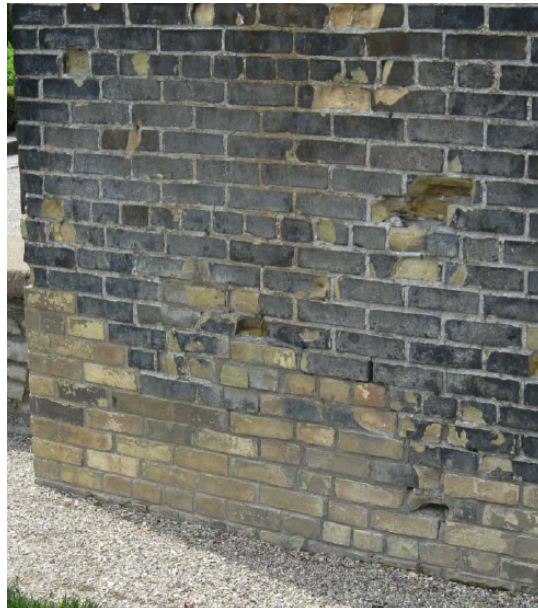


Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

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Freeze-Thaw Damage

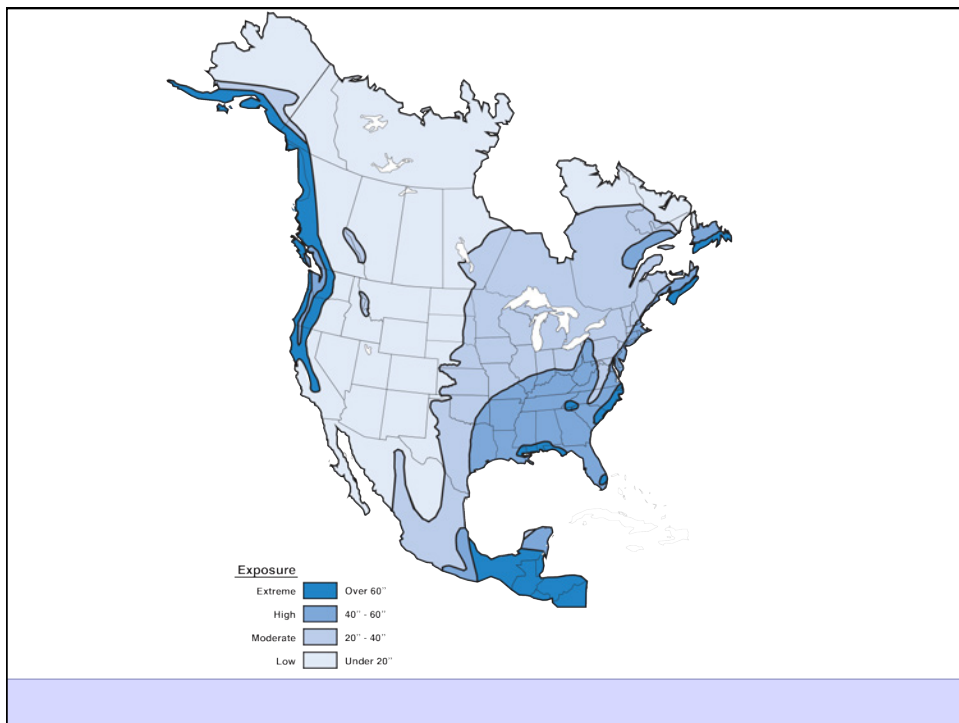
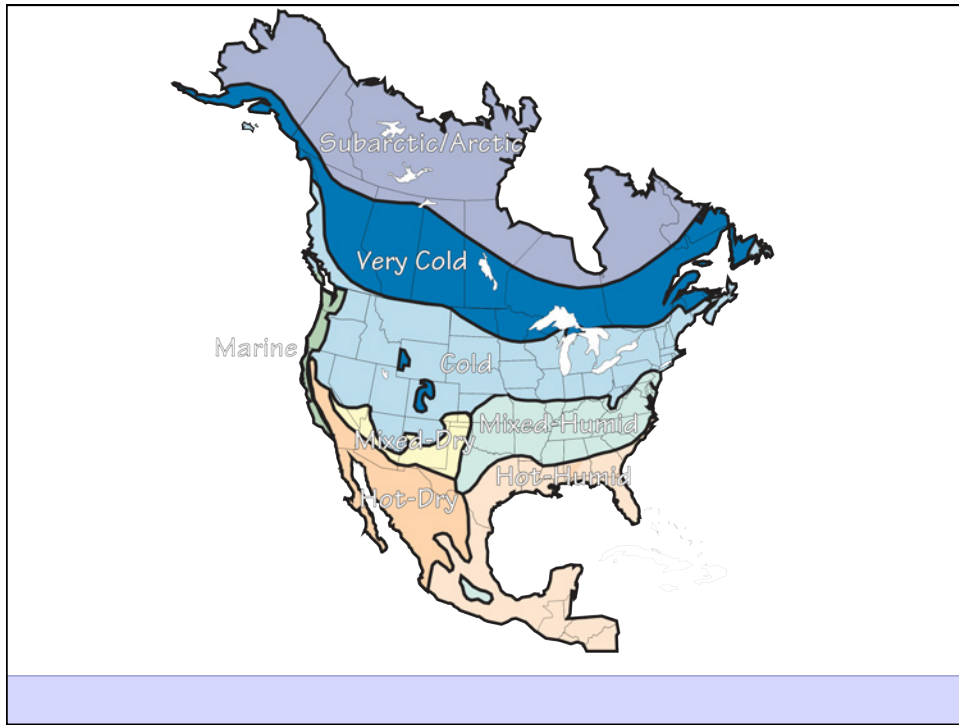
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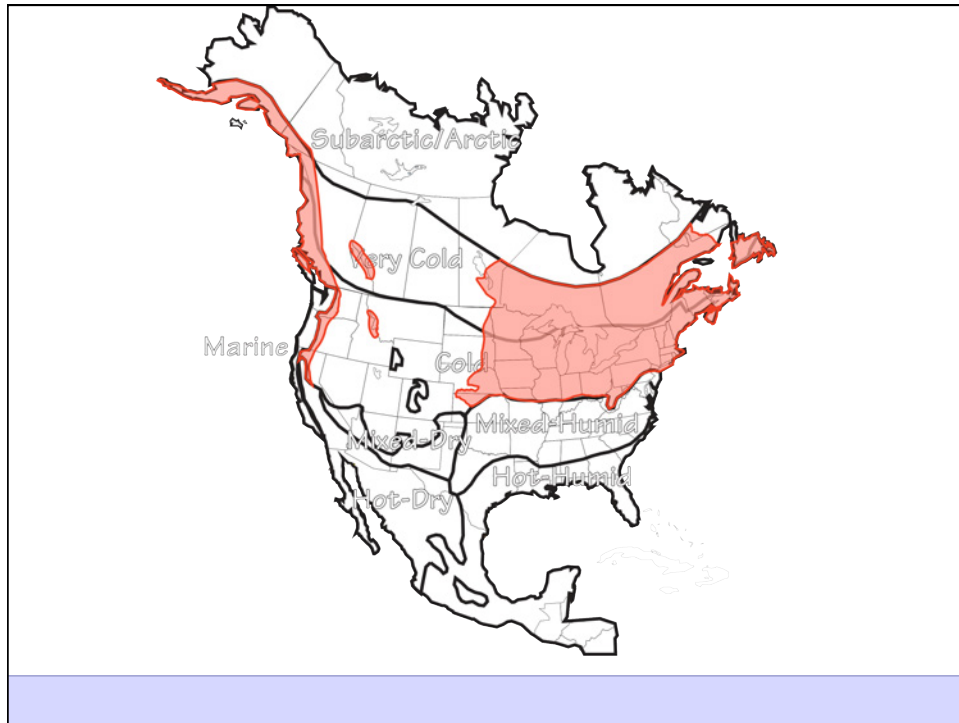
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Freeze-Thaw Damage
Freezing Temperatures
Water
Susceptible Brick

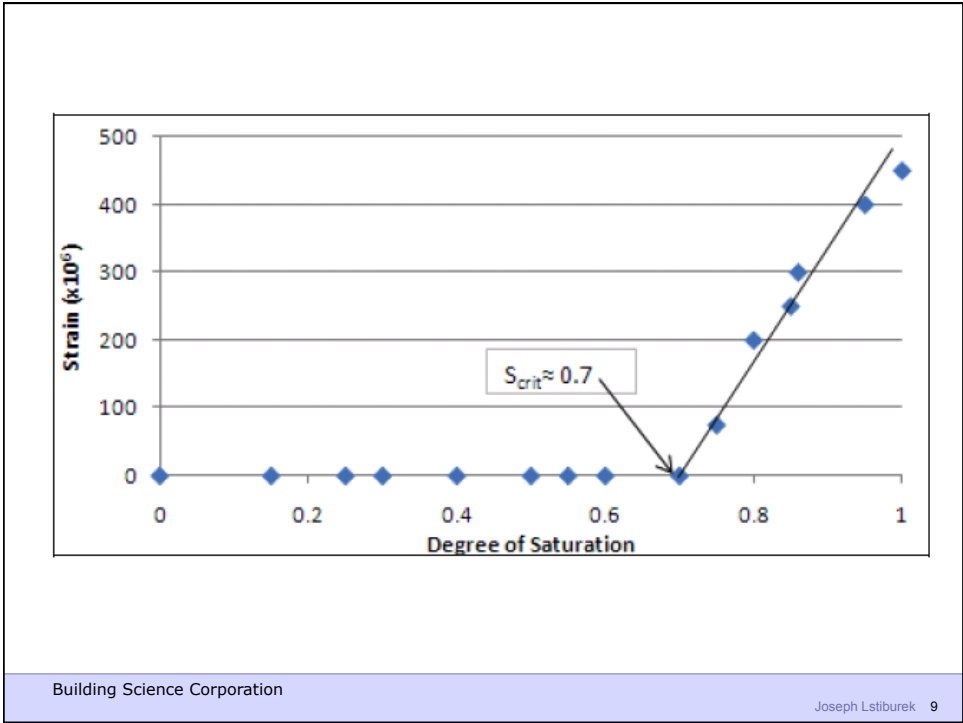
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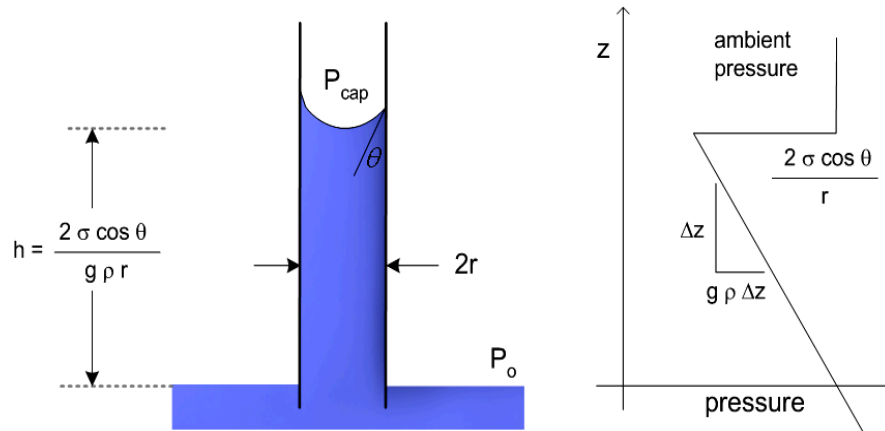




Susceptible Brick
Firing Temperature
Vitrification



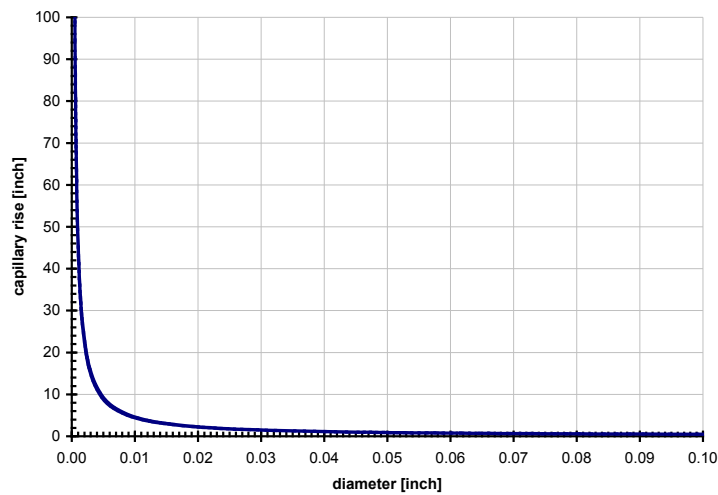
Calculating capillary rise



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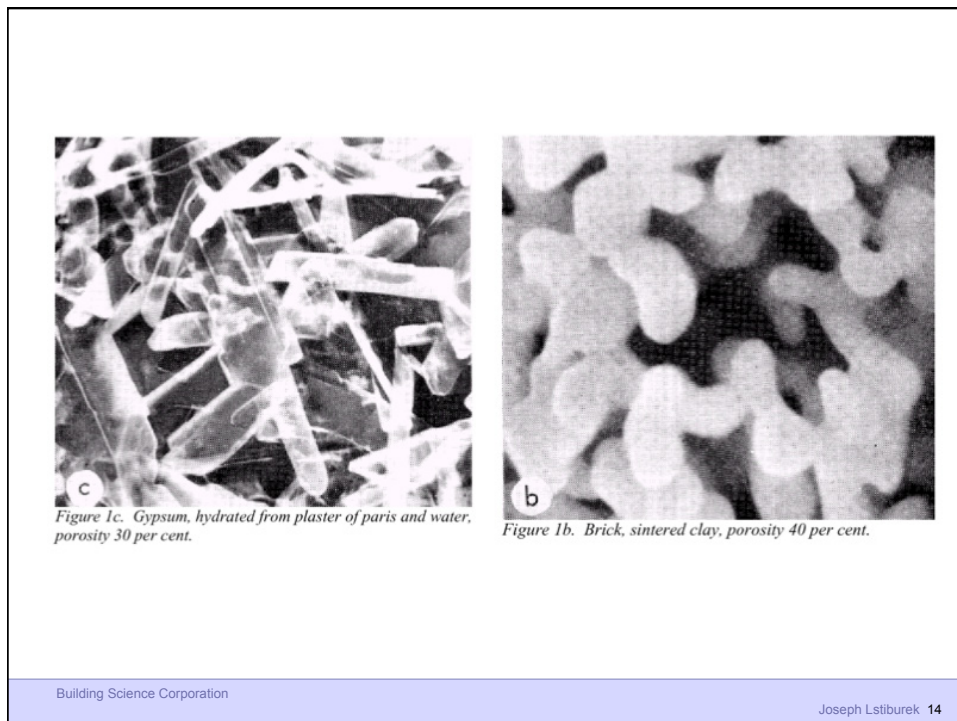
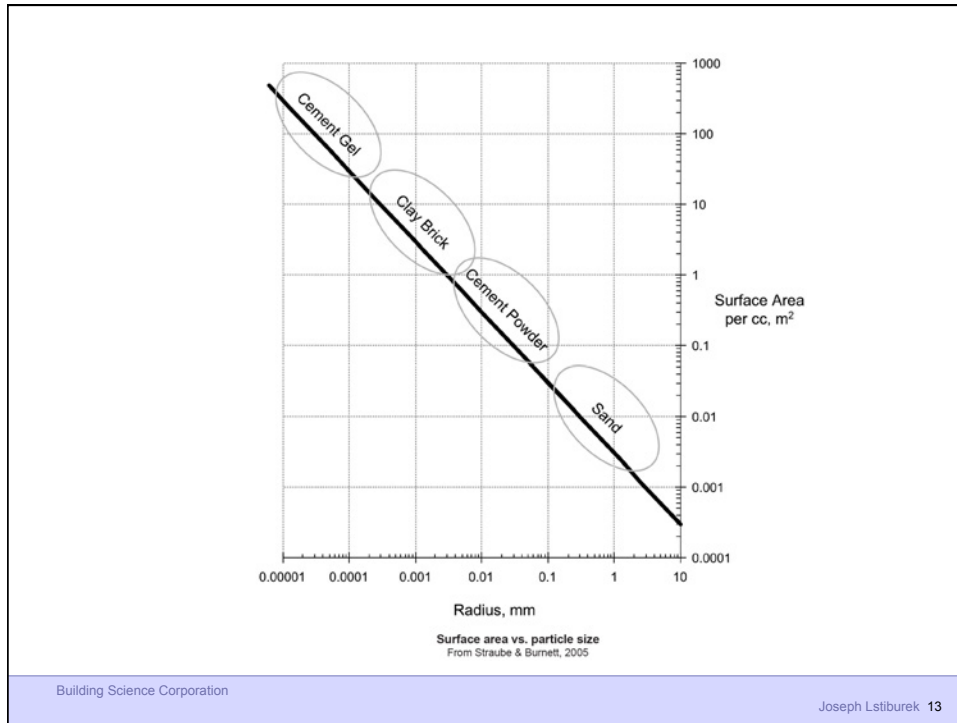
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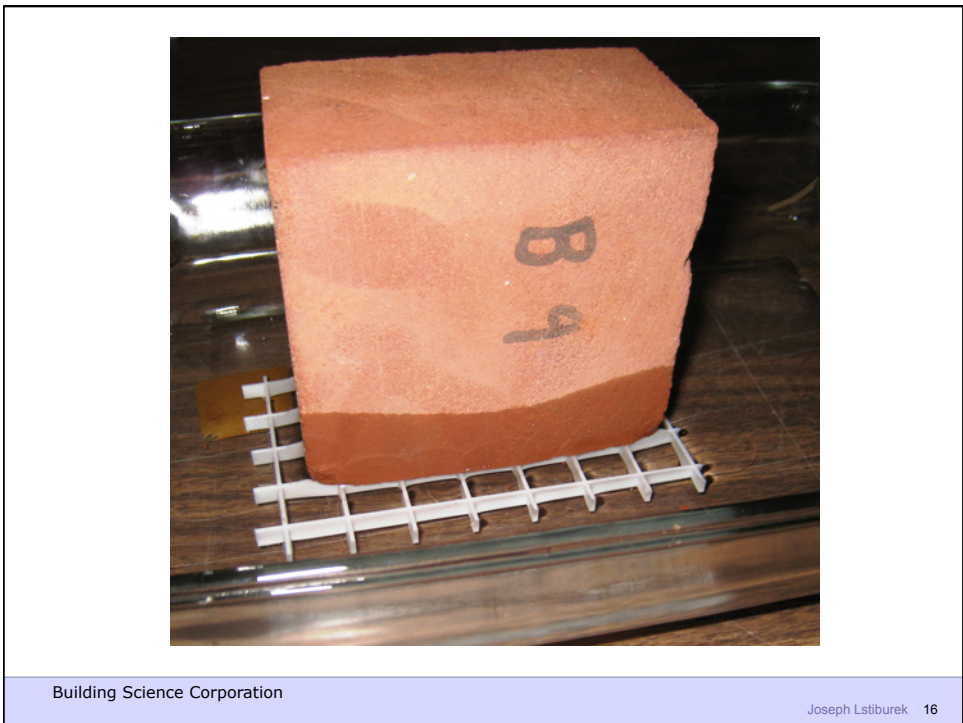
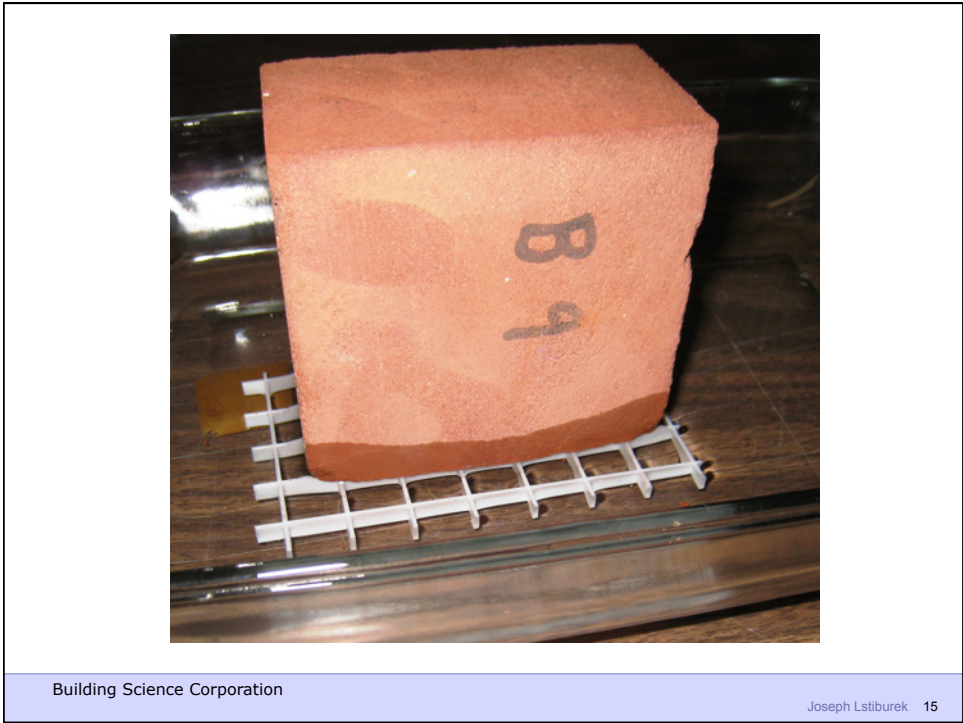
Capillary rise versus diameter

