

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

Building Science

Adventures In Building Science

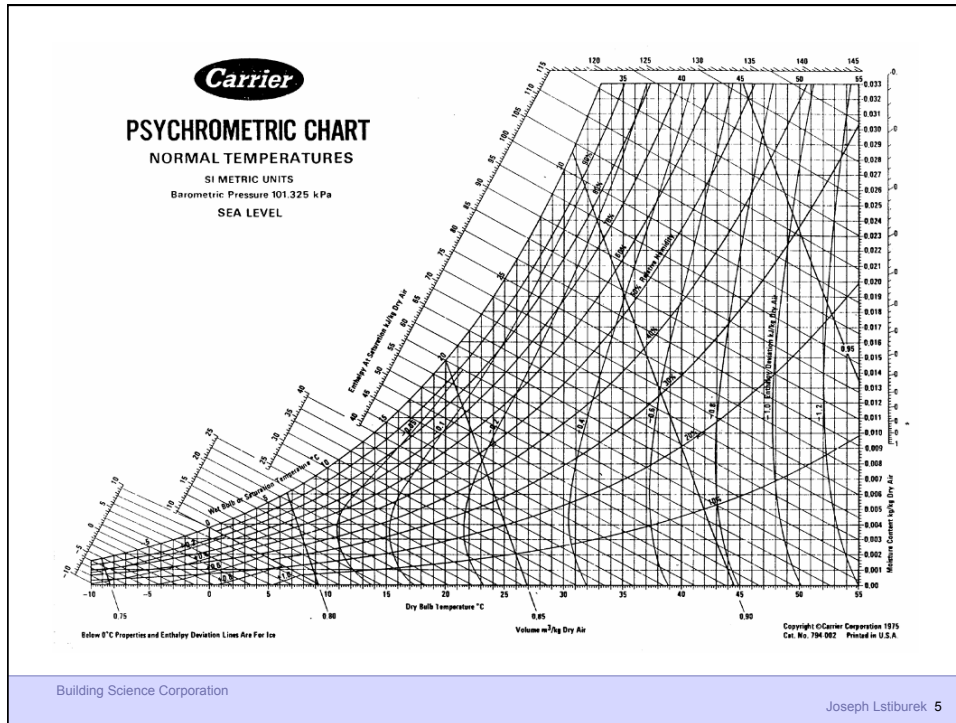
www.buildingscience.com

2nd 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



Damage Functions

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Joseph Lstiburek 6

The figure is a slide titled 'Damage Functions'. It contains the text 'Building Science Corporation' at the bottom left and 'Joseph Lstiburek 6' at the bottom right.

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

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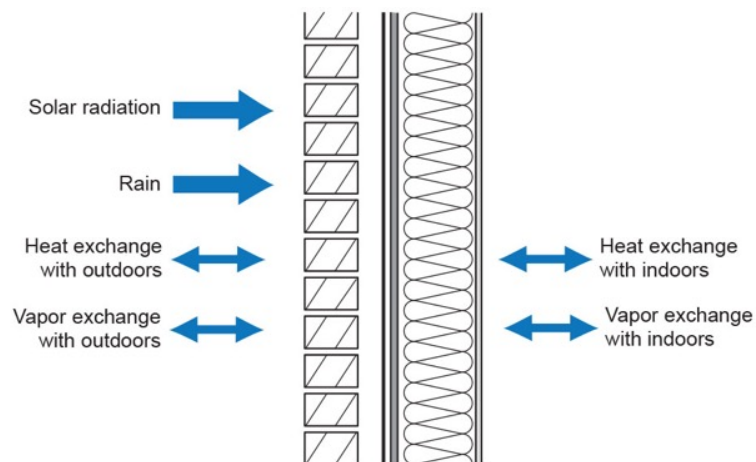
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What is a Building?

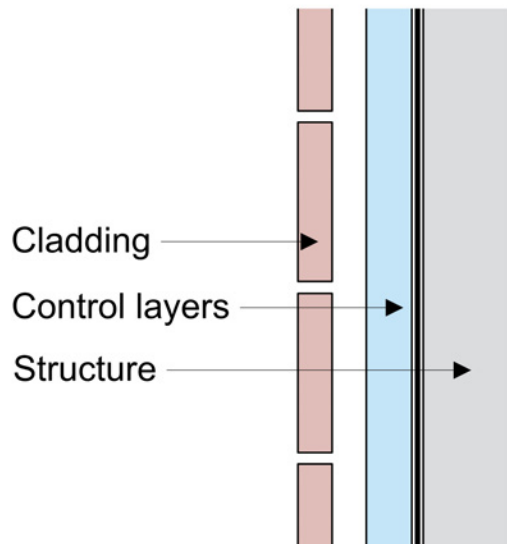
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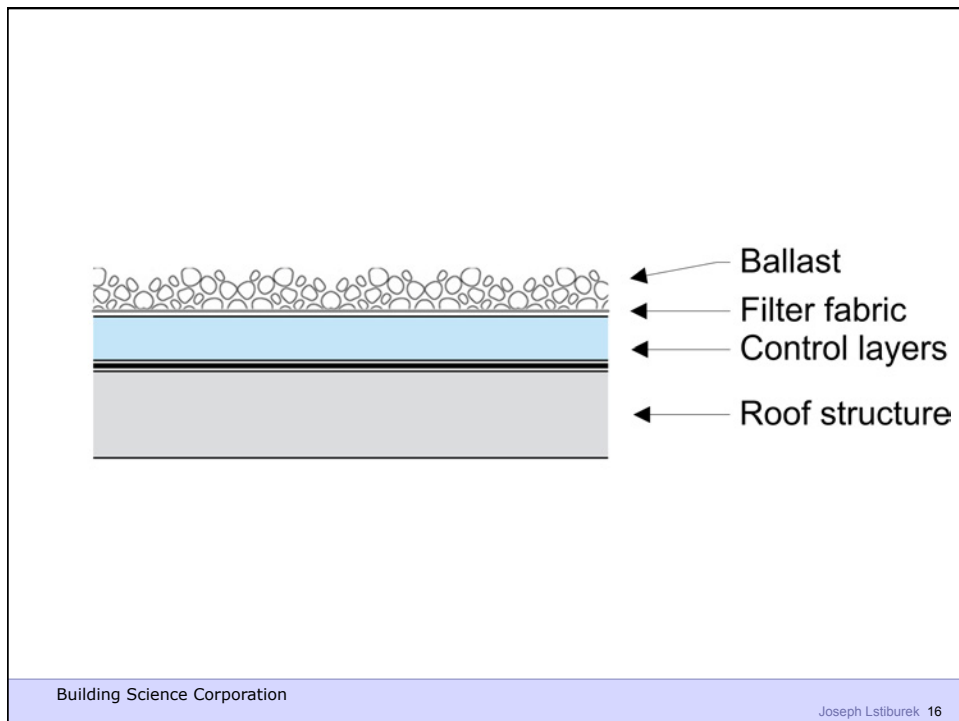
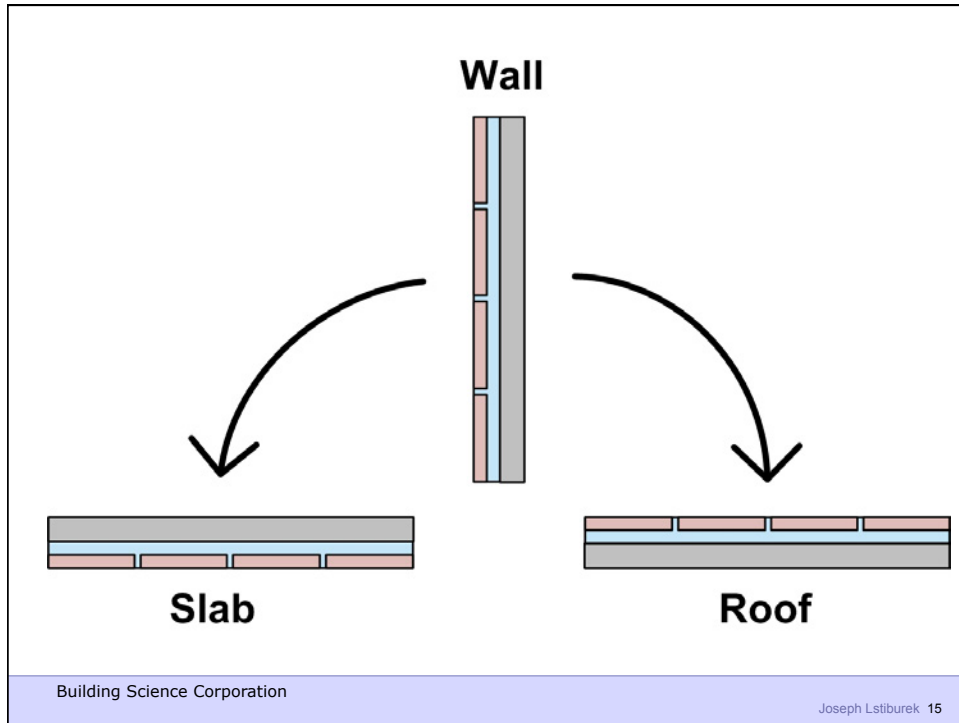
Joseph Lstiburek 10

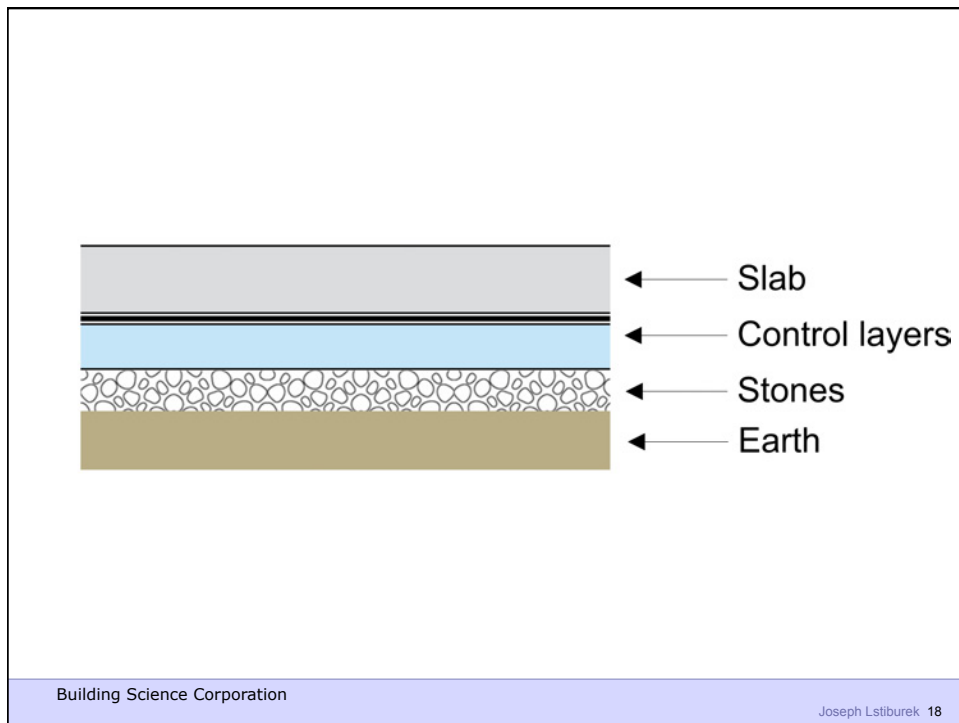
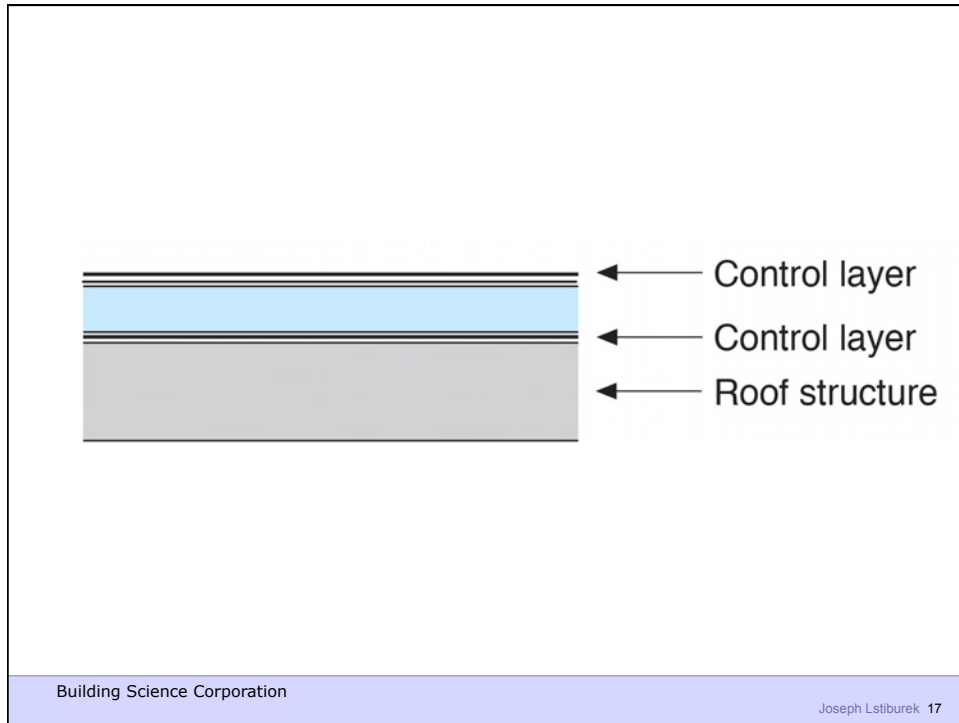
- Control heat flow
- Control airflow
- Control water vapor flow
- Control rain
- Control ground water
- Control light and solar radiation
- Control noise and vibrations
- Control contaminants, environmental hazards and odors
- Control insects, rodents and vermin
- Control fire
- Provide strength and rigidity
- Be durable
- Be aesthetically pleasing
- Be economical

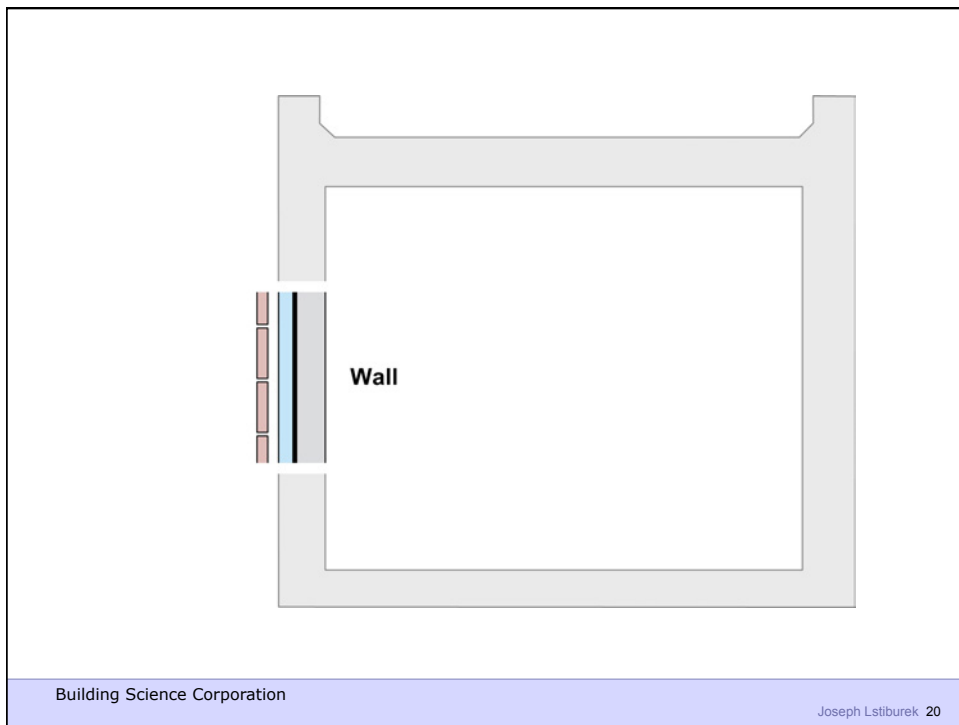
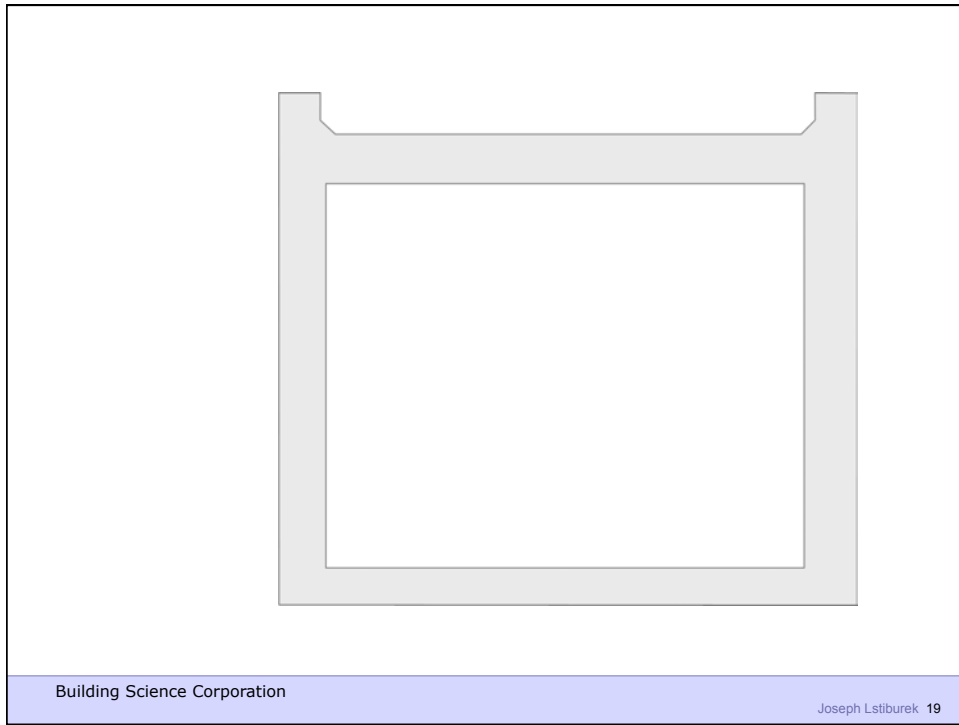


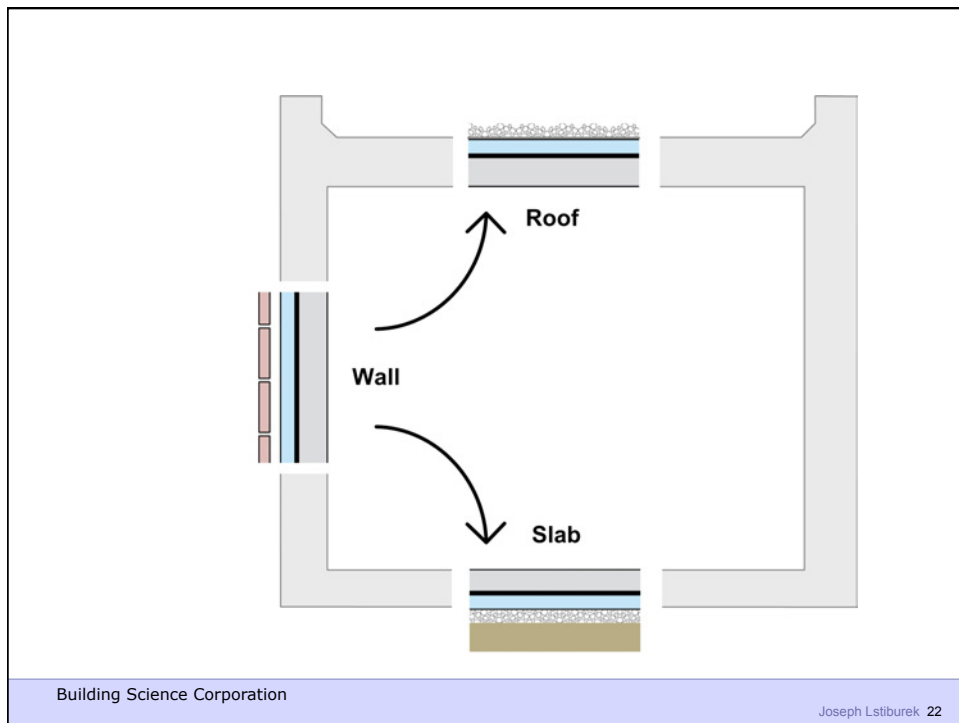
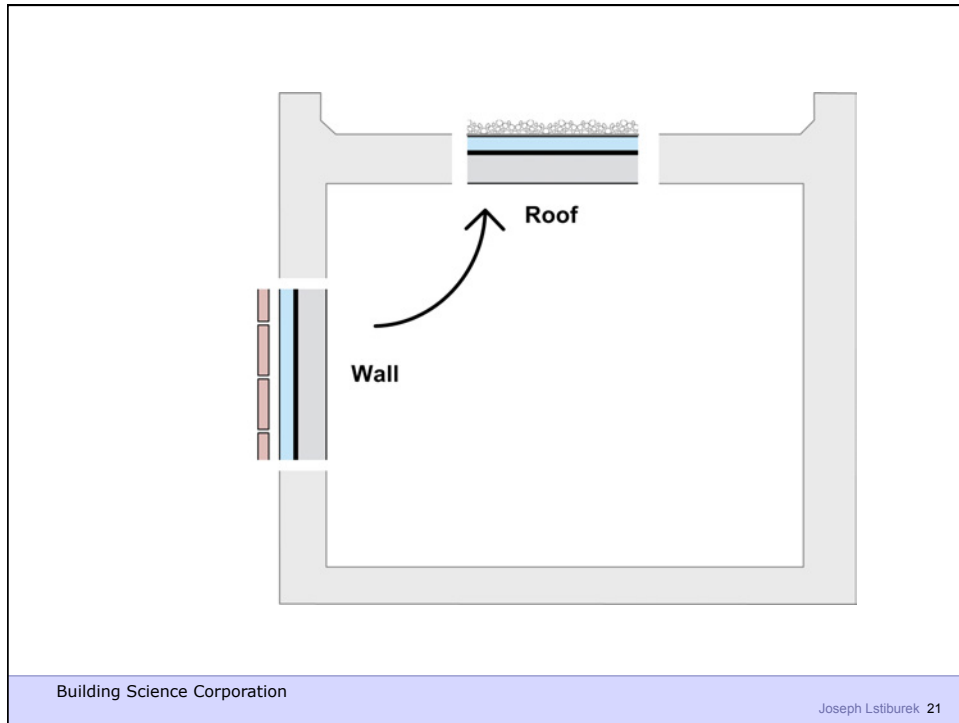
Water Control Layer
Air Control Layer
Vapor Control Layer
Thermal Control Layer

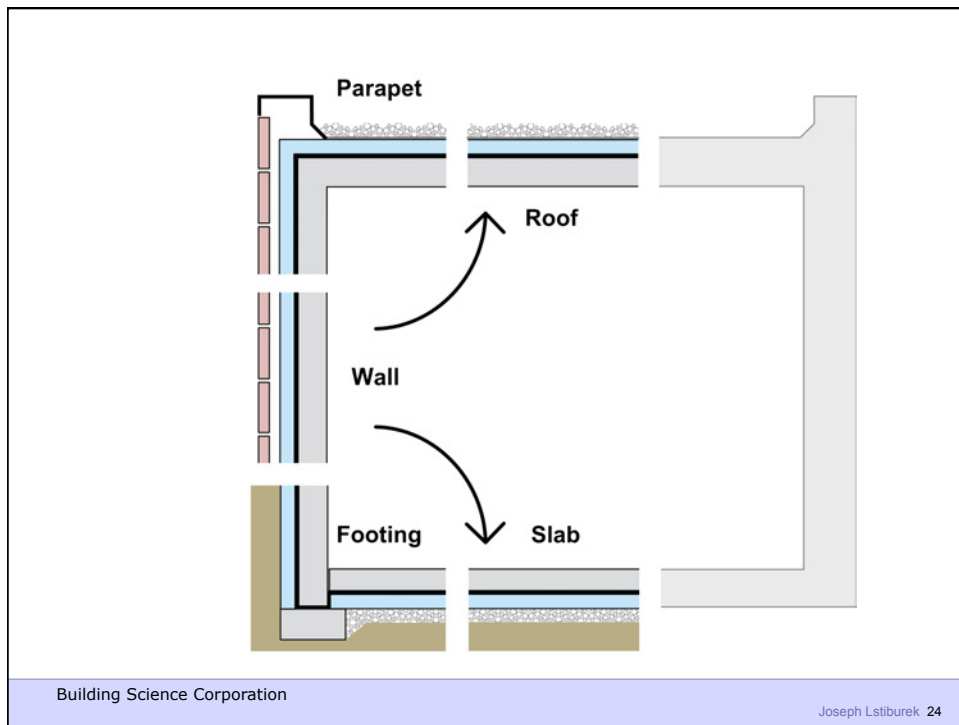
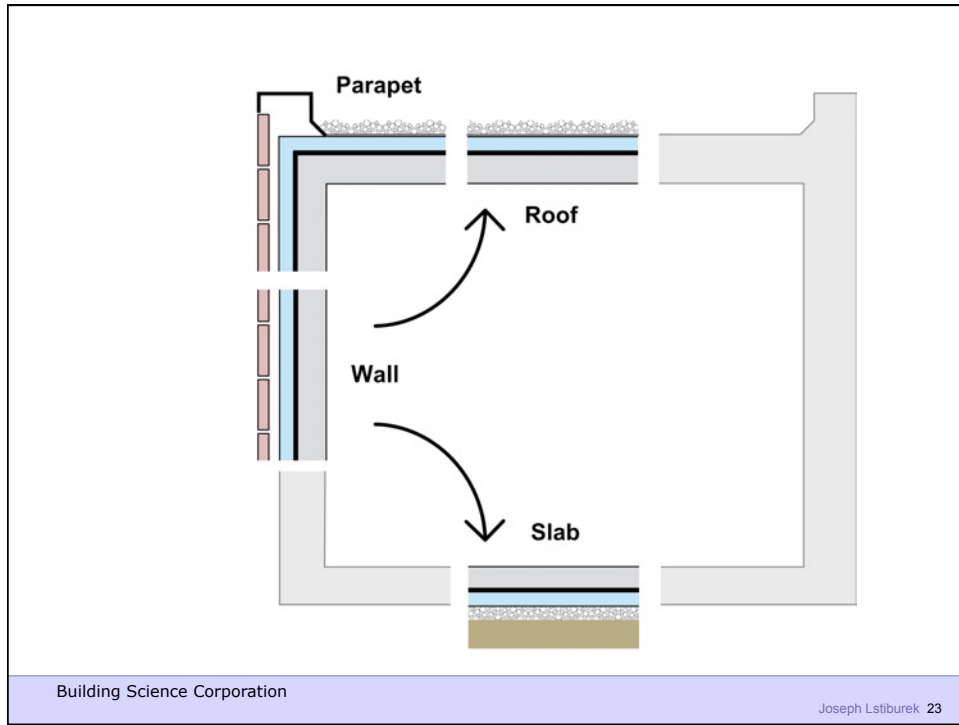


