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

Building Science

Mass Assemblies

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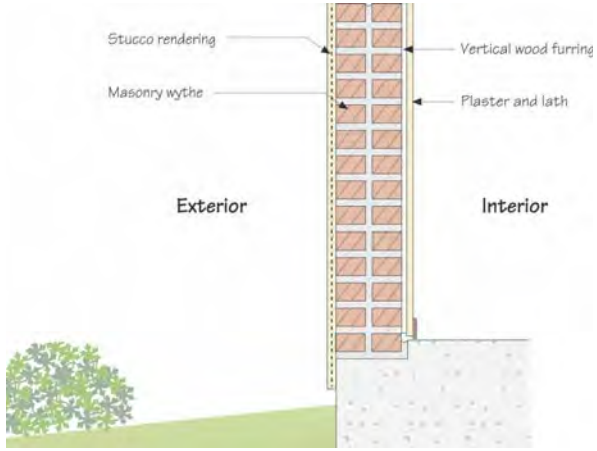
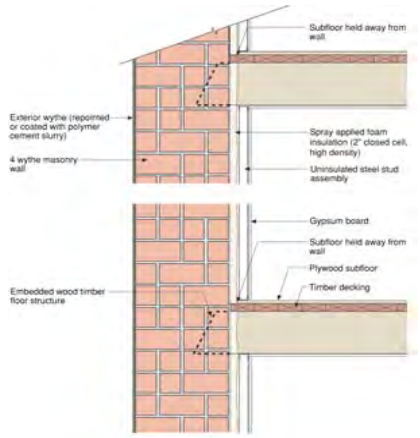
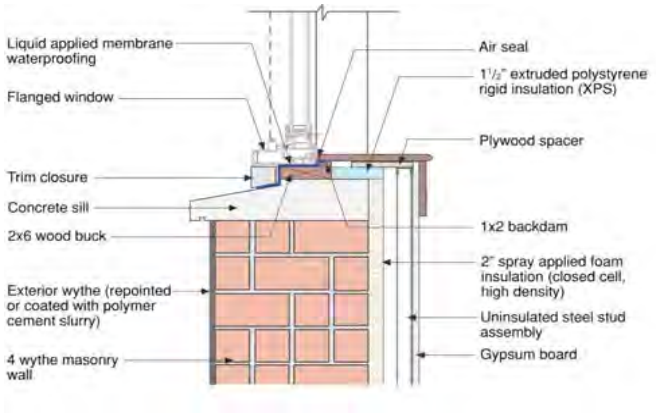
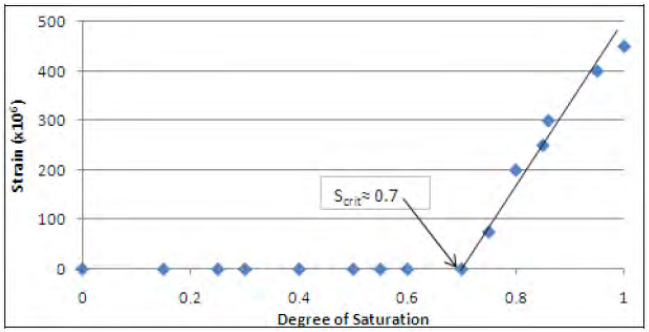
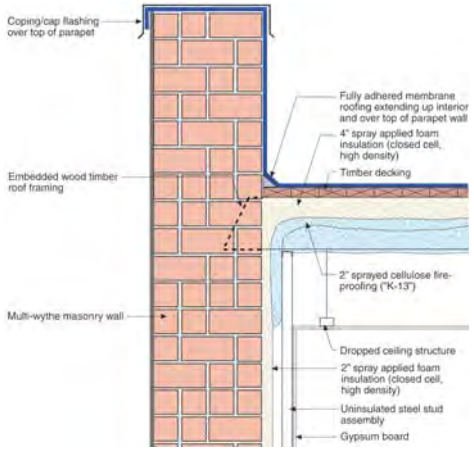


