Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

Building Science

Adventures In Building Science

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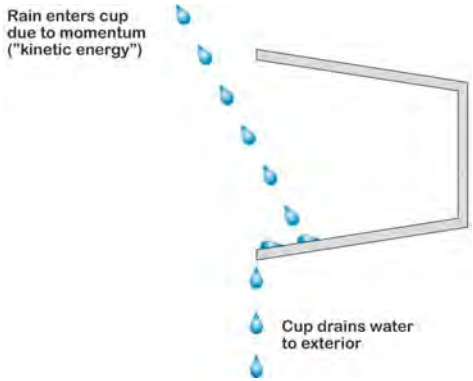
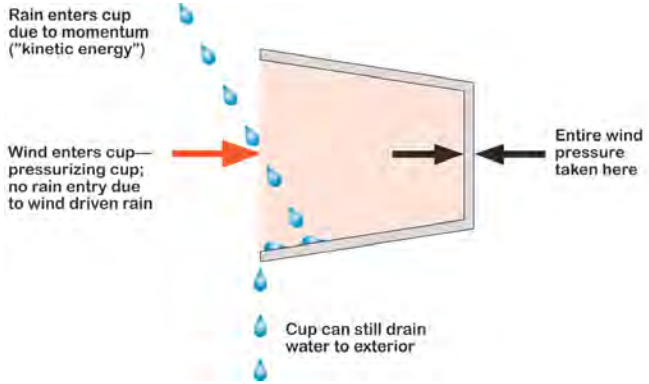
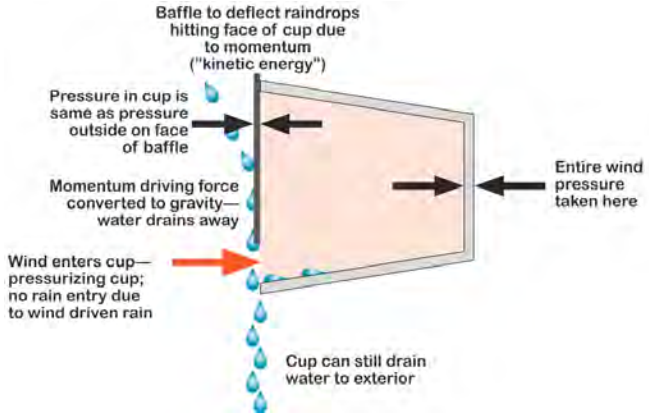
4. Windows







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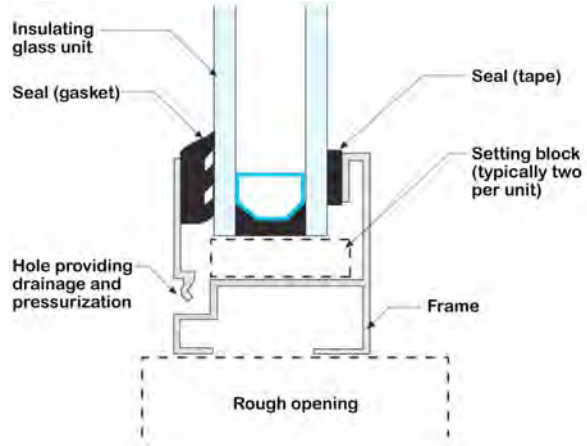

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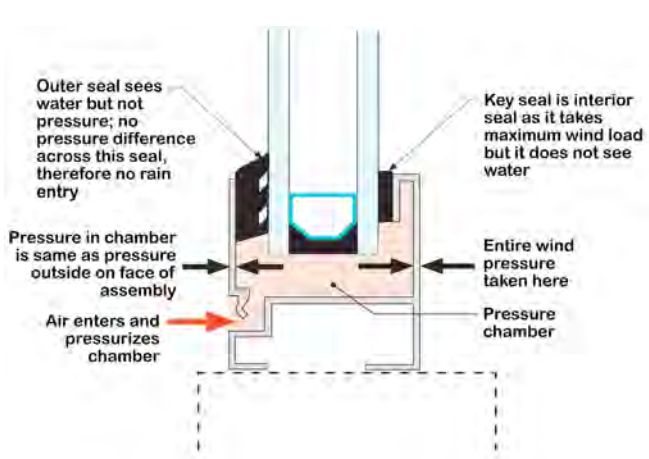