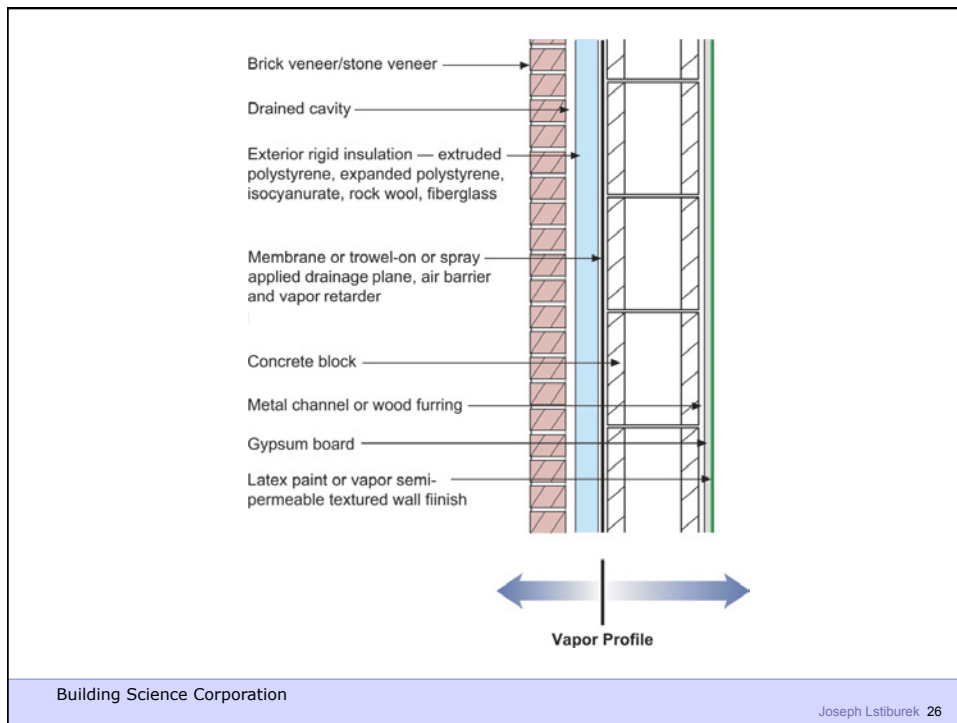
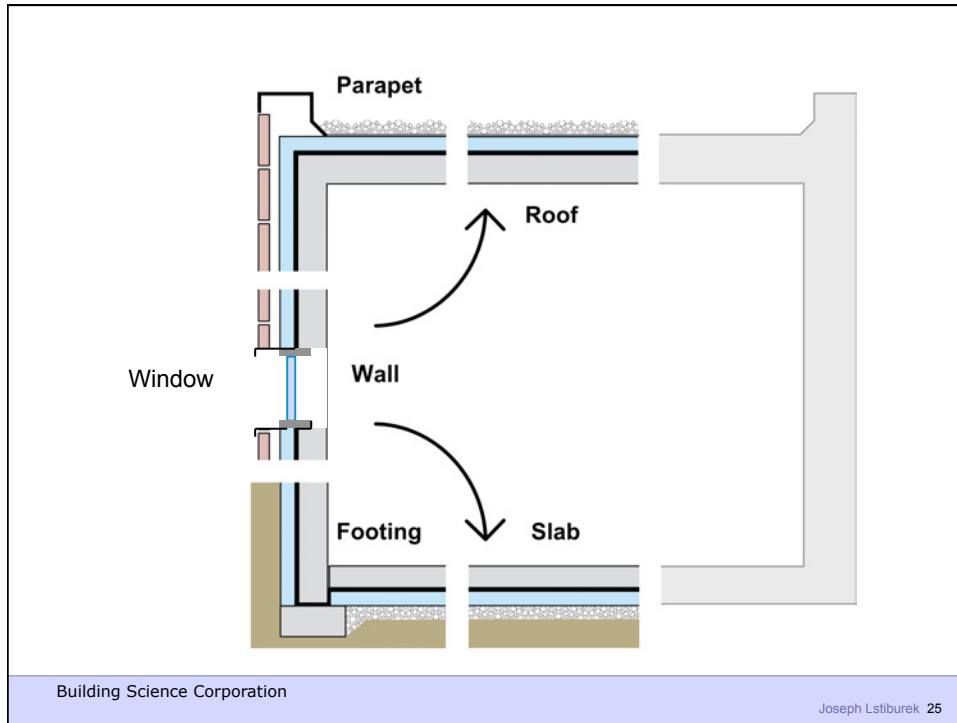


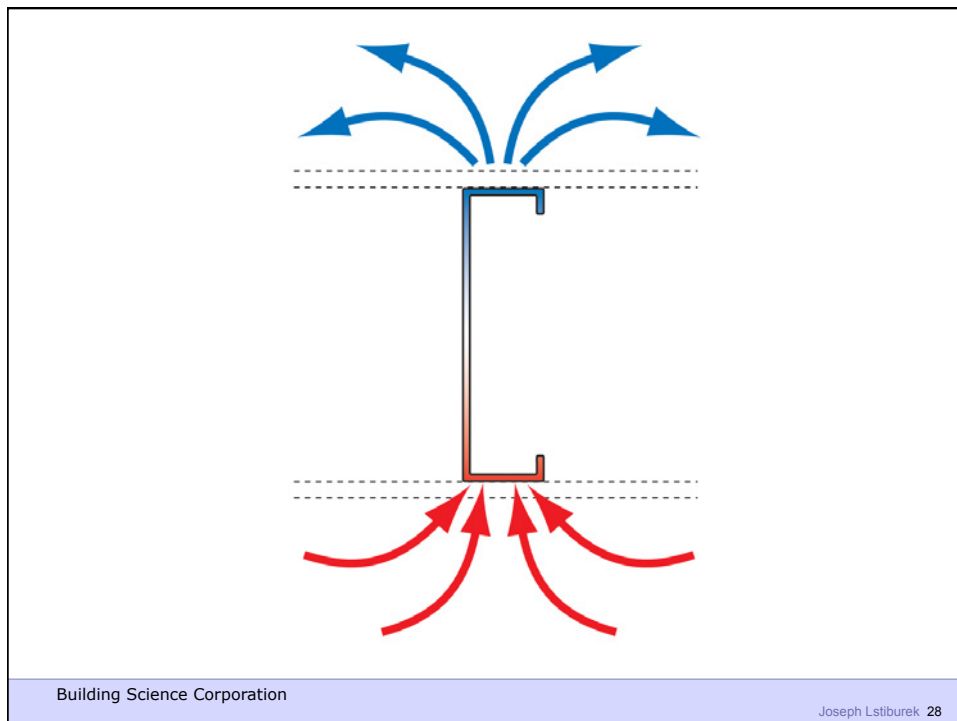
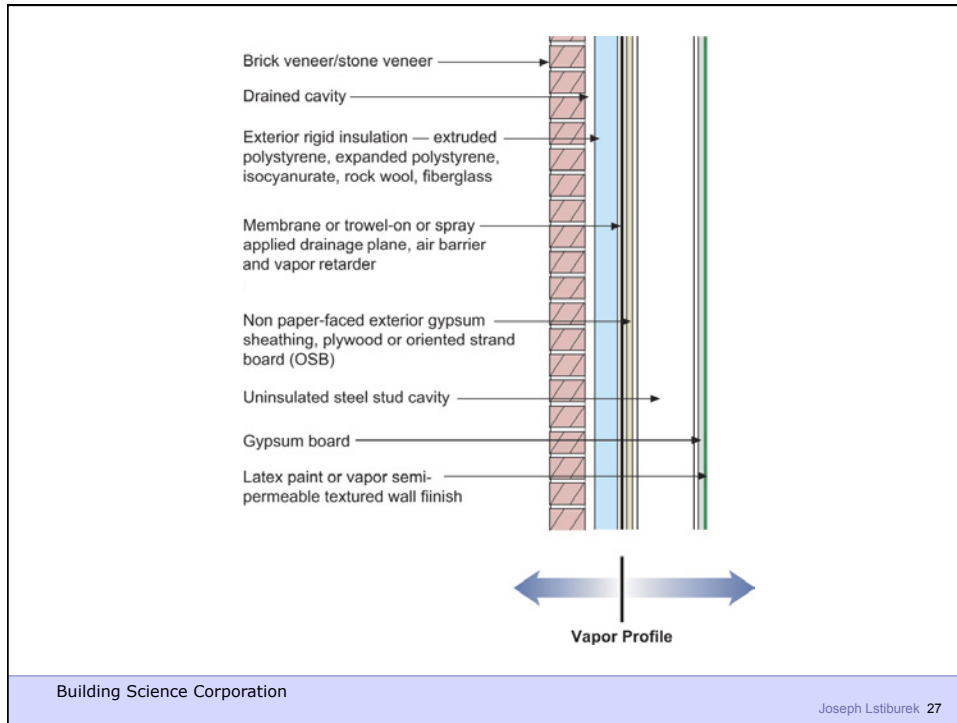


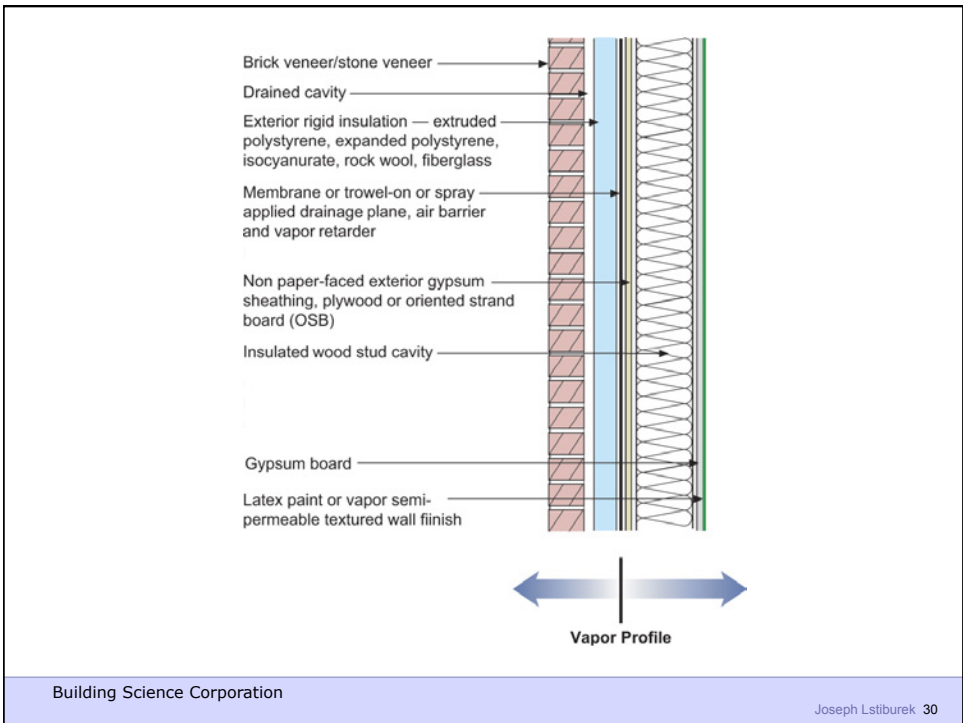


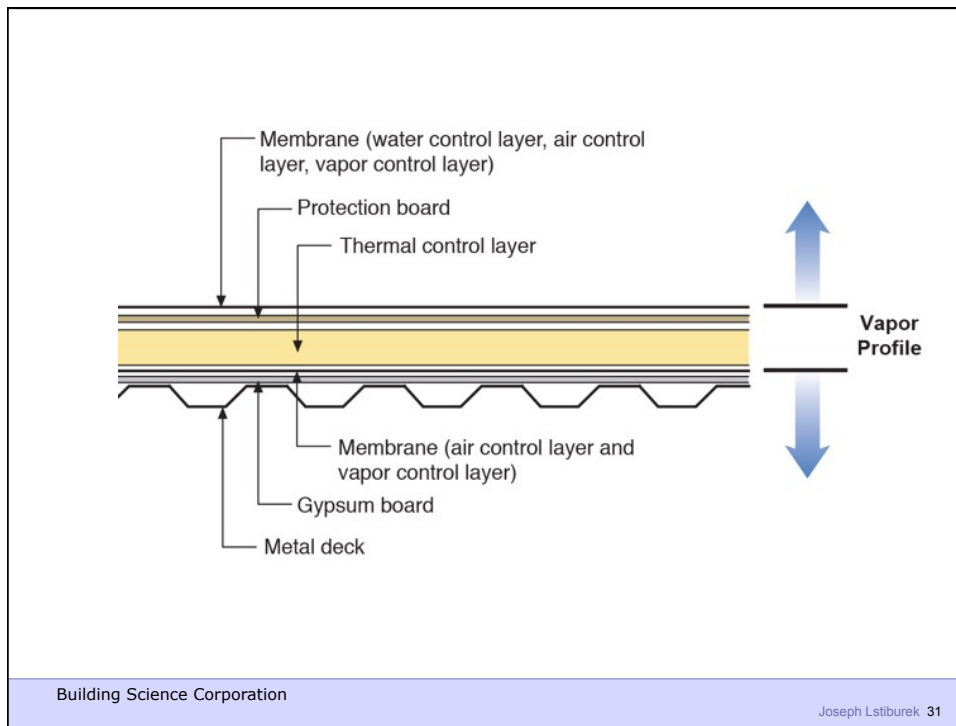




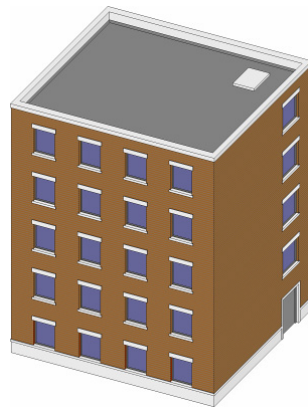




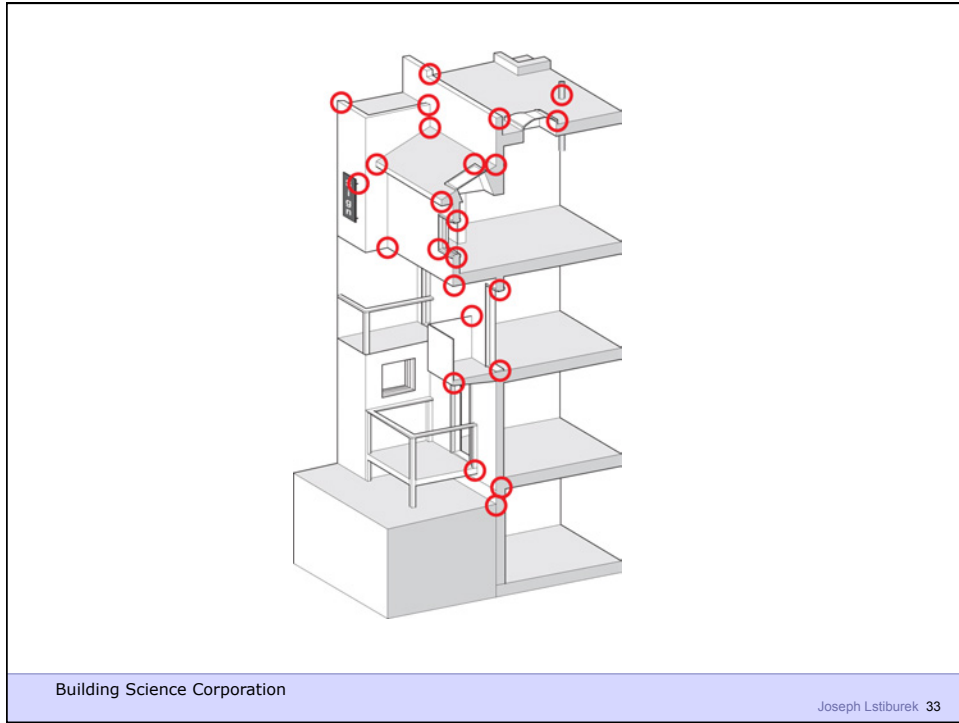




Commercial Enclosure: Simple Layers



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



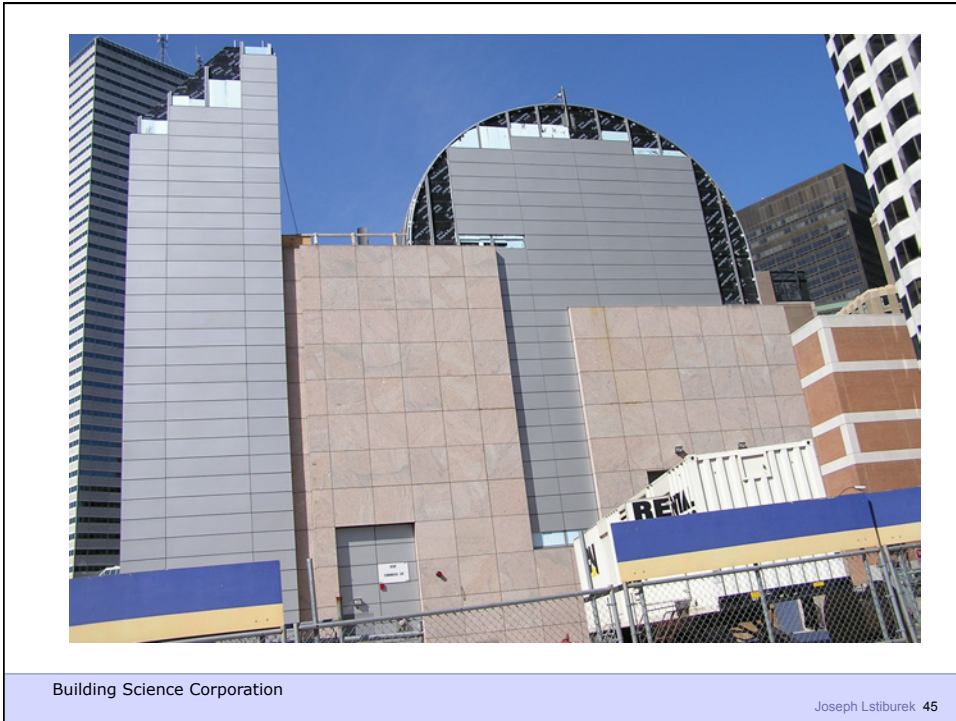


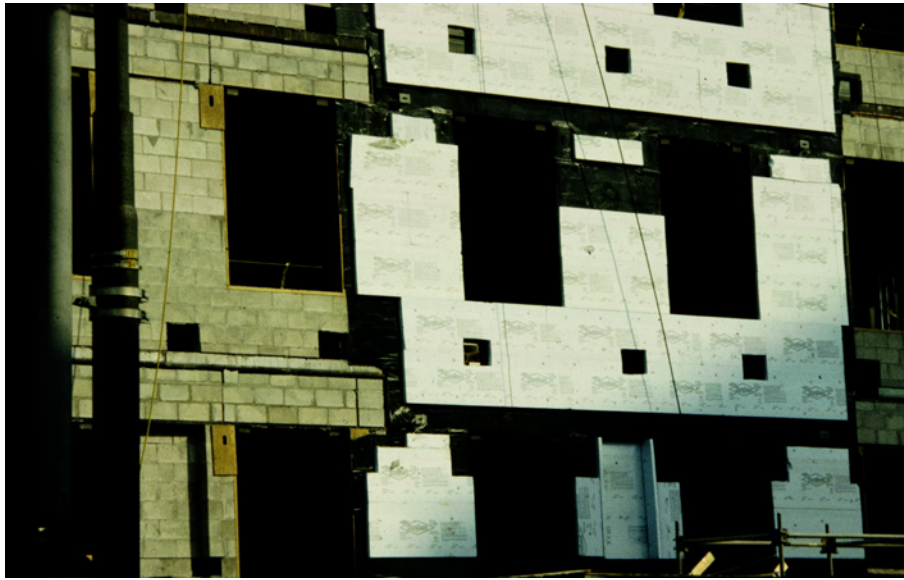












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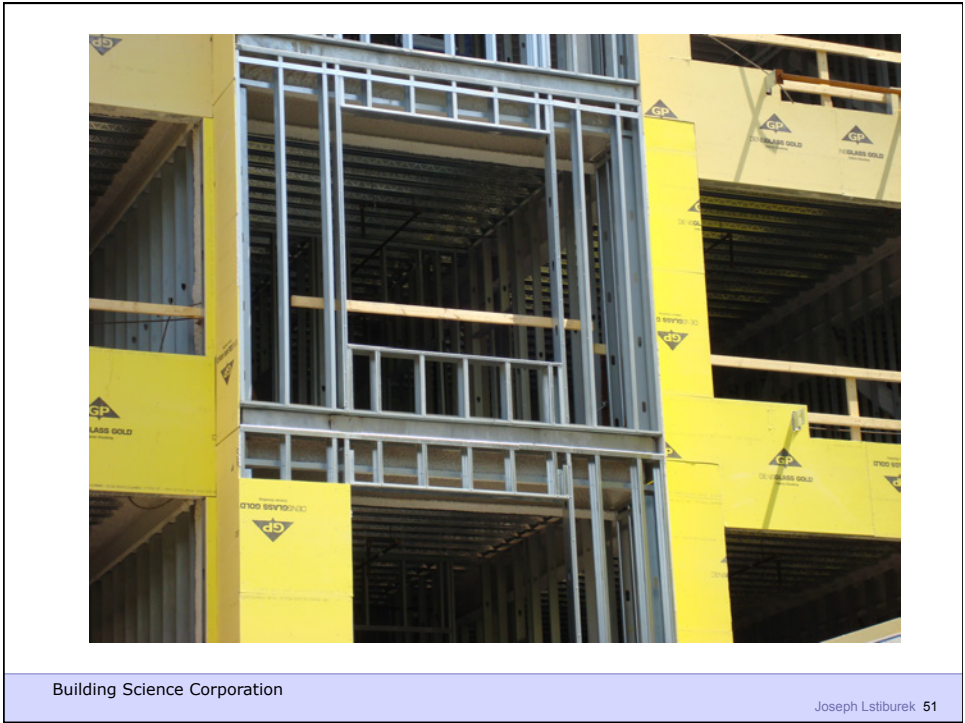
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Joseph Lstiburek 48









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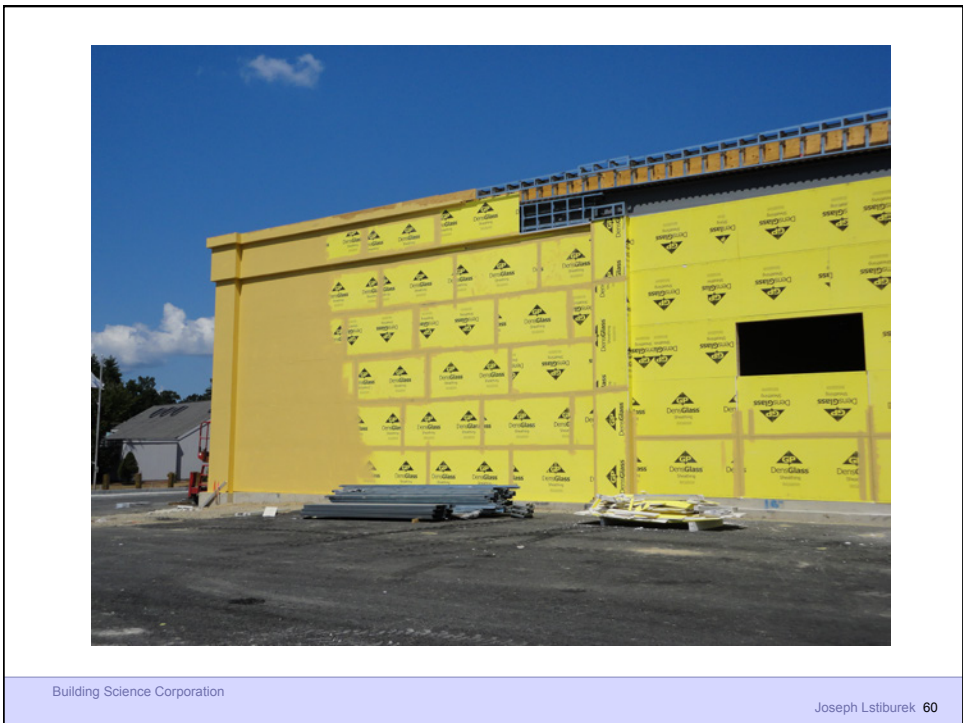
Joseph Lstiburek 55



