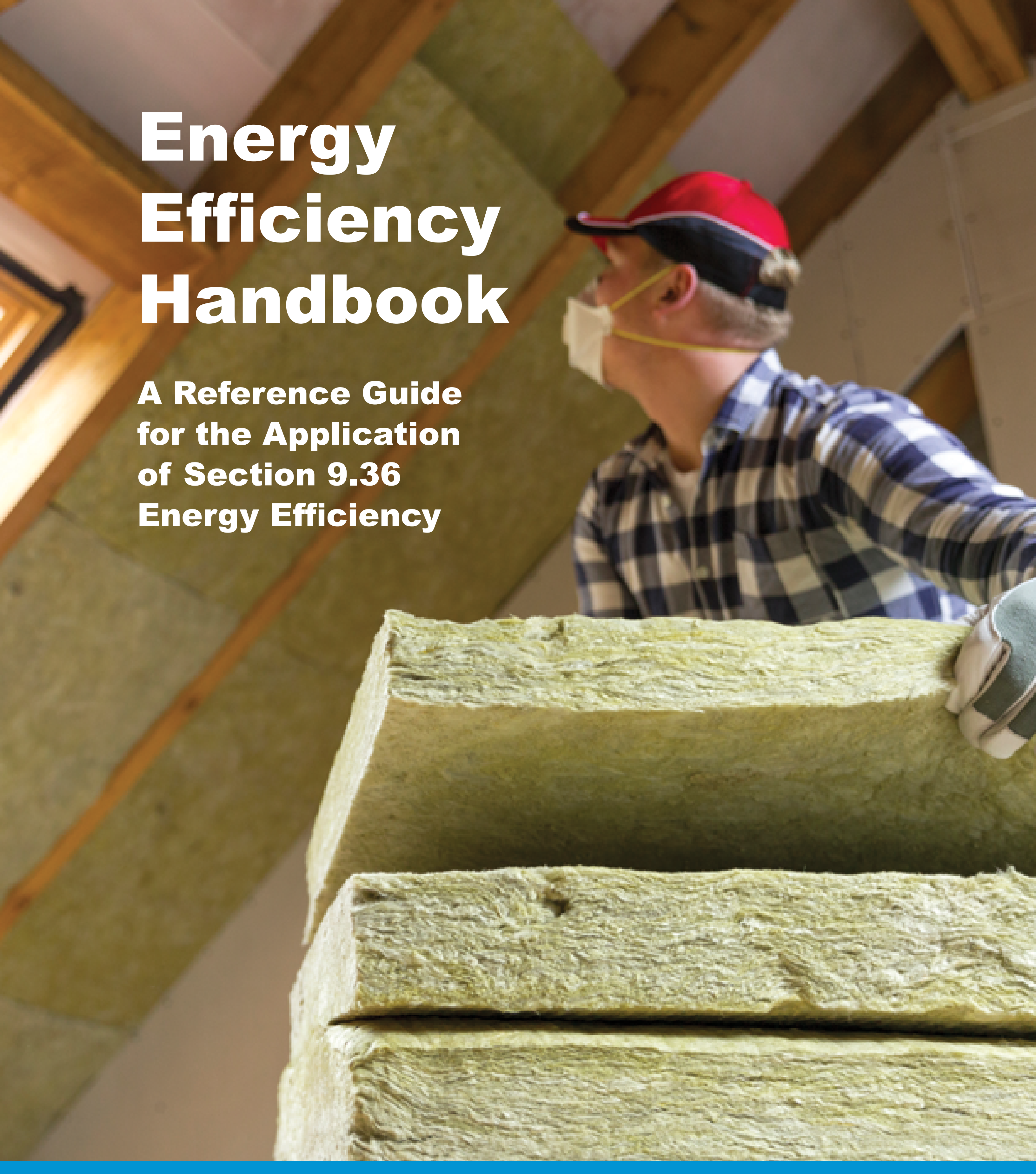
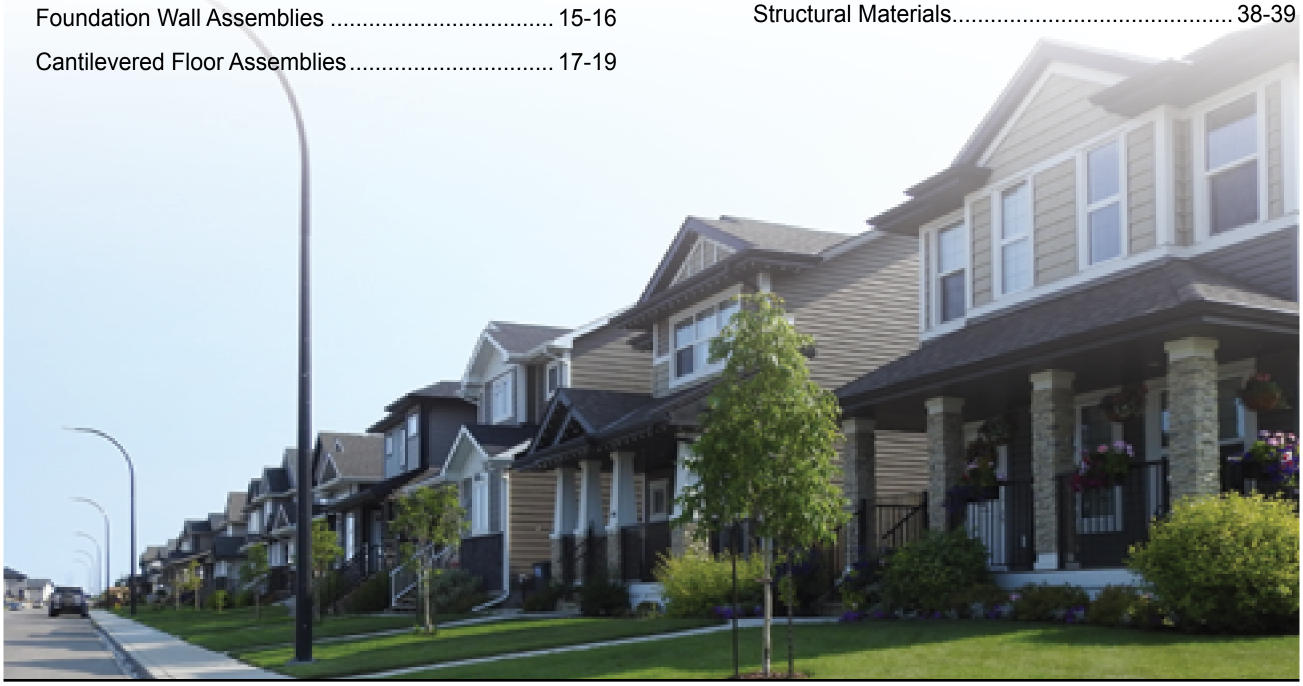


Energy Efficiency Handbook

A Reference Guide for the Application of Section 9.36 Energy Efficiency

City of Saskatoon
Building Standards

CONTENTS



The Province of Saskatchewan adopts the National Building Code of Canada (NBC) and the City of Saskatoon enforces it within the municipality's limits. All information in this document is provided from the NBC 2015 and throughout this document will be referred to as NBC or the building code.

DISCLAIMER: Nothing here relieves any person from complying with any Federal, Provincial or Municipal law or regulation, bylaw, or any requirement of any lawful permit, order or license. If inconsistent with any codes applicable to the inspection being done the appropriate code requirements will be enforced.

It is the sole responsibility of the user to ensure they have the most current version of this handbook available. Updates and changes to this handbook will occur as they are needed and at the discretion of the City of Saskatoon Building Standards.

The most current version of this document is posted online at **saskatoon.ca/buildingstandards**.

BEFORE YOU BUILD

History and Implementation

On January 1, 2018 the Province of Saskatchewan adopted the 2015 National Building Code of Canada (NBC) including the Saskatchewan amendments to the code. The implementation of Section 9.36 ***Energy Efficiency*** and the 2017 National Energy Code for Buildings (NECB) was delayed in order to facilitate a reasonable transition for stakeholders.

The City of Saskatoon began enforcing Section 9.36 *Energy Efficiency* and the 2017 NECB within city limits as of that day.

Residential buildings up to 300m^2 (excluding the area of parking garages in multi-unit buildings), and buildings containing business and personal services, mercantile or low-hazard industrial occupancies that do not exceed 300m^2 can be designed to NBC 9.36. All other conditioned or heated buildings must meet the NECB.

Meeting Energy Requirements

NBC Section 9.36 calls for a minimum level of energy efficiency in buildings and gives three methods to meet these requirements. The ***prescriptive method*** provides a minimum thermal resistance that each assembly must meet. The ***trade-off method*** allows the thermal resistance of one or more assemblies to be less then prescribed. To compensate, the thermal resistance of one or more assemblies is increased to a point that the overall energy efficiency of the building in maintained. Finally, the ***performance method*** uses performance compliance calculations to determine if a proposed building meets the required energy efficiency levels. The performance compliance calculations are done with an acceptable computer modelling program. For more information about these methods please refer to the ***City of Saskatoon Energy Efficiency Compliance Form***.

To properly determine the energy efficiency of buildings a few things must be established. RSI *(R-value Systeme International)* is the metric unit the building code uses for thermal resistance of assemblies. U-value is the unit that the building code uses for the thermal resistance of windows and doors. U-value is simply the inverse of RSI. All assemblies must meet a minimum effective RSI (RSI_{eff}) — see ***Section 4*** of this guide for an example of how to calculate RSI_{eff}. The climate zone where you are located is the determining factor for the minimum RSIeff prescribed by the NBC. Saskatoon is in climate zone 7A. Unheated slabs with insulation underneath will need to be desgined by a professional for possible movement due to freezing; however, Section 9.36.2.8.(4)(b) allows for the slab insultation to be installed on the full height of the exterior of the foundation wall.

A list of common materials and their RSI values is included in the table under ***Section 8*** of this guide.

Conversions: R = 5.678 RSI U = 1 / RSI ER = 57-20^{x}RSI

RSI is measured in (m^2·K)/W where m= metres, K=Kelvin, W=watts

About This Guide

This package has been created to show how the effective RSI of assemblies is calculated and includes details for compliance with the prescriptive requirement of NBC Section 9.36 for Saskatoon’s climate zone. The examples illustrated in this guide are intended to show how different combinations of materials can affect the effective RSI value. NBC Section 9.36 establishes the minimum level of energy efficiency a given *assembly* must achieve, but there are several ways that these requirements can be met.

These details are for information purposes only and are not meant to limit or exclude assemblies not illustrated here. It is up to each individual owner, designer or contractor to develop details and specifications in compliance to the NBC that best suit their projects.

BEFORE YOU BUILD

Calculating Thermal Resistance of a Wood-Frame Assembly Using the Isothermal Planes and Parallel-Path Flow Methods

To calculate the effective thermal resistance of a building envelope assembly containing wood framing (RSI_{eff}), add up the results of the following calculations:

A. Calculate the effective thermal resistance of all layers with continuous materials using the isothermal-planes method; and,

B. Calculate the effective thermal resistance of the framing portion, $RSI_{parallel}$, using the following equation, taken from the parallel-path flow method described in the *American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbook - Fundamentals:*

$$RSI_{parallel} = \frac{100}{\dfrac{\text{\% area of framing}}{RSI_F} + \dfrac{\text{\% area of cavity}}{RSI_C}}$$

Where (table refers NBC):

RSI_F = thermal resistance of the framing member obtained from Table A-9.36.2.4.(1)-D

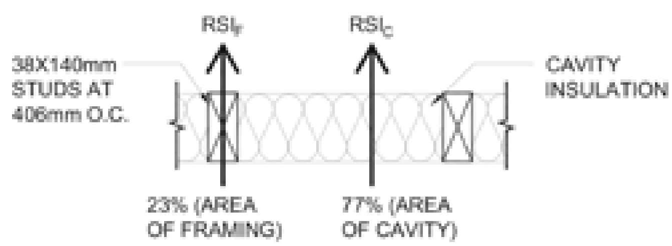
RSI_C = thermal resistance of the insulation in the cavity obtained from Table A-9.36.2.4.(1)-D

% area of framing = value between 0 and 100 obtained from Table A-9.36.2.4.(1)-A or by calculation, and

% area of cavity = value between 0 and 100 obtained from Table A-9.36.2.4.(1)-A or by calculation.

When the values in Table A-9.36.2.4.(1)-D are used in the calculation of effective thermal resistance of assemblies, they must not be rounded - only the final result, RSI_{eff}, can be rounded to the nearest significant digit.

Example of calculation of RSI_{eff} for a Typical 38 x 140 mm (2"x6") Wood Frame Wall Assembly Using the Isothermal Planes and Parallel-Path Flow Methods.



1) Determine the thermal resistance of each continuous material layer incorporated in the assembly using NBC Table A-9.36.2.4.(1)-D

2) Calculate the thermal resistance of a section of framing and adjacent cavity portion, $RSI_{parallel}$, using the parallel-path flow method as follows:

   (i) along a line that goes through the framing, which is designated RSI_F, and

   (ii) along a line that goes through the cavity (usually filled with insulation), which is designated RSI_C.

Look up the per cent area of framing and cavity for a typical 38x140mm wood frame wall assembly with studs 400mm on-centre (o.c.) using Table A-9.36.2.4.(1)-A:

% area of framing = 23%, and

% area of cavity = 77%

Then, combine the sums of RSI_F and RSI_C in proportion to the relative areas of framing and insulation to calculate the value to $RSI_{parallel}$ (thermal resistance of the framing portion):

$$RSI_{parallel} = \frac{100}{(23/1.19) + (77/3.34)} = 2.36\ (m^2 \cdot K)/W \qquad (U\ value = 0.42\ W/(m^2 \cdot K))$$

3) Add up the values obtained in steps 1 and 2 to determine the effective thermal resistance of the wall assembly, RSI_{eff}.

