	2.62	2.56	2.50	2.47	2.40	2.35
R2.0	2.91	2.84	2.79	2.76	2.69	2.64
R2.5	3.30	3.24	3.18	3.14	3.07	3.02
R3.0	3.77	3.71	3.65	3.60	3.54	3.49

F24. Carpeted Timber, Sub-floor Walls, Bulk Insulation Between Joists, Cavity Disconnected or Timber Frame

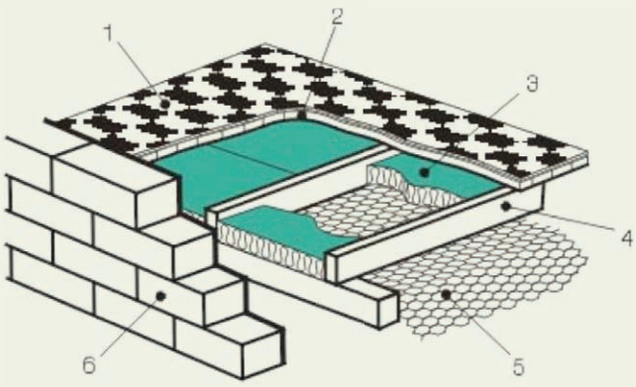


1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Bulk insulation
5. Timber floor joist
6. Mesh
7. Sub-floor wall

Height 0.6 m
Joists @450 or 600 crs
NOTE: R3.0 - 120 mm joists

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
R1.5	3.12	3.05	3.00	2.97	2.91	2.85
R2.0	3.42	3.36	3.30	3.28	3.22	3.17
R2.5	3.85	3.79	3.73	3.70	3.64	3.58
R3.0	4.32	4.26	4.20	4.17	4.10	3.97
Particleboard						
R1.5	3.09	3.02	2.96	2.94	2.87	2.82
R2.0	3.39	3.32	3.27	3.25	3.18	3.13
R2.5	3.82	3.75	3.70	3.68	3.60	3.55
R3.0	4.29	4.22	4.17	4.13	4.07	4.01
Hardwood						
R1.5	3.04	2.98	2.92	2.89	2.83	2.78
R2.0	3.35	3.28	3.23	3.20	3.14	3.09
R2.5	3.77	3.71	3.65	3.62	3.55	3.50
R3.0	4.24	4.18	4.12	4.08	4.02	3.97

F25. Tiled Timber, Sub-floor Walls, Bulk Insulation Between Joists, Cavity Disconnected or Timber Frame

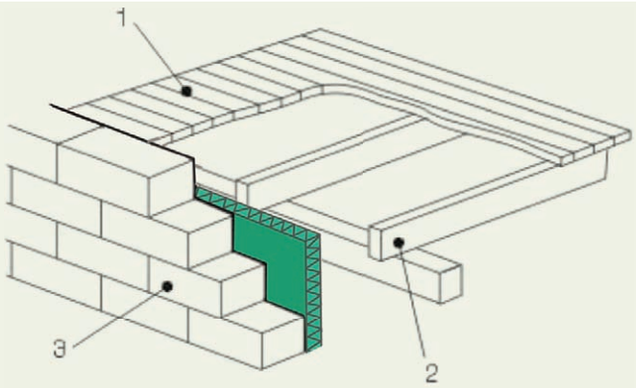


1. 6 mm tiles
2. 19 mm timber floor
3. Bulk insulation
4. Timber floor joist
5. Mesh
6. Sub-floor wall

Height 0.6 m
Joists @450 or 600 crs
NOTE: R3.0 - 120 mm joists

Floor Material	Total R-value for floor system (m²K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
R1.5	2.71	2.64	2.59	2.55	2.49	2.44
R2.0	3.00	2.93	2.88	2.85	2.79	2.73
R2.5	3.40	3.33	3.28	3.24	3.17	3.12
R3.0	3.87	3.80	3.75	3.70	3.64	3.59
Particleboard						
R1.5	2.61	2.61	2.55	2.67	2.46	2.41
R2.0	2.96	2.90	2.84	2.81	2.75	2.70
R2.5	3.36	3.30	3.24	3.20	3.13	3.08
R3.0	3.83	3.77	3.71	3.66	3.60	3.55
Hardwood						
R1.5	2.63	2.57	2.51	2.48	2.41	2.36
R2.0	2.92	2.85	2.80	2.77	2.70	2.65
R2.5	3.31	3.25	3.19	3.15	3.08	3.03
R3.0	3.79	3.72	3.67	3.62	3.55	3.50