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Joseph Lstiburek 56







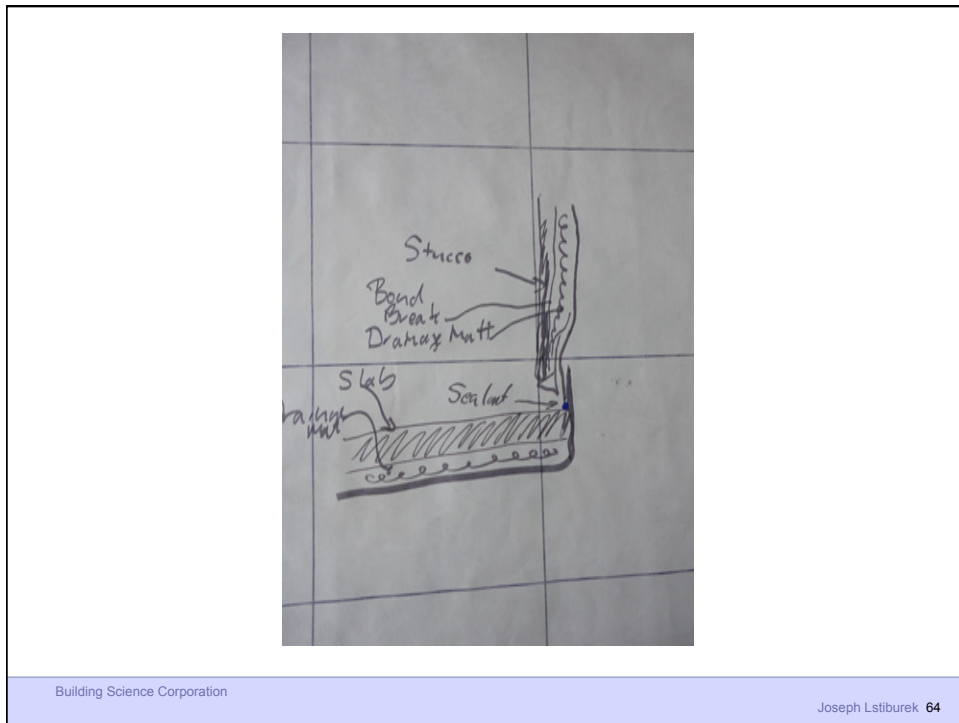
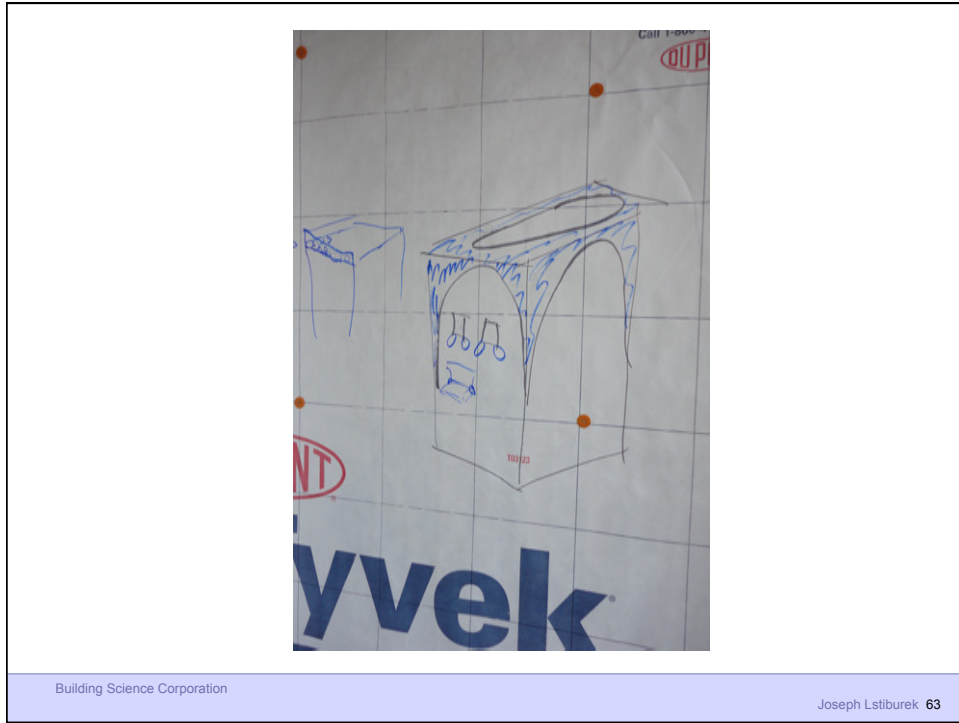
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Joseph Lstiburek 68



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Joseph Lstiburek – HVAC 69



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Joseph Lstiburek 70



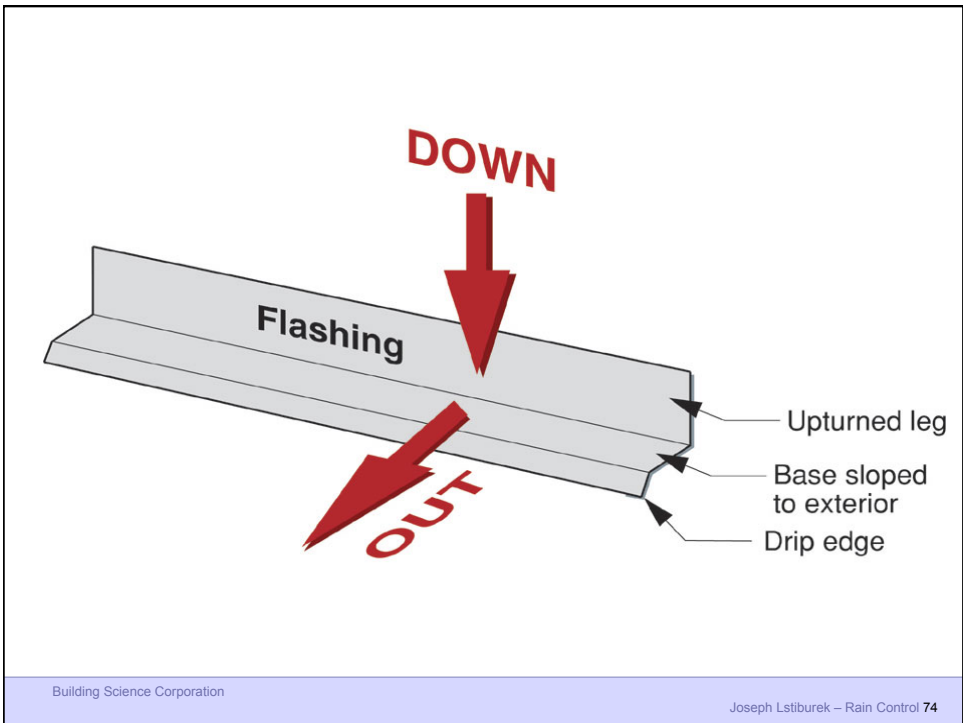
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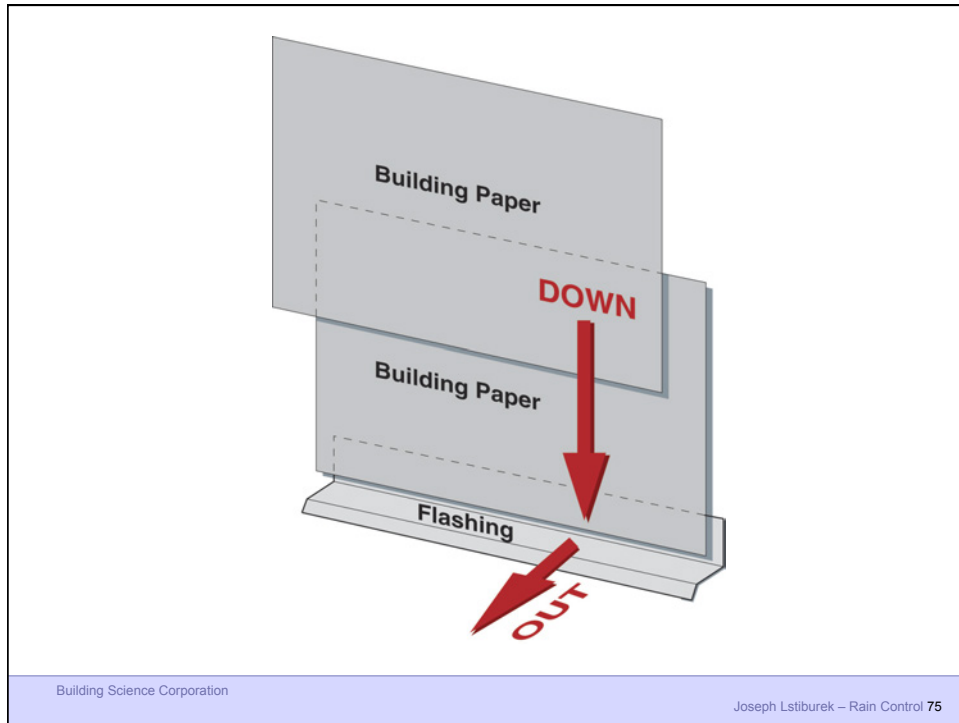
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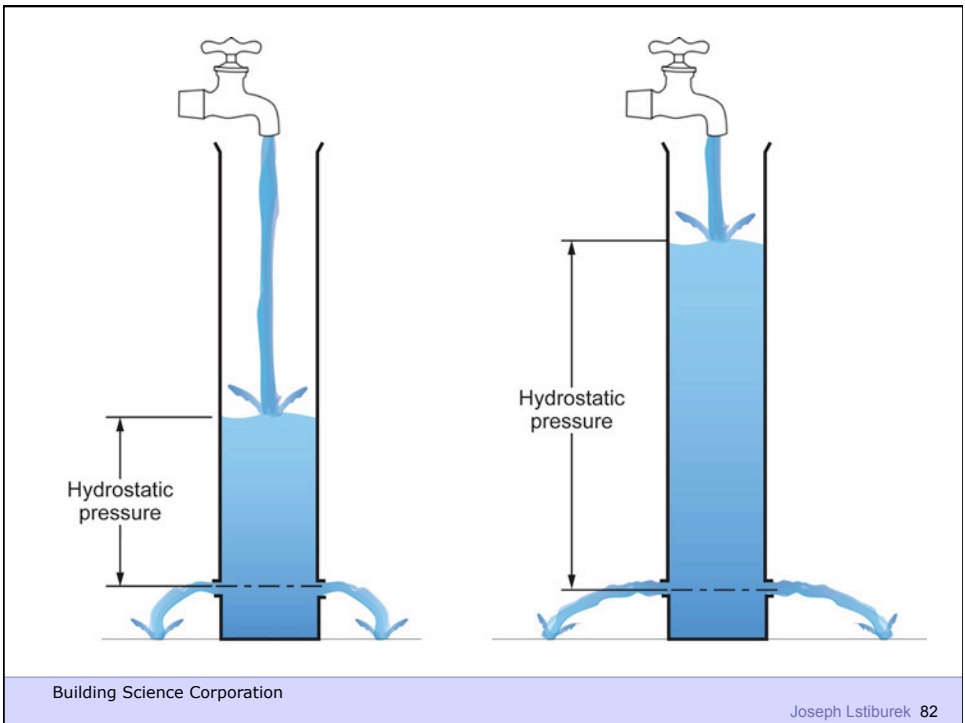
Joseph Lstiburek – HVAC 72







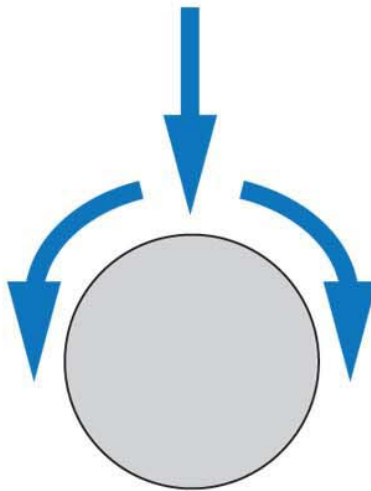






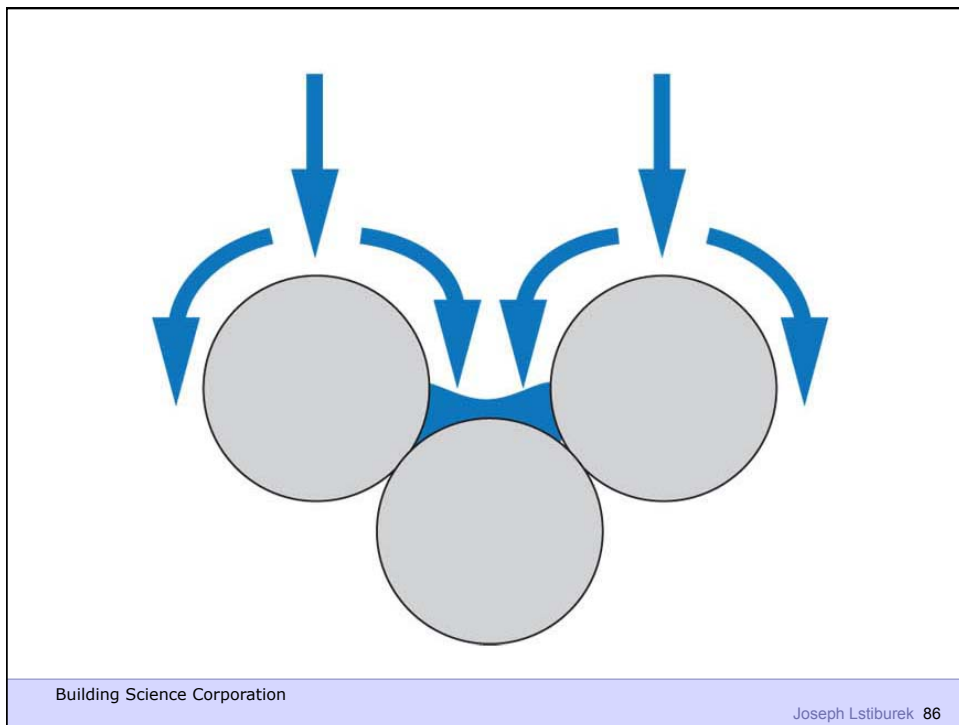
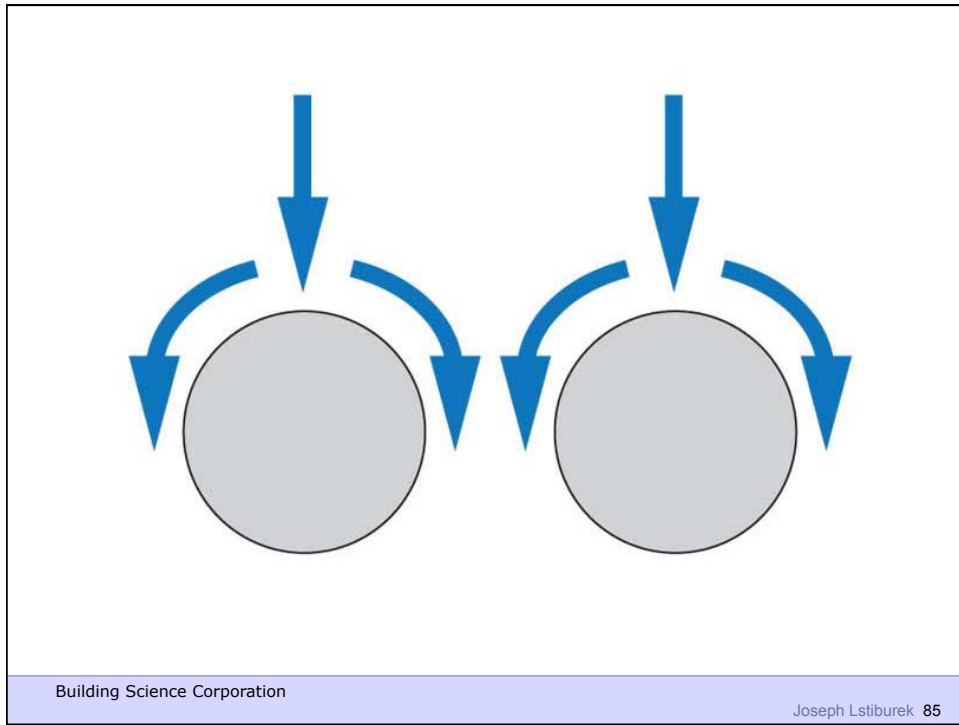
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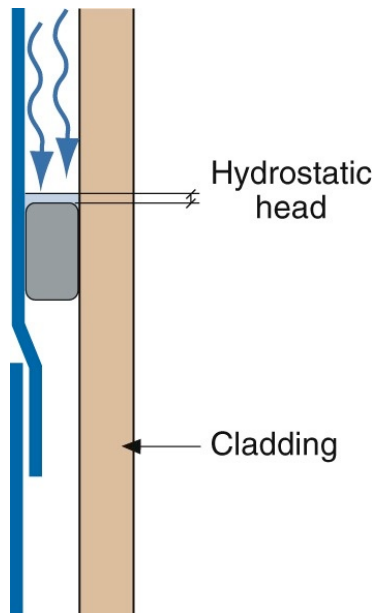
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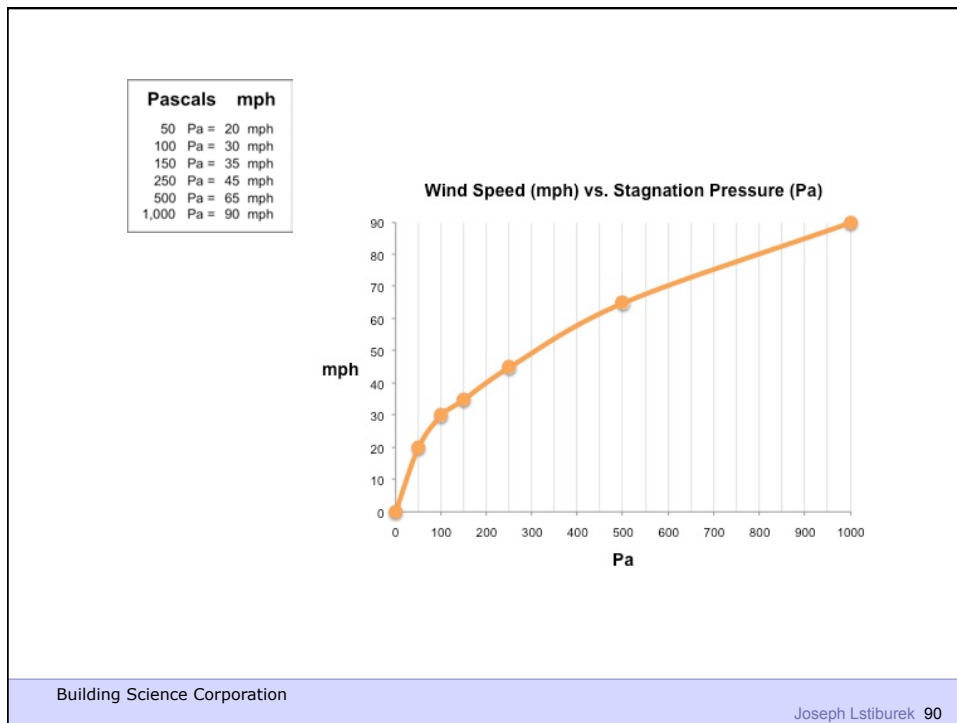
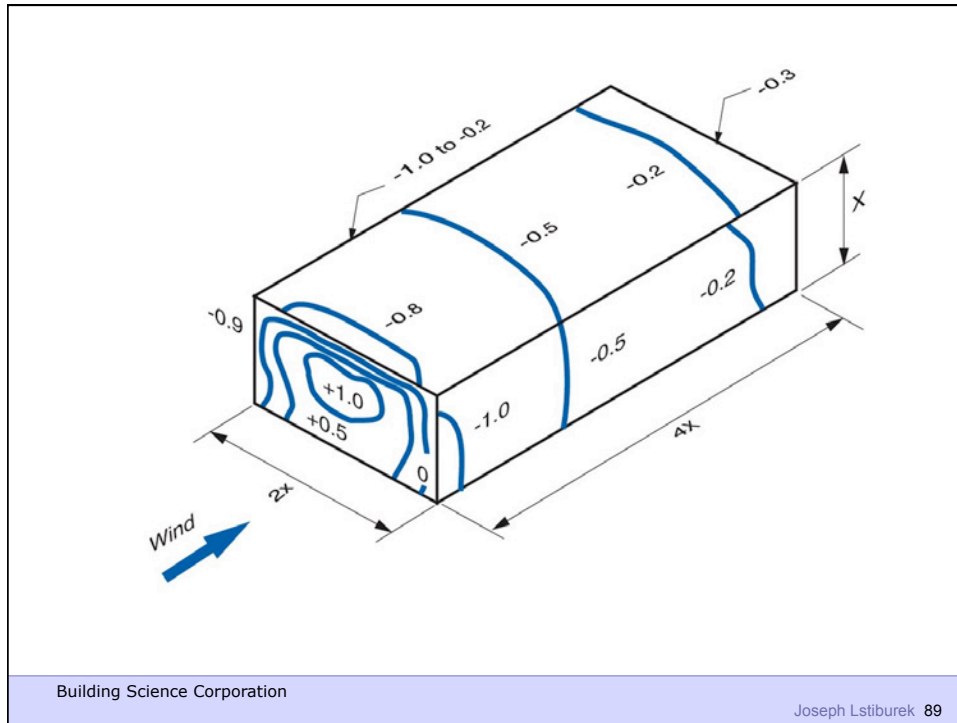
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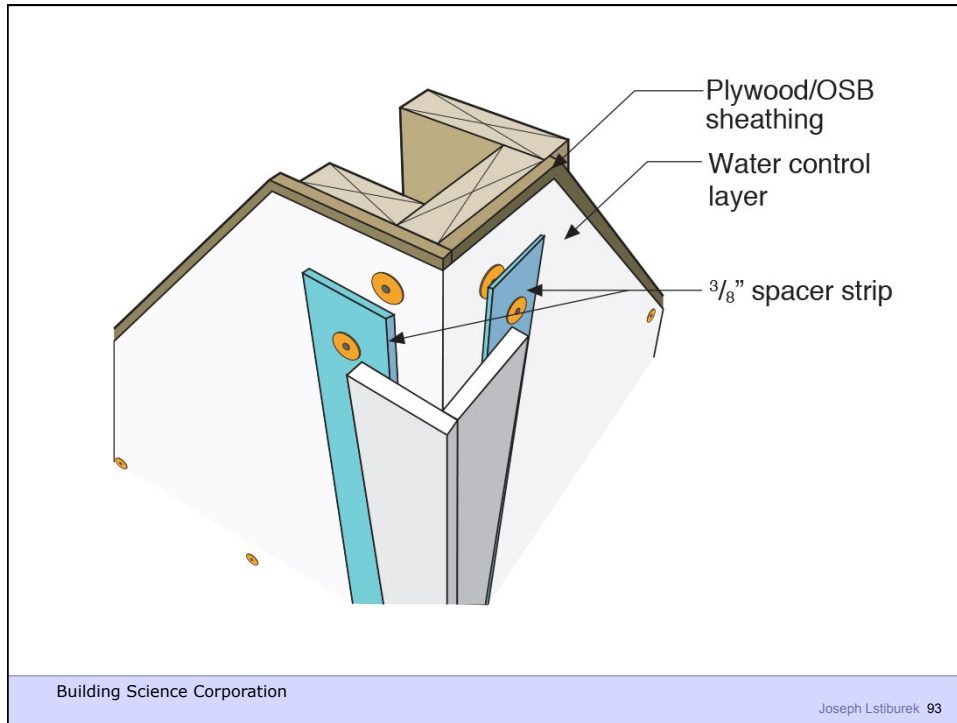
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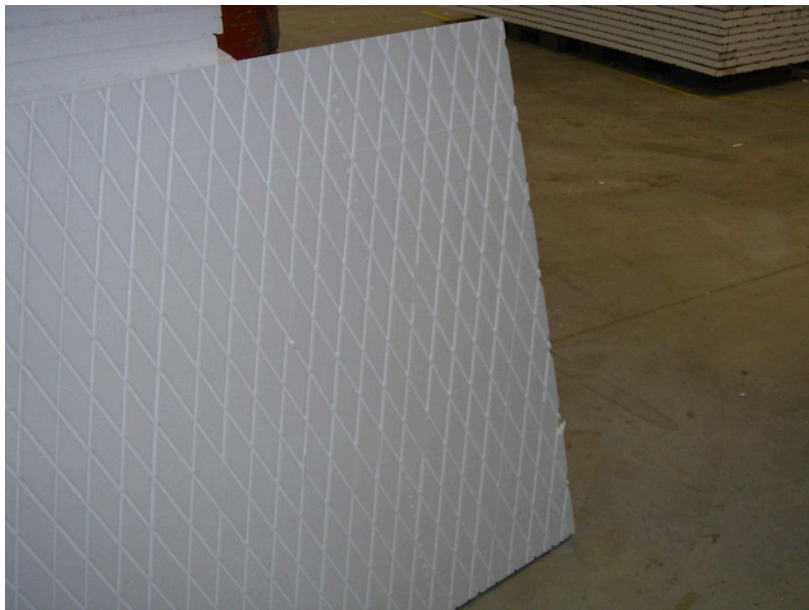
Joseph Lstiburek – Rain Control 92





