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

# Building Science

## Adventures In Building Science

www.buildingscience.com

Buildings Get Wet From The Outside
Buildings Get Wet From The Inside
Buildings Start Out Wet
Wet Happens



Buildings Must Be Designed To Dry

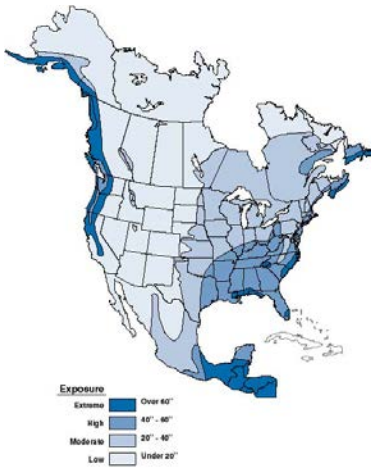


Buildings Can Dry To The Outside
Buildings Can Dry To The Inside
Buildings Can Dry To Both Sides

2nd Law of Thermodynamics



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



Don’t Do Stupid Things

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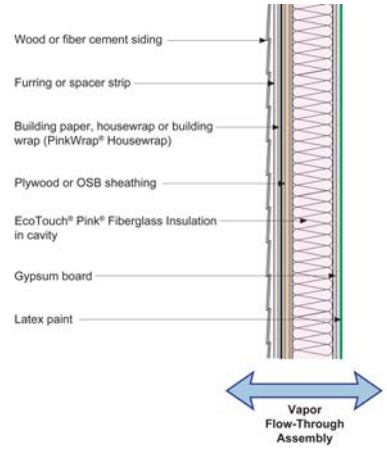
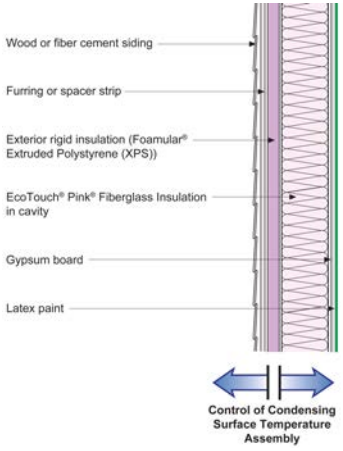
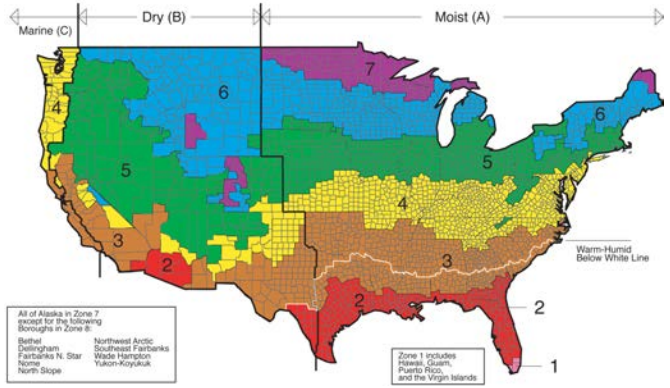
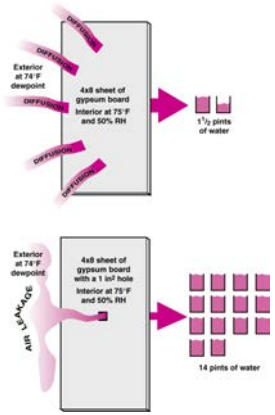

Wood or fiber cement siding
Furring or spacer strip
Building paper, housewrap or building wrap (PinkWrap® Housewrap)
Plywood or OSB sheathing
EcoTouch® Pink® Fiberglass Insulation in cavity
Gypsum board
Latex paint
Vapor Flow-Through Assembly




Wood or fiber cement siding
Furring or spacer strip
Exterior rigid insulation (Foamular® Extruded Polystyrene (XPS))
EcoTouch® Pink® Fiberglass Insulation in cavity
Gypsum board
Latex paint
Control of Condensing Surface Temperature Assembly




Marine (C)
Dry (B)
Moist (A)
1
2
3
4
5
6
7
Warm-Humid Below White Line
All of Alaska in Zone 7 except for the following Boroughs in Zone 8:
Bethel
Dellingham
Fairbanks N. Star
Nome
North Slope
Northwest Arctic
Southeast Fairbanks
Wade Hampton
Yukon-Koyukuk
Zone 1 includes Hawaii, Guam, Puerto Rico, and the Virgin Islands

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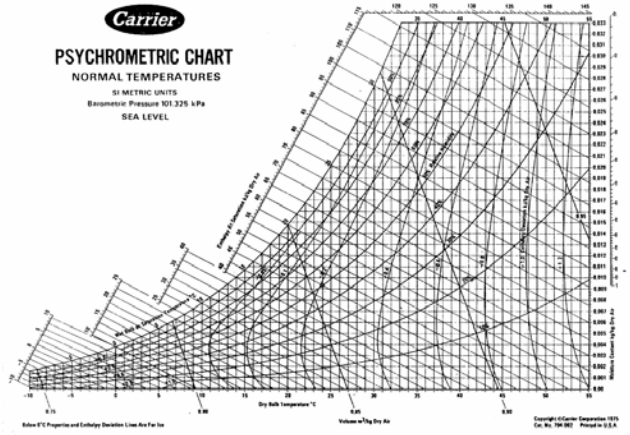


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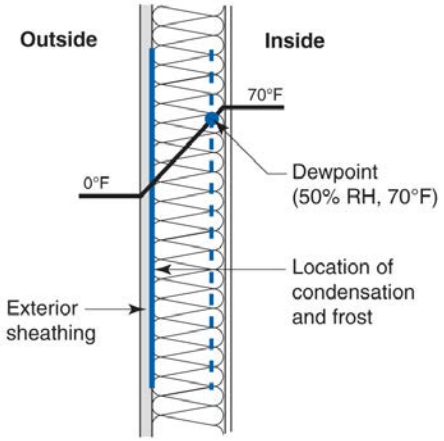


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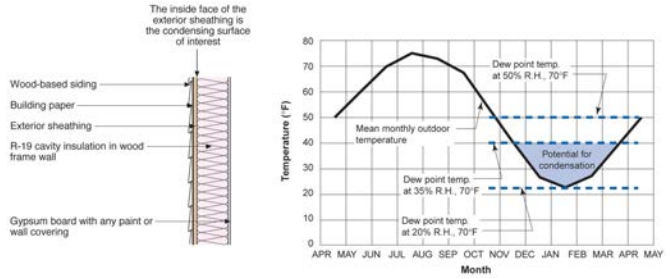


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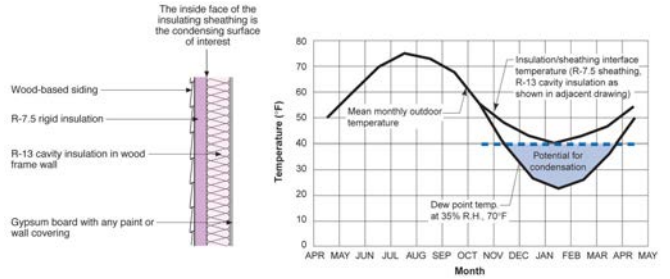


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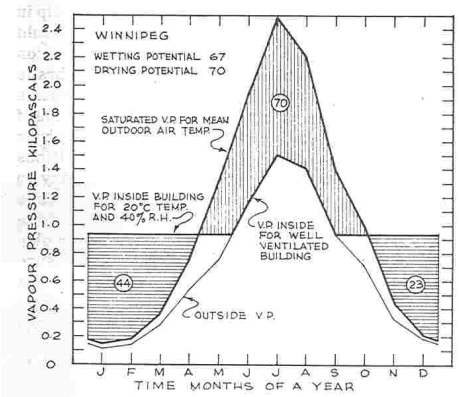
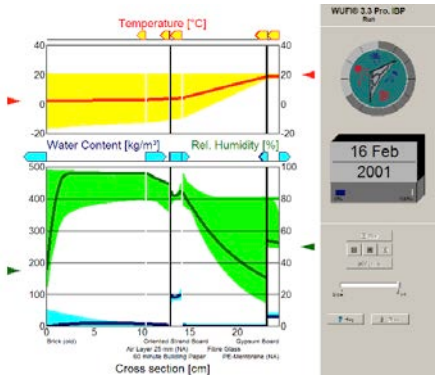



Figure 8-7. Outside vapour pressure, saturated vapour pressure and inside vapour pressure for Winnipeg.



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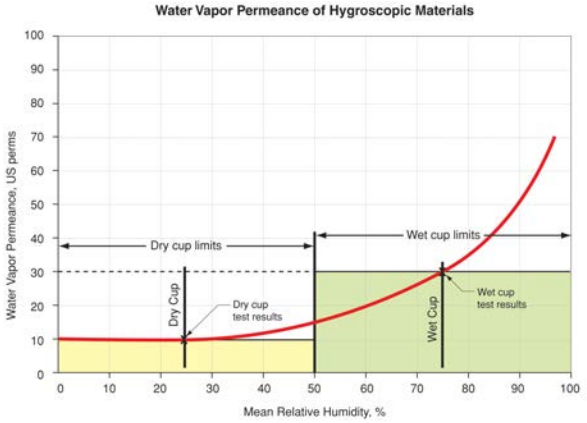

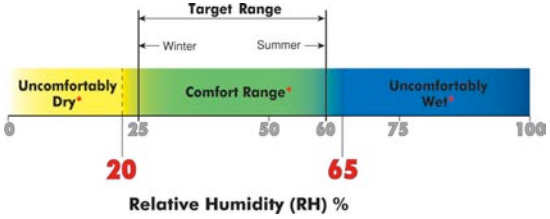


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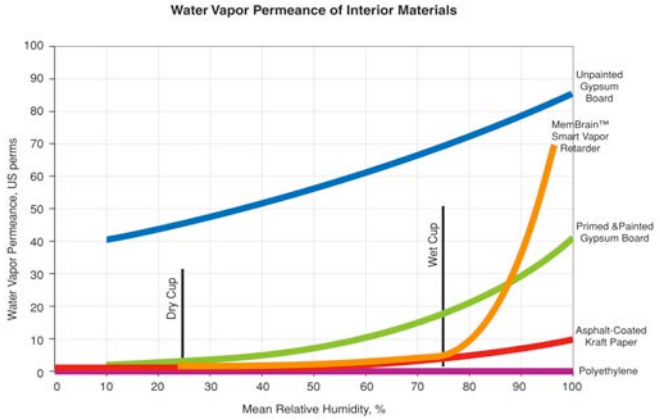


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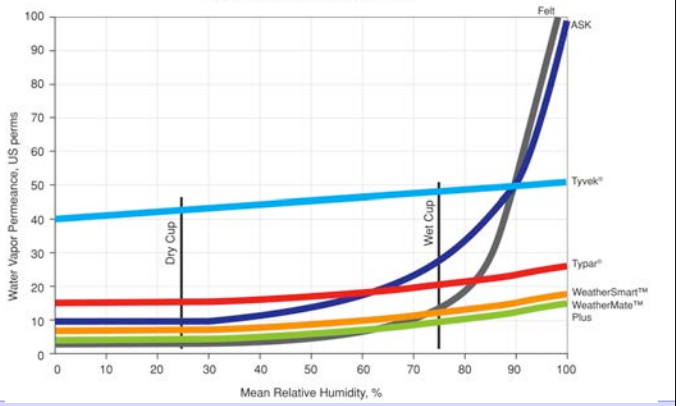