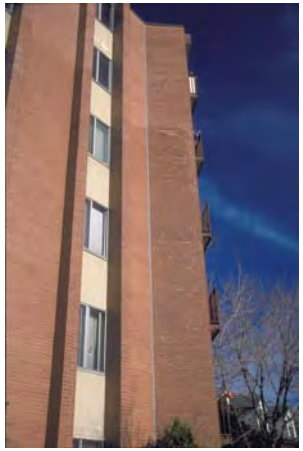

WEST SIDE VILLAGE
113 North 13th Street

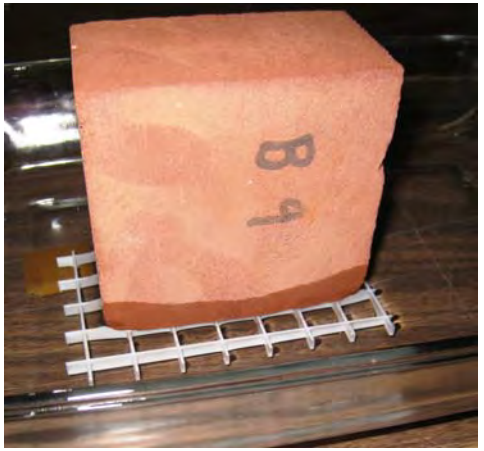

Subfloor held away from wall
Exterior wythe (repointed or coated with polymer cement slurry)
4 wythe masonry wall
Spray applied foam insulation (2" closed cell, high density)
Uninsulated steel stud assembly
Gypsum board
Subfloor held away from wall
Plywood subfloor
Timber decking
Embedded wood timber floor structure

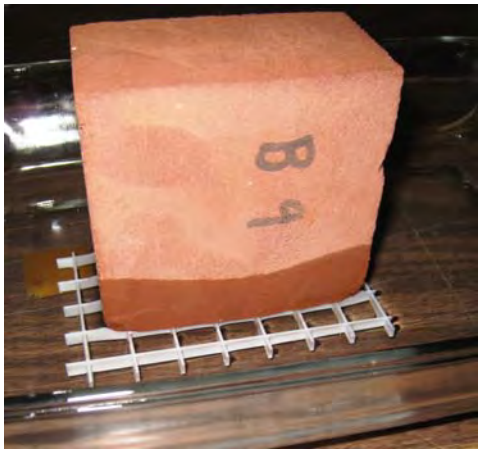

Liquid applied membrane waterproofing
Flanged window
Trim closure
Concrete sill
2x6 wood buck
Exterior wythe (repointed or coated with polymer cement slurry)
4 wythe masonry wall
Air seal
1½" extruded polystyrene rigid insulation (XPS)
Plywood spacer
1x2 backdam
2" spray applied foam insulation (closed cell, high density)
Uninsulated steel stud assembly
Gypsum board


500
400
300
200
100
0
Strain (x10⁶)
0
0.2
0.4
0.6
0.8
1
Degree of Saturation
$S_{crit} \approx 0.7$


Coping/cap flashing over top of parapet
Fully adhered membrane roofing extending up interior and over top of parapet wall
4" spray applied foam insulation (closed cell, high density)
Timber decking
Embedded wood timber roof framing
2" sprayed cellulose fire-proofing ("K-13")
Multi-wythe masonry wall
Dropped ceiling structure
2" spray applied foam insulation (closed cell, high density)
Uninsulated steel stud assembly
Gypsum board