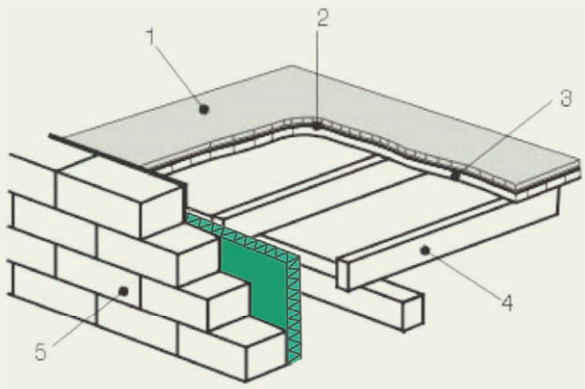
F26. Bare Timber, R1.5 Insulated Sub-floor Walls, Cavity Disconnected or Timber Frame



1. 19 mm timber floor
2. Timber floor joist
3. Sub-floor wall + R1.5

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	1.60	1.45	1.33	1.45	1.30	1.19
2.4 m height	1.28	1.20	1.13	1.15	1.06	1.00
Particleboard						
0.6 m height	1.57	1.42	1.30	1.42	1.27	1.16
2.4 m height	1.25	1.16	1.09	1.12	1.03	0.97
Hardwood						
0.6 m height	1.53	1.38	1.26	1.37	1.23	1.12
2.4 m height	1.21	1.12	1.05	1.08	0.99	0.93
Foil-backed particleboard						
0.6 m height	2.18	2.02	1.91	1.54	1.39	1.29
2.4 m height	1.86	1.77	1.70	1.24	1.16	1.09

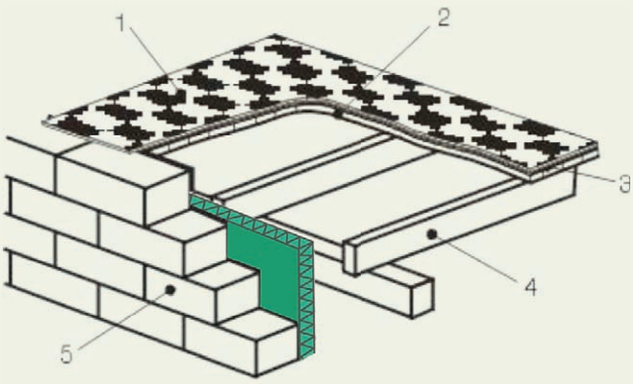
F27. Carpeted Timber, R1.5 Insulated Sub-floor Walls, Cavity Disconnected or Timber Frame



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Timber floor joist
5. Sub-floor wall + R1.5

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.01	1.86	1.74	1.86	1.71	1.6
2.4 m height	1.69	1.61	1.54	1.56	1.47	1.41
Particleboard						
0.6 m height	1.98	1.83	1.71	1.83	1.68	1.57
2.4 m height	1.66	1.57	1.50	1.53	1.44	1.38
Hardwood						
0.6 m height	1.94	1.79	1.67	1.78	1.64	1.53
2.4 m height	1.62	1.53	1.46	1.49	1.40	1.34
Foil-backed particleboard						
0.6 m height	2.59	2.43	2.32	1.95	1.80	1.0
2.4 m height	2.27	2.18	2.11	1.65	1.57	1.50

F28. Tiled Timber, R1.5 Insulated Sub-floor Walls, Cavity Disconnected or Timber Frame