Layers in 38x140mm Wood-frame Wall Assembly with Studs Spaced 400mm o.c.			RSI, ($m^2 \cdot K/W$)
Outside Air Film			0.03
Metal Siding			0.11
Sheathing Paper			------
Oriented Strandboard (OSB) (9.5mm)			0.093 ($m^2 \cdot K/W$)
Stud (140mm x 0.0085 RSI/mm)	RSI_F = 1.19	% area of framing = 23%	$RSI_{parallel}$ = 2.36
Insulation (140mm think; RSI 3.34)	RSI_C = 3.34	% area of cavity = 77%	(U-value = 0.42 W/($m^2 \cdot K$)
Polyethylene (vapour barrier)			------
Gypsum (12.7mm)			0.08
Interior Air Film			0.12
Total			RSI_{eff} = 2.78 ($m^2 \cdot K/W$)
** Information from the 2015 National Building Code, A-9.36.2.4.(1)*			(U-value = 0.36 W/($m^2 \cdot K$)

Trade-Off Options

The code allows for some degree of flexibility in energy efficient features of houses and buildings. One or more assemblies with lower RSI values than prescribed can be traded off when one or more assemblies have their RSI values increased to compensate. There are several conditions that must be met before the trade-off can be pursued:

1) Above ground opaque building envelope assemblies can be traded with above ground opaque building envelope assemblies, and windows can be traded with windows.
2) An area that already has a reduction allowed in the code (at a truss heel for example) cannot be included in the increased thermal resistance trade-off area;
3) The effective thermal resistance of above-ground opaque building envelope assemblies cannot have an RSI_{eff} less than 55% of what is prescribed for walls and joist-type roofs (flat or cathedral), or not less than 60% for other opaque assemblies (ceilings below attics, floors over unheated spaces);
4) Assemblies with embedded heating cannot be used in trade-offs;
5) Doors and access hatches cannot be used in trade-offs.
6) Windows used in trade-off calculations must all be orientated in the same direction.

To begin the calculation, we need two models: the reference model, which meets the prescriptive requirements, and the proposed model, which has an assembly that does not meet the minimum and an assembly whose insulation is increased to compensate. The areas in the reference and proposed models must be the same. The ratios of area and effective thermal resistance (A/R) of the assemblies in the reference case and the proposed case are then compared. The sum of the A/R of the reference assemblies must be greater than or equal to the sum of the A/R of the proposed assemblies.

$[(A/R)_{Ref} \geq (A/R)_{Prop}]$

Trade-Off Calculation for Above-Ground Opaque Building Assemblies

Example 1

A designer wants to reduce the insulation in 20m^2 of wall area in the proposed design from the required RSI value of 2.97 to a value of 2.70 (2x6 at 16" o.c. with R20 batt insulation and fibre-cement siding). The proposed design has 100m^2 of attic space where more insulation can be added (Any areas of the attic where this RSI is not achieved can not be included in this area). The designer would like to increase the roof insulation to 425mm (R60) blown-in cellulous insulation as the trade-off.

Assemblies Being Traded	Area of Each Assembly (A)	Reference Design Values (R)		Proposed Design Values (R)	
		RSI_{eff} value	Area/RSI_{eff} (A/R)Value	RSI_{eff} value	Area/RSI_{eff} (A/R)Value
Attic	100m^2	8.67	11.53 W/K	10.45	9.57 W/K
Wall	20m^2	2.97	6.73 W/K	2.7	7.41 W/K
		Total A/R value	18.26 W/K	**Total A/R value**	16.98 W/K

$(A/R)_{Ref} \geq (A/R)_{Prop}$

18.26 > 16.98 So this is acceptable

Example 2

To find the minimum additional added insulation required, there are a few more steps. This example will be at a tall wall requiring 2x6 studs at 12" o.c. with R20 batt insulation and stucco.

Assemblies Being Traded	Area of Each Assembly (A)	Reference Design Values		Proposed Design Values	
		RSI_{eff} value (R)	Area/RSI_{eff} (A/R)Value	RSI_{eff} value	Area/RSI_{eff} (A/R)Value
Attic	100m^2	8.67	11.53 W/K	8.67	11.53 W/K
Wall	20m^2	2.97	6.73 W/K	2.65	7.55 W/K
		Total A/R value	18.26 W/K	**Total A/R value**	19.08 W/K

Calculate the difference between the total A/R values, then subtract this difference from the Attic A/R value

19.08 - 18.26 = 0.82

11.53 - 0.82 = 10.71 W/K New attic $(A/R)_{Prop}$

Check that $(A/R)_{Ref} \geq (A/R)_{Prop}$

$(A/R)_{Ref}$ = 18.26 $(A/R)_{Prop}$ = 10.71 + 7.55 = 18.26 W/K ✓

To determine the RSI value to be made up by insulation in the attic of the proposed design, divide the area of the attic by the new $(A/R)_{Prop}$ value required for the attic of the proposed design (10.71 W/K).

100 / 10.71= RSI 9.33 (R52)

Assemblies Being Traded	Area of Each Assembly (A)	Reference Design Values		Proposed Design Values	
		RSI_{eff} value (R)	Area/RSI_{eff} (A/R)Value	RSI_{eff} value	Area/RSI_{eff} (A/R)Value
Attic	100m^2	8.67	11.53 W/K	9.33	10.71 W/K
Wall	20m^2	2.97	6.73 W/K	2.65	7.55 W/K
		Total A/R value	18.26 W/K	**Total A/R value**	18.26 W/K

Conclusion: The attic would be required to have at least an RSI_{eff} of 9.33 (R_{eff} 52), adding RSI 0.55 (R 3.12) of insulation to the attic cavity.

Trade-Off Calculation for Windows

Similar to opaque trade-off, the (A/R)Ref shall be greater than or equal to (A/R)Prop. All windows must be oriented in the same direction. As windows are rated by U-value or energy rating (ER). The first step is to convert this value to RSI.

RSI = 1/U   Saskatoon's energy requirements for windows: max. U= 1.6
min. ER = 25

A home owner would like to install a stained glass window on the south side of his new house. The window has a U-value of 2.7 W/m²•K and it has an area of 2m². The total windows on that side of the house is 12m² in area.

First convert the U-values of the windows to RSI   1/2.7 = 0.37 m²•K/W proposed window
1/1.6= 0.63 m²•K/W reference windows

Windows with South Orientation	Area of Assemblies (A)	Reference Design Values		Proposed Design Values	
		RSI value	Area/RSI (A/R)Value	RSI value	Area/RSI (A/R)Value
Stained glass window	2m²	0.63	3.17 W/K	0.37	5.41 W/K
Other windows	10m²	0.63	15.87 W/K	0.63	15.87 W/K
		Total A/R value	19.05 W/K	**Total A/R value**	21.28 W/K

Calculate the difference between the total A/R values, then subtract this difference from the A/R value of the 10m² of windows

21.28 - 19.05 =.............................2.23

15.87 - 2.23 = ...13.64 W/K New $(A/R)_{Prop}$ for 10m² of windows

Check that $(A/R)_{Ref} \geq (A/R)_{Prop}$

$(A/R)_{Ref}$ = 19.05 $(A/R)_{Prop}$ = 5.41 + 13.64 =   19.05 W/K ✓

To determine the RSI value to be made up by the remaining windows, divide the area of these windows by the new (A/R)Prop value required.

10 / 13.64 =   0.73 m²•K/W (RSI)

1 / 0.733 =   1.3 W/m²•K (U-value)

Assemblies with South Orientation	Area of Assemblies (A)	Reference Design Values		Proposed Design Values	
		RSI value	Area/RSI (A/R)Value	RSI value	Area/RSI (A/R)Value
Stained glass window	2m²	0.63	3.17 W/K	0.37	5.41 W/K
Other windows	10m²	0.63	15.87 W/K	0.733	13.64 W/K
		Total A/R value	19.05 W/K	**Total A/R value**	19.05 W/K

Conclusion: The windows would be required to have a U-value of at most 1.3W/m2•K.

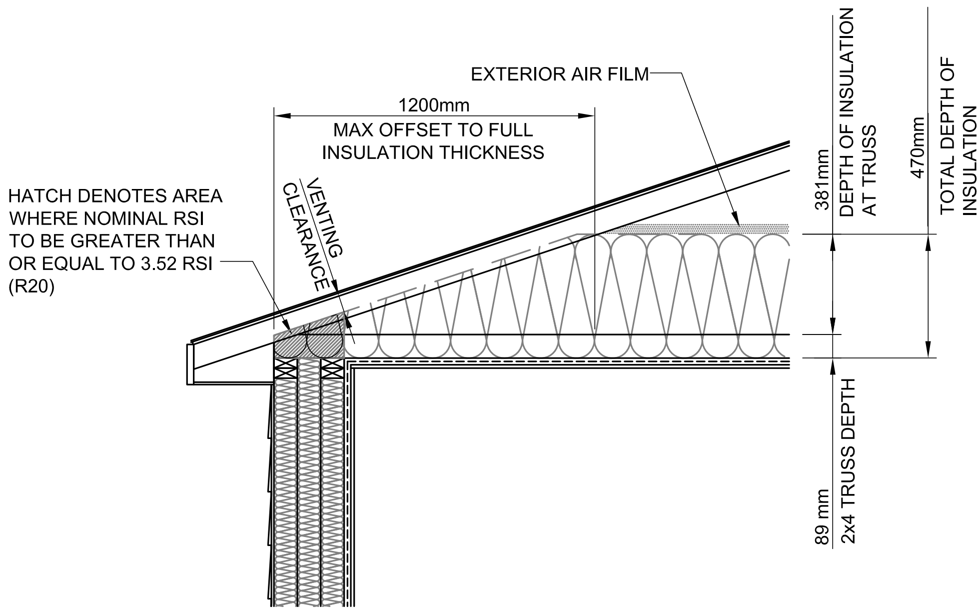
Additional Information

The City of Saskatoon Building Standards division will be releasing information about the implementation of these new standards over the next few months. You can stay up to date on the latest information by:

- Recent updates to Building Standards requirements are posted regularly on the City's website at **saskatoon.ca/buildingstandards**;
- Emailing us at building.standards@saskatoon.ca; and/or,
- Phoning us at 306-975-2645.

Roof Assemblies

CEILINGS BELOW ATTICS
TYPICAL 89mm TRUSSES WITH R50 GLASS FIBRE LOOSE FILL INSULATION
(w/HRV RSI OF 8.67 REQUIRED)
(w/o HRV RSI OF 10.43 REQUIRED - DOES NOT MEET)



CEILINGS BELOW ATTIC: 8.83 RSI (R = 5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
ROOFING MATERIAL	NOT INCLUDED [3]	—
SHEATHING	NOT INCLUDED [3]	—
EXTERIOR AIR FILM	0.03 [1]	0.03
ENGINEERED TRUSSES @ 610mm O.C. w/ 470mm LOOSE FILL INSULATION	100/ [(11/0.7565*) + (89/1.66875*)] [2] *0.7565 = 89 x 0.0085 (WOOD S.P.F.) [1] *1.66875 = 89 x 0.01875 (LOOSE FILL) [1]	1.4733
LOOSE FILL INSULATION	381 x 0.01875 [1]	7.14375
6 mil CGSB VAPOUR BARRIER	—	—
12.7mm GYPSUM BOARD	12.7 x 0.0061 [1]	0.0775
INTERIOR AIR FILM	0.11 [1]	0.11
TOTAL		8.83

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

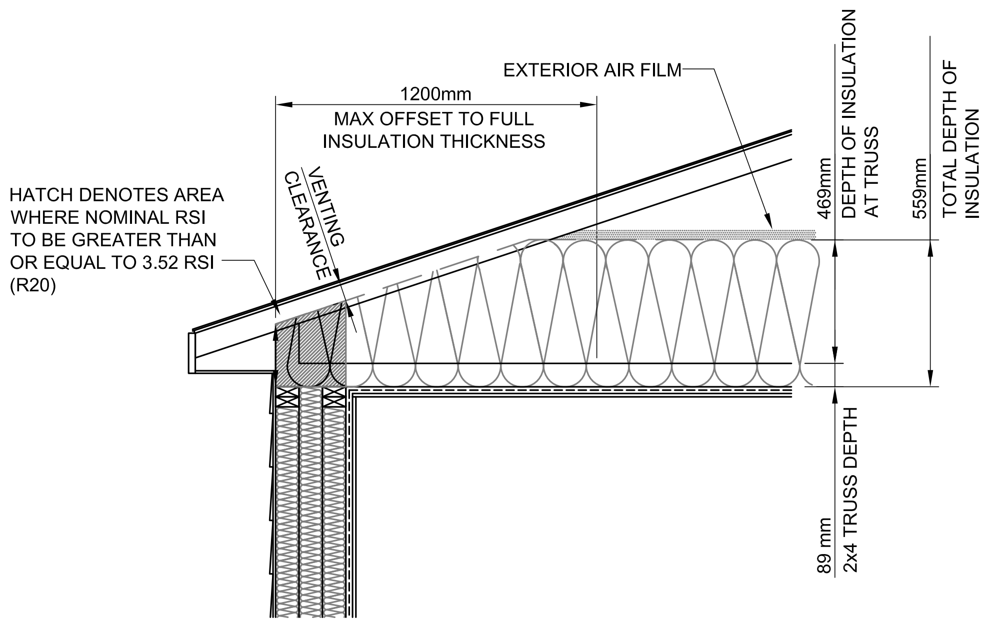
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) MATERIALS INSTALLED TOWARDS THE EXTERIOR OF A VENTED AIR SPACE CANNOT BE INCLUDED IN THE CALCULATION OF EFFECTIVE THERMAL RESISTANCE OF THE ASSEMBLY.

