BUILDING PERFORMANCE

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Effective until 4 August 2022
Replaced by H1/AS1 Fifth Edition Amendment 1

H1 Energy Efficiency

Acceptable Solution H1/AS1

Energy efficiency for all housing, and buildings up to 300 m²

FIFTH EDITION | EFFECTIVE 29 NOVEMBER 2021

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

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Preface

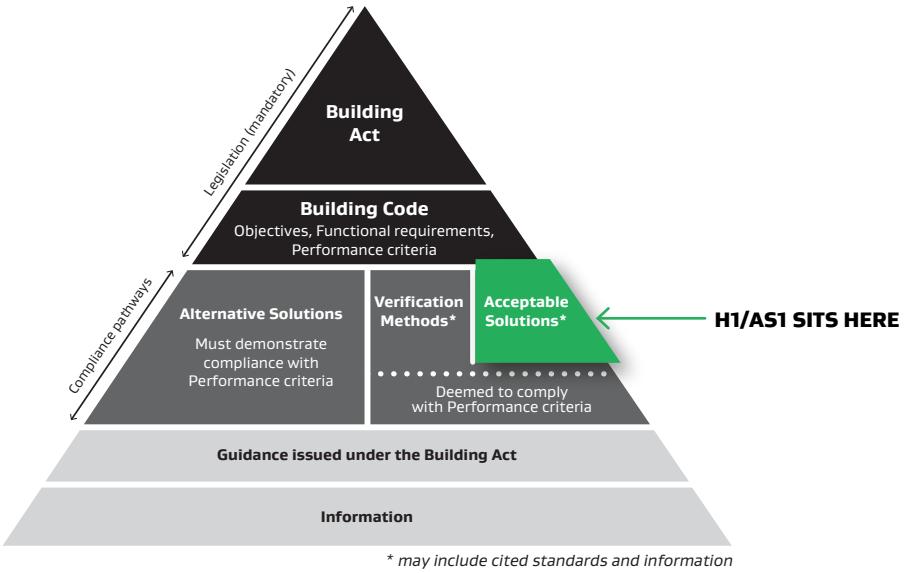
Document status

This document (H1/AS1) is an acceptable solution issued under section 22 (1) of the Building Act 2004 and is effective on 29 November 2021. It does not apply to building consent applications submitted before 29 November 2021. The previous Acceptable Solution H1/AS1 Fourth Edition Amendment 4, can be used to show compliance until 2 November 2022 and can be used for building consent applications submitted before 3 November 2022.

Building Code regulatory system

Each acceptable solution outlines the provisions of the Building Code that it relates to. Complying with an acceptable solution or verification method is a way of complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act.

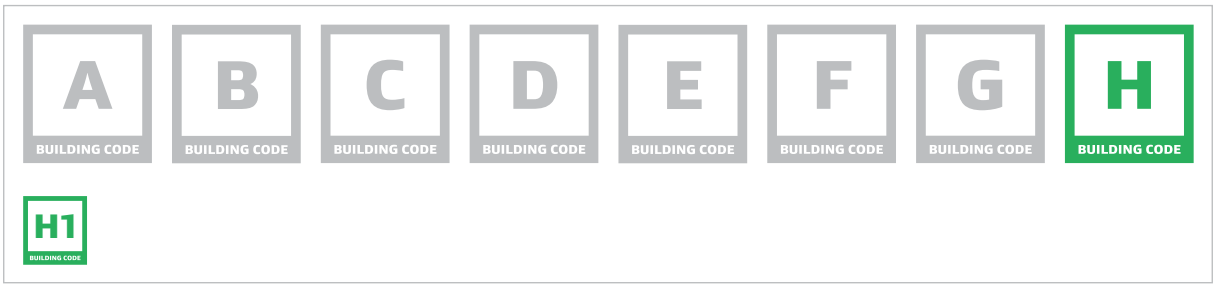
Schematic of the Building Code System



** may include cited standards and information*

A building design must take into account all parts of the Building Code. The Building Code is located in Schedule 1 of the Building Regulations 1992 and available online at www.legislation.govt.nz

The part of the Building Code that this acceptable solution relates to is clause H Energy Efficiency. Further information on the scope of this document is provided in Part 1. General.



Further information about the Building Code, the objectives, functional requirements and performance criteria provisions that it contains, and other acceptable solutions and verification methods are available at www.building.govt.nz

Main changes in this version

This acceptable solution is the fifth edition of H1/AS1. The main changes from the previous version are:

- The scope of H1/AS1 has been reduced to cover only housing, and buildings other than housing less than 300 m^2. Requirements applicable to buildings other than housing over 300 m^2 have been combined into the new Acceptable Solution H1/AS2. To reflect the new scope of the documents and the new document layout, a new introduction and scope has been provided in Part 1. General.
- Buildings with curtain walling have been excluded from the scope of H1/AS1.
- Citation of NZS 4218: 2009 "Thermal insulation – Housing and small buildings" has been removed from the document. The relevant content from this standard has been adopted into H1/AS1 with permission from Standards New Zealand.
- The minimum R-values previously found in NZS 4218 are replaced with new values and new text in Part 2. Building thermal envelope.
- The requirements for determining the thermal resistance and construction R-value of building elements have been revised to better reflect the thermal performance of windows, doors, skylights and slab-on-ground floors.
- Portions of text have been re-written to enhance clarity in the document and provide consistent language with other acceptable solutions and verification methods.
- Requirements for artificial lighting have been removed from H1/AS1 as these now apply to buildings outside of the new scope of H1/AS1.
- References have been revised to include only documents within the scope of H1/AS1 and have been amended to include the most recent versions of AS/NZS 4859.1, NZS 4246, and ALF in Appendix A.
- Additional references have been added to include BS EN 673, ISO 10077-1, ISO 13370, and ISO 13789 in Appendix A.
- The definitions page has been revised to include all defined terms used in this document in Appendix B.
- The three-zone climate zone map previously found in NZS 4218 has been updated with a six-zone climate zone map in Appendix C.
- Requirements for establishing the orientation of a building have been added in Appendix D.
- The thermal performance tables for windows and glazing previously found in NZS 4218 have been replaced with a single table with updated construction R-values for vertical windows and doors in Appendix E.
- Tables with construction R-values of selected slab-on-ground floor scenarios have been added to a new Appendix F.

People using this document should check for amendments on a regular basis. The Ministry of Business, Innovation and Employment may amend any part of any acceptable solution or verification method at any time. Up-to-date versions of acceptable solutions or verification methods are available from www.building.govt.nz.

Features of this document

- For the purposes of Building Code compliance, the standards and documents referenced in this acceptable solution must be the editions, along with their specific amendments listed in Appendix A.
- Words in *italic* are defined at the end of this document in Appendix B.
- Hyperlinks are provided to cross-references within this document and to external websites and appear with a blue underline.
- Classified uses for *buildings*, as described in clause A1 of the Building Code, are printed in **bold** in this document. These requirements are also denoted with classified use icons for:

H **Housing**	Com **Commercial**	Out **Outbuildings**
CR **Communal residential**	Ind **Industrial**	Anc **Ancillary**
CN **Communal non-residential**		

- Appendices to this acceptable solution are part of, and have equal status to, the acceptable solution. Figures are informative only and the wording of the paragraphs takes precedence. Text boxes headed 'COMMENT' occur throughout this document and are for guidance purposes only.

Contents

Part 1. General

1.1 Introduction

1.1.1 Scope of this document

1.1.1.1 This document applies to:

H

a) **housing**; and

b) other *buildings* with a *floor area* of *occupied space* no greater than 300 m^2.

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COMMENT: **Housing** includes detached dwellings, multi-unit dwellings such as *buildings* which contain more than one separate household or family, e.g. an apartment *building*, and also group dwellings, e.g. a *wharenui*.

1.1.1.2 For *buildings* that do not meet these characteristics, refer to the Acceptable Solution H1/AS2 or Verification Method H1/VM2 as a means to demonstrate compliance or use an alternative means to demonstrate compliance.

1.1.2 Items outside the scope of this document

1.1.2.1 This acceptable solution does not include the use of foil insulation.

1.1.2.2 This acceptable solution does not apply to *buildings* with *curtain walling*. For these, use Verification Method H1/VM1 or use an alternative means to demonstrate compliance.

Com 1.1.2.3 For **commercial** *buildings*, this acceptable solution does not include requirements to comply with clause H1.3.6 of the Building Code. For this clause, use Verification Method H1/VM3 or use an alternative means to demonstrate compliance.

1.1.3 Compliance pathway

1.1.3.1 This acceptable solution is one option that provides a means of establishing compliance with the performance criteria in Building Code clauses H1.3.1, H1.3.3, H1.3.4, and H1.3.5.

1.1.3.2 Options for demonstrating compliance with H1 Energy Efficiency through the use of acceptable solutions and verification methods are summarised in Table 1.1.3.2. Compliance may also be demonstrated using an alternative solution.

1.1.3.3 Compliance with Building Code clause H1.3.1(a) (*adequate thermal resistance*) satisfies clause H1.3.2E (*Building Performance Index* or *BPI*).

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COMMENT:

1. The Schedule and Calculation methods as described in Part 2 are acceptable solutions for Building Code clause H1.3.1(a) (*adequate thermal resistance*). However, compliance with clause H1.3.2E (*Building Performance Index or BPI*) is not sufficient for demonstrating compliance with clause H1.3.1(a) (*adequate thermal resistance*).
2. ALF 4.0, published by BRANZ, calculates the *BPI*. Note that the ALF procedures are intended for detached dwellings and are not suitable for multi-unit dwellings.
3. The 20°C stated in the definition of *heating energy* is for calculation purposes only.

TABLE 1.1.3.2: Demonstrating compliance with H1 Energy Efficiency through acceptable solutions and verification methods

Paragraph 1.1.3.2

Performance clause	Applies to	Relevant acceptable solutions and verification methods
H1.3.1 (a) and (b) *Thermal Envelope*	H **Housing** CR **Communal residential** CN **Communal non-residential** (assembly care only) Com **Commercial**	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large *buildings*: H1/AS2 or H1/VM2
H1.3.2E *Building performance index*	H **Housing**	H1/AS1 or H1/VM1
H1.3.3 (a) to (f) Physical conditions	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 or H1/VM1 For large *buildings*: H1/AS2 or H1/VM2
H1.3.4 (a) Heating of hot water	All *buildings*	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (b) Storage vessels and distribution systems	Individual storage vessels ≤ 700 L in capacity and distribution systems	For **housing**, and *buildings* no greater than 300 m²: H1/AS1 For large *buildings*: H1/AS2
H1.3.4 (c) Efficient use of hot water	H **Housing**	H1/AS1
H1.3.5 Artificial lighting	Lighting not provided solely to meet the requirements of Building Code clause F6 in: Com CN **Commercial** and **Communal non-residential** having *occupied space* greater than 300 m²	H1/AS2
H.1.3.6 *HVAC systems*	Com **Commercial**	H1/VM3

1.2 Using this acceptable solution

1.2.1 Determining the classified use

1.2.1.1 Classified uses for *buildings* are described in clause A1 of the Building Code. Where a specific classified use is mentioned within a subheading and/or within the text of a paragraph, this requirement applies only to the specified classified use(s), and does not apply to other classified uses.

Ind 1.2.1.2 In *buildings* containing both **industrial** and other classified uses, the non-industrial portion shall be treated separately according to its classified use. For example, in a *building* containing both **industrial** and **commercial** classified uses, the **commercial** area shall meet the relevant energy efficiency requirements of the Building Code.

1.2.2 Determining the area of the building

H 1.2.2.1 For **housing**, use the *floor area* of the *building*.

1.2.2.2 For *buildings* other than **housing**, calculate the area based on the *occupied space* of the *building*.

Part 2. Building thermal envelope

2.1 Thermal resistance

2.1.1 Demonstrating compliance

H CR CN Com

2.1.1.1 For **housing, communal residential, communal non-residential** assembly care, and **commercial** *buildings,* the *building envelope* shall be provided with *construction* that provides *adequate thermal resistance.* The minimum required *construction R-values* shall be determined through the use of:

a) The Schedule method in Subsection 2.1.2, or

b) The Calculation method in Subsection 2.1.3, or

c) The Modelling method in H1/VM1.

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COMMENT: To satisfy the Building Code performance requirement E3.3.1 for internal moisture, it may be necessary, depending on the method adopted, to provide more insulation (a greater *R-value*) than that required to satisfy energy efficiency provisions alone.

2.1.1.2 The requirements for the Schedule method and Calculation method are separated based on the relevant climate zone for the *building*. A list of the New Zealand Climate zones is provided in Appendix C.

2.1.1.3 For *building elements* with embedded heating systems, the minimum *construction R-values* shall be determined through the Schedule method. These apply whenever *building elements* that are part of the *thermal envelope* include heating systems and may not be reduced by applying the Calculation method in Subsection 2.1.3.

2.1.1.4 The *construction R-values* of individual *building elements* shall be determined in accordance with Subsection 2.1.4.

2.1.1.5 Insulation materials shall be installed in a way that achieves the intended thermal performance in *buildings* without compromising the durability and safety of insulation or *building elements* and the health and safety of installers and *building* occupants. NZS 4246 sections 5, 6, 7 and 10 provide acceptable methods for installing bulk thermal insulation in light-timber and steel-framed residential *buildings*.

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COMMENT: Slab perimeter insulation should be protected against water absorption, ultraviolet (UV) exposure, and impact damage. However, deviating from step 2 in section 10.3 in NZS 4246, encapsulation of slab perimeter insulation is not recommended as it can result in moisture getting trapped.