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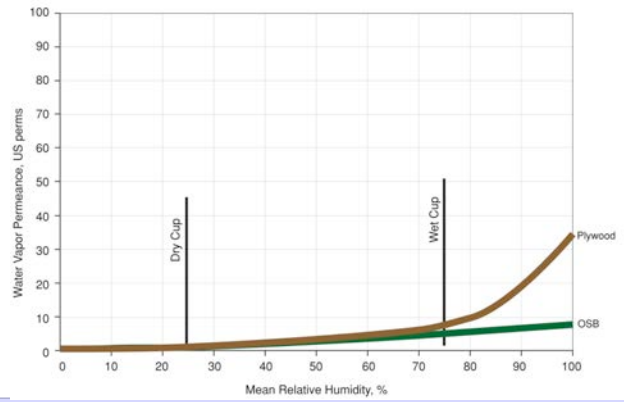


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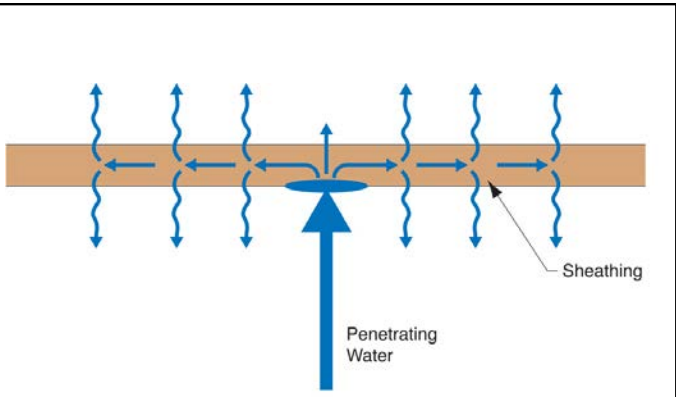


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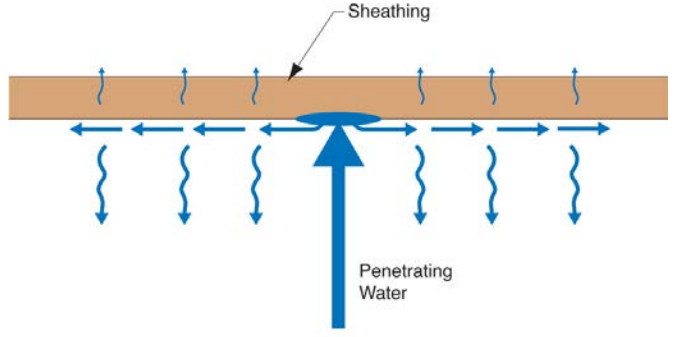


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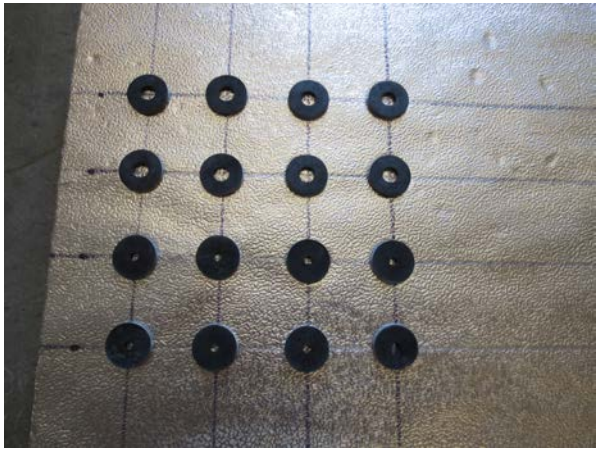
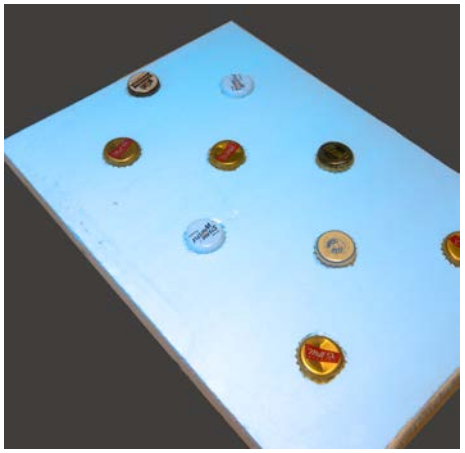
Rain Screen







Beer Screen?



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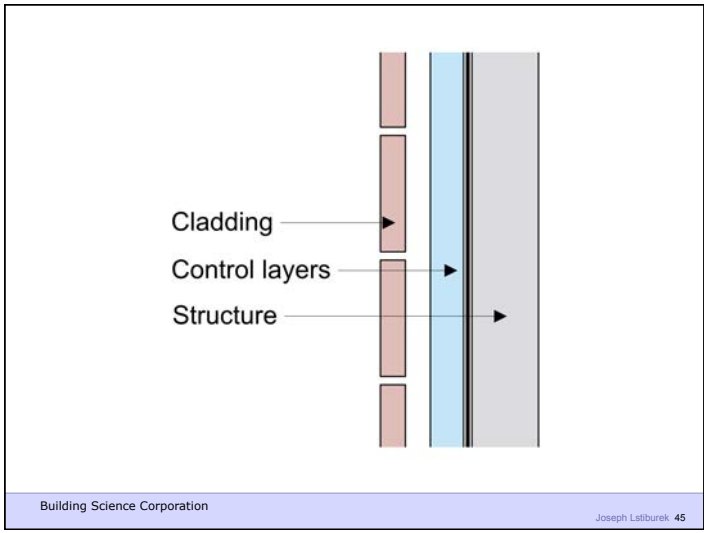
If You Need To Run A Hygrothermal Model To Figure Out If Your Wall Works You Have The Wrong Design