B 9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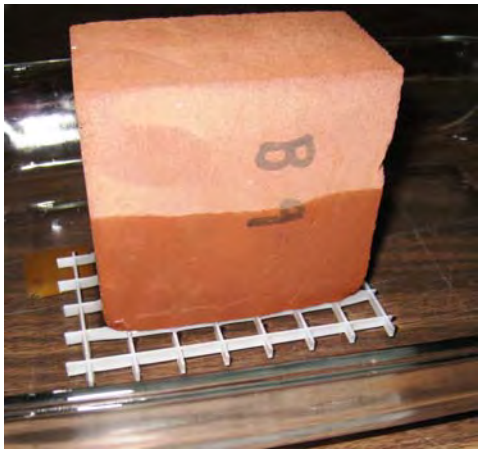
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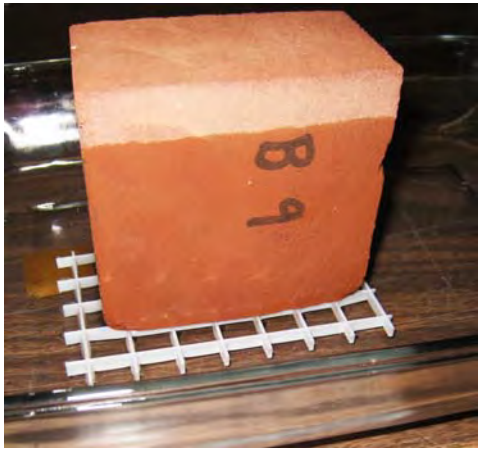
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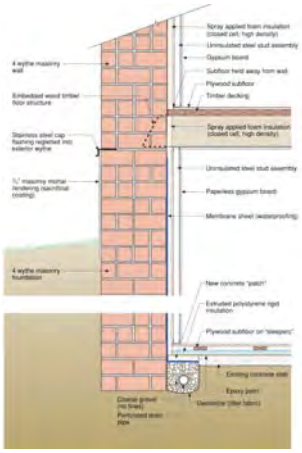
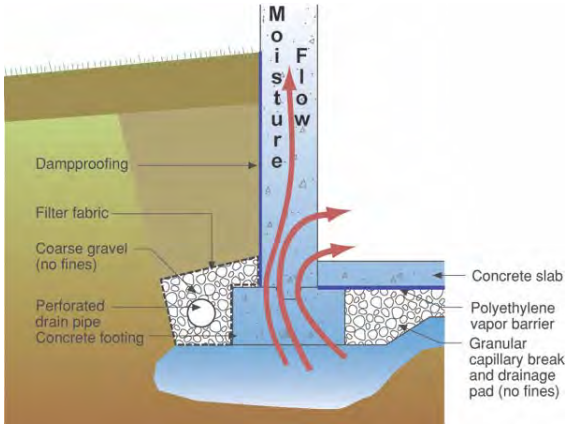
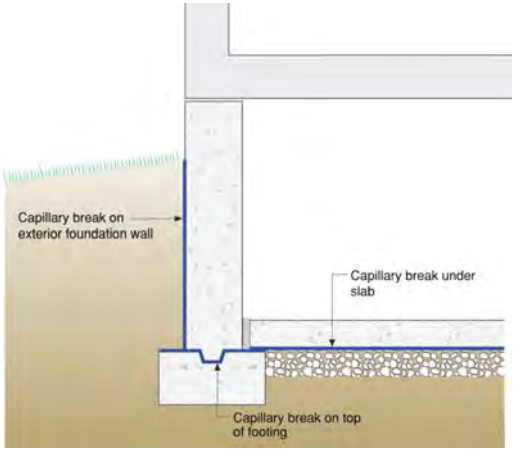
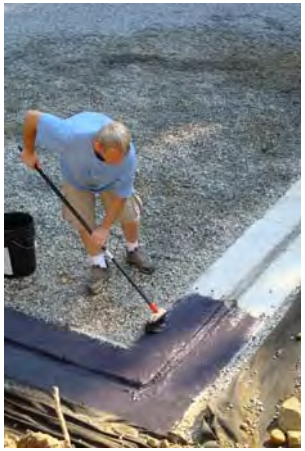


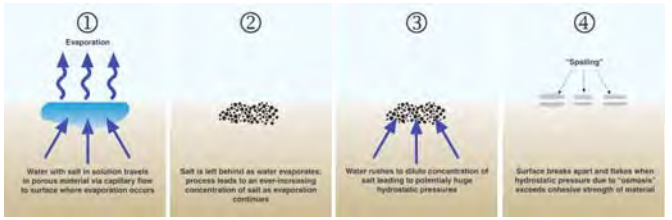

Moisture Flow
Dampproofing
Filter fabric
Coarse gravel (no fines)
Perforated drain pipe
Concrete footing
Concrete slab
Polyethylene vapor barrier
Granular capillary break and drainage pad (no fines)


