

In Class 5:

Analyze alternative envelope strategies

Organization

Break into your five groups

Do, and report on the in-class problem

Turn in materials produced, with names of participants, for credit

Background Information

Table 1304.2.5 of 780 CMR, included with this exercise, shows insulation requirements for building envelopes with glazing of at least 10% but no more than 25% of the wall surface. These requirements, in general, meet the needs of ASHRAE 90.1 to which reference is made in the USGBC's standards for LEED certification.

The Colorado energy guide shows R-values of common building elements

The USGBC's certification requirements for thermal conductance of envelopes require, at a minimum, compliance with ASHRAE 90.1

Additional credit is given for exceeding those requirements

Discussion / Writing (use the overhead projector transparencies)

- 1 Select one of your group's designs for the building envelope from assignment 4 for discussion
- 2 Using the R-value table provided, analyze the contribution of materials other than insulation to the overall R-value of the assembly
- 3 Using the R-value table provided analyze the R-value of the insulation in the assembly
- 4 Propose how the design can be modified to exceed the table's requirements for insulation by 25%.
- 5 Propose how the design can be modified to exceed the requirements for insulation by 50%

Presentation: Report out your results to the class

TABLE 1304.2.6 BUILDING ENVELOPE REQUIREMENTS
Climate Zone 13a
Glazing Area Over 10% but not greater than 25% of Above Grade Wall Area

Above-Grade Walls:	Continuous Insulation (or average insulation value)*	Metal Framing (c.i. = continuous insulation)	Wood Framing
Framed or Masonry < 35 psf.	R-7	R-13 + R-3 c.i.	R-11
Masonry >= 35 psf.	R-5	R-11 + R-3 c.i.	R-11

Window Assemblies:	SHGC (maximum)	U-Value (maximum)	
PF < 0.25	0.6	0.6	
0.25 <= PF < 0.50	0.7	0.6	
PF >= 0.50	Any	0.6	
Skylights - U-Value (maximum)	NA	0.8	

Roof Assemblies. (either/or)	Insulation Between Framing	Continuous Insulation	
All-Wood Joist/Truss	R-25	R-19	
Non-wood Joist/Truss	R-25	R-20	
Concrete Slab or Deck	NA	R-19	
Metal Purlin with Thermal Break	R-30	R-20	
Metal Purlin w/o Thermal Break	NA	R-20	

Floor Assemblies. (either/or)	Insulation Between Framing	Continuous Insulation	
All-Wood Joist/Truss	R-19	R-16	
Non-wood Joist/Truss	R-25	R-17	
Concrete Slab or Deck	NA	R-17	
Slab, Perimeter, and Below-Grade Wall	R-5		

R-Value Table

Insulation Values For Selected Materials

Use the R-value table below to help you determine the R-value of your wall or ceiling assemblies. To obtain a wall or ceiling assembly R-value you must add the r-values of the individual components together. See the following example:

Calculating Assembly Wall R-Value*

Formula: Assembly R-value = 1 / (Assembly U-value) = 1 / (U-studs x % + U-cavity x %)

Component	R-Value Studs	R-Value Cavity	Assembly R-Value
Wall - Outside Air Film	0.17	0.17	
Siding - Wood Bevel	0.80	0.80	
Plywood Sheathing - 1/2"	0.63	0.63	
3 1/2" Fiberglass Batt		11.00	
3 1/2" Stud	4.38		
1/2" Drywall	0.45	0.45	
Inside Air Film	0.68	0.68	
Percent for 16" o.c. + Additional studs	15%	85%	
Total Wall Component R-Values	7.12	13.73	
Wall Component U-Values	0.1404	0.0728	
Total Wall Assembly R-Value			12.05

* This example is just for wood frame construction. Steel studs are a more complicated calculation.

R-Value Table

Material	R/ Inch	R/ Thickness
Insulation Materials		
Fiberglass Batt	3.14-4.30	
Fiberglass Blown (attic)	2.20-4.30	
Fiberglass Blown (wall)	3.70-4.30	
Rock Wool Batt	3.14-4.00	
Rock Wool Blown (attic)	3.10-4.00	
Rock Wool Blown (wall)	3.10-4.00	
Cellulose Blown (attic)	3.13	
Cellulose Blown (wall)	3.70	
Vermiculite	2.13	
Autoclaved Aerated Concrete	1.05	
Urea Terpolymer Foam	4.48	
Rigid Fiberglass (> 4lb/ft3)	4.00	
Expanded Polystyrene (beadboard)	4.00	

Extruded Polystyrene	5.00	
Polyurethane (foamed-in-place)	6.25	
Polyisocyanurate (foil-faced)	7.20	
Construction Materials		
Concrete Block 4"		0.80
Concrete Block 8"		1.11
Concrete Block 12"		1.28
Brick 4" common		0.80
Brick 4" face		0.44
Poured Concrete	0.08	
Soft Wood Lumber	1.25	
2" nominal (1 1/2")		1.88
2x4 (3 1/2")		4.38
2x6 (5 1/2")		6.88
Cedar Logs and Lumber	1.33	
Sheathing Materials		
Plywood	1.25	
1/4"		0.31
3/8"		0.47
1/2"		0.63
5/8"		0.77
3/4"		0.94
Fiberboard	2.64	
1/2"		1.32
25/32"		2.06
Fiberglass (3/4")		3.00
(1")		4.00
(1 1/2")		6.00
Extruded Polystyrene (3/4")		3.75
(1")		5.00
(1 1/2")		7.50
Foil-faced Polyisocyanurate (3/4")		5.40
(1")		7.20
(1 1/2")		10.80
Siding Materials		
Hardboard (1/2")		0.34
Plywood (5/8")		0.77
(3/4")		0.93
Wood Bevel Lapped		0.80
Aluminum, Steel, Vinyl (hollow backed)		0.61
(w/ 1/2" Insulating board)		1.80

Brick 4"		0.44
Interior Finish Materials		
Gypsum Board (drywall 1/2")		0.45
(5/8")		0.56
Paneling (3/8")		0.47
Flooring Materials		
Plywood	1.25	
(3/4")		0.93
Particle Board (underlayment)	1.31	
(5/8")		0.82
Hardwood Flooring	0.91	
(3/4")		0.68
Tile, Linoleum		0.05
Carpet (fibrous pad)		2.08
(rubber pad)		1.23
Roofing Materials		
Asphalt Shingles		0.44
Wood Shingles		0.97
Windows		
Single Glass		0.91
w/storm		2.00
Double insulating glass (3/16") air space		1.61
(1/4" air space)		1.69
(1/2" air space)		2.04
(3/4" air space)		2.38
(1/2" w/ Low-E 0.20)		3.13
(w/ suspended film)		2.77
(w/ 2 suspended films)		3.85
(w/ suspended film and low-E)		4.05
Triple insulating glass (1/4" air spaces)		2.56
(1/2" air spaces)		3.23
Addition for tight fitting drapes or shades, or closed blinds		0.29
Doors		
Wood Hollow Core Flush (1 3/4")		2.17
Solid Core Flush (1 3/4")		3.03
Solid Core Flush (2 1/4")		3.70
Panel Door w/ 7/16" Panels (1 3/4")		1.85
Storm Door (wood 50% glass)		1.25
(metal)		1.00
Metal Insulating		15.00

(2" w/ urethane)		
Air Films		
Interior Ceiling		0.61
Interior Wall		0.68
Exterior		0.17
Air Spaces		
1/2" to 4" approximately		1.00

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