2.1.2 Schedule method

2.1.2.1 The schedule method shall only be used where:

a) The *glazing* area is 30% or less of the *total wall area*; and

b) The combined *glazing area* on the east, south, and west facing walls (refer to Appendix D) is 30% or less of the combined total area of these walls; and

c) The *skylight area* is no more than 1.5 m^2 or 1.5% of the *total roof area* (whichever is greater);

d) The *opaque door area* is no more than 6 m^2 or 6% of the *total wall area* (whichever is greater).

2.1.2.2 *Building elements* that are part of the *thermal envelope* shall have minimum *construction R-values* no less than those in:

a) For *building elements* that contain embedded heating systems, those in Table 2.1.2.2A; or

b) For *building elements* that do not contain embedded heating systems, those in Table 2.1.2.2B.

2.1.2.3 For *building consent* applications submitted before 2 November 2023, the minimum *construction R-values* for windows and doors in climate zones 1 and 2 are permitted to be reduced to R0.37 m²·K/W.

COMMENT: Paragraph 2.1.2.3. allows for a longer transition period for higher minimum *construction R-values* for windows and doors in climate zones 1 and 2. However, starting on 2 November 2023, all *building consent* applications for climate zones 1 and 2 must use a minimum *construction R-value* of R0.46 m²·K/W.

TABLE 2.1.2.2A: Minimum construction R-values for heated ceilings, walls or floors

Paragraph 2.1.2.2 a), 2.1.3.1

Building element	Construction R-values (m²·K/W)[1],[2],[3]					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Heated ceiling[4]	R6.6	R6.6	R6.6	R6.6	R6.6	R6.6
Heated wall	R2.9	R2.9	R2.9	R2.9	R2.9	R2.9
Heated floor	R2.5	R2.5	R2.5	R2.8	R3.0	R3.0

Notes:

(1) R_{IN}/*R-value* < 0.1 and R_{IN} is the *thermal resistance* between the heated plane and the inside air.

(2) Floor coverings, for example carpet or cork, will reduce the efficiency of the *heated floor*.

(3) Climate zone boundaries are shown in Appendix C.

(4) In *roofs* with a *roof* space, where the insulation is installed over a horizontal ceiling, the *roof R-value* may be reduced to R3.3 for a distance of up to 500 mm from the outer edge of the ceiling perimeter where space restrictions do not allow full-thickness insulation to be installed.

TABLE 2.1.2.2B: Minimum construction R-values for building elements that do not contain embedded heating systems

Paragraph 2.1.2.2 b), 2.1.3.1

Building element	Construction R-values (m²·K/W)[1]					
	Climate zone 1	Climate zone 2	Climate zone 3	Climate zone 4	Climate zone 5	Climate zone 6
Roof[2]	R6.6	R6.6	R6.6	R6.6	R6.6	R6.6
Wall	R2.0	R2.0	R2.0	R2.0	R2.0	R2.0
Floor						
Slab-on-ground floors	R1.5	R1.5	R1.5	R1.5	R1.6	R1.7
Floors other than *slab-on-ground*	R2.5	R2.5	R2.5	R2.8	R3.0	R3.0
Windows and doors[3]	R0.46[3]	R0.46[3]	R0.46	R0.46	R0.50	R0.50
Skylights	R0.46	R0.46	R0.54	R0.54	R0.62	R0.62

Notes:

(1) Climate zone boundaries are shown in Appendix C.

(2) In *roofs* with a *roof* space, where the insulation is installed over a horizontal ceiling, the *roof R-value* may be reduced to R3.3 for a distance of up to 500 mm from the outer edge of the ceiling perimeter where space restrictions do not allow the full-thickness of insulation to be installed.

(3) For *building consent* applications submitted before 2 November 2023, the minimum *construction R-values* for windows and doors in climate zones 1 and 2 are permitted to be reduced to R0.37 m²·K/W.

2.1.3 Calculation method

2.1.3.1 This method compares the proposed *building* with the reference *building* which is insulated in accordance with Table 2.1.2.2A and Table 2.1.2.2B. This method permits *roof*, wall, floor, window, door, and *skylight* insulation combinations which differ from these tables, but the *building* must perform at least as well as the reference *building*.

2.1.3.2 The calculation method shall only be used where the *glazing area* is 40% or less of the *total wall area*.

2.1.3.3 *Building elements* that form part of the *thermal envelope* with *construction R-values* different from those in the Schedule method in Subsection 2.1.2 may be used providing the heat loss of the proposed *building* ($HL_{Proposed}$) is less than or equal to the heat loss of the reference *building* ($HL_{Reference}$) for the relevant climate zone and window *area*.

2.1.3.4 $HL_{Reference}$ shall be calculated using the equations in Table 2.1.3.4.

TABLE 2.1.3.4: Reference building heat loss equations

Paragraph 2.1.3.4

Climate zone[1]	Reference building heat loss equation[3]
1 and 2[2]	$HL_{Reference} = \frac{A_{roof} + A_{skylight}}{6.6} + \frac{A_{70\% \text{ of the total wall area}}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.5} + \frac{A_{other\ floor}}{2.5} + \frac{A_{30\% \text{ of total wall area}}}{0.46}$
3	$HL_{Reference} = \frac{A_{roof} + A_{skylight}}{6.6} + \frac{A_{70\% \text{ of the total wall area}}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.5} + \frac{A_{other\ floor}}{2.5} + \frac{A_{30\% \text{ of total wall area}}}{0.46}$
4	$HL_{Reference} = \frac{A_{roof} + A_{skylight}}{6.6} + \frac{A_{70\% \text{ of the total wall area}}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.5} + \frac{A_{other\ floor}}{2.8} + \frac{A_{30\% \text{ of total wall area}}}{0.46}$
5	$HL_{Reference} = \frac{A_{roof} + A_{skylight}}{6.6} + \frac{A_{70\% \text{ of the total wall area}}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.6} + \frac{A_{other\ floor}}{3.0} + \frac{A_{30\% \text{ of total wall area}}}{0.50}$
6	$HL_{Reference} = \frac{A_{roof} + A_{skylight}}{6.6} + \frac{A_{70\% \text{ of the total wall area}}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.7} + \frac{A_{other\ floor}}{3.0} + \frac{A_{30\% \text{ of total wall area}}}{0.50}$

Notes:

(1) Climate zone boundaries are shown in Appendix C.

(2) For *building consent* applications submitted before 2 November 2023 for climate zones 1 and 2, $HL_{Reference}$ is permitted to be calculated in accordance with Paragraph 2.1.3.5.

(3) For these equations,$HL_{Reference}$ is the heat loss of the reference *building*, and

A_{roof} is the *roof area* of the proposed *building* (m^2), and
$A_{skylight}$ is the *skylight* area of the proposed *building* (m^2), and
$A_{70\% \text{ of total wall area}}$ is the 70% of the *total wall area* of the proposed *building thermal envelope* (m^2), and
$A_{30\% \text{ of total wall area}}$ is the 30% of the *total wall area* of the proposed *building thermal envelope* (m^2), and
$A_{slab\text{-}on\text{-}ground\ floor}$ is the area of *slab-on-ground floors* in the proposed *building thermal envelope* (m^2), and
$A_{otherfloor}$ is the area of other floors in the *thermal envelope* of the proposed *building* (m^2).

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COMMENT: The reference *building* used in these equations has the minimum *construction R-values* for each climate zone given in the Schedule method in Table 2.1.2.2B. It is assumed that the *reference building* has the same *roof area, skylight area*, and areas of floor as the proposed *building*. The *total wall area* in the reference *building* is assumed to contain a *glazing area* of 30%.

2.1.3.5 For *building consent* applications submitted before 2 November 2023 for climate zones 1 and 2, $HL_{Reference}$ is permitted to be calculated using Equation 1.

Equation 1: $$HL_{Reference} = \frac{A_{roof} + A_{skylight}}{6.6} + \frac{A_{70\% \text{ of the total wall area}}}{2.0} + \frac{A_{slab\text{-}on\text{-}ground\ floor}}{1.5} + \frac{A_{other\ floor}}{2.5} + \frac{A_{30\% \text{ of total wall area}}}{0.37}$$

where:

$HL_{Reference}$ is the heat loss of the reference *building*, and
A_{roof} is the *roof area* of the proposed *building* (m^2), and
$A_{skylight}$ is the *skylight area* of the proposed *building* (m^2), and
$A_{70\% \text{ of total wall area}}$ equals 70% of the *total wall area* of the proposed *building* (m^2), and
$A_{30\% \text{ of total wall area}}$ equals 30% of the *total wall area* of the proposed *building* (m^2), and
$A_{slab\text{-}on\text{-}ground\ floor}$ is the area of *slab-on-ground floors* in the *thermal envelope* of the proposed *building* (m^2), and
$A_{otherfloor}$ is the area of other floors in the *thermal envelope* of the proposed *building* (m^2).

COMMENT: Paragraph 2.1.3.5 allows for a longer transition period for higher minimum *construction R-values* for windows and doors in climate zones 1 and 2. However, starting on 2 November 2023, all *building consent* applications for climate zones 1 and 2 must use the minimum *construction R-value* for the reference *building* of R0.46 $m^2 \cdot K/W$ for windows and doors and the equations in Table 2.1.3.4

2.1.3.6 $HL_{Proposed}$ shall be calculated as the sum of all the *building element* heat losses according to Equation 2.

Equation 2: $$HL_{Reference} = \frac{A_{roof}}{R_{roof}} + \frac{A_{wall}}{R_{wall}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{glazing}}{R_{window}} + \frac{A_{door,\ opaque}}{R_{door,\ opaque}} + \frac{A_{skylight}}{R_{skylight}}$$

where:
$HL_{Proposed}$ is the heat loss of the proposed *building*, and
A_{roof} is the *roof area* of the proposed *building* (m^2), and
R_{roof} is the *construction R-value* of the *roof* in the proposed *thermal envelope* ($m^2 \cdot K/W$), and
A_{wall} is the *wall area* of the proposed *building* (m^2), and
R_{wall} is the *construction R-value* of the wall in the proposed *thermal envelope* ($m^2 \cdot K/W$), and
A_{floor} is the *thermal envelope floor area* of the proposed *building* (m^2), and
R_{floor} is the *construction R-value* of the floor in the proposed *thermal envelope* ($m^2 \cdot K/W$), and
$A_{glazing}$ is the *glazing area* of the proposed *building* (m^2), and
R_{window} is the *construction R-value* of the vertical windows, and glazing in doors, in the proposed *thermal envelope* ($m^2 \cdot K/W$) and
$A_{door,opaque}$ is the *opaque door area* of the proposed *building* (m^2) and
$R_{door,opaque}$ is the *construction R-value* of *opaque door areas* in the proposed *thermal envelope* ($m^2 \cdot K/W$) and
$A_{skylight}$ is the *skylight area* of the proposed *building* (m^2) and
$R_{skylight}$ is the *construction R-value* of the *skylight(s)* in the proposed *thermal envelope* ($m^2 \cdot K/W$).

2.1.3.7 Where a *building element* is proposed to have parts with different *thermal resistances* (for example walls with different *construction R-values*), the corresponding term in Equation 2 shall be expanded to suit. For example:

$$\frac{A_{wall}}{R_{wall}} \text{ becomes } \frac{A_{wall(1)}}{R_{wall(1)}} + \frac{A_{wall(2)}}{R_{wall(2)}}$$

2.1.3.8 The *construction R-value* in the proposed *building* for *roofs*, walls, and floors, that form part of the *building thermal envelope* shall be at least 50% of the *construction R-value* of the corresponding *building element* in the reference *building* equation.

2.1.3.9 Where the *construction R-value* of a *building element* is not known, default *construction R-values* of 0.18 $m^2 \cdot K/W$ for an opaque *building element* and 0.15 $m^2 \cdot K/W$ for windows shall be used in the heat loss equation for the proposed *building*.

2.1.4 Determining thermal resistance of building elements

2.1.4.1 Acceptable methods for determining the *thermal resistance* (*R-values*) of *building elements* are:

a) For walls, *roofs* and floors other than *slab-on-ground floors*, contained in NZS 4214; and

b) For windows, doors and *skylights*, specified in Appendix E; and

c) For *slab-on-ground floors*, specified in Appendix F.

> COMMENT: The BRANZ House Insulation Guide provides *thermal resistances* of common *building* components and is based on calculations from NZS 4214. However, the BRANZ House Insulation Guide, 5th edition or earlier, should not be used for determining the *thermal resistances* of *slab-on-ground floors*, windows and doors due to differences in calculation methods and assumptions compared to Appendix E and Appendix F.

2.1.4.2 The *thermal resistance (R-values)* of insulation materials may be verified by using AS/NZS 4859.1.

2.1.4.3 The *construction R-values* of *building elements* shall be calculated as follows:

a) For walls and *roofs*, the *R-value* is of a typical area of the *building element*; and

b) For framed walls, the *R-value* shall include the effects of studs, dwangs, top plates and bottom plates, but may exclude the effects of lintels, sills, additional studs that support lintels and sills, and additional studs at corners and junctions; and

c) For walls without frames, the *R-value* excludes any attachment requirements for windows and doors; and

d) For windows, doors and *skylights*, as specified in Appendix E; and

e) For *slab-on-ground* floors, the *R-value* is as specified in Appendix F; and

f) For floors other than *slab-on-ground floors*, the *R-value* is of a typical area of the floor ignoring the effect of floor coverings (including carpets).

2.1.4.4 The *R-value* of an unconditioned air-space between the *thermal envelope* and the *building envelope* may be included in the *construction R-value*. This can include a subfloor, *roof* space, garage, and/or conservatory.