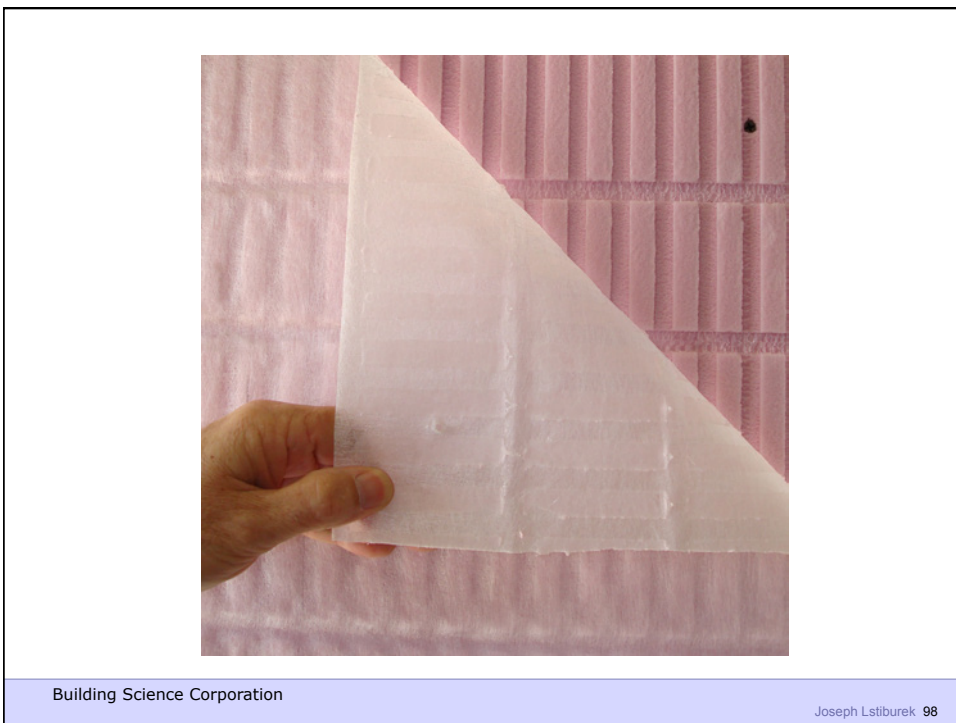
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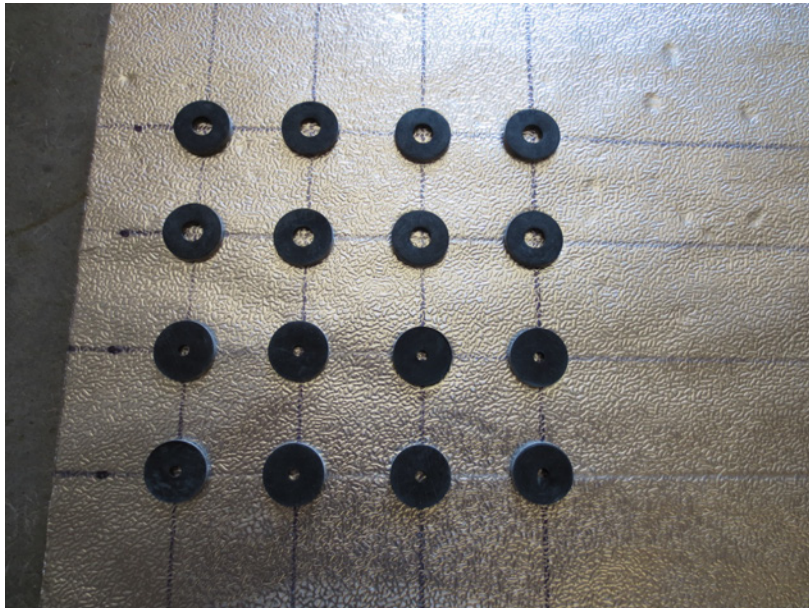




Rain Screen

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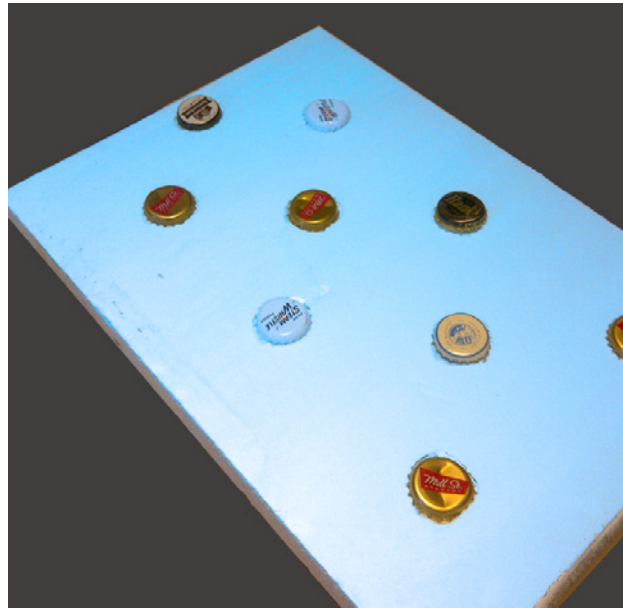
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Beer Screen?

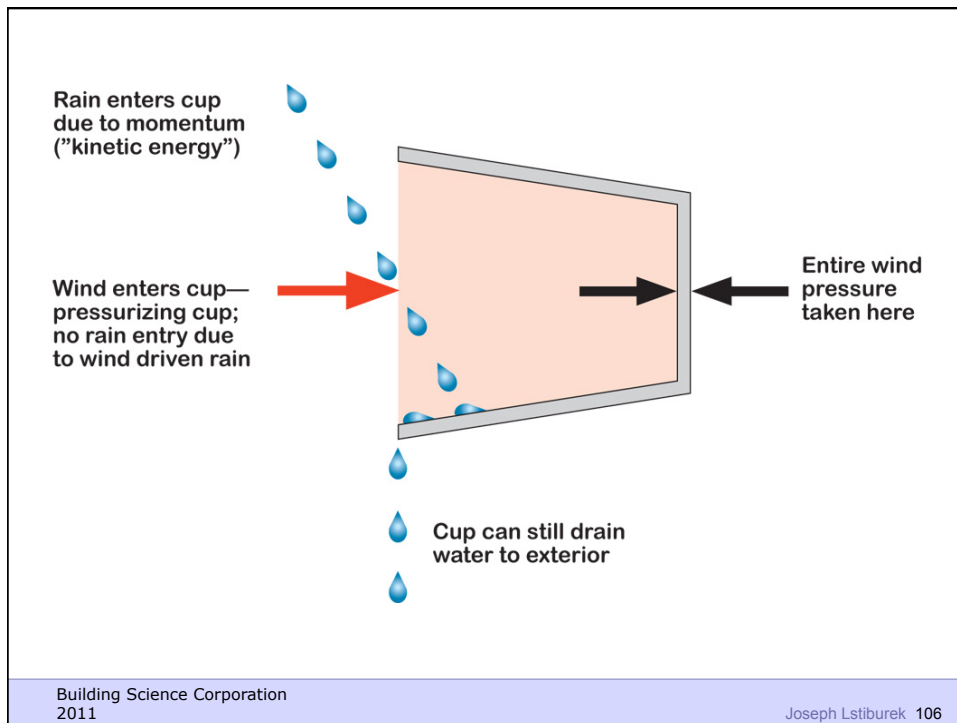
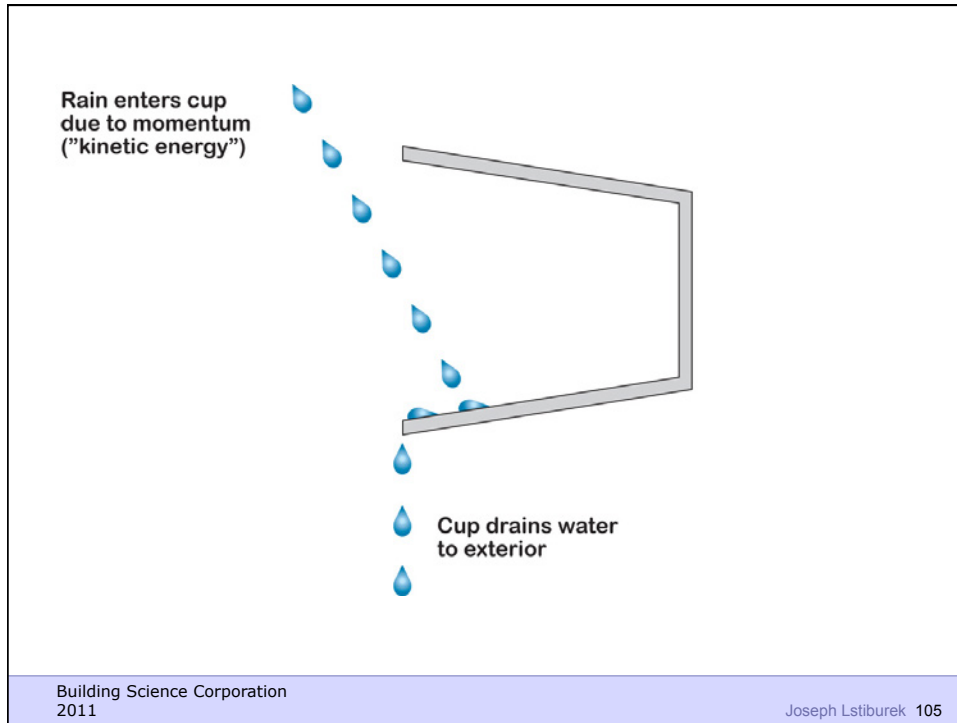
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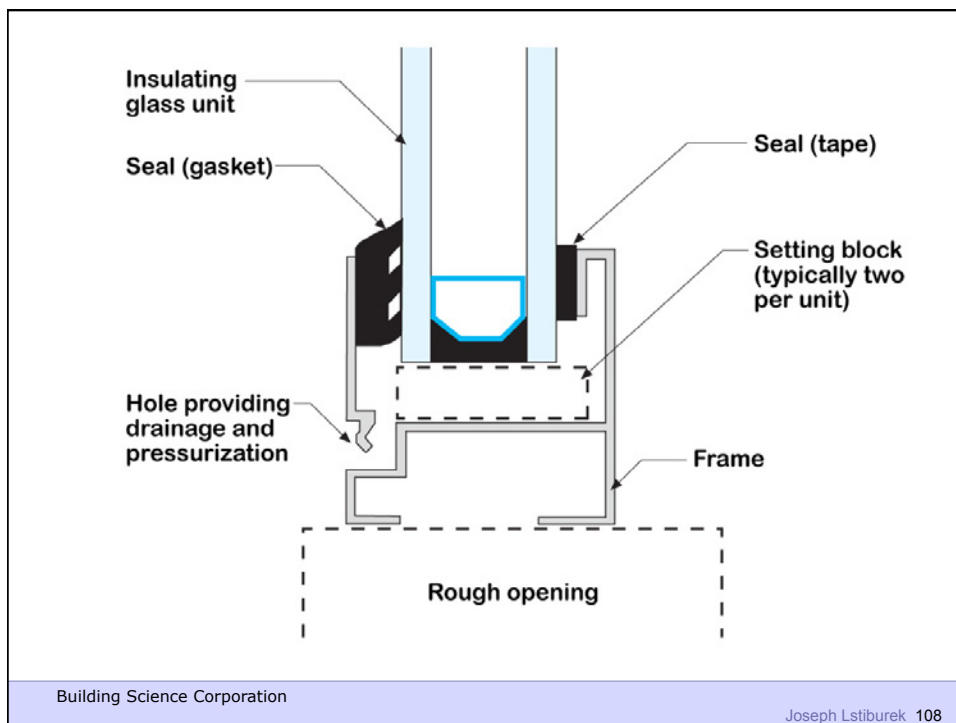
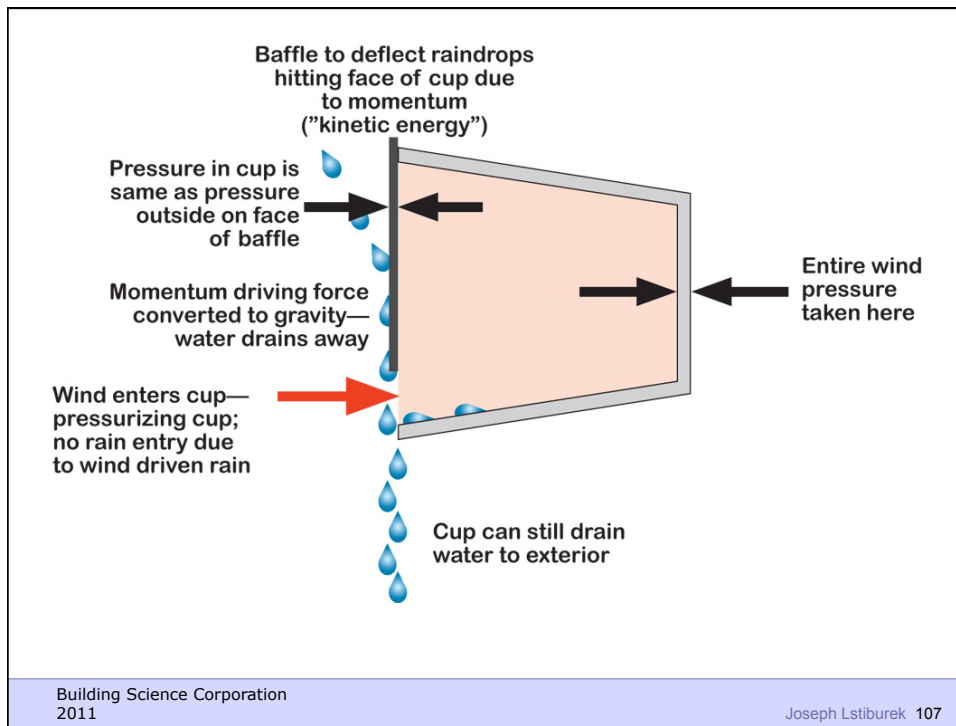
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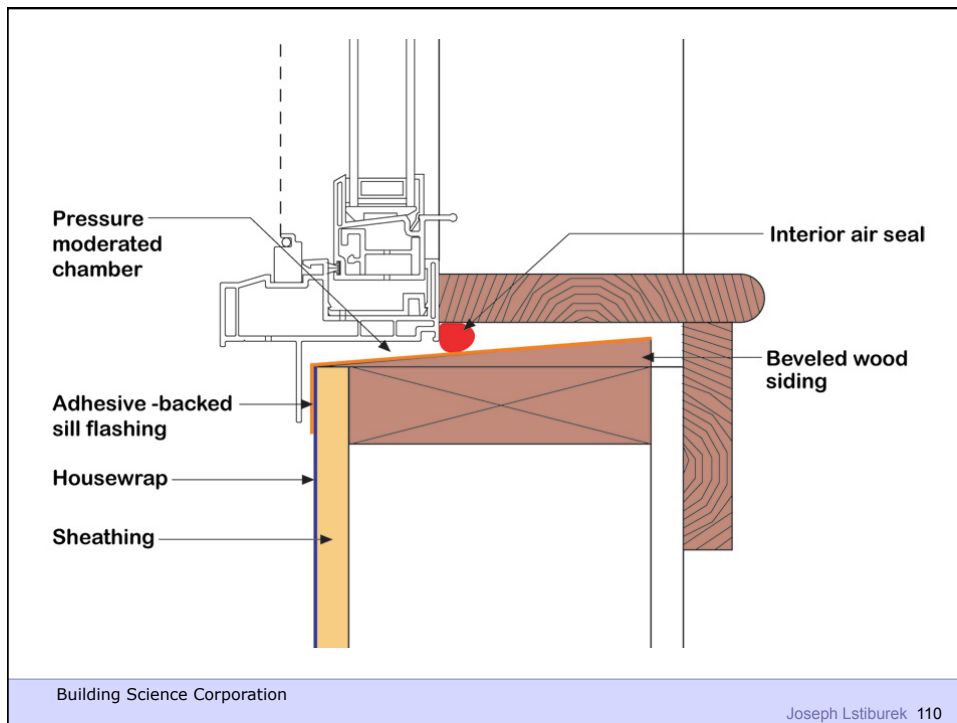
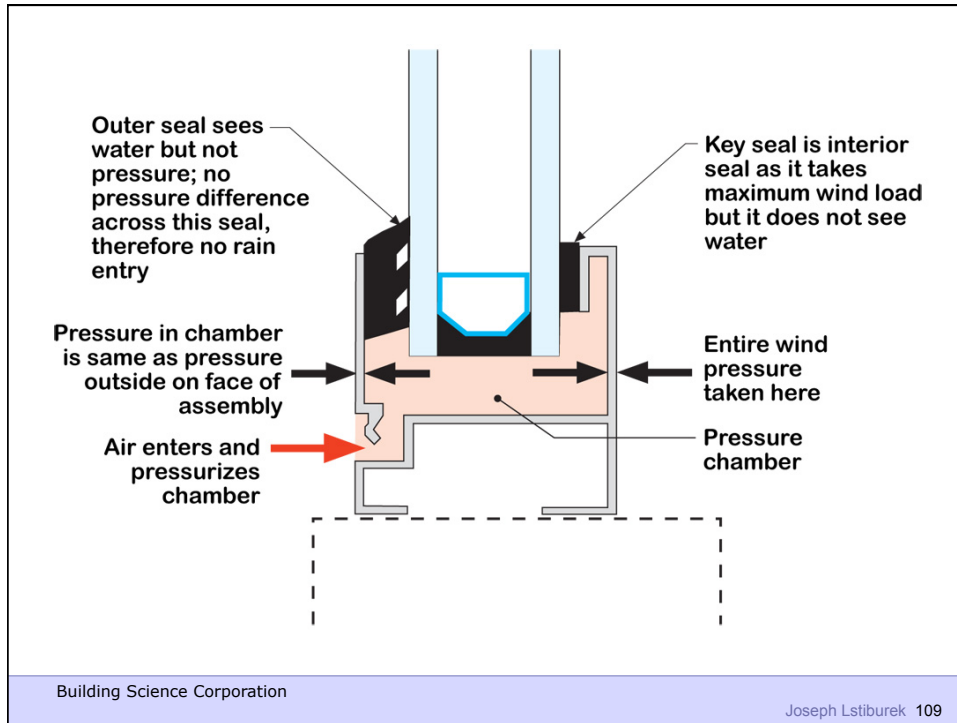


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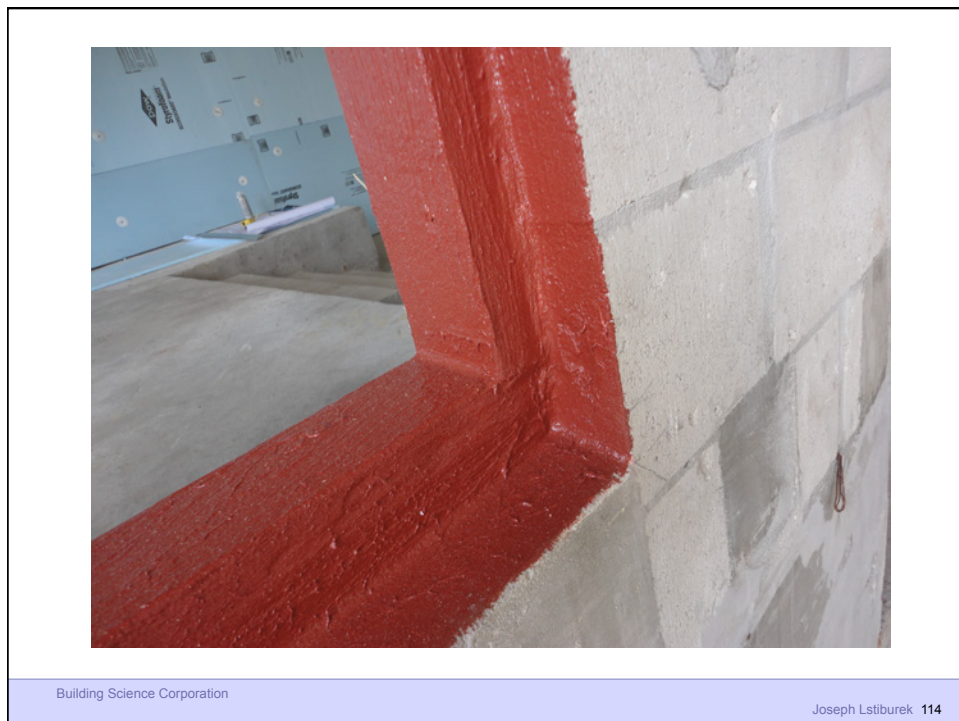
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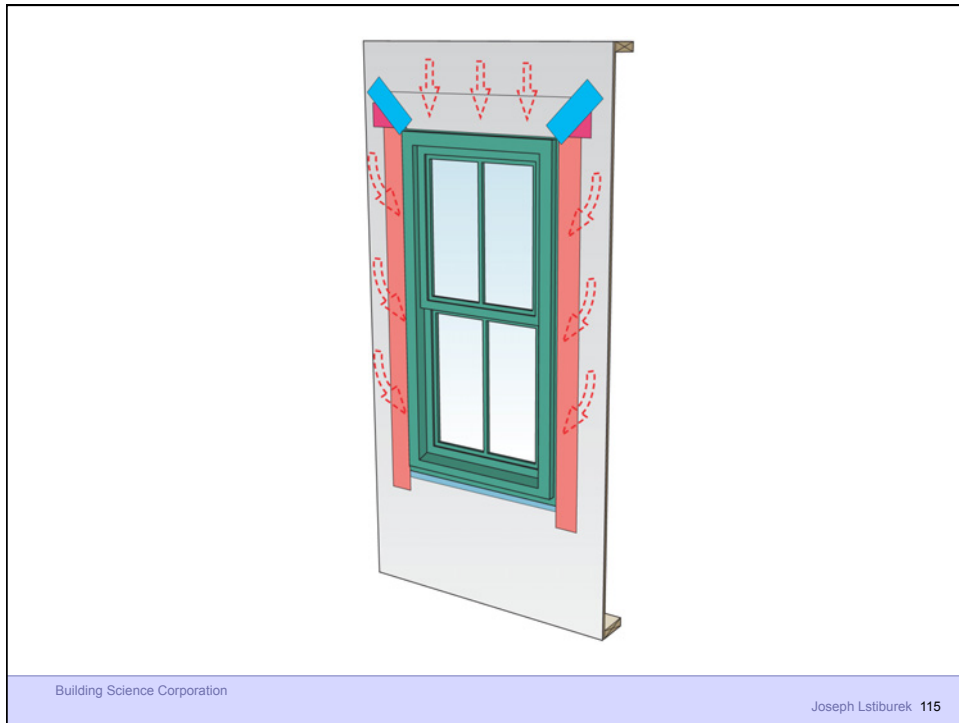
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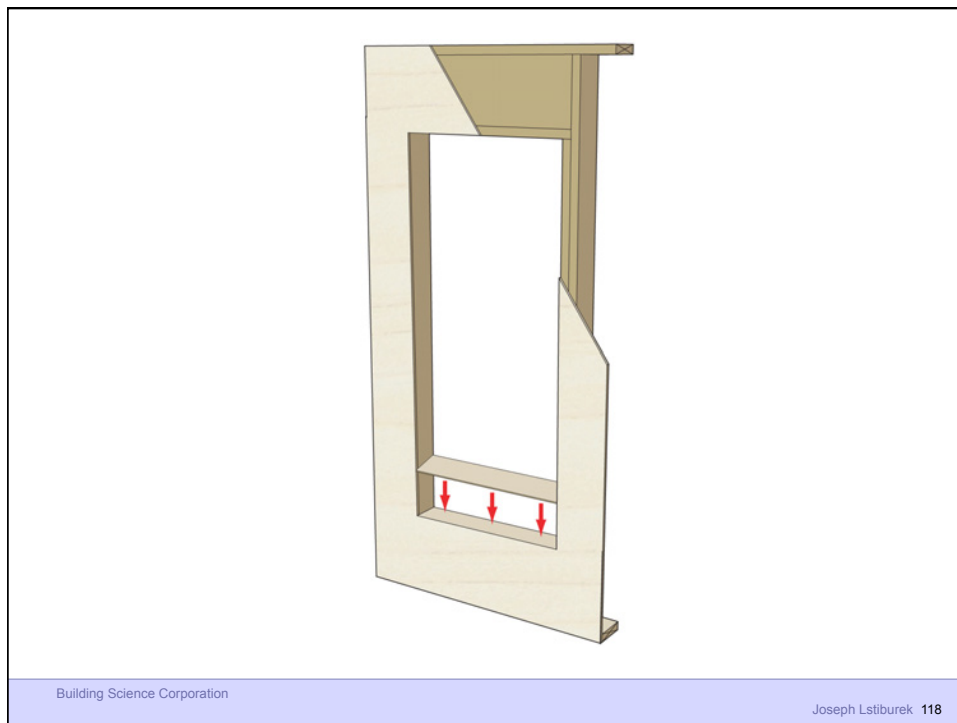
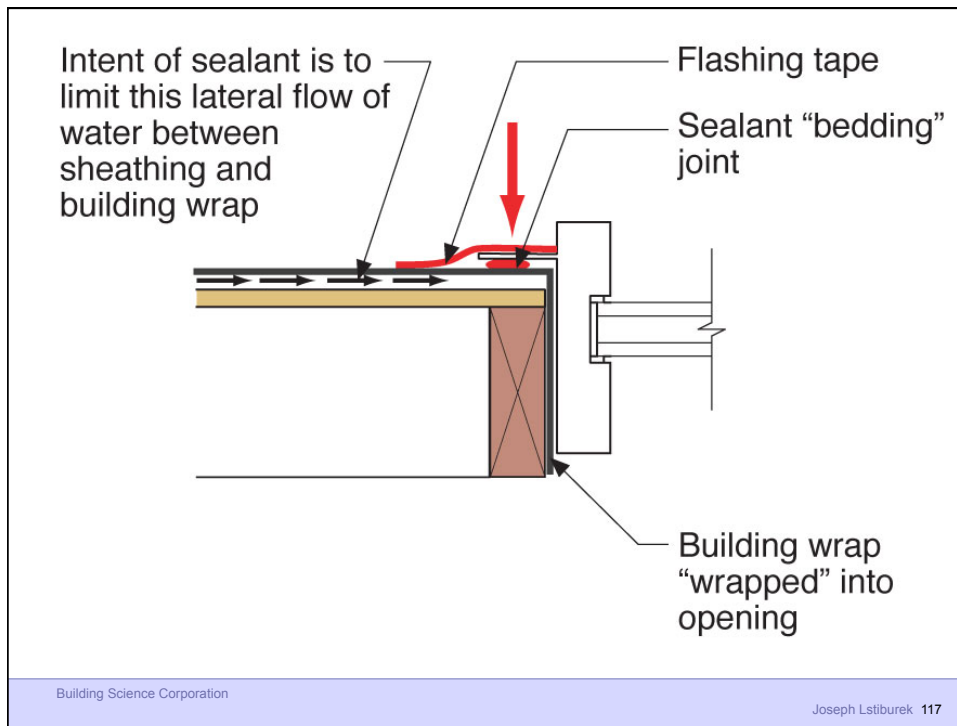


