Resources and Information

NRCAN Energy Efficiency

http://www.nrcan.gc.ca/energy/efficiency

Canadian Wood Council Wall Thermal Design Tool

http://cwc.ca/resources/wall-thermal-design/

City of Brandon Energy Efficiency Information

http://www.brandon.ca/brandon-design-studio

Owens Corning Effective Thermal Resistance Calculator

http://insulation.owenscorning.ca/builders/calculators/thermal-project-calculator/

2010 National Building Code

http://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/2010_national_building_code.html

1 RSI = 5.678263 R

1 R = 0.17611 RSI

City of Brandon Planning & Building Safety Department

204-729-2110

638 Princess Avenue,

Brandon MB

R7A 0P3

9.36. Energy Efficiency

User's Guide and Reference Manual

City of BRANDON

Inside this Guide:

Design Checklist

Compliance Method:

- ☐ Prescriptive
- ☐ Trade-Off
- ☐ Energy Performance (Modelling)

☐ All attics are ≥ RSI 8.50

- ☐ *All RSI values indicated on drawings*

☐ All exterior walls are ≥ RSI 2.80

- ☐ *All RSI values indicated on drawings*

☐ All foundation walls are ≥ RSI 2.80

- ☐ *All RSI values indicated on drawings*

☐ Heated basement floor is insulated ≥ RSI 2.84

- ☐ *All RSI values indicated on drawings*

☐ Basement floor above frost line ≥ RSI 1.96

- ☐ *All RSI values indicated on drawings*

☐ Floor over garage is ≥ RSI 5.02

- ☐ *All RSI values indicated on drawings*

☐ Wall penetrations are insulated @ 4x element depth

☐ All windows and doors are ≥ RSI 0.63

☐ All skylights are ≥ RSI 0.37

☐ Gas furnace AFUE ≥ 94%

☐ HWT meets Table 9.36.4.2

☐ DWV Stack equipped with Drain Water Heat Recovery

☐ Trade-Off Calculations Included

Typical Building Assembly Detail Lists

TYPICAL ROOF CONSTRUCTION: RSI 9.09 (8.50 REQUIRED)
ASPHALT SHINGLES (0.00)
2 LAYERS ROOFING FELT (RSI 0.00)
7/16" OSB SHEATHING C/W H-CLIPS (RSI 0.00)
ENGINEERED ROOF TRUSS @ 24" O.C. (RSI 1.21)
R50 BLOW-IN INSULATION (RSI 6.8)
6 MIL CGSB RATED POLY V.B. (RSI 0.00)
5/8" TYPE 'X' DRYWALL (RSI 0.97)
CEILING FINISH BY OWNER
INTERIOR AIR FILM (RSI 0.11)

TYPICAL EXTERIOR WALL CONSTRUCTION: RSI 2.90 (2.8 REQUIRED)
OUTSIDE AIR FILM (RSI 0.03)
ACRYLIC STUCCO EXTERIOR FINISH (RSI 0.009)
2"X2" WELDED WIRE MESH (RSI 0.00)
APPROVED WATER BARRIER—('TYVEC' OR SIMILAR) (RSI 0.00)
7/16" OSB SHEATHING (RSI 0.108)
2x6 WOOD STUDS @ 16" O.C. C/W
R22 BATT INSULATION BETWEEN STUDS (RSI 2.55)
6 MIL CGSB RATED POLY V.B. (RSI 0.00)
1/2" DRYWALL (RSI 0.08)
INTERIOR FINISH BY OWNER(RSI 0.00)
INTERIOR AIR FILM (RSI 0.12)

TYPICAL FOUNDATION WALL CONSTRUCTION RSI 3.20 (RSI 2.8 RQ'D)
PARGING TO BELOW 6" BELOW GRADE (RSI 0.00)
ASPHALT DAMP-PROOFING BELOW GRADE (RSI 0.21)
8" X 96" CONCRETE WALL (RSI 0.08)
3" AIR SPACE (RSI 0.18)
2x4 WOOD STUDS @ 24" O.C. C/W
R20 BATT INSULATION BETWEEN STUDS (RSI 2.53)
6 MIL CGSB RATED POLY V.B. (RSI 0.00)
1/2" DRYWALL (RSI 0.08)
INTERIOR FINISH BY OWNER(RSI 0.00)
INTERIOR AIR FILM (RSI 0.12)

Building Assembly	Min. Effective RSI Value	Min. Effective R Value
Ceilings Below Attics	8.50	48.3
Cathedral ceilings and flat roofs	5.02	28.5
Walls above ground	2.80	15.9
Floors over unheated spaces	5.02	28.5
Foundation walls	2.8	15.9
Unheated floor below frost line	0.0	0.0
Unheated floor above frost line	1.96	11.1
Heated floors	2.84	16.1
Thickened edge slab	2.84	16.1
Windows & Doors	0.63	3.5
Skylights	0.37	2.1

9.36.2.11. Trade-Off Options for Above-ground Envelope Components and Assemblies.

An owner would like to reduce the wall insulation, to do so, is willing to increase the attic insulation to RSI 10.6 (R60).