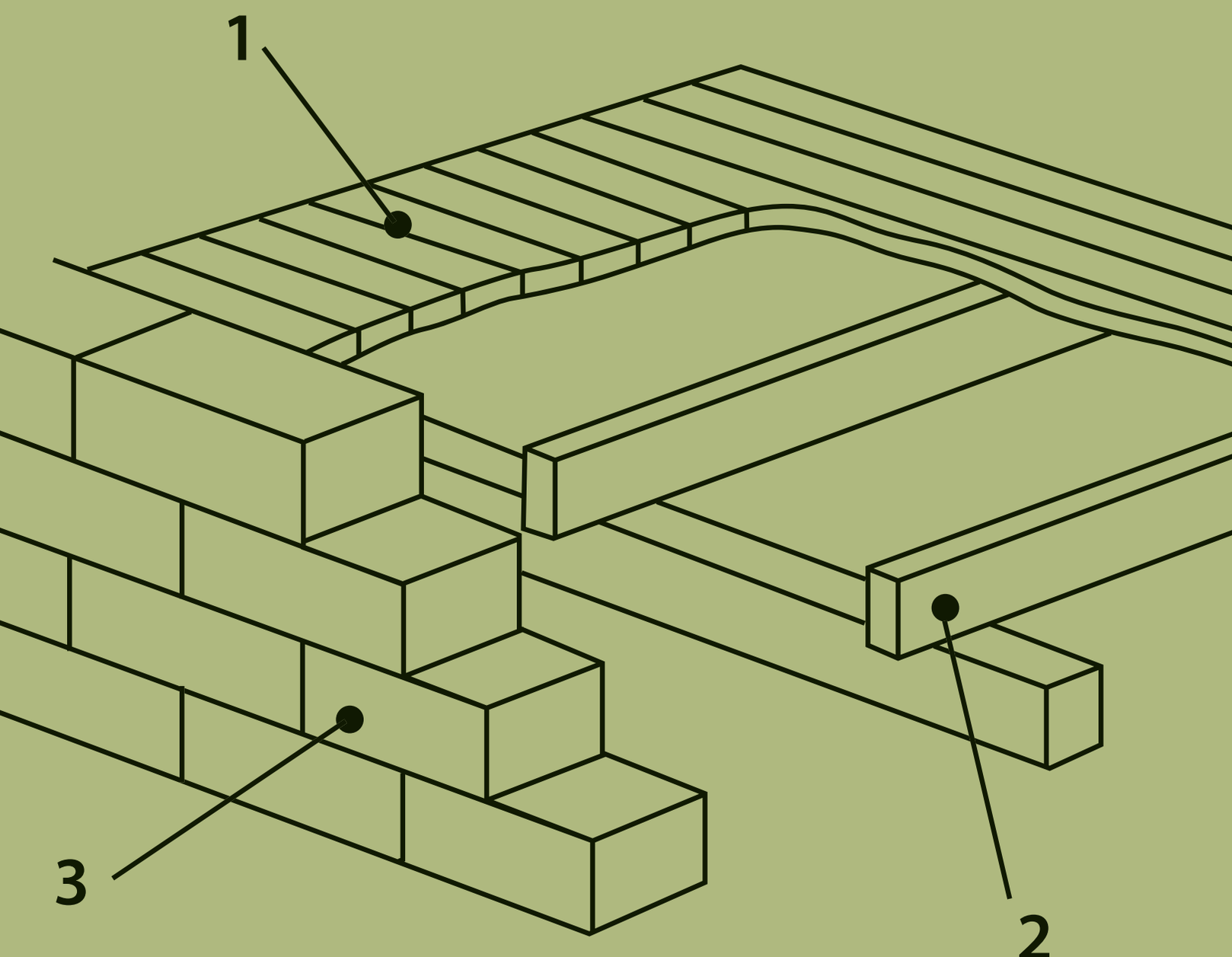


1. 6 mm tiles
2. 19 mm timber floor
3. Tile underlay
4. Timber floor joist
5. Sub-floor wall + R1.5

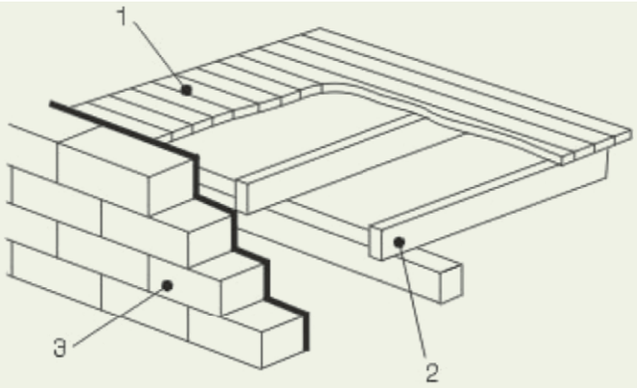
Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	1.61	1.46	1.34	1.46	1.31	1.21
2.4 m height	1.29	1.21	1.14	1.16	1.08	1.01
Particleboard						
0.6 m height	1.58	1.43	1.34	1.43	1.28	1.17
2.4 m height	1.26	1.17	1.10	1.13	1.04	0.98
Hardwood						
0.6 m height	1.54	1.39	1.27	1.39	1.24	1.13
2.4 m height	1.22	1.13	1.06	1.09	1.00	0.94
Foil-backed particleboard						
0.6 m height	2.19	2.03	1.92	1.55	1.40	1.30
2.4 m height	1.87	1.78	1.71	1.25	1.17	1.10