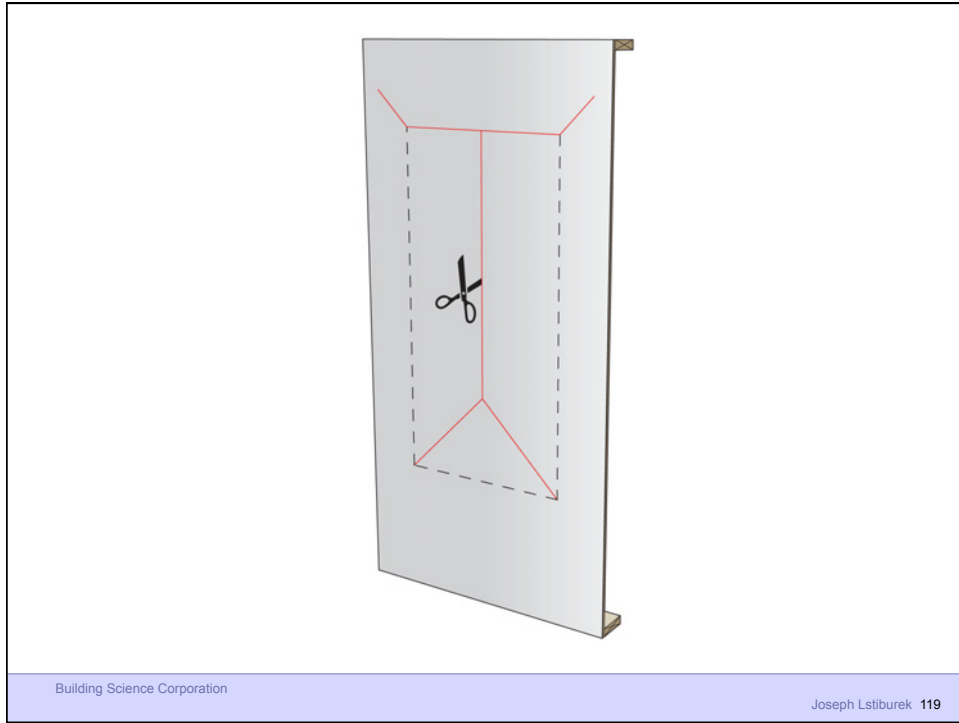
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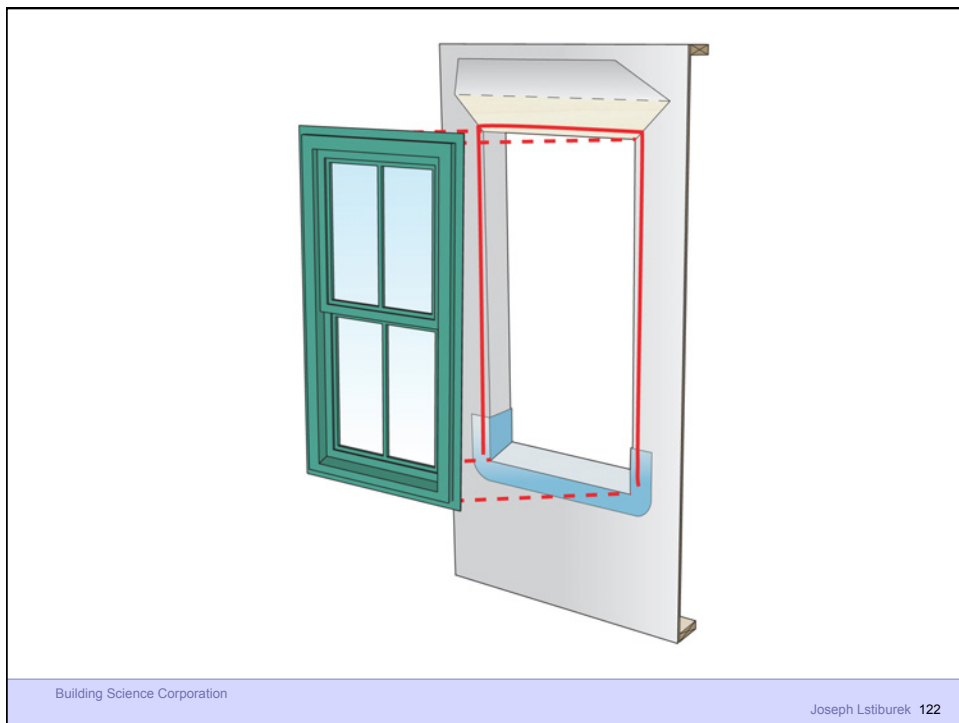
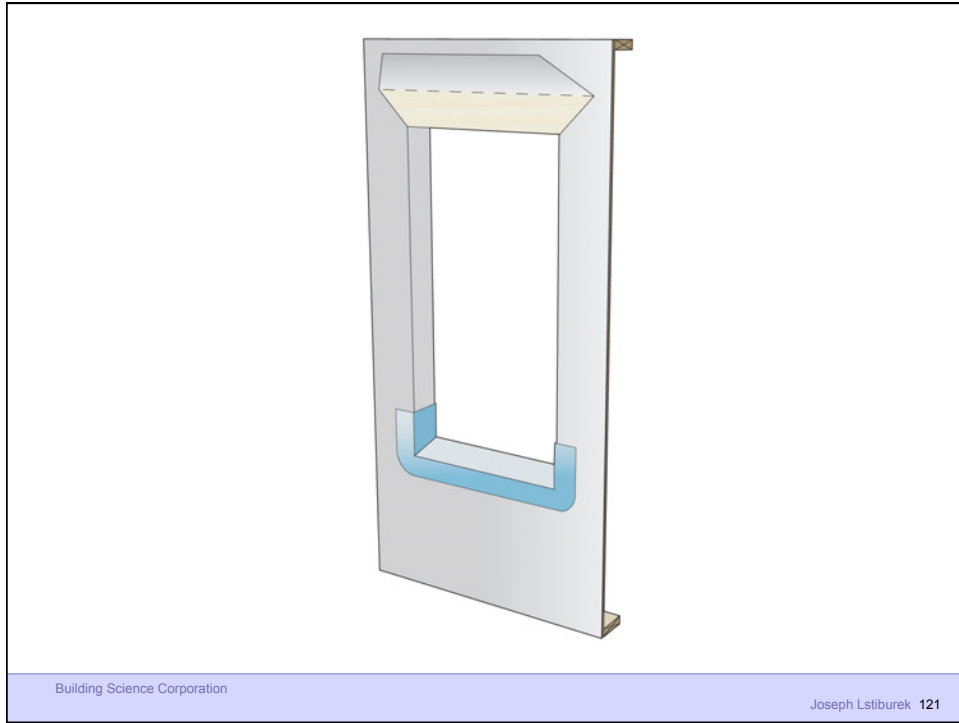
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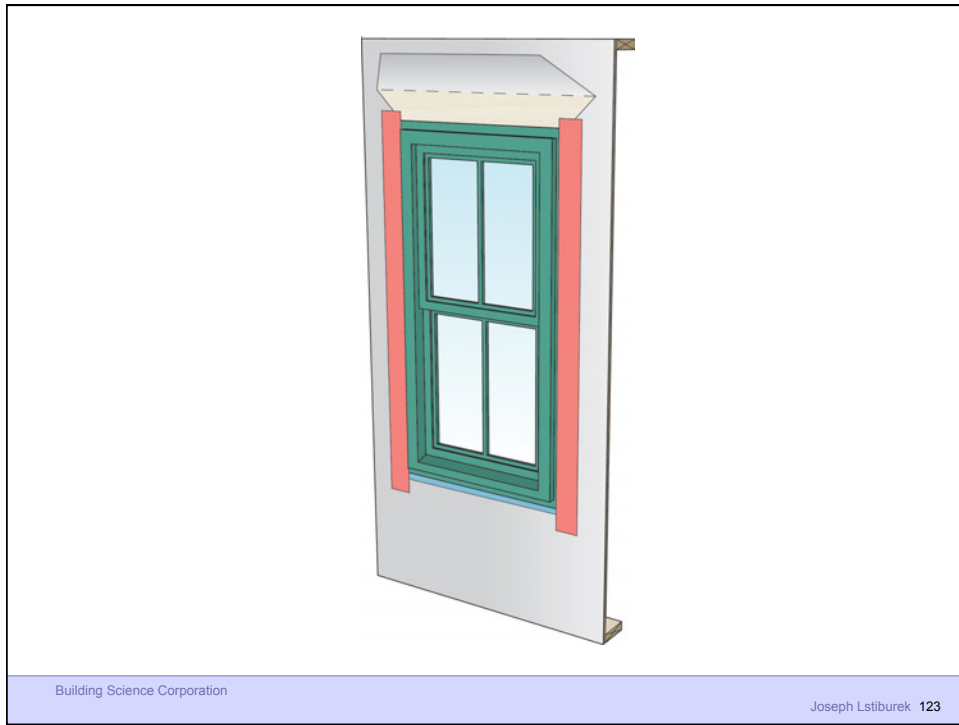


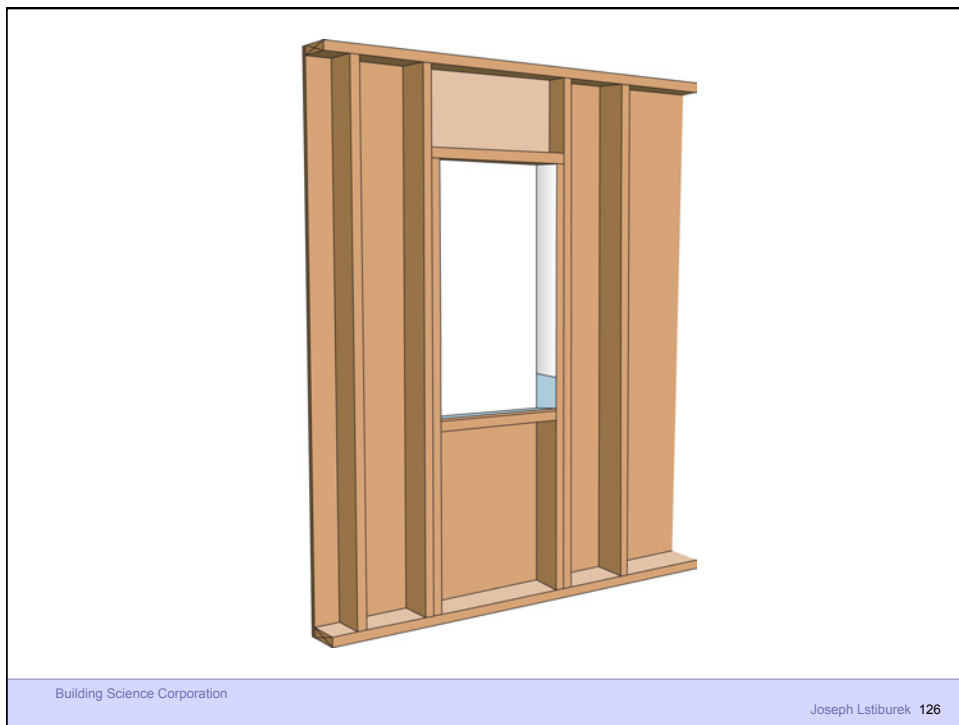
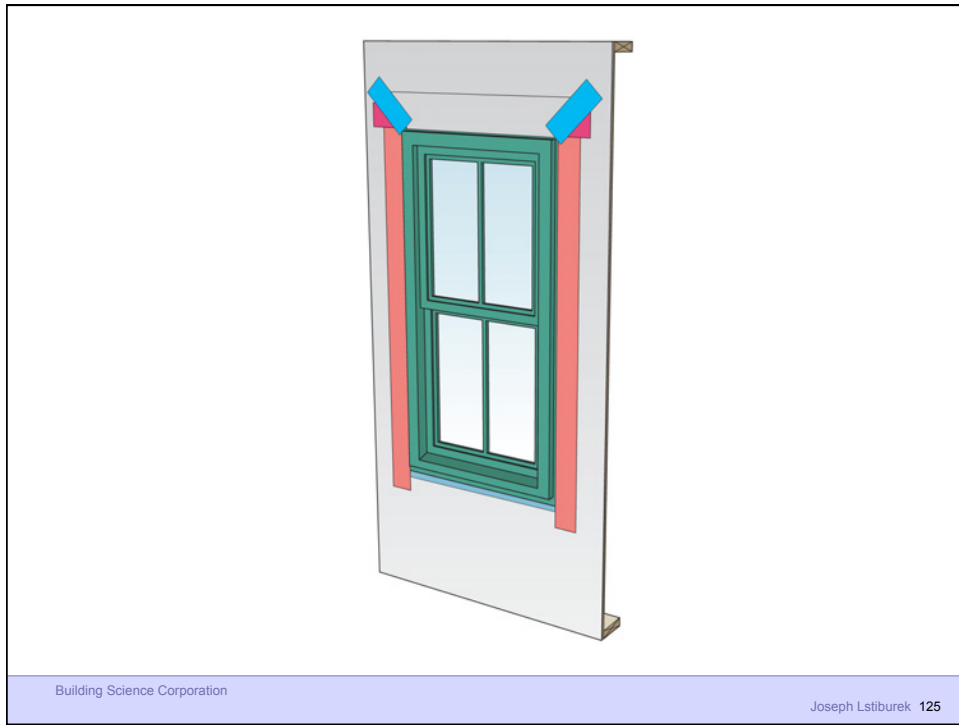


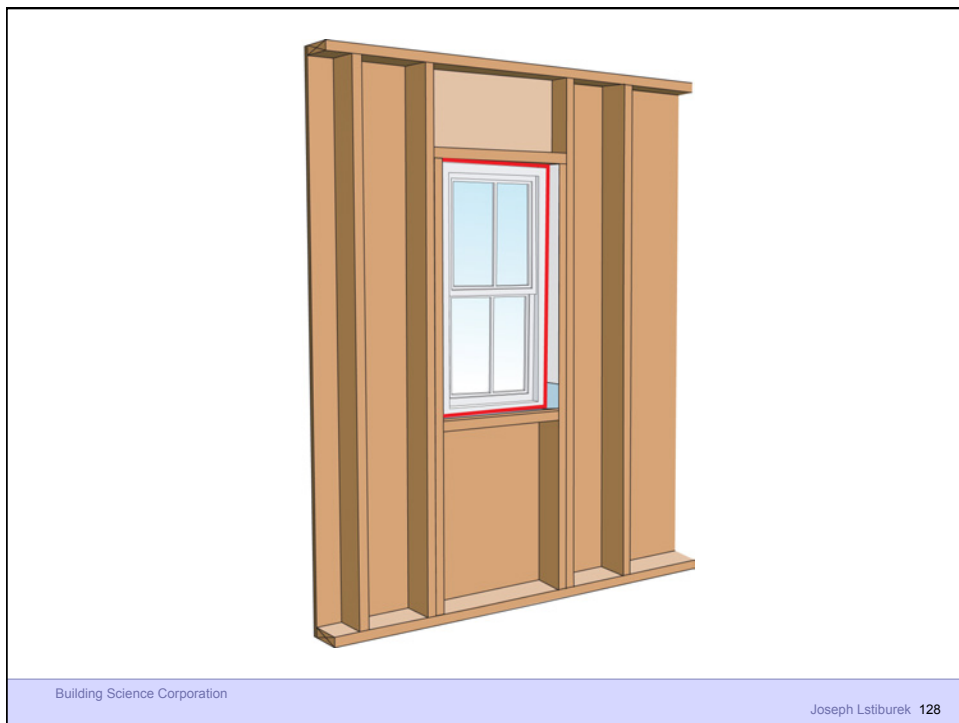
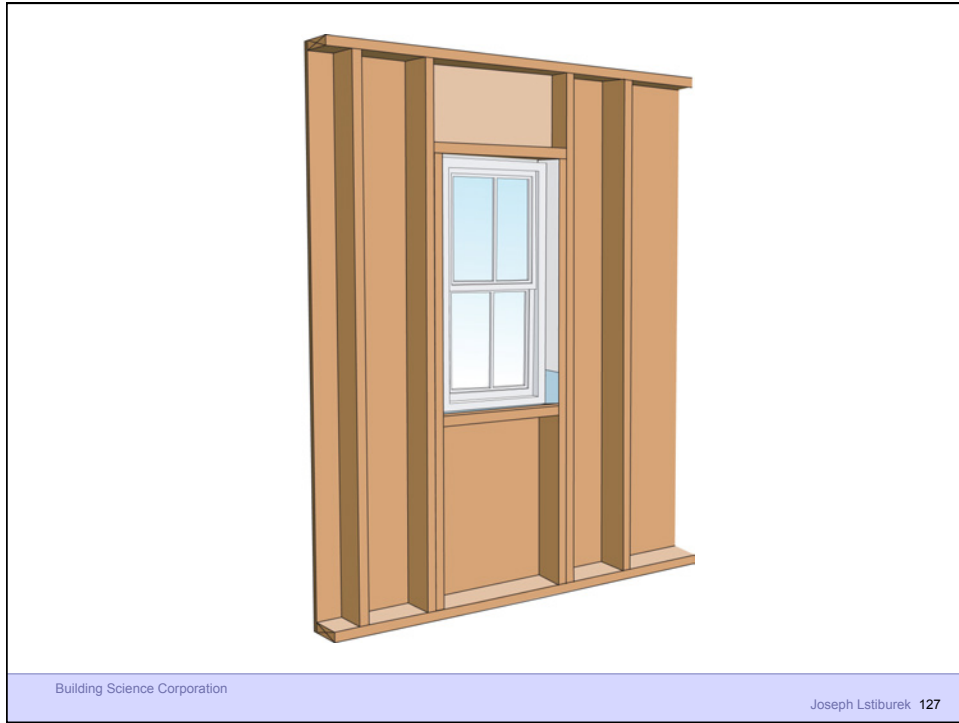