The ceiling area is 500m² and the total wall area is 250m².

∑ = Sum or total
$A_{reference}$ = The area of the reference element(s)
$RSI_{reference}$ = The RSI value of the reference element(s)
$A_{proposed}$ = The area of the proposed element(s)
$RSI_{proposed}$ = The RSI value of the proposed element(s)

$$\sum (A_{reference} / RSI_{reference}) \geq \sum (A_{proposed} / RSI_{proposed})$$

Reference building (9.36) ≥ Proposed building

$$\{(A_{wall} / RSI_{wall}) + (A_{roof} / RSI_{roof})\} \geq \{(A_{wall} / RSI_{wall}) + (A\ roof / RSI_{\ roof})\}$$

$$\{(250/2.8) + (500/8.5)\} \geq \{(250 / RSI_{wall}) + (500/10.6)\}$$

$$\{89.29 + 58.82\} \geq \{(250 / RSI_{wall}) + 47.17\}$$

$$148.11 - 47.17 \geq 250 / RSI_{wall}$$

$$100.94 \geq 250 / RSI_{wall}$$

$$RSI_{wall} \geq 250 / 100.94$$

$$RSI_{wall} \geq 2.48\ (R14.1)$$

The proposed walls must possess an effective RSI value of not less than 2.48 (R14.1) in order to satisfy the minimum effective RSI value prescribed in 9.36.2.11.

These same calculations are used for windows. The windows must be facing the same direction and the total area of all the windows traded is equal.

Essentially, the proposed reduction in performance of the proposed element must be absorbed by the remaining elements such that all combined elements meet the prescriptive requirements of the code.

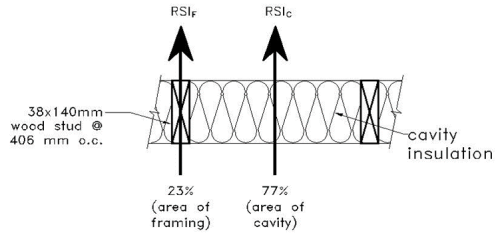
Effective Thermal Resistance (RSI) Values of the Framing/Cavity Portion of Above-Ground Wall Assemblies

Nominal Thermal Resistance of Cavity Insulation		Size and spacing (inches o.c). of above ground wall assembly							
		2x4				2x6			
		12	16	19.2	24	12	16	19.2	24
RSI	R Value	Effective thermal resistance of framing/cavity portion (RSI)							
1.94	11	1.40	1.43	1.45	1.48	—	—	—	—
2.11	12	1.47	1.49	1.52	1.55	—	—	—	—
2.29	13	1.53	1.56	1.59	1.63	—	—	—	—
2.47	14	1.59	1.62	1.66	1.70	1.95	1.98	2.01	2.03
2.64	15	1.64	1.68	1.72	1.76	2.03	2.06	2.09	2.12
2.82	16	1.69	1.73	1.78	1.82	2.11	2.14	2.18	2.21
2.99	17	1.74	1.78	1.83	1.88	2.18	2.22	2.26	2.30
3.17	18	1.78	1.83	1.88	1.94	2.25	2.29	2.33	2.38
3.34	19	1.82	1.87	1.93	1.98	2.32	2.36	2.41	2.45
3.52	20	1.86	1.91	1.97	2.03	2.38	2.43	2.48	2.53
3.70	21	—	—	—	—	2.44	2.49	2.55	2.60
3.87	22	—	—	—	—	2.49	2.55	2.61	2.67
4.05	23	—	—	—	—	2.55	2.61	2.67	2.74
4.23	24	—	—	—	—	2.60	2.66	2.73	2.80
4.40	25	—	—	—	—	2.65	2.72	2.78	2.86
4.58	26	—	—	—	—	2.70	2.77	2.84	2.92
4.76	27	—	—	—	—	2.74	2.82	2.89	2.98
4.93	28	—	—	—	—	2.79	2.86	2.94	3.03
5.11	29	—	—	—	—	2.83	2.91	2.99	3.08
5.28	30	—	—	—	—	2.87	2.95	3.04	3.13