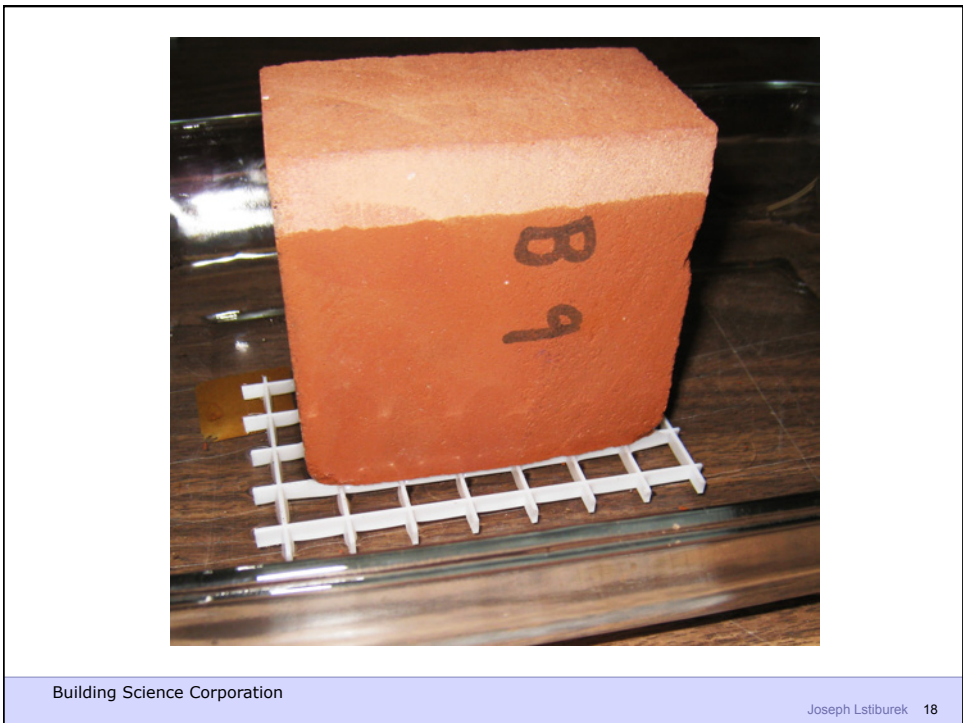
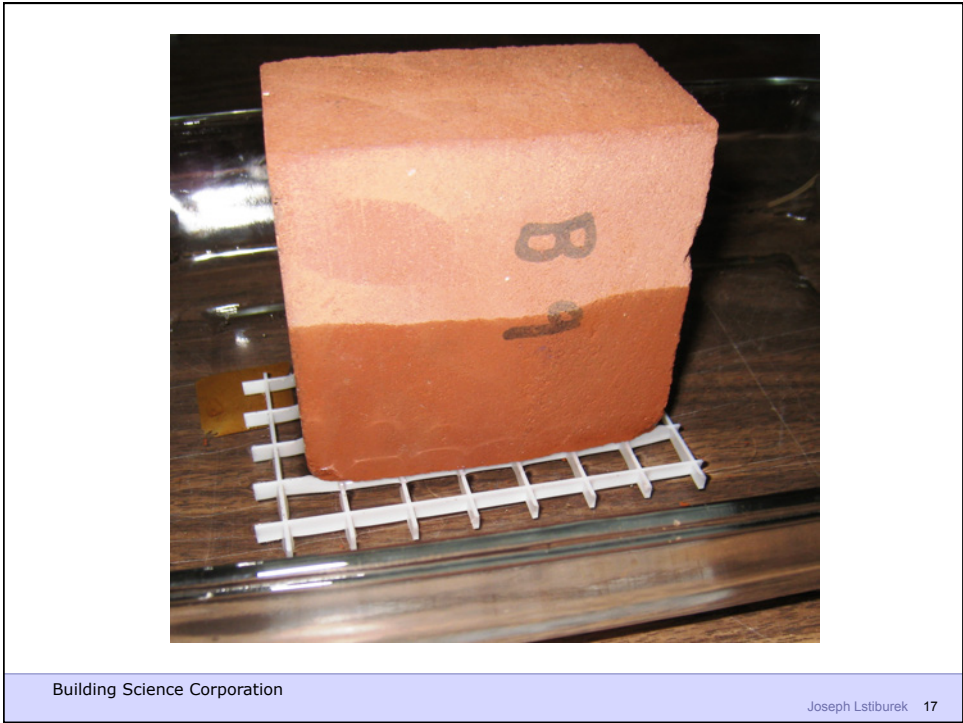


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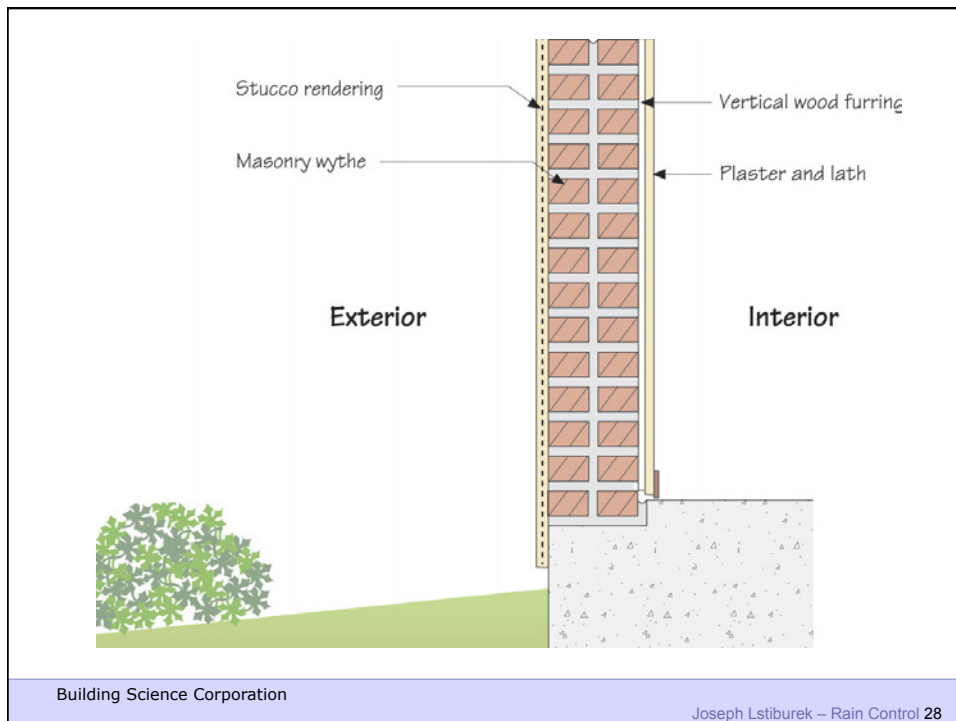
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Joseph Lstiburek – Rain Control 27



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Joseph Lstiburek – Rain Control 28



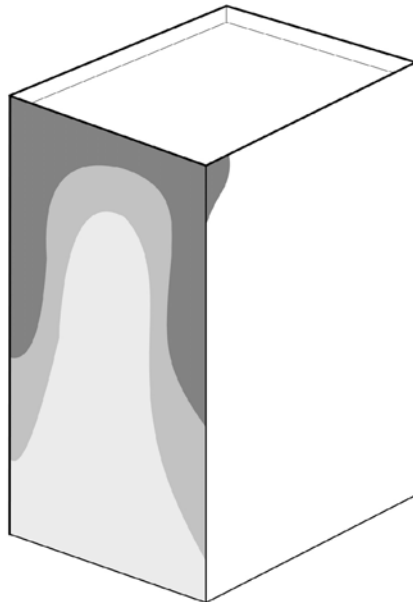
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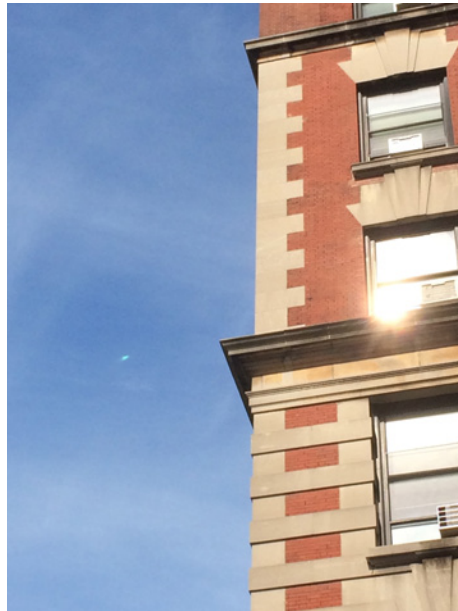
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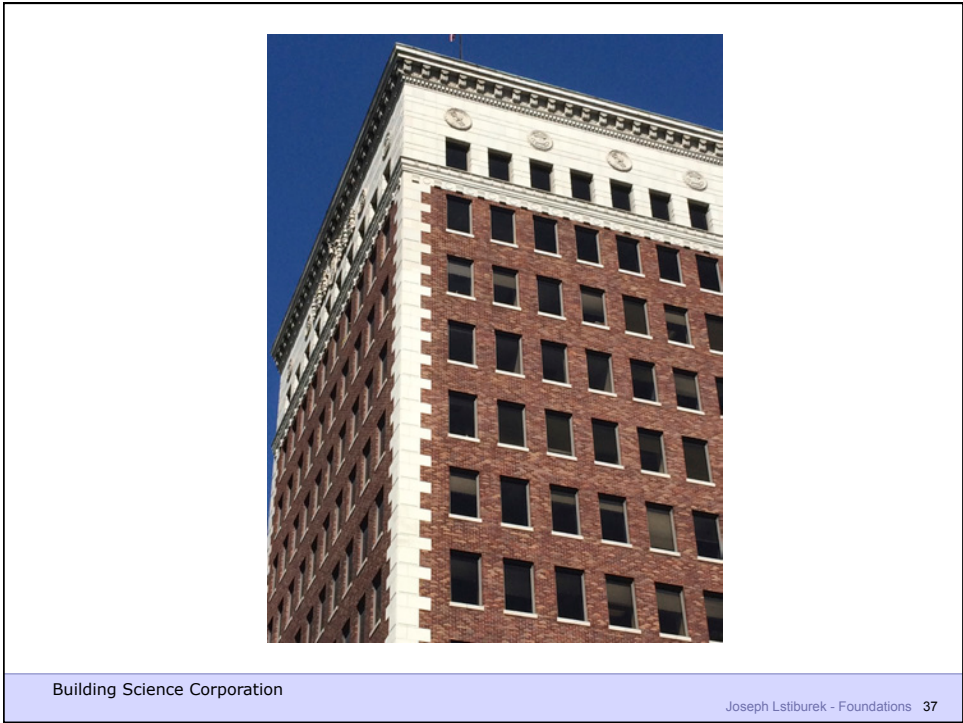
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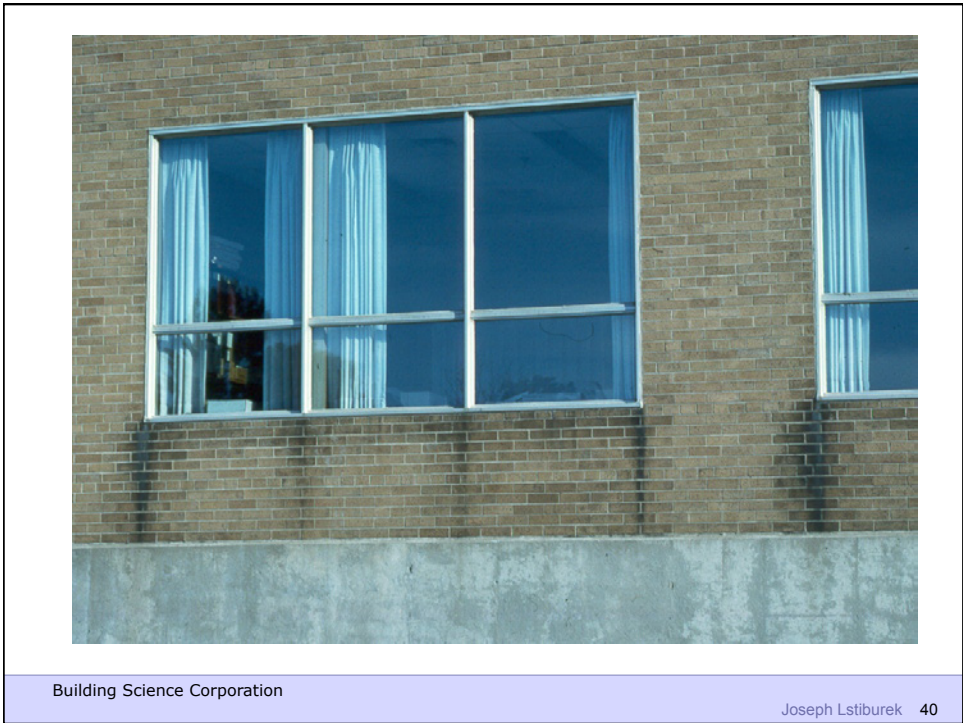
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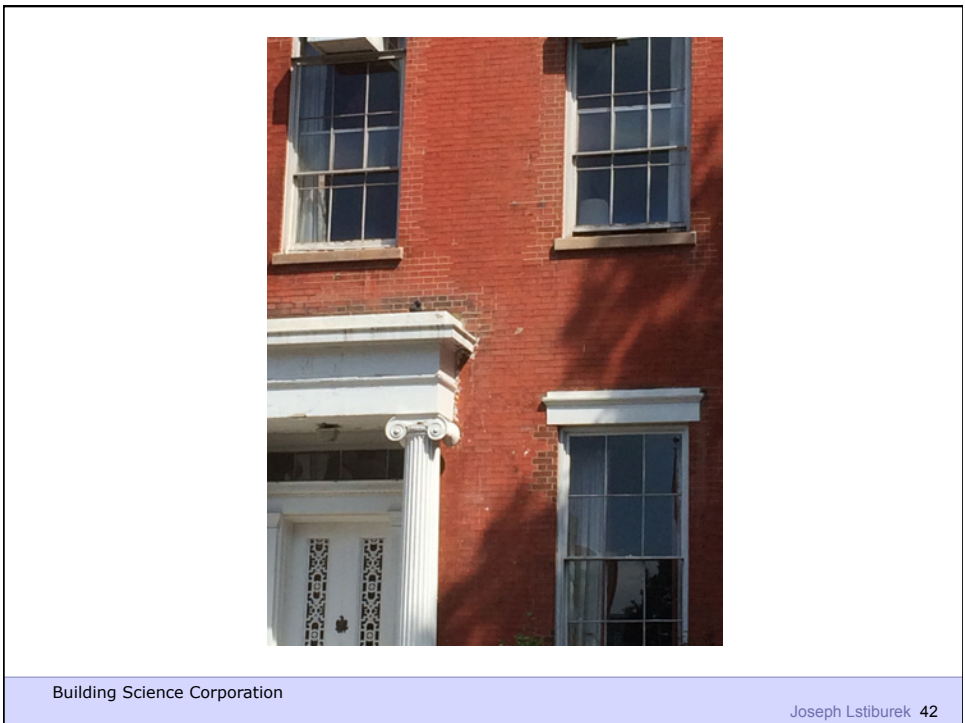
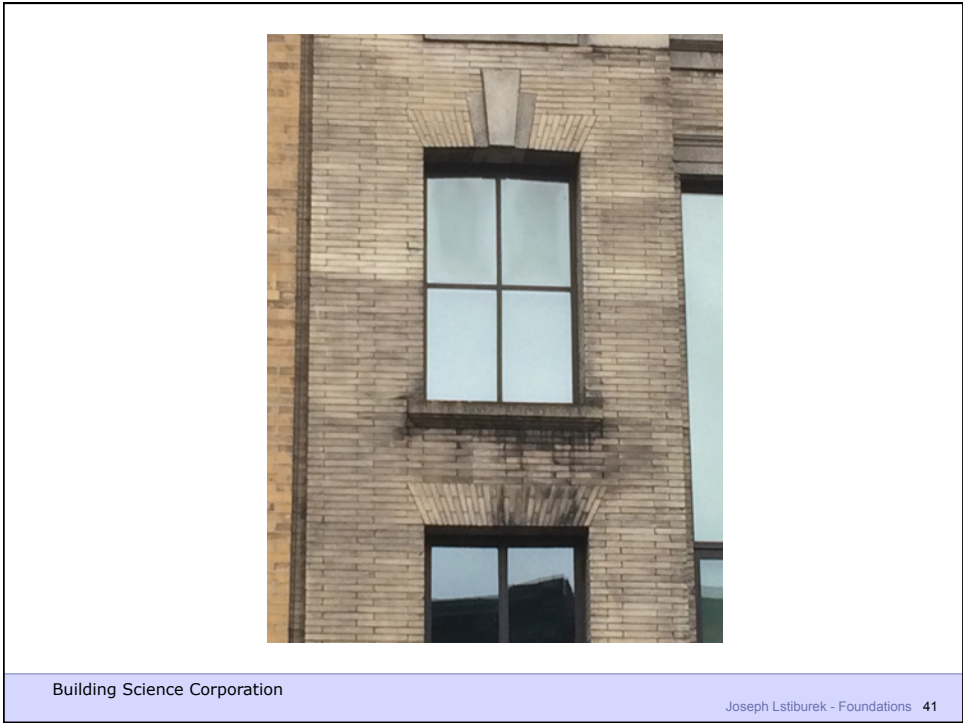