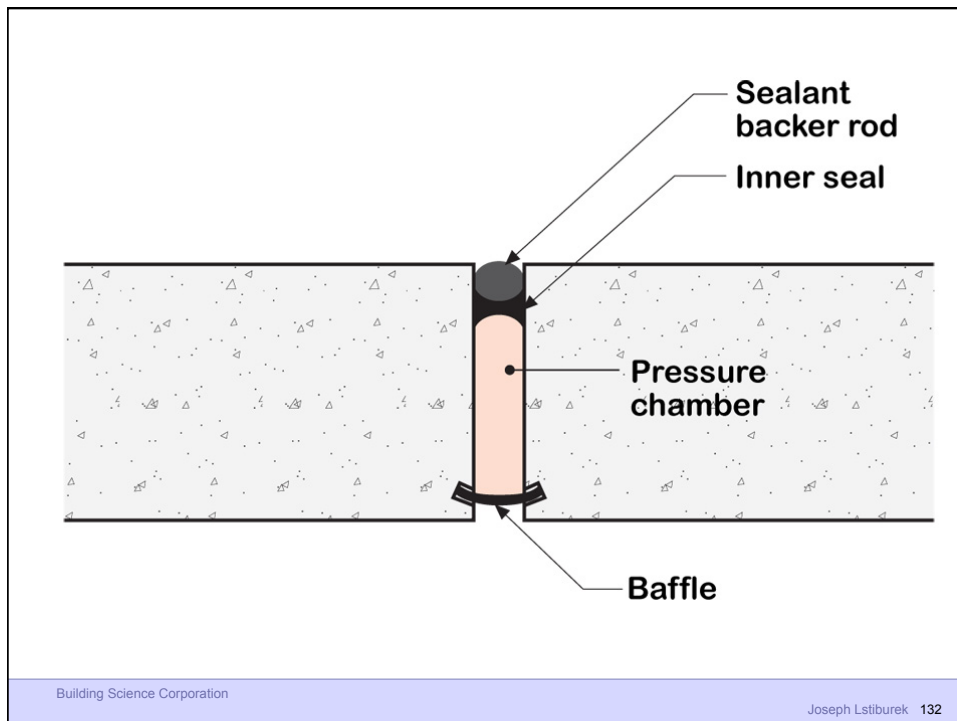
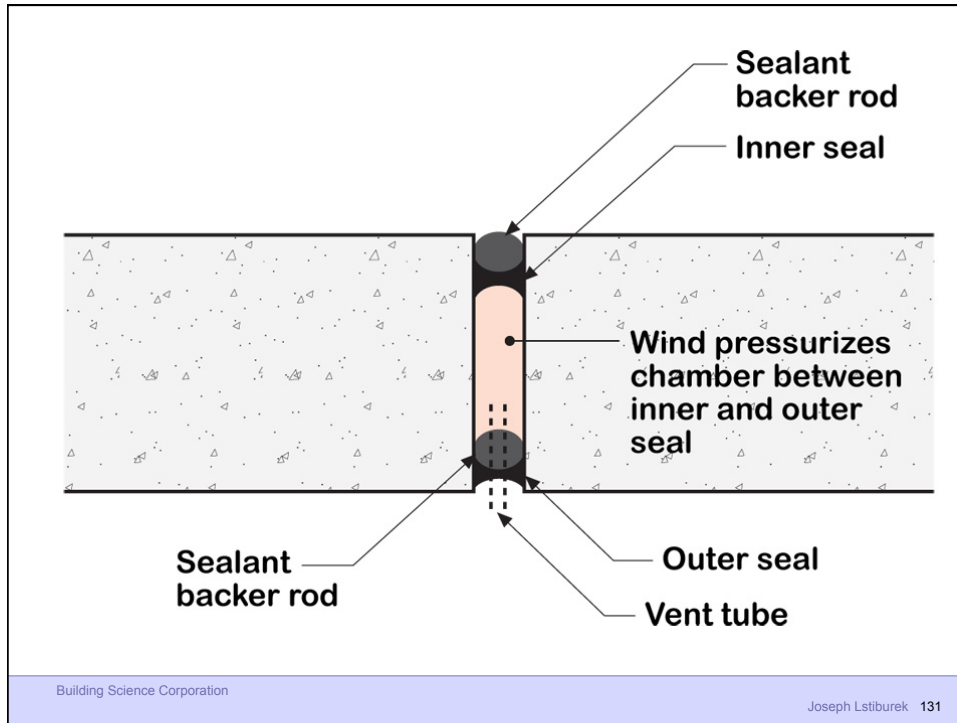
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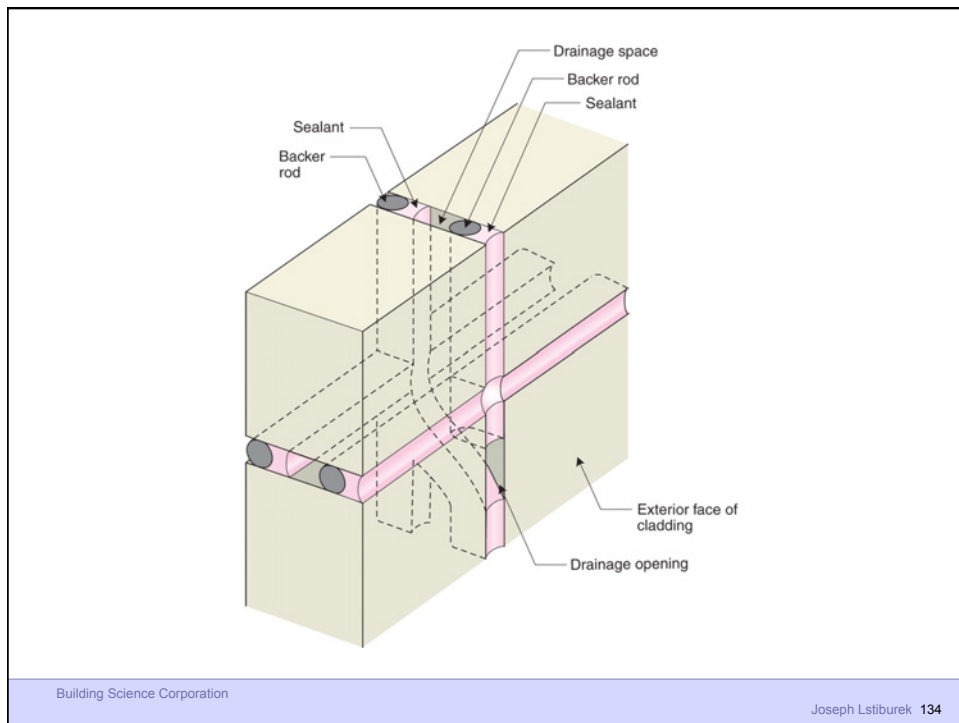
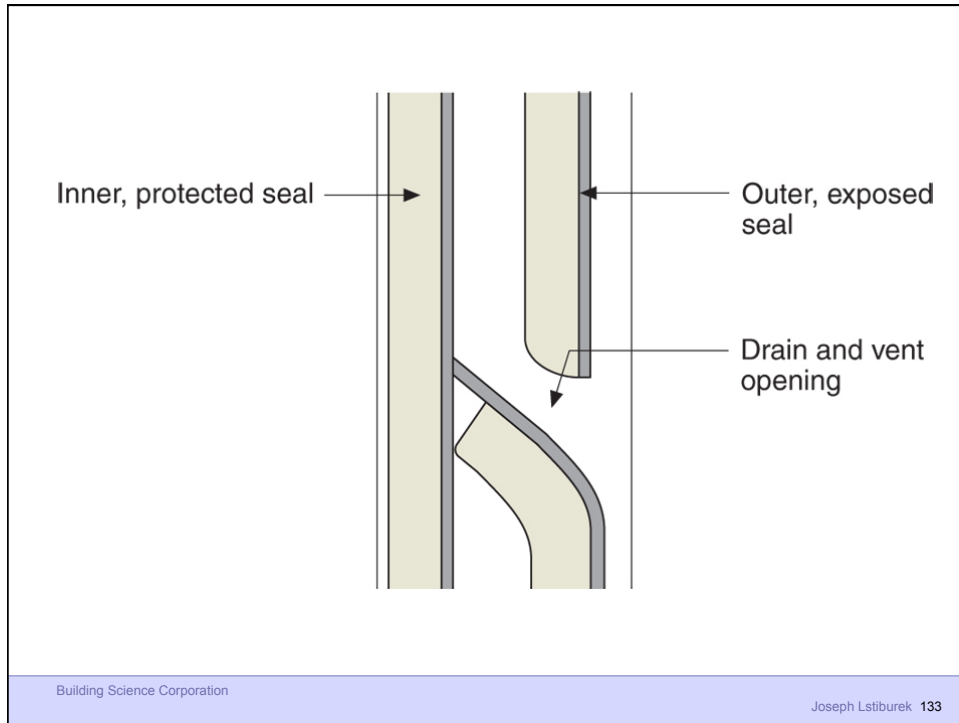
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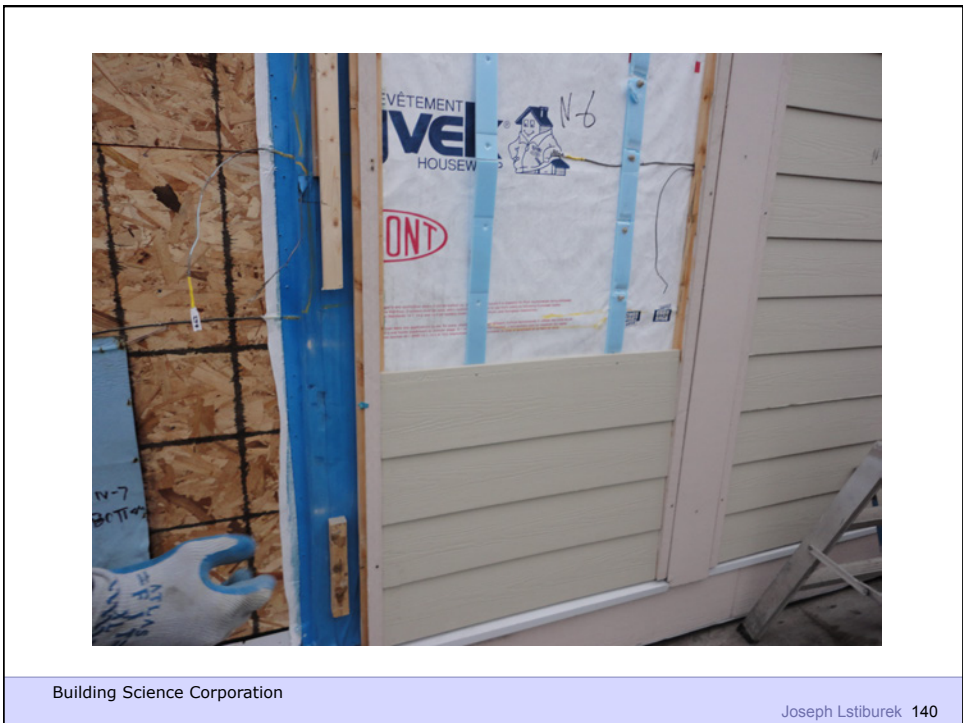
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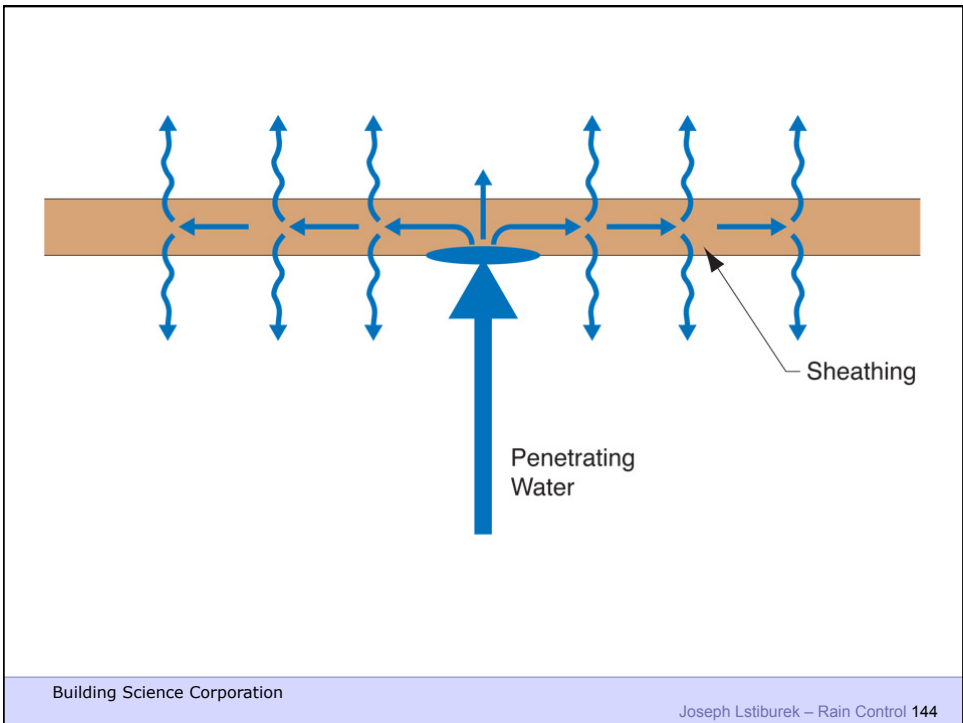


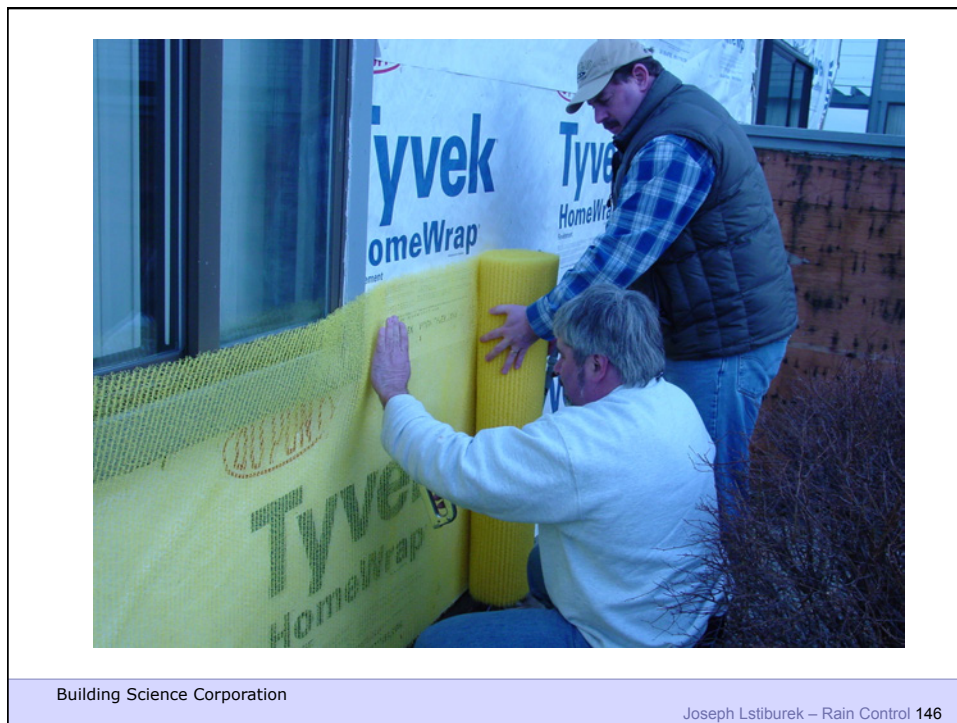
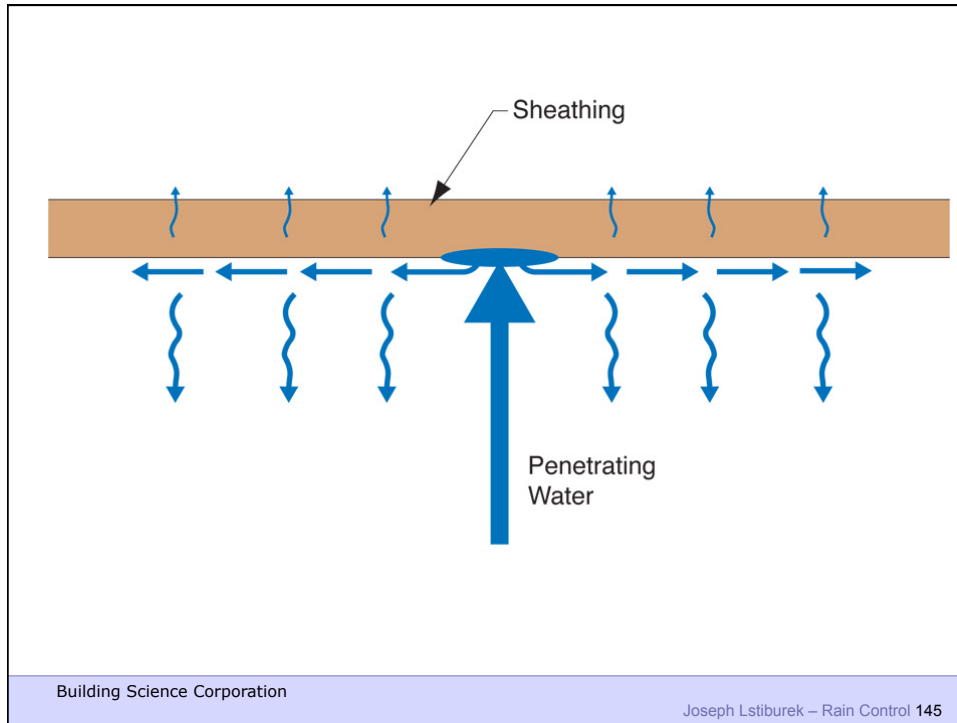
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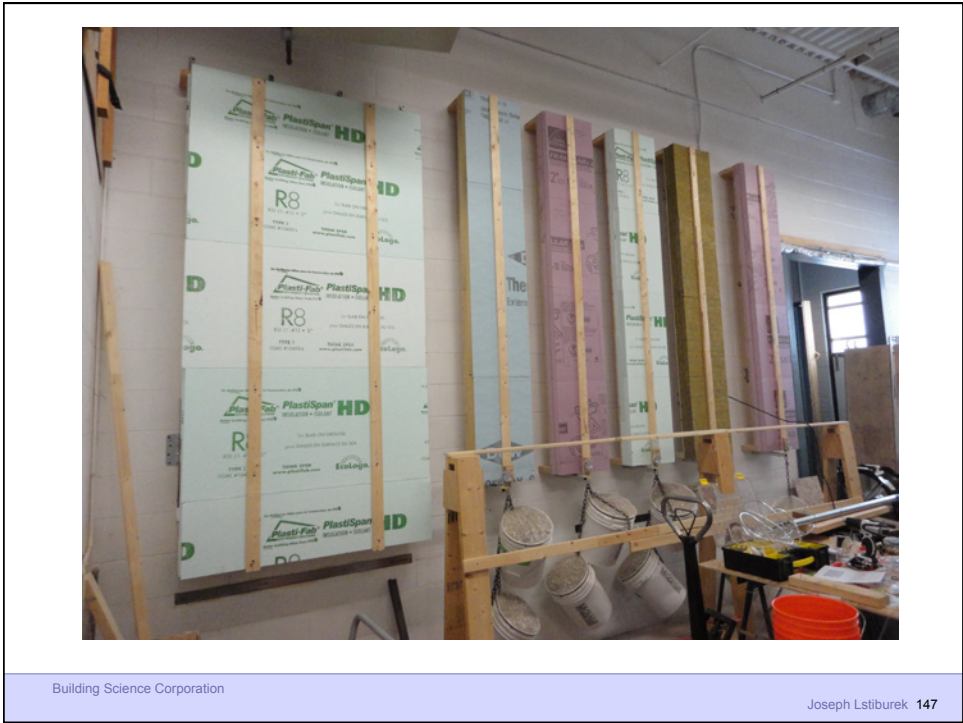
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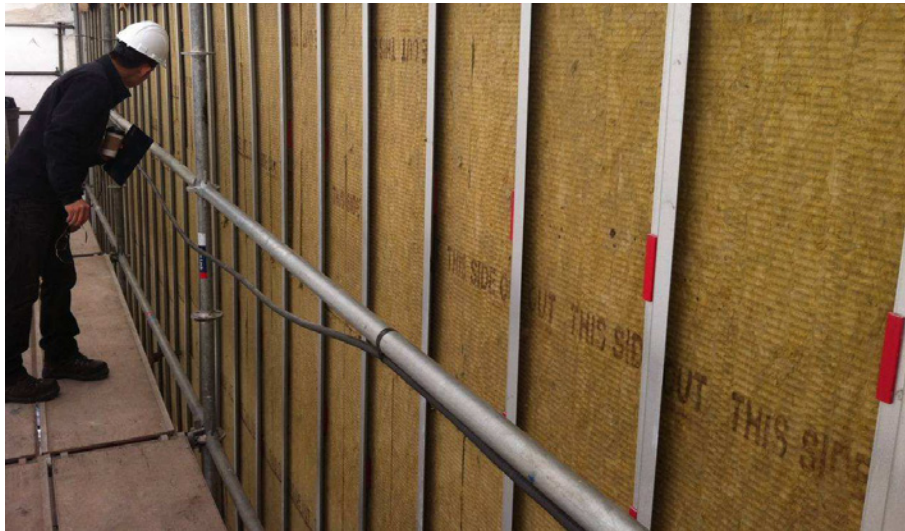






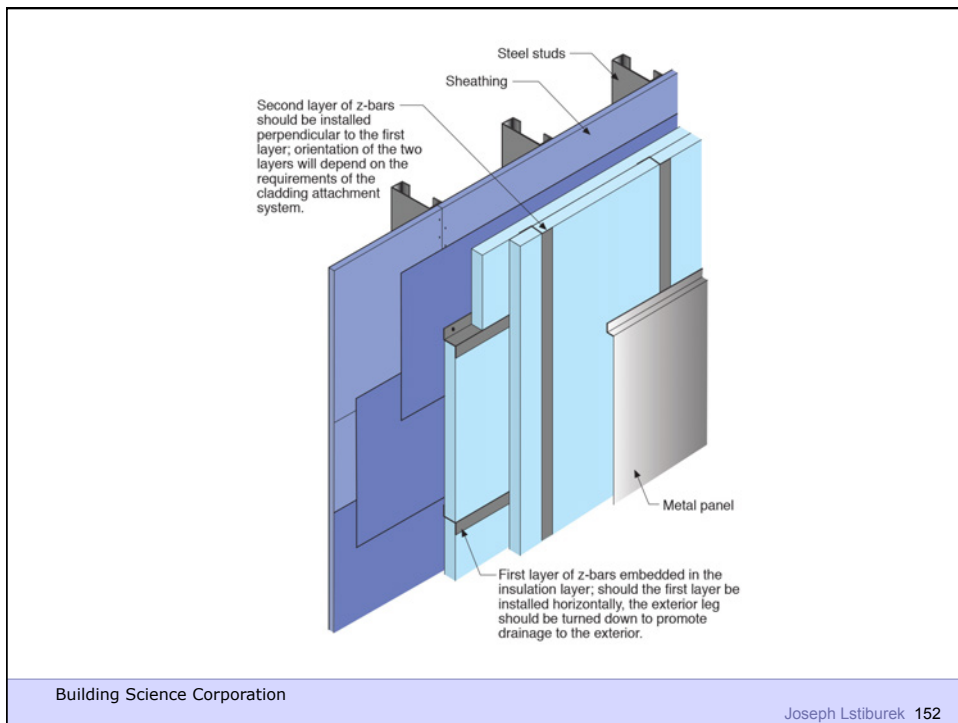
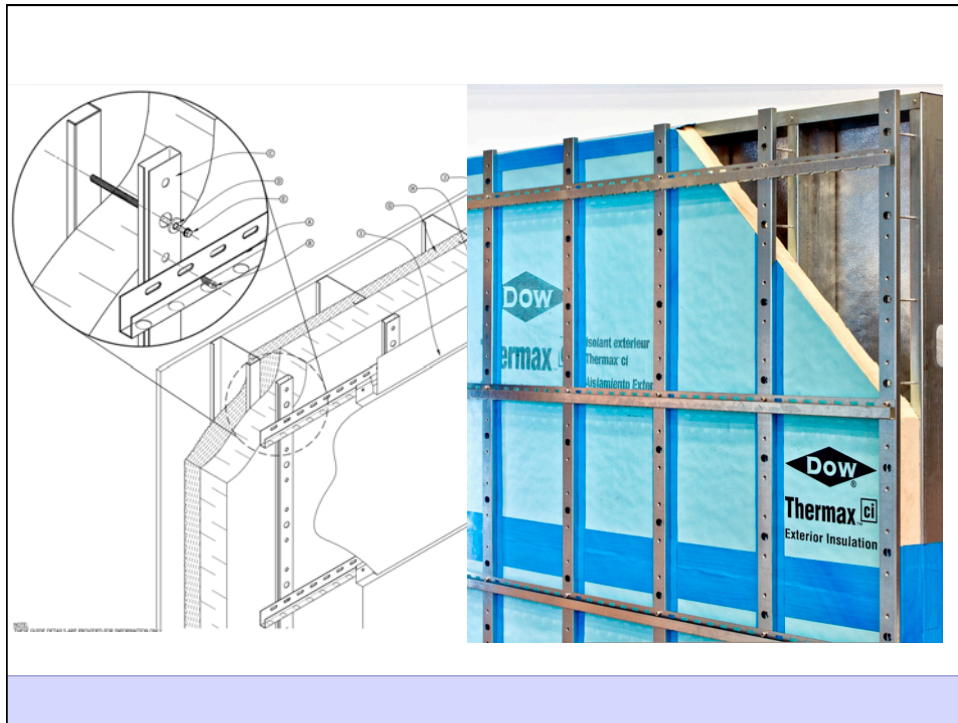
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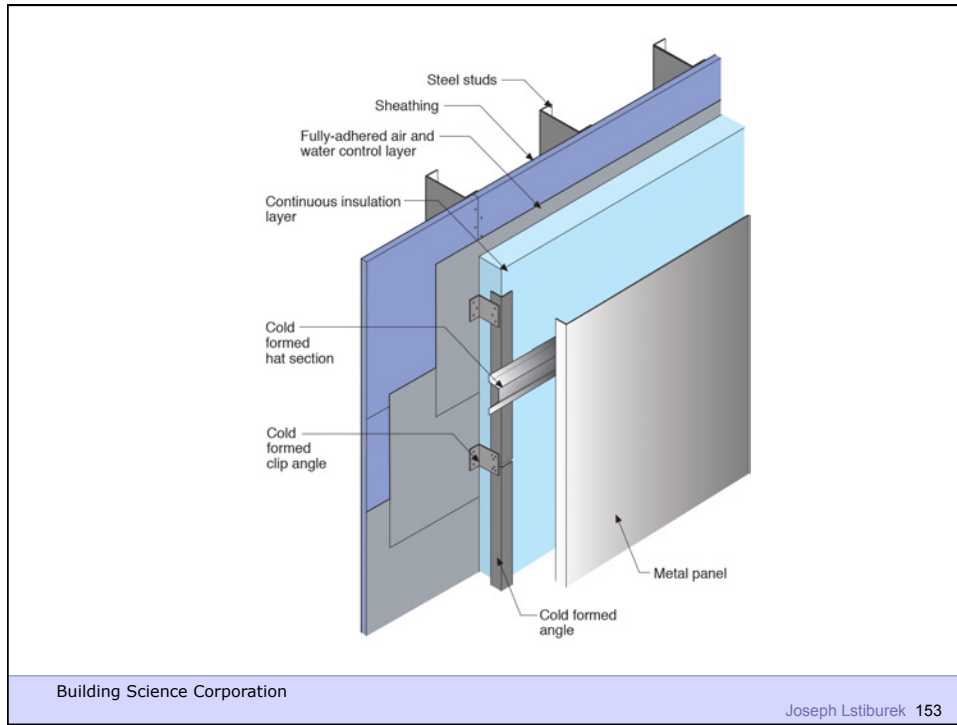
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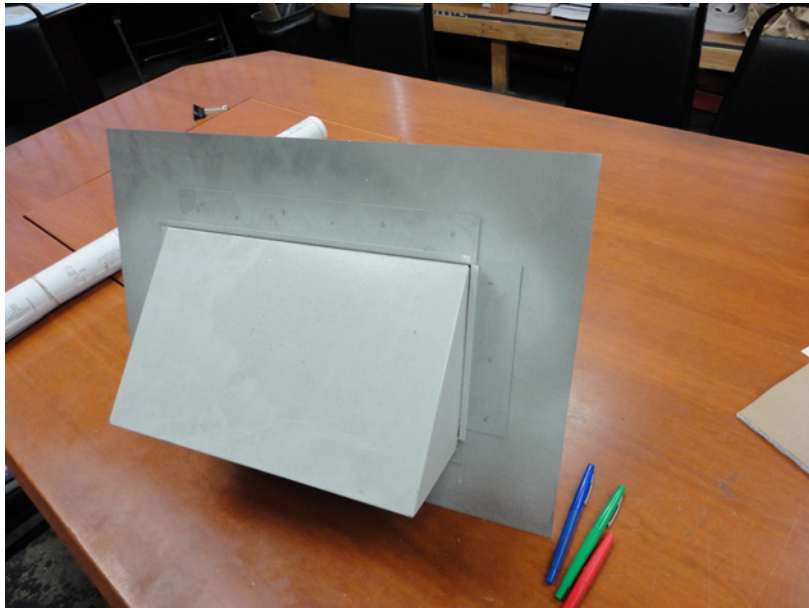