Water Control Layer
Air Control Layer
Vapor Control Layer
Thermal Control Layer


Cladding
Control layers
Structure
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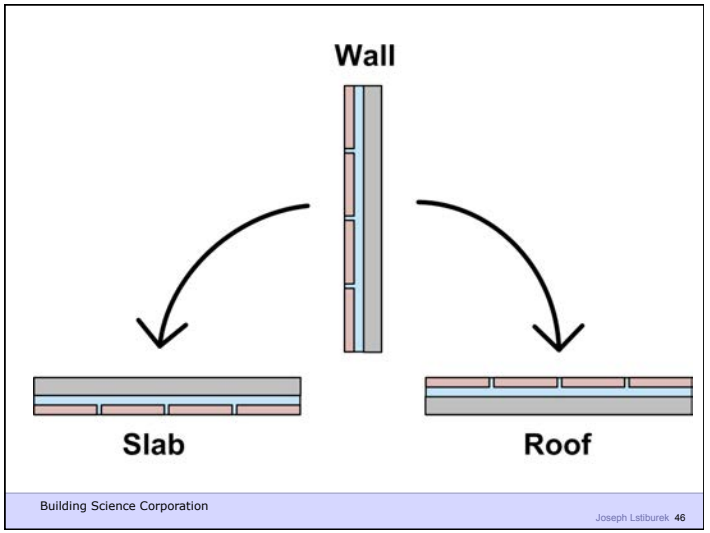
Wall
Slab
Roof
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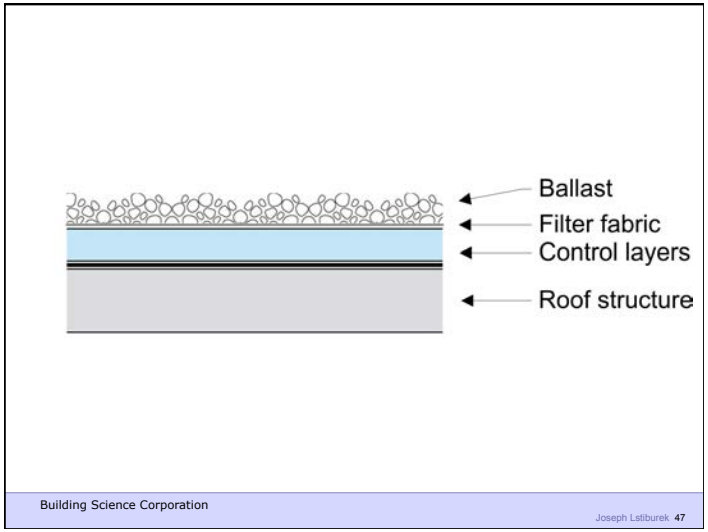
Ballast
Filter fabric
Control layers
Roof structure
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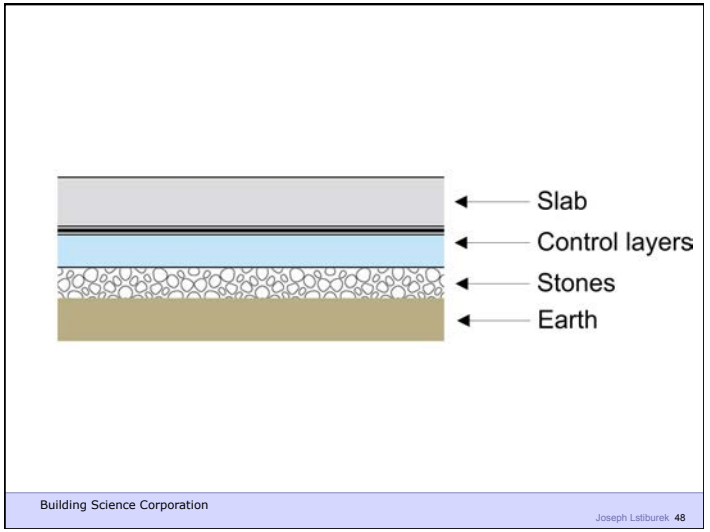
Slab
Control layers
Stones
Earth
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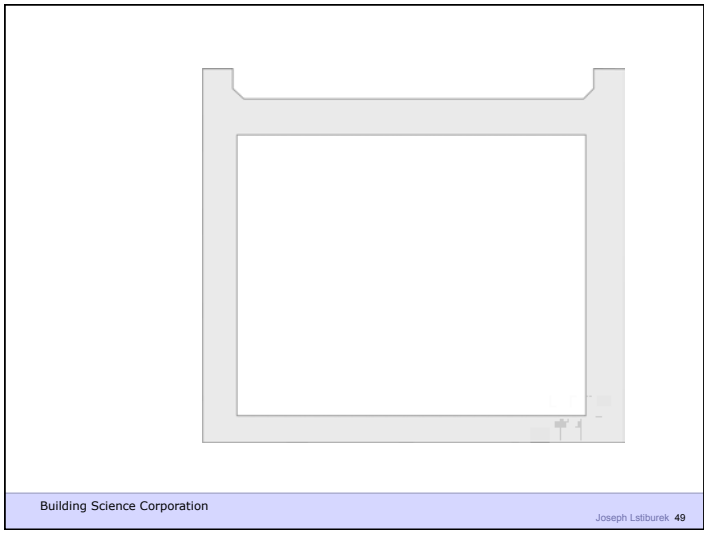
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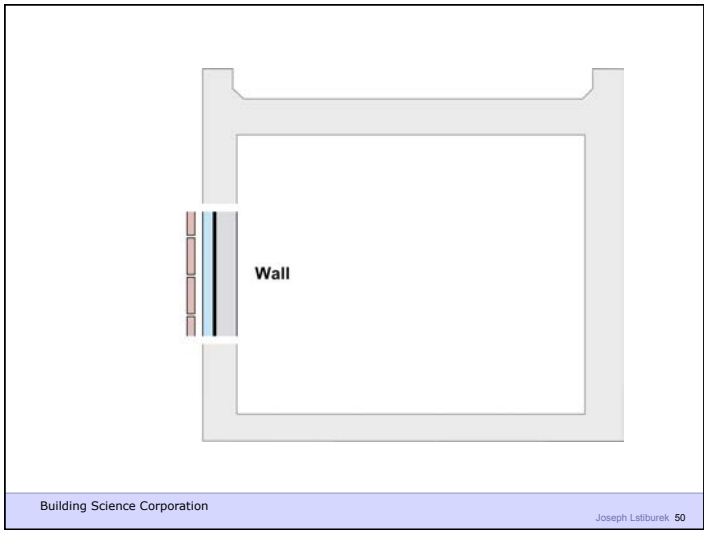
Wall
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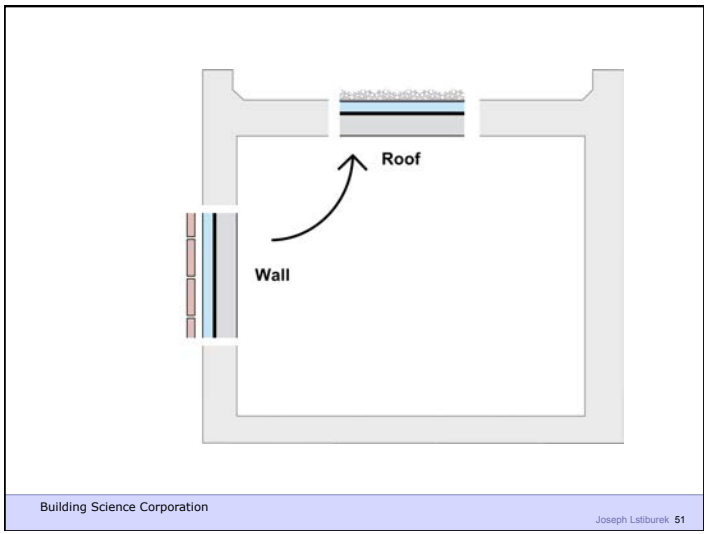
Roof
Wall
Building Science Corporation
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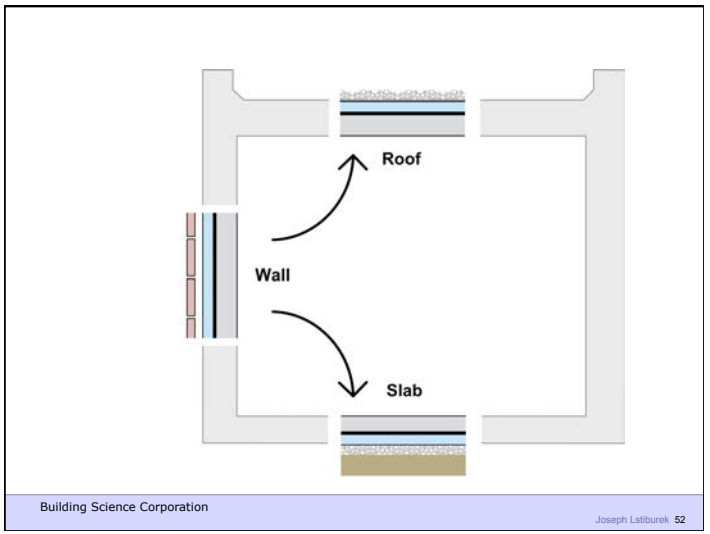
Roof
Wall
Slab
Building Science Corporation
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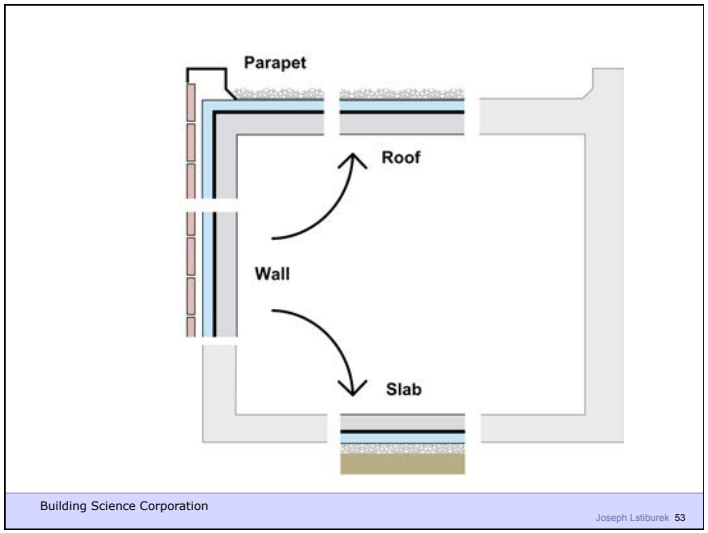
Parapet
Roof
Wall
Slab
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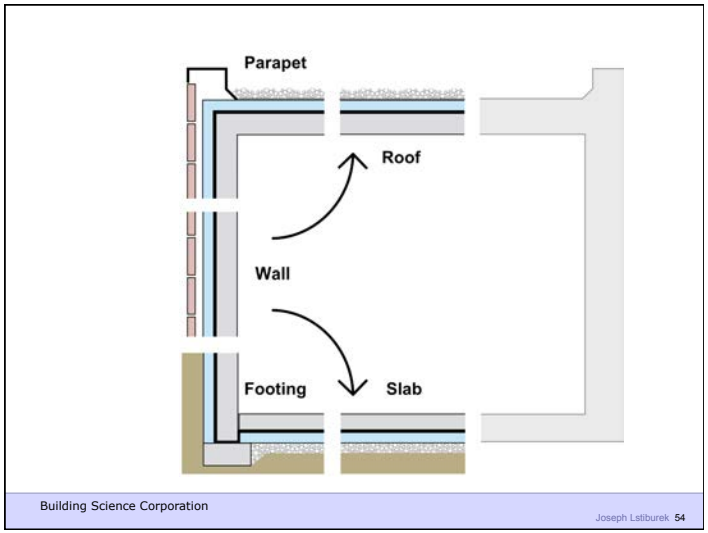
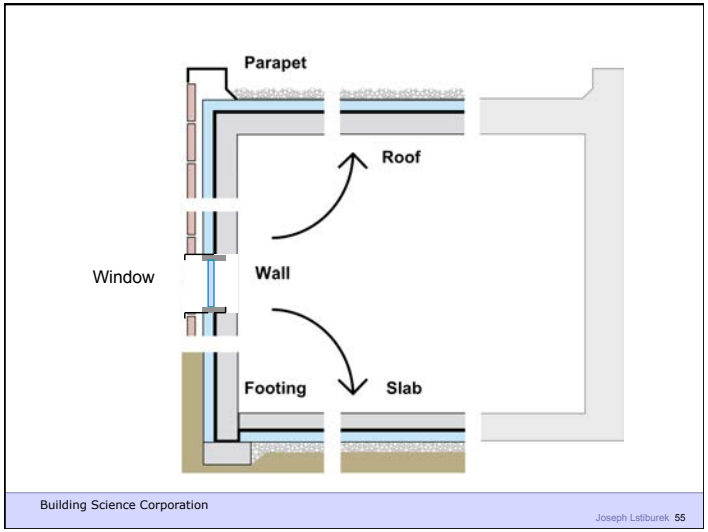

Parapet
Roof
Wall
Footing
Slab
Building Science Corporation
Joseph Lstiburek 54


Parapet
Roof
Window
Wall
Footing
Slab
Building Science Corporation
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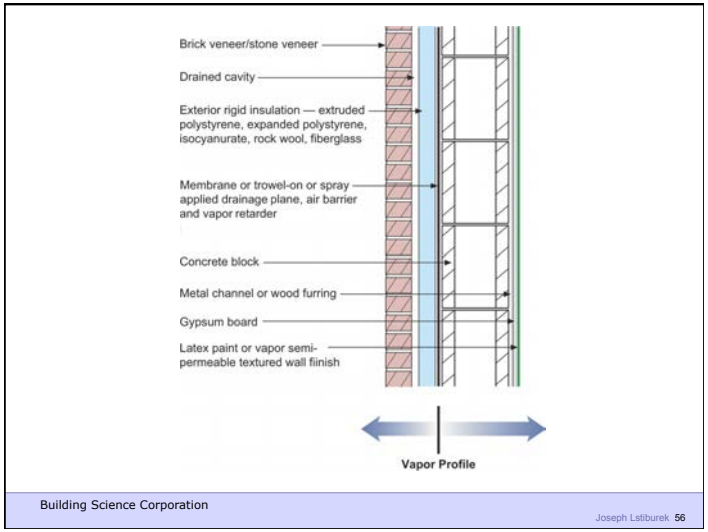
Brick veneer/stone veneer
Drained cavity
Exterior rigid insulation — extruded polystyrene, expanded polystyrene, isocyanurate, rock wool, fiberglass
Membrane or trowel-on or spray applied drainage plane, air barrier and vapor retarder
Concrete block
Metal channel or wood furring
Gypsum board
Latex paint or vapor semi-permeable textured wall fiinish
Vapor Profile
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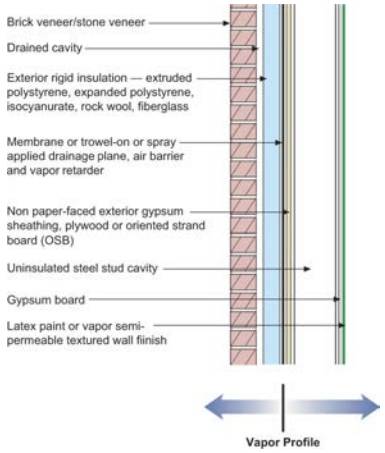


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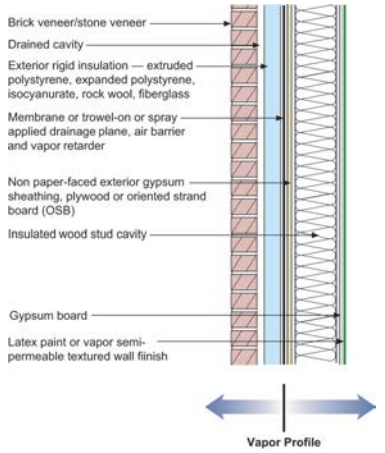


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Building Science Corporation Joseph Lstiburek 60

## Commercial Enclosure: Simple Layers

- Structure
- Rain/Air/Vapor
- Insulation
- Finish

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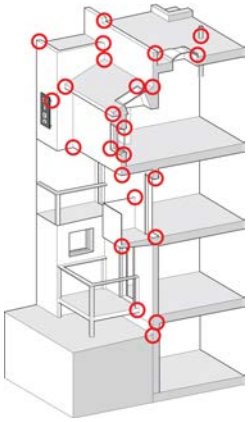

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Building Science Corporation
Joseph Lstiburek 67

Building Science Corporation
Joseph Lstiburek 68

Building Science Corporation Joseph Lstiburek 69

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Building Science Corporation Joseph Lstiburek 72