> COMMENT: Garages should form part of the *unconditioned space* of a *building*, that is, they should be outside the *thermal envelope*. Any *building elements* between attached garages and the *conditioned spaces* of a *building* form part of the *thermal envelope* and should therefore be insulated.

2.2 Airflow

2.2.1 Control of airflow

2.2.1.1 **Housing, communal residential, communal non-residential** assembly care, and **commercial** *buildings* shall have windows, doors, vents or other *building elements* that allow significant movement of air, to be *constructed* in such a way that they are capable of being fixed in the closed position.

COMMENT:

1. G4/AS1 provides for the supply of outdoor air for ventilation by way of windows and doors that can be fixed in the open position.
2. Measures should be taken to limit the amount of moisture that can migrate from *occupied spaces* into the *roof* or *roof* space. This includes limiting the air permeability of ceilings, including through ceiling linings and penetrations such as recessed luminaires, electrical and plumbing services, and ceiling access hatches.

2.3 Solar heat gains

2.3.1 Control of solar heat gains

2.3.1.1 Requirements to account for heat gains from solar radiation are satisfied by complying with the requirements for *thermal resistance* in Section 2.1.

COMMENT: Passive measures to prevent overheating from excessive solar heat gains through the *building envelope* should be taken to reduce dependence on active cooling systems. Such measures should include a combination of:

- Providing *adequate thermal resistance* to the *thermal envelope* of the *building*; and
- Avoiding excessive *window areas* (particularly on the east, north and west-facing facades); and
- Avoiding excessive *skylight* areas; and
- Selecting glass types with appropriate *solar heat gain coefficients (SHGC)*; and
- Providing external shading for windows and *skylights*; and
- Providing the ability to ventilate the *building* at a sufficient rate to maintain comfortable indoor temperatures in summer.

Part 3. Building services

3.1 Hot water systems

3.1.1 Hot water systems for sanitary fixtures and sanitary appliances

3.1.1.1 Hot water systems for *sanitary fixtures* and *sanitary appliances* having a storage water heater capacity of up to 700 litres shall comply with NZS 4305.

COMMENT:

1. NZS 4305 deals with domestic type electrical and gas systems having a storage water heater capacity of up to 700 litres. Larger systems and their associated piping are not controlled by the Building Code.
2. The manufacture and sale of hot water cylinders and gas water heaters are covered by the Energy Efficiency (Energy Using Products) Regulations 2002. The associated NZ Minimum Energy Performance Standards for electric storage water heaters (MEPS as defined in NZS 4606.1 and the relevant NZ section of AS/NZS 4692.2) are equivalent to the requirements in this acceptable solution (see NZS 4305 clause 2.1.1). Electric storage water heaters that do not comply with NZ MEPS do not comply with this acceptable solution.

Appendix A. References

For the purposes of Building Code compliance, the standards and documents referenced in this acceptable solution must be the editions, along with their specific amendments, listed below.

Standards New Zealand		Where quoted
NZS 4214: 2006	Methods of determining the total thermal resistance of parts of buildings	2.1.4.1, Definitions
NZS 4246: 2016	Energy efficiency – Installing bulk thermal insulation in residential buildings	2.1.1.5
NZS 4305: 1996	Energy efficiency – domestic type hot water systems	3.1.1.1
NZS 4606:-	Storage water heaters	
Part 1: 1989	General requirements	3.1.1.1 Comment
AS/NZS 4692:-	Electric water heaters	
Part 2: 2005	Minimum Energy Performance Standards (MEPS) requirements and energy labelling	3.1.1.1 Comment
AS/NZS 4859:-	Thermal insulation materials for buildings	
Part 1: 2018	General criteria and technical provisions	2.1.4.2

These standards can be accessed from www.standards.govt.nz

British Standards Institute

BS EN 673: 2011	Glass in building – Determination of thermal transmittance (U value) – Calculation method	Table E.1.1.1, E.2.1.2 a)

International Organization for Standardization

ISO 10077:-	Thermal performance of windows, doors and shutters - Calculation of thermal transmittance	
Part 1: 2017	General	Table E.1.1.1, E.2.1.2
Part 2: 2017	Numerical method for frames	E.2.1.2 b)
ISO 13370: 2017	Thermal performance of buildings – Heat transfer via the ground – Calculation methods	F.1.2.2 Comment
ISO 13789: 2017	Thermal performance of buildings – Transmission and ventilation heat transfer coefficients – Calculation method	Equation F.1

These standards can be accessed from www.standards.govt.nz

BRANZ Ltd

ALF 4.0	Annual Loss Factor 4.0, 4th Edition (2018)	1.1.3.3 Comment Definitions
BRANZ House Insulation Guide (5th Edition), 1 July 2014		2.1.4.1 Comment F.1.1.1 Comment
Cox-Smith, I. (2016). Perimeter insulation of concrete slab foundations. Study Report SR352, BRANZ Ltd, Judgeford, New Zealand.		F.1.2.2 Comment

These documents can be accessed from www.branz.co.nz

References

National Institute of Water and Atmospheric Research Ltd (NIWA)

Temperature Normals for New Zealand 1961-1990 by A I Tomlinson and J Sansom (ISBN 0478083343) — Definitions

This document can be accessed from www.niwa.co.nz

New Zealand Legislation

Energy Efficiency (Energy Using Products) Regulations 2002 — 3.1.1.1 Comment

This document can be accessed from www.legislation.govt.nz.

Appendix B. Definitions

These definitions are specific to this acceptable solution. Other defined terms found in italics within the definitions are provided in clause A2 of the Building Code.

Adequate	Means *adequate* to achieve the objectives of the Building Code.
Approved temperature data	Means the temperature data contained in A I Tomlinson and J Sansom, Temperature Normals for New Zealand for period 1961 to 1990 (NIWA, ISBN 0478083343).
Building	Has the meaning given to it by sections 8 and 9 of the Building Act 2004.
Building consent	Means a consent to carry out *building* work granted by a *building consent authority* under section 49 of the Building Act 2004.
Building element	Any structural or non-structural component or assembly incorporated into or associated with a *building*. Included are *fixtures*, services, *drains*, permanent mechanical installations for access, glazing, partitions, ceilings, and temporary supports.
Building envelope	The *building thermal envelope* plus the exterior surface of any spaces not requiring conditioning, e.g. garage, floor space (below insulating layer), *roof* space (above any outer surface defining an attic or when there is no attic above the insulating layer).
Building performance index (BPI)	In relation to a *building*, means the *heating energy* of the *building* divided by the product of the *heating degrees total* and the sum of the *floor area* and the *total wall area*, and so is calculated in accordance with the following formula: $BPI = \frac{\text{Heating energy}}{\textit{Heating degrees total} \times (\textit{floor area} + \text{total wall area})}$
Conditioned space	That part of a *building* within the *building thermal envelope* that may be directly or indirectly heated or cooled for occupant comfort. It is separated from *unconditioned space* by *building elements* (walls, windows, *skylights*, doors, *roof*, and floor) to limit uncontrolled airflow and heat loss.
Construct	In relation to a *building*, includes to design, build, erect, prefabricate, and relocate the *building*.
Construction R-value	The total *thermal resistance (R-value)* of a typical area of a *building element*.
Curtain walling	Part of the *building envelope* made of a framework usually consisting of horizontal and vertical profiles, connected together and anchored to the supporting structure of the *building*, and containing fixed and/or openable infills, which provides all the required functions of an internal or *external wall* or part thereof, but does not contribute to the load bearing or the stability of the structure of the *building*.
External wall	Any vertical exterior face of a *building* consisting of primary and/or secondary elements intended to provide protection against the outdoor environment.
Floor area	In relation to a *building*, means the *floor area* (expressed in square metres) of all interior spaces used for activities normally associated with domestic living.
Glazing Area ($A_{glazing}$)	The total area of vertical windows and doors that include glazing in the *thermal envelope* including transparent or translucent glazing, frames and opening tolerances, decorative glazing, and louvres. This excludes opaque panels, opaque doors, and *skylights*.

Definitions

Habitable space	A space used for activities normally associated with domestic living, but excludes any bathroom, laundry, water-closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, or other space of a specialised nature occupied neither frequently nor for extended periods.
Heated ceiling, wall or floor	Any ceiling, wall, or floor incorporating embedded pipes, electrical cables, or similar means of raising the temperature of the ceiling, wall, or floor for room heating.
Heating degrees	In relation to a location and a *heating month*, means the degrees obtained by subtracting from a base temperature of 14°C the mean (calculated using the *approved temperature data*) of the outdoor temperatures at that location during that month.
Heating degrees total	In relation to a location and year, means whichever is the greater of the following: a) the value of 12; and b) the sum of all the *heating degrees* (calculated using the *approved temperature data*) for all of the *heating months* of the year.
Heating energy	In relation to a *building*, means the energy from a *network utility operator* or a depletable resource (expressed in kilowatt-hours, and calculated using ALF 4.0, A tool for determining the *Building Performance Index (BPI)* of a house design (2018, BRANZ, Ltd) or some other method that can be correlated with that manual) needed to maintain the *building* at all times within a year at a constant internal temperature under the following standard conditions: a) a continuous temperature of 20°C throughout the *building:* b) an air change rate of 1 change per hour or the actual air leakage rate, whichever is the greater: c) a heat emission contribution arising from internal heat sources for any period in the year of 1000 kilowatt-hours for the first 50 m^2 of *floor area*, and 10 kilowatt-hours for every additional square metre of *floor area:* d) no allowance for— i) carpets; or ii) blinds, curtains, or drapes, on windows: e) windows to have a *shading coefficient* of 0.6 (made up of 0.8 for windows and recesses and 0.75 for site shading).
Heating month	In relation to a location, means a month in which a base temperature of 14°C is greater than the mean (calculated using the *approved temperature data*) of the outdoor temperatures at that location during that month.
HVAC system	For the purposes of performance H1.3.6 and in relation to a *building*, means a mechanical, electrical, or other system for modifying air temperature, modifying air humidity, providing ventilation, or doing all or any of those things, in a space within the *building*.
Insulating glazing unit (IGU)	Two or more panes of glass spaced apart and factory sealed with dry air or special gases in the unit cavity (often abbreviated to IGU or referred to as the unit or double glazing).

Definitions

Intended use	In relation to a *building*, — a) includes any or all of the following: i) any reasonably foreseeable occasional use that is not incompatible with the intended use; ii) normal maintenance; iii) activities undertaken in response to *fire* or any other reasonably foreseeable emergency; but b) does not include any other maintenance and repairs or rebuilding.
Network utility operator	Means a *person* who— a) undertakes or proposes to undertake the distribution or transmission by pipeline of natural or manufactured gas, petroleum, biofuel, or geothermal energy; or b) operates or proposes to operate a network for the purposes of— i) telecommunications as defined in section 5 of the Telecommunications Act 2001; or ii) radiocommunications as defined in section 2(1) of the Radiocommunications Act 1989; or c) is an electricity operator or electricity distributor as defined in section 2 of the Electricity Act 1992 for the purpose of line function services as defined in that section; or d) undertakes or proposes to undertake the distribution of water for supply (including irrigation); or e) undertakes or proposes to undertake a drainage or sewerage system.
Occupied space	Any space within a *building* in which a *person* will be present from time to time during the *intended use* of the *building*.
Opaque door area ($A_{door,opaque}$)	The total area of opaque doors and opaque panels of doors in the *thermal envelope*, including frames and opening tolerances.
Persons	Includes— a) the Crown; and b) a corporation sole; and c) a body of *persons* (whether corporate or unincorporated).
R-value	The common abbreviation for describing the values of both *thermal resistance* and *total thermal resistance*.
Roof	Any roof/ceiling combination where the exterior surface of the *building* is at an angle of 60° or less to the horizontal and has its upper surface exposed to the outside.
Roof area (A_{roof})	The area of the *roof* that is part of the thermal envelope, excluding the *skylight area*.
Sanitary appliance	An appliance which is intended to be used for *sanitation*, but which is not a *sanitary fixture*. Included are machines for washing dishes and clothes.
Sanitary fixture	Any *fixture* which is intended to be used for *sanitation.*
Sanitation	The term used to describe the activities of washing and/or excretion carried out in a manner or condition such that the effect on health is minimised, with regard to dirt and infection.
Shading coefficient	The ratio of the total *solar heat gain coefficient* (SHGC) through a particular glass compared to the total *solar heat gain coefficient* through 3 mm clear float glass.

Definitions

Skylight	Translucent or transparent parts of the *roof*, including frames and glazing.
Skylight area($A_{skylight}$)	The area of *skylights* that are part of the *roof thermal envelope*, including frames and opening tolerances.
Slab-on-ground floors	Floor *construction* consisting of a concrete slab or concrete raft foundation in contact with the ground over its whole area.
Solar heat gain coefficient (SHGC)	The total solar energy entering a *building* through the glazing, that is, the direct transmission of energy from the sun plus the inwards re-radiation of heat from solar radiation that is absorbed in the glass. The SHGC is also known as the solar factor (SF) or g (glazing factor).
Thermal envelope	The *roof*, wall, window, *skylight*, door, and floor *construction* between *unconditioned spaces* and *conditioned spaces*.
Thermal envelope floor area (A_{floor})	The area of the floor that forms part of the *thermal envelope*.
Thermal resistance	The resistance to heat flow of a given component of a *building element*. It is equal to the air temperature difference (K) needed to produce unit heat flux (W/m^2) through unit area (m^2) under steady conditions. The units are $m^2 \cdot K/W$.
Total roof area	The *roof* area (A_{roof}) plus the *skylight area* ($A_{skylight}$).
Total thermal resistance	The overall air-to-air *thermal resistance* across all components of a *building element* such as a wall, *roof,* or floor. (This includes the surface resistances which may vary with environmental changes e.g. temperature and humidity, but for most purposes can be regarded as having standard values as given in NZS 4214.)
Total wall area	In relation to a *building,* means the sum (expressed in square metres) of the following: a) the *wall area* of the *building*; and b) the area (expressed in square metres) of all vertical windows and doors in *external walls* of the *building.*
Unconditioned space	Space within the *building envelope* that is not *conditioned space* (for example, this may include a garage, conservatory, atrium, attic, subfloor, and so on). However, where a garage, conservatory, or atrium is expected to be heated or cooled these spaces shall be included in the *conditioned space*.
Wall area	The area of walls that are part of the *thermal envelope*, excluding the *opaque door area* and the *glazing area*.
Wharenui	A communal meeting house having a large open *floor area* used for both assembly and sleeping in the traditional Māori manner.