Suspended Timber Floors

Enclosed Sub-Floor, Cavity Connected



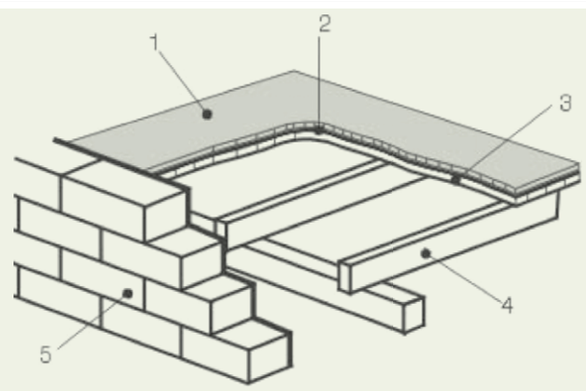
F29. Bare Timber, Sub-floor Walls, Cavity Connected



1. 19 mm timber floor
2. Timber floor joist
3. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	0.75	0.75	0.74	0.63	0.63	0.63
2.4 m height	0.68	0.68	0.67	0.56	0.56	0.56
Particleboard						
0.6 m height	0.72	0.72	0.71	0.61	0.60	0.59
2.4 m height	0.65	0.64	0.64	0.53	0.53	0.52
Hardwood						
0.6 m height	0.68	0.68	0.67	0.57	0.56	0.55
2.4 m height	0.61	0.60	0.60	0.49	0.49	0.48

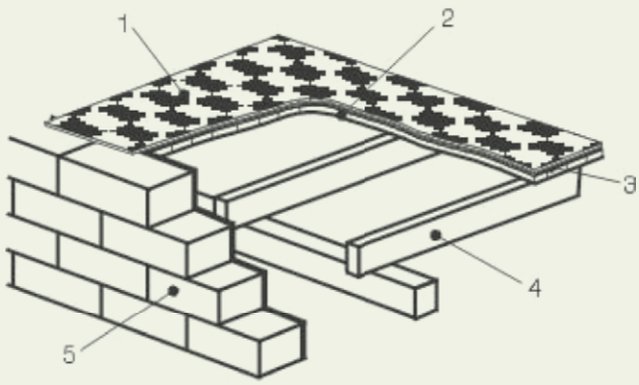
F30. Carpeted Timber, Sub-floor Walls, Cavity Connected



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	1.16	1.16	1.14	1.05	1.04	1.03
2.4 m height	1.09	1.08	1.08	0.97	0.97	0.96
Particleboard						
0.6 m height	1.13	1.12	1.11	1.02	1.01	1.00
2.4 m height	1.05	1.05	1.05	0.94	0.94	0.93
Hardwood						
0.6 m height	1.09	1.08	1.07	0.98	0.97	0.96
2.4 m height	1.01	1.01	1.01	0.90	0.90	0.89

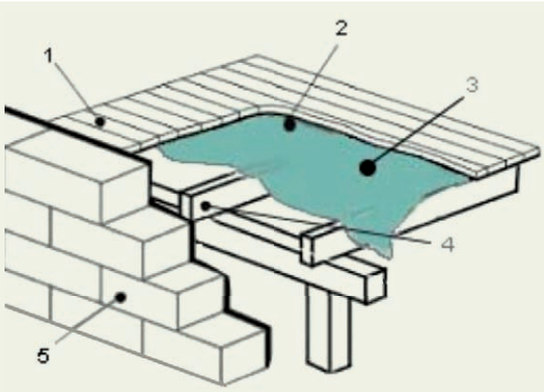
F31. Tiled Timber, Sub-floor Walls, Cavity Connected



1. 6 mm tiles
2. 19 mm timber floor
3. Tile underlay
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	0.76	0.75	0.75	0.64	0.64	0.63
2.4 m height	0.69	0.68	0.68	0.57	0.57	0.57
Particleboard						
0.6 m height	0.73	0.72	0.72	0.61	0.61	0.60
2.4 m height	0.66	0.65	0.65	0.54	0.54	0.54
Hardwood						
0.6 m height	0.69	0.68	0.67	0.57	0.56	0.56
2.4 m height	0.62	0.61	0.61	0.50	0.50	0.49

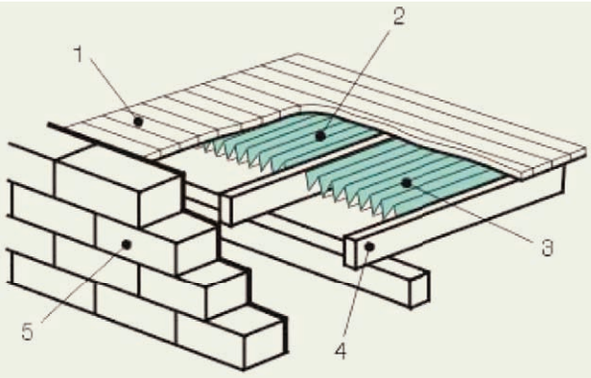
F32. Bare Timber, Sub-floor Walls, RFL Over Joists, Cavity Connected