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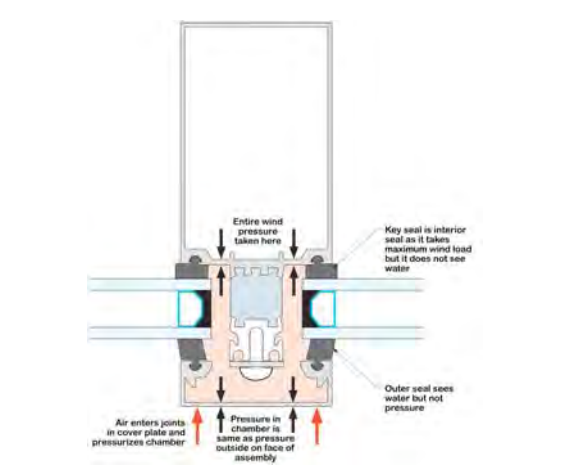

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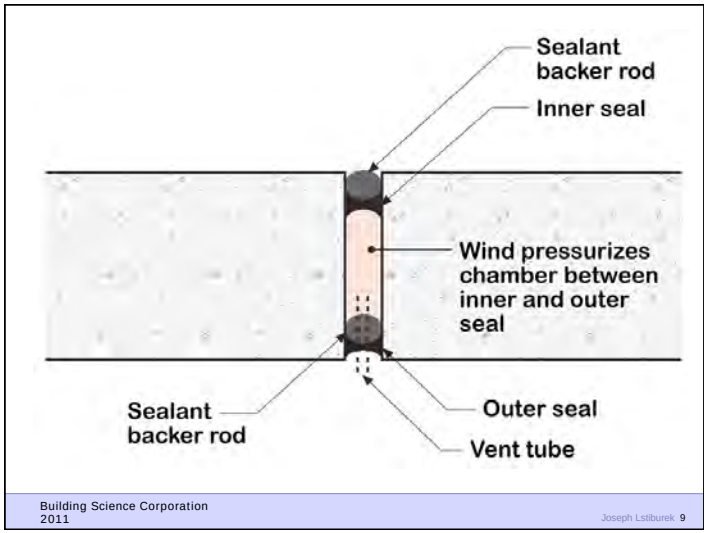
Sealant backer rod
Inner seal
Wind pressurizes chamber between inner and outer seal
Sealant backer rod
Outer seal
Vent tube
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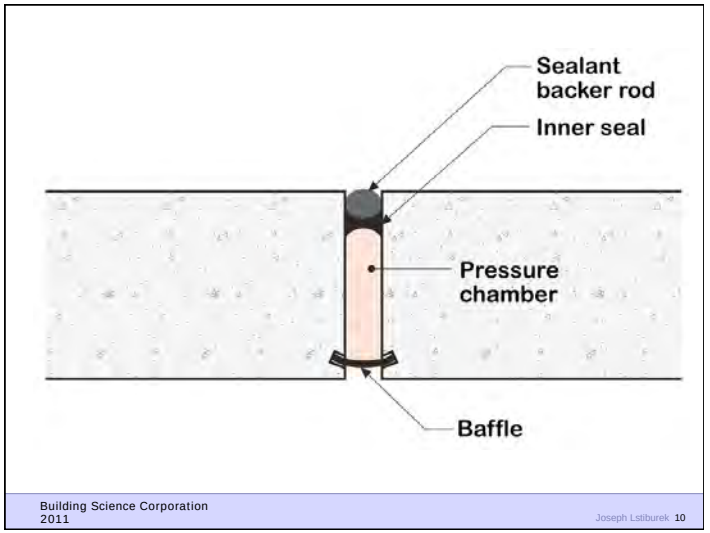
Sealant backer rod
Inner seal
Pressure chamber
Baffle
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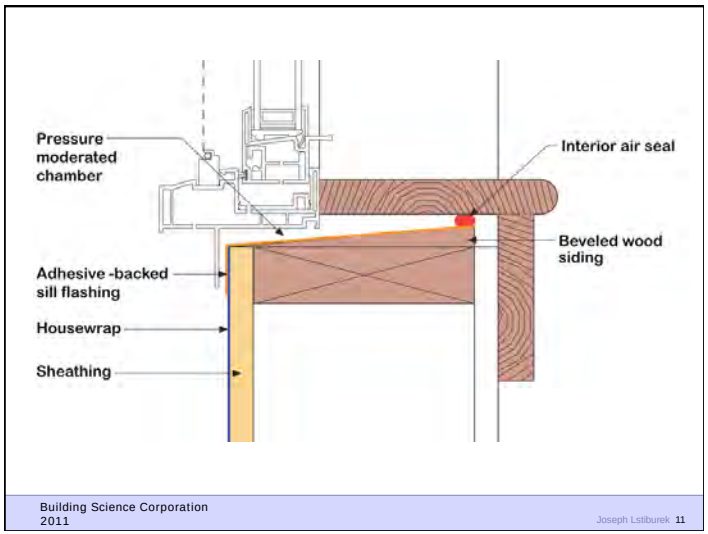
Pressure moderated chamber
