

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

Building Science

Don't Do Stupid Things

www.buildingscience.com

Life is Tough Enough As it Is...

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Life is Tough Enough As it Is...
It's Harder When You Are Stupid

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Don't Do Stupid Things

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What is a Building?

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A Building is an Environmental Separator

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2nd Law of Thermodynamics

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In an isolated system, a process can occur only if it increases the total entropy of the system

Rudolf Clausius

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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

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Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

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Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion

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Moisture Flow Is From Warm To Cold
Moisture Flow Is From More To Less

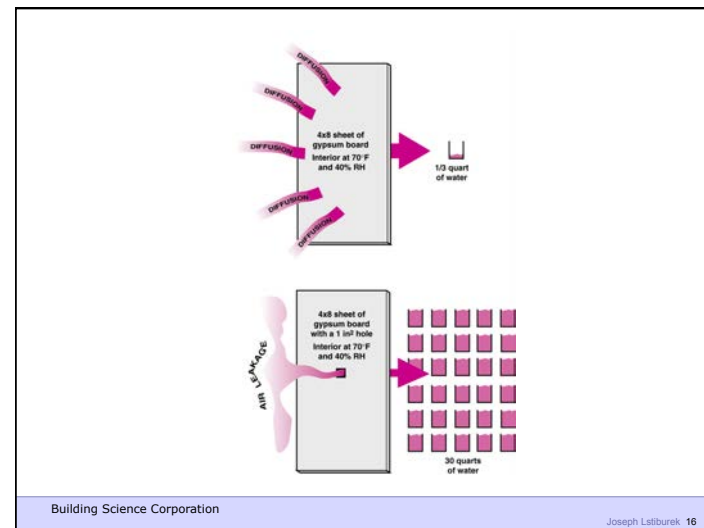