Appendix C. New Zealand climate zones

C.1 Climate zones

C.1.1 Climate zone boundaries

C.1.1.1 There are six climate zones. The climate zone boundaries are based on climatic data taking into consideration territorial authority boundaries.

C.1.1.2 A list of the climate zones for each territorial authority is provided in Table C.1.1.2 and illustrated in Figure C.1.1.2. The list in the table takes precedence over the figure.

New Zealand climate zones

TABLE C.1.1.2: Climate zones by territorial authority

Paragraph C.1.1.2

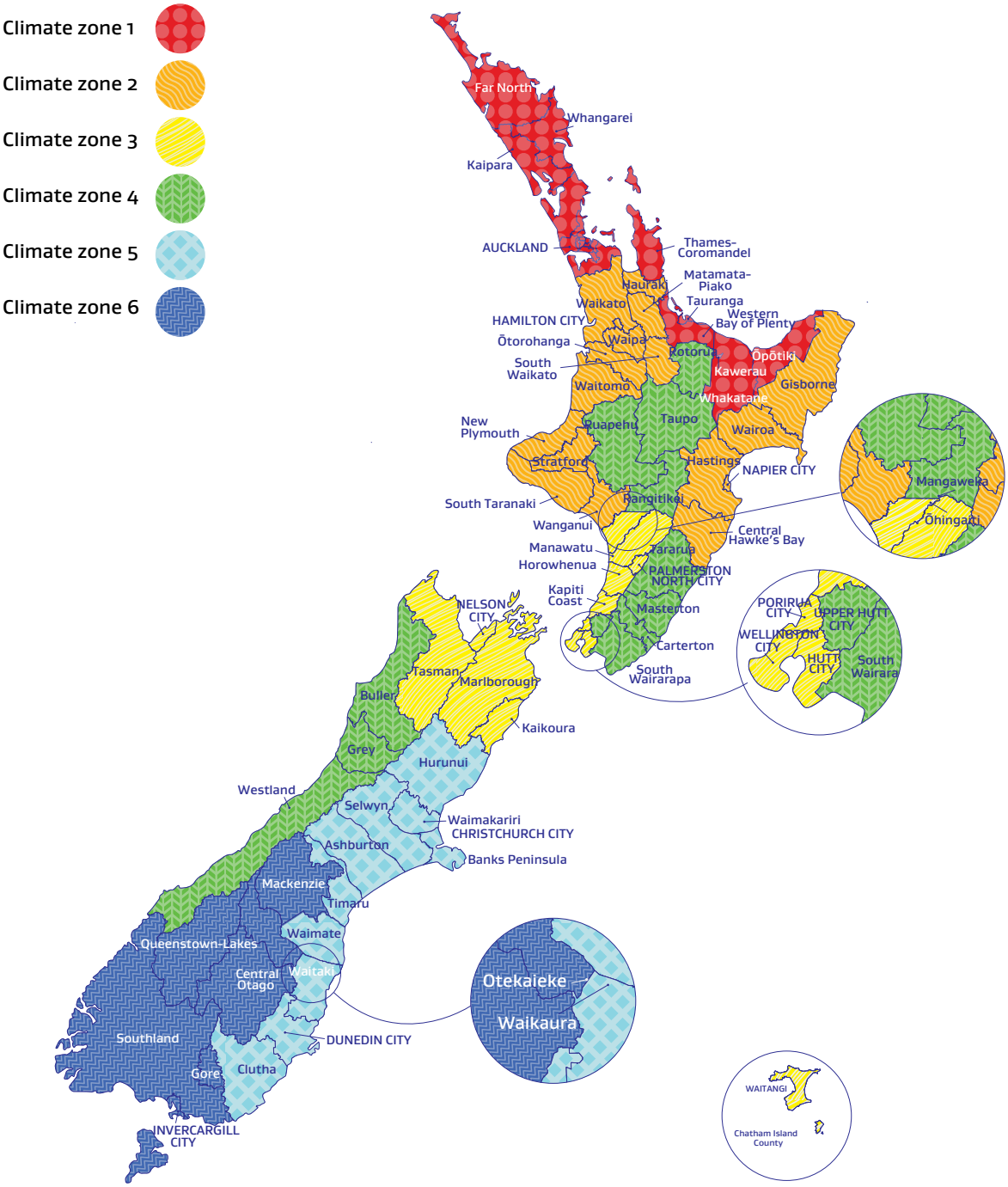
North Island/Te Ika-a-Māui	
Territorial authority	**Climate zone**
Far North District	1
Whangarei District	1
Kaipara District	1
Auckland	1
Thames-Coromandel district	1
Hauraki District	2
Waikato District	2
Matamata-Piako District	2
Hamilton City	2
Waipa District	2
Ōtorohanga District	2
South Waikato District	2
Waitomo District	2
Taupo District	4
Western Bay of Plenty District	1
Tauranga City	1
Rotorua District	4
Whakatane District	1
Kawerau District	1
Ōpōtiki District	1
Gisborne District	2
Wairoa District	2
Hastings District	2
Napier City	2
Central Hawke's Bay District	2
New Plymouth District	2
Stratford District	2
South Taranaki District	2
Ruapehu District	4
Whanganui District	2
Rangitikei District (north of 39°50'S (-39.83))	4
Rangitikei District (south of 39°50'S (-39.83))	3
Manawatu District	3
Palmerston North City	3
Tararua District	4
Horowhenua District	3
Kapiti Coast District	3
Porirua City	3
Upper Hutt City	4
Lower Hutt City	3
Wellington City	3
Masterton District	4
Carterton District	4
South Wairarapa District	4

South Island/Te Waipounamu	
Territorial authority	**Climate zone**
Tasman District	3
Nelson City	3
Marlborough District	3
Kaikoura District	3
Buller District	4
Grey District	4
Westland District	4
Hurunui District	5
Waimakariri District	5
Christchurch City	5
Selwyn District	5
Ashburton District	5
Timaru District	5
Mackenzie District	6
Waimate District	5
Chatham Islands	3
Waitaki District (true left of the Otekaieke river)	6
Waitaki District (true right of the Otekaieke river)	5
Central Otago District	6
Queenstown-Lakes District	6
Dunedin City	5
Clutha District	5
Southland District	6
Gore District	6
Invercargill City	6

New Zealand climate zones

FIGURE C.1.1.2: Map of New Zealand climate zones

Paragraph C.1.1.2



Appendix D. Orientation

D.1 Orientation

D.1.1 Establishing building orientation

D.1.1.1 A *building* wall, including *glazing areas* it contains, shall be considered to face north if it faces any direction in the north orientation sector of Figure D.1.2.1.

D.1.1.2 The orientations of *skylights* and other walls, including the *glazing areas* they contain, shall be determined in a similar way.

D.1.2 Description of sectors

D.1.2.1 Orientation sectors are based on true north and are as follows (see Figure D.1.2.1):

a) North sector lies between north west (more than 315°) and north east (less than 45°); and

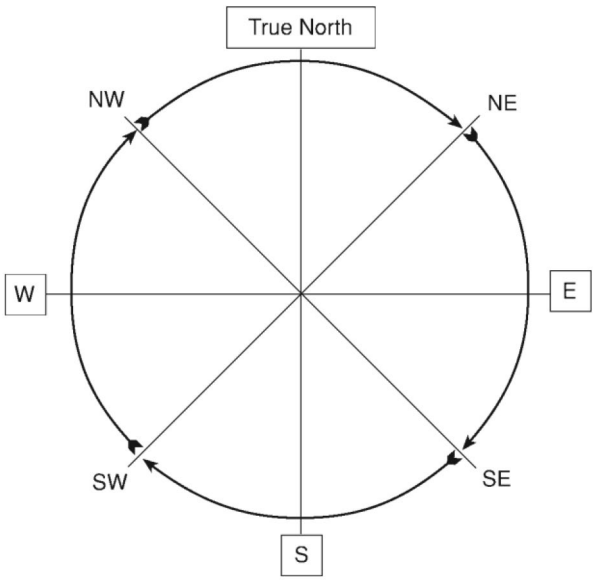
b) East sector lies between north east (45°) and south east (135°); and

c) South sector lies between south east (more than 135°) and south west (less than 225°); and

d) West sector lies between south west (225°) and north west (315°).

FIGURE D.1.2.1: Orientation sector map

Paragraphs D.1.1.1, D.1.2.1



COMMENT: A compass points toward magnetic north. Magnetic north varies from true north by 21° in Auckland, 24° in Wellington and 24° in Christchurch. In New Zealand magnetic north is always east of true north. It is important that true north is used for the orientation rather than magnetic north. The following website calculates the difference between magnetic north and true north (magnetic declination) www.gns.cri.nz/Home/Our-Science/Land-and-Marine-Geoscience/Earth-s-Magnetic-Field/Declination-around-New-Zealand.

Appendix E. Windows, doors, and skylights

E.1 Vertical windows and doors

E.1.1 Methods for determining construction R-values

E.1.1.1 The *construction R-values* for vertical windows and glazing in doors (R_{window}) shall include the effects of both the glazing and the frame. R_{window} shall be determined using one of the following methods:

a) For **housing** only, from Table E.1.1.1; or

b) Calculation in accordance with Verification Method H1/VM1 Appendix E.

E.1.1.2 Acceptable methods for determining the *construction R-values* of opaque doors and opaque door panels (R_{door}) are contained in NZS 4214.

COMMENT:

1. The *R-values* in Table E.1.1.1 are representative *construction R-values* of vertical windows and glazing in doors typical to New Zealand housing. The values provided in this table are not representative of windows and doors in *buildings* other than **housing**.
2. Table E.1.1.1 does not apply to opaque doors, or to opaque door panels.
3. For doors with glazing, the *R-values* in Table E.1.1.1 include the effects of both the glazing and the frame, but not the effect of any opaque parts other than the frames around the glazing. For doors with both glazing and opaque panels, when using Table E.1.1.1, the opaque panel areas need to be treated separately from the areas with glazing (including frames around the glazing), with the *R-value* of the opaque panel areas determined in accordance with Paragraph E.1.1.2.

E.2 Skylights

E.2.1 Construction R-values

E.2.1.1 The *construction R-values* for *skylights* ($R_{Skylight}$) shall include the effects of both the glazing materials and the frame materials and shall be calculated in accordance with Equation E.1. The *construction R-value* shall be rounded down to no less than two significant figures.

Equation E.1: $$R_{skylight} = \frac{1}{U_w}$$

where:

$R_{skylight}$ is the *construction R-value* of the *skylight* ($m^2 \cdot K/W$); and

U_w is the thermal transmittance of the *skylight* ($W/(m^2 \cdot K)$), determined in accordance with Paragraph E.2.1.2.

E.2.1.2 The thermal transmittance (U_w) of a *skylight* shall be determined in accordance with ISO 10077-1, with:

a) the thermal transmittance of the glazing (U_g) determined using BS EN 673, considering the effects of horizontal or angled glazing on the heat transfer; and

b) the thermal transmittance of the frame (U_f) determined using ISO 10077-2.

TABLE E.1.1.1: Construction R-values (R_{Window}) of selected generic vertical windows and doors

Paragraph E.1.1.1 a)

Type of glazing	U_g (1)	Spacer type (2)	Example IGU (3), (4) (informative)	R_{window} (m^2·K/W) for different frames			
				Aluminium frame	Thermally broken aluminium frame	uPVC frame	Timber frame
Double pane	2.63	Aluminium	Glass: Clear/Clear Gas: Air	R0.26	R0.32	R0.40	R0.44
	1.90	Aluminium	Glass: Low E_1/Clear Gas: Argon	R0.30	R0.39	R0.50	R0.56
	1.60	Thermally improved	Glass: Low E_2/Clear Gas: Argon	R0.33	R0.42	R0.56	R0.63
	1.30	Thermally improved	Glass: Low E_3/Clear Gas: Argon	R0.35	R0.46	R0.63	R0.71
	1.10	Thermally improved	Glass: Low E_4/Clear Gas: Argon	R0.37	R0.50	R0.69	R0.77
	0.90	Thermally improved	Glass: Low E_4/Clear Gas: Krypton	R0.40	R0.54	R0.76	R0.85
Triple pane	1.89	Thermally improved	Glass: Clear/Clear/Clear Gas: Air		R0.38	R0.50	R0.56
	1.20	Thermally improved	Glass: Low E_2/Clear/Clear Gas: Argon		R0.48	R0.66	R0.74
	1.00	Thermally improved	Glass: Low E_3/Clear/Clear Gas: Argon		R0.52	R0.73	R0.81
	0.70	Thermally improved	Glass: Low E_3/Low E_3/ Clear Gas: Argon		R0.59	R0.86	R0.95
	0.60	Thermally improved	Glass: Low E_4/Low E_4/ Clear Gas: Argon		R0.62	R0.91	R1.01

Notes:

(1) Thermal transmittance of the glazing determined using BS EN 673. Where the U_g-value of the proposed glazing is different from the values included in the table, R_{window} shall be determined based on the nearest U_g-value in the table that is greater than the U_g-value of the proposed glazing.