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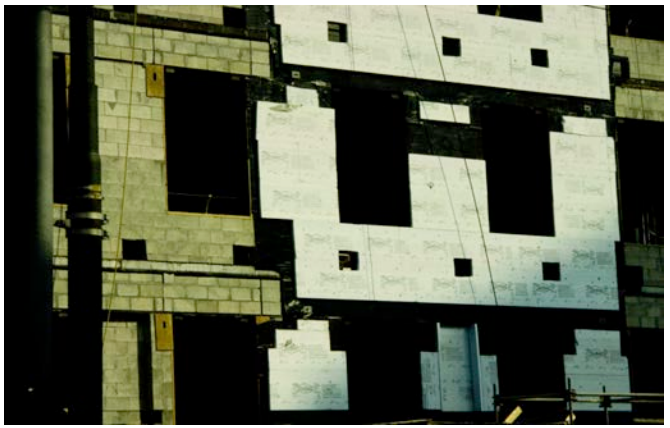
Joseph Lstiburek 73



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Joseph Lstiburek 75

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Building Science Corporation Joseph Lstiburek 77

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Building Science Corporation Joseph Lstiburek 79

Building Science Corporation Joseph Lstiburek 80

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Joseph Lstiburek 85

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Joseph Lstiburek 89

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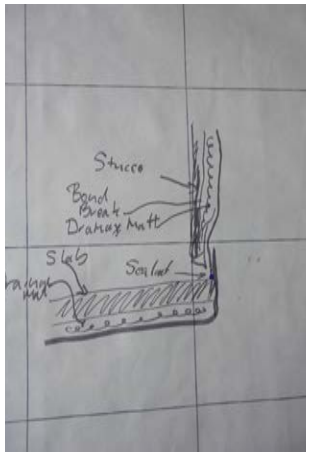
Joseph Lstiburek 90

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Joseph Lstiburek 92

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Joseph Lstiburek 94

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Joseph Lstiburek 96

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Joseph Lstiburek 97

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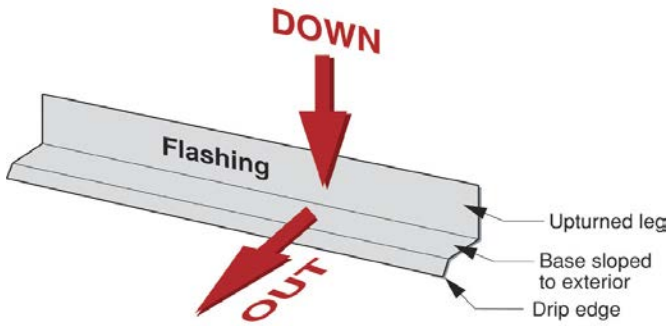
Joseph Lstiburek 98

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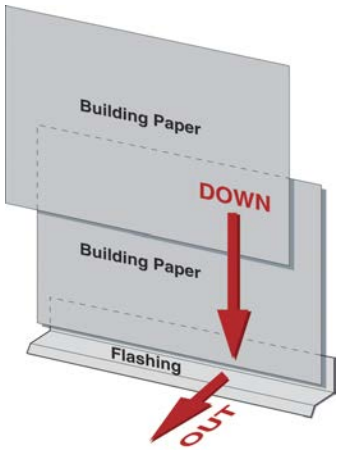


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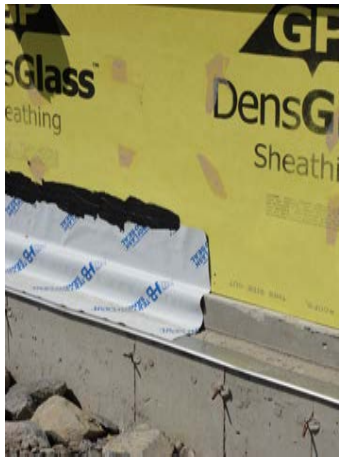


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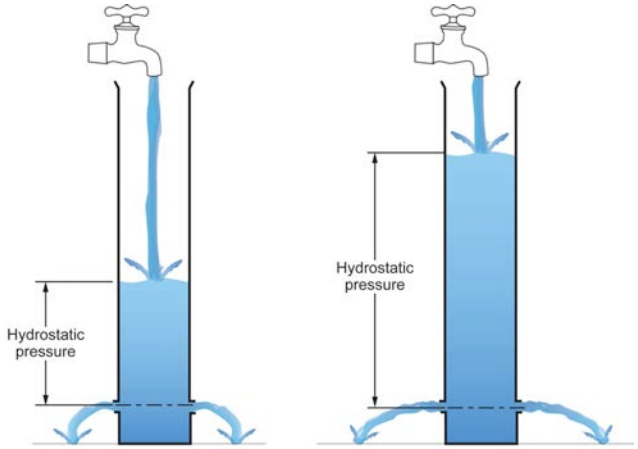
Building Science Corporation
Joseph Lstiburek 102

Building Science Corporation
Joseph Lstiburek 103

Building Science Corporation
Joseph Lstiburek 104

Building Science Corporation Joseph Lstiburek 105

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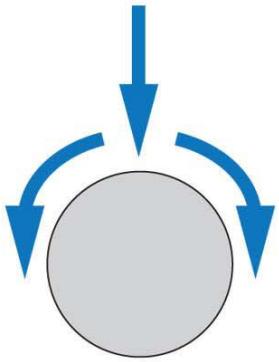
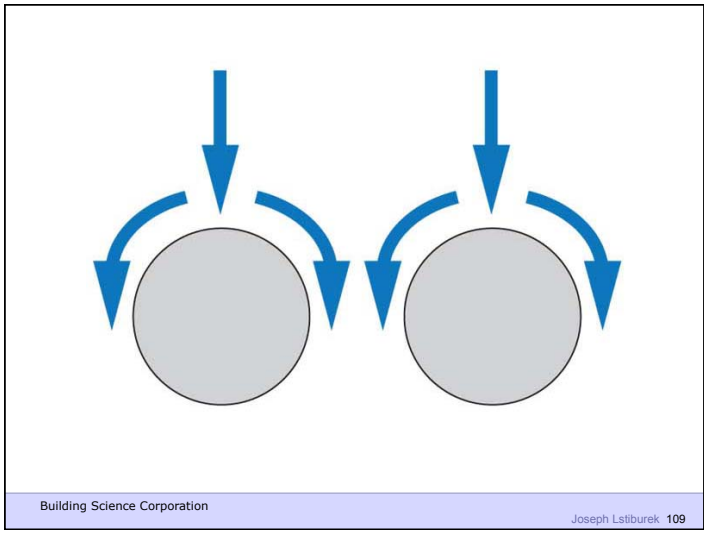
Building Science Corporation Joseph Lstiburek 107



Building Science Corporation Joseph Lstiburek 108



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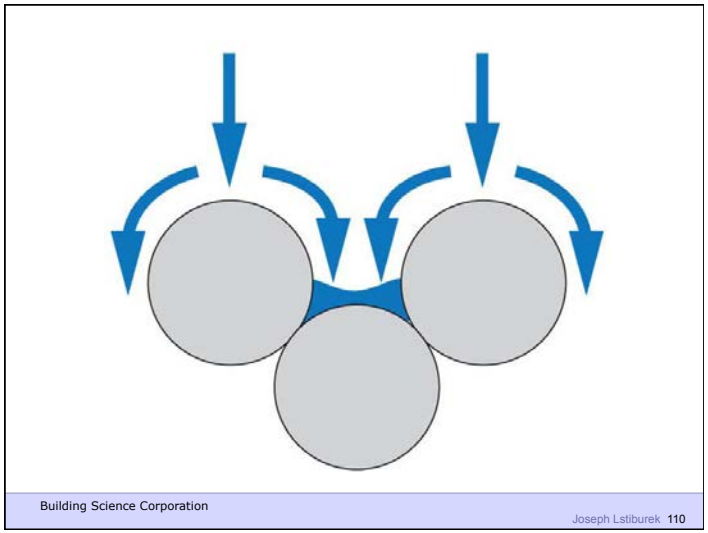
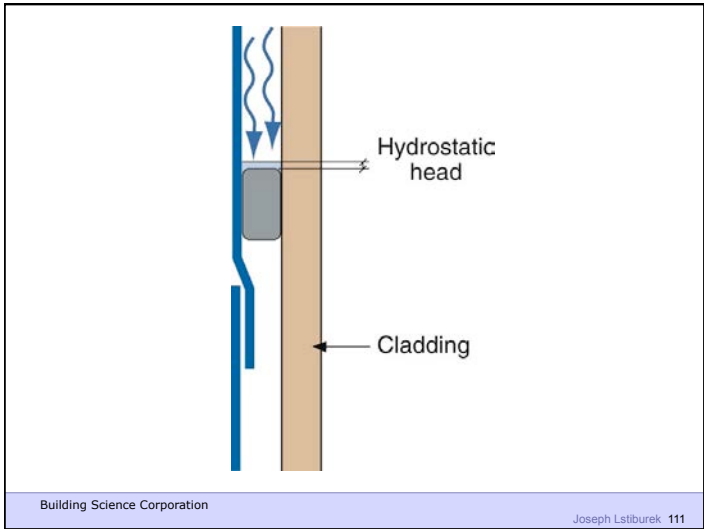
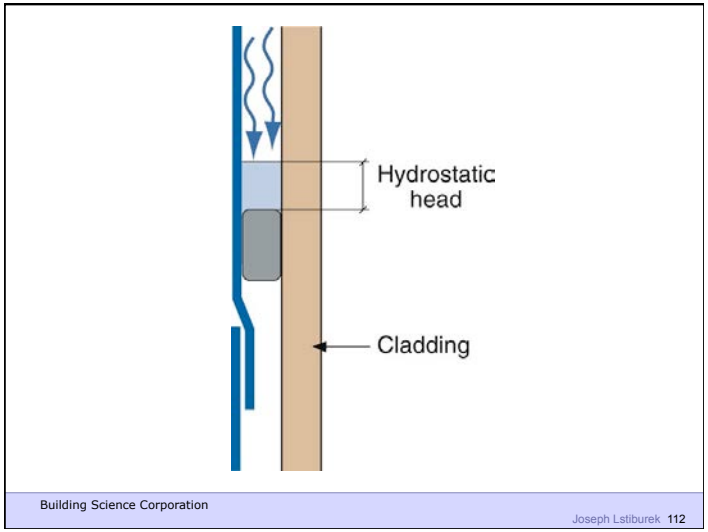


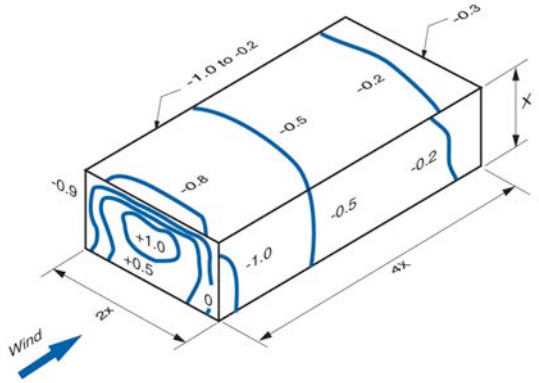
Building Science Corporation Joseph Lstiburek 110