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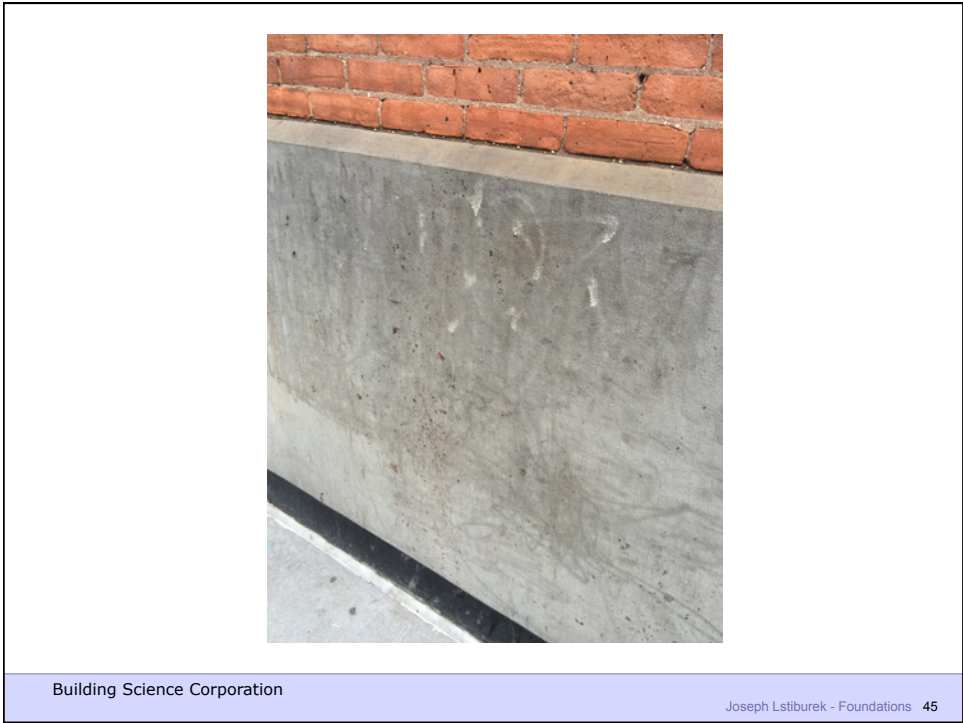
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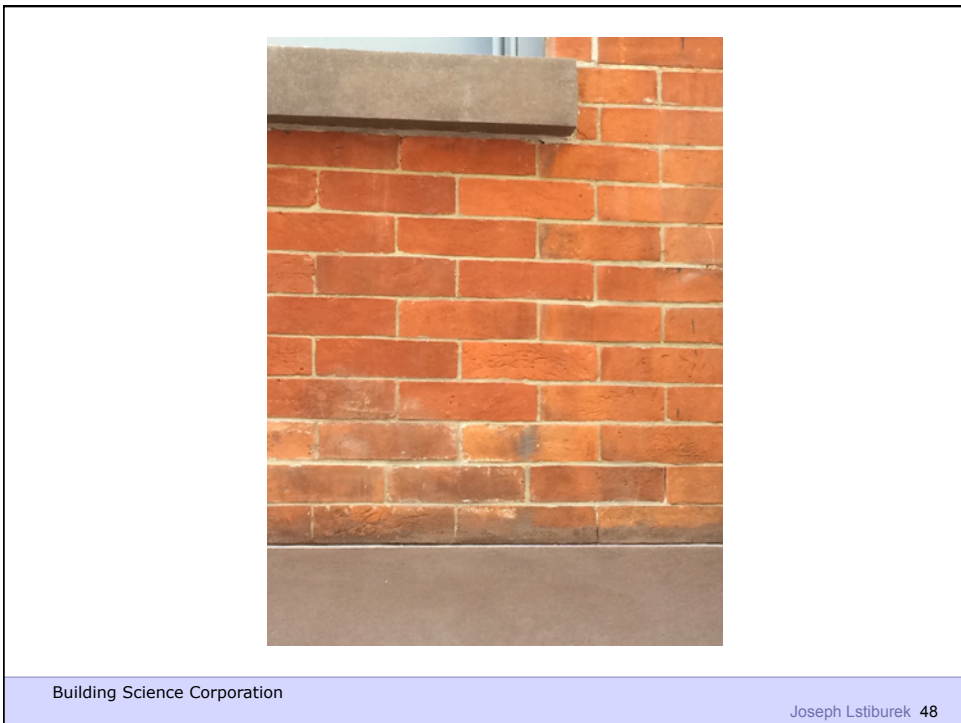
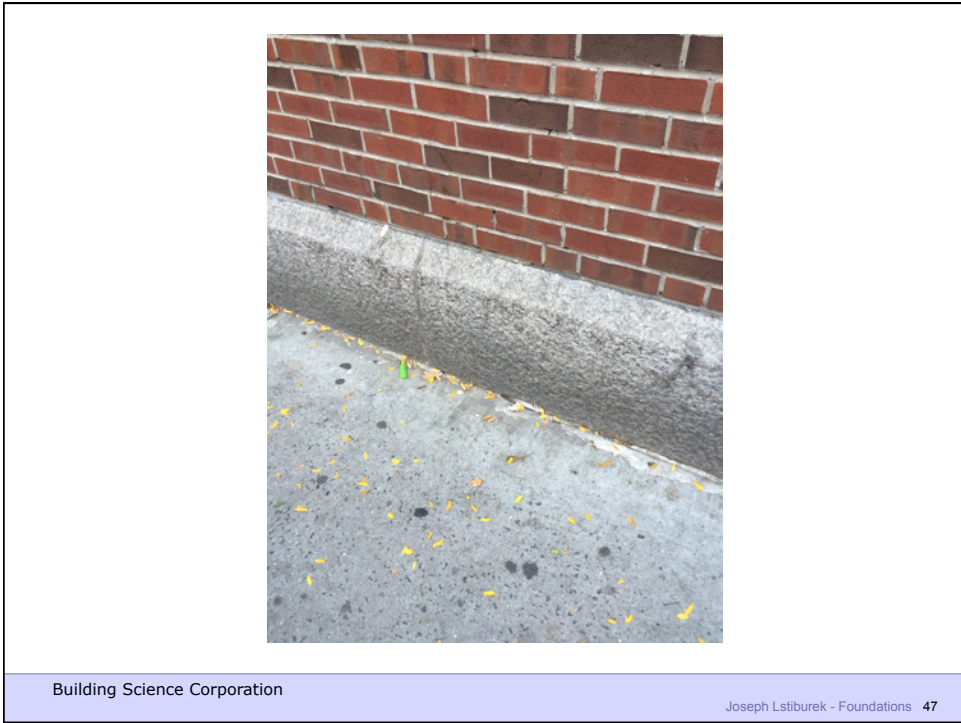










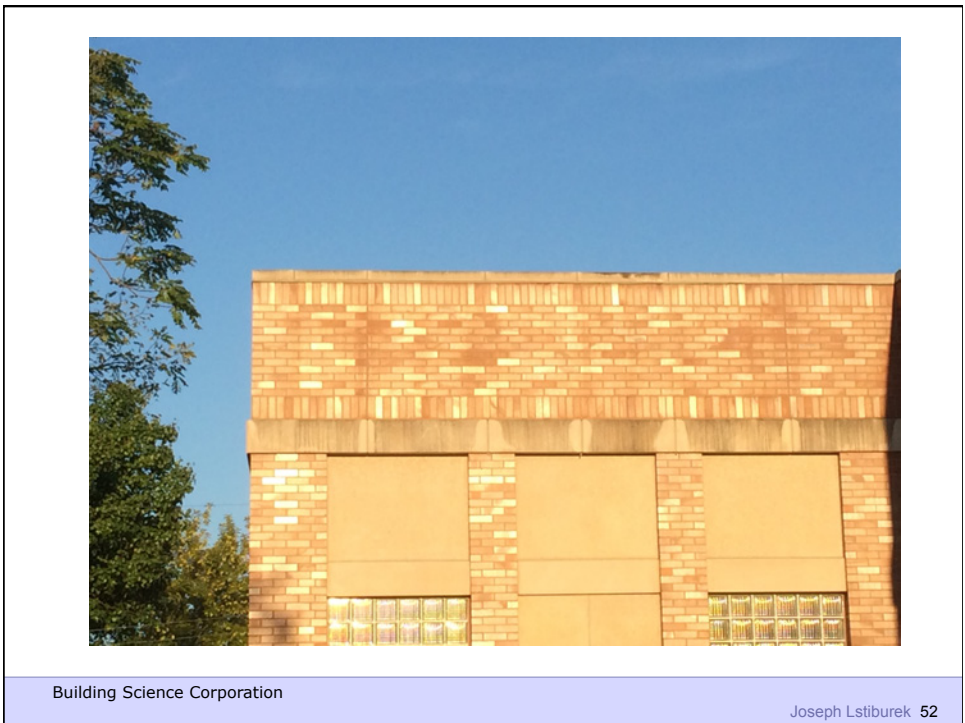
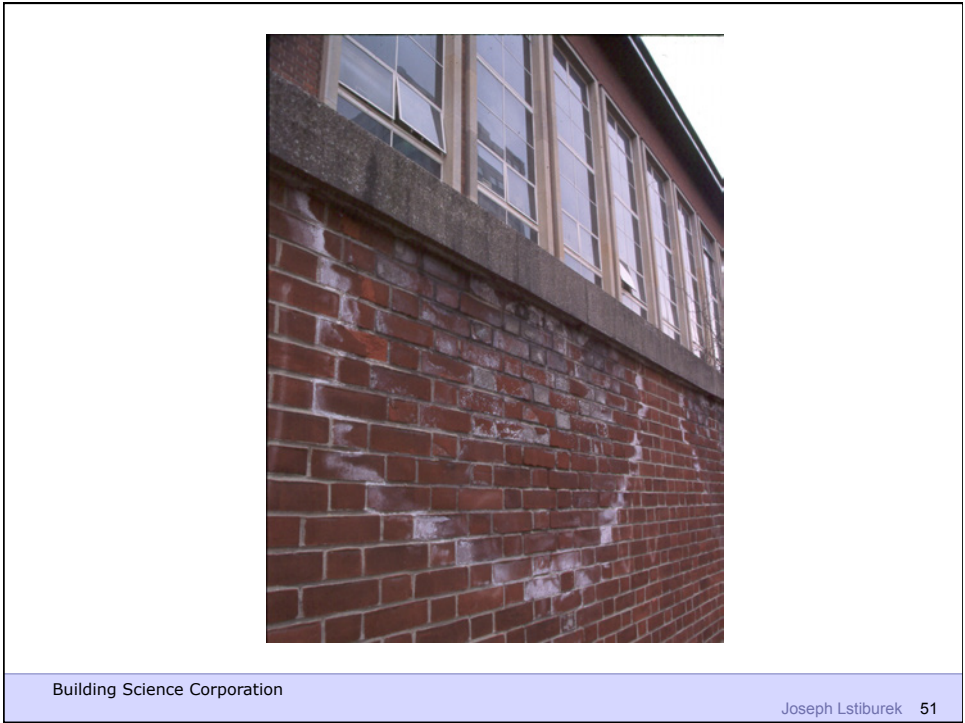