(2) 'Thermally improved' refers to a spacer that meets the definition of thermally improved spacer in ISO 10077-1 Annex G.

(3) The examples provided are informative descriptions only of the *insulated glazing unit (IGU)* types that might be used to deliver the nominated U_g-values. When using this table, R_{window} shall be determined based on U_g, spacer type and frame type.

(4) The properties of each of the glass panes within the *IGU* are provided and separated by '/'. 'Clear' refers to clear float glass. 'Low E_1', 'Low E_2', 'Low E_3' and 'Low E_4' refer to glass with low emissivity coatings at different performance levels.

Appendix F. Thermal resistance of slab-on-ground floors

F.1 Construction R-values

F.1.1 Methods for determining construction R-values for slab-on-ground floors

F.1.1.1 The *construction R-values* for concrete *slab-on-ground floors*, including floors of basements that contain *conditioned spaces*, shall be determined using:

a) The performance tables described in Section F.1.2; or

b) The calculation method in Verification Method H1/VM1 Appendix F.

COMMENT:

1. The *thermal resistances* for *slab-on-ground floors* provided in the BRANZ House Insulation Guide, 5th edition or earlier, should not be used for determining compliance with the requirements of this acceptable solution. This is because they are based on a different calculation method and different assumptions than those specified in this Appendix.
2. Where a concrete floor is only partially in contact with the ground, with other parts being suspended, the part that is in contact with the ground shall be treated as a *slab-on-ground floor*, and the other part be treated as a suspended floor.

F.1.2 Performance tables for slab-on-ground floor R-values

F.1.2.1 The *construction R-value* for selected generic concrete *slab-on-ground floors* is provided for different floor types, floor insulation types, and *external walls* types. An overview of the *construction R-value* tables included in this subsection for different combinations of these components is provided in Table F.1.2.1.

F.1.2.2 The *construction R-value* of selected generic concrete *slab-on-ground floors* may be determined from:

a) For concrete raft foundation floors without insulation, where the *external walls* have masonry veneer cladding, Table F.1.2.2A; and

b) For concrete raft foundation floors without insulation, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2B; and

c) For concrete raft foundation floors with R1.0 vertical edge insulation, where the *external walls* have masonry veneer cladding, Table F.1.2.2C; and

d) For concrete raft foundation floors with R1.0 vertical edge insulation, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2D; and

e) For slab-floors without insulation, where the *external walls* have masonry veneer cladding, Table F.1.2.2E; and

f) For slab-floors without insulation, where the *external walls* do not have masonry veneer cladding, Table, F.1.2.2F; and

g) For slab-floors with R1.0 vertical edge insulation but without underslab insulation, where the *external walls* have masonry veneer cladding, Table F.1.2.2G; and

h) For slab-floors with R1.0 vertical edge insulation but without underslab insulation, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2H; and

i) For slab-floors with a 1.2 m wide strip of R1.2 underslab insulation along the slab perimeter, where the *external walls* have masonry veneer cladding, Table F.1.2.2I; and

j) For slab-floors with a 1.2 m wide strip of R1.2 underslab insulation along the slab perimeter, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2J; and

k) For slab-floors with a 1.2 m wide strip of R2.4 underslab insulation along the slab perimeter, where the *external walls* have masonry veneer cladding, Table F.1.2.2K; and

l) For slab-floors with a 1.2 m wide strip of R2.4 underslab insulation along the slab perimeter, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2L; and

m) For slab-floors with R1.2 full cover underslab insulation, where the *external walls* have masonry veneer cladding, Table F.1.2.2M; and

n) For slab-floors with R1.2 full cover underslab insulation, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2N; and

o) For slab-floors with R2.4 full cover underslab insulation, where the *external walls* have masonry veneer cladding, Table F.1.2.2O; and

p) For slab-floors with R2.4 full cover underslab insulation, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2P; and

q) For slab-floors with R1.0 vertical edge insulation and with a 1.2m wide strip of R1.2 underslab insulation along the slab perimeter, where the *external walls* have masonry veneer cladding, Table F.1.2.2Q; and

r) For slab-floors with R1.0 vertical edge insulation and with a 1.2m wide strip of R1.2 underslab insulation along the slab perimeter, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2R; and

s) For slab-floors with R1.0 vertical edge insulation and with a 1.2m wide strip of R2.4 underslab insulation along the slab perimeter, where the *external walls* have masonry veneer cladding, Table F.1.2.2S; and

t) For slab-floors with R1.0 vertical edge insulation and with a 1.2m wide strip of R2.4 underslab insulation along the slab perimeter, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2T; and

u) For slab-floors with R1.0 vertical edge insulation and with R1.2 full cover underslab insulation, where the *external walls* have masonry veneer cladding, Table F.1.2.2U; and

v) For slab-floors with R1.0 vertical edge insulation and with R1.2 full cover underslab insulation, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2V; and

w) For slab-floors with R1.0 vertical edge insulation and with R2.4 full cover underslab insulation, where the *external walls* have masonry veneer cladding, Table F.1.2.2W; and

x) For slab-floors with R1.0 vertical edge insulation and with R2.4 full cover underslab insulation, where the *external walls* do not have masonry veneer cladding, Table F.1.2.2X.

Thermal resistance of slab-on-ground floors

COMMENT:

1. Any parts of a *slab-on-ground floor* that are not part of the *thermal envelope* (such as the floor of porches, attached garages or storage areas) should be thermally separated by installing vertical edge insulation in between conditioned and unconditioned parts of the floor.
2. Since insulation cannot be easily retrofitted to *slab-on-ground floors*, it is recommended to also insulate the floor of any *unconditioned spaces* of the *building*, where these may become *conditioned spaces* at a later stage during the *building* life. An example is an attached garage that could potentially be converted into a *habitable space* in the future.
3. Tables F.1.2.2A – F.1.2.2X differentiate situations where the *external walls* have a masonry veneer cladding from walls with other types of cladding. With masonry veneer walls, the slab edge has a step-down, resulting in different heat transfer characteristics compared to *slab-on-ground floors* for other *external wall* types.
4. *Construction R-values* are only provided for vertical edge insulation with a *thermal resistance* of 1.0 $m^2 \cdot K/W$. The thermal benefits of increasing the *R-value* of vertical edge insulation beyond R1.0 are very limited. Refer to BRANZ study report SR352 (2016) for further details.
5. The *construction R-values* provided in Tables F.1.2.2A – F.1.2.2X are based on the calculation method provided in Verification Method H1/VM1 Appendix F, using the default values for the thermal properties of the ground from ISO 13370 Table 7 category 2 (thermal conductivity $\lambda = 2.0$ W/(m·K), heat capacity per volume $\rho c = 2.0 \times 10^6$ J/(m^3·K)).

F.1.2.3 When determining the slab area-to-perimeter ratio, any parts of the *slab-on-ground floor* that are not part of the *thermal envelope* (such as the floor of patios, porches, attached garages or storage areas) shall be treated as if they were not present.

F.1.2.4 The slab area-to-perimeter ratio of the proposed *building* may be determined using:

a) The overall internal slab dimensions in accordance with Equation F.1; or

b) The external slab dimensions in accordance with Equation F.2.

Equation F.1: $$\text{slab area-to-perimeter ratio} = \frac{A_{\text{slab, internal}}}{P_{\text{slab, internal}}}$$

where:

$A_{\text{slab,internal}}$ is the area of the *slab-on-ground floor* that is part of the *thermal envelope*, measured using overall internal dimensions (ignoring internal partitions, as per ISO 13789) between the interior surfaces of the walls that form the *thermal envelope* (m^2); and

$P_{\text{slab,internal}}$ is the perimeter of the *slab-on-ground floor* that is part of the *thermal envelope*, measured using overall internal dimensions (ignoring internal partitions, as per ISO 13789) along the interior surfaces of the walls that form the *thermal envelope*, including the length of any wall(s) between *conditioned spaces* and *unconditioned spaces* (m).

Equation F.2: $$\text{slab area-to-perimeter ratio} = \frac{A_{\text{slab, external}}}{P_{\text{slab, external}}} - \frac{w}{2}$$

where:

$A_{\text{slab,external}}$ is the area of the *slab-on-ground floor* that is part of the *thermal envelope*, measured between the exterior vertical edges of the slab beneath *external walls* and the unconditioned edges of any wall(s) between *conditioned spaces* and *unconditioned spaces* (m^2); and

$P_{\text{slab,external}}$ is the perimeter of the *slab-on-ground floor* that is part of the *thermal envelope*, measured along the exterior vertical edges of the slab beneath *external walls* and including the length of any wall(s) between *conditioned spaces* and *unconditioned spaces* (m); and

w is the horizontal distance between the outermost exterior concrete slab edge and the interior surface of the *external wall* (m).

Thermal resistance of slab-on-ground floors

COMMENT:
Where the *external walls* do not have masonry veneer cladding, w is the same as the 'Effective thickness of *external walls* on slab' in Tables F.1.2.2A – F.1.2.2X. However, where the *external walls* have masonry veneer cladding, w is to be determined from the exterior concrete slab edge at the bottom of the step-down, whereas the 'Effective thickness of *external walls* on slab' in Tables F.1.2.2A – F.1.2.2X is to be determined from the concrete slab edge at floor level.

Table F.1.2.1: Overview of construction R-value tables for selected slab-on-ground floor scenarios

Paragraph F.1.2.1

Floor type	Floor insulation type	External wall type	Table number
Concrete raft foundation	None	Masonry veneer	Table F1.2.2A
		Other	Table F1.2.2B
	Vertical edge R1.0	Masonry veneer	Table F1.2.2C
		Other	Table F1.2.2D
Slab floor	None	Masonry veneer	Table F1.2.2E
		Other	Table F1.2.2F
	Vertical edge R1.0	Masonry veneer	Table F1.2.2G
		Other	Table F1.2.2H
	Underslab 1.2 m strip R1.2	Masonry veneer	Table F1.2.2I
		Other	Table F1.2.2J
	Underslab 1.2 m strip R2.4	Masonry veneer	Table F1.2.2K
		Other	Table F1.2.2L
	Underslab full cover R1.2	Masonry veneer	Table F1.2.2M
		Other	Table F1.2.2N
	Underslab full cover R2.4	Masonry veneer	Table F1.2.2O
		Other	Table F1.2.2P
	Vertical edge R1.0 and Underslab 1.2 m strip R1.2	Masonry veneer	Table F1.2.2Q
		Other	Table F1.2.2R
	Vertical edge R1.0 and Underslab 1.2 m strip R2.4	Masonry veneer	Table F1.2.2S
		Other	Table F1.2.2T
	Vertical edge R1.0 and Underslab full cover R1.2	Masonry veneer	Table F1.2.2U
		Other	Table F1.2.2V
	Vertical edge R1.0 and Underslab full cover R2.4	Masonry veneer	Table F1.2.2W
		Other	Table F1.2.2X

Thermal resistance of slab-on-ground floors

Table F.1.2.2A: Construction R-values for slab-floors with a 1.2m wide strip of R1.2 underslab insulation along the slab perimeter, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 a)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
No vertical edge insulation	1.6	R1.2	R1.2	R1.2	R1.3	R1.3
	1.8	R1.3	R1.3	R1.3	R1.4	R1.4
	2.0	R1.3	R1.4	R1.4	R1.4	R1.5
	2.2	R1.4	R1.5	R1.5	R1.5	R1.6
	2.4	R1.5	R1.6	R1.6	R1.6	R1.7
	2.6	R1.6	R1.6	R1.6	R1.7	R1.7
	2.8	R1.7	R1.7	R1.7	R1.8	R1.8
	3.0	R1.7	R1.8	R1.8	R1.9	R1.9
	3.2	R1.8	R1.9	R1.9	R2.0	R2.0
	3.4	R1.9	R1.9	R2.0	R2.0	R2.0
	3.6	R2.0	R2.0	R2.0	R2.1	R2.1
	3.8	R2.0	R2.1	R2.1	R2.2	R2.2
	4.0	R2.1	R2.1	R2.2	R2.2	R2.3
	5.0	R2.5	R2.5	R2.6	R2.6	R2.7
	6.0	R2.8	R2.9	R2.9	R3.0	R3.0
	7.0	R3.2	R3.3	R3.3	R3.4	R3.4
	8.0	R3.6	R3.6	R3.7	R3.8	R3.8
	9.0	R3.9	R4.0	R4.1	R4.2	R4.2
	≥ 10.0	R4.3	R4.4	R4.4	R4.5	R4.6