Building Science Corporation Joseph Lstiburek 111

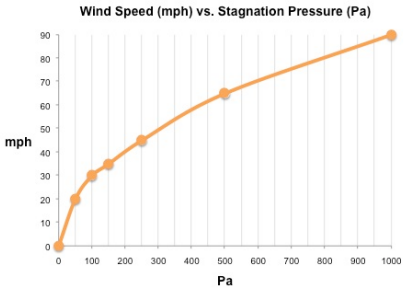



Building Science Corporation Joseph Lstiburek 112




Building Science Corporation Joseph Lstiburek 113

| 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 |




Building Science Corporation Joseph Lstiburek 114

Building Science Corporation Joseph Lstiburek 115

Building Science Corporation Joseph Lstiburek – Rain Control 116

Building Science Corporation
Joseph Lstiburek 117

Building Science Corporation
Joseph Lstiburek 118

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Joseph Lstiburek 119

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Joseph Lstiburek 120

Building Science Corporation Joseph Lstiburek 121

Building Science Corporation Joseph Lstiburek 122

Building Science Corporation Joseph Lstiburek 123

Building Science Corporation Joseph Lstiburek 124

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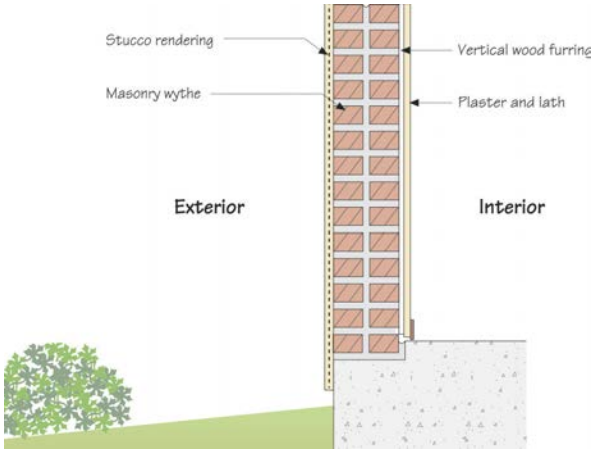
Joseph Lstiburek 125

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Joseph Lstiburek 128

Building Science Corporation
Joseph Lstiburek 129

Building Science Corporation
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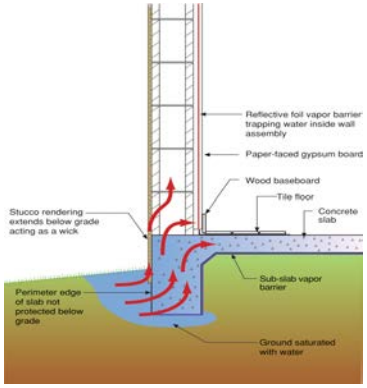
Building Science Corporation Joseph Lstiburek 135

Building Science Corporation Joseph Lstiburek 136

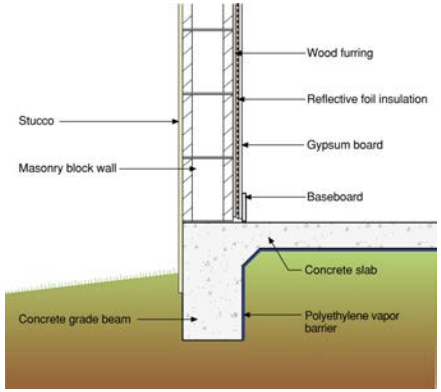
Building Science Corporation Joseph Lstiburek 137

Building Science Corporation Joseph Lstiburek 138

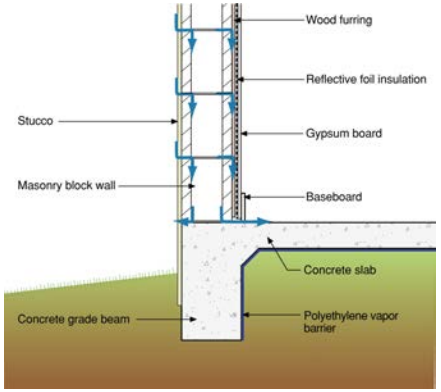
Building Science Corporation Joseph Lstiburek 139



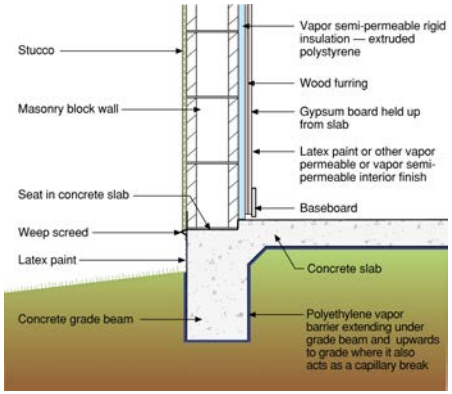

Building Science Corporation Joseph Lstiburek 140




Building Science Corporation Joseph Lstiburek 141

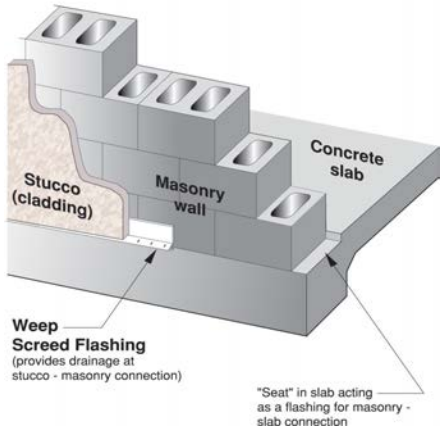



Building Science Corporation Joseph Lstiburek 142




Building Science Corporation Joseph Lstiburek 143

Building Science Corporation Joseph Lstiburek 144

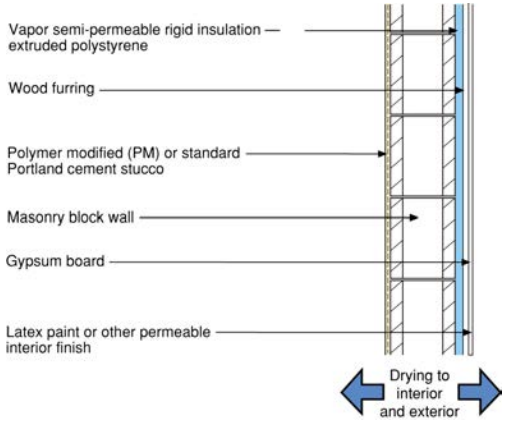



Building Science Corporation
Joseph Lstiburek 145

Building Science Corporation
Joseph Lstiburek 146

Building Science Corporation
Joseph Lstiburek 147

Building Science Corporation
Joseph Lstiburek 148


Vapor semi-permeable rigid insulation — extruded polystyrene
Wood furring
Polymer modified (PM) or standard Portland cement stucco
Masonry block wall
Gypsum board
Latex paint or other permeable interior finish
Drying to interior and exterior

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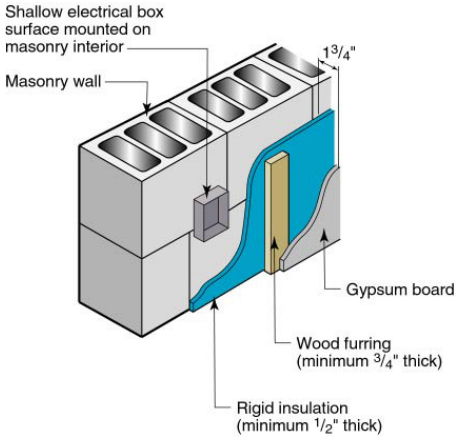
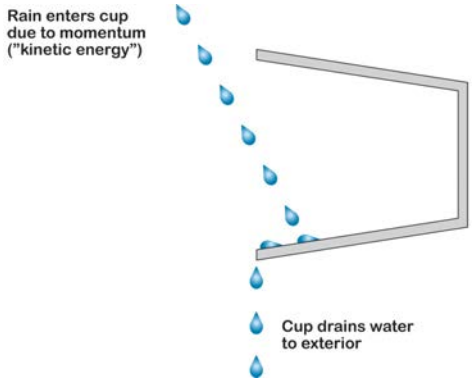
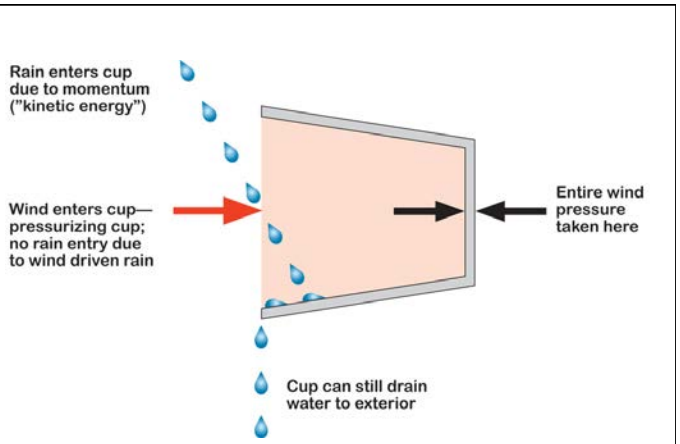
Building Science Corporation Joseph Lstiburek 154

Building Science Corporation Joseph Lstiburek 155

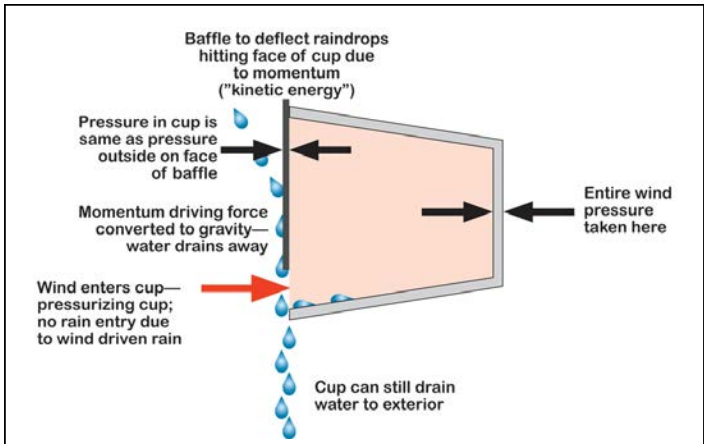
Building Science Corporation Joseph Lstiburek 156


Shallow electrical box
surface mounted on
masonry interior
Masonry wall
1 3/4"
Gypsum board
Wood furring
(minimum 3/4" thick)
Rigid insulation
(minimum 1/2" thick)