Capillary break on exterior foundation wall
Capillary break under slab
Capillary break on top of footing



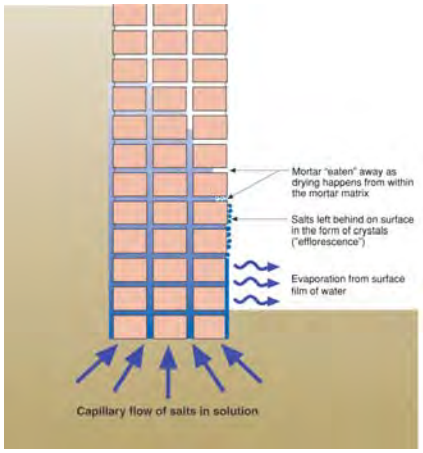
Capillarity + Salt = Osmosis

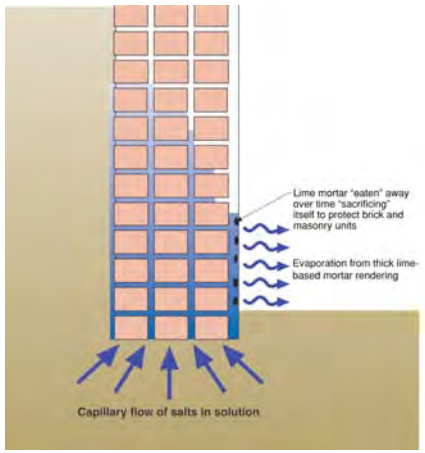
- Mineral salts carried in solution by capillary water
- When water evaporates from a surface the salts left behind form crystals in process called efflorescence
- When water evaporated beneath a surface the salts crystallize within the pore structure of the material in called sub-efflorescence
- The salt crystallization causes expansive forces that can exceed the cohesive strength of the material leading to spalling



Diffusion + Capillarity + Osmosis = Problem

- Diffusion Vapor Pressure 3 to 5 psi
- Capillary Pressure 300 to 500 psi
- Osmosis Pressure 3,000 to 5,000 psi


Mortar "eaten" away as drying happens from within the mortar matrix
Salts left behind on surface in the form of crystals ("efflorescence")
Evaporation from surface film of water
Capillary flow of salts in solution