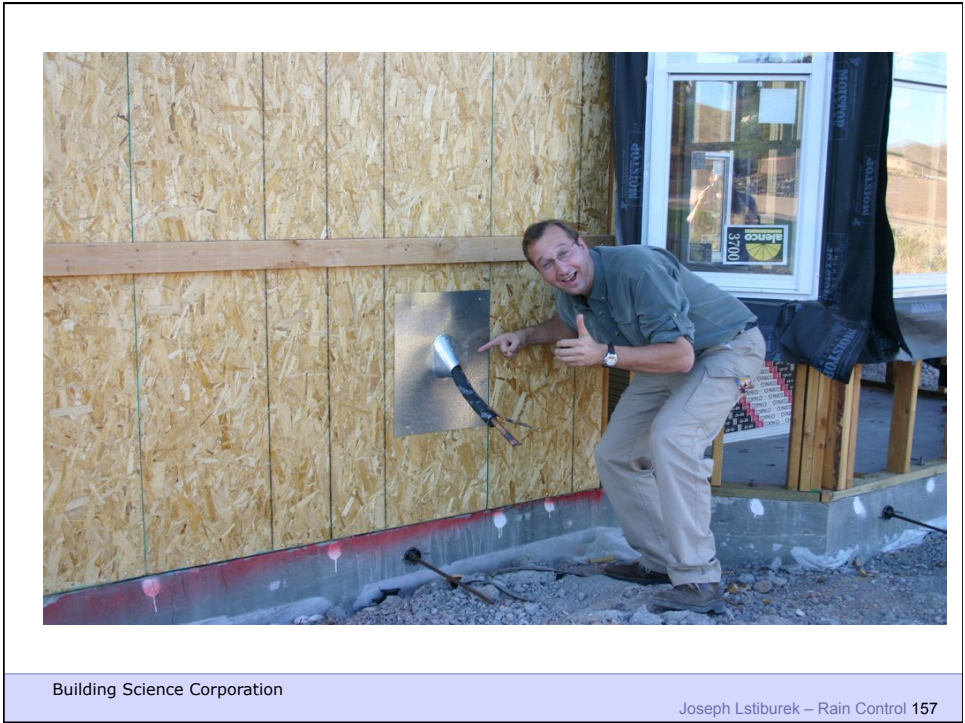
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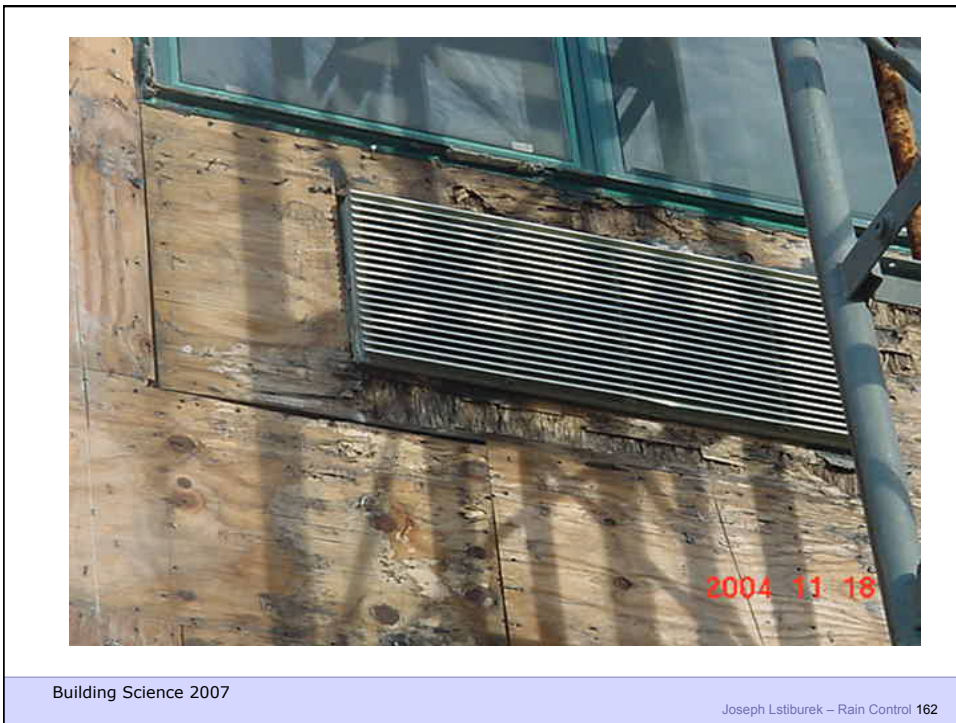
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Joseph Lstiburek – Rain Control 160





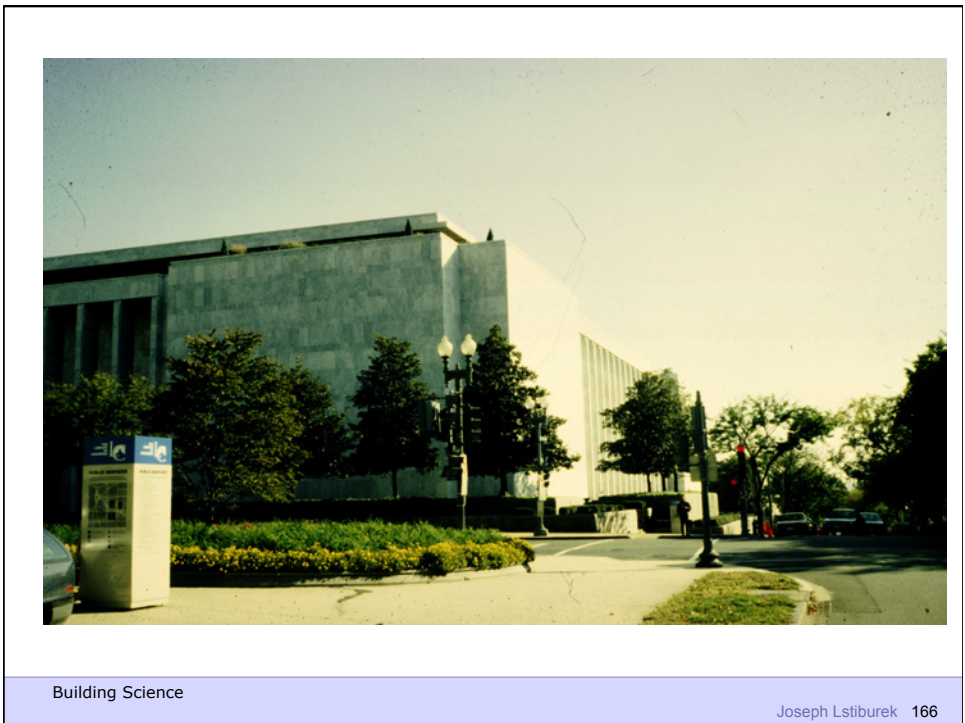
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People
Pollutant (hot, wet, UV, ozone)
Path
Pressure

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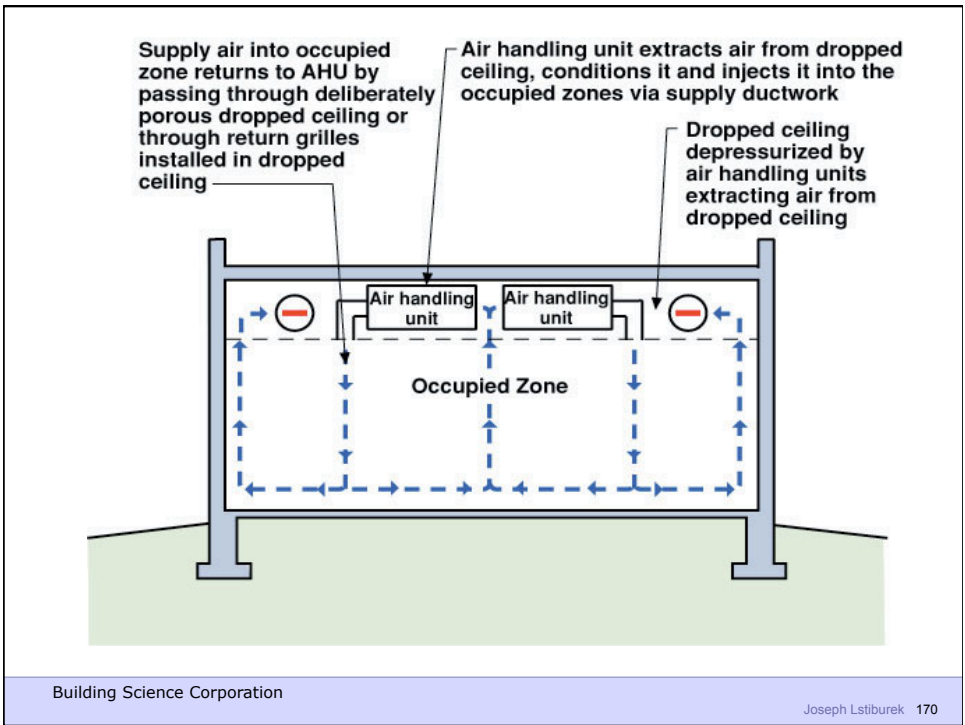
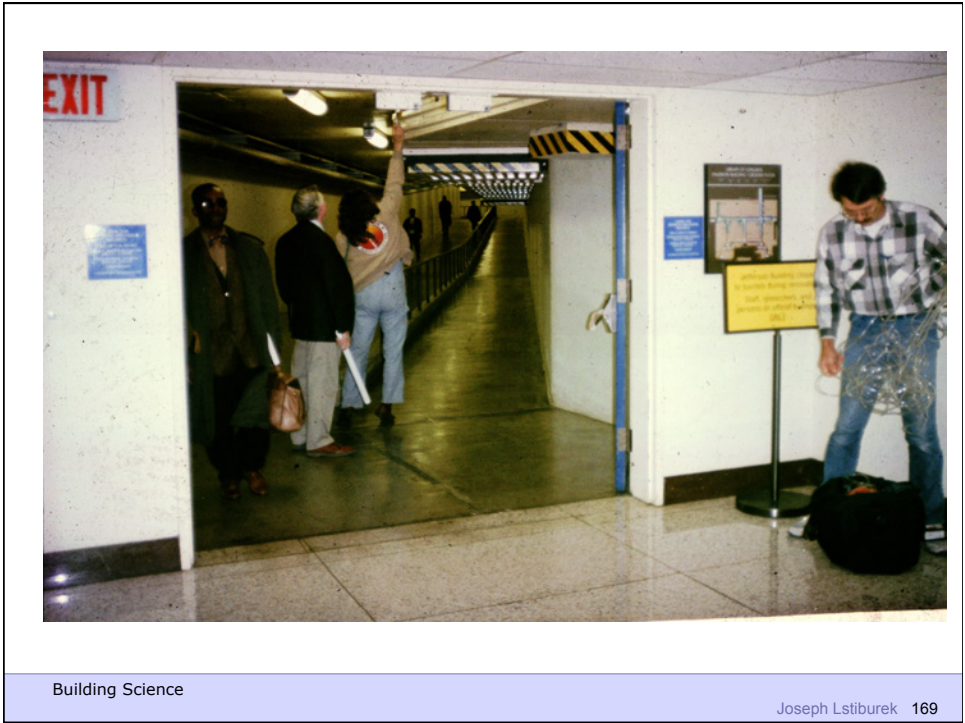
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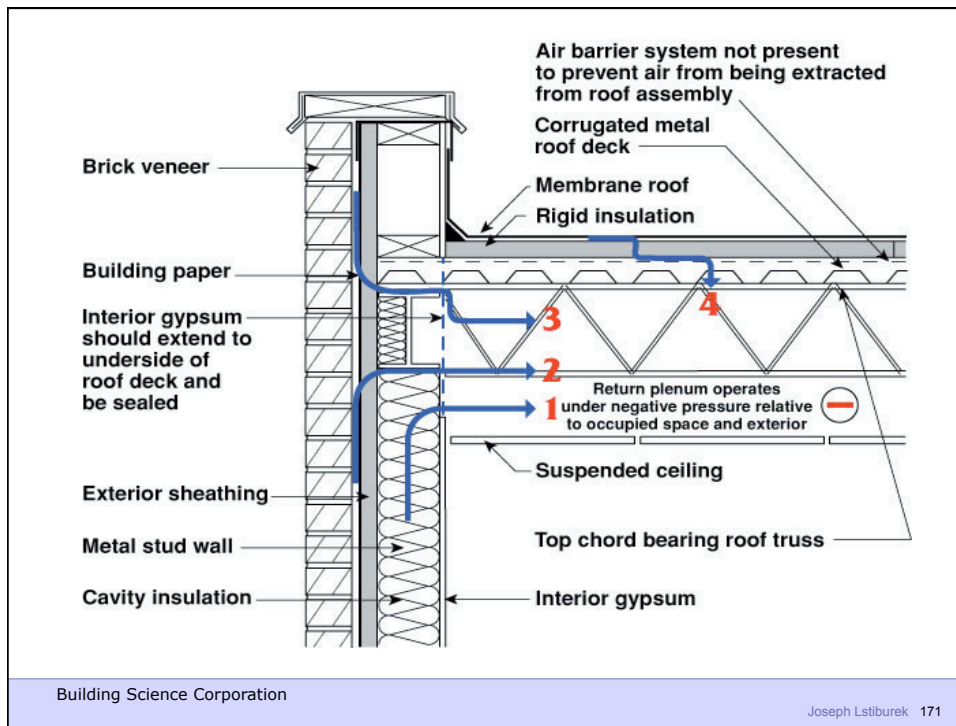
Joseph Lstiburek 167



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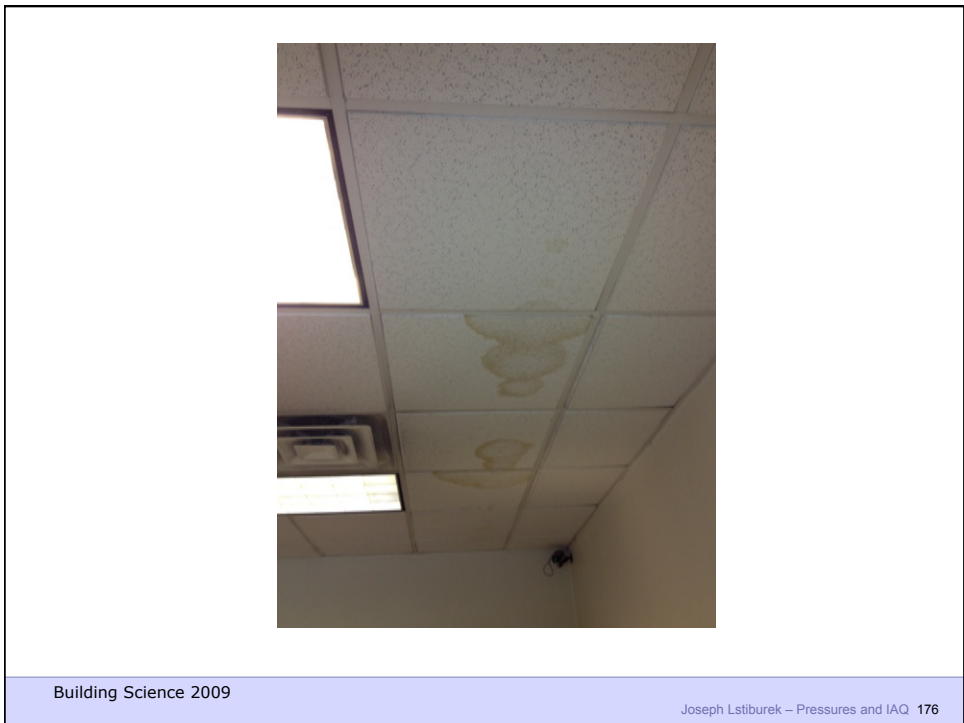
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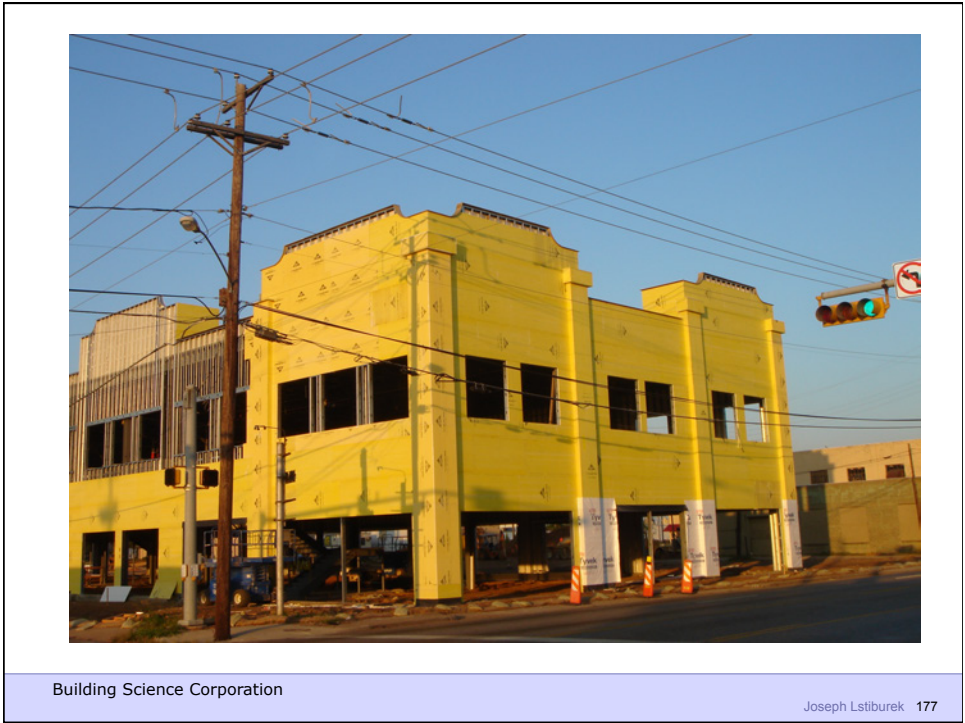
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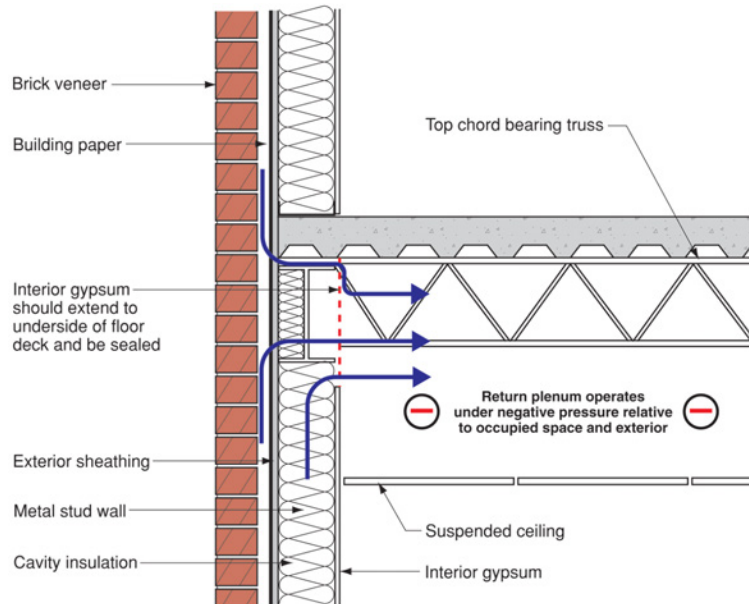






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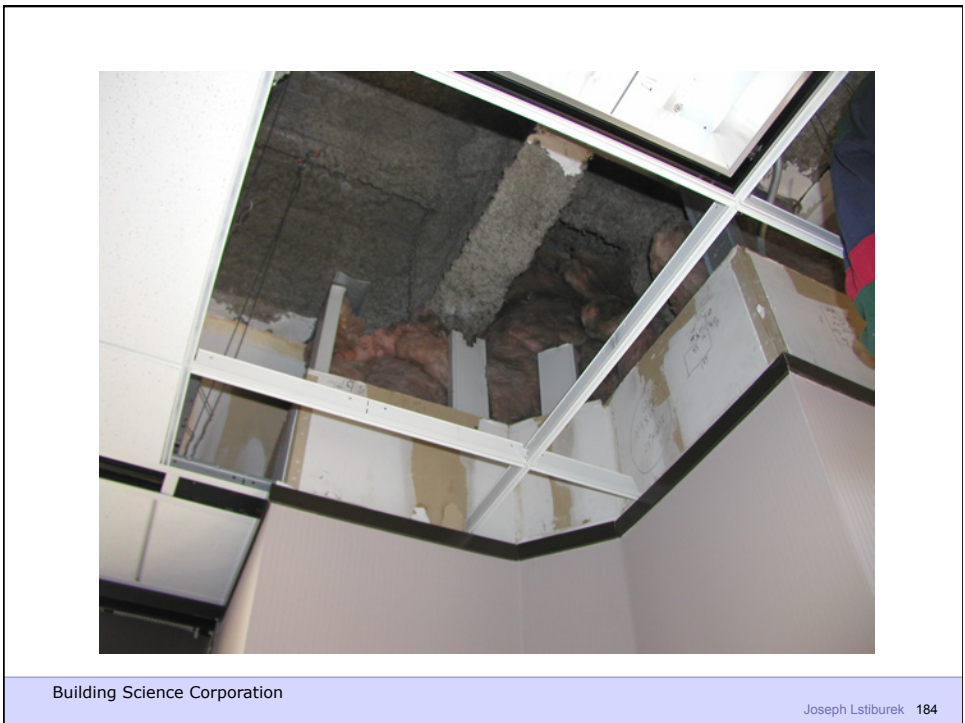
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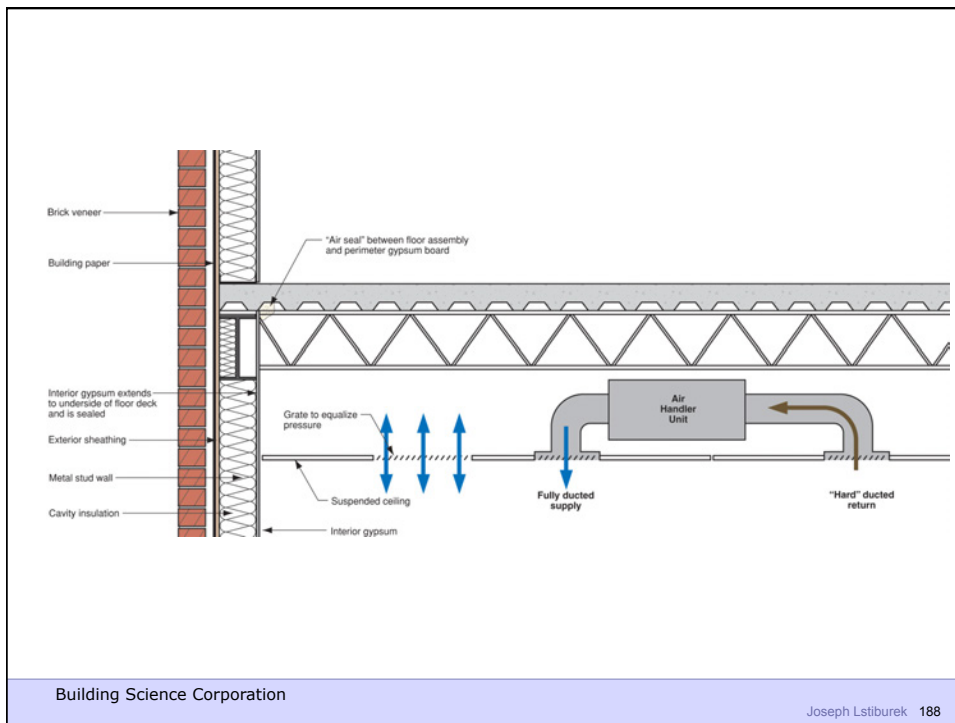
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Pressure difference

Flow Rate (CFM)

Area of opening

Air Flow

- Air flow depends on size of hole
- Air flow depends on pressure difference
- $Flow = Area \times \sqrt{\Delta P \times Coefficient}$
- Air flows from higher pressure to lower pressure