1. 19 mm timber floor
2. Air space (reflective)
3. RFL
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	1.97	1.96	1.96	1.10	1.09	1.09
2.4 m height	1.90	1.90	1.89	1.03	1.03	1.02
Particleboard						
0.6 m height	1.94	1.93	1.93	1.07	1.07	1.06
2.4 m height	1.87	1.86	1.86	1.00	1.00	0.99
Hardwood						
0.6 m height	1.90	1.89	1.88	1.03	1.02	1.02
2.4 m height	1.83	1.82	1.82	0.96	0.96	0.95

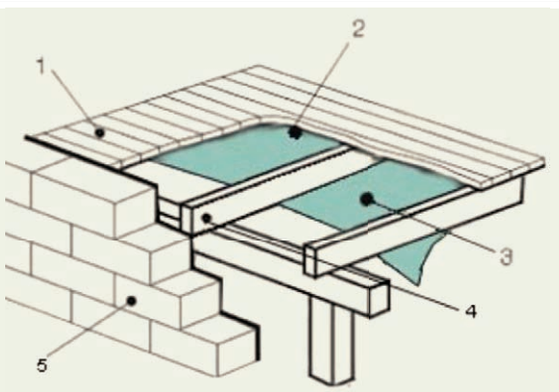
F33. Bare Timber, Sub-floor Walls, RFL Between Joists, Cavity Connected



1. 19 mm timber floor
2. Air space (reflective)
3. RFL
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.33	2.33	2.32	1.22	1.21	1.21
2.4 m height	2.26	2.26	2.26	1.15	1.15	1.14
Particleboard						
0.6 m height	2.30	2.29	2.29	1.19	1.18	1.17
2.4 m height	2.23	2.22	2.22	1.12	1.11	1.11
Hardwood						
0.6 m height	2.26	2.25	2.24	1.14	1.13	1.13
2.4 m height	2.18	2.18	2.18	1.07	1.07	1.07

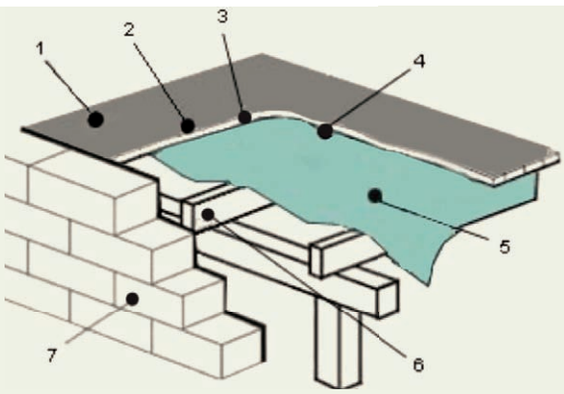
F34. Bare Timber, Sub-floor Walls, RFL Under Joists, Cavity Connected



1. 19 mm timber floor
2. Air space (reflective)
3. RFL
4. Timber floor joist
5. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.48	2.47	2.47	1.23	1.23	1.22
2.4 m height	2.41	2.41	2.40	1.16	1.16	1.16
Particleboard						
0.6 m height	2.45	2.44	2.43	1.20	1.19	1.18
2.4 m height	2.38	2.37	2.37	1.13	1.12	1.12
Hardwood						
0.6 m height	2.41	2.40	2.39	1.15	1.15	1.14
2.4 m height	2.34	2.33	2.33	1.08	1.08	1.08

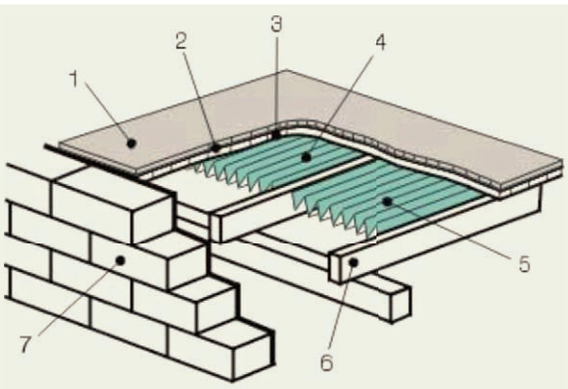
F35. Carpeted Timber, Sub-floor Walls, RFL Over Joists, Cavity Connected