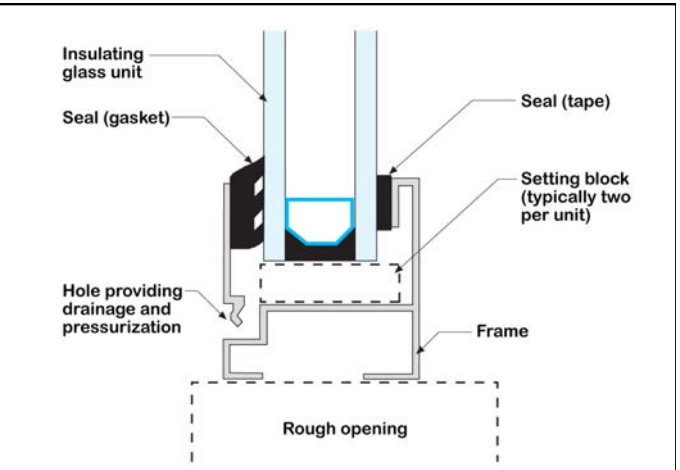

Rain enters cup
due to momentum
("kinetic energy")
Cup drains water
to exterior



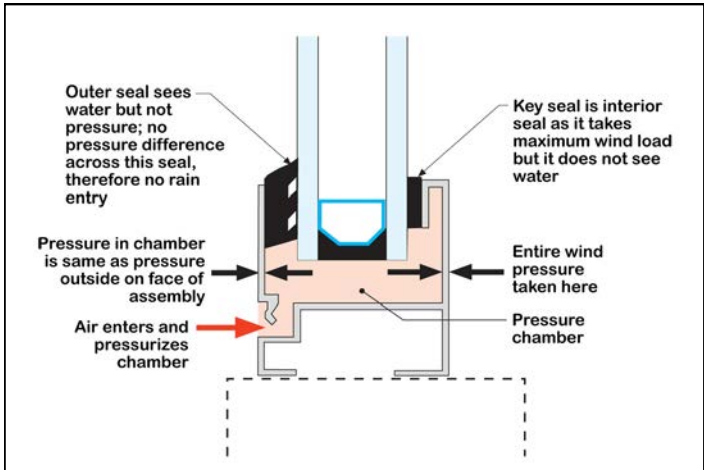

Building Science Corporation 2011 Joseph Lstiburek 161



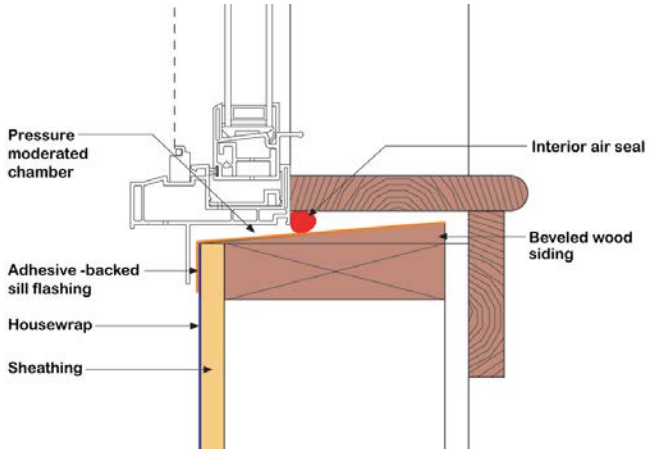

Building Science Corporation 2011 Joseph Lstiburek 162




Building Science Corporation 2011 Joseph Lstiburek 163




Building Science Corporation 2011 Joseph Lstiburek 164




Building Science Corporation 2011 Joseph Lstiburek 165

Building Science Corporation Joseph Lstiburek 166

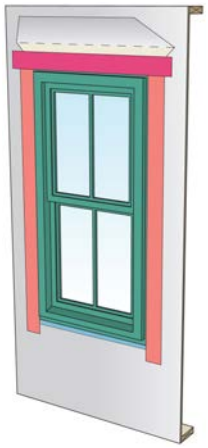
Building Science Corporation Joseph Lstiburek 167

Building Science Corporation Joseph Lstiburek 168

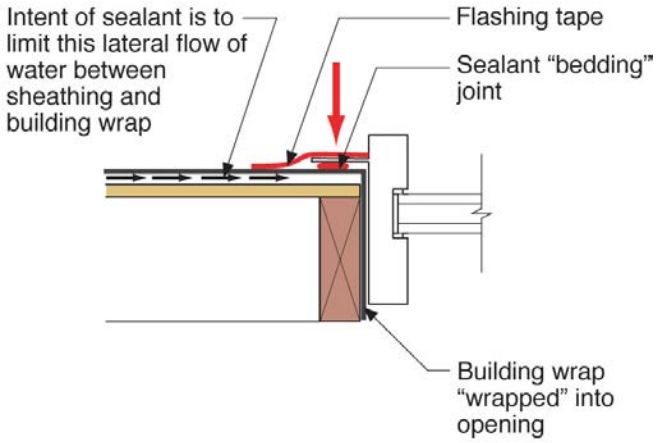
Building Science Corporation
Joseph Lstiburek 169

Building Science Corporation
Joseph Lstiburek 170

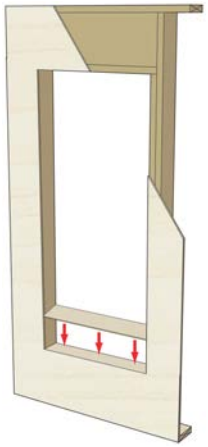
Building Science Corporation
Joseph Lstiburek 171



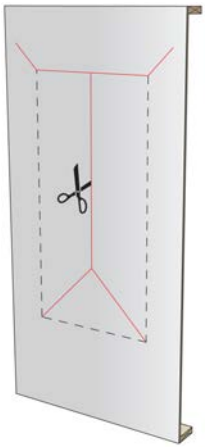
Building Science Corporation
Joseph Lstiburek 172



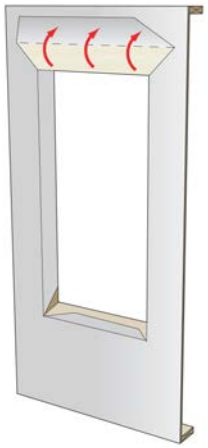

Building Science Corporation Joseph Lstiburek 173



Building Science Corporation Joseph Lstiburek 174



Building Science Corporation Joseph Lstiburek 175



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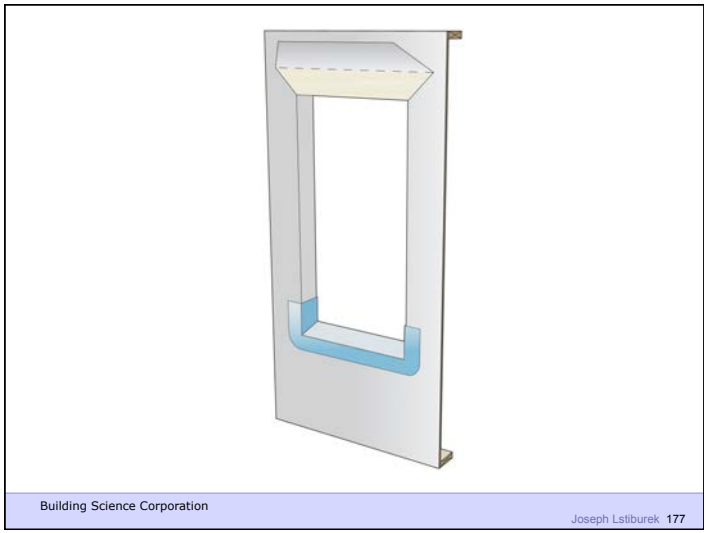
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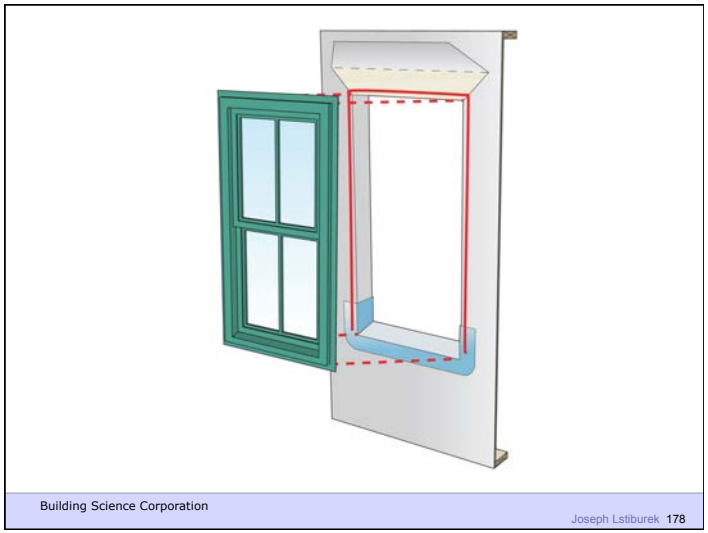
Joseph Lstiburek 177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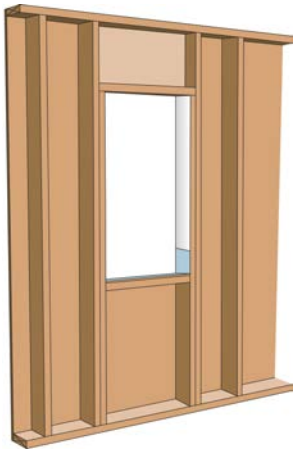
Joseph Lstiburek 178

Building Science Corporation
Joseph Lstiburek 179

Building Science Corporation
Joseph Lstiburek 180

Building Science Corporation Joseph Lstiburek 181

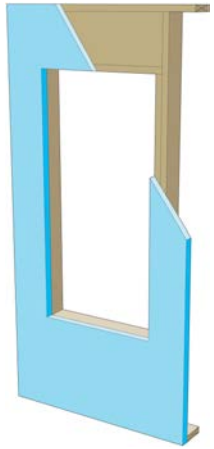


Building Science Corporation Joseph Lstiburek 182

Building Science Corporation Joseph Lstiburek 183

Building Science Corporation Joseph Lstiburek 184

Building Science Corporation Joseph Lstiburek 185



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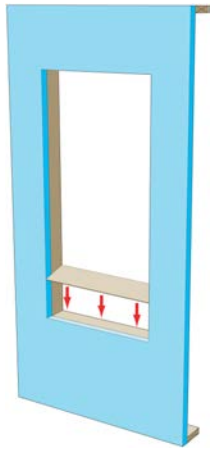

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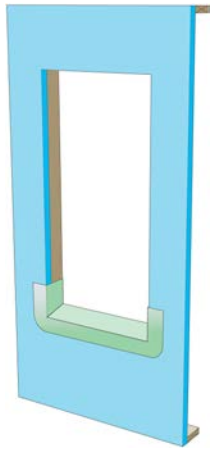

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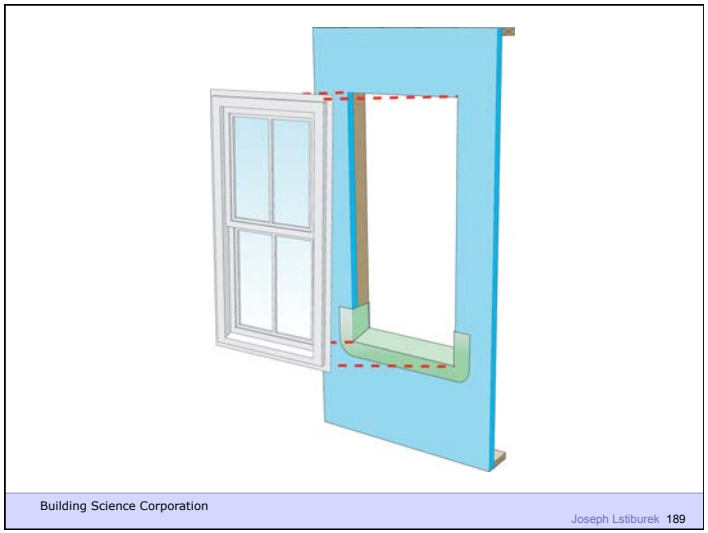
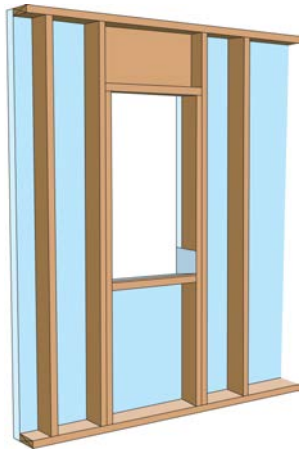