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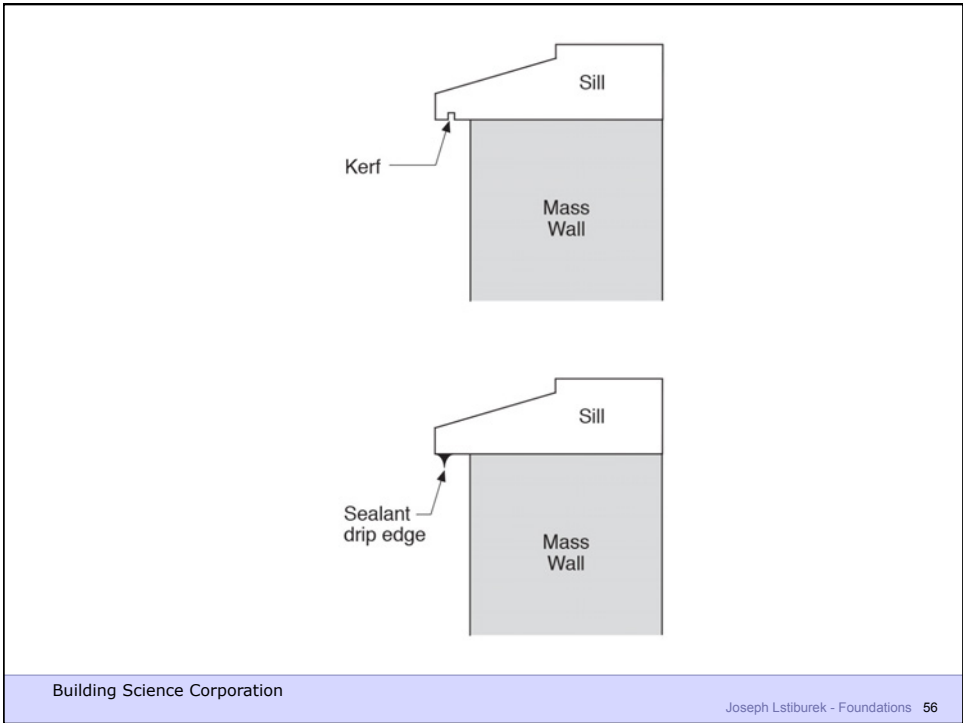
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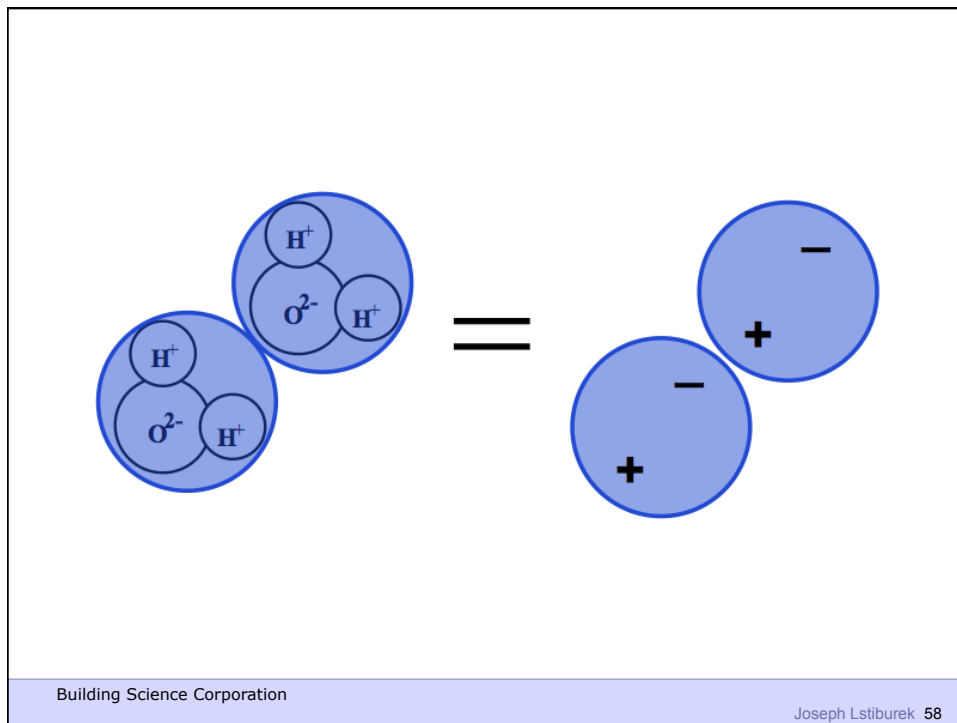
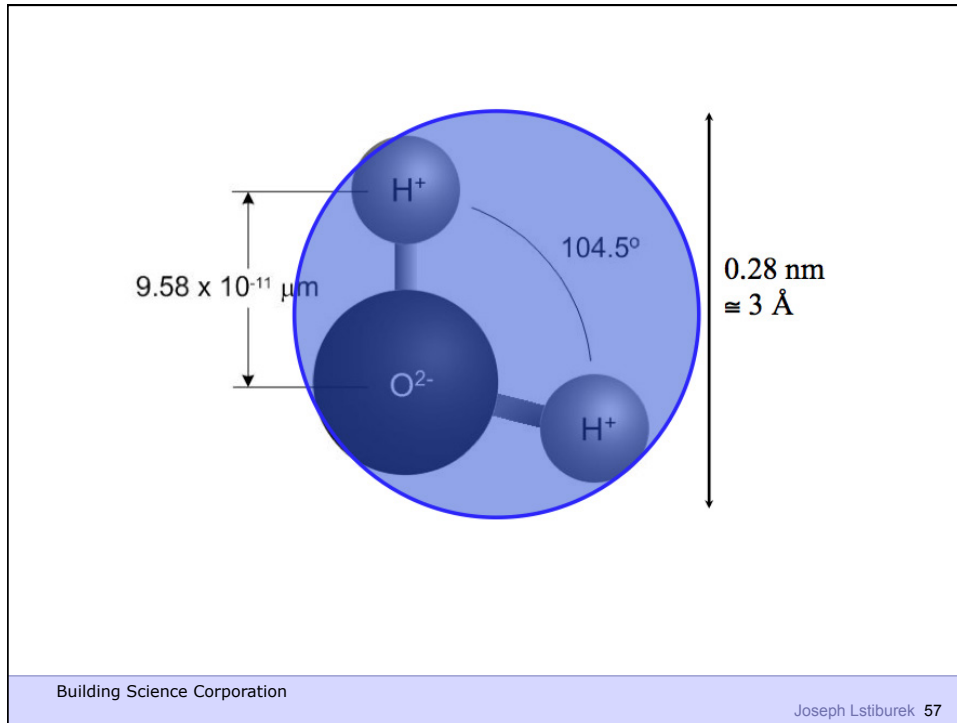
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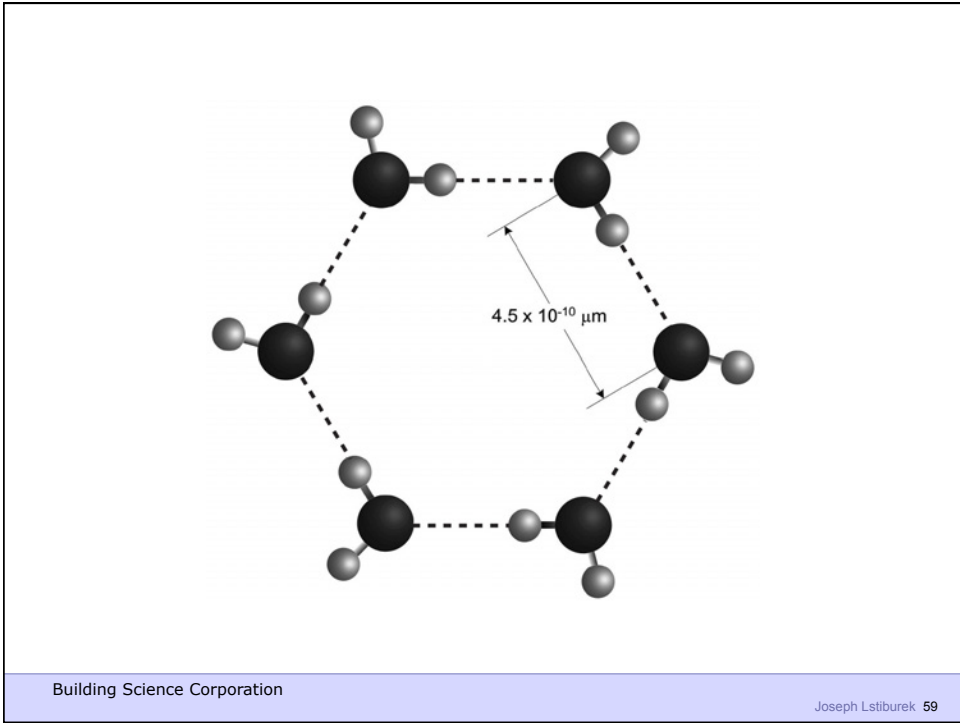


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2nd Law of Thermodynamics

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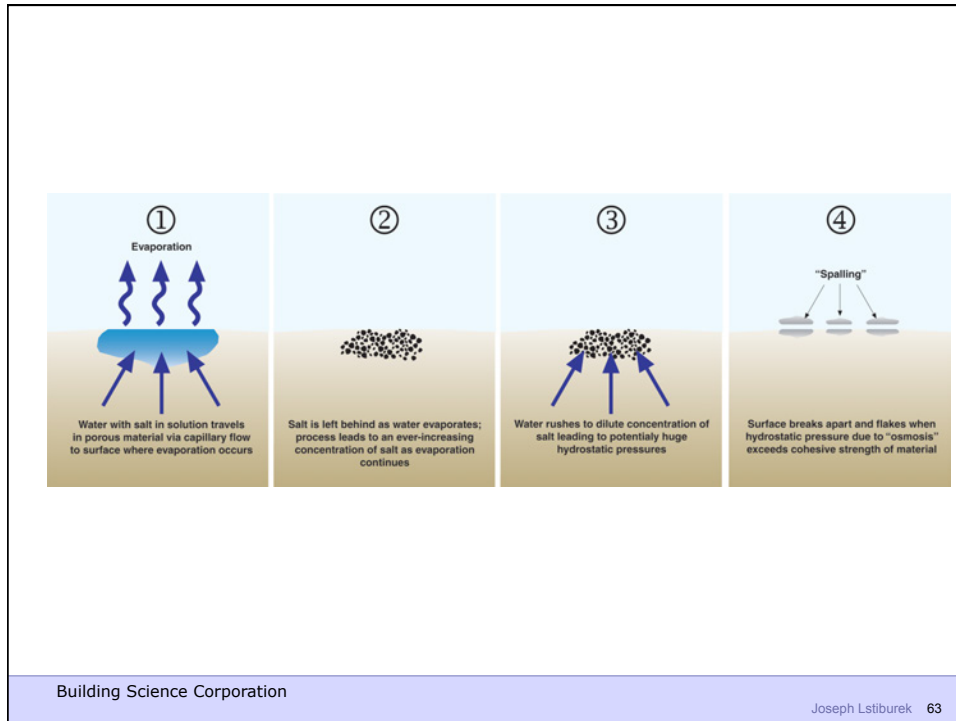
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Moisture Transport in Porous Media		
Phase	Transport Process	Driving Potential
Vapor	Diffusion	Vapor Concentration
Adsorbate	Surface Diffusion	Concentration
Liquid	Capillary Flow	Suction Pressure
	Osmosis	Solute Concentration

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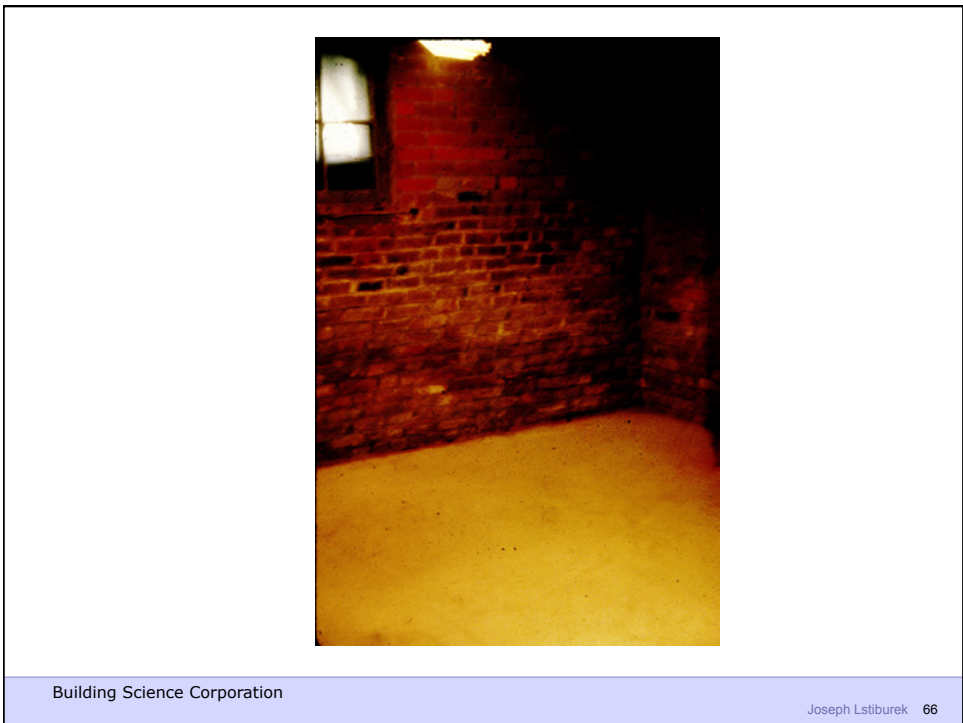
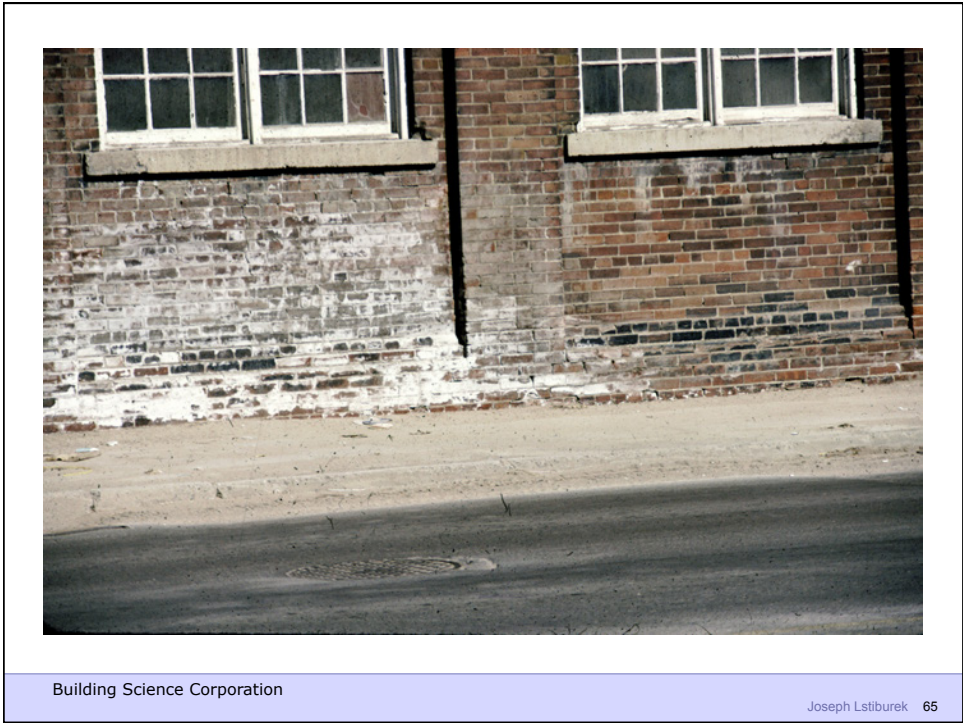
Capillarity + Salt = Osmosis
<ul style="list-style-type: none"> • Mineral salts carried in solution by capillary water • When water evaporates from a surface the salts left behind form crystals in process called efflorescence • When water evaporated beneath a surface the salts crystallize within the 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

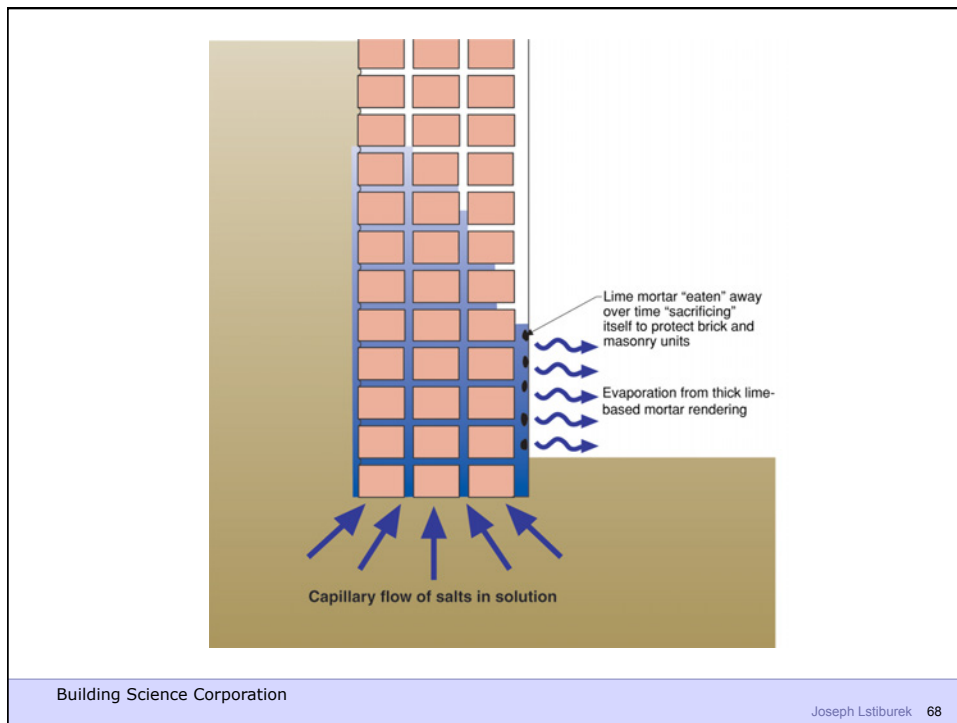
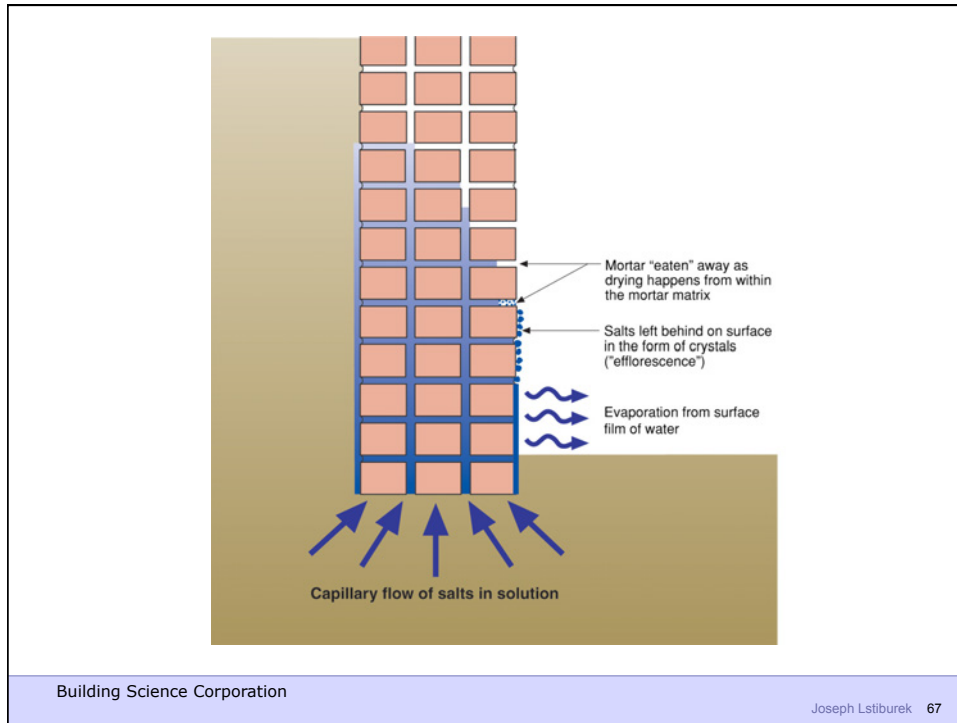
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Diffusion + Capillarity + Osmosis = Problem

