Building Envelope

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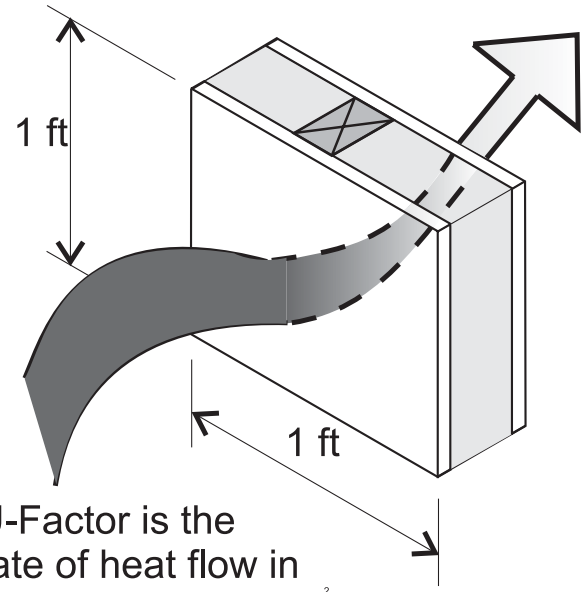
Overview

Cross-cutting Issues Related to Building Envelope

	Goals/Cross-Cutting Issues									
	Health and IAQ	Thermal Comfort	Visual Comfort	Acoustic Comfort	Security and Safety	Ecosystem Protection	Energy Efficiency	Water Efficiency	Materials Efficiency	Building as a Teaching Tool
Energy-Efficient Building Shell		●		●			●		●	●

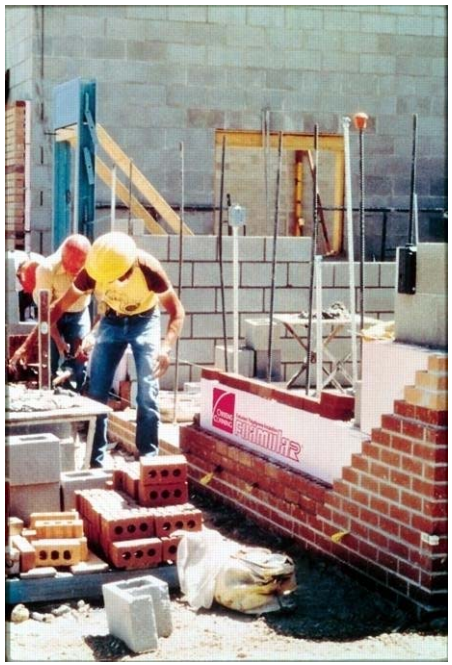
Heat Transfer through Building Envelope

- U-factor
- R-values
- Thermal Mass
- Heat Capacity



U-Factor is the rate of heat flow in Btu/h through one ft^2 area when one side is 1° F warmer

Heat Transfer through Building Envelope



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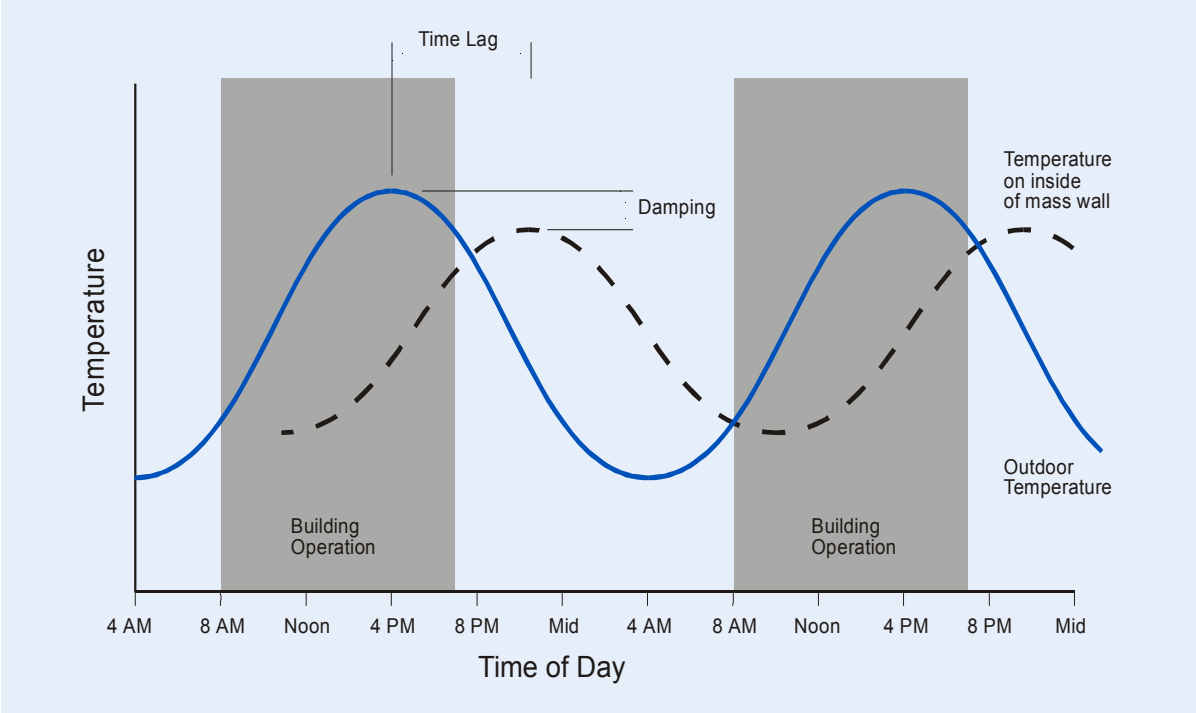