Building Science Corporation
Joseph Lstiburek 189

Building Science Corporation
Joseph Lstiburek 190

Building Science Corporation
Joseph Lstiburek 191

Building Science Corporation
Joseph Lstiburek 192



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Joseph Lstiburek 193

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Joseph Lstiburek 194

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Joseph Lstiburek 195

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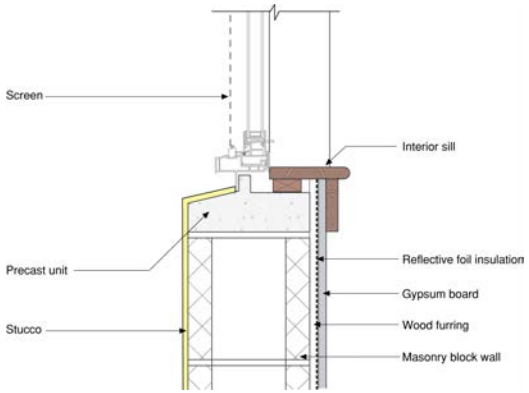
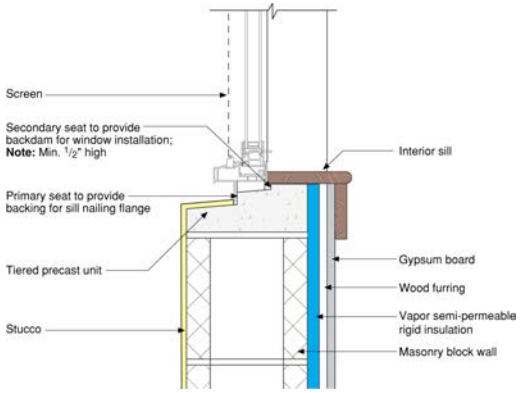
Joseph Lstiburek 196




Building Science Corporation Joseph Lstiburek 197

Building Science Corporation Joseph Lstiburek 198

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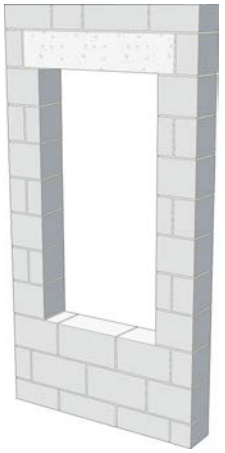

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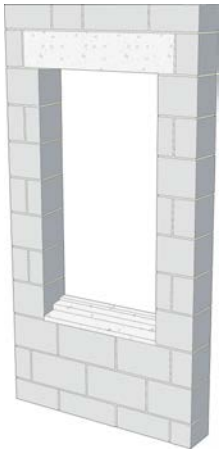

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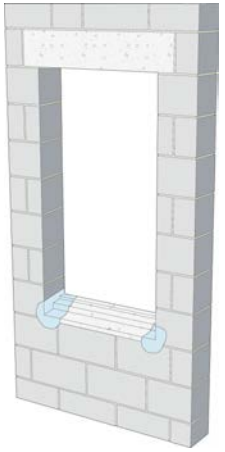

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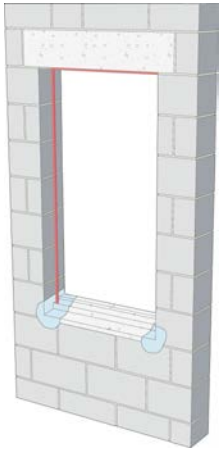

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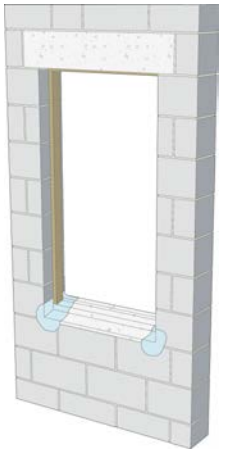
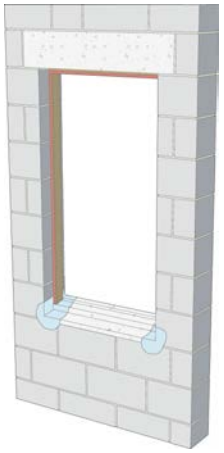


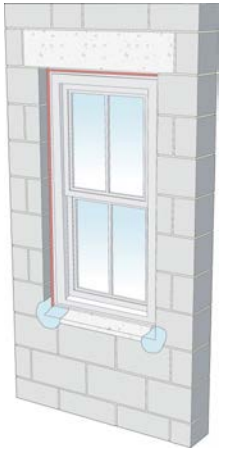
Building Science Corporation

Joseph Lstiburek 205



Building Science Corporation

Joseph Lstiburek 206



Building Science Corporation

Joseph Lstiburek 207

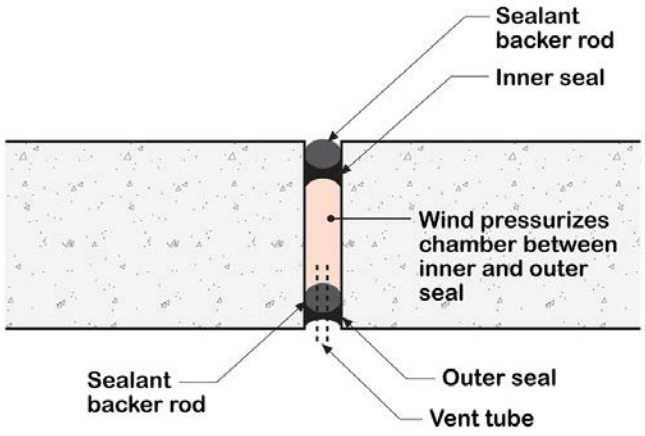
Building Science Corporation

Joseph Lstiburek 208

Building Science Corporation Joseph Lstiburek 209

Building Science Corporation Joseph Lstiburek 210

Building Science Corporation Joseph Lstiburek 211

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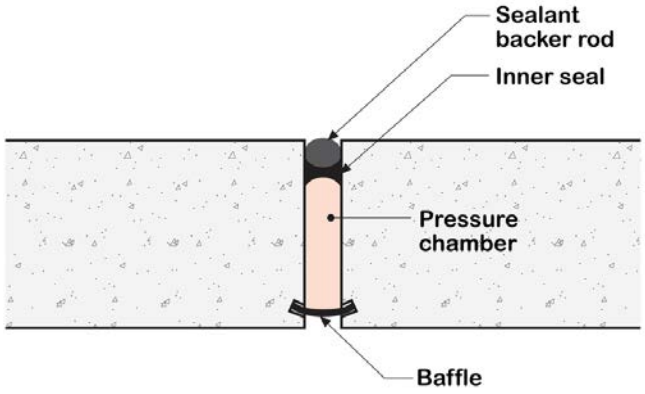


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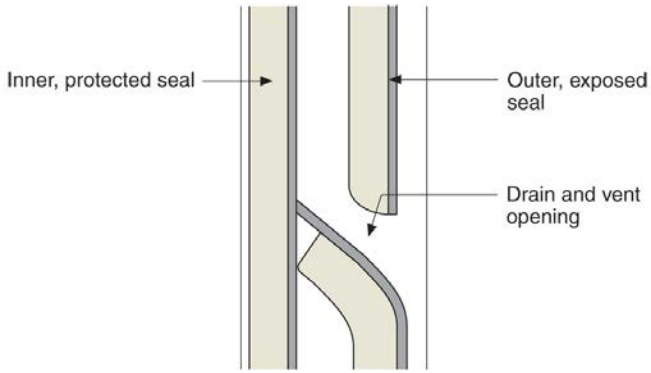


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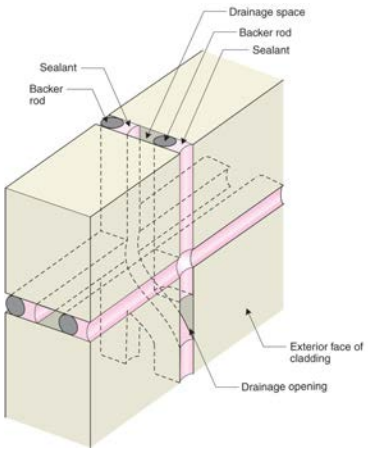
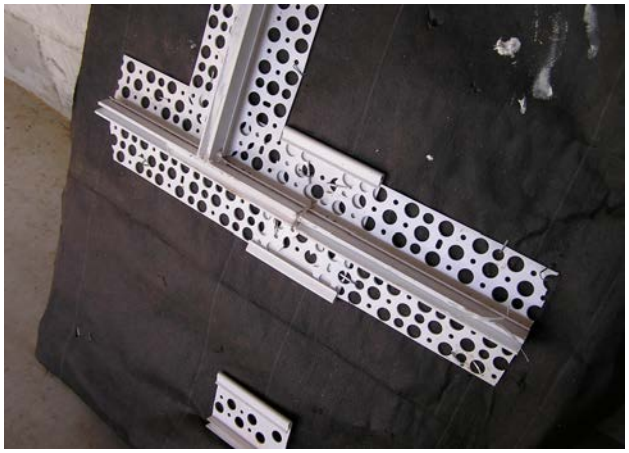



Building Science Corporation Joseph Lstiburek 215

Building Science Corporation Joseph Lstiburek 216



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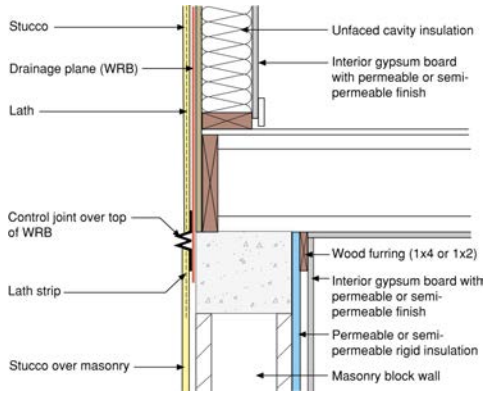
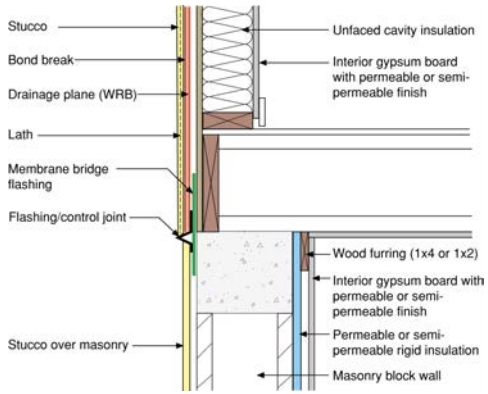
Building Science Corporation Joseph Lstiburek 218

Building Science Corporation Joseph Lstiburek 219




Building Science Corporation Joseph Lstiburek 220

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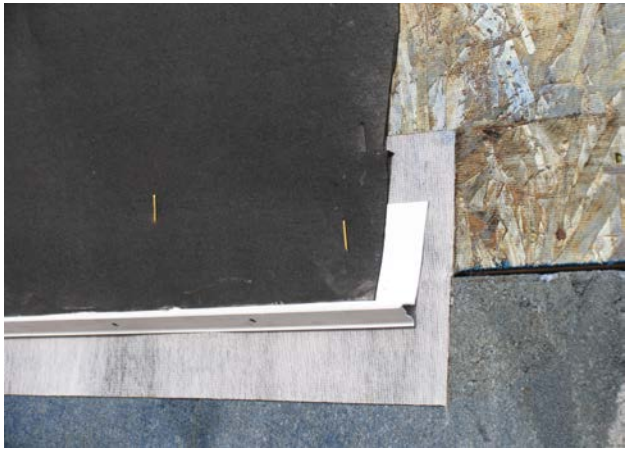
Building Science Corporation Joseph Lstiburek 223