Interior air seal
Beveled wood siding
Adhesive -backed sill flashing
Housewrap
Sheathing
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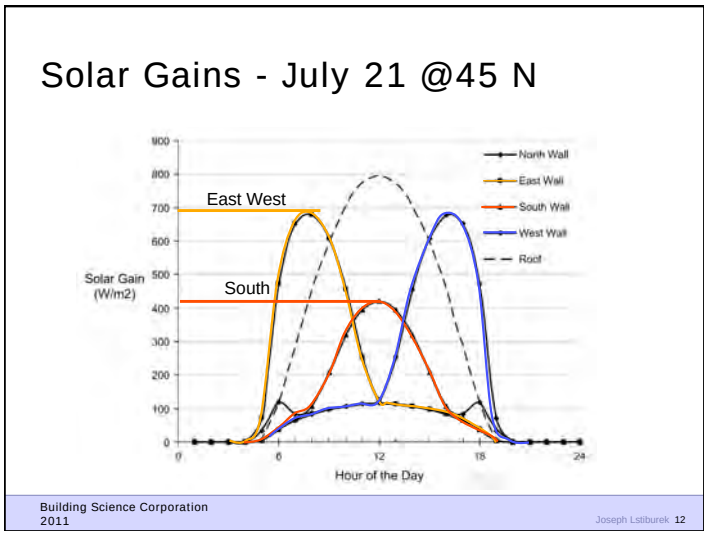
Solar Gains - July 21 @45 N
East West
South
Solar Gain (W/m2)
Hour of the Day
North Wall
East Wall
South Wall
West Wall
Roof
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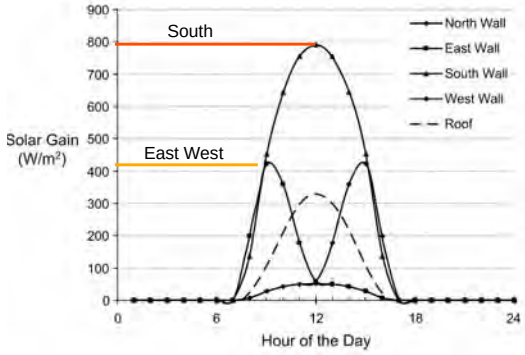
Mother Nature is try to tell you something



Frames

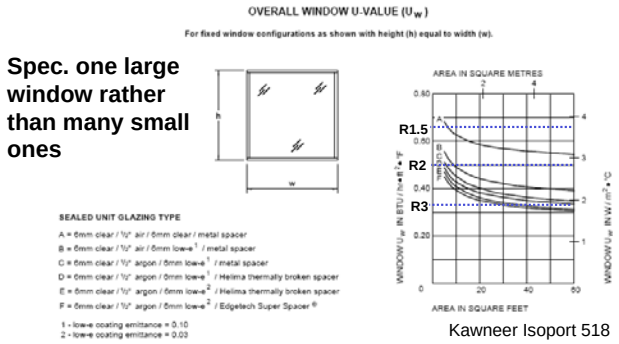
A large amount of heat can also be conducted through the frame