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

Thermal resistance of slab-on-ground floors

Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 b)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} ($m^2 \cdot K/W$) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
No vertical edge insulation	1.6	R1.0	R1.0	R1.1	R1.1	R1.1
	1.8	R1.1	R1.1	R1.2	R1.2	R1.2
	2.0	R1.2	R1.2	R1.3	R1.3	R1.4
	2.2	R1.2	R1.3	R1.3	R1.4	R1.4
	2.4	R1.3	R1.4	R1.4	R1.5	R1.5
	2.6	R1.4	R1.4	R1.5	R1.5	R1.6
	2.8	R1.4	R1.5	R1.5	R1.6	R1.6
	3.0	R1.5	R1.6	R1.6	R1.7	R1.7
	3.2	R1.6	R1.6	R1.7	R1.8	R1.8
	3.4	R1.6	R1.7	R1.7	R1.8	R1.9
	3.6	R1.7	R1.8	R1.8	R1.9	R1.9
	3.8	R1.8	R1.8	R1.9	R2.0	R2.0
	4.0	R1.9	R1.9	R2.0	R2.0	R2.1
	5.0	R2.2	R2.3	R2.3	R2.4	R2.5
	6.0	R2.5	R2.6	R2.7	R2.7	R2.8
	7.0	R2.8	R2.9	R3.0	R3.1	R3.2
	8.0	R3.2	R3.3	R3.3	R3.5	R3.5
	9.0	R3.5	R3.6	R3.7	R3.8	R3.9
	≥ 10.0	R3.9	R4.0	R4.1	R4.2	R4.3

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

Thermal resistance of slab-on-ground floors

Table F.1.2.2C: Construction R-values for concrete raft foundation floors with R1.0 vertical edge insulation, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 c)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} ($m^2 \cdot K/W$) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation(3)	1.6	R1.3	R1.3	R1.3	R1.3	R1.4
	1.8	R1.4	R1.4	R1.4	R1.5	R1.5
	2.0	R1.4	R1.5	R1.5	R1.5	R1.5
	2.2	R1.5	R1.6	R1.6	R1.6	R1.6
	2.4	R1.6	R1.7	R1.7	R1.7	R1.7
	2.6	R1.7	R1.7	R1.7	R1.8	R1.8
	2.8	R1.8	R1.8	R1.8	R1.9	R1.9
	3.0	R1.9	R1.9	R1.9	R2.0	R2.0
	3.2	R2.0	R2.0	R2.0	R2.1	R2.1
	3.4	R2.0	R2.0	R2.1	R2.1	R2.1
	3.6	R2.1	R2.1	R2.2	R2.2	R2.2
	3.8	R2.2	R2.2	R2.2	R2.3	R2.3
	4.0	R2.2	R2.3	R2.3	R2.3	R2.4
	5.0	R2.6	R2.7	R2.7	R2.8	R2.8
	6.0	R3.0	R3.0	R3.1	R3.1	R3.2
	7.0	R3.4	R3.4	R3.5	R3.5	R3.6
	8.0	R3.8	R3.8	R3.9	R3.9	R4.0
	9.0	R4.2	R4.2	R4.3	R4.4	R4.4
	≥ 10.0	R4.5	R4.6	R4.7	R4.8	R4.8

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an R-value of 1.0 $m^2 \cdot K/W$, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2D: Construction R-values for concrete raft foundation floors with R1.0 vertical edge insulation, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 d)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation(3)	1.6	R1.3	R1.3	R1.3	R1.3	R1.3
	1.8	R1.4	R1.4	R1.4	R1.4	R1.4
	2.0	R1.5	R1.5	R1.5	R1.6	R1.6
	2.2	R1.5	R1.5	R1.6	R1.6	R1.6
	2.4	R1.6	R1.6	R1.7	R1.7	R1.7
	2.6	R1.7	R1.8	R1.8	R1.8	R1.8
	2.8	R1.8	R1.8	R1.8	R1.8	R1.9
	3.0	R1.9	R1.9	R1.9	R1.9	R2.0
	3.2	R2.0	R2.0	R2.0	R2.0	R2.1
	3.4	R2.0	R2.0	R2.1	R2.1	R2.1
	3.6	R2.1	R2.1	R2.1	R2.2	R2.2
	3.8	R2.2	R2.2	R2.2	R2.3	R2.3
	4.0	R2.3	R2.3	R2.3	R2.3	R2.4
	5.0	R2.6	R2.7	R2.7	R2.7	R2.8
	6.0	R3.0	R3.1	R3.1	R3.1	R3.2
	7.0	R3.4	R3.4	R3.5	R3.5	R3.6
	8.0	R3.8	R3.8	R3.9	R3.9	R4.0
	9.0	R4.2	R4.2	R4.3	R4.3	R4.4
	≥ 10.0	R4.6	R4.6	R4.7	R4.8	R4.8

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an R-value of 1.0 m^2·K/W, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2E: Construction R-values for slab-floors without insulation, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 e)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
No insulation	1.6	R0.8	R0.9	R0.9	R0.9	R0.9
	1.8	R0.9	R0.9	R1.0	R1.0	R1.0
	2.0	R1.0	R1.0	R1.0	R1.1	R1.1
	2.2	R1.0	R1.1	R1.1	R1.1	R1.2
	2.4	R1.1	R1.1	R1.2	R1.2	R1.2
	2.6	R1.2	R1.2	R1.2	R1.3	R1.3
	2.8	R1.2	R1.3	R1.3	R1.3	R1.4
	3.0	R1.3	R1.3	R1.4	R1.4	R1.4
	3.2	R1.4	R1.4	R1.4	R1.5	R1.5
	3.4	R1.4	R1.5	R1.5	R1.5	R1.6
	3.6	R1.5	R1.5	R1.6	R1.6	R1.6
	3.8	R1.6	R1.6	R1.6	R1.7	R1.7
	4.0	R1.6	R1.7	R1.7	R1.7	R1.8
	5.0	R1.9	R2.0	R2.0	R2.1	R2.1
	6.0	R2.3	R2.3	R2.4	R2.4	R2.5
	7.0	R2.6	R2.6	R2.7	R2.8	R2.8
	8.0	R2.9	R3.0	R3.0	R3.1	R3.2
	9.0	R3.2	R3.3	R3.4	R3.5	R3.5
	≥ 10.0	R3.5	R3.6	R3.7	R3.8	R3.9

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

Thermal resistance of slab-on-ground floors

Table F.1.2.2F: Construction R-values for slab-floors without insulation, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 f)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
No insulation	1.6	R0.8	R0.8	R0.8	R0.9	R0.9
	1.8	R0.8	R0.9	R0.9	R0.9	R0.9
	2.0	R0.9	R0.9	R0.9	R1.0	R1.0
	2.2	R0.9	R1.0	R1.0	R1.1	R1.1
	2.4	R1.0	R1.0	R1.1	R1.1	R1.2
	2.6	R1.1	R1.1	R1.1	R1.2	R1.2
	2.8	R1.1	R1.2	R1.2	R1.3	R1.3
	3.0	R1.2	R1.2	R1.3	R1.3	R1.4
	3.2	R1.2	R1.3	R1.3	R1.4	R1.4
	3.4	R1.3	R1.3	R1.4	R1.4	R1.5
	3.6	R1.4	R1.4	R1.4	R1.5	R1.5
	3.8	R1.4	R1.5	R1.5	R1.6	R1.6
	4.0	R1.5	R1.5	R1.6	R1.6	R1.7
	5.0	R1.8	R1.8	R1.9	R2.0	R2.0
	6.0	R2.1	R2.1	R2.2	R2.3	R2.3
	7.0	R2.4	R2.4	R2.5	R2.6	R2.7
	8.0	R2.7	R2.7	R2.8	R2.9	R3.0
	9.0	R2.9	R3.0	R3.1	R3.2	R3.3
	≥ 10.0	R3.3	R3.4	R3.4	R3.6	R3.7

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

Thermal resistance of slab-on-ground floors

Table F.1.2.2G: Construction R-values for slab-floors with R1.0 vertical edge insulation but without underslab insulation, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 g)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} ($m^2 \cdot K/W$) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation[3]	1.6	R0.9	R0.9	R1.0	R1.0	R1.0
	1.8	R1.0	R1.0	R1.0	R1.1	R1.1
	2.0	R1.1	R1.1	R1.1	R1.1	R1.2
	2.2	R1.1	R1.2	R1.2	R1.2	R1.2
	2.4	R1.2	R1.2	R1.3	R1.3	R1.3
	2.6	R1.3	R1.3	R1.3	R1.4	R1.4
	2.8	R1.3	R1.4	R1.4	R1.4	R1.5
	3.0	R1.4	R1.4	R1.5	R1.5	R1.5
	3.2	R1.5	R1.5	R1.5	R1.6	R1.6
	3.4	R1.6	R1.6	R1.6	R1.6	R1.7
	3.6	R1.6	R1.6	R1.7	R1.7	R1.7
	3.8	R1.7	R1.7	R1.7	R1.8	R1.8
	4.0	R1.8	R1.8	R1.8	R1.9	R1.9
	5.0	R2.1	R2.1	R2.2	R2.2	R2.2
	6.0	R2.4	R2.5	R2.5	R2.6	R2.6
	7.0	R2.8	R2.8	R2.9	R2.9	R3.0
	8.0	R3.1	R3.2	R3.2	R3.3	R3.3
	9.0	R3.5	R3.5	R3.6	R3.7	R3.7
	≥ 10.0	R3.8	R3.9	R3.9	R4.0	R4.1

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an R-value of 1.0 $m^2 \cdot K/W$, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2H: Construction R-values for slab-floors with R1.0 vertical edge insulation but without underslab insulation, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 h)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} ($m^2 \cdot K/W$) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation[3]	1.6	R1.0	R1.0	R1.0	R1.0	R1.0
	1.8	R1.0	R1.1	R1.1	R1.1	R1.1
	2.0	R1.1	R1.1	R1.1	R1.2	R1.2
	2.2	R1.2	R1.2	R1.2	R1.2	R1.3
	2.4	R1.3	R1.3	R1.3	R1.3	R1.3
	2.6	R1.3	R1.4	R1.4	R1.4	R1.4
	2.8	R1.4	R1.4	R1.4	R1.5	R1.5
	3.0	R1.5	R1.5	R1.5	R1.5	R1.6
	3.2	R1.5	R1.6	R1.6	R1.6	R1.6
	3.4	R1.6	R1.6	R1.7	R1.7	R1.7
	3.6	R1.7	R1.7	R1.7	R1.8	R1.8
	3.8	R1.8	R1.8	R1.8	R1.8	R1.9
	4.0	R1.8	R1.8	R1.9	R1.9	R1.9
	5.0	R2.2	R2.2	R2.2	R2.3	R2.3
	6.0	R2.5	R2.5	R2.6	R2.6	R2.7
	7.0	R2.9	R2.9	R2.9	R3.0	R3.0
	8.0	R3.2	R3.3	R3.3	R3.4	R3.4
	9.0	R3.6	R3.6	R3.7	R3.7	R3.8
	≥ 10.0	R3.9	R4.0	R4.0	R4.1	R4.2

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an R-value of 1.0 $m^2 \cdot K/W$, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2I: Construction R-values for slab-floors with a 1.2 m wide strip of R1.2 underslab insulation along the slab perimeter, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 i)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
1.2 m wide strip of R1.2 underslab insulation(3)	1.6	R1.1	R1.2	R1.2	R1.2	R1.2
	1.8	R1.2	R1.2	R1.2	R1.3	R1.3
	2.0	R1.2	R1.3	R1.3	R1.3	R1.4
	2.2	R1.3	R1.3	R1.4	R1.4	R1.4
	2.4	R1.3	R1.4	R1.4	R1.5	R1.5
	2.6	R1.4	R1.4	R1.5	R1.5	R1.6
	2.8	R1.5	R1.5	R1.6	R1.6	R1.6
	3.0	R1.5	R1.6	R1.6	R1.7	R1.7
	3.2	R1.6	R1.6	R1.7	R1.7	R1.8
	3.4	R1.7	R1.7	R1.8	R1.8	R1.8
	3.6	R1.7	R1.8	R1.8	R1.9	R1.9
	3.8	R1.8	R1.9	R1.9	R2.0	R2.0
	4.0	R1.9	R1.9	R2.0	R2.0	R2.1
	5.0	R2.2	R2.3	R2.3	R2.4	R2.4
	6.0	R2.5	R2.6	R2.7	R2.7	R2.8
	7.0	R2.9	R3.0	R3.0	R3.1	R3.2
	8.0	R3.2	R3.3	R3.4	R3.5	R3.5
	9.0	R3.6	R3.7	R3.8	R3.9	R3.9
	≥ 10.0	R3.9	R4.0	R4.1	R4.2	R4.3

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) A 1.2 m wide strip of horizontal underslab insulation with an *R-value* of 1.2 m^2·K/W, installed along the entire slab perimeter, placed on the interior side of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2J: Construction R-values for slab-floors with a 1.2 m wide strip of R1.2 underslab insulation along the slab perimeter, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 j)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
1.2 m wide strip of R1.2 underslab insulation[3]	1.6	R1.0	R1.0	R1.1	R1.1	R1.2
	1.8	R1.0	R1.1	R1.1	R1.2	R1.2
	2.0	R1.1	R1.1	R1.2	R1.2	R1.3
	2.2	R1.1	R1.2	R1.2	R1.3	R1.3
	2.4	R1.2	R1.3	R1.3	R1.4	R1.4
	2.6	R1.3	R1.3	R1.4	R1.4	R1.5
	2.8	R1.3	R1.4	R1.4	R1.5	R1.5
	3.0	R1.4	R1.4	R1.5	R1.6	R1.6
	3.2	R1.4	R1.5	R1.6	R1.6	R1.7
	3.4	R1.5	R1.6	R1.6	R1.7	R1.7
	3.6	R1.6	R1.6	R1.7	R1.8	R1.8
	3.8	R1.6	R1.7	R1.7	R1.8	R1.9
	4.0	R1.7	R1.8	R1.8	R1.9	R1.9
	5.0	R2.0	R2.1	R2.1	R2.2	R2.3
	6.0	R2.3	R2.4	R2.5	R2.6	R2.6
	7.0	R2.6	R2.7	R2.8	R2.9	R3.0
	8.0	R2.9	R3.1	R3.1	R3.3	R3.4
	9.0	R3.3	R3.4	R3.5	R3.6	R3.7
	≥ 10.0	R3.6	R3.7	R3.8	R4.0	R4.1