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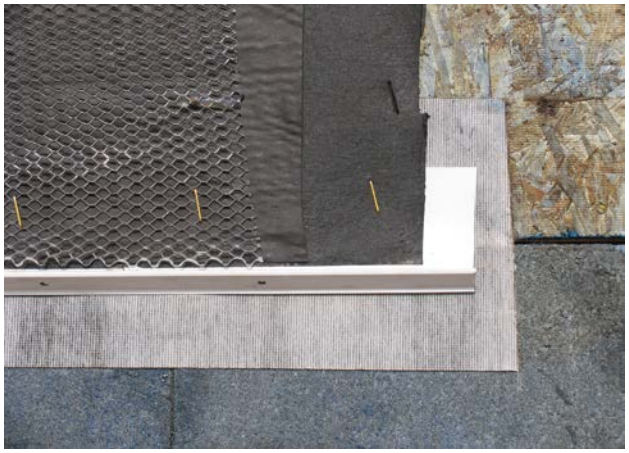

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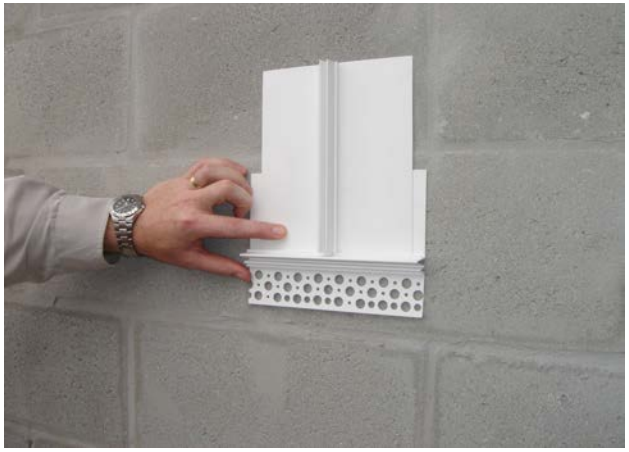
Building Science Corporation Joseph Lstiburek 226



Building Science Corporation Joseph Lstiburek 227

Building Science Corporation Joseph Lstiburek 228

Building Science Corporation Joseph Lstiburek 229

Building Science Corporation Joseph Lstiburek 230

Building Science Corporation Joseph Lstiburek 231

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Building Science Corporation Joseph Lstiburek 233

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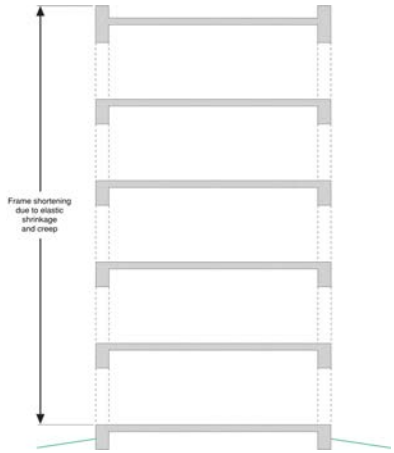
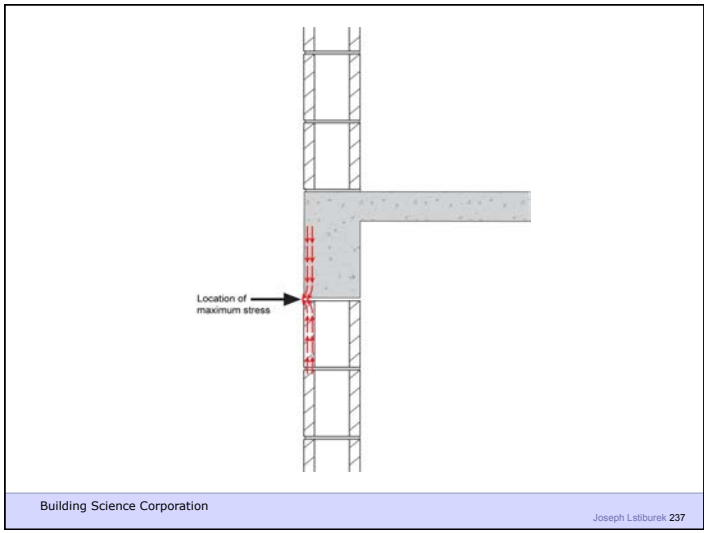
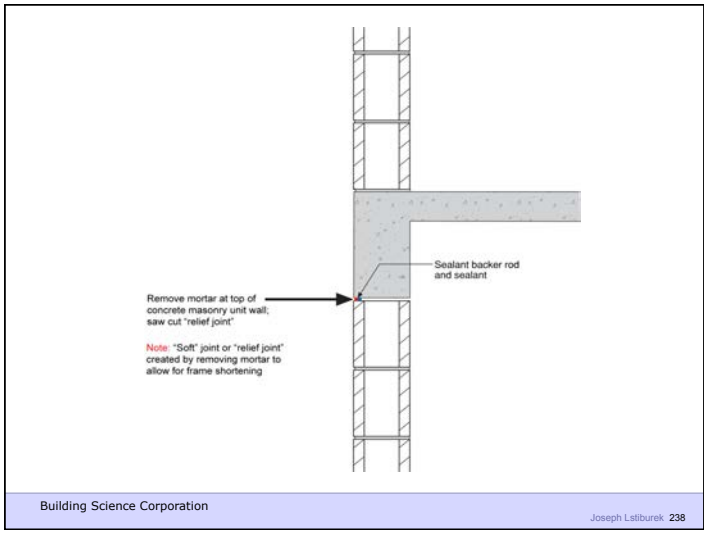
Building Science Corporation Joseph Lstiburek 235



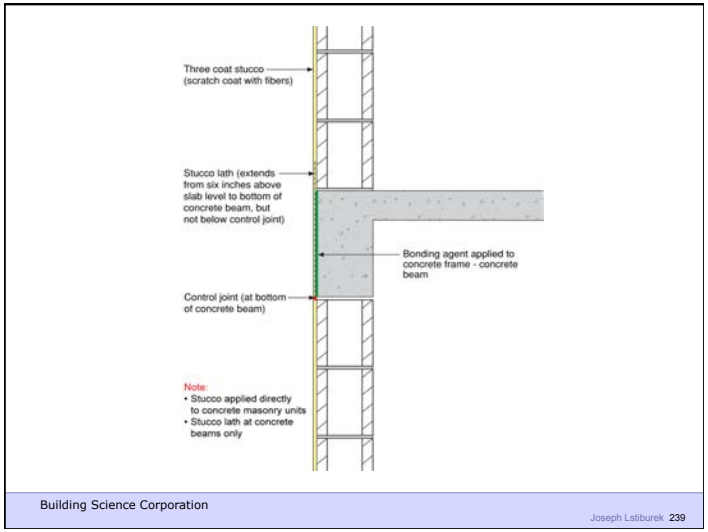

Building Science Corporation Joseph Lstiburek 236



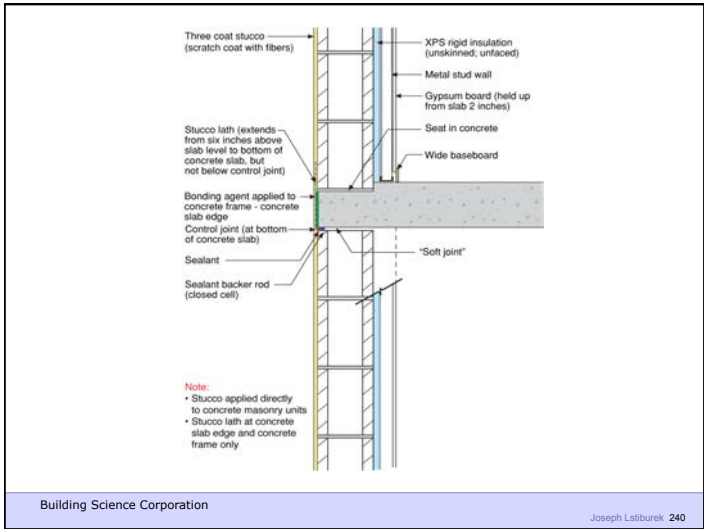

Building Science Corporation Joseph Lstiburek 237




Building Science Corporation Joseph Lstiburek 238




Building Science Corporation Joseph Lstiburek 239

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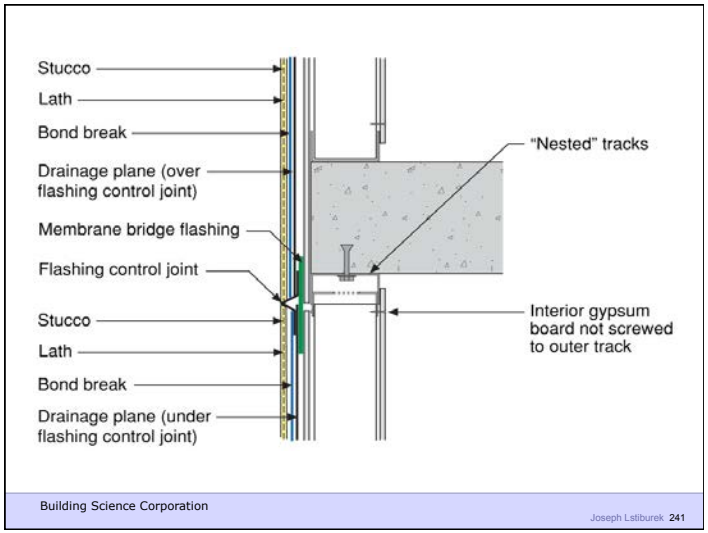
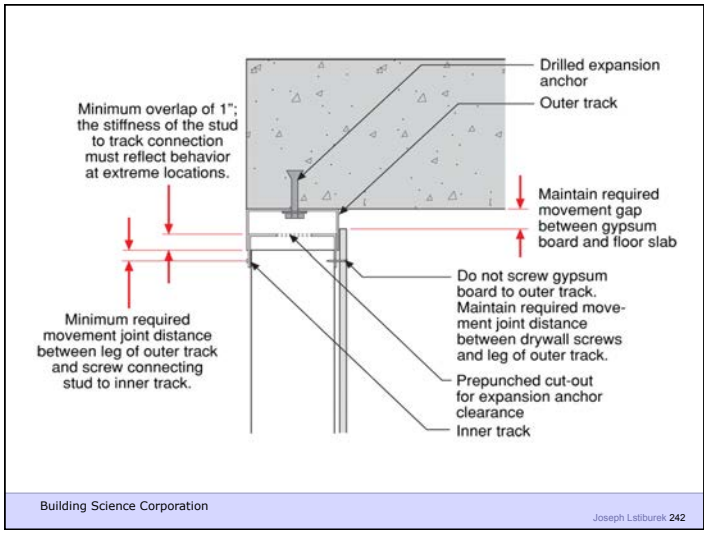

Stucco
Lath
Bond break
Drainage plane (over flashing control joint)
Membrane bridge flashing
Flashing control joint
Stucco
Lath
Bond break
Drainage plane (under flashing control joint)
"Nested" tracks
Interior gypsum board not screwed to outer track
Building Science Corporation
Joseph Lstiburek 241


Minimum overlap of 1"; the stiffness of the stud to track connection must reflect behavior at extreme locations.
Minimum required movement joint distance between leg of outer track and screw connecting stud to inner track.
Drilled expansion anchor
Outer track
Maintain required movement gap between gypsum board and floor slab
Do not screw gypsum board to outer track. Maintain required movement joint distance between drywall screws and leg of outer track.
Prepunched cut-out for expansion anchor clearance
Inner track
Building Science Corporation
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