- Conductivity of the material (lower = better)
- Geometry of the frame

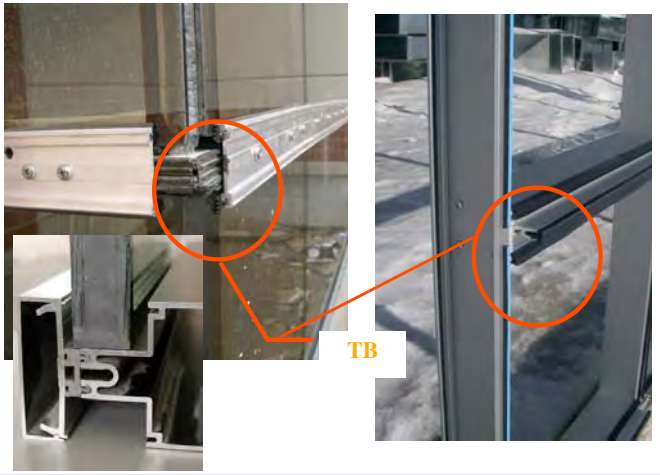
Frame Material	Conductivity W/mk	Conductivity R/inch
Wood	0.10 to 0.18	0.8 to 1.4
PVC	0.17	0.8
Fiberglass	0.30	0.5
Bronze	93	0.002
Aluminum	221	0.001

More Frames = More Heat flow

Spec. one large window rather than many small ones



Kawneer Isoport 518



Beware Thermal Flanking

- Beware heat flow around window frame

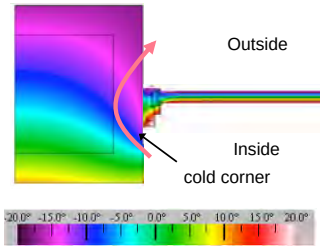


Figure 1: Thermal Flanking

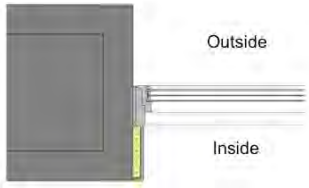


Figure 2: Flanking Reduced

Low-e Coatings

- Low-e coatings reduce the amount of heat transferred by radiation

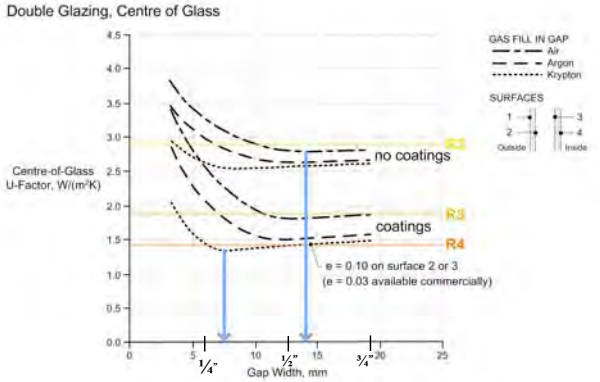
Coating	Emissivity	Radiation Reduction
Uncoated Glass	0.84	-
Low-e 0.2	0.20	62%
Low-e 0.1	0.10	79%
Low-e 0.03	0.03	93%

Gas Fills

- Gas fills reduce the amount of heat transferred by conduction and convection through the space in the glazing unit

Fill	Conductivity W/mK	Conductivity R/inch	Reduction in Conduction
Air	0.0241	6.0	-
Argon	0.0162	8.9	33%
Krypton	0.0086	16.8	64%
Xenon	0.0051	28.3	79%

Double IGU



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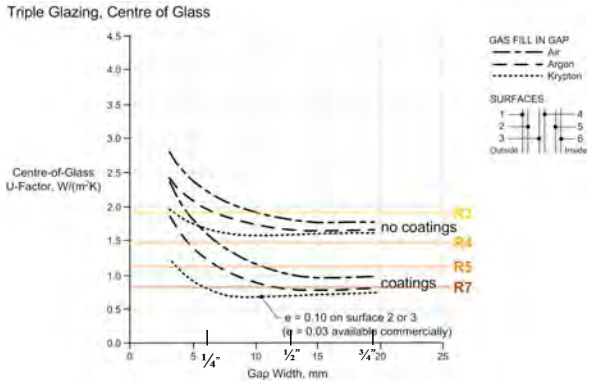
Triple IGU