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







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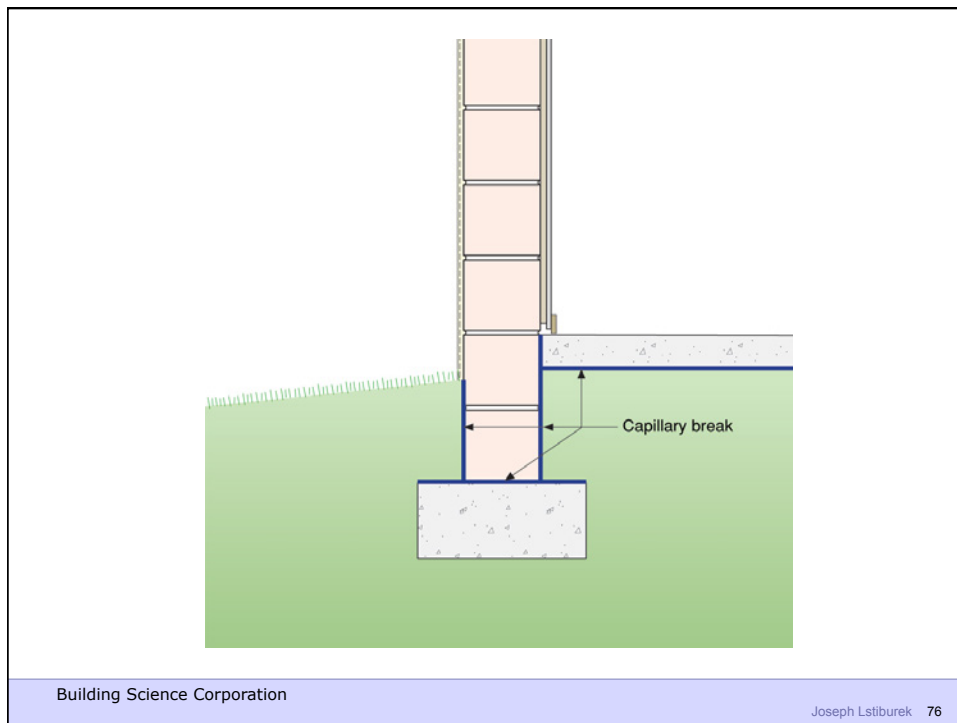
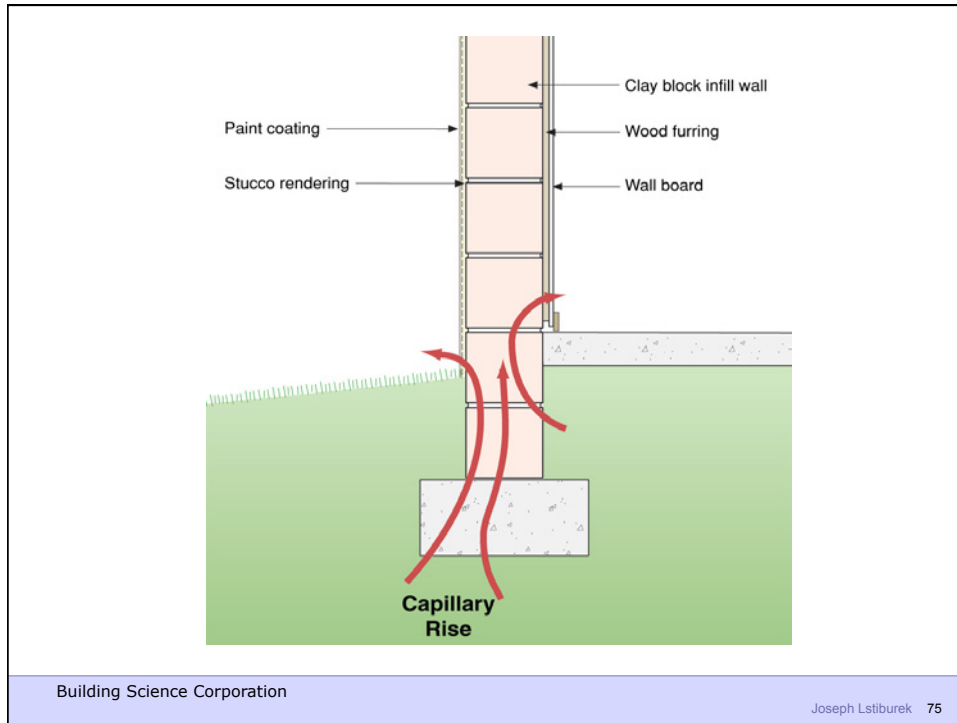
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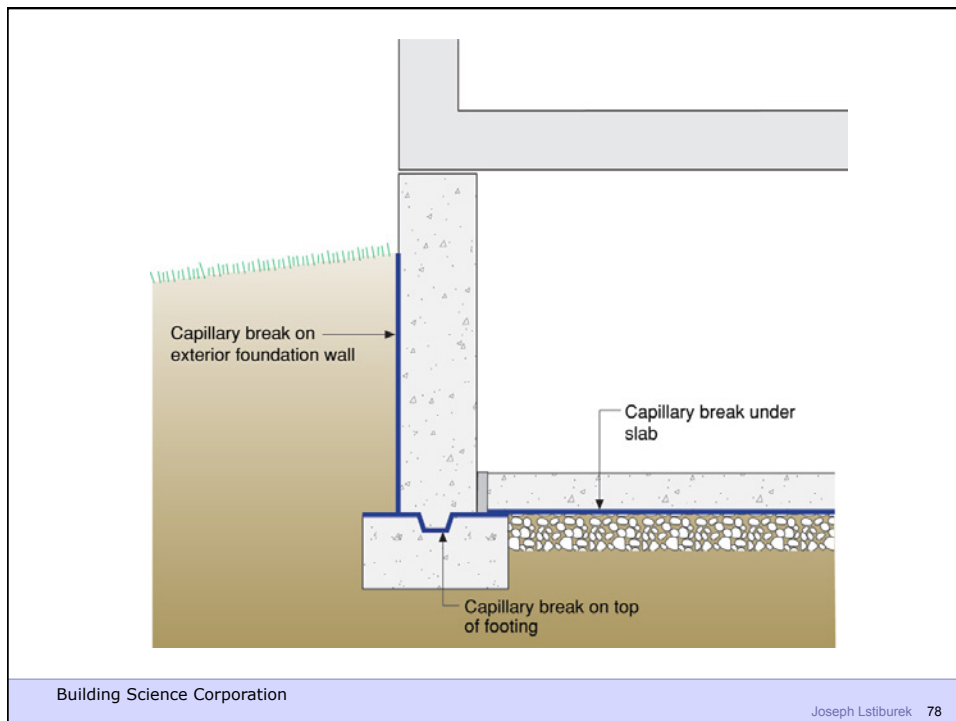
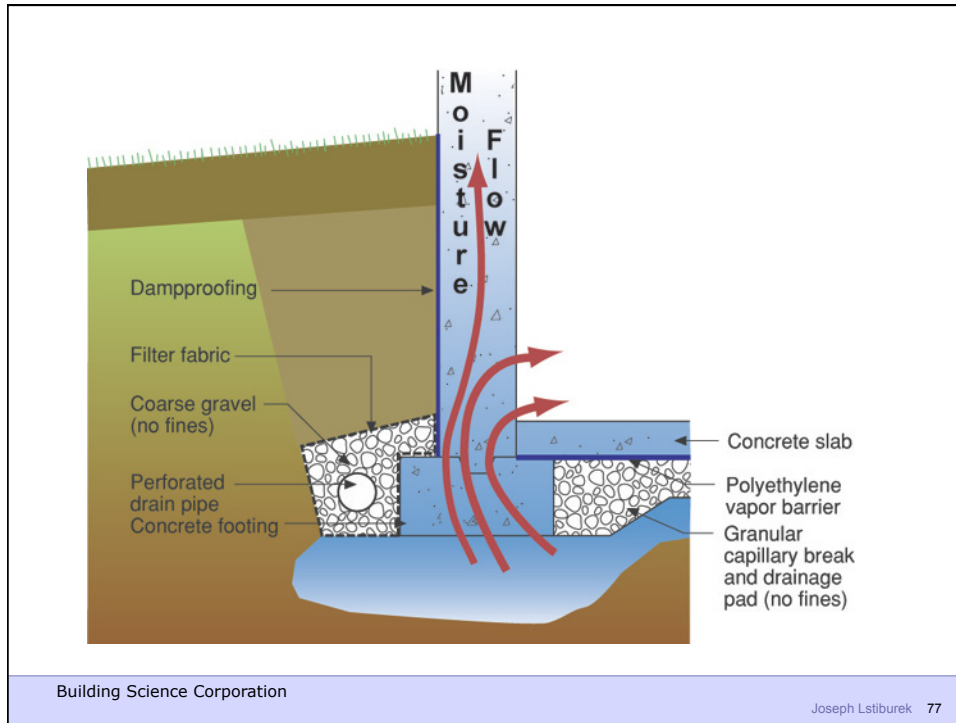


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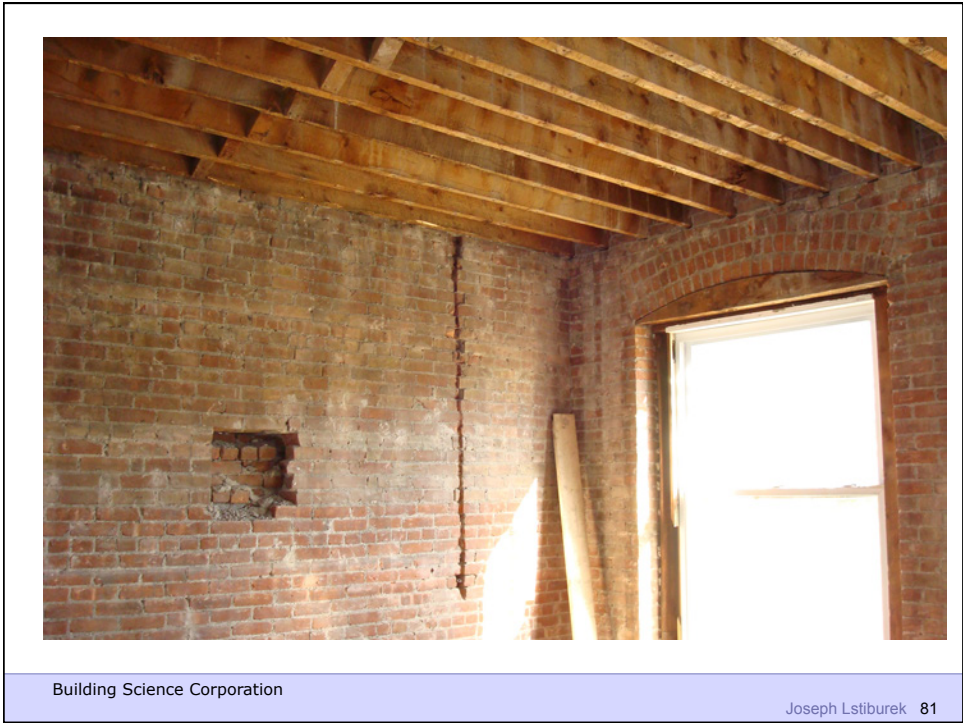
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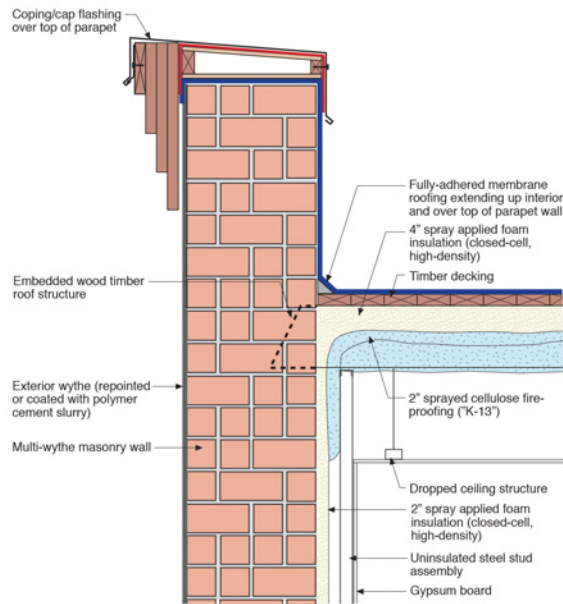
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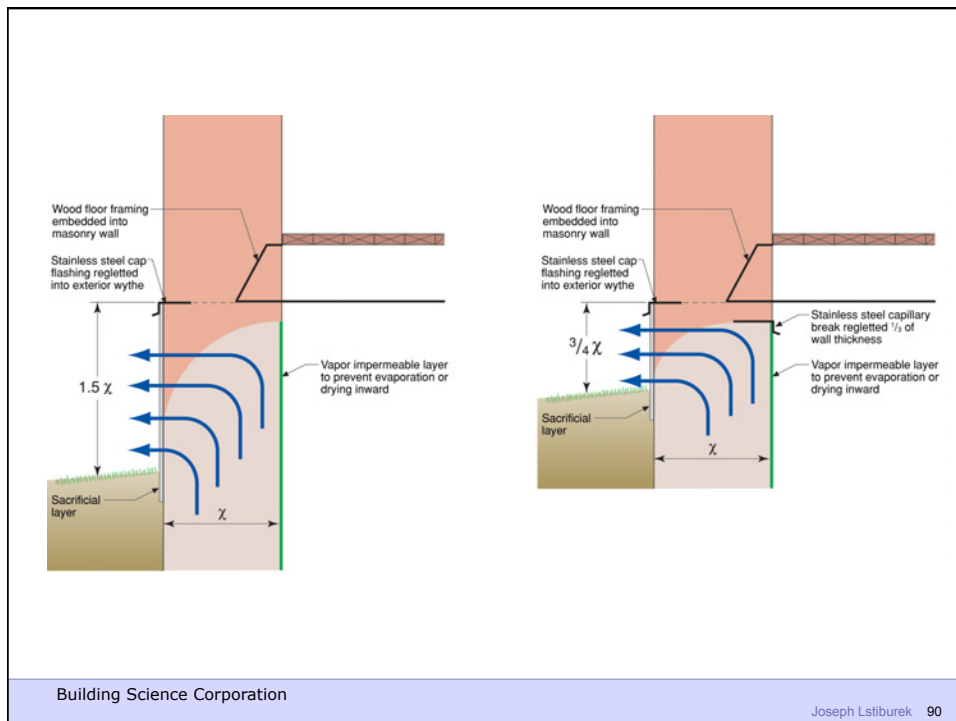
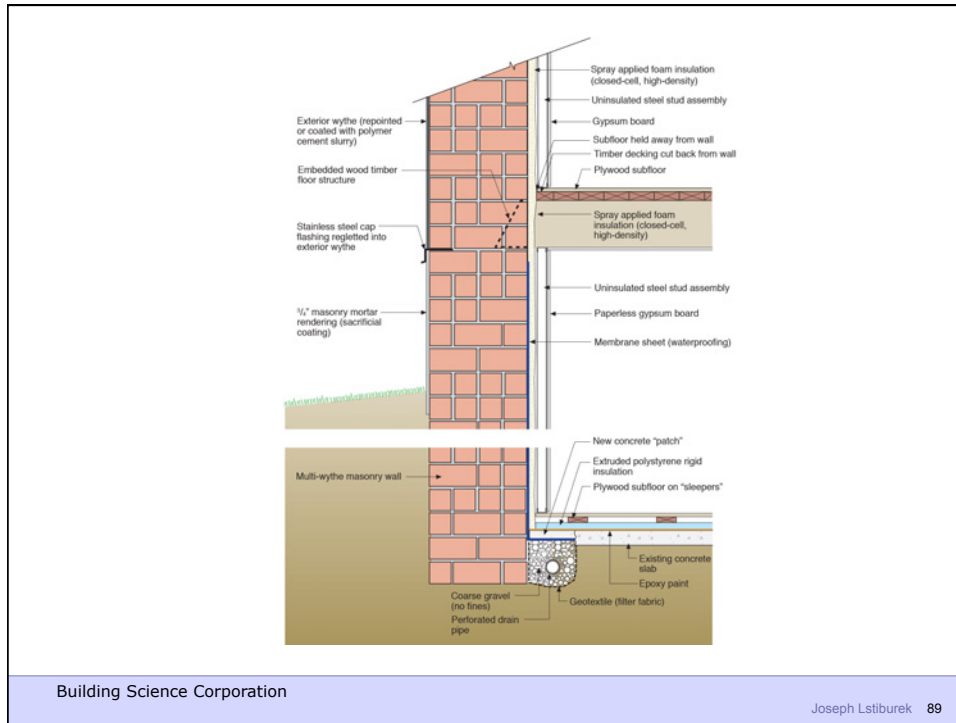
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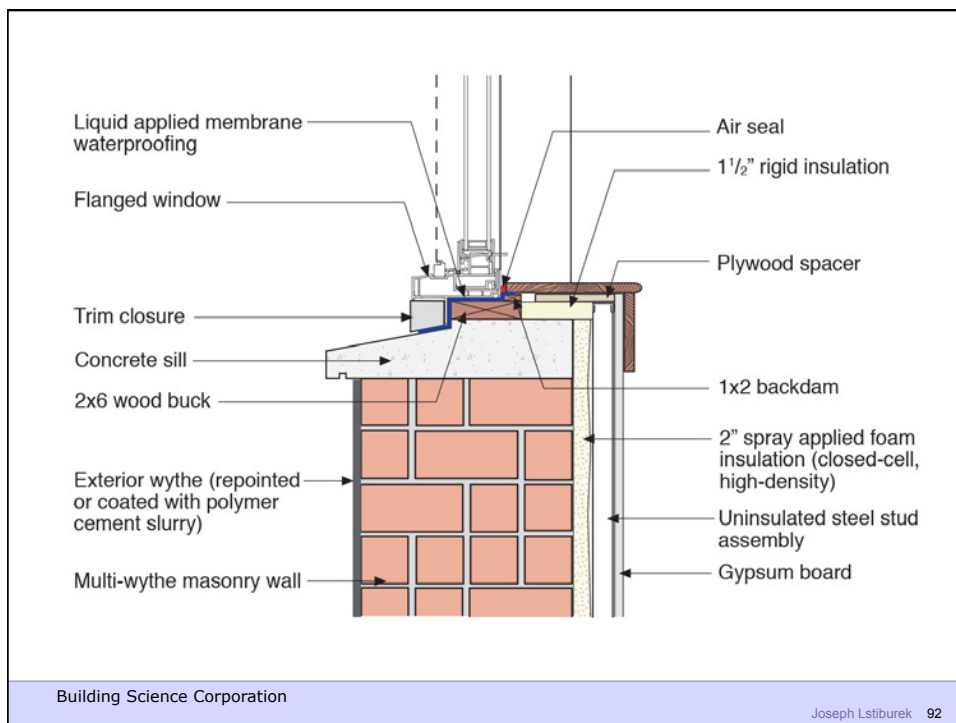
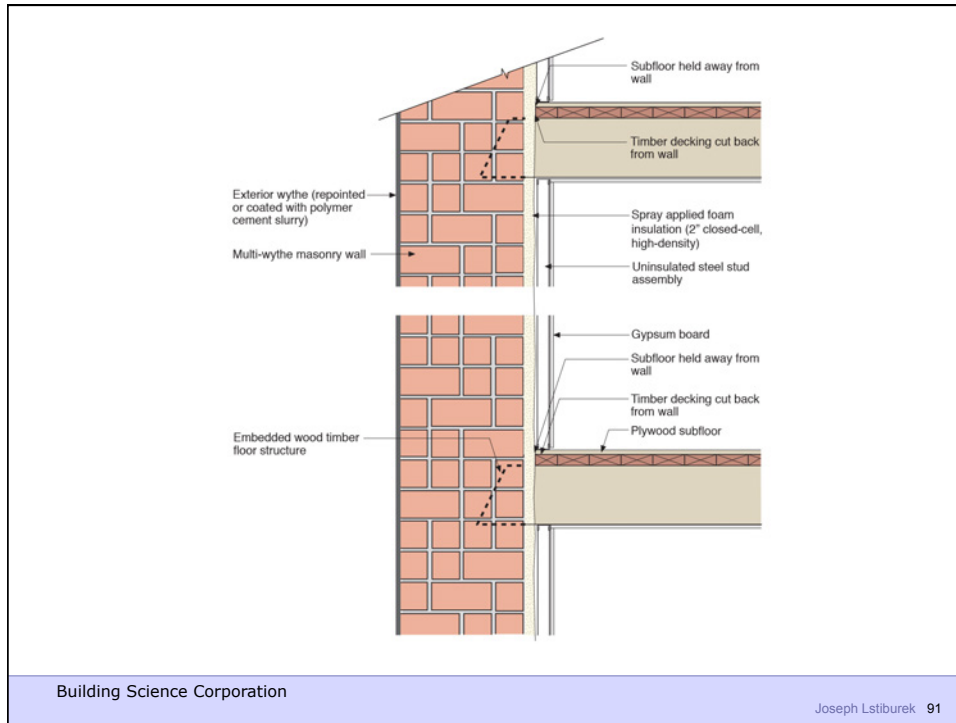
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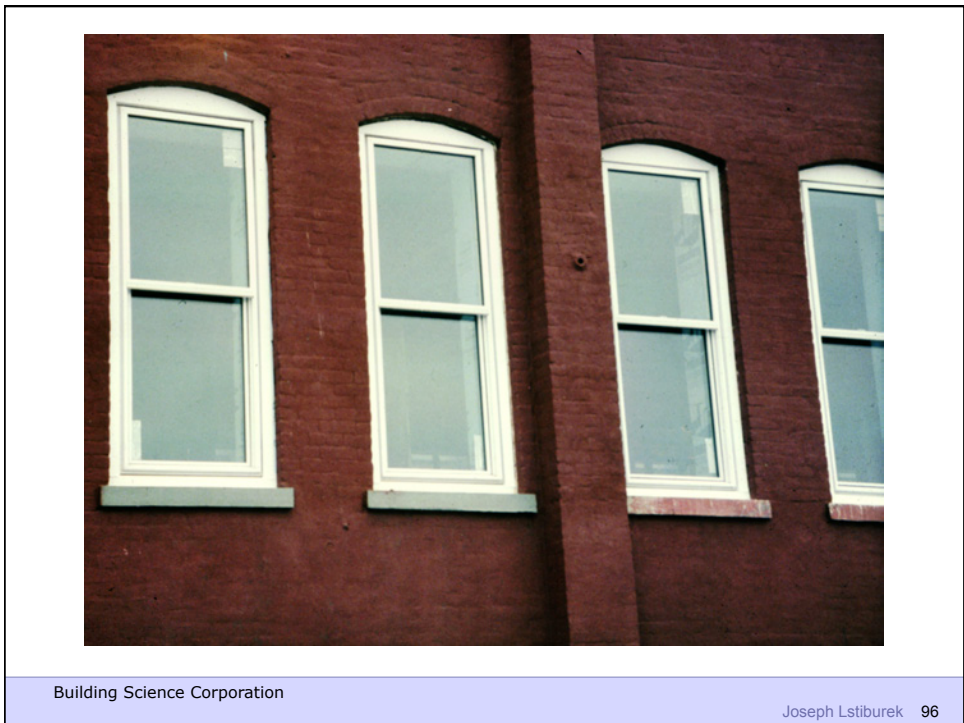
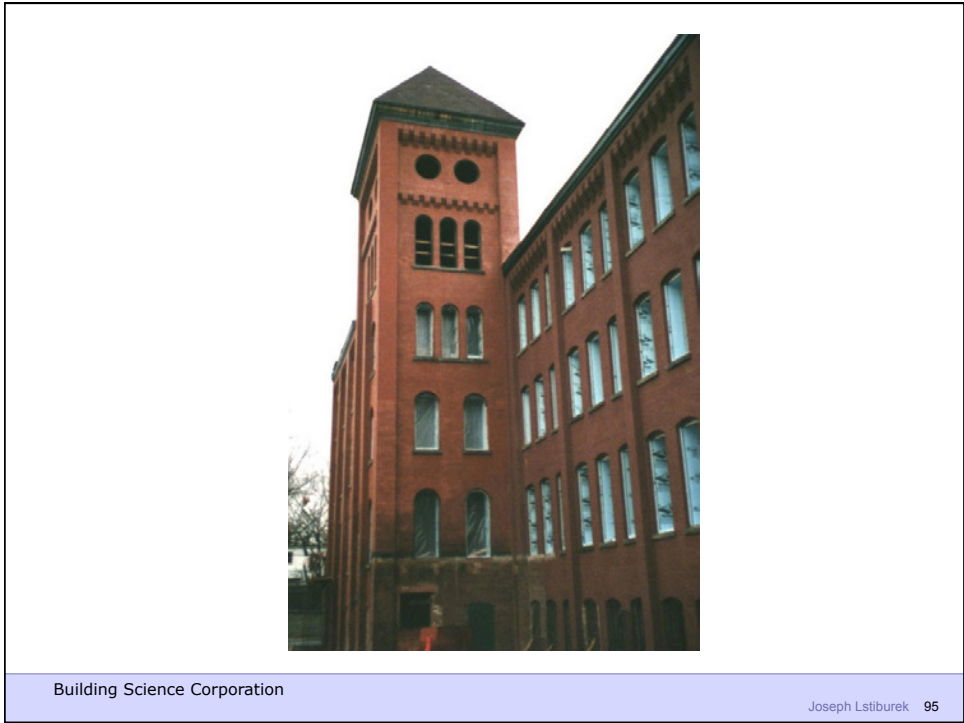
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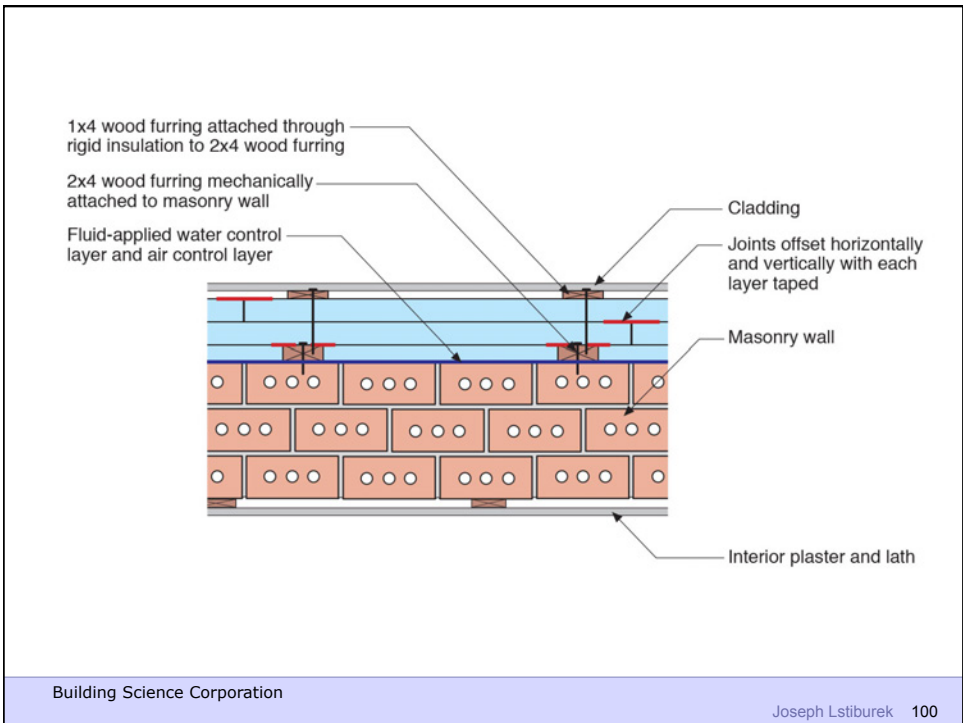