SAMPLE **CALCULATIONS**

Roof Assemblies

CEILINGS BELOW ATTICS
TYPICAL 89mm TRUSSES WITH R60 GLASS FIBRE LOOSE FILL INSULATION
(w/HRV RSI OF 8.67 REQUIRED)
(w/o HRV RSI OF 10.43 REQUIRED)



CEILINGS BELOW ATTIC: 10.48 RSI (R = 5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
ROOFING MATERIAL	NOT INCLUDED [3]	—
SHEATHING	NOT INCLUDED [3]	—
EXTERIOR AIR FILM	0.03 [1]	0.03
ENGINEERED TRUSSES @ 610mm O.C. w/ 559mm LOOSE FILL INSULATION	100/ [(11/0.7565*) + (89/1.66875*)] [2] *0.7565 = 89 x 0.0085 (WOOD S.P.F.) [1] *1.66875 = 89 x 0.01875 (LOOSE FILL) [1]	1.4733
LOOSE FILL INSULATION	469 x 0.01875 [1]	8.79375
6 mil CGSB VAPOUR BARRIER	—	—
12.7mm GYPSUM BOARD	12.7 x 0.0061 [1]	0.0775
INTERIOR AIR FILM	0.11 [1]	0.11
TOTAL		10.48

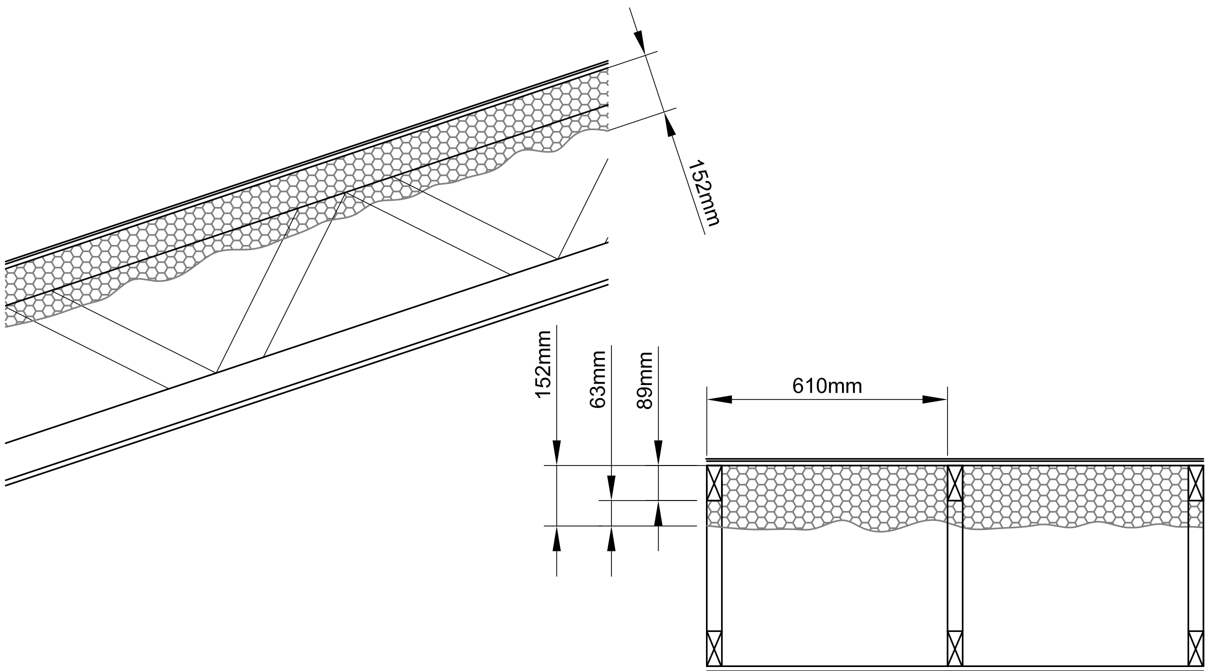
(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) MATERIALS INSTALLED TOWARDS THE EXTERIOR OF A VENTED AIR SPACE CANNOT BE INCLUDED IN THE CALCULATION OF EFFECTIVE THERMAL RESISTANCE OF THE ASSEMBLY.

Roof Assemblies

CATHEDRAL ROOF w/ 152mm OF MEDIUM DENSITY
SPRAY-APPLIED RIGID POLYURETHANE FOAM INSULATION
(w/HRV RSI OF 5.02 REQUIRED)
(w/o HRV RSI OF 5.02 REQUIRED)



CEILINGS WITH RAISED HEEL (PARALLAM CHORD TRUSS): 5.37 RSI (R = 5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
EXTERIOR AIR FILM	0.03 [(1)]	0.03
METAL ROOF	NEGLIGIBLE [(1)]	—
OSB (11mm)	0.108 [(1)]	0.108
ENGINEERED TRUSS @ 610mm o.c. w/ 152mm SPRAY FOAM INSULATION	100/ [(7/0.7565*) + (93/3.204*)][(2)] *0.7565 = 89 x 0.0085 (WOOD CHORD S.P.F.)[(1)] *3.204 = 89 x 0.036 (SPRAY FOAM)[(1)]	2.612
SPRAY FOAM INSULATION	63 x 0.036[(1)]	2.268
AIR CAVITY	0.16[(1)]	0.16
12.7mm GYPSUM BOARD	12.7 x 0.0061[(1)]	0.0775
INTERIOR AIR FILM	0.11[(1)]	0.11
TOTAL		5.37

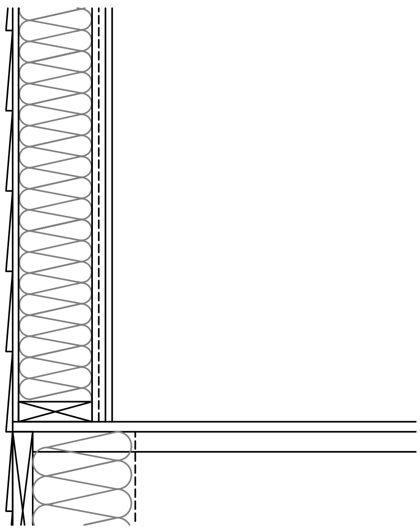
(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

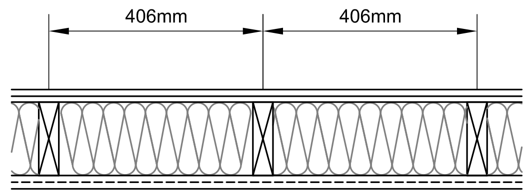
SAMPLE CALCULATIONS

Wood Framed Wall Assemblies

38x140mm STUD WALL w/ VINYL SIDING
(w/HRV RSI OF 2.97 REQUIRED)
(w/o HRV RSI OF 3.08 RSI REQUIRED - DOES NOT MEET)



SECTION



PLAN VIEW

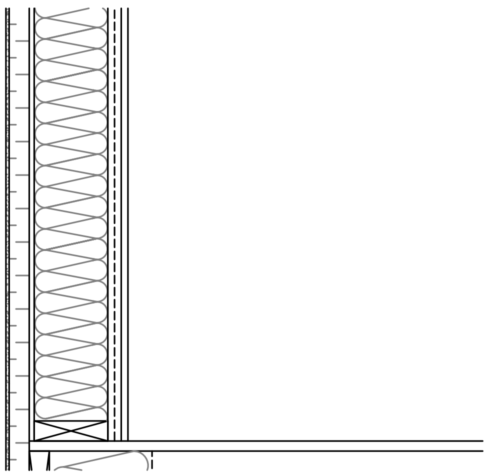
TYPICAL WOOD FRAME WALL : 2.99 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 (1)	0.03
VINYL SIDING HOLLOW BACKED	0.11 (1)	0.11
SHEATHING PAPER	—	—
11mm OSB SHEATHING	0.108	0.108
38x140 STUD WALL @ 406 o.c. w/ R22 FIBREGLASS BATT INSULATION	100/ [(23/1.19*) + (77/3.87*)] (2) *1.19 = 140 x 0.0085 (WOOD STUD S.P.F.) (1) *3.87 = RSI FOR R22 BATT (1)	2.55
6 mil CGSB VAPOUR BARRIER	—	—
12.7mm GYPSUM BOARD	12.7 x 0.0061 (1)	0.0775
INTERIOR AIR FILM	0.12 (1)	0.12
TOTAL		2.99

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

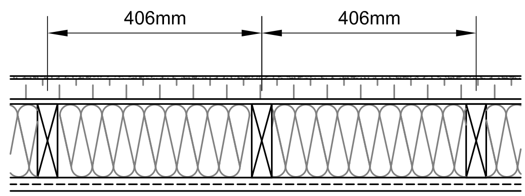
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

Wood Framed Wall Assemblies

38x140mm STUD WALL w/ E.I.F.S.
(w/HRV RSI OF 2.97 REQUIRED)
(w/o HRV RSI OF 3.08 REQUIRED)



SECTION



PLAN VIEW

TYPICAL WOOD FRAME WALL w/ E.I.F.S. : 3.87 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 (1)	0.03
SYNTHETIC COATING SYSTEM (1.5mm)	1.5 x 0.0009 (1)(3)	0.0014
EXPANDED POLYSTYRENE (38mm) TYPE 1	38 x 0.026 (1)(3)	0.988
11mm OSB SHEATHING	0.0098 (1)	0.108
38x140 STUD WALL @ 406 o.c. w/ R20 FIBREGLASS BATT INSULATION	100/ [(23/1.19*) + (77/3.34*)] (2) *1.19 = 140 x 0.0085 (WOOD STUD S.P.F.) (1) *3.34 = RSI FOR R20 BATT (1)	2.3595
6 mil CGSB VAPOUR BARRIER	—	—
12.7mm GYPSUM BOARD	12.7 x 0.0061 (1)	0.0775
INTERIOR AIR FILM	0.12 (1)	0.12
TOTAL		3.68

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

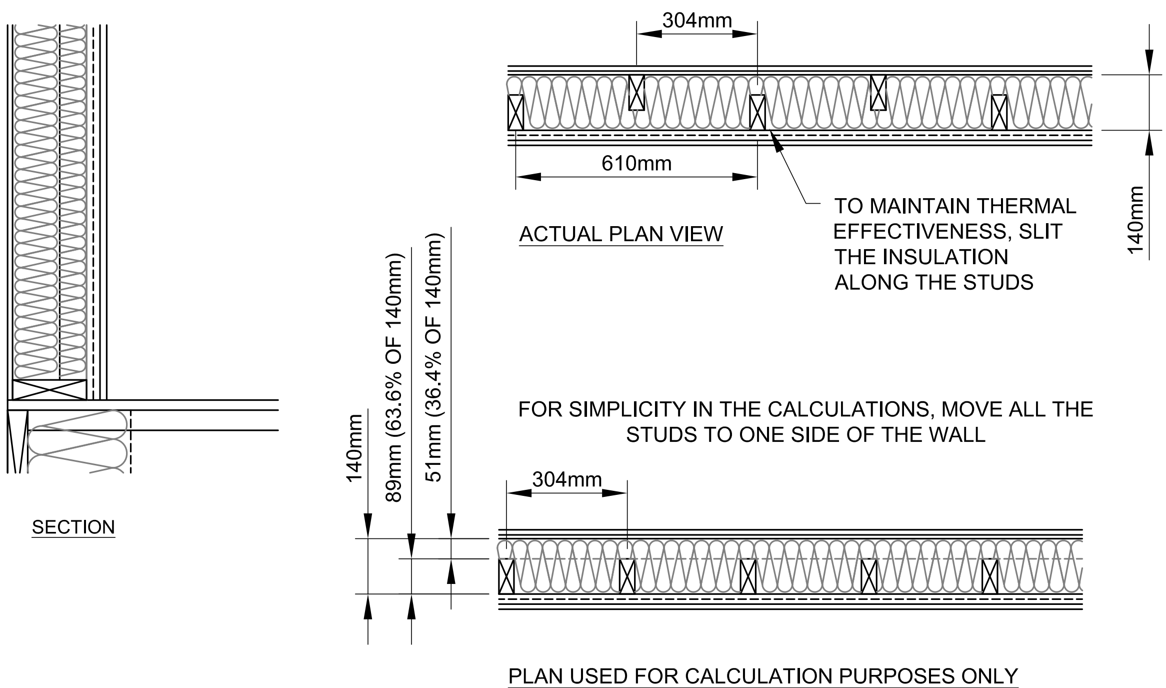
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) VARIES DEPENDING ON PRODUCT

SAMPLE CALCULATIONS

Wood Framed Wall Assemblies

STAGGERED STUD WALL ON A 38x140 TOP AND BOTTOM PLATE
(w/HRV RSI OF 2.97 REQUIRED)
(w/o HRV RSI OF 3.08 REQUIRED)



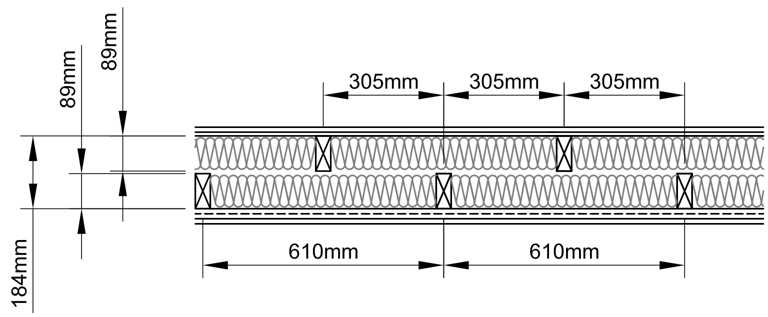
TYPICAL WOOD FRAME WALL, STAGGERED STUD : 3.12 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 (1)	0.03
VINYL SIDING, HOLLOW BACKED	0.11(1)	0.11
SHEATHING PAPER	—	—
9.5mm OSB SHEATHING	0.093 (1)	0.093
38x89 STUD WALL @ 304 o.c. w/ R20 FIBREGLASS BATTS	100/ [(24.5/0.7565*) + (75.5/2.12*)] (2) *0.7565 = 89 x 0.0085 (WOOD STUD S.P.F.)(1) * 2.12 = 3.34 x 63.6% PORTION (1) OF RSI FOR R20 BATT	1.47
REMAINDER OF R20 BATT	1.22 = 3.34 - 2.12	1.22
6 mil CGSB VAPOUR BARRIER	—	—
12.7mm GYPSUM BOARD	12.7 x 0.0061 (1)	0.0775
INTERIOR AIR FILM	0.12 (1)	0.12
TOTAL		3.12

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

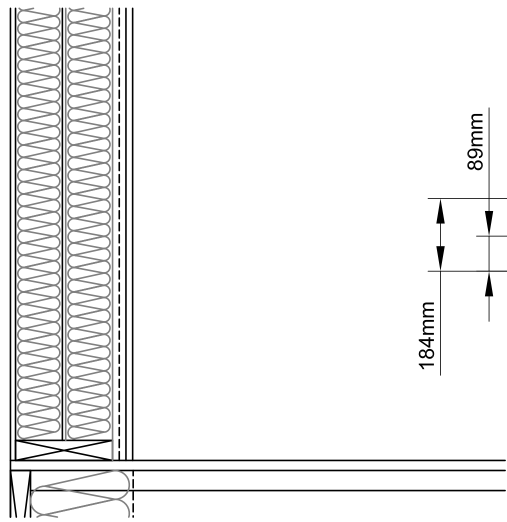
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

Wood Framed Wall Assemblies

STAGGERED STUD WALL ON A 38x184 TOP AND BOTTOM PLATE
(w/HRV RSI OF 2.97 REQUIRED)
(w/o HRV RSI OF 3.08 REQUIRED)