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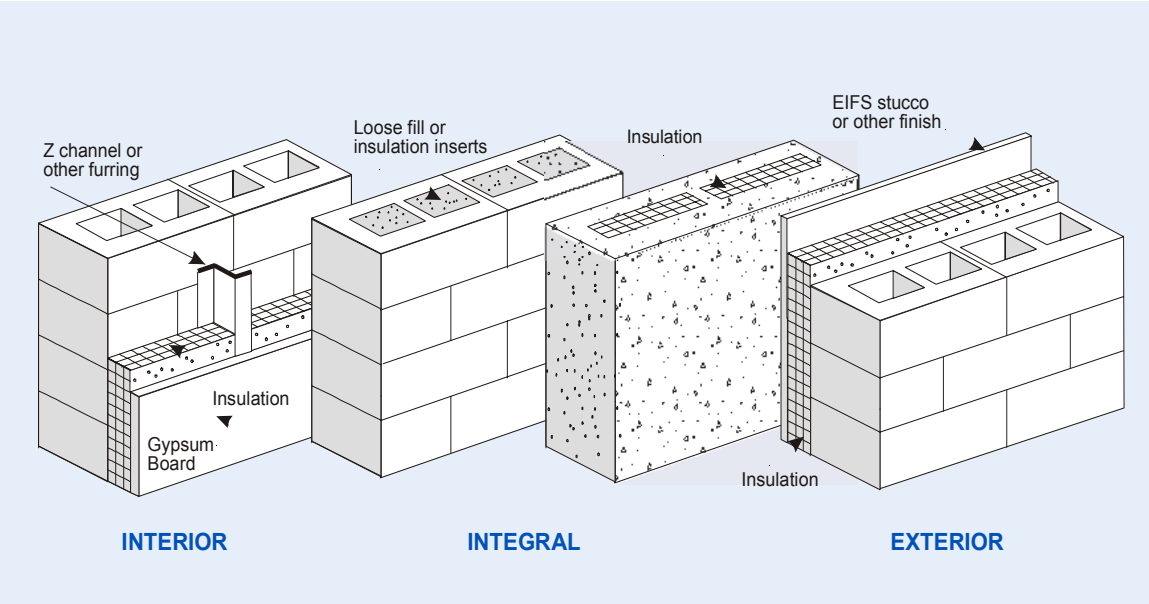