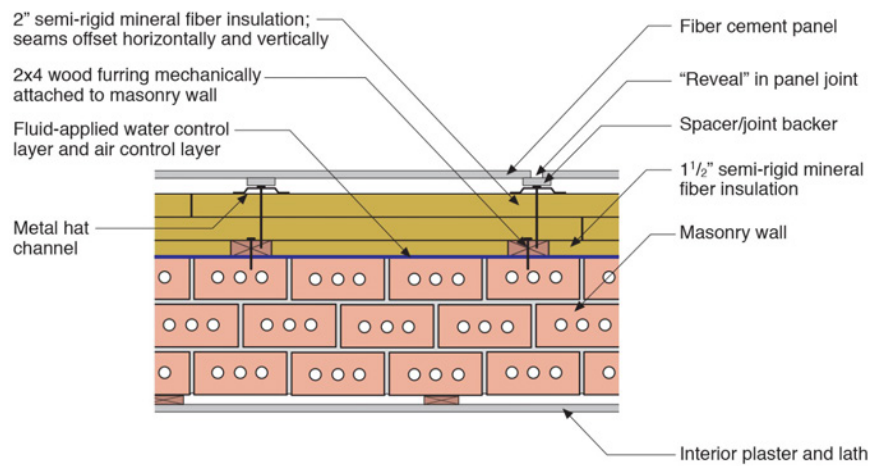






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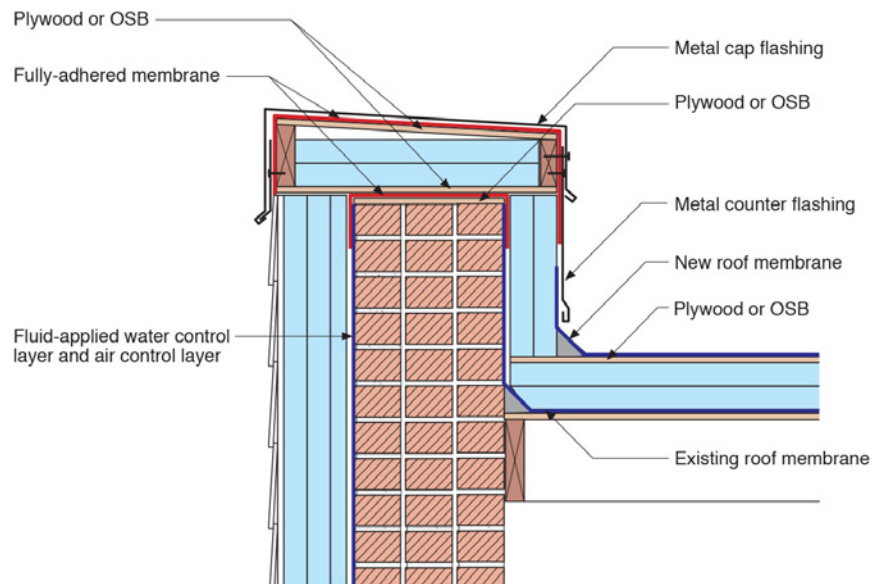
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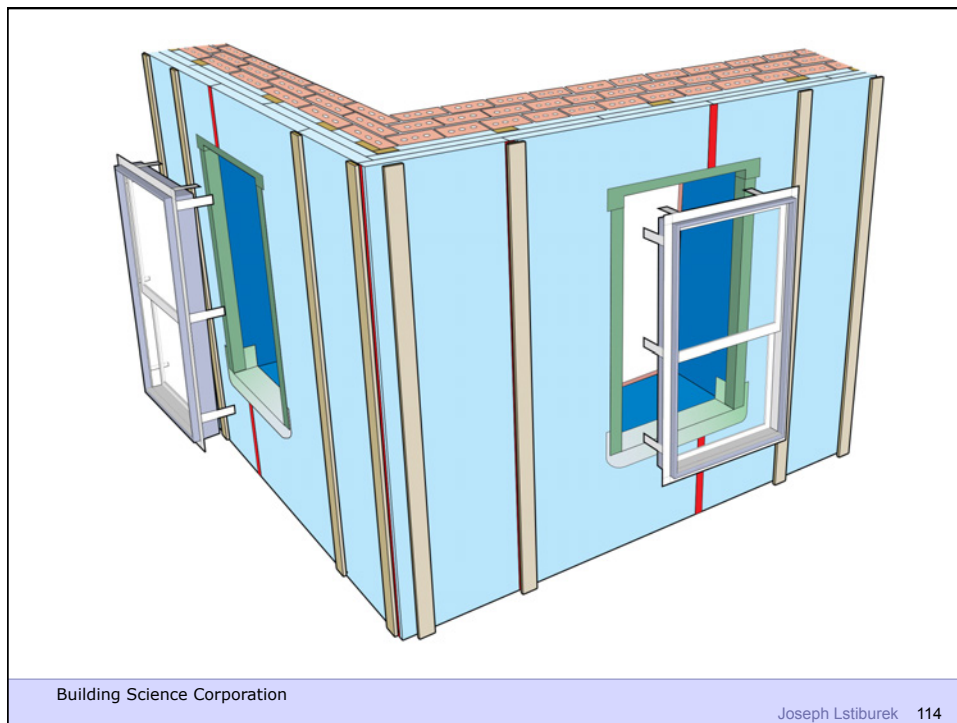
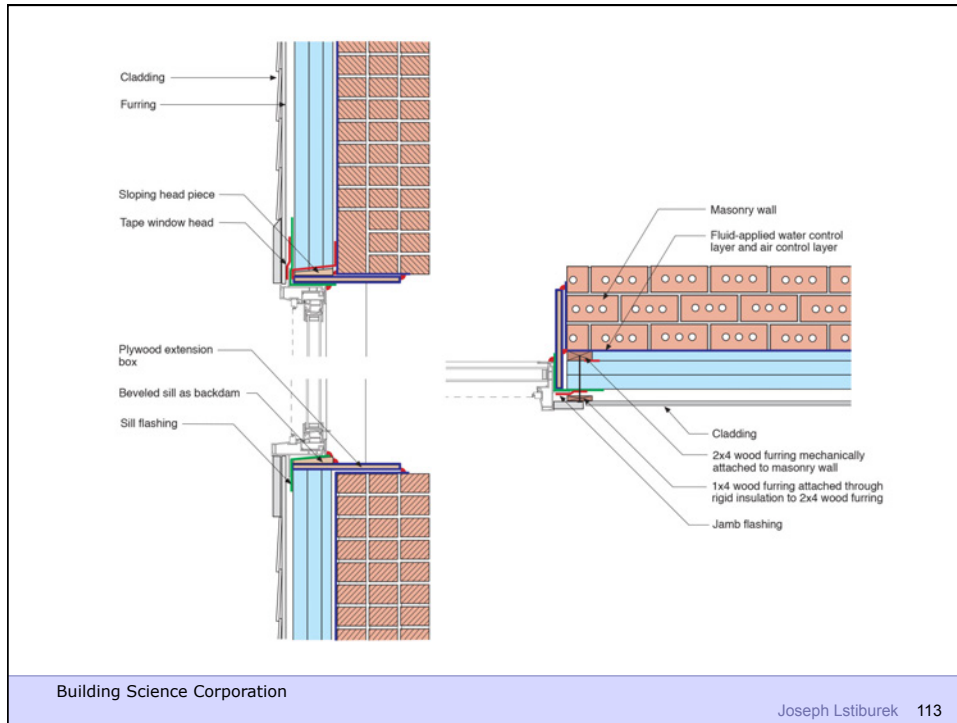
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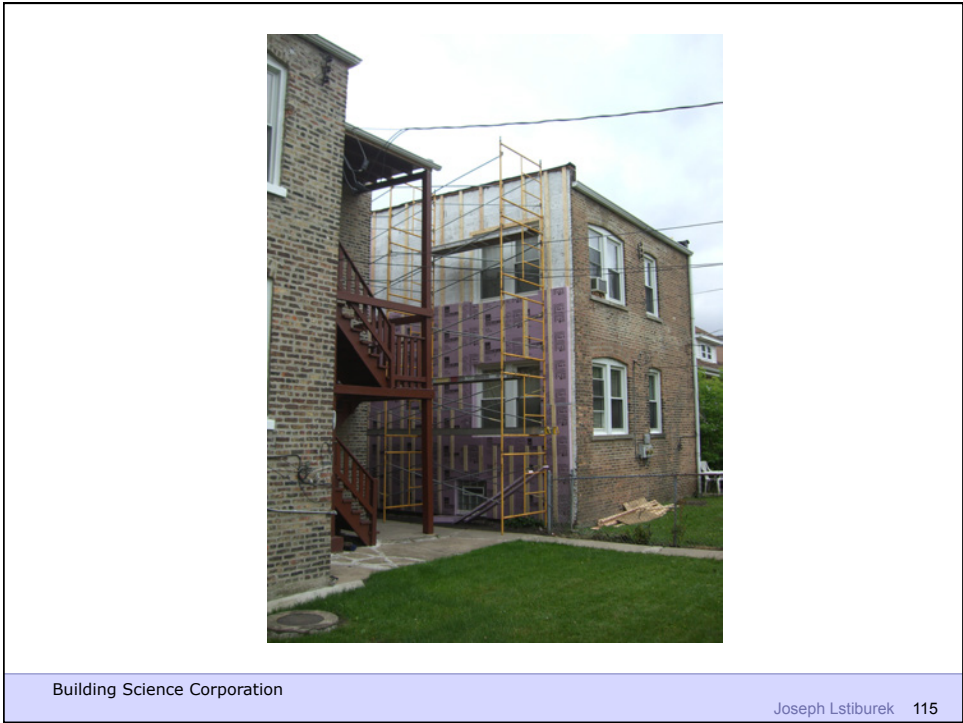
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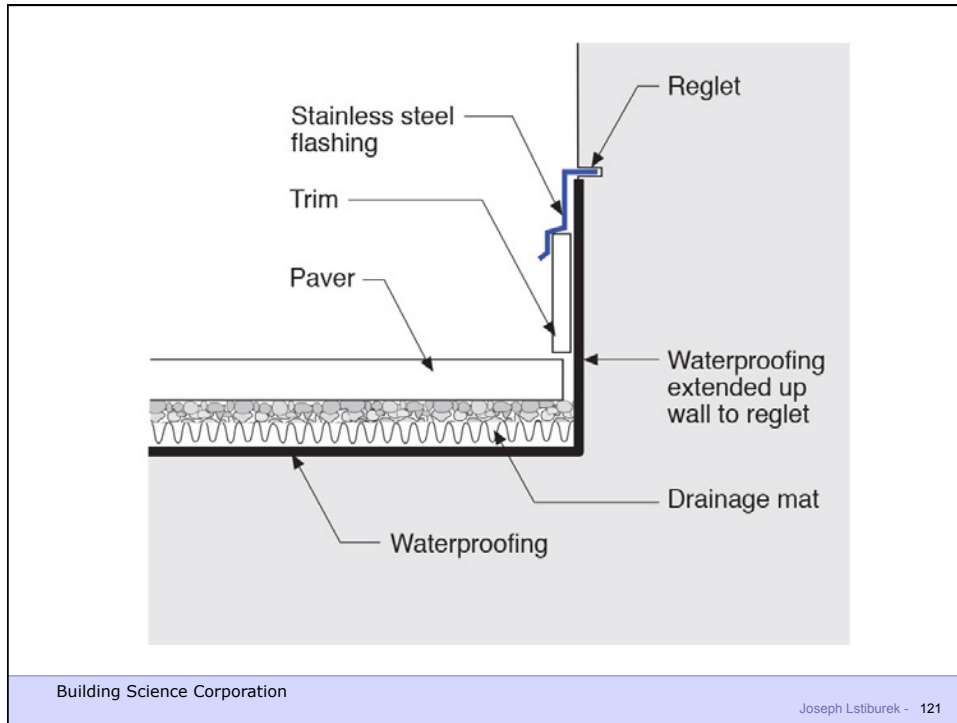
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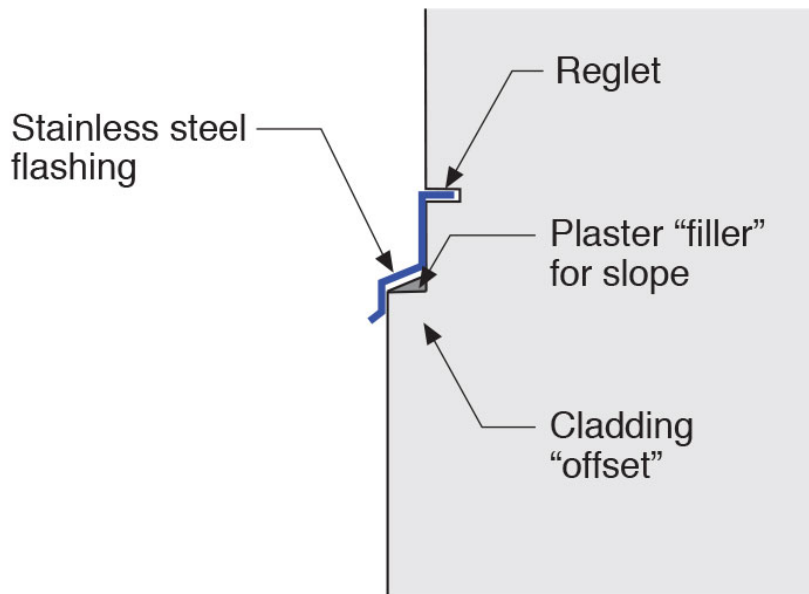