PLAN



SECTION

TYPICAL WOOD FRAME WALL, STAGGERED STUD : 3.53 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 (1)	0.03
VINYL SIDING, HOLLOW BACKED	0.11 (1)	0.11
SHEATHING PAPER	—	—
9.5mm OSB SHEATHING	0.093 (1)	0.093
38x89 STUD WALL @ 610 o.c. w/ R12 FIBREGLASS BATT INSULATION	100/ [(20/0.7565*) + (80/2.11*)] (2) *0.7565 = 89 x 0.0085 (WOOD STUD S.P.F.) (1) *2.11 RSI FOR R12 BATT (1)	1.55
38x89 STUD WALL @ 610 o.c. w/ R12 FIBREGLASS BATT INSULATION	100/ [(20/0.7565*) + (80/2.11*)] (2) *0.7565 = 89 x 0.0085 (WOOD STUD S.P.F.) (1) *2.11 RSI FOR R12 BATT (1)	1.55
6 mil CGSB VAPOUR BARRIER	—	—
12.7mm GYPSUM BOARD	12.7 x 0.0061 (1)	0.0775
INTERIOR AIR FILM	0.12 (1)	0.12
TOTAL		3.53

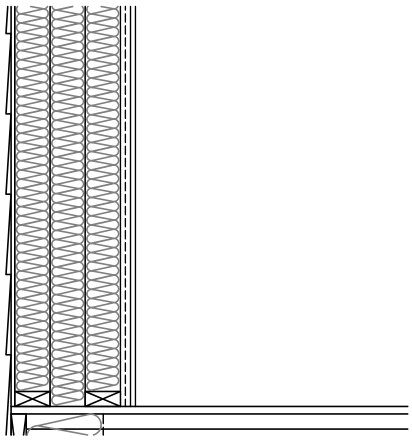
(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

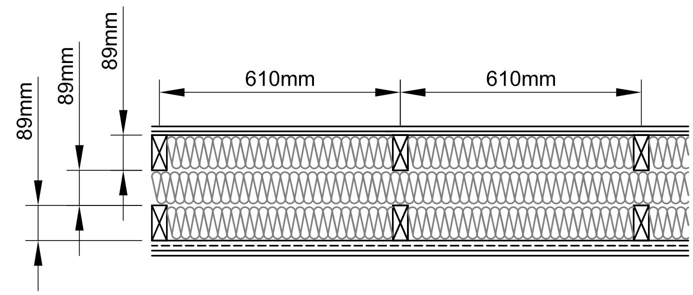
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

SAMPLE CALCULATIONS

Wood Framed Wall Assemblies

38x89mm DOUBLE STUD WALL
w/ 89mm GAP BETWEEN STUDS
(w/HRV RSI OF 2.97 REQUIRED)
(w/o HRV RSI OF 3.08 REQUIRED)


SECTION



PLAN VIEW

TYPICAL WOOD FRAME DOUBLE WALL w/ 89mm INSULATED GAP: 5.56 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 (1)	0.03
8mm HARDIE PLANK SIDING (3)	0.003 (1)	0.026
SHEATHING PAPER	—	—
9.5mm OSB SHEATHING	0.093 (1)	0.093
38x89 STUD WALL @ 610 o.c. w/ R12 FIBREGLASS BATT INSULATION	100/ [(20/0.7565*) + (80/2.11*)] (2) *0.7565 = 89 x 0.0085 (WOOD STUD S.P.F.) (1) *2.11 RSI FOR R12 BATT (1)	1.55
R12 FIBREGLASS BATT	2.11 (1)	2.11
38x89 STUD WALL @ 610 o.c. w/ R12 FIBREGLASS BATT INSULATION	100/ [(20/0.7565*) + (80/2.11*)] (2) *0.7565 = 89 x 0.0085 (WOOD STUD S.P.F.) (1) *2.11 = RSI FOR R12 BATT (1)	1.55
6 mil CGSB VAPOUR BARRIER	—	—
12.7mm GYPSUM BOARD	12.7 x 0.0061 (1)	0.0775
INTERIOR AIR FILM	0.12 (1)	0.12
TOTAL		5.56

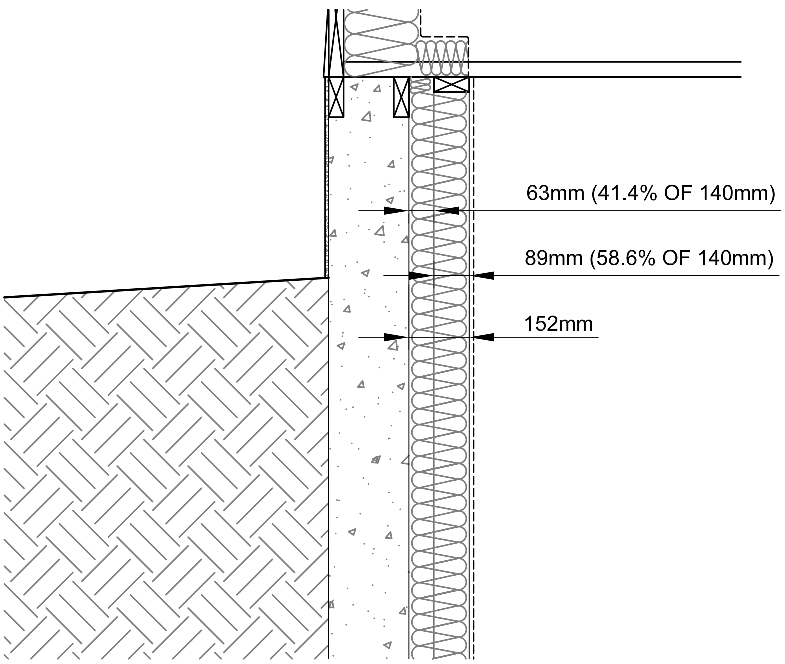
(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) HARDIE PLANK SIDING IS FIBRE-CEMENT: SINGLE FACED, CELLULOSE FIBRE REINFORCED CEMENT FROM TABLE A-9.36.2.4(1) - D

Foundation Wall Assemblies

203mm FOUNDATION WALL
38x89 STUDS @ 610 o.c. w/ R20 BATT INSULATION
(w/HRV RSI OF 2.98 REQUIRED)
(w/o HRV RSI OF 3.46 REQUIRED - DOES NOT MEET)



FOUNDATION WALL: 3.34 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
203mm CONCRETE	203 x 0.0004 [(1)]	0.0812
DAMP PROOFING	—	—
AREA BEHIND STUD WALL (R20 BATTS USED - RSI 3.52)	1.46 = (3.52 x 41.4%) [(1) (3)]	1.46
38x89 STUD WALL @ 610 o.c. w/ R20 FIBREGLASS BATT INSULATION	100/ [(13/0.7565 + (87/2.06*)] [(2)] *0.7565 = 89 x 0.0085 (WOOD STUD S.P.F.) [(1)] *2.06 = (3.52 x 58.6%) [(1)]	1.68
6 mil CGSB VAPOUR BARRIER	—	—
INTERIOR AIR FILM	0.12 [(1)]	0.12
TOTAL		3.34

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

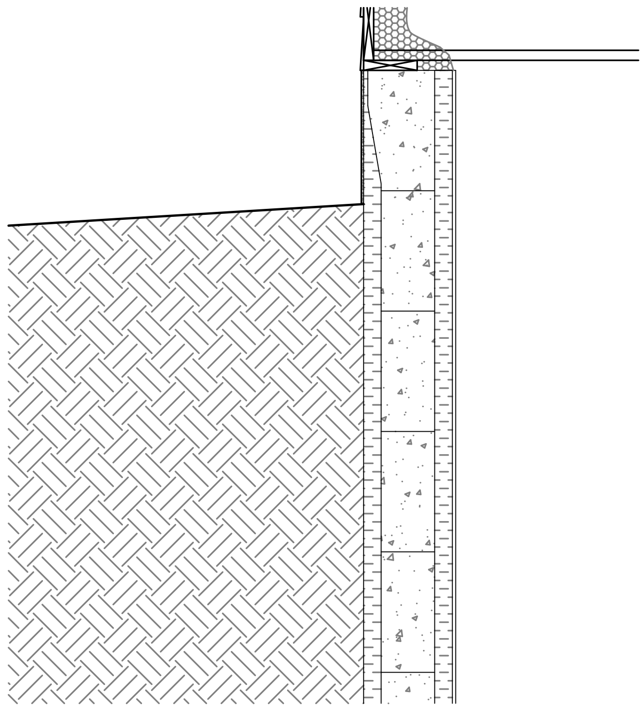
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) ALL VOIDS TO BE FILLED WITH INSULATION INCLUDING THE SPACE DIRECTLY BEHIND EACH STUD.

SAMPLE **CALCULATIONS**

Foundation Wall Assemblies

203mm ICF FOUNDATION WALL
(w/HRV RSI OF 2.98 REQUIRED)
(w/o HRV RSI OF 3.46 REQUIRED)



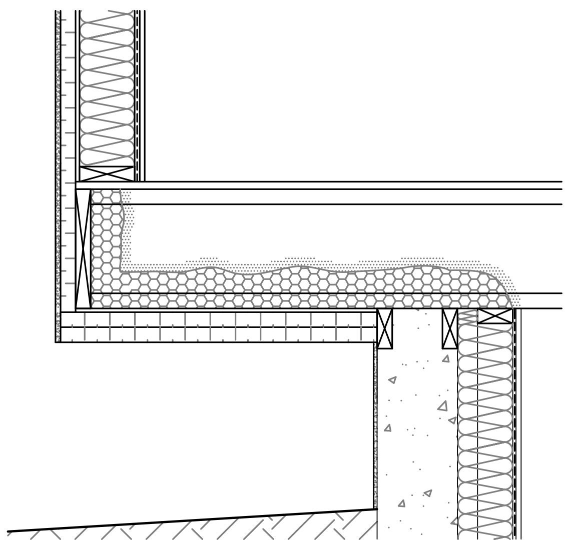
ICF FOUNDATION WALL: 4.01 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
EXPANDED POLYSTYRENE (66.7mm) TYPE 2	66.7 x 0.028 (1)(2)	1.868
203mm CONCRETE	203 x 0.0004 (1)	0.0812
EXPANDED POLYSTYRENE (66.7mm) TYPE 2	66.7 x 0.028 (1)(2)	1.868
12.7mm GYPSUM BOARD	12.7 x 0.0061 (1)	0.0775
INTERIOR AIR FILM	0.12 (1)	0.12
TOTAL		4.01

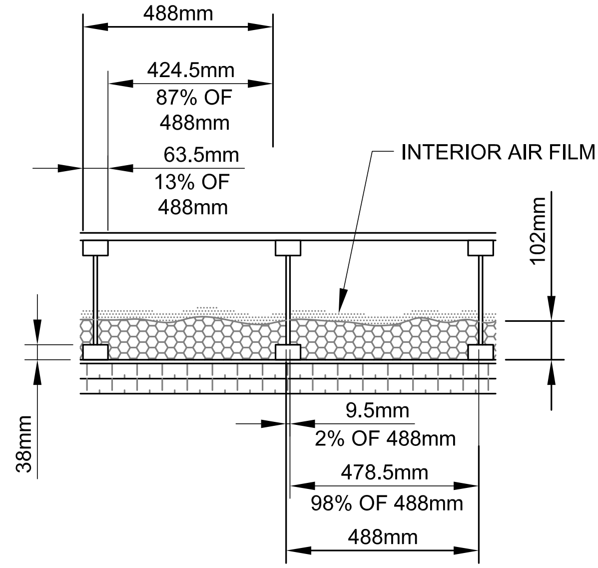
(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) INSULATION THICKNESS AND RSI VALUE MAY VARY DEPENDING ON MANUFACTURER. PLEASE CONFIRM WITH ICF SUPPLIER.

Cantilevered Floor Assemblies

CANTILEVER I-JOIST w 102mm OF MEDIUM DENSITY SPRAY-APPLIED RIGID POLYURETHANE FOAM INSULATION AND 76mm OF EXTRUDED POLYSTYRENE
(w/HRV RSI OF 5.02 REQUIRED)
(w/o HRV RSI OF 5.02 REQUIRED)





CANTILEVER I-JOIST FLOOR : 5.11 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 [1]	0.03
METAL SOFFIT	NEGLIGIBLE [1]	—
EXTRUDED POLYSTYRENE (50mm)	50 x 0.0336[1]	1.68
9.5mm OSB SHEATHING	0.093 [1]	0.093
I-JOISTS @ 488 o.c. w/ MEDIUM DENSITY SPRAY FOAM (FLANGE PORTION OF JOIST)	100/ [(13/0.323*) + (87/1.368*)] *0.323 = 38 x 0.0085 (JOIST FLANGE S.P.F.)[1] *1.368 = 38 x 0.036 (SPRAY FOAM) [1]	0.963
SPRAY FOAM (64mm) @ 9.5mm OSB WEB PORTION OF I-JOIST	100/ [(2/0.6272*) + (98/2.304*)] *0.6272 = 64 x 0.0098 (JOIST WEB OSB) [1] *2.304 = 64 x 0.036 (SPRAY FOAM) [1]	2.187
INTERIOR AIR FILM	0.16 [1]	0.16
AIR CAVITY	NOT INCLUDED [2]	—
19.1mm T&G OSB	NOT INCLUDED [2]	—
TOTAL		5.11

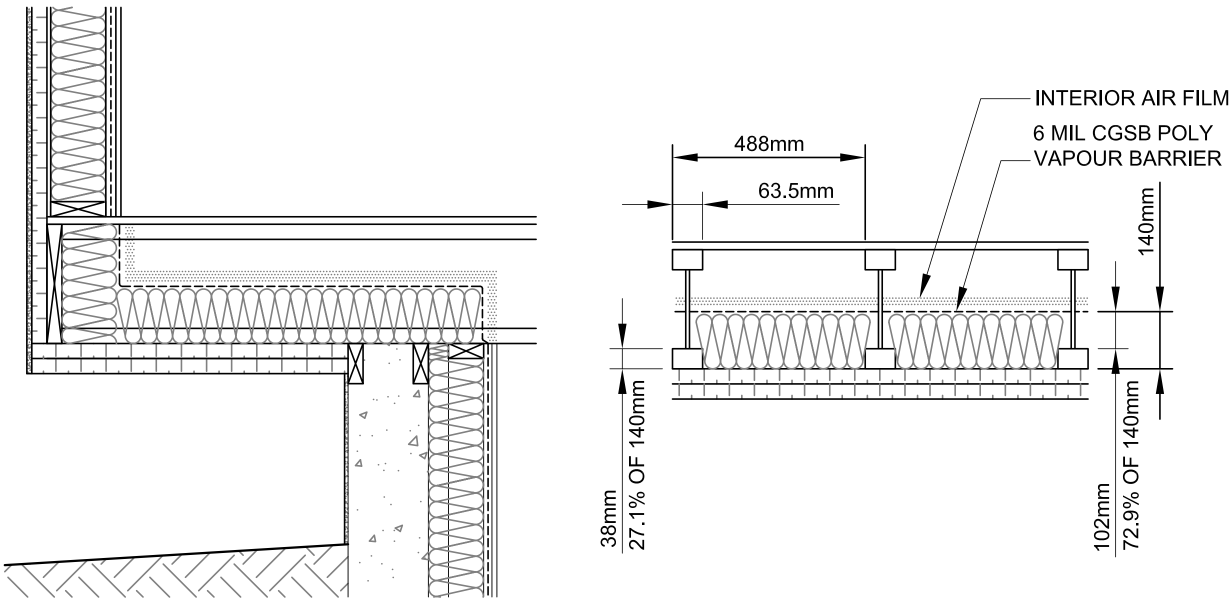
(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) MATERIALS INSTALLED TOWARDS THE INTERIOR OF A CONDITIONED AIR SPACE CANNOT BE INCLUDED IN THE CALCULATION OF EFFECTIVE THERMAL RESISTANCE OF THE ASSEMBLY.