Lime mortar "eaten" away over time "sacrificing" itself to protect brick and masonry units
Evaporation from thick lime-based mortar rendering
Capillary flow of salts in solution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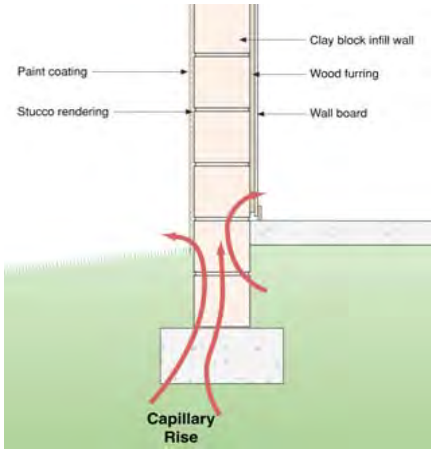
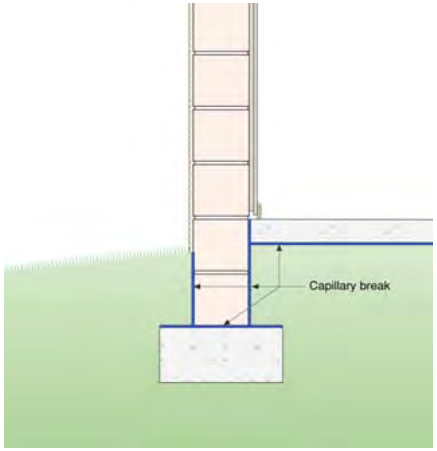
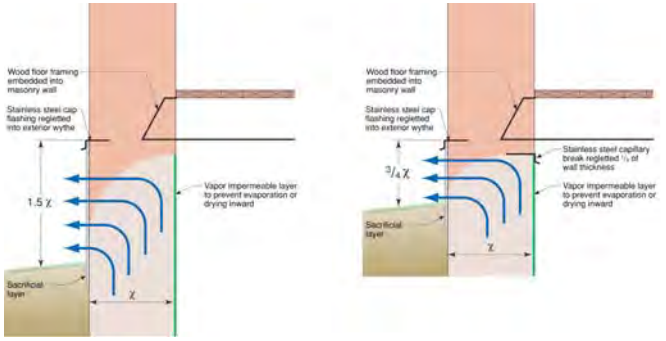
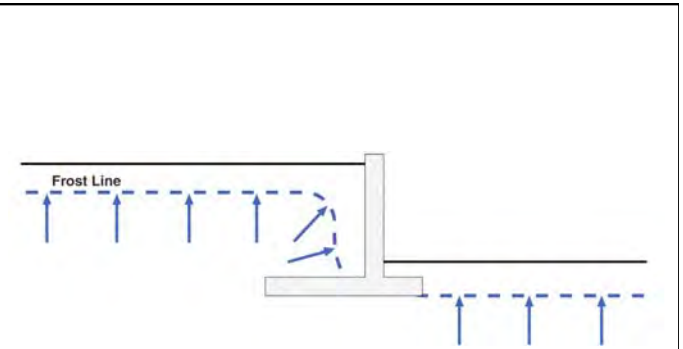
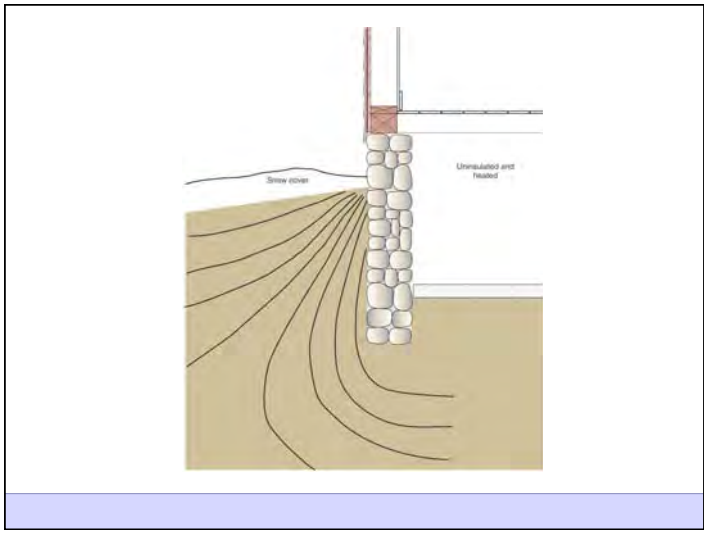

Clay block infill wall
Paint coating
Wood furring
Stucco rendering
Wall board
Capillary Rise