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Air space (reflective)
5.RFL
6. Timber floor joist
7. Sub-floor wall

Floor Material	Total R-value for floor system (m²K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.38	2.37	2.37	1.50	1.49	1.49
2.4 m height	2.31	2.31	2.30	1.43	1.43	1.42
Particleboard						
0.6 m height	2.35	2.34	2.33	1.47	1.46	1.45
2.4 m height	2.28	2.27	2.27	1.40	1.39	1.39
Hardwood						
0.6 m height	2.31	2.30	2.29	1.43	1.42	1.42
2.4 m height	2.24	2.23	2.23	1.36	1.36	1.35

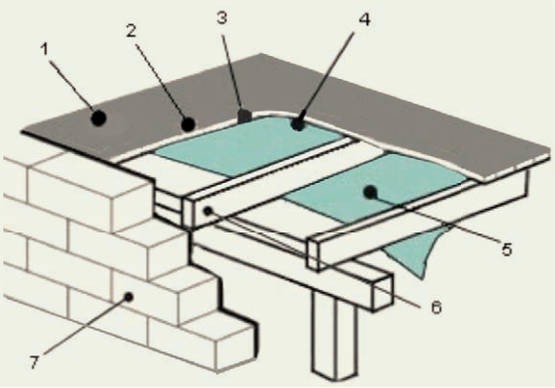
F36. Carpeted Timber, Sub-floor Walls, RFL Between Joists, Cavity Connected



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Air space (reflective)
5.RFL
6. Timber floor joist
7. Sub-floor wall

Floor Material	Total R-value for floor system (m²K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.34	2.35	2.33	1.23	1.23	1.22
2.4 m height	2.27	2.27	2.27	1.16	1.16	1.15
Particleboard						
0.6 m height	2.31	2.30	2.30	1.20	1.18	1.18
2.4 m height	2.24	2.24	2.24	1.13	1.12	1.12
Hardwood						
0.6 m height	2.27	2.26	2.26	1.15	1.14	1.14
2.4 m height	2.19	2.19	2.19	1.08	1.08	1.08

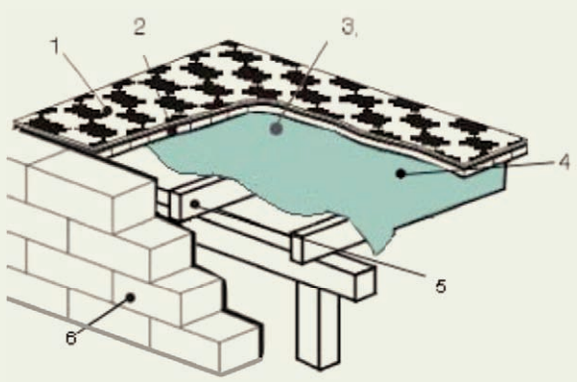
F37. Carpeted Timber, Sub-floor Walls, RFL Under Joists, Cavity Connected



1. 10 mm carpet
2. 10 mm underlay
3. 19 mm timber floor
4. Air space (reflective)
5.RFL
6. Timber floor joist
7. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.89	2.88	2.88	1.63	1.63	1.62
2.4 m height	2.82	2.82	2.81	1.56	1.56	1.56
Particleboard						
0.6 m height	2.86	2.85	2.83	1.60	1.58	1.57
2.4 m height	2.79	2.78	2.78	1.53	1.51	1.52
Hardwood						
0.6 m height	2.82	2.81	2.80	1.55	1.55	1.54
2.4 m height	2.75	2.74	2.74	1.48	1.48	1.48

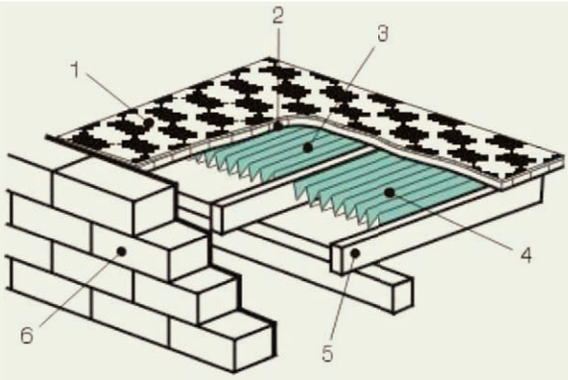
F38. Tiled Timber, Sub-floor Walls, RFL Over Joists, Cavity Connected



1. 6m m tiles
2. 19 mm timber floor
3. Air space (reflective)
4.RFL
5. Timber floor joist
6. Sub-floor wall