Thermal Resistance for Common Building Materials			
Air Films	**Thickness (mm)**	**RSI per mm**	**Total RSI**
Interior: Ceiling Floor walls	— — —	— — —	0.11 0.16 0.12
Cladding	**Thickness (mm)**	**RSI per mm**	**Total RSI**
Brick	100 mm	0.0007	0.07
Stucco	—	0.0009	—
Metal/vinyl siding	—	—	0.11
Roofing	**Thickness (mm)**	**RSI per mm**	**Total RSI**
Asphalt roll roofing	—	—	0.03
Metal deck	—	—	0.00
Asphalt shingle	—	—	0.08
Flooring	**Thickness (mm)**	**RSI per mm**	**Total RSI**
Plywood	—	0.0087	—
OSB	—	0.0098	—
Sheathing	**Thickness (mm)**	**RSI per mm**	**Total RSI**
OSB	9.5 mm 11 mm	0.0098	0.093 0.108
Insulating Materials	**Thickness (mm)**	**RSI per mm**	**Total RSI**
R12 batt	89/92	—	2.11
R14 batt	89/92	—	2.46
R20 batt	152	—	3.52
R22 batt	140/152	—	3.87
R31 batt	241	—	5.46
Extruded polystyrene	25 mm 50mm	0.035 0.0336	0.88 1.68
Loose fill cellulose	—	0.025	—
Loose fill glass fibre	112 to 565	0.01875	—
Structural Materials	**Thickness (mm)**	**RSI per mm**	**Total RSI**
Concrete	—	0.0004	—
Interior Finish Materials	**Thickness (mm)**	**RSI per mm**	**Total RSI**
Gypsum board	12.7	0.0061	0.08
Carpet and fibrous pad	—	—	0.37
Carpet and rubber pad	—	—	0.22
Hardwood flooring	19	—	0.12
Linoleum, vinyl, rubber	—	—	0.009
Ceramic tile	9.5	—	0.005

Commonly Used Above Ground Wall Assemblies						
Wall No.	**Stud Size**	**Stud Spacing**	**Insulation**	**XTPS**	**RSI Value**	**R Value**
W1	2x4	24”	R 12	1”	2.8	15.9
W2	2x6	24”	R 20	none	2.9	16.4
W3	2x6	16”	R 22	none	2.9	16.5
W4	2x6	24”	R 22	none	3.0	17.0
W5	2x4	24”	R 12	1.5”	3.2	18.2
W6	2x4	16”	R 12	2”	3.5	19.9
W7	2x4	24”	R 12	2”	3.6	20.4
W8	2x6	16”	R 20	1.5”	4.1	23.3
W9	2x6	24”	R 20	1.5”	4.2	23.8
W10	2x6	16”	R 22	1.5”	4.2	23.8
W11	2x6	24”	R 22	1.5”	4.3	25.0
Commonly Used Below Ground Wall Assemblies						
F1	2x4	24”	R20	none	2.8	15.9
F2	2x4	24”	R20	none	2.9	16.5
F3	2x4	24”	R24	none	3.0	17.0
F4	2x4	24”	2 layers R20	none	4.2	23.8

Example of Calculation RSI_{eff} for a typical 38x140mm woof-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 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 % area of framing and cavity for a typical 38x140mm wood-frame wall assembly with studs 400mm 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 of $RSI_{parallel}$(thermal resistance of the framing portion):

$$RSI_{parallel} = \frac{100}{\left(\frac{23}{1.19}\right) + \left(\frac{77}{3.34}\right)} = 2.36$$

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 the wall assembly	**RSI Value**
Outside air film	0.03
Vinyl siding	0.11
Sheathing paper	-
11mm OSB sheathing	0.108
Wood stud framing $RSI_F = 1.19$ % area of framing = 23%	2.36
Insulation $RSI_C = 3.34$ % area of cavity = 77%	
6 mil poly vapor barrier	-
Drywall (12.7mm)	0.08
Interior air film	0.12
RSI_{eff} = 2.81 (m²*K)/W (R15.9)	

Framing and Cavity Percentages for Typical Wood-frame Assemblies

Wood-frame Assemblies		Frame Spacing (inches o.c.) 12 % Area Framing	12 % Area Cavity	16 % Area Framing	16 % Area Cavity	19.2 % Area Framing	19.2 % Area Cavity	24 % Area Framing	24 % Area Cavity
Floors	Lumber joists	-	-	13	87	11.5	88.5	10	90
	I-joists and trusses	-	-	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 ceilings with I-joists	-	-	9	91	7.5	92.5	6	94
Walls	Typical wood-frame	24.5	75.5	23	77	21.5	78.5	20	80
	Advanced wood-frame with double top plate	-	-	19	81	17.5	82.5	16	84
	Basement wood-frame inside concrete foundation wall	-	-	16	84	14.5	85.5	13	87