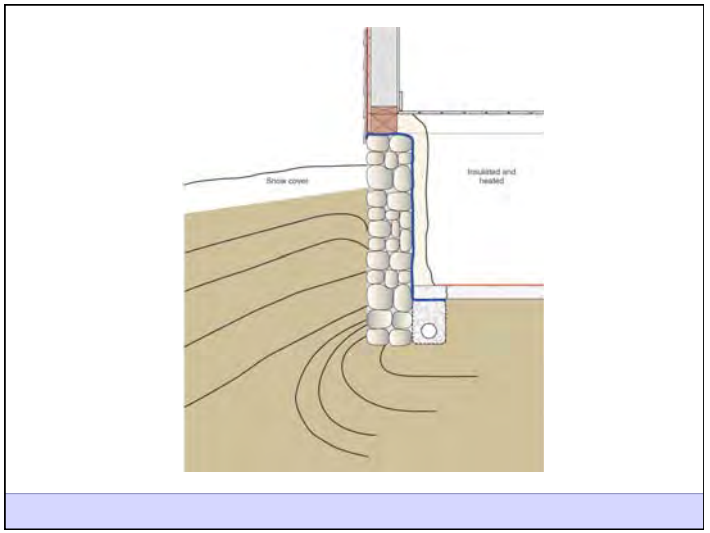

Capillary break

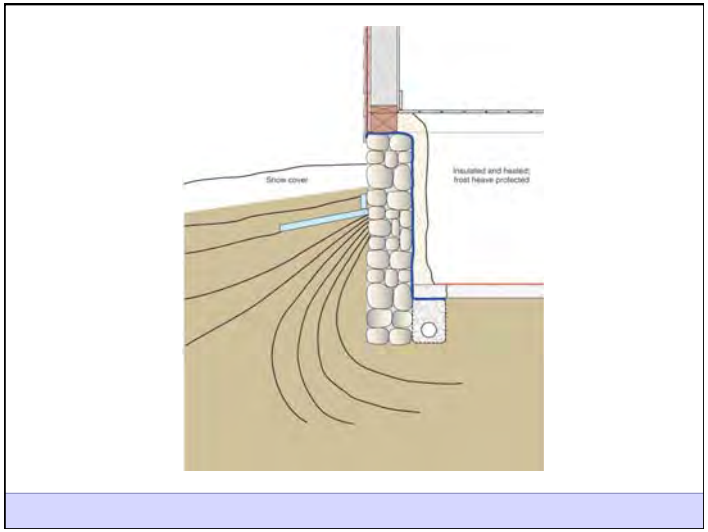

Wood floor framing embedded into masonry wall
Stainless steel cap flashing reglettted into exterior wythe
1.5 X
Vapor impermeable layer to prevent evaporation or drying inward
Sacrificial layer
X
Wood floor framing embedded into masonry wall
Stainless steel cap flashing reglettted into exterior wythe
Stainless steel capillary break reglettted ¼ of wall thickness
3/4 X
Vapor impermeable layer to prevent evaporation or drying inward
Sacrificial layer
X

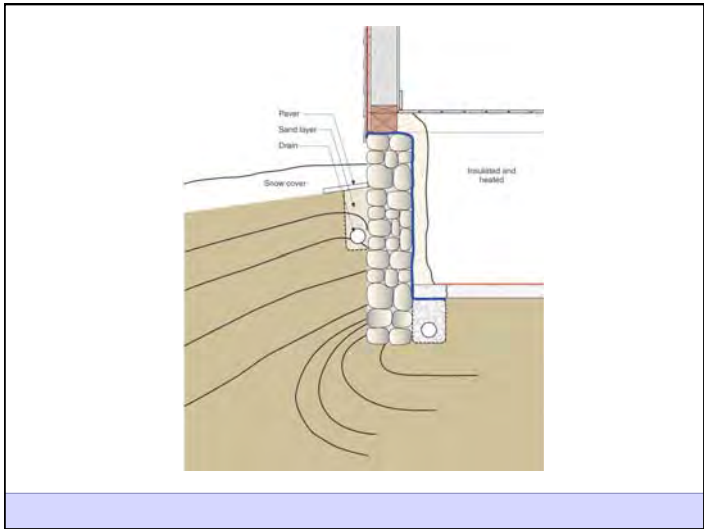

30"
40"
50"
60"
70"
80"
90"
100"
From the US Army Corps Engineers Extreme Frost Penetration (in inches) based on state averages.

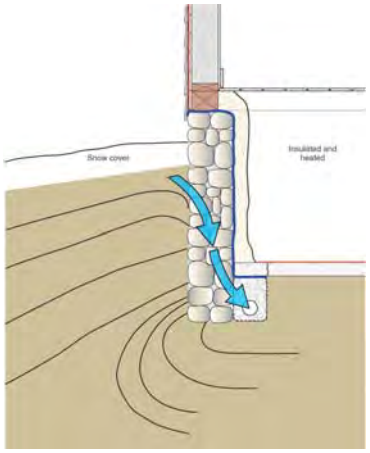

Frost Line


Snow cover
Uninsulated and heated


Snow cover
Insulated and heated


Snow cover
Insulated and heated; frost heave protected


Paver
Sand layer
Drain
Snow cover
Insulated and heated


Snow cover
Insulated and heated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of
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