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	1.98	1.98	1.97	1.11	1.11	1.10
2.4 m height	1.91	1.91	1.90	1.04	1.04	1.03
Particleboard						
0.6 m height	1.95	1.94	1.94	1.08	1.07	1.07
2.4 m height	1.88	1.88	1.87	1.01	1.00	1.00
Hardwood						
0.6 m height	1.91	1.90	1.90	1.04	1.03	1.03
2.4 m height	1.84	1.83	1.83	0.97	0.97	0.96

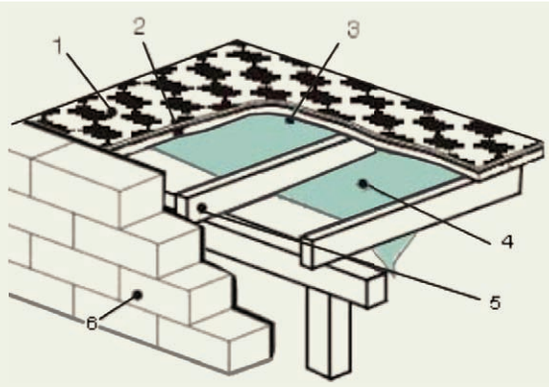
F39. Tiled Timber, Sub-floor Walls, RFL Under Joists, Cavity Connected



1. 6 mm tiles
2. 19 mm timber floor
3. Air space (reflective)
4. RFL
5. Timber floor joist
6. Sub-floor wall

Floor Material	Total R-value for floor system (m²K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.34	2.35	2.33	1.23	1.23	1.22
2.4 m height	2.27	2.27	2.27	1.16	1.16	1.15
Particleboard						
0.6 m height	2.31	2.30	2.30	1.20	1.18	1.18
2.4 m height	2.24	2.24	2.24	1.13	1.12	1.12
Hardwood						
0.6 m height	2.27	2.26	2.26	1.15	1.14	1.14
2.4 m height	2.19	2.19	2.19	1.08	1.08	1.08

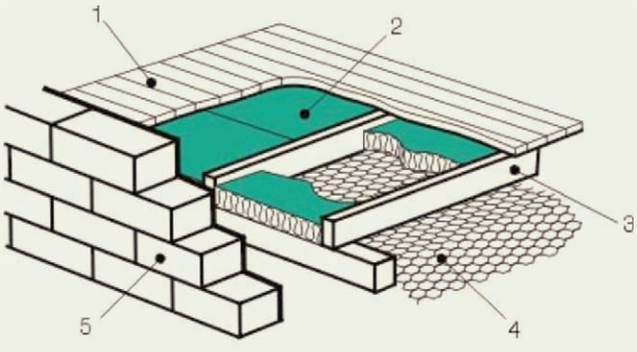
F40. Tiled Timber, Sub-floor Walls, RFL Under Joists, Cavity Connected



1. 6 mm tiles
2. 19 mm timber floor
3. Air space (reflective)
4. RFL
5. Timber floor joist
6. Sub-floor wall

Floor Material	Total R-value for floor system (m²K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
0.6 m height	2.49	2.49	2.48	1.24	1.25	1.23
2.4 m height	2.42	2.42	2.41	1.17	1.17	1.17
Particleboard						
0.6 m height	2.46	2.45	2.44	1.21	1.19	1.19
2.4 m height	2.39	2.39	2.39	1.14	1.13	1.13
Hardwood						
0.6 m height	2.42	2.41	2.41	1.16	1.16	1.15
2.4 m height	2.35	2.34	2.34	1.09	1.09	1.09

F41. Bare Timber, Sub-floor Walls, Bulk Insulation Between Joists, Cavity Connected

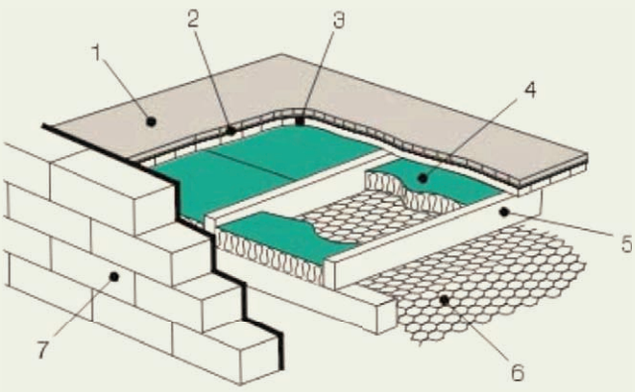


1. 19 mm timber floor
2. Bulk insulation
3. Timber floor joist
4. Mesh
5. Sub-floor wall