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Overall - Performance

Typical Window Performance Numbers

Including Frame	U	SHGC	VT
Double-glazed broken Alu	0.64	0.62	0.62
Dbl Clr Wood/vinyl	0.49	0.56	0.58
Dbl Low-E Gain Wood/vinyl	0.36	0.52	0.53
Dbl Low-E Solar Wood/vinyl	0.32	0.30	0.50
Triple Low E Fibreglass	0.18	0.39	0.49
Alu Curtainwall – no TB	1.2	0.60	0.60
Alu Curtainwall – normal TB	0.60	0.60	0.60
Alu Curtainwall –high perf TB	0.40	0.25	0.55

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4. Slabs

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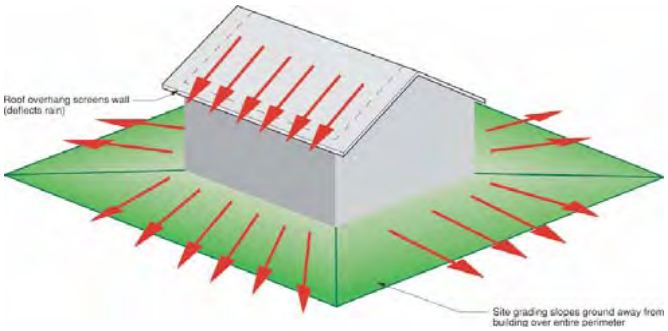

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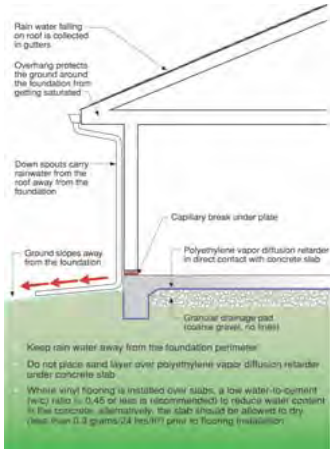

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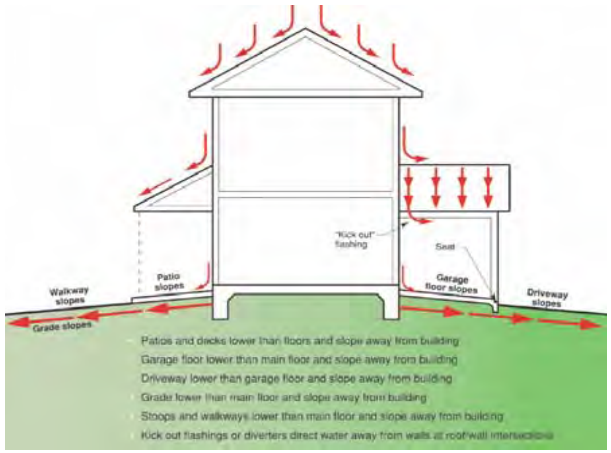

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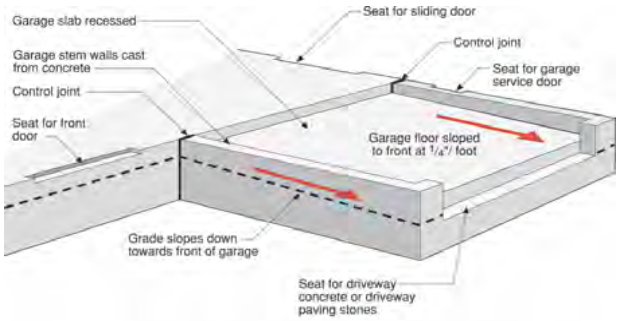

- Garage floor lower than main floor and slopes away from building
- Garage door area recessed to prevent water entry
- Entry doors recessed to prevent water entry
- Stem walls cast from concrete, not constructed with masonry

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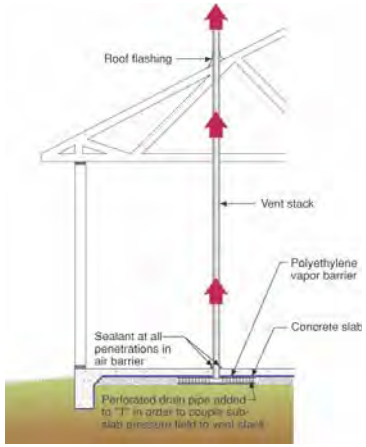

