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Building Science

Adventures In Building Science

www.buildingscience.com
What is a Building?
A Building is an Environmental Separator
• Control heat flow
• Control airflow
• Control water vapor flow
• Control rain
• Control ground water
• Control light and solar radiation
• Control noise and vibrations
• Control contaminants, environmental hazards and odors
• Control insects, rodents and vermin
• Control fire
• Provide strength and rigidity
• Be durable
• Be aesthetically pleasing
• Be economical
Order of Magnitude
Order of Magnitude
1 to 10
10 to 100
100 to 1000
1000 to 10000
First Order Effects, Second Order Effects….
Arrhenius Equation
For Every 10 Degree K Rise
Reaction Rate Doubles

\[ k = Ae^{-E_a/(RT)} \]
Damage Functions
Water
Heat
Ultra-violet Radiation
The Three Biggest Problems In Buildings Are Water, Water and Water...
80 Percent of all Construction Problems are Related to Water
Thermodynamics
Zeroth Law – Equal Systems
First Law - Conservation of Energy
Second Law - Entropy
Third Law – Absolute Zero
2\textsuperscript{nd} Law of Thermodynamics
In an isolated system, a process can occur only if it increases the total entropy of the system

Rudolf Clausius
Heat Flow Is From Warm To Cold
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less
Air Flow Is From A Higher Pressure to a Lower Pressure
Gravity Acts Down
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion
Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion

Vapor Diffusion
Thermodynamic Potential
Water Control Layer
Air Control Layer
Vapor Control Layer
Thermal Control Layer
Configurations of the Perfect Wall
Brick veneer/stone veneer

Drained cavity

Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass

Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder

Concrete block

Metal channel or wood furring

Gypsum board

Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Building Science Corporation

Brick veneer/stone veneer

Drained cavity

Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fibreglass

Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder

Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)

Uninsulated steel stud cavity

Gypsum board

Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Brick veneer/stone veneer
Drained cavity
Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
Non paper-faced exterior gypsum sheathing, plywood or oriented strand board (OSB)
Insulated wood stud cavity
Gypsum board
Latex paint or vapor semi-permeable textured wall finish

Vapor Profile
Commercial Enclosure: Simple Layers

- Structure
- Rain/Air/Vapor
- Insulation
- Finish
Flashings in downspouts are designed to prevent water from entering the building. The upturned leg is sloped away from the building to direct water away from the structure. The drip edge ensures that water runs off the building, keeping the base protected.
Hydrostatic pressure

Hydrostatic pressure
Wind Speed (mph) vs. Stagnation Pressure (Pa)

Pascals  mph
50  Pa = 20  mph
100  Pa = 30  mph
150  Pa = 35  mph
250  Pa = 45  mph
500  Pa = 65  mph
1,000  Pa = 90  mph
Rain Screen
Beer Screen?
Rain enters cup due to momentum ("kinetic energy")

Cup drains water to exterior
Rain enters cup due to momentum ("kinetic energy")

Wind enters cup—pressurizing cup; no rain entry due to wind driven rain

Cup can still drain water to exterior

Entire wind pressure taken here
Baffle to deflect raindrops hitting face of cup due to momentum ("kinetic energy")

Pressure in cup is same as pressure outside on face of baffle

Momentum driving force converted to gravity—water drains away

Wind enters cup—pressurizing cup; no rain entry due to wind driven rain

Cup can still drain water to exterior

Entire wind pressure taken here
Outer seal sees water but not pressure; no pressure difference across this seal, therefore no rain entry.

Key seal is interior seal as it takes maximum wind load but it does not see water.

Pressure in chamber is same as pressure outside on face of assembly.

Air enters and pressurizes chamber.

Entire wind pressure taken here.

Pressure chamber.
Intent of sealant is to limit this lateral flow of water between sheathing and building wrap.

- Flashing tape
- Sealant "bedding" joint
- Building wrap "wrapped" into opening
Sealant backer rod

Inner seal

Wind pressurizes chamber between inner and outer seal

Sealant backer rod

Outer seal

Vent tube
Open Joints vs Closed Joints
Open Joints vs Closed Joints
Limits of Pressure Equalization
Life is Tough Enough As it Is…
Life is Tough Enough As it Is…
It’s Harder When You Are Stupid
Don’t Do Stupid Things
“The Ugly”

“The Bad”

“The Good”
WEDGE SHIMS INSERTED BEHIND/FRONT OF ANGLE TO ENSURE DIRECT BEARING ON BRACKET AND PROVIDE LEVEL (IF NECESSARY)