Height 0.6 m
Joists @450 or 600 crs
NOTE: R3.0 - 120 mm joists

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
R1.5	2.24	2.23	2.22	2.10	2.09	2.09
R2.0	2.53	2.52	2.51	2.39	2.39	2.38
R2.5	2.93	2.90	2.91	2.78	2.77	2.77
R3.0	3.40	3.39	3.38	3.25	3.24	3.28
Particleboard						
R1.5	2.20	2.19	2.22	2.06	2.06	2.09
R2.0	2.49	2.49	2.56	2.36	2.36	2.42
R2.5	2.89	2.86	2.88	2.74	2.73	2.73
R3.0	3.36	3.35	3.35	3.21	3.20	3.19
Hardwood						
R1.5	2.16	2.15	2.15	2.02	2.03	2.01
R2.0	2.45	2.44	2.43	2.31	2.30	2.30
R2.5	2.84	2.83	2.83	2.69	2.68	2.68
R3.0	3.31	3.30	3.30	3.16	3.15	3.14

F42. Carpeted Timber, Sub-floor Walls, Bulk Insulation Between Joists, Cavity Connected

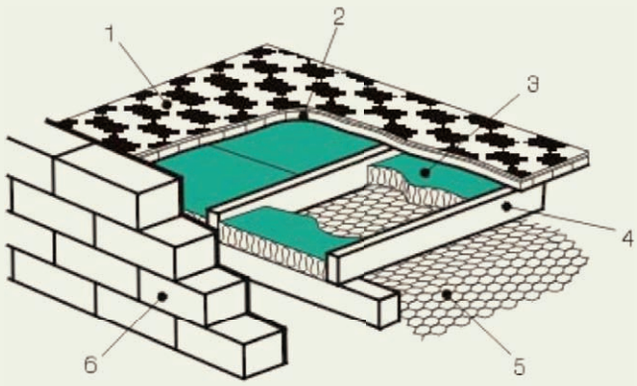


1. 19 mm timber floor
2. Bulk insulation
3. Timber floor joist
4. Mesh
5. Sub-floor wall

Height 0.6 m
Joists @450 or 600 crs
NOTE: R3.0 - 120 mm joists

Floor Material	Total R-value for floor system (m²K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
R1.5	2.66	2.65	2.64	2.42	2.52	2.51
R2.0	2.96	2.95	2.95	2.83	2.83	2.82
R2.5	3.39	3.38	3.38	3.23	3.25	3.24
R3.0	3.86	3.86	3.85	3.60	3.71	3.71
Particleboard						
R1.5	2.62	2.62	2.61	2.39	2.48	2.48
R2.0	2.93	2.92	2.91	2.80	2.79	2.79
R2.5	3.36	3.35	3.34	3.19	3.21	3.20
R3.0	3.83	3.82	3.81	3.56	3.68	3.67
Hardwood						
R1.5	2.58	2.57	2.57	2.35	2.44	2.43
R2.0	2.89	2.88	2.87	2.76	2.75	2.75
R2.5	3.31	3.30	3.30	3.15	3.17	3.16
R3.0	3.78	3.77	3.77	3.52	3.63	3.20

F43. Tiled Timber, Sub-floor Walls, Bulk Insulation Between Joists, Cavity Connected



1. 6 mm tiles
2. 19 mm timber floor
3. Bulk insulation
4. Timber floor joist
5. Mesh
6. Sub-floor wall

Height 0.6 m
Joists @450 or 600 crs
NOTE: R3.0 - 120 mm joists

Floor Material	Total R-value for floor system (m^2K/W)					
	Heat flow DOWN			Heat flow UP		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Softwood						
R1.5	2.25	2.24	2.23	2.11	2.10	2.10
R2.0	2.54	2.53	2.52	2.40	2.40	2.39
R2.5	2.94	2.92	2.91	2.79	2.78	2.78
R3.0	3.41	3.40	3.40	3.26	3.25	3.25
Particleboard						
R1.5	2.21	2.20	2.23	2.07	2.07	2.10
R2.0	2.59	2.57	2.57	2.44	2.43	2.43
R2.5	2.90	2.87	2.89	2.75	2.74	2.74
R3.0	3.37	3.36	3.36	3.22	3.21	3.20
Hardwood						
R1.5	2.17	2.16	2.16	2.03	2.04	2.02
R2.0	2.46	2.45	2.44	2.32	2.31	2.31
R2.5	2.85	2.84	2.84	2.70	2.69	2.69
R3.0	3.32	3.31	3.31	3.17	3.16	3.15

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