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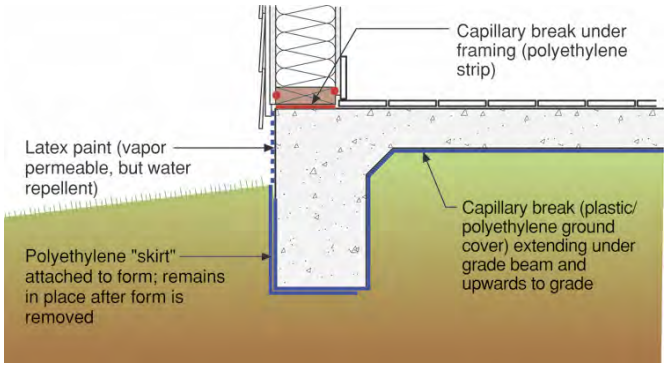

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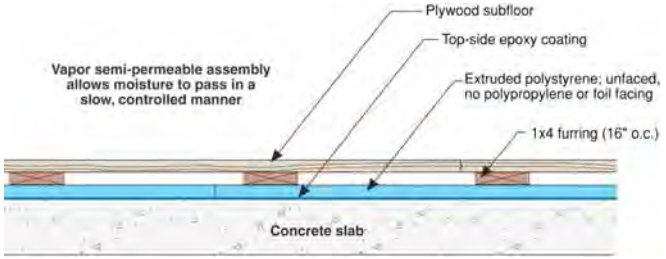

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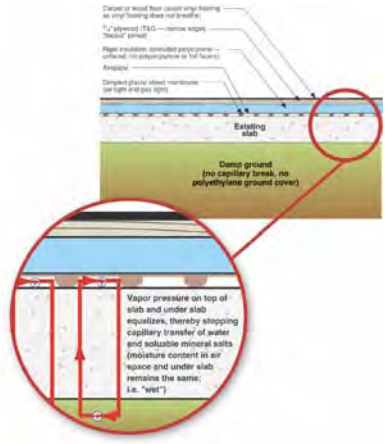

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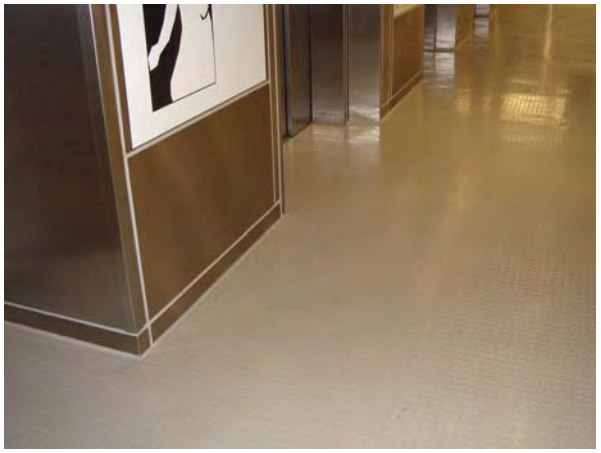