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) A 1.2 m wide strip of horizontal underslab insulation with an *R-value* of 1.2 m^2·K/W, installed along the entire slab perimeter, placed on the interior side of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2K: Construction R-values for slab-floors with a 1.2 m wide strip of R2.4 underslab insulation along the slab perimeter, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 k)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
1.2 m wide strip of R2.4 underslab insulation[3]	1.6	R1.2	R1.2	R1.3	R1.3	R1.3
	1.8	R1.2	R1.3	R1.3	R1.4	R1.4
	2.0	R1.3	R1.3	R1.4	R1.4	R1.4
	2.2	R1.3	R1.4	R1.4	R1.5	R1.5
	2.4	R1.4	R1.5	R1.5	R1.5	R1.6
	2.6	R1.5	R1.5	R1.6	R1.6	R1.6
	2.8	R1.5	R1.6	R1.6	R1.7	R1.7
	3.0	R1.6	R1.6	R1.7	R1.7	R1.8
	3.2	R1.7	R1.7	R1.8	R1.8	R1.8
	3.4	R1.7	R1.8	R1.8	R1.9	R1.9
	3.6	R1.8	R1.8	R1.9	R2.0	R2.0
	3.8	R1.9	R1.9	R2.0	R2.0	R2.1
	4.0	R1.9	R2.0	R2.0	R2.1	R2.1
	5.0	R2.3	R2.3	R2.4	R2.5	R2.5
	6.0	R2.6	R2.7	R2.7	R2.8	R2.9
	7.0	R3.0	R3.0	R3.1	R3.2	R3.3
	8.0	R3.3	R3.4	R3.5	R3.6	R3.6
	9.0	R3.7	R3.8	R3.9	R4.0	R4.0
	≥ 10.0	R4.0	R4.1	R4.2	R4.4	R4.4

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) A 1.2 m wide strip of horizontal underslab insulation with an *R-value* of 2.4 m^2·K/W, installed along the entire slab perimeter, placed on the interior side of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2L: Construction R-values for slab-floors with a 1.2 m wide strip of R2.4 underslab insulation along the slab perimeter, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 I)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
1.2 m wide strip of R2.4 underslab insulation(3)	1.6	R1.1	R1.1	R1.2	R1.2	R1.3
	1.8	R1.1	R1.1	R1.2	R1.3	R1.3
	2.0	R1.1	R1.2	R1.3	R1.3	R1.4
	2.2	R1.2	R1.3	R1.3	R1.4	R1.4
	2.4	R1.2	R1.3	R1.4	R1.4	R1.5
	2.6	R1.3	R1.4	R1.4	R1.5	R1.5
	2.8	R1.4	R1.4	R1.5	R1.6	R1.6
	3.0	R1.4	R1.5	R1.6	R1.6	R1.7
	3.2	R1.5	R1.6	R1.6	R1.7	R1.7
	3.4	R1.5	R1.6	R1.7	R1.8	R1.8
	3.6	R1.6	R1.7	R1.7	R1.8	R1.9
	3.8	R1.7	R1.7	R1.8	R1.9	R2.0
	4.0	R1.7	R1.8	R1.9	R2.0	R2.0
	5.0	R2.0	R2.1	R2.2	R2.3	R2.4
	6.0	R2.4	R2.5	R2.5	R2.7	R2.7
	7.0	R2.7	R2.8	R2.9	R3.0	R3.1
	8.0	R3.0	R3.1	R3.2	R3.4	R3.5
	9.0	R3.3	R3.5	R3.6	R3.7	R3.8
	≥ 10.0	R3.7	R3.8	R3.9	R4.1	R4.2

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) A 1.2 m wide strip of horizontal underslab insulation with an *R-value* of 2.4 m^2·K/W, installed along the entire slab perimeter, placed on the interior side of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2M: Construction R-values for slab-floors with R1.2 full cover underslab insulation, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 m)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.2 full cover underslab insulation[3]	1.6	R1.3	R1.4	R1.5	R1.6	R1.6
	1.8	R1.4	R1.5	R1.6	R1.7	R1.7
	2.0	R1.5	R1.6	R1.7	R1.8	R1.8
	2.2	R1.6	R1.7	R1.8	R1.9	R1.9
	2.4	R1.7	R1.8	R1.9	R2.0	R2.0
	2.6	R1.8	R1.9	R1.9	R2.0	R2.1
	2.8	R1.9	R2.0	R2.0	R2.1	R2.2
	3.0	R2.0	R2.0	R2.1	R2.2	R2.3
	3.2	R2.0	R2.1	R2.2	R2.3	R2.4
	3.4	R2.1	R2.2	R2.3	R2.4	R2.4
	3.6	R2.2	R2.3	R2.4	R2.5	R2.5
	3.8	R2.3	R2.4	R2.4	R2.5	R2.6
	4.0	R2.3	R2.4	R2.5	R2.6	R2.7
	5.0	R2.7	R2.8	R2.9	R3.0	R3.1
	6.0	R3.1	R3.2	R3.3	R3.4	R3.5
	7.0	R3.5	R3.6	R3.7	R3.8	R3.9
	8.0	R3.8	R4.0	R4.1	R4.2	R4.3
	9.0	R4.2	R4.3	R4.5	R4.6	R4.7
	≥ 10.0	R4.6	R4.7	R4.9	R5.0	R5.2

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Horizontal underslab insulation with an *R-value* of 1.2 m^2·K/W, installed in between footings underneath the entire floor slab.

Thermal resistance of slab-on-ground floors

Table F.1.2.2N: Construction R-values for slab-floors with R1.2 full cover underslab insulation, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 n)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.2 full cover underslab insulation(3)	1.6	R1.1	R1.2	R1.3	R1.4	R1.5
	1.8	R1.2	R1.3	R1.4	R1.5	R1.6
	2.0	R1.3	R1.4	R1.5	R1.6	R1.7
	2.2	R1.4	R1.5	R1.6	R1.7	R1.8
	2.4	R1.5	R1.6	R1.7	R1.8	R1.9
	2.6	R1.5	R1.6	R1.7	R1.9	R1.9
	2.8	R1.6	R1.7	R1.8	R2.0	R2.0
	3.0	R1.7	R1.8	R1.9	R2.0	R2.1
	3.2	R1.8	R1.9	R2.0	R2.1	R2.2
	3.4	R1.8	R1.9	R2.0	R2.2	R2.3
	3.6	R1.9	R2.0	R2.1	R2.3	R2.4
	3.8	R2.0	R2.1	R2.2	R2.3	R2.4
	4.0	R2.1	R2.2	R2.3	R2.4	R2.5
	5.0	R2.4	R2.5	R2.6	R2.8	R2.9
	6.0	R2.7	R2.9	R3.0	R3.2	R3.3
	7.0	R3.1	R3.2	R3.4	R3.6	R3.7
	8.0	R3.4	R3.6	R3.7	R3.9	R4.1
	9.0	R3.8	R4.0	R4.1	R4.3	R4.5
	≥ 10.0	R4.1	R4.3	R4.5	R4.7	R4.9

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Horizontal underslab insulation with an *R-value* of 1.2 m^2·K/W, installed in between footings underneath the entire floor slab.

Thermal resistance of slab-on-ground floors

Table F.1.2.2O: Construction R-values for slab-floors with R2.4 full cover underslab insulation, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 o)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} ($m^2 \cdot K/W$) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R2.4 full cover underslab insulation[3]	1.6	R1.6	R1.7	R1.8	R2.0	R2.1
	1.8	R1.7	R1.8	R2.0	R2.1	R2.2
	2.0	R1.8	R2.0	R2.1	R2.2	R2.3
	2.2	R2.0	R2.1	R2.2	R2.4	R2.5
	2.4	R2.1	R2.2	R2.3	R2.5	R2.6
	2.6	R2.2	R2.3	R2.4	R2.6	R2.7
	2.8	R2.3	R2.4	R2.5	R2.7	R2.8
	3.0	R2.4	R2.5	R2.6	R2.8	R2.9
	3.2	R2.5	R2.6	R2.7	R2.9	R3.0
	3.4	R2.6	R2.7	R2.8	R3.0	R3.1
	3.6	R2.6	R2.8	R2.9	R3.1	R3.2
	3.8	R2.7	R2.9	R3.0	R3.2	R3.3
	4.0	R2.8	R3.0	R3.1	R3.3	R3.4
	5.0	R3.2	R3.4	R3.5	R3.7	R3.8
	6.0	R3.7	R3.8	R4.0	R4.2	R4.3
	7.0	R4.1	R4.2	R4.4	R4.6	R4.7
	8.0	R4.5	R4.6	R4.8	R5.0	R5.2
	9.0	R4.9	R5.1	R5.2	R5.5	R5.6
	≥ 10.0	R5.3	R5.5	R5.7	R5.9	R6.1

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Horizontal underslab insulation with an *R-value* of 2.4 $m^2 \cdot K/W$, installed in between footings underneath the entire floor slab.

Thermal resistance of slab-on-ground floors

Table F.1.2.2P: Construction R-values for slab-floors with R2.4 full cover underslab insulation, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 p)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R2.4 full cover underslab insulation(3)	1.6	R1.3	R1.4	R1.5	R1.7	R1.9
	1.8	R1.4	R1.5	R1.7	R1.9	R2.0
	2.0	R1.5	R1.7	R1.8	R2.0	R2.1
	2.2	R1.6	R1.8	R1.9	R2.1	R2.2
	2.4	R1.7	R1.9	R2.0	R2.2	R2.3
	2.6	R1.8	R2.0	R2.1	R2.3	R2.4
	2.8	R1.9	R2.1	R2.2	R2.4	R2.5
	3.0	R2.0	R2.1	R2.3	R2.5	R2.6
	3.2	R2.1	R2.2	R2.4	R2.6	R2.7
	3.4	R2.2	R2.3	R2.5	R2.7	R2.8
	3.6	R2.3	R2.4	R2.6	R2.8	R2.9
	3.8	R2.3	R2.5	R2.7	R2.9	R3.0
	4.0	R2.4	R2.6	R2.7	R3.0	R3.1
	5.0	R2.8	R3.0	R3.2	R3.4	R3.6
	6.0	R3.2	R3.4	R3.6	R3.8	R4.0
	7.0	R3.6	R3.8	R4.0	R4.2	R4.4
	8.0	R3.9	R4.2	R4.4	R4.7	R4.8
	9.0	R4.3	R4.5	R4.8	R5.1	R5.3
	≥ 10.0	R4.7	R4.9	R5.2	R5.5	R5.7

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Horizontal underslab insulation with an *R-value* of 2.4 m^2·K/W, installed in between footings underneath the entire floor slab.

Thermal resistance of slab-on-ground floors

Table F.1.2.2Q: Construction R-values for slab-floors with R1.0 vertical edge insulation and with a 1.2m wide strip of R1.2 underslab insulation along the slab perimeter, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 q)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation[3] plus 1.2 m wide strip of R1.2 underslab insulation[4]	1.6	R1.2	R1.2	R1.3	R1.3	R1.3
	1.8	R1.3	R1.3	R1.3	R1.3	R1.4
	2.0	R1.3	R1.3	R1.4	R1.4	R1.4
	2.2	R1.4	R1.4	R1.4	R1.5	R1.5
	2.4	R1.4	R1.5	R1.5	R1.5	R1.6
	2.6	R1.5	R1.5	R1.6	R1.6	R1.6
	2.8	R1.6	R1.6	R1.6	R1.7	R1.7
	3.0	R1.6	R1.7	R1.7	R1.8	R1.8
	3.2	R1.7	R1.8	R1.8	R1.8	R1.9
	3.4	R1.8	R1.8	R1.9	R1.9	R1.9
	3.6	R1.9	R1.9	R1.9	R2.0	R2.0
	3.8	R1.9	R2.0	R2.0	R2.0	R2.1
	4.0	R2.0	R2.0	R2.1	R2.1	R2.2
	5.0	R2.3	R2.4	R2.4	R2.5	R2.5
	6.0	R2.7	R2.8	R2.8	R2.9	R2.9
	7.0	R3.1	R3.1	R3.2	R3.3	R3.3
	8.0	R3.4	R3.5	R3.6	R3.6	R3.7
	9.0	R3.8	R3.9	R3.9	R4.0	R4.1
	≥ 10.0	R4.2	R4.3	R4.3	R4.4	R4.5

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an *R-value* of 1.0 m^2·K/W, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