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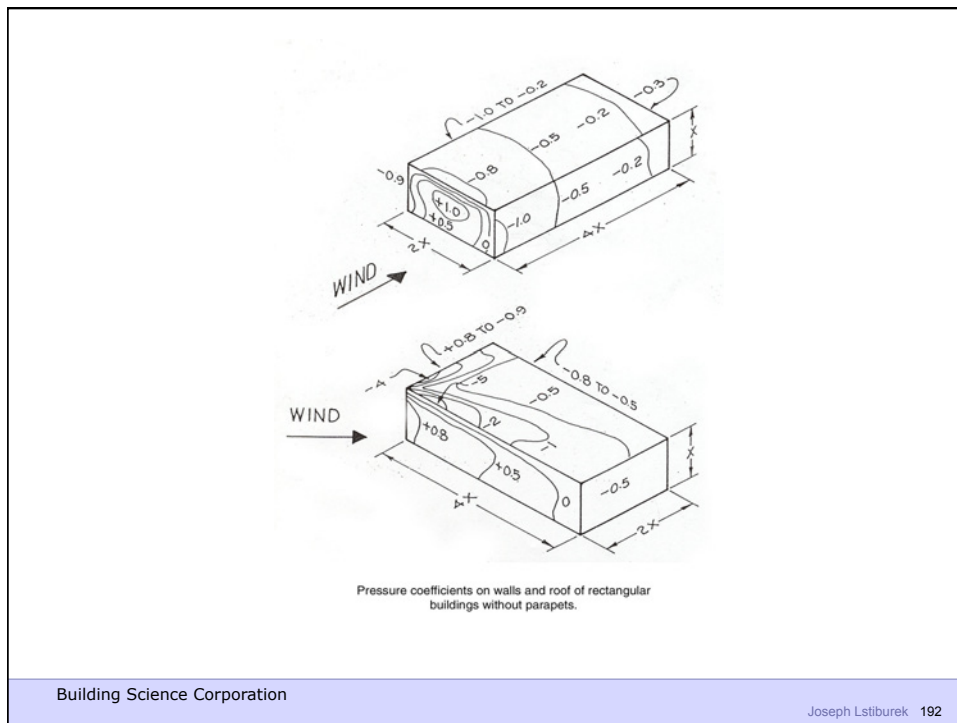
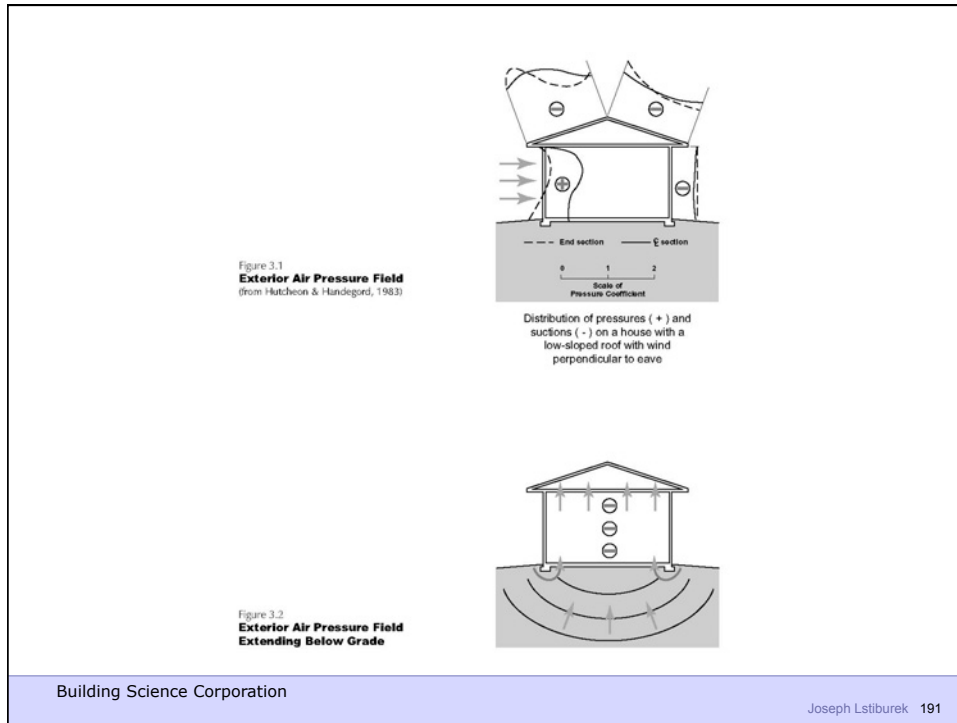
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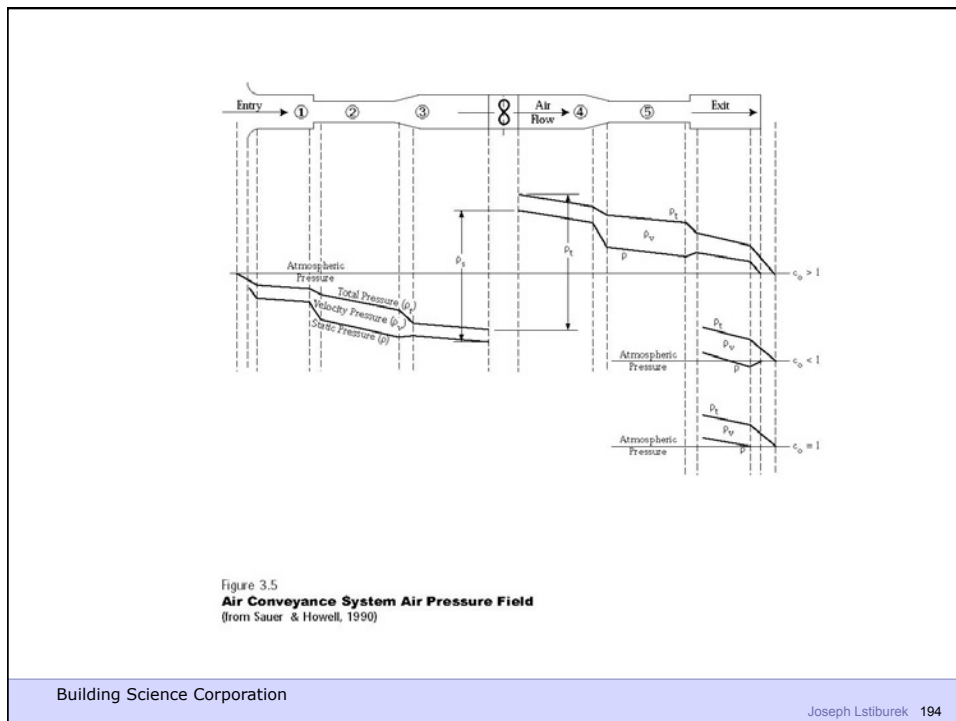
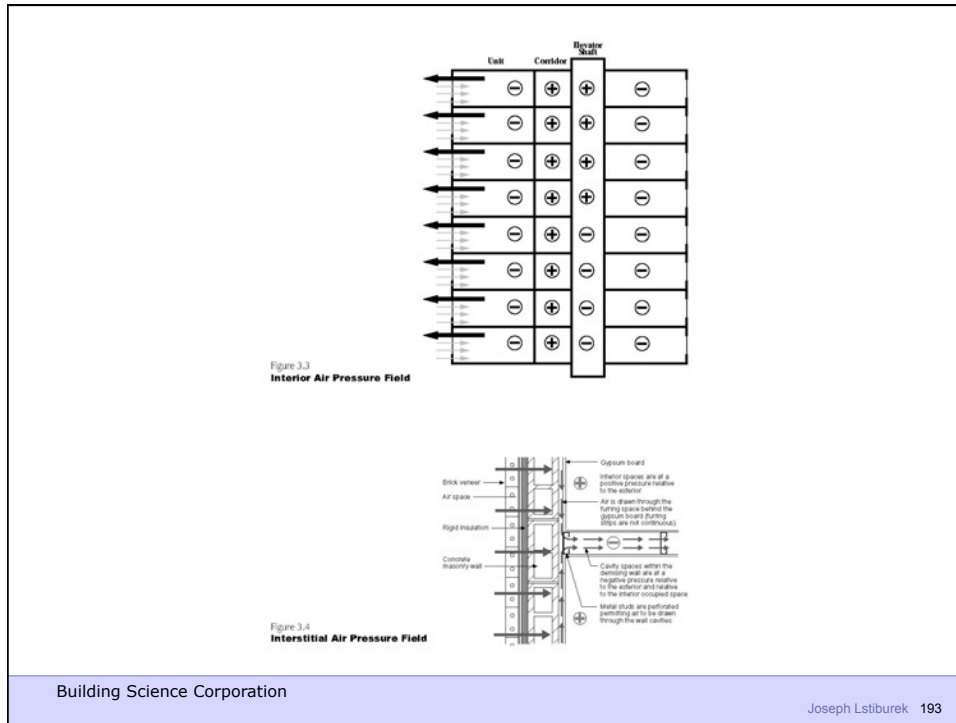
Figure 2.11
Three Dimensional Multi-Layer Multi-Cell Analogue

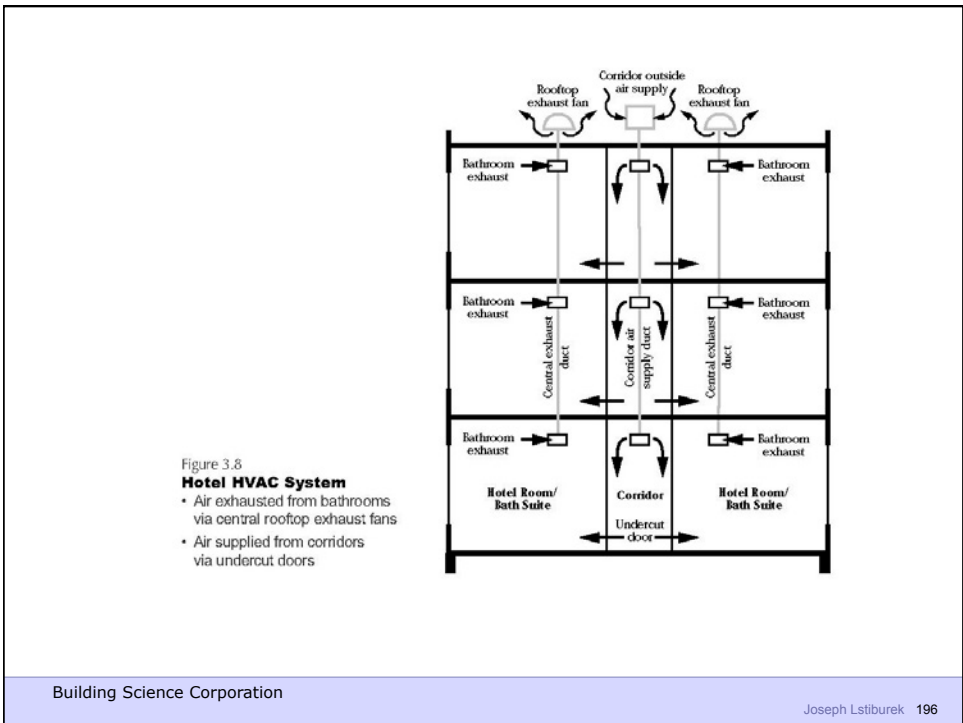
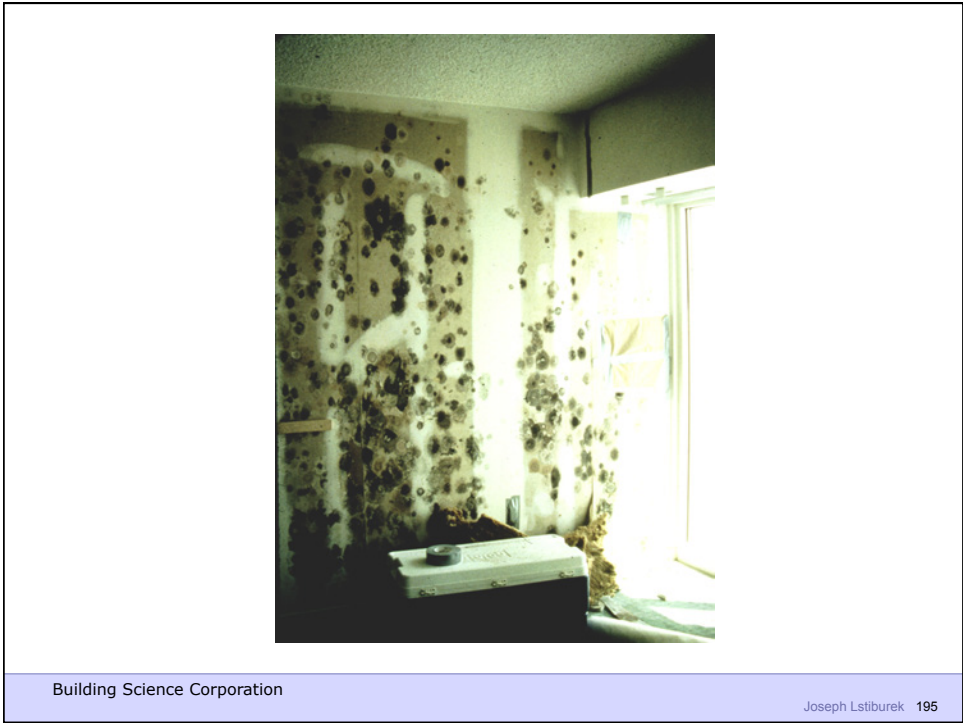
Figure 2.12
Three Dimensional Multi-Layer Multi-Cell Non-Contiguous Analogue

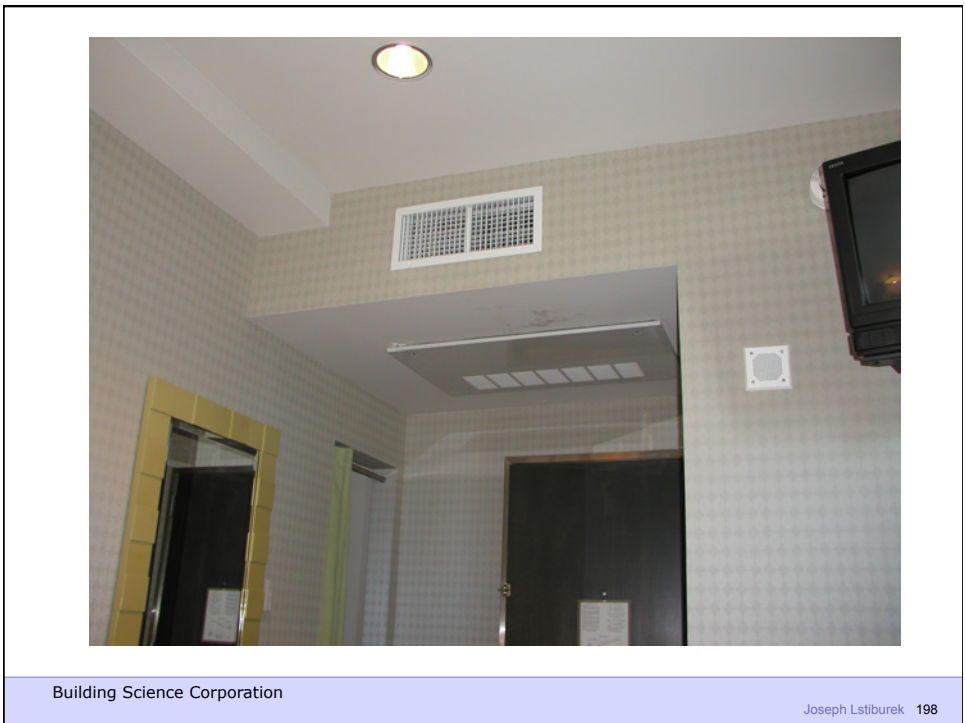
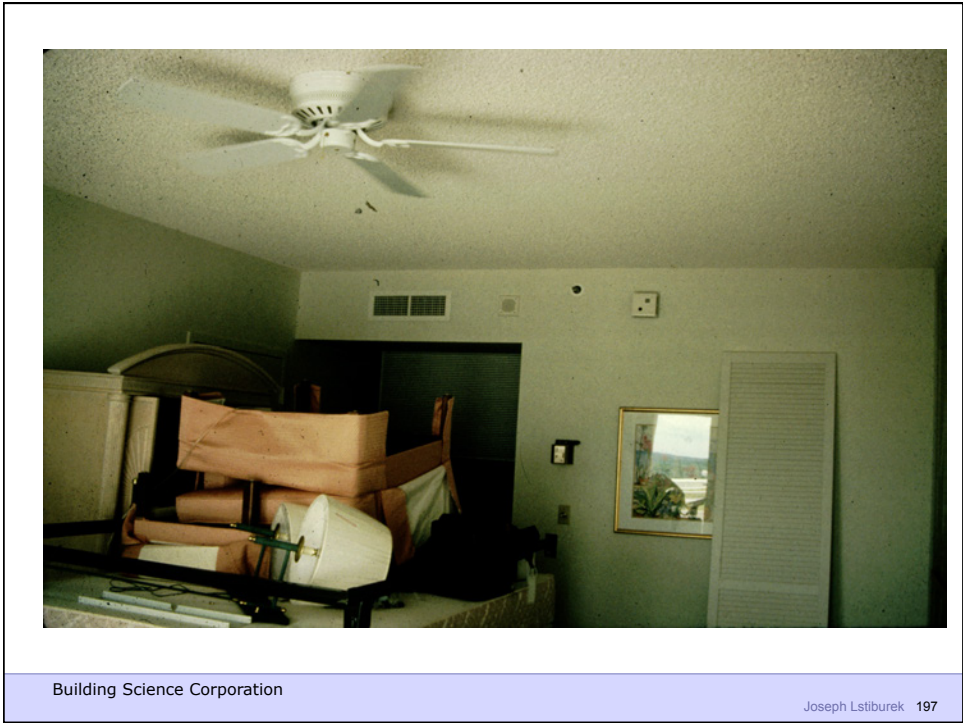
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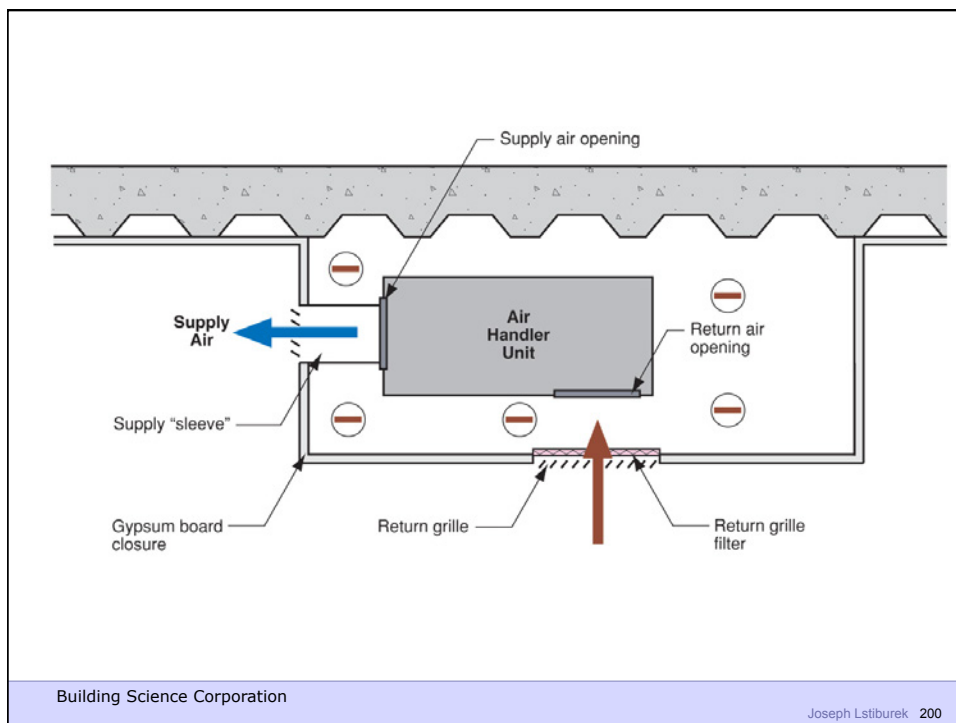
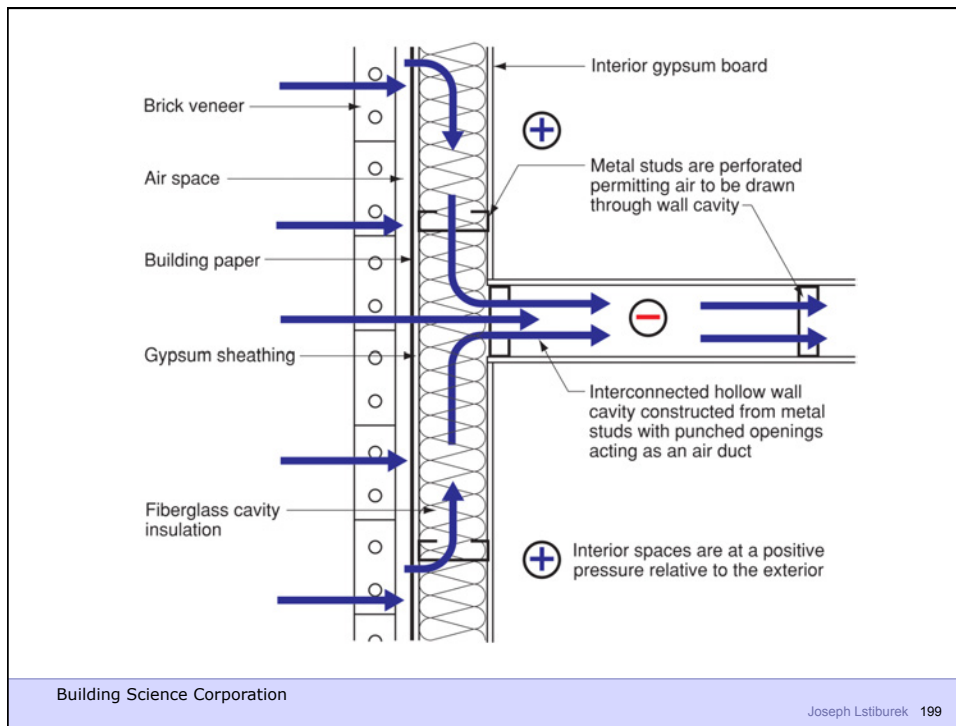
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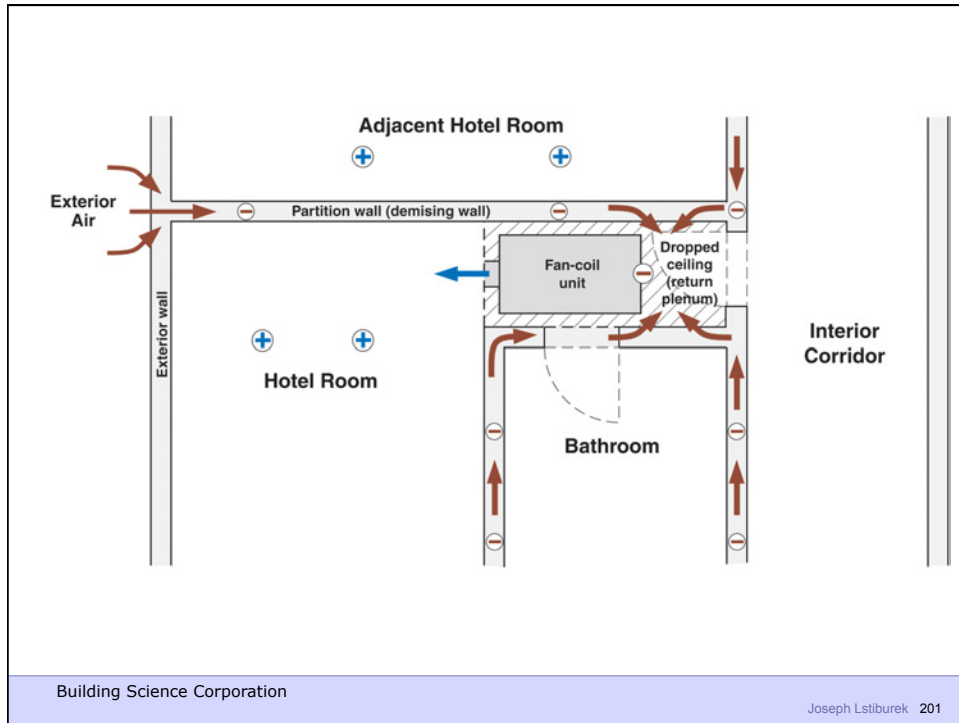




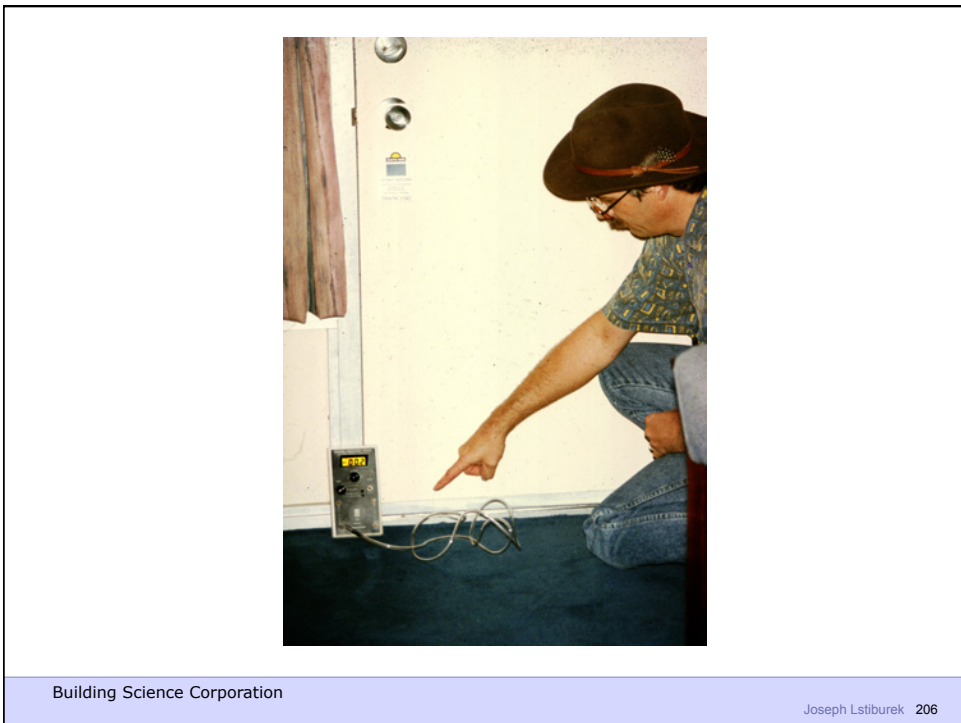
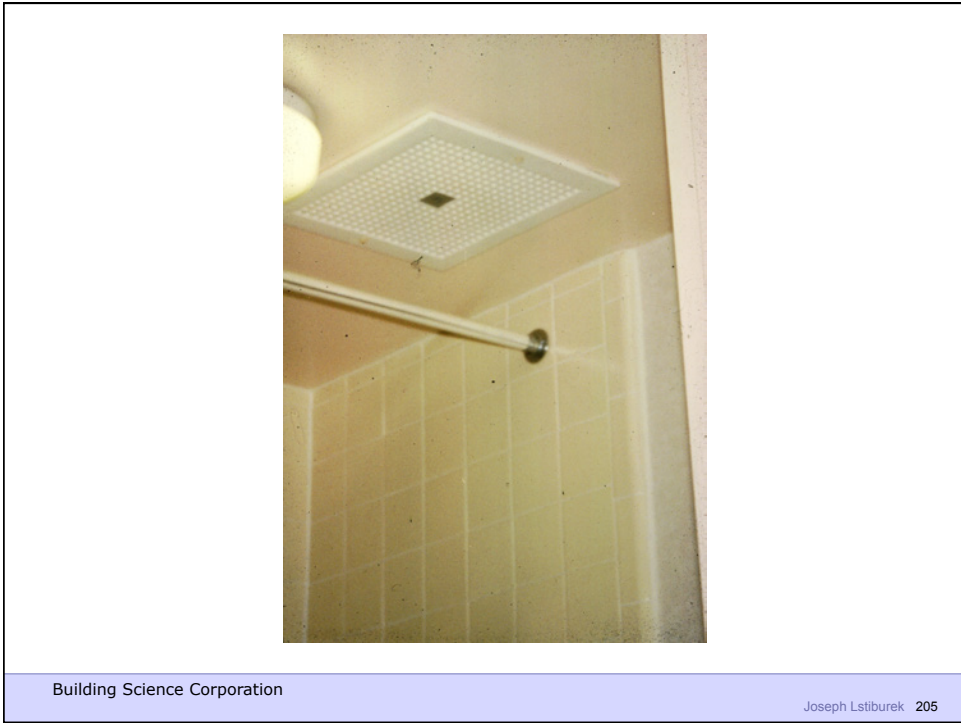
















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