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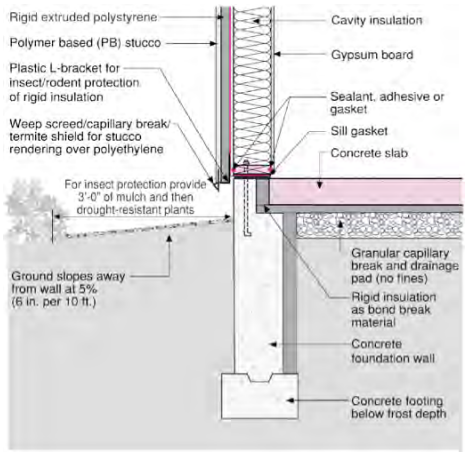
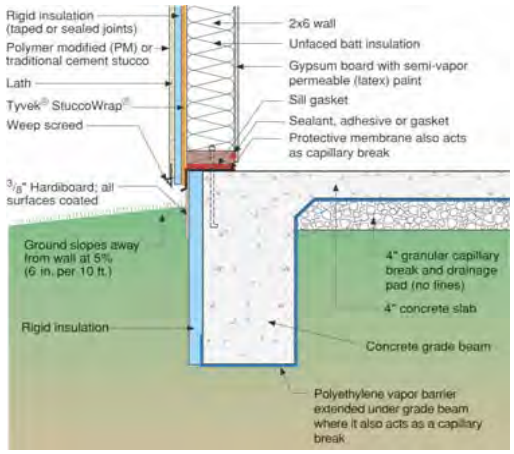
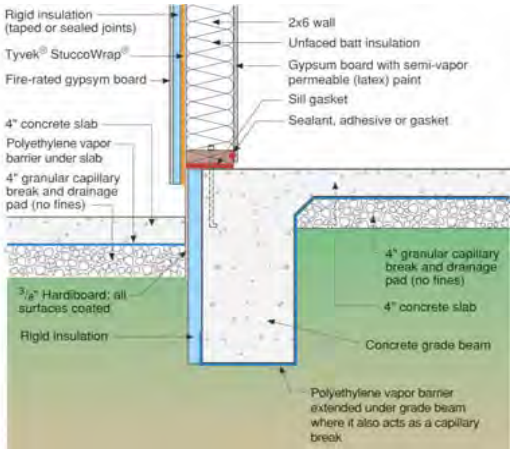

Rigid extruded polystyrene
Polymer based (PB) stucco
Plastic L-bracket for insect/rodent protection of rigid insulation
Weep screed/capillary break/termite shield for stucco rendering over polyethylene
For insect protection provide 3'-0" of mulch and then drought-resistant plants
Ground slopes away from wall at 5% (6 in. per 10 ft.)
Cavity insulation
Gypsum board
Sealant, adhesive or gasket
Sill gasket
Concrete slab
Granular capillary break and drainage pad (no fines)
Rigid insulation as bond break material
Concrete foundation wall
Concrete footing below frost depth


Rigid insulation (taped or sealed joints)
Polymer modified (PM) or traditional cement stucco
Lath
Tyvek® StuccoWrap®
Weep screed
3/8" Hardiboard; all surfaces coated
Ground slopes away from wall at 5% (6 in. per 10 ft.)
Rigid insulation
2x6 wall
Unfaced batt insulation
Gypsum board with semi-vapor permeable (latex) paint
Sill gasket
Sealant, adhesive or gasket
Protective membrane also acts as capillary break
4" granular capillary break and drainage pad (no fines)
4" concrete slab
Concrete grade beam
Polyethylene vapor barrier extended under grade beam where it also acts as a capillary break



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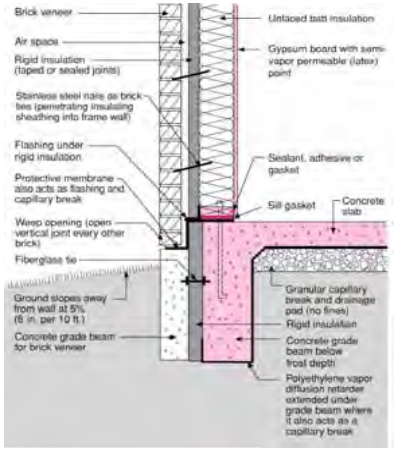