(4) A 1.2 m wide strip of horizontal underslab insulation with an *R-value* of 1.2 m^2·K/W, installed along the entire slab perimeter, placed on the interior side of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2R: Construction R-values for slab-floors with R1.0 vertical edge insulation and with a 1.2m wide strip of R1.2 underslab insulation along the slab perimeter, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 r)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation(3) plus 1.2 m wide strip of R1.2 underslab insulation(4)	1.6	R1.3	R1.3	R1.3	R1.3	R1.3
	1.8	R1.3	R1.3	R1.3	R1.4	R1.4
	2.0	R1.4	R1.4	R1.4	R1.4	R1.5
	2.2	R1.4	R1.4	R1.5	R1.5	R1.5
	2.4	R1.5	R1.5	R1.5	R1.6	R1.6
	2.6	R1.5	R1.6	R1.6	R1.6	R1.7
	2.8	R1.6	R1.6	R1.7	R1.7	R1.7
	3.0	R1.7	R1.7	R1.8	R1.8	R1.8
	3.2	R1.8	R1.8	R1.8	R1.9	R1.9
	3.4	R1.8	R1.9	R1.9	R1.9	R2.0
	3.6	R1.9	R1.9	R2.0	R2.0	R2.0
	3.8	R2.0	R2.0	R2.0	R2.1	R2.1
	4.0	R2.0	R2.1	R2.1	R2.2	R2.2
	5.0	R2.4	R2.4	R2.5	R2.5	R2.6
	6.0	R2.8	R2.8	R2.9	R2.9	R3.0
	7.0	R3.1	R3.2	R3.2	R3.3	R3.4
	8.0	R3.5	R3.6	R3.6	R3.7	R3.8
	9.0	R3.9	R4.0	R4.0	R4.1	R4.2
	≥ 10.0	R4.3	R4.3	R4.4	R4.5	R4.6

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an *R-value* of 1.0 m^2·K/W, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

(4) A 1.2 m wide strip of horizontal underslab insulation with an *R-value* of 1.2 m^2·K/W, installed along the entire slab perimeter, placed on the interior side of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2S: Construction R-values for slab-floors with R1.0 vertical edge insulation and with a 1.2m wide strip of R2.4 underslab insulation along the slab perimeter, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 s)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation(3) plus 1.2 m wide strip of R2.4 underslab insulation(4)	1.6	R1.3	R1.3	R1.4	R1.4	R1.4
	1.8	R1.3	R1.4	R1.4	R1.4	R1.4
	2.0	R1.4	R1.4	R1.4	R1.5	R1.5
	2.2	R1.4	R1.5	R1.5	R1.5	R1.6
	2.4	R1.5	R1.5	R1.6	R1.6	R1.6
	2.6	R1.6	R1.6	R1.6	R1.7	R1.7
	2.8	R1.6	R1.7	R1.7	R1.8	R1.8
	3.0	R1.7	R1.7	R1.8	R1.8	R1.8
	3.2	R1.8	R1.8	R1.9	R1.9	R1.9
	3.4	R1.8	R1.9	R1.9	R2.0	R2.0
	3.6	R1.9	R2.0	R2.0	R2.0	R2.1
	3.8	R2.0	R2.0	R2.1	R2.1	R2.1
	4.0	R2.1	R2.1	R2.1	R2.2	R2.2
	5.0	R2.4	R2.5	R2.5	R2.6	R2.6
	6.0	R2.8	R2.8	R2.9	R3.0	R3.0
	7.0	R3.1	R3.2	R3.3	R3.3	R3.4
	8.0	R3.5	R3.6	R3.7	R3.7	R3.8
	9.0	R3.9	R4.0	R4.0	R4.1	R4.2
	≥ 10.0	R4.3	R4.4	R4.4	R4.5	R4.6

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an *R-value* of 1.0 m^2·K/W, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

(4) A 1.2 m wide strip of horizontal underslab insulation with an *R-value* of 2.4 m^2·K/W, installed along the entire slab perimeter, placed on the interior side of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2T: Construction R-values for slab-floors with R1.0 vertical edge insulation and with a 1.2m wide strip of R2.4 underslab insulation along the slab perimeter, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 t)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation(3) plus 1.2 m wide strip of R2.4 underslab insulation(4)	1.6	R1.3	R1.4	R1.4	R1.4	R1.4
	1.8	R1.4	R1.4	R1.4	R1.5	R1.5
	2.0	R1.4	R1.5	R1.5	R1.5	R1.5
	2.2	R1.5	R1.5	R1.5	R1.6	R1.6
	2.4	R1.5	R1.6	R1.6	R1.7	R1.7
	2.6	R1.6	R1.6	R1.7	R1.7	R1.7
	2.8	R1.7	R1.7	R1.7	R1.8	R1.8
	3.0	R1.7	R1.8	R1.8	R1.9	R1.9
	3.2	R1.8	R1.8	R1.9	R1.9	R2.0
	3.4	R1.9	R1.9	R2.0	R2.0	R2.0
	3.6	R2.0	R2.0	R2.0	R2.1	R2.1
	3.8	R2.0	R2.1	R2.1	R2.2	R2.2
	4.0	R2.1	R2.1	R2.2	R2.2	R2.3
	5.0	R2.5	R2.5	R2.5	R2.6	R2.6
	6.0	R2.8	R2.9	R2.9	R3.0	R3.0
	7.0	R3.2	R3.3	R3.3	R3.4	R3.4
	8.0	R3.6	R3.6	R3.7	R3.8	R3.8
	9.0	R4.0	R4.0	R4.1	R4.2	R4.3
	≥ 10.0	R4.4	R4.4	R4.5	R4.6	R4.7

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an *R-value* of 1.0 m^2·K/W, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

(4) A 1.2 m wide strip of horizontal underslab insulation with an *R-value* of 2.4 m^2·K/W, installed along the entire slab perimeter, placed on the interior side of the wall footing.

Thermal resistance of slab-on-ground floors

Table F.1.2.2U: Construction R-values for slab-floors with R1.0 vertical edge insulation and with R1.2 full cover underslab insulation, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 u)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation[3] plus R1.2 full cover underslab insulation[4]	1.6	R1.4	R1.5	R1.6	R1.7	R1.7
	1.8	R1.5	R1.6	R1.7	R1.8	R1.8
	2.0	R1.6	R1.7	R1.8	R1.9	R1.9
	2.2	R1.7	R1.8	R1.9	R2.0	R2.0
	2.4	R1.8	R1.9	R2.0	R2.1	R2.1
	2.6	R1.9	R2.0	R2.1	R2.1	R2.2
	2.8	R2.0	R2.1	R2.1	R2.2	R2.3
	3.0	R2.1	R2.2	R2.2	R2.3	R2.4
	3.2	R2.2	R2.2	R2.3	R2.4	R2.5
	3.4	R2.3	R2.3	R2.4	R2.5	R2.5
	3.6	R2.3	R2.4	R2.5	R2.6	R2.6
	3.8	R2.4	R2.5	R2.6	R2.7	R2.7
	4.0	R2.5	R2.6	R2.6	R2.7	R2.8
	5.0	R2.9	R3.0	R3.1	R3.2	R3.2
	6.0	R3.3	R3.4	R3.5	R3.6	R3.6
	7.0	R3.7	R3.8	R3.9	R4.0	R4.1
	8.0	R4.1	R4.2	R4.3	R4.4	R4.5
	9.0	R4.5	R4.6	R4.7	R4.8	R4.9
	≥ 10.0	R4.9	R5.0	R5.1	R5.3	R5.4

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an *R-value* of 1.0 m^2·K/W, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

(4) Horizontal underslab insulation with an *R-value* of 1.2 m^2·K/W, installed in between footings underneath the entire floor slab.

Thermal resistance of slab-on-ground floors

Table F.1.2.2V: Construction R-values for slab-floors with R1.0 vertical edge insulation and with R1.2 full cover underslab insulation, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 v)

Insulation type	Slab area-to-perimeter ratio [1]	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab[2]				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation[3] plus R1.2 full cover underslab insulation[4]	1.6	R1.4	R1.5	R1.6	R1.7	R1.7
	1.8	R1.6	R1.6	R1.7	R1.8	R1.8
	2.0	R1.7	R1.7	R1.8	R1.9	R1.9
	2.2	R1.7	R1.8	R1.9	R2.0	R2.0
	2.4	R1.8	R1.9	R2.0	R2.1	R2.1
	2.6	R1.9	R2.0	R2.1	R2.2	R2.2
	2.8	R2.0	R2.1	R2.1	R2.2	R2.3
	3.0	R2.1	R2.2	R2.2	R2.3	R2.4
	3.2	R2.2	R2.3	R2.3	R2.4	R2.5
	3.4	R2.3	R2.3	R2.4	R2.5	R2.6
	3.6	R2.4	R2.4	R2.5	R2.6	R2.7
	3.8	R2.4	R2.5	R2.6	R2.7	R2.7
	4.0	R2.5	R2.6	R2.7	R2.8	R2.8
	5.0	R2.9	R3.0	R3.1	R3.2	R3.2
	6.0	R3.3	R3.4	R3.5	R3.6	R3.7
	7.0	R3.7	R3.8	R3.9	R4.0	R4.1
	8.0	R4.1	R4.2	R4.3	R4.4	R4.5
	9.0	R4.5	R4.6	R4.7	R4.9	R5.0
	≥ 10.0	R4.9	R5.0	R5.2	R5.3	R5.4

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an *R-value* of 1.0 m^2·K/W, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

(4) Horizontal underslab insulation with an *R-value* of 1.2 m^2·K/W, installed in between footings underneath the entire floor slab.

Thermal resistance of slab-on-ground floors

Table F.1.2.2W: Construction R-values for slab-floors with R1.0 vertical edge insulation and with R2.4 full cover underslab insulation, where the external walls have masonry veneer cladding

Paragraph F.1.2.2 w)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation(3) plus R2.4 full cover underslab insulation(4)	1.6	R1.7	R1.8	R1.9	R2.1	R2.2
	1.8	R1.8	R2.0	R2.1	R2.2	R2.3
	2.0	R2.0	R2.1	R2.2	R2.3	R2.4
	2.2	R2.1	R2.2	R2.3	R2.5	R2.6
	2.4	R2.2	R2.3	R2.4	R2.6	R2.7
	2.6	R2.3	R2.4	R2.5	R2.7	R2.8
	2.8	R2.4	R2.5	R2.7	R2.8	R2.9
	3.0	R2.5	R2.6	R2.8	R2.9	R3.0
	3.2	R2.6	R2.7	R2.9	R3.0	R3.1
	3.4	R2.7	R2.8	R3.0	R3.1	R3.2
	3.6	R2.8	R2.9	R3.1	R3.2	R3.3
	3.8	R2.9	R3.0	R3.1	R3.3	R3.4
	4.0	R3.0	R3.1	R3.2	R3.4	R3.5
	5.0	R3.4	R3.6	R3.7	R3.9	R4.0
	6.0	R3.9	R4.0	R4.1	R4.3	R4.4
	7.0	R4.3	R4.5	R4.6	R4.8	R4.9
	8.0	R4.7	R4.9	R5.0	R5.2	R5.3
	9.0	R5.2	R5.3	R5.5	R5.7	R5.8
	≥ 10.0	R5.6	R5.8	R5.9	R6.1	R6.3

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an *R-value* of 1.0 m^2·K/W, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

(4) Horizontal underslab insulation with an *R-value* of 2.4 m^2·K/W, installed in between footings underneath the entire floor slab.

Thermal resistance of slab-on-ground floors

Table F.1.2.2X: Construction R-values for slab-floors with R1.0 vertical edge insulation and with R2.4 full cover underslab insulation, where the external walls do not have masonry veneer cladding

Paragraph F.1.2.2 x)

Insulation type	Slab area-to-perimeter ratio (1)	R_{floor} (m^2·K/W) for different effective thicknesses of external walls on slab(2)				
		≥ 90 mm to < 140 mm	≥ 140 mm to < 180 mm	≥ 180 mm to < 250 mm	≥ 250 mm to < 300 mm	≥ 300 mm
R1.0 vertical edge insulation(3) plus R2.4 full cover underslab insulation(4)	1.6	R1.7	R1.8	R1.9	R2.0	R2.1
	1.8	R1.8	R1.9	R2.0	R2.2	R2.3
	2.0	R1.9	R2.0	R2.1	R2.3	R2.4
	2.2	R2.1	R2.2	R2.3	R2.4	R2.5
	2.4	R2.2	R2.3	R2.4	R2.6	R2.7
	2.6	R2.3	R2.4	R2.5	R2.7	R2.8
	2.8	R2.4	R2.5	R2.6	R2.8	R2.9
	3.0	R2.5	R2.6	R2.7	R2.9	R3.0
	3.2	R2.6	R2.7	R2.8	R3.0	R3.1
	3.4	R2.7	R2.8	R2.9	R3.1	R3.2
	3.6	R2.8	R2.9	R3.0	R3.2	R3.3
	3.8	R2.9	R3.0	R3.1	R3.3	R3.4
	4.0	R3.0	R3.1	R3.2	R3.4	R3.5
	5.0	R3.4	R3.6	R3.7	R3.9	R4.0
	6.0	R3.9	R4.0	R4.1	R4.3	R4.4
	7.0	R4.3	R4.4	R4.6	R4.8	R4.9
	8.0	R4.7	R4.9	R5.0	R5.2	R5.4
	9.0	R5.2	R5.3	R5.5	R5.7	R5.8
	≥ 10.0	R5.6	R5.8	R5.9	R6.2	R6.3

Notes:

(1) The slab area-to-perimeter ratio shall be determined in accordance with Paragraphs F.1.2.3 and F.1.2.4. Where the slab area-to-perimeter ratio of the proposed floor is different from the values included in the table, the *construction R-value* shall be determined based on the nearest slab area-to-perimeter ratio in the table that is smaller than the slab area-to-perimeter ratio of the proposed floor.

(2) The effective thickness of *external walls* is the horizontal distance between the exterior concrete slab edge at floor level, and the interior wall surface.

(3) Vertical edge insulation with an *R-value* of 1.0 m^2·K/W, installed on all exterior vertical faces of the concrete slab / wall footing, extending from the outermost top edge down to the bottom of the wall footing.

(4) Horizontal underslab insulation with an *R-value* of 2.4 m^2·K/W, installed in between footings underneath the entire floor slab.

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