Minimum R-values from ASHRAE 90.1

	Climate Region						
	Hot and Dry (Phoenix)	Hot and Humid (Orlando)	Temperate and Humid (Atlanta)	Temperate Mixed (Seattle)	Cool and Humid (Boston)	Cool and Dry (Denver)	Cold and Humid (Minneapolis)
Roofs							
Insulation Entirely above Deck	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-15 ci
Attic and Other	R-30	R-30	R-30	R-30	R-30	R-30	R-38
Walls, Above Grade							
Mass	NR	NR	R-5.7 ci	R-5.7 ci	R-7.6 ci	R-7.6 ci	R-9.5 ci
Steel Framed	R-13	R-13	R-13	R-13	R-13+3.8 ci	R-13+3.8 ci	R-13+3.8 ci
Wood Framed and Other	R-13	R-13	R-13	R-13	R-13	R-13	R-13
Wall, Below Grade							
Below Grade Wall	NR	NR	NR	NR	NR	NR	NR
Floors							
Mass	R-4.2 ci	R-4.2 ci	R-6.3 ci	R-6.3 ci	R-8.3 ci	R-8.3 ci	R-8.3 ci
Steel Joist	R-19	R-19	R-19	R-19	R-19	R-19	R-30
Wood Framed and Other	R-19	R-19	R-19	R-19	R-30	R-30	R-30
Slab-On-Grade Floors							
Unheated	NR	NR	NR	NR	NR	NR	NR
Heated	R-7.5@12 in.	R-7.5@12 in.	R-7.5@12 in.	R-7.5@24 in.	R-10@36 in.	R-10@36 in.	R-10@36 in.

Note: “ci” means continuous insulation. “NR” means no requirement.

Recommended R-values for schools

	Climate Region						
	Hot and Dry (Phoenix)	Hot and Humid (Orlando)	Temperate and Humid (Atlanta)	Temperate Mixed (Seattle)	Cool and Humid (Boston)	Cool and Dry (Denver)	Cold and Humid (Minneapolis)
Roofs							
Insulation Entirely above Deck	R-20 ci	R-20 ci	R-20 ci	R-20 ci	R-20 ci	R-20 ci	R-20 ci
Attic and Other	R-38	R-38	R-38	R-38	R-38	R-38	R-60
Walls, Above Grade							
Mass	R-7.6 ci	R-7.6 ci	R-9.5 ci	R-11.4 ci	R-13.3 ci	R-13.3 ci	R-15.2 ci
Steel Framed	R-13+3.8 ci	R-13+3.8 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci
Wood Framed and Other	R-13	R-13	R-13	R-13	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci
Wall, Below Grade							
Below Grade Wall	NR	NR	NR	R-7.5 ci	R-7.5 ci	R-7.5 ci	R-7.5 ci
Floors							
Mass	R-8.3 ci	R-8.3 ci	R-8.3 ci	R-10.4 ci	R-12.5 ci	R-12.5 ci	R-14.6 ci
Steel Joist	R-30	R-30	R-30	R-30	R-30	R-30	R-38
Wood Framed and Other	R-30	R-30	R-30	R-30	R-30	R-30	R-30
Slab-On-Grade Floors							
Unheated	NR	NR	NR	NR	R-10@24 in.	R-10@24 in.	R-15@24 in.
Heated	R-7.5@12 in.	R-7.5@12 in.	R-10@36 in.	R-10@36 in.	R-10	R-10	R-15

Note: “ci” means continuous insulation. “NR” means no requirement.

Measuring Thermal Performance

- Calculation Methods
  - Series
  - Parallel Path
  - Effective R-value
  - Two-dimensional
  - Testing
- Computer Programs
- Pre-calculated Data