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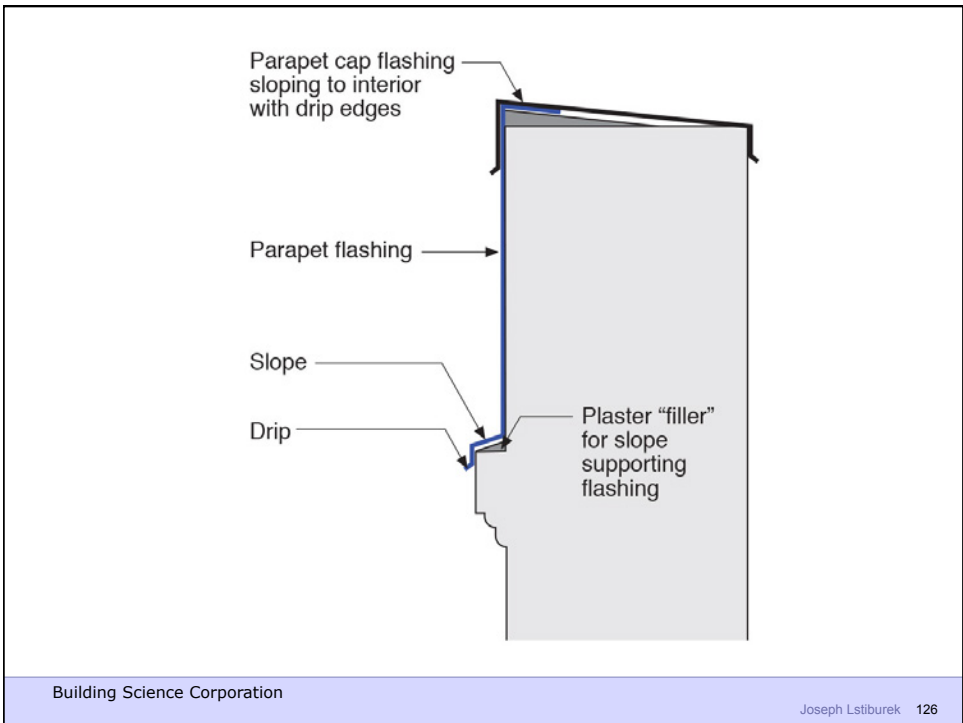
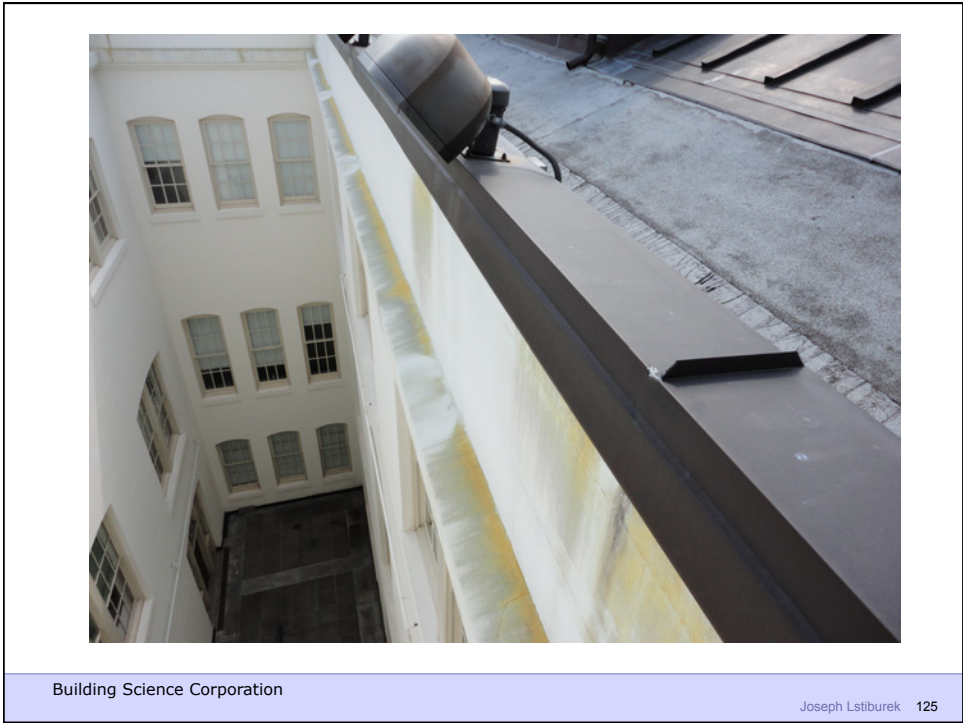
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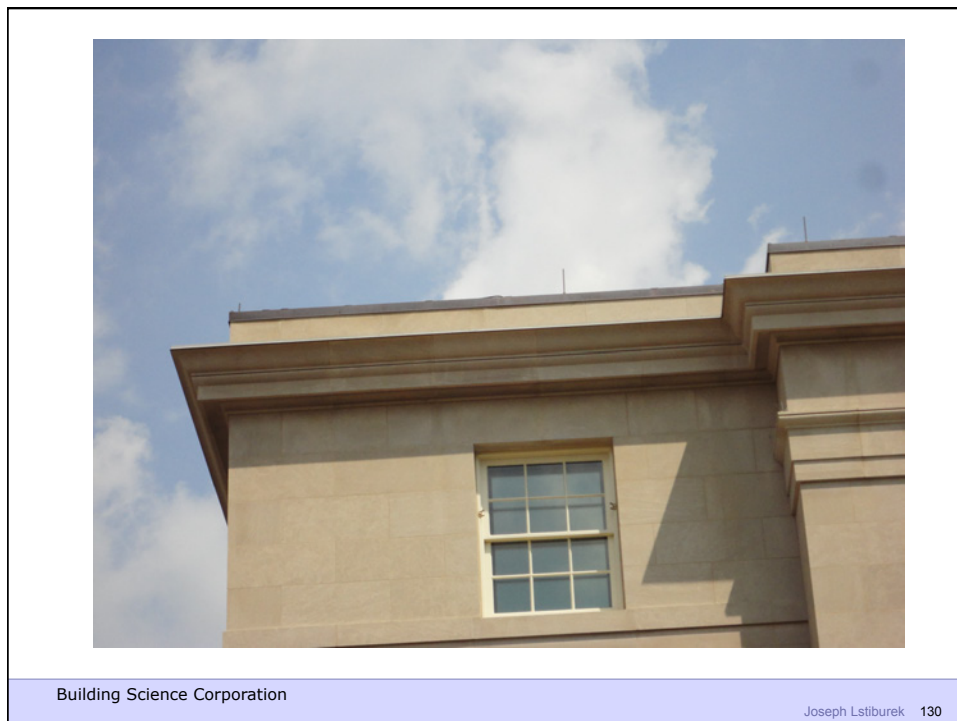
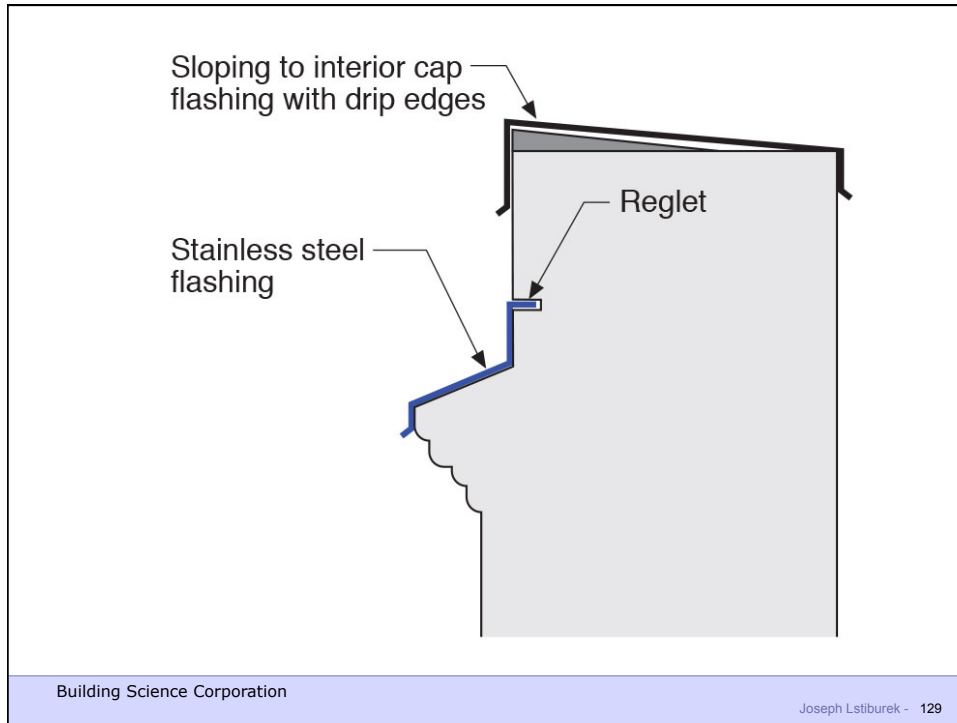
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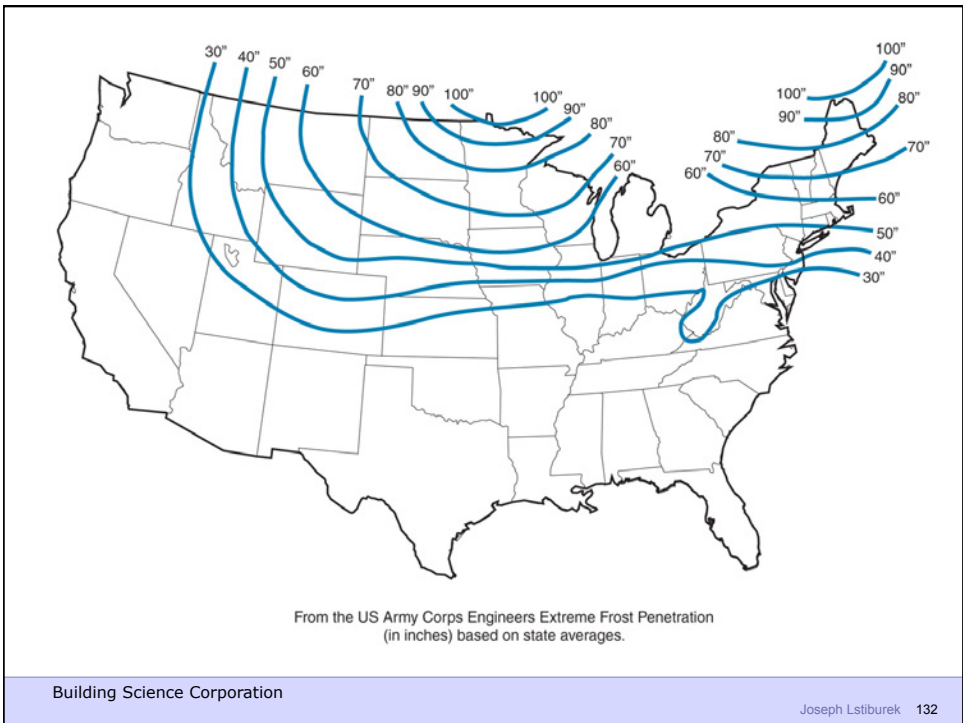
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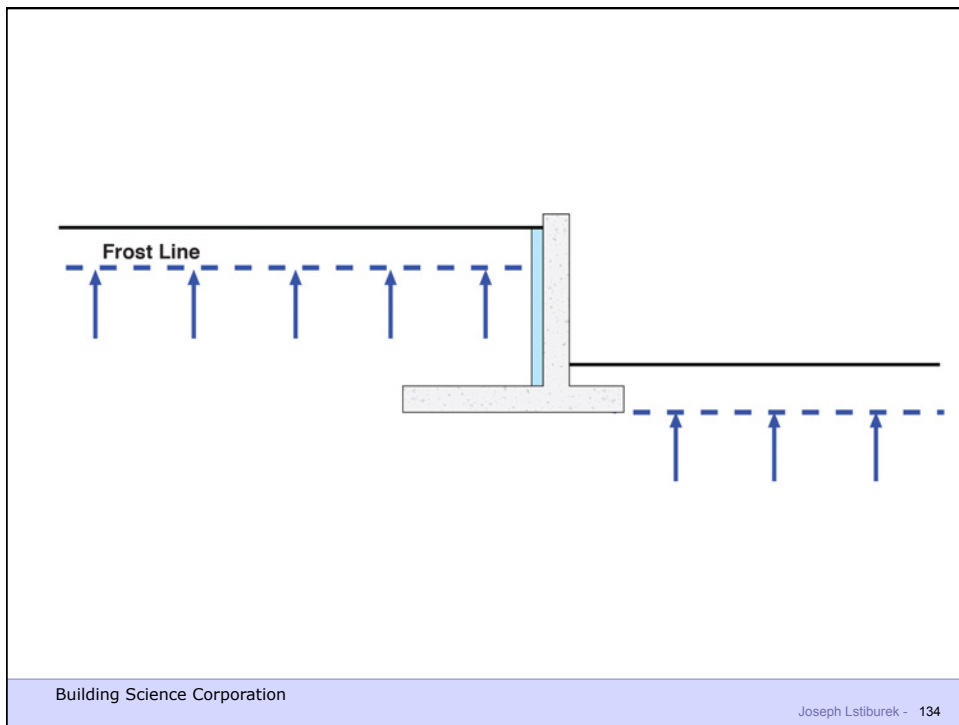
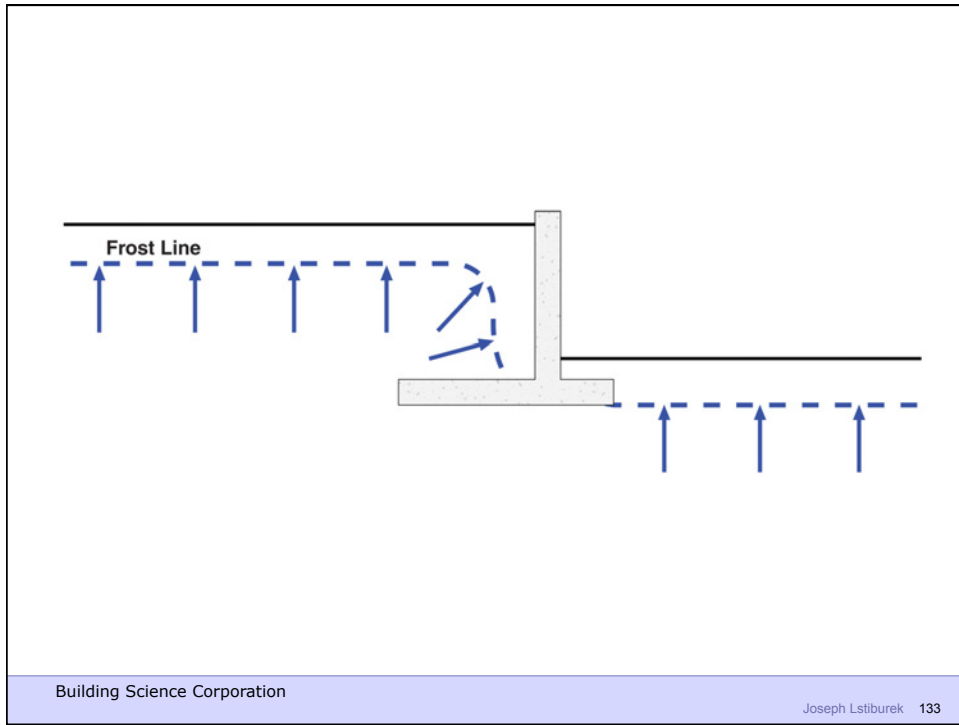