SAMPLE **CALCULATIONS**

Cantilevered Floor Assemblies

CANTILEVER I-JOIST w/ R22 FIBREGLASS BATT INSULATION
AND 76mm TYPE 2 EXPANDED POLYSTYRENE
(w/HRV RSI OF 5.02 REQUIRED)
(w/o HRV RSI OF 5.02 REQUIRED)



CANTILEVER I-JOIST FLOOR : 5.34 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 (1)	0.03
METAL SOFFIT	NEGLIGIBLE (1)	—
EXPANDED POLYSTYRENE (76mm) TYPE 2	76 x 0.028 (1)	2.128
I-JOISTS @ 488 o.c. w/ R22 FIBREGLASS BATT INSULATION	100/ [(7.5/0.816*) + (92.5/3.87*)] (2) *0.323 = 38 x 0.0085 (JOIST FLANGE S.P.F.)(1) 1.00 = 102 x 0.0098 (JOIST WEB O.S.B.) (1) 0.816 = (27.1% x 0.323) + (72.9% x 1.00) *3.87 (R22 BATT) (1)	3.02
6 mil CGSB VAPOUR BARRIER	—	—
INTERIOR AIR FILM	0.16 (1)	0.16
AIR CAVITY	NOT INCLUDED (3)	—
19.1mm T&G OSB	NOT INCLUDED (3)	—
TOTAL		5.34

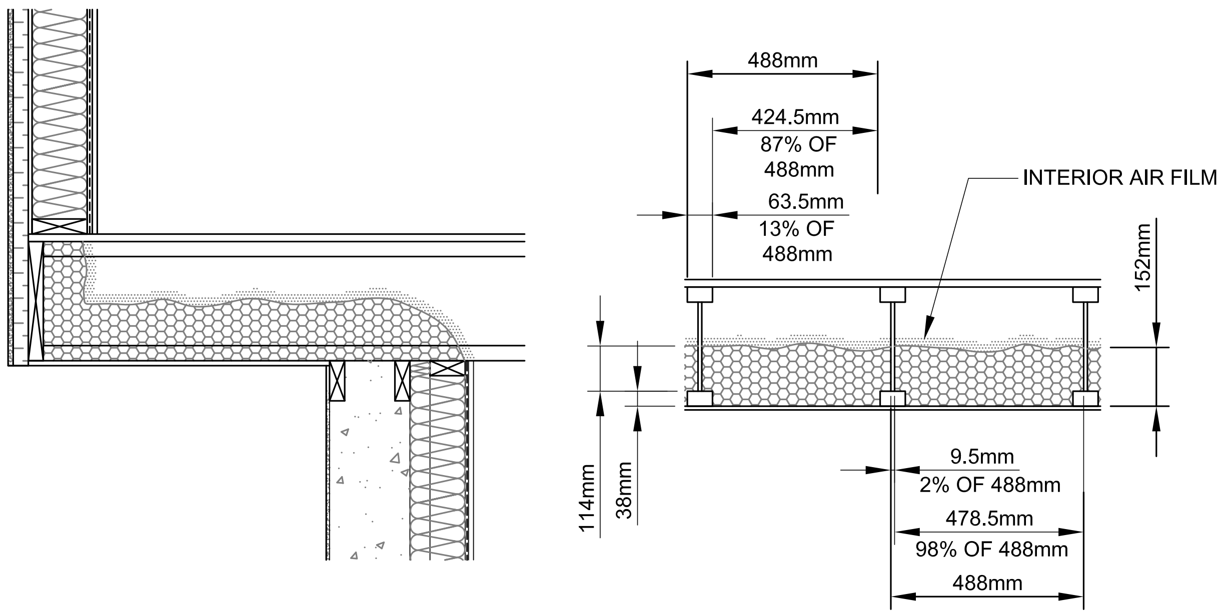
(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) MATERIALS INSTALLED TOWARDS THE INTERIOR OF A CONDITIONED AIR SPACE CANNOT BE INCLUDED IN THE CALCULATION OF EFFECTIVE THERMAL RESISTANCE OF THE ASSEMBLY.

Cantilevered Floor Assemblies

CANTILEVER I-JOIST w 152mm OF MEDIUM DENSITY SPRAY-APPLIED
RIGID POLYURETHANE FOAM INSULATION
(w/HRV RSI OF 5.02 REQUIRED)
(w/o HRV RSI OF 5.02 REQUIRED)



CANTILEVER I-JOIST FLOOR : 5.14 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 (1)	0.03
METAL SOFFIT	NEGLIGIBLE (1)	—
9.5mm OSB SHEATHING	0.093 (1)	0.093
I-JOISTS @ 488 o.c. w/ MEDIUM DENSITY SPRAY FOAM (FLANGE PORTION OF JOIST)	100/ [(13/0.323*) + (87/1.368*)] *0.323 = 38 x 0.0085 (JOIST FLANGE S.P.F.)(1) *1.368 = 38 x 0.036 (SPRAY FOAM)(1)	0.963
SPRAY FOAM (114mm) @ 9.5mm OSB WEB PORTION OF I-JOIST	100/ [(2/1.1172*) + (98/4.104*)] *1.1172 = 114 x 0.0098 (JOIST WEB OSB)(1) *4.104 = 114 x 0.036 (SPRAY FOAM)(1)	3.896
INTERIOR AIR FILM	0.16 (1)	0.16
AIR CAVITY	NOT INCLUDED (2)	—
19.1mm T&G OSB	NOT INCLUDED (2)	—
TOTAL		5.14

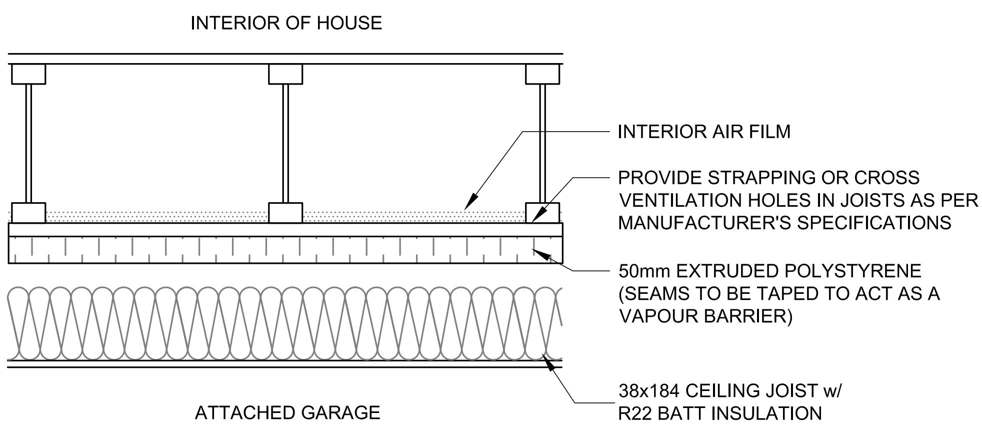
(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) MATERIALS INSTALLED TOWARDS THE INTERIOR OF A CONDITIONED AIR SPACE CANNOT BE INCLUDED IN THE CALCULATION OF EFFECTIVE THERMAL RESISTANCE OF THE ASSEMBLY.

SAMPLE **CALCULATIONS**

Floor Over Attached Garage Assemblies

BONUS ROOM FLOOR w/ 50mm EXTRUDED POLYSTYRENE
AND A 38x184 CEILING JOIST w/ R22 FIBREGLASS BATT INSULATION
(w/HRV RSI OF 4.86[4] REQUIRED)
(w/o HRV RSI OF 4.86[4] REQUIRED)



SECTION

I-JOIST FLOOR w/ 38x184 CEILING JOIST : 5.14 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 [1]	0.03
12.7mm GYPSUM BOARD	12.7 x 0.0061[1]	0.0775
38x184 CEILING JOIST @ 406 o.c. w/ R22 FIBREGLASS BATT INSULATION	100/ [(13/1.19*) + (87/3.87*)] [2] *1.19 = 140 x 0.0085 (CEILING JOIST S.P.F.)[1] *3.87 = RSI FOR R22 BATT [1]	2.99
AIR CAVITY (44mm)	0.20 [1]	0.20
EXTRUDED POLYSTYRENE (50mm)	1.68 [1]	1.68
INTERIOR AIR FILM	0.16 [1]	0.16
AIR CAVITY	NOT APPLICABLE [3]	–
19.1mm T&G OSB	NOT APPLICABLE [3]	–
TOTAL		5.14

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

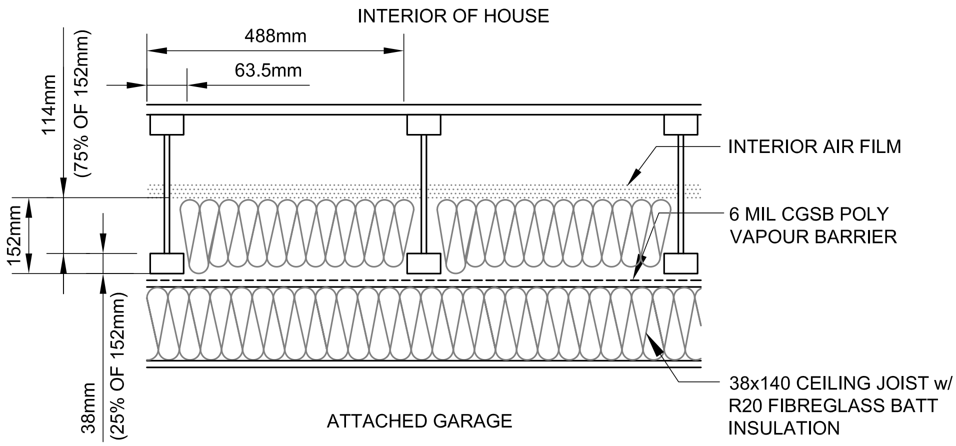
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) MATERIALS INSTALLED TOWARDS THE INTERIOR OF A CONDITIONED AIR SPACE CANNOT BE INCLUDED IN THE CALCULATION OF EFFECTIVE THERMAL RESISTANCE OF THE ASSEMBLY.

(4) WHERE COMPONENTS OF THE BUILDING ENVELOPE IS PROTECTED BY AN ENCLOSED UNCONDITIONED SPACE, SUCH AS A SUN PORCH, ENCLOSED VERANDA, VESTIBULE OR ATTACHED GARAGE, THE REQUIRED EFFECTIVE THERMAL RESISTANCE OF THE BUILDING ENVELOPE COMPONENT BETWEEN THE BUILDING AND THE UNCONDITIONED ENCLOSURE IS PERMITTED TO BE REDUCED BY 0.16 ($m^2 \cdot K$)/W.

Floor Over Attached Garage Assemblies

BONUS ROOM FLOOR w/ R20 FIBREGLASS BATT INSULATION AND
A 38x140 CEILING JOIST w/ R19 FIBREGLASS BATT INSULATION
(w/HRV RSI OF 4.86[5] REQUIRED)
(w/o HRV RSI OF 4.86[5] REQUIRED)



SECTION

I-JOIST FLOOR w/ 38x140 CEILING JOIST : 5.78 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 [1]	0.03
12.7mm GYPSUM BOARD	12.7 x 0.0061[1]	0.0775
38x140 CEILING JOIST @ 406 o.c. w/ R20 FIBREGLASS BATT INSULATION	100/ [(13/1.19*) + (87/3.34*)] [2] *1.19 = 140 x 0.0085 (CEILING JOIST S.P.F.)[1] *3.34 = RSI FOR R19 BATT [1][3]	2.70
6 mil CGSB VAPOUR BARRIER	—	—
I-JOISTS @ 488 o.c. w/ R20 FIBREGLASS BATT INSULATION	100/ [(7.5/0.95975*) + (92.5/3.52*)][2] *0.323 = 38 x 0.0085 (JOIST FLANGE S.P.F.)[1] 1.1172 = 114 x 0.0098 (JOIST WEB O.S.B.)[1] 0.95975 = (25% x 0.323) + (75% x 1.1172) *3.52 (R20 BATT)[1]	2.9332
INTERIOR AIR FILM	0.16 [1]	0.16
AIR CAVITY	NOT APPLICABLE [4]	–
19.1mm T&G OSB	NOT APPLICABLE [4]	–
TOTAL		5.90

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) AN RSI 3.52 (R20) BATT COMPRESSED INTO A 140mm CAVITY HAS A THERMAL RESISTANCE VALUE OF 3.34 (R19); IF INSTALLED UNCOMPRESSED IN A 152mm CAVITY, IT WILL RETAIN ITS FULL RSI VALUE OF 3.52.