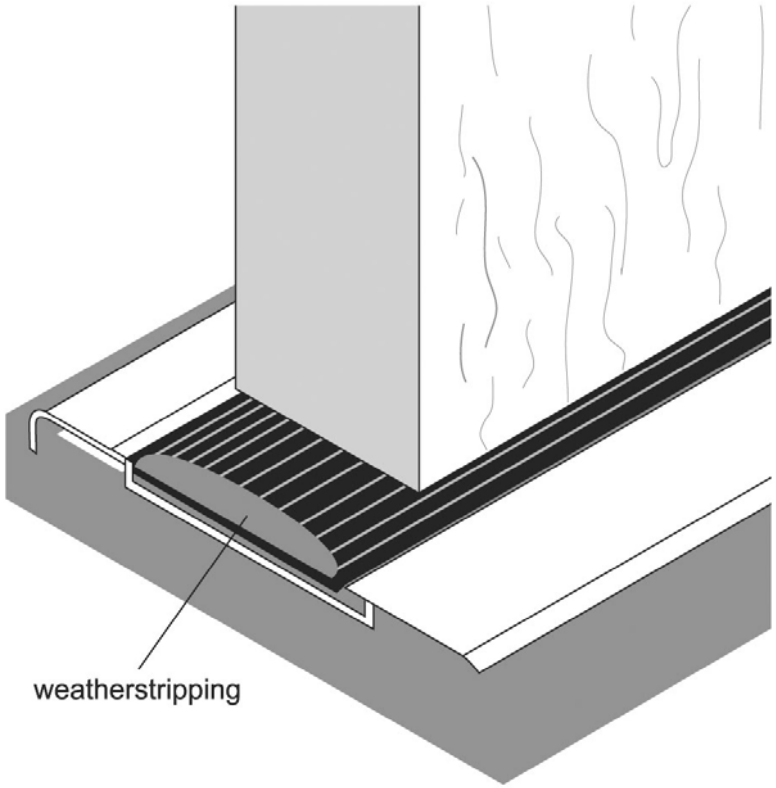
Moisture Control

- Vapor migration occurs from the warm humid side to the cool dry side of the construction where it can condense and lead to mold growth.
- Install vapor barriers on the warm, moist side of framed walls, doors and roofs:
  - Outside of the assembly in humid climates.
  - Inside the assembly for non-humid climates.
- Provide adequate ventilation in attics, crawl space, wall cavities (only in extreme climates).

Air Infiltration

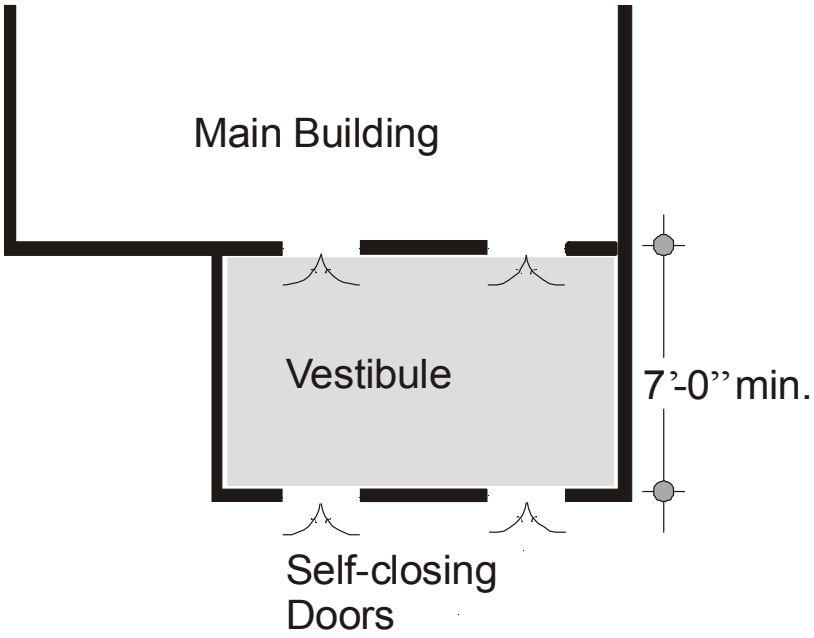
Strategies for reducing infiltration:

- Continuous air barrier on roof and walls.
- Windows/doors with low rates of infiltration.
- Weatherstripping.
- Using air lock entries in cold climates.



Air Infiltration

- Vestibule doors should be at least 7 feet from the school's main entrance.
- Vestibule doors should have self-closing devices.



Insulation Recommendations – Wood Framed Walls

- Install a minimum of R-13 cavity insulation in all climates.
- In the Cool and Humid, Cold and Humid, and Cool and Dry climates, also install R-7.5 insulating sheathing.

Insulation Recommendations – Metal-Framed Walls

- Install a minimum of R-13 cavity insulation in all climates.
- In the Hot and Humid and Hot and Dry climates, also install R-3.8 continuous insulating sheathing. In the other climates, use R-7.5 continuous insulating sheathing.

Insulation Recommendations – Mass Walls

- Install R-7.6 continuous insulation in the Hot and Dry and Hot and Humid climates.
- Upgrade this to R-9.5 in the Temperate and Humid climate, to R-13.3 in the Cool and Humid and Cool and Dry climates, and to R-15.2 in the Cold and Humid climate.
- Higher levels of insulation may be appropriate depending on local climate.

Insulation Recommendations – Mass Walls