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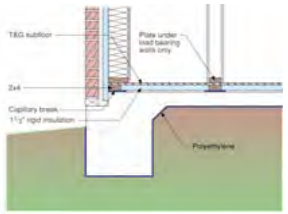
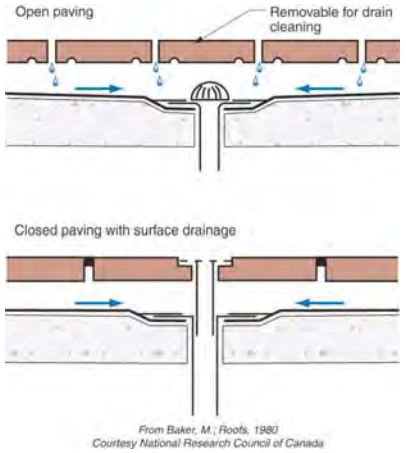
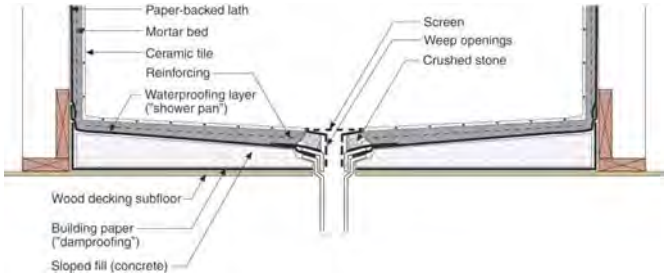
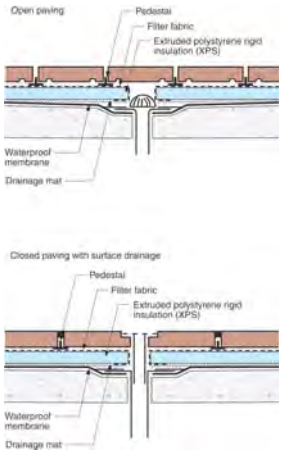
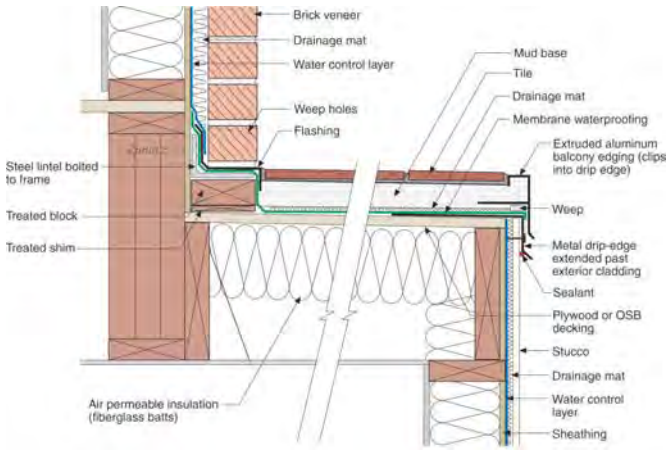

T&G subfloor
Plate under load bearing walls only
2x4
Capillary break
1"(+/-" rigid insulation
Polyethylene
T&G subfloor
Plate under load bearing walls only
2x4
Capillary break
1"(+/-" rigid insulation
Polyethylene


Open paving
Removable for drain cleaning
Closed paving with surface drainage
From Baker, M.; Roofs, 1980
Courtesy National Research Council of Canada


Paper-backed lath
Mortar bed
Ceramic tile
Reinforcing
Waterproofing layer ("shower pan")
Screen
Weep openings
Crushed stone
Wood decking subfloor
Building paper ("damproofing")
Sloped fill (concrete)


Open paving
Pedestal
Filter fabric
Extruded polystyrene rigid insulation (XPS)
Waterproof membrane
Drainage mat
Closed paving with surface drainage
Pedestal
Filter fabric
Extruded polystyrene rigid insulation (XPS)
Waterproof membrane
Drainage mat



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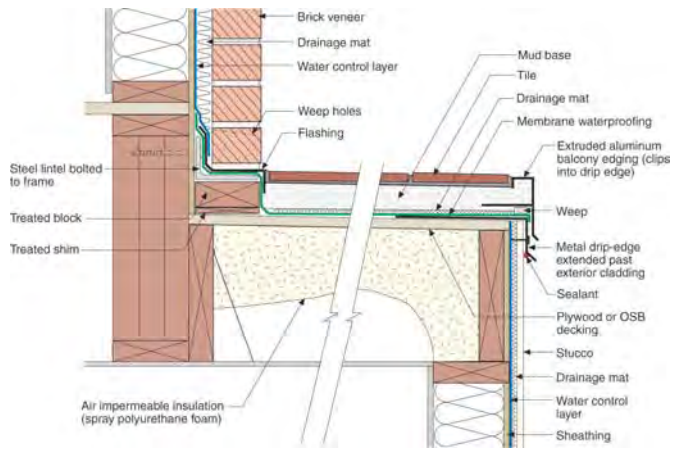

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