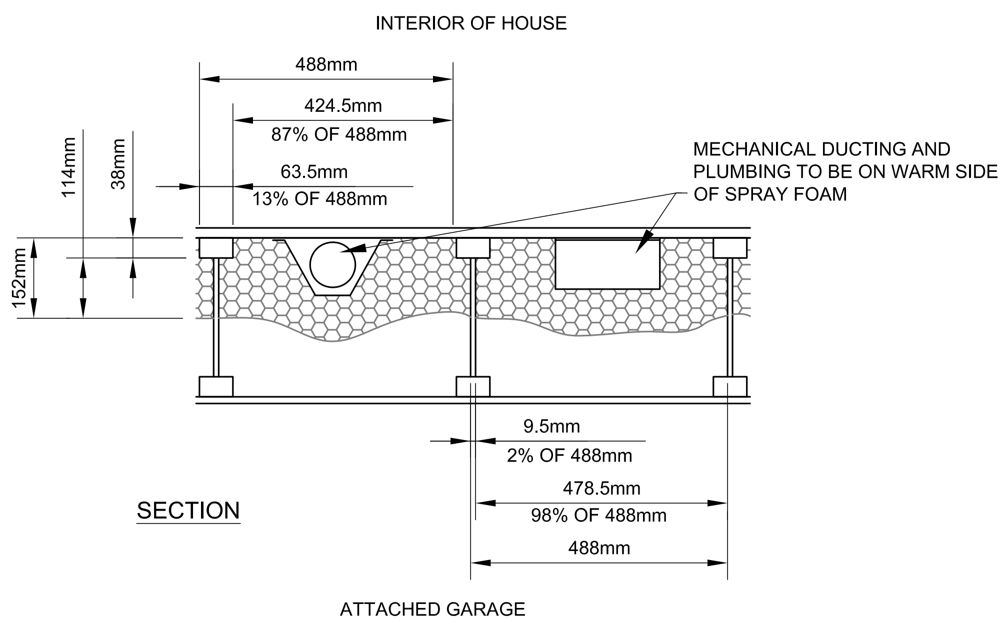
(4) MATERIALS INSTALLED TOWARDS THE INTERIOR OF A CONDITIONED AIR SPACE CANNOT BE INCLUDED IN THE CALCULATION OF EFFECTIVE THERMAL RESISTANCE OF THE ASSEMBLY.

(5) WHERE COMPONENTS OF THE BUILDING ENVELOPE IS PROTECTED BY AN ENCLOSED UNCONDITIONED SPACE, SUCH AS A SUN PORCH, ENCLOSED VERANDA, VESTIBULE OR ATTACHED GARAGE, THE REQUIRED EFFECTIVE THERMAL RESISTANCE OF THE BUILDING ENVELOPE COMPONENT BETWEEN THE BUILDING AND THE UNCONDITIONED ENCLOSURE IS PERMITTED TO BE REDUCED BY 0.16 ($m^2 \cdot K$)/W.

SAMPLE CALCULATIONS

Floor Over Attached Garage Assemblies

BONUS ROOM FLOOR w/ 152mm MEDIUM DENSITY SPRAY-APPLIED
RIGID POLYURETHANE FOAM INSULATION
(w/HRV RSI OF 4.86 [2] REQUIRED)
(w/o HRV RSI OF 4.86 [2] REQUIRED)



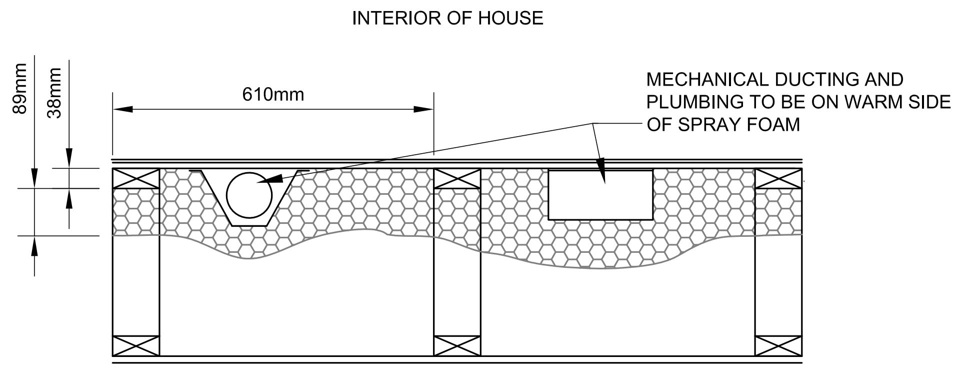
I-JOIST FLOOR w/ MEDIUM DENSITY SPRAY FOAM: 5.53 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 [1]	0.03
12.7mm GYPSUM BOARD	12.7 x 0.0061 [1]	0.0775
AIR CAVITY ≥ 90mm	0.22 [1]	0.22
SPRAY FOAM (114mm) @ 9.5mm OSB WEB PORTION OF I-JOIST	100/ [(2/1.1172*) + (98/4.104*)] *1.1172 = 114 x 0.0098 (JOIST WEB OSB) [1] *4.104 = 114 x 0.036 (SPRAY FOAM) [1]	3.896
I-JOISTS @ 488 o.c. w/ MEDIUM DENSITY SPRAY FOAM (FLANGE PORTION OF JOIST)	100/ [(13/0.323*) + (87/1.368*)] *0.323 = 38 x 0.0085 (JOIST FLANGE S.P.F.) [1] *1.368 = 38 x 0.036 (SPRAY FOAM) [1]	0.963
19.1mm T&G OSB	19.1 x 0.0098 [1]	0.1872
INTERIOR AIR FILM	0.16 [1]	0.16
TOTAL		5.53

[1] VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

[2] WHERE COMPONENTS OF THE BUILDING ENVELOPE IS PROTECTED BY AN ENCLOSED UNCONDITIONED SPACE, SUCH AS A SUN PORCH, ENCLOSED VERANDA, VESTIBULE OR ATTACHED GARAGE, THE REQUIRED EFFECTIVE THERMAL RESISTANCE OF THE BUILDING ENVELOPE COMPONENT BETWEEN THE BUILDING AND THE UNCONDITIONED ENCLOSURE IS PERMITTED TO BE REDUCED BY 0.16 ($m^2 \cdot K$)/W.

Floor Over Attached Garage Assemblies

BONUS ROOM FLOOR w/ 127mm MEDIUM DENSITY
SPRAY-APPLIED RIGID POLYURETHANE FOAM INSULATION
(w/HRV RSI OF 4.86 [3] REQUIRED)
(w/o HRV RSI OF 4.86 [3] REQUIRED)



SECTION

O.W.W.J. FLOOR w/ MEDIUM DENSITY SPRAY FOAM : 5.02 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 [1]	0.03
12.7mm GYPSUM BOARD	12.7 x 0.0061[1]	0.0775
AIR CAVITY ≥ 90mm	0.22 [1]	0.22
SPRAY FOAM (89mm)	89 x 0.036 [1]	3.204
O.W.W.J. @ 610 o.c. w/ MEDIUM DENSITY SPRAY FOAM	100/ [(6/0.323*) + (94/1.368*)][2] *0.323 = 38 x 0.0085 (JOIST FLANGE S.P.F.)[1] *1.368 = 38 x 0.036 (SPRAY FOAM)[1]	1.146
19.1mm T&G OSB	19.1 x 0.0098 [1]	0.1872
INTERIOR AIR FILM	0.16 [1]	0.16
TOTAL		5.02

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

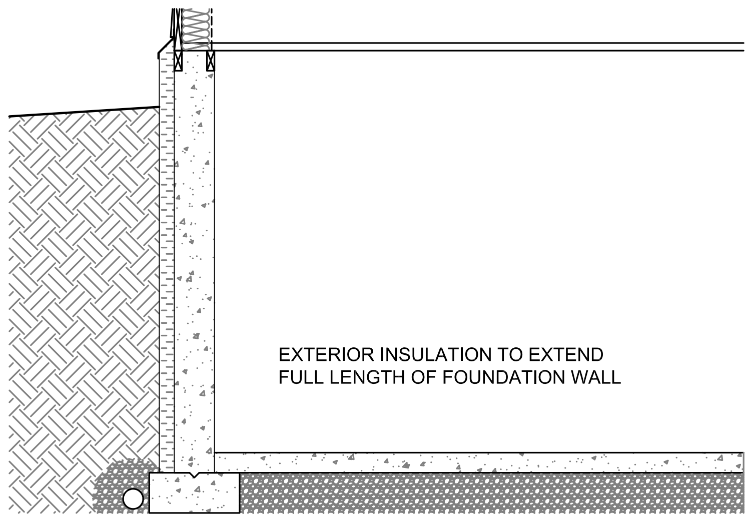
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) WHERE COMPONENTS OF THE BUILDING ENVELOPE IS PROTECTED BY AN ENCLOSED UNCONDITIONED SPACE, SUCH AS A SUN PORCH, ENCLOSED VERANDA, VESTIBULE OR ATTACHED GARAGE, THE REQUIRED EFFECTIVE THERMAL RESISTANCE OF THE BUILDING ENVELOPE COMPONENT BETWEEN THE BUILDING AND THE UNCONDITIONED ENCLOSURE IS PERMITTED TO BE REDUCED BY 0.16 ($m^2 \cdot$ K)/W.

SAMPLE CALCULATIONS

Slab Assemblies

FOUNDATION WALL w/ UNHEATED FLOOR
LOCATED ABOVE FROST LINE - OPTION 1
(w/HRV RSI OF 1.96 REQUIRED FOR SLAB & RSI 2.98 FOR FOR FOUNDATION WALL)
(w/o HRV RSI OF 1.96 REQUIRED FOR SLAB & RSI 3.46 FOR FOUNDATION WALL)



FOUNDATION WALL ASSEMBLY, UNHEATED SLAB[3] : 3.19 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
89mm EXTRUDED POLYSTYRENE	89 x 0.0336[1]	2.99
203mm CONCRETE	203 x 0.0004[1]	0.0812
DAMP PROOFING	—	—
INTERIOR AIR FILM	0.12[1]	0.12
TOTAL		3.19

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

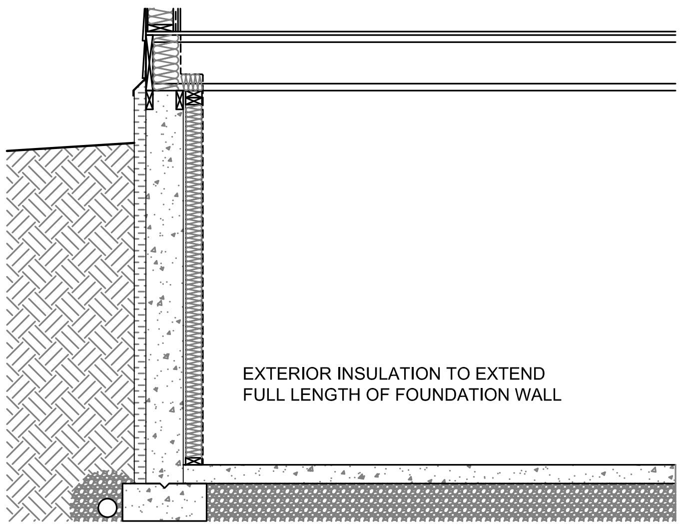
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) EXTERIOR INSULATION USED IN UNHEATED SLAB CALCULATION CAN BE INCLUDED IN THE CALCULATION FOR THE REQUIRED RSI OF THE FOUNDATION WALL AS PER CLAUSE 9.36.2.8.(4)(a)

NOTE: RSI VALUES MAY VARY BETWEEN PRODUCTS

Slab Assemblies

FOUNDATION WALL w/ UNHEATED FLOOR
LOCATED ABOVE FROST LINE - OPTION 2
(w/HRV RSI 2.98 REQUIRED)
(w/o HRV RSI OF 3.46 REQUIRED)



FOUNDATION WALL ASSEMBLY, UNHEATED SLAB[3] : 4.03 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
63mm EXTRUDED POLYSTYRENE	63 x 0.0336 [1]	2.117 [4]
203mm CONCRETE	203 x 0.0004 [1]	0.0812
DAMP PROOFING	—	—
38x89 STUD WALL @ 610 o.c. w/ R12 FIBREGLASS BATT INSULATION	100/ [(13/0.7565 + (87/2.11*)] [2] *0.7565 = 89 x 0.0085 (WOOD STUD S.P.F.)[1] *2.11 = R12 BATT [1]	1.71
6 mil CGSB VAPOUR BARRIER	—	—
INTERIOR AIR FILM	0.12 [1]	0.12
TOTAL		4.03

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

(3) EXTERIOR INSULATION USED IN UNHEATED SLAB CALCULATION CAN BE INCLUDED IN THE CALCULATION FOR THE REQUIRED RSI OF THE FOUNDATION WALL AS PER CLAUSE 9.36.2.8.(4)(a)

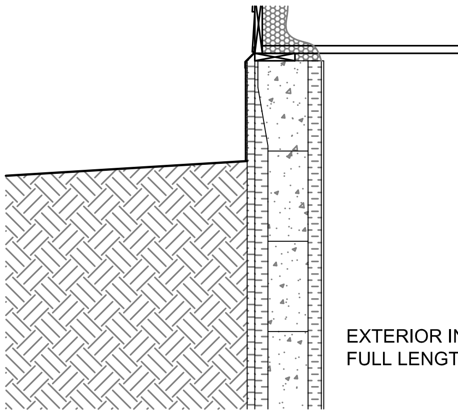
(4) EXTERIOR INSULATION REQUIRED TO HAVE MINIMUM RSI = 1.96 (m² ·K)/W

NOTE: RSI VALUES MAY VARY BETWEEN PRODUCTS

SAMPLE **CALCULATIONS**

Slab Assemblies

ICF FOUNDATION WALL w/ UNHEATED FLOOR
LOCATED ABOVE FROST LINE w/ 38mm OF EXTRUDED POLYSTYRENE
(w/HRV RSI OF 1.96 REQUIRED)
(w/o HRV RSI OF 1.96 REQUIRED)



INSULATION ON THE EXTERIOR OF FOUNDATION WALL, UNHEATED[2] SLAB : 2.932 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
38mm EXPANDED POLYSTYRENE TYPE 2	38 x 0.028 [1]	1.064
66.7mm EXPANDED POLYSTYRENE TYPE 2	66.7 x 0.028 [1]	1.868
TOTAL		2.932

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) EXTERIOR INSULATION USED IN UNHEATED SLAB CALCULATION CAN BE INCLUDED IN THE CALCULATION FOR THE REQUIRED RSI OF THE FOUNDATION WALL