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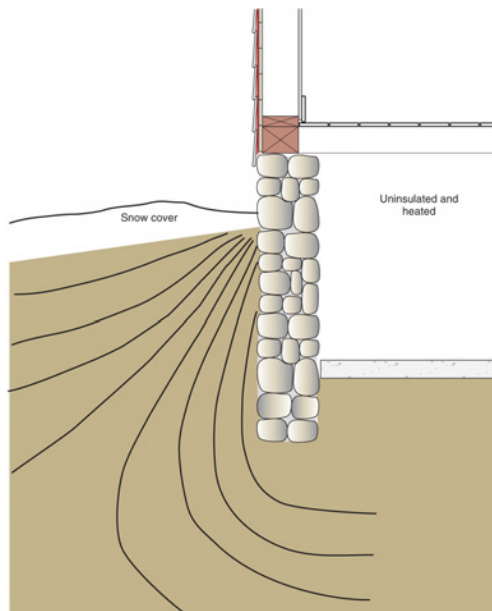






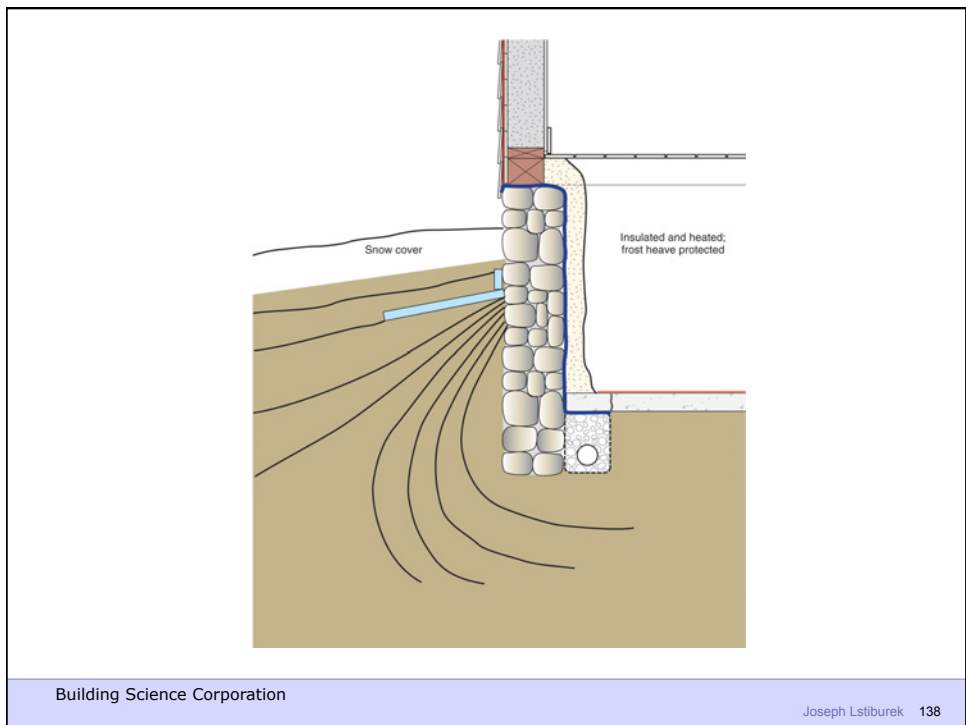
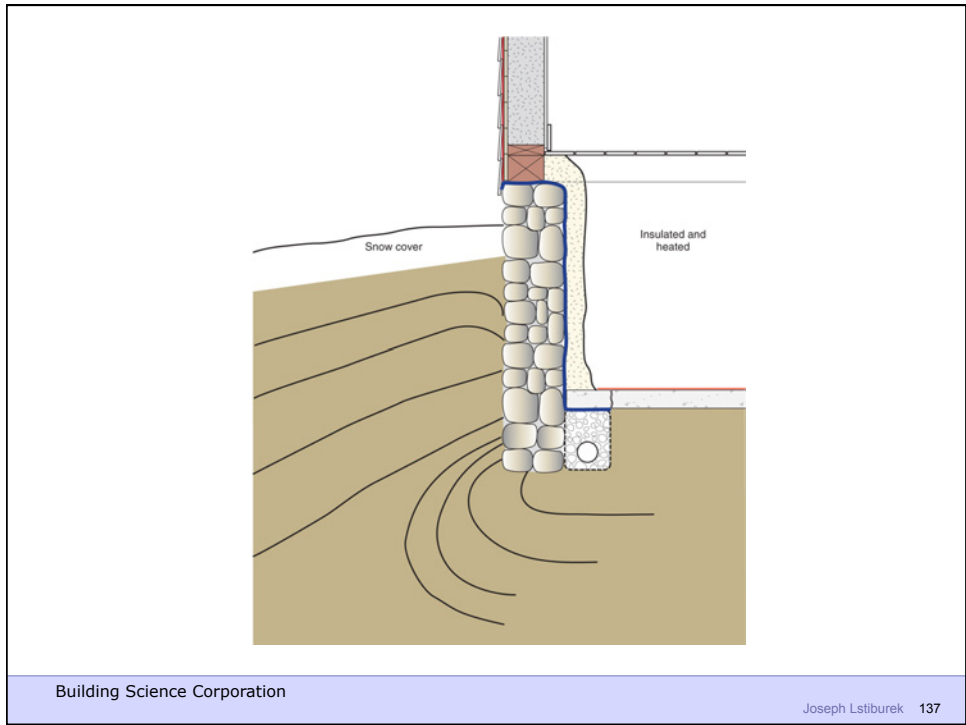
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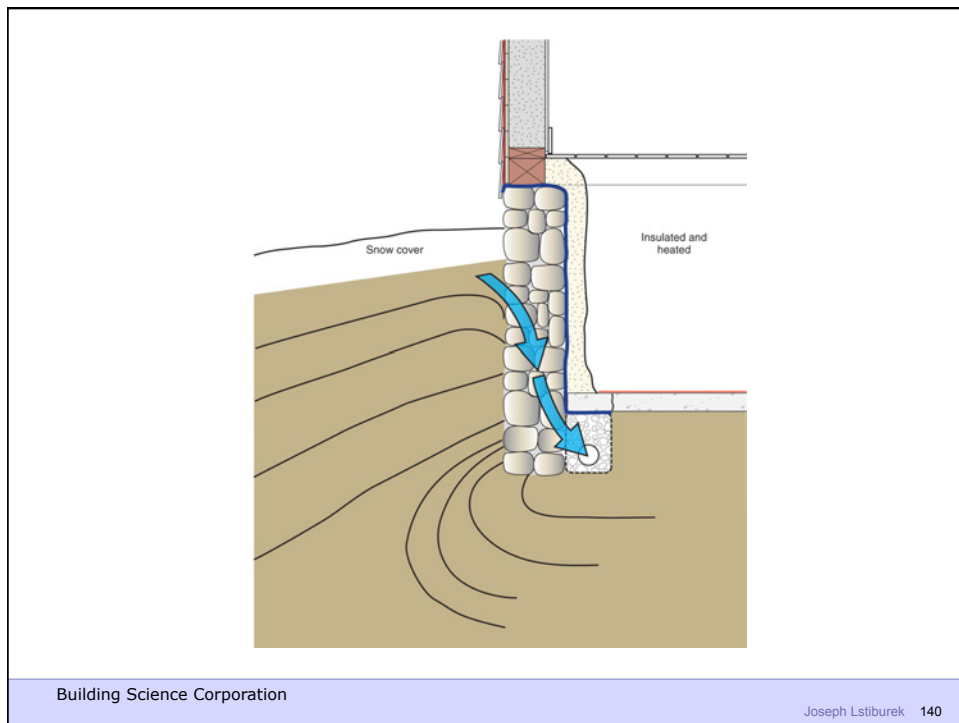
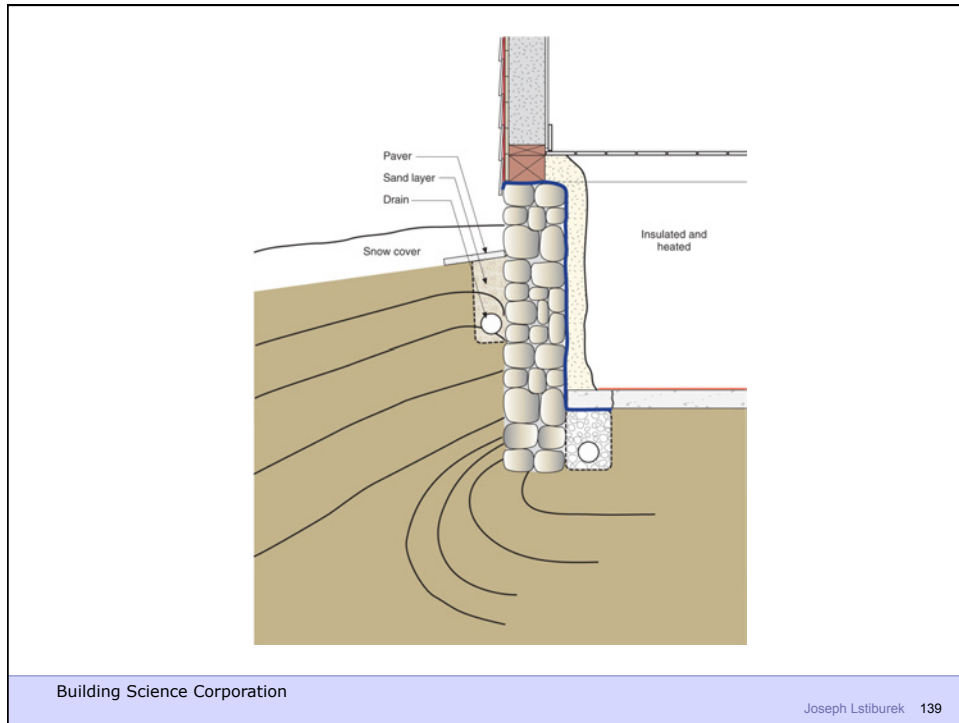
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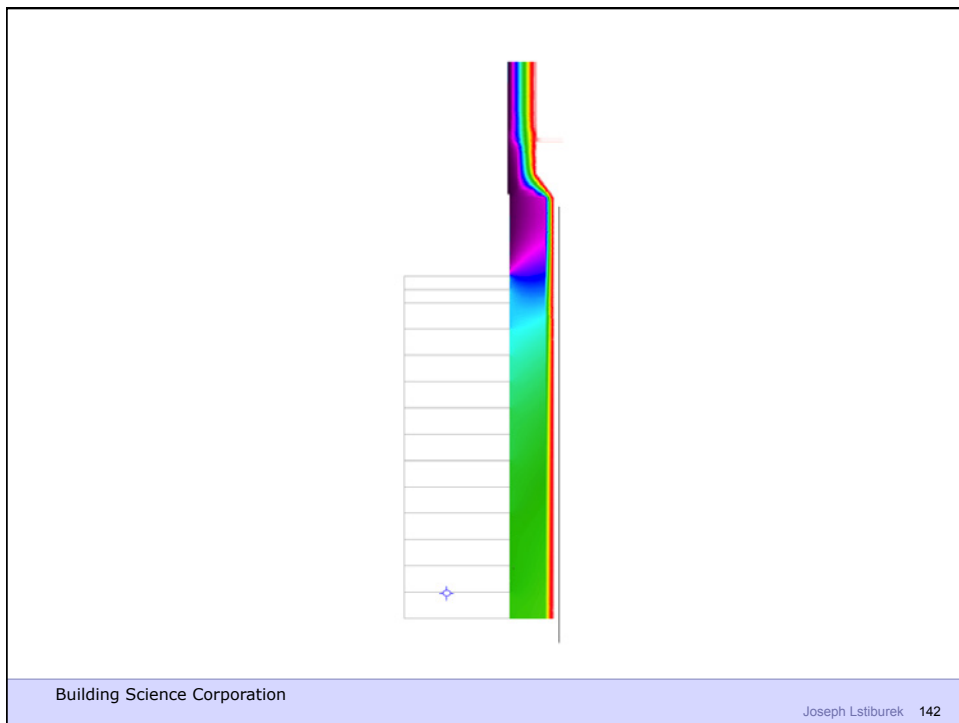
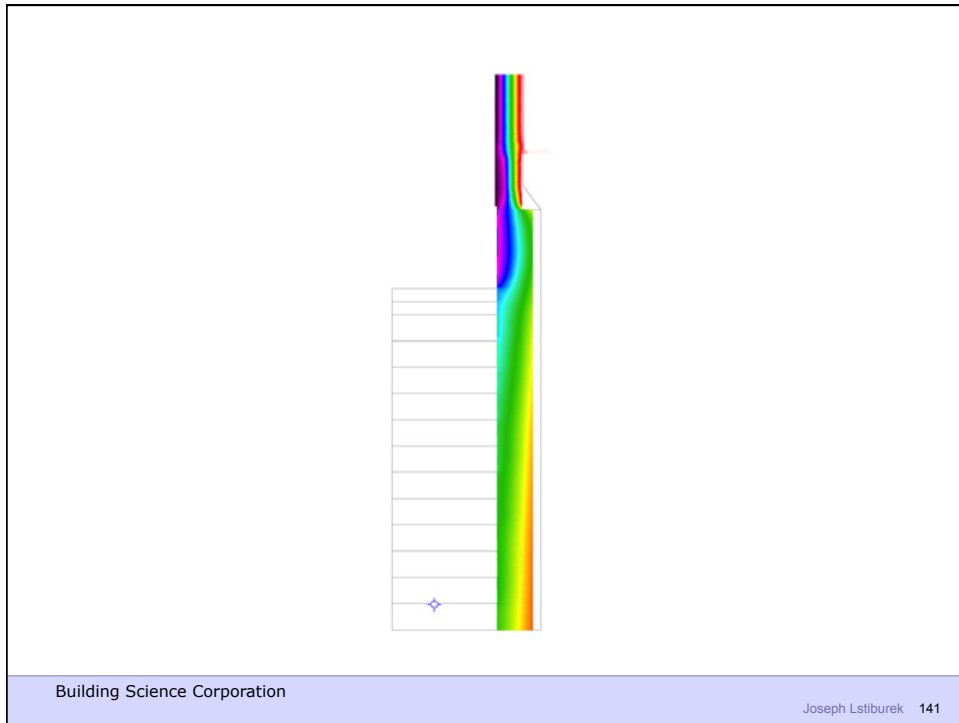


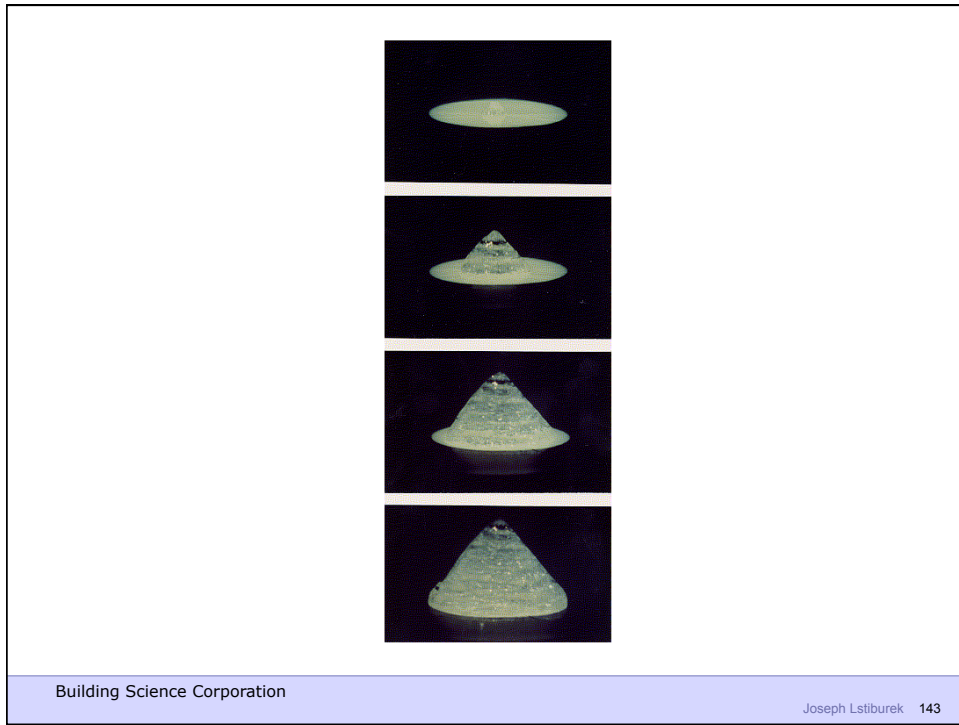
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Mysterious giant hole in Siberia gradually filling up with water, expanding (PHOTOS)

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The mysterious hole-turned-lake in Siberia's Yamal peninsula has expanded to 50 meters in depth, Russian scientists said. Researchers have been puzzled by its origins saying it was likely caused by gas explosions.

The giant sinkhole located not far from Gazprom's Bovanenkovo gas field in Russia's northern Yamal Peninsula has been expanding, scientists said as cited by Yamal region TV. The researchers also discovered additional smaller craters appearing around it, the media said. The whole area is within Russia's key strategic oil and gas region – the Yamalo-Nenets.

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