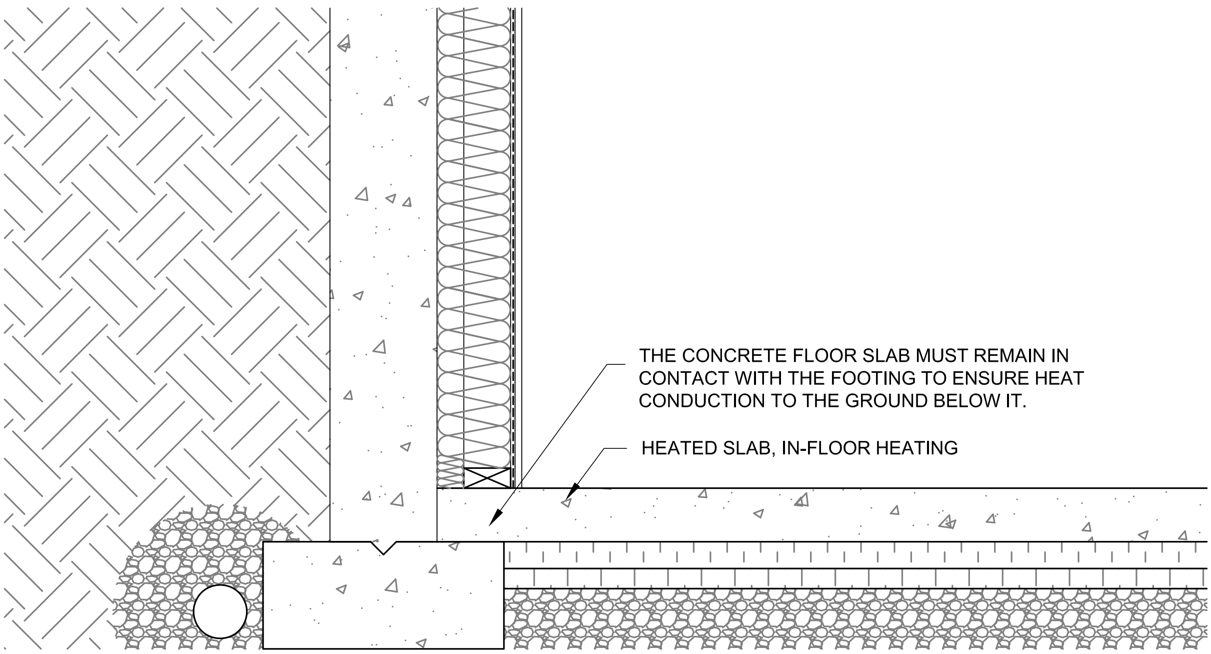
ICF FOUNDATION WALL: 5.08 RSI (R=5.678 x RSI) (RSI 2.98 REQ'D w/ HRV & RSI 3.46 REQ'D w/o HRV)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
38mm EXPANDED POLYSTYRENE TYPE 2	38 x 0.028 [1]	1.064
66.7 mm EXPANDED POLYSTYRENE TYPE 2	66.7 x 0.028 [1]	1.868
203mm CONCRETE	203 x 0.0004 [1]	0.0812
66.7 mm EXPANDED POLYSTYRENE TYPE 2	66.7 x 0.028 [1]	1.868
12.7mm GYPSUM BOARD	12.7 x 0.0061 [1]	0.0775
INTERIOR AIR FILM	0.12 [1]	0.12
TOTAL		5.08

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) INSULATION THICKNESS AND RSI VALUE MAY VARY DEPENDING ON MANUFACTURER.
PLEASE CONFIRM WITH ICF SUPPLIER.

Slab Assemblies

HEATED CONCRETE SLAB w/
89mm OF EXTRUDED POLYSTYRENE
(w/HRV RSI OF 2.84 REQUIRED)
(w/o HRV RSI OF 2.84 REQUIRED)



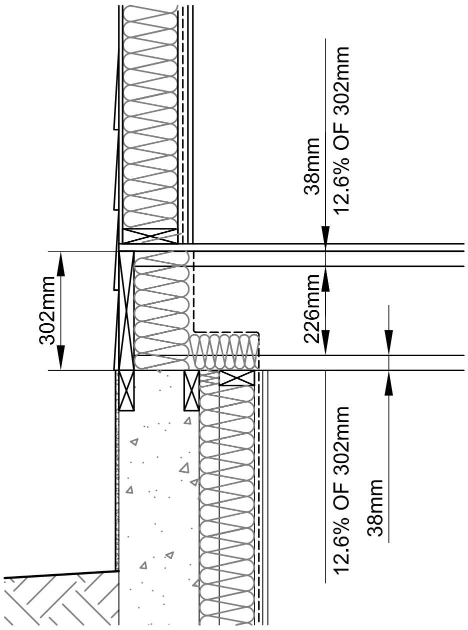
HEATED SLAB : 3.19 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
89mm EXTRUDED POLYSTYRENE	89 x 0.0336 (1)	2.99
6 mil CGSB POLY	—	—
102mm CONCRETE SLAB	102 x 0.0004 (1)	0.0408
INTERIOR AIR FILM	0.16 (1)	0.16
TOTAL		3.19

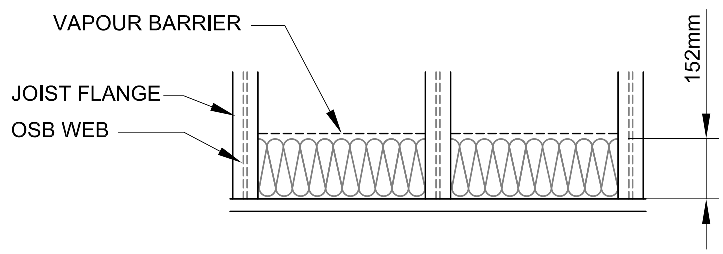
(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

SAMPLE **CALCULATIONS**

Rim Joist Assemblies

RIM JOIST DETAIL w/ I-JOISTS AND R20 BATT INSULATION
(w/HRV RSI OF 2.97 REQUIRED)
(w/o HRV RSI OF 3.02 REQUIRED)





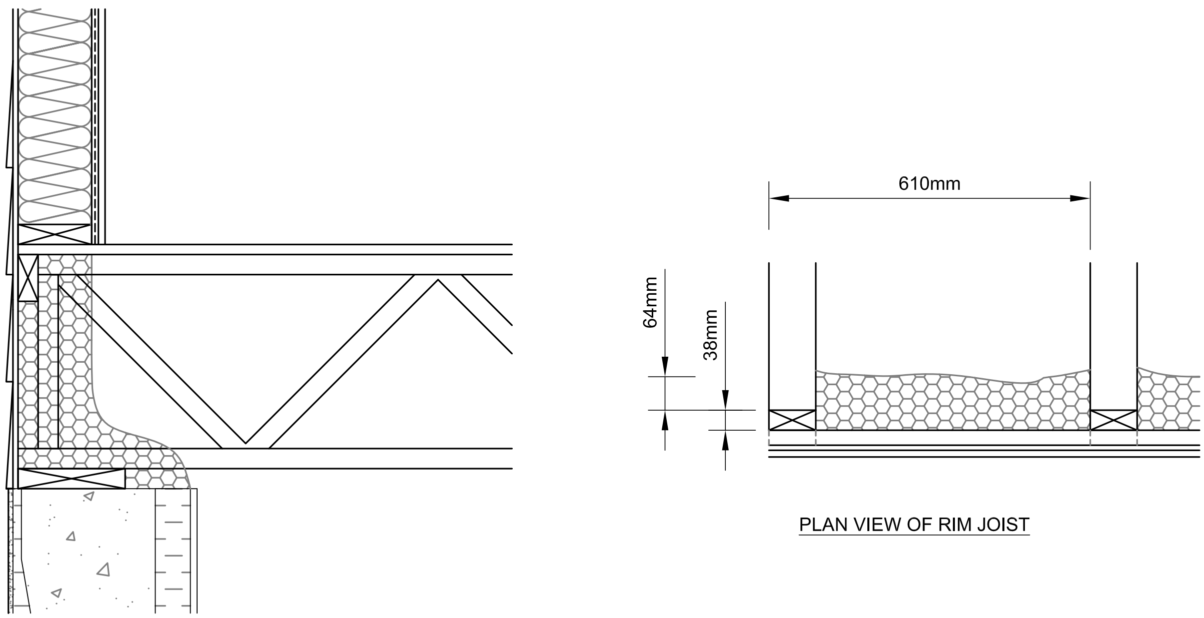
PLAN VIEW OF RIM JOIST

RIM JOIST w/ R20 BATT INSULATION : 3.72 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 (1)	0.03
VINYL SIDING, HOLLOW BACKED	0.11 (1)	0.11
28.6mm RIM JOIST	28.6 x 0.0098 (1)	0.2803
302mm I-JOISTS @ 488mm o.c. w/ R20 BATT	100/ [(7.5/1.440*) + (92.5/3.52*)] (2) *1.292 = 152 x 0.0085 (JOIST FLANGE S.P.F.)(1) 1.4896 = 152 x 0.0098 (JOIST WEB O.S.B.) (1) 1.440 = (25.2% x 1.292) + (74.8% x 1.4896) *3.52 (R20 BATT) (1)	3.18
6 mil CGSB VAPOUR BARRIER	—	—
INTERIOR AIR FILM	0.12 (1)	0.12
TOTAL		3.72

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

Rim Joist Assemblies

RIM JOIST DETAIL w/ O.W.W.J. AND 102mm MEDIUM DENSITY SPRAY-APPLIED RIGID POLYURETHANE FOAM INSULATION
(w/HRV RSI OF 2.97 REQUIRED)
(w/o HRV RSI OF 3.02 REQUIRED)



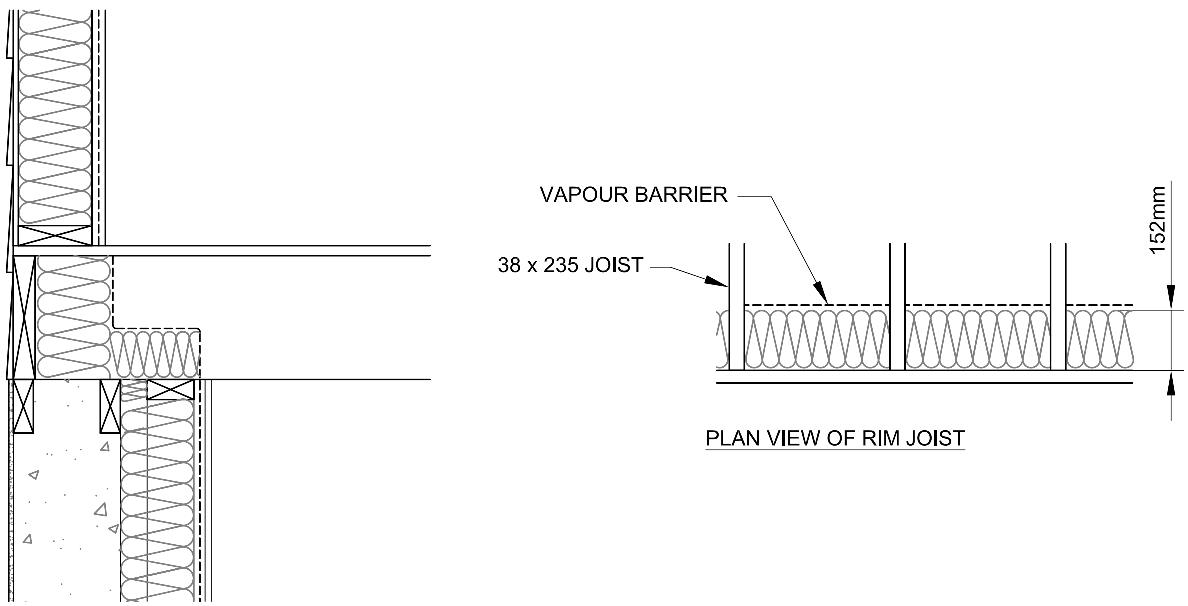
RIM JOIST w/ MEDIUM DENSITY SPRAY FOAM : 3.80 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 [1]	0.03
VINYL SIDING, HOLLOW BACKED	0.11 [1]	0.11
9.5mm OSB SHEATHING	0.093 [1]	0.093
406mm O.W.W.J. @ 610 o.c. w/ SPRAY FOAM	100/ [(6/0.323*) + (94/1.368*)] [2] *0.323 = 38 x 0.0085 (JOIST FLANGE S.P.F.)[1] *1.368 = 38 x 0.036 (SPRAY FOAM)[1]	1.146
SPRAY FOAM	64 x 0.036 [1]	2.304
INTERIOR AIR FILM	0.12 [1]	0.12
TOTAL		3.80

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D
(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

SAMPLE CALCULATIONS

Rim Joist Assemblies

RIM JOIST DETAIL w/ 38 x 235 JOISTS AND R20 BATT INSULATION
(w/HRV RSI OF 2.97 REQUIRED)
(w/o HRV RSI OF 3.02 REQUIRED)



RIM JOIST w/ R20 BATT INSULATION : 3.45 RSI (R=5.678 x RSI)		
COMPONENT	RSI CALCULATION	RSI FOR COMPONENT
OUTSIDE AIR FILM	0.03 (1)	0.03
VINYL SIDING, HOLLOW BACKED	0.11 (1)	0.11
38mm RIM JOIST	38 x 0.0085 (1)	0.323
38 x 235 JOISTS @ 406mm o.c. w/ R20 BATT	100/ [(13/1.292*) + (87/3.52*)] (2) *1.292 = 152 x 0.0085 (JOIST S.P.F.) (1) *3.52 (R20 BATT) (1)	2.88
6 mil CGSB VAPOUR BARRIER	—	—
INTERIOR AIR FILM	0.12 (1)	0.12
TOTAL		3.45

(1) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - D

(2) VALUES FROM NBC 2015 TABLE A-9.36.2.4.(1) - A

REFERENCE MATERIAL

Framing and Cavity Percentages for Typical Wood-Frame Assemblies

		Frame Spacing, mm o.c.									
		304		406		488		610		1220	
Wood Frame Assemblies (1)		% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity	% Area Framing	% Area Cavity
Floors	lumber joists	----	----	13	87	11.5	88.5	10	90	----	----
	I-joists and truss	----	----	9	91	7.5	92.5	6	94	----	----
Roofs/ Ceilings	ceilings with typical trusses	----	----	14	86	12.5	87.5	11	89	----	----
	ceilings with raised heel trusses	----	----	10	90	8.5	91.5	7	93	----	----
	roofs with lumber rafters and ceilings with lumber joists	----	----	13	87	11.5	88.5	10	90	----	----
	roofs with I-joist rafters and ceiling with I-joists	----	----	9	91	7.5	92.5	6	94	----	----
	roofs with structural insulated panels (SIPs)	----	----	----	----	----	----	----	----	9	91
Walls	typical wood-frame	24.5	75.5	23	71	21.5	78.5	20	80	----	----
	advanced wood-frame with double stud top plate (2)	----	----	19	81	17.5	82.5	16	84	----	----
	SIPs	----	----	----	----	----	----	----	----	14	86
	basement wood-frame inside concrete foundation wall	----	----	16	84	14.5	85.5	13	87	----	----

(1) The framing percentages given in the Table account not just for the repetitive framing components but also for common framing practices, such as lintels, double top plates, cripple studs, etc., and include an allowance for typical mixes of studs, lintels and plates. The values listed represent the percentage of wall area taken up by framing and are based on the net wall area (i.e. gross wall area minus fenestration and door area.) If the actual % areas of framing and cavity are known, those should be used rather than the ones in the Table. Rim joists are not accounted for in this Table because they are addressed separately in Sentence 9.36.2.6.(2) (The effective thermal resistance of rim joists shall be not less than that required for above-ground walls.)

(2) “Advanced framing” refers to a variety of framing techniques designed to reduce the thermal bridging and therefore increase the energy efficiency of a building. Some advance framing solutions require that some framing components be insulated or eliminated; in such cases, it may be appropriate to calculate the actual % area of framing. Note that using an advance framing technique may require additional engineering of the framing system, The framing percentage values listed in this Table for advanced framing are based on constructions with insulated lintels or faming designed without lintels, corners with one or two studs, no cripple or jack studs, and double top plates.

** Information from the 2015 National Building Code, Table A-9.36.2.4.(1)-A*

Thermal Resistance Values of Common Materials

		Thickness of Material	Thermal Resistance (RSI), ($m^2 \cdot K$)/W per mm	Thermal Resistance (RSI), ($m^2 \cdot K$)/W for thickness listed
Air Films	Exterior:			
	ceiling, floors and walls wind 6.7 m/s winter	----	----	0.03
	Interior:			
	ceiling (heat flow up)	----	----	0.11
	floor (heat flow down)	----	----	0.16
	walls (heat flow horizontal)	----	----	0.12
Air Cavities	Ceiling (heat flow up) faced with non-reflective material	13 mm	----	0.15
		20 mm	----	0.15
		40 mm	----	0.16
		90 mm	----	0.16
	Floors (heat flow up) faced with non-reflective material	13 mm	----	0.16
		20 mm	----	0.18
		40 mm	----	0.20
		90 mm	----	0.22
	Walls (heat flow horizontal) faced with non-reflective material	13 mm	----	0.16
		20 mm	----	0.18
		40 mm	----	0.18
		90 mm	----	0.18
Sheathing Materials	Gypsum sheathing (drywall)	12.7 mm	0.0063	0.08
	Insulating fibreboard	----	0.016	----
	Plywood - generic softwood	9.5 mm		0.083
		11 mm		0.096
		12.5 mm	0.0087	0.109
		15.5 mm		0.135
		18.5 mm		0.161
	Plywood - douglas fir	9.5 mm		0.105
		11 mm		0.122
		12.5 mm	0.0111	0.139
		15.5 mm		0.172
		18.5 mm		0.205
	Sheet materials:			
	permeable felt	----	----	0.011
	seal, 2 layers of mopped (0.73 kg/m^3)	----	----	0.210
	seal, plastic film	----	----	negligible
	Oriented Strandboard (OSB)	9.5 mm	0.0098	0.093
		11 mm		0.108

** Values from NBC 2015 Table A-9.36.2.4.(1)-D*

REFERENCE MATERIAL

Thermal Resistance Values of Common Materials

		Thickness of Material	Thermal Resistance (RSI), (m²·K)/W per mm	Thermal Resistance (RSI), (m²·K)/W for thickness listed
Cladding Materials	Brick:			
	fired clay (2400 kg/m²)	100 mm	0.0007	0.07
	concrete: sand and gravel, or stone (2400 kg/m²)	100 mm	0.0004	0.04
	Cement/lime, mortor, and stucco	----	0.0009	----
	Wood shingles:			
	400 mm, 190 mm exposure	----	----	0.15
	400 mm, 300 mm exposure (double exposure)	----	----	0.21
	insulating backer board	8 mm	----	0.25
	Siding:			
	Metal or vinyl siding over sheathing:			
	hollow backed	----	----	0.11
	insulating -board-backed	9.5 mm nominal	----	0.32
	foiled-backed	9.5 mm nominal	----	0.52
	Wood:			
	bevel, 200 mm, lapped	13 mm	----	0.14
	bevel, 250 mm, lapped	20 mm	----	0.18
	drop, 200 mm	20 mm	----	0.14
	hardboard	11 mm	----	0.12
	plywood, lapped	9.5 mm	----	0.10
	Stone:			
	quartzitic and sandstone (2240 kg/m³)	----	0.0003	----
	calcitic, dolomitic, limestone, marble and granite (2240 kg/m³)	----	0.0004	----
	Fibre cement: single-faced, cellulose fibre-reinforced cement	6.35 mm 8 mm	0.003 0.003	0.023 0.026
Roofing Materials	Asphalt roll roofing	----	----	0.03
	Asphalt/tar	----	0.0014	----
	Built-up roofing	10 mm	----	0.06
	Crushed stone	----	0.0006	----
	Metal Deck	----	----	negligible
	Shingle:			
	Asphalt	----	----	0.08
	Wood	----	----	0.17
	Slate	13 mm	----	0.01

** Values from NBC 2015 Table A-9.36.2.4.(1)-D*

Thermal Resistance Values of Common Materials

		Thickness of Material	Thermal Resistance (RSI), (m²·K)/W per mm	Thermal Resistance (RSI), (m²·K)/W for thickness listed
Insulation Materials	Blanket and batt: rock or glass mineral fibre (CAN/ULC-S702)			
	R12	89/92 mm	----	2.11
	R14	89/92 mm	----	2.46
	R19 (R20 compressed)	140 mm	----	3.34
	R20	152 mm	----	3.52
	R22	140/152 mm	----	3.87
	R22.5	152 mm	----	3.96
	R24	140/152 mm	----	4.23
	R28	178/216 mm	----	4.93
	R31	241 mm	----	5.46
	R35	267 mm	----	6.16
	R40	279/300 mm	----	7.04
	Boards and slabs:			
	Roof board	----	0.018	----
	Building board or ceiling tile, lay - in panel	----	0.016	----
	Polyisocyanurate/polyurethane-faced sheathing: Types 1, 2 and 3 (CAN/ULC-S704)			
	permeably faced	25 mm	0.03818	0.97
		50 mm	0.0360	1.80
	impermeably faced	25 mm	0.03937	1.00
		50 mm	0.0374	1.87
	Expanded polystyrene (CAN/ULC-S701)			
	Type 1	25 mm	0.026	0.65
	Type 2	25 mm	0.028	0.71
	Type 3	25 mm	0.030	0.76
	Extruded polystyrene: Types 2, 3 and 4 (CAN/ULC-S701)	25 mm	0.035	0.88
		50 mm	0.0336	1.68
	Semi-rigid glass fibre wall/roof insulation (48kg/m³)	25 mm	0.0298	0.757
	Semi-rigid rock wool wall insulation (56 kg/m³)	25 mm	0.0277	0.704
	Loose-fill insulation			
	Cellulose (CAN/ULC-S703)	----	0.025	----
	Glass fibre loose fill insulation for attics (CAN/ULC-S702)	112 to 565 mm	0.01875	----
	Glass fibre loose fill insulation for walls (CAN/ULC-S702)	89 mm	0.02865	2.55
		140 mm	0.0289	4.05
		152 mm	0.030	4.23

** Values from NBC 2015 Table A-9.36.2.4.(1)-D*

REFERENCE MATERIAL

Thermal Resistance Values of Common Materials

		Thickness of Material	Thermal Resistance (RSI), ($m^2 \cdot K$)/W per mm	Thermal Resistance (RSI), ($m^2 \cdot K$)/W for thickness listed
Insulation Materials	Spray-applied insulation:			
	Sprayed polyurethane foam			
	medium density (CAN/ULC-S705.1)	25mm	0.036	0.90
		50mm	0.036	1.80
	light density (CAN/ULC-S712.1)	25mm	0.026	0.65
	Sprayed cellulosic fibre (CAN/ULC-S703)	settled thickness	0.024	----
	Spray-applied glass-fibre insulation (CAN/ULC-S702)			
	density: 16 kg/m^3	89 mm	0.025	2.30
		140 mm	0.025	3.53
	density: 28.8 kg/m^3	89 mm	0.029	2.64
		140 mm	0.029	4.06
Hollow Clay Bricks	Multi-cored without insulation in cores	90 mm	----	0.27
	Rectangle 2 - core			
	no insulation in cores	140 mm	----	0.39
		190 mm	----	0.41
		290 mm	----	0.47
	cores filled with vermiculite	140 mm	----	0.65
		190 mm	----	0.86
		290 mm	----	1.29
	Rectangle 3 - core			
	no insulation in cores	90 mm	----	0.35
		140 mm	----	0.38
		190 mm	----	0.41
		240 mm	----	0.43
		290 mm	----	0.45
	cores filled with vermiculite	140 mm	----	0.68
		190 mm	----	0.86
		240 mm	----	1.06
		290 mm	----	1.19

** Values from NBC 2015 Table A-9.36.2.4.(1)-D*

Thermal Resistance Values of Common Materials

		Thickness of Material	Thermal Resistance (RSI), ($m^2 \cdot K$)/W per mm	Thermal Resistance (RSI), ($m^2 \cdot K$)/W for thickness listed
Concrete Blocks	Limestone aggregate with 2 cores			
	cores filled with perlite	190 mm	----	0.37
		290 mm	----	0.65
	Light-weight units (expanded shale, clay, slate, or slag aggregate) with 2 or 3 cores			
	no insulation in cores	90mm	----	0.24
		140 mm	----	0.30
		190 mm	----	0.32
		240 mm	----	0.33
		290 mm	----	0.41
	cores filled with perlite	140 mm	----	0.74
		190 mm	----	0.99
		290 mm	----	1.35
	cores filled with vermiculite	140 mm	----	0.58
		190 mm	----	0.81
		240 mm	----	0.98
		290 mm	----	1.06
	cores filled with EPS beads	190 mm	----	0.85
	molded EPS inserts in cores	190 mm	----	0.62
	Medium-weight units (comb of normal and low-mass aggregate) with 2 or 3 cores			
	no insulation in cores	190 mm	----	0.26
	cores filled with molded EPS beads	190 mm	----	0.56
	molded EPS inserts in cores	190 mm	----	0.47
	cores filled with perlite	190 mm	----	0.53
	cores filled with vermiculite	190 mm	----	0.58
	Normal-weight units (sand and gravel aggregate) with 2 or 3 cores			
	no insulation in cores	90 mm	----	0.17
		140 mm	----	0.19
		190 mm	----	0.21
		240 mm	----	0.24
		290 mm	----	0.26
	cores filled with perlite	190 mm	----	0.35
	cores filled with vermiculite	140 mm	----	0.40
		190 mm	----	0.51
		240 mm	----	0.61
		290 mm	----	0.69

** Values from NBC 2015 Table A-9.36.2.4.(1)-D*

REFERENCE MATERIALS

Thermal Resistance Values of Common Materials

		Thickness of Material	Thermal Resistance (RSI), $(m^2 \cdot K)/W$ per mm	Thermal Resistance (RSI), $(m^2 \cdot K)/W$ for thickness listed
Structural Materials	Concrete			
	Low-density aggregate			
	expanded shale, slate or slags, cinders (1600 kg/m3)	----	0.0013	----
	perlite, vermiculite, and			
	polystyrene bead (480 kg/m3)	----	0.0063	----
	Normal-density aggregate			
	sand and gravel or stone aggregate (2400 kg/m3)	----	0.0004	----
	Hardwood			
	Ash	----	0.0063	----
	Birch	----	0.0055	----
	Maple	----	0.0063	----
	Oak	----	0.0056	----
	Softwood			
	Amabilis fir	----	0.0080	----
	California redwood	----	0.0089	----
	Douglas fir-larch	----	0.0069	----
	Eastern white cedar	----	0.0099	----
	Eastern wihte pine	----	0.0092	----
	Hemlock-fir	----	0.0084	----
	Lodgepole pine	----	0.0082	----
	Red pine	----	0.0077	----
	Western hemlock	----	0.0074	----
	Western red cedar	----	0.0102	----
	White spruce	----	0.0097	----
	Yellow cyprus-cedar	----	0.0077	----
	Wood, structural framing, spruce-pine-fir	----	0.0085	----
	Steel, galvanized sheet, 0.14% carbon content	----	0.0000161	----

** Values from NBC 2015 Table A-9.36.2.4.(1)-D*

Thermal Resistance Values of Common Materials

		Thickness of Material	Thermal Resistance (RSI), ($m^2·K$)/W per mm	Thermal Resistance (RSI), ($m^2·K$)/W for thickness listed
Structural Materials	Gypsum board	----	0.0061	----
	Hardboard - medium density (800 kg/m^3)	----	0.0095	----
	Interior finish (plank, tile) board	----	0.0198	----
	Particleboard			
	low-density (590 kg/m^3)	----	0.0098	----
	medium-density (800 kg/m^3)	----	0.0074	----
	high-density (1000 kg/m^3)	----	0.0059	----
	underlay	15.9 mm	----	0.140
	Plywood	----	0.0087	----
	Flooring material			
	Carpet and fibrous pad	----	----	0.370
	Carpet and rubber pad	----	----	0.220
	Cork tile	3.2 mm	----	0.049
	Hardwood flooring	19 mm	----	0.120
	Terrazzo	25 mm	----	0.014
	Tile (linoleum, vinyl, rubber)	----	----	0.009
	Tile (ceramic)	9.5 mm	----	0.005
	Wood subfloor	19 mm	----	0.170
	Plastering			
	Cement plaster: sand aggregate	----	0.0014	----
	Gypsum plaster			
	low-density aggregate	----	0.0044	----
	sand aggregate	----	0.0012	----

** Values from NBC 2015 Table A-9.36.2.4.(1)-D*

City of Saskatoon
Building Standards

222 3rd Avenue North
Saskatoon Saskatchewan S7K 0J5

P 306-975-2645 • **F** 306-975-7712
E buildingstandards@saskatoon.ca

saskatoon.ca/buildingstandards

This handbook has no legal status and cannot be used as an official interpretation of the various codes and regulations currently in effect. Users are advised to contact Building Standards for assistance, as the City of Saskatoon accepts no responsibility for persons relying solely on this information.

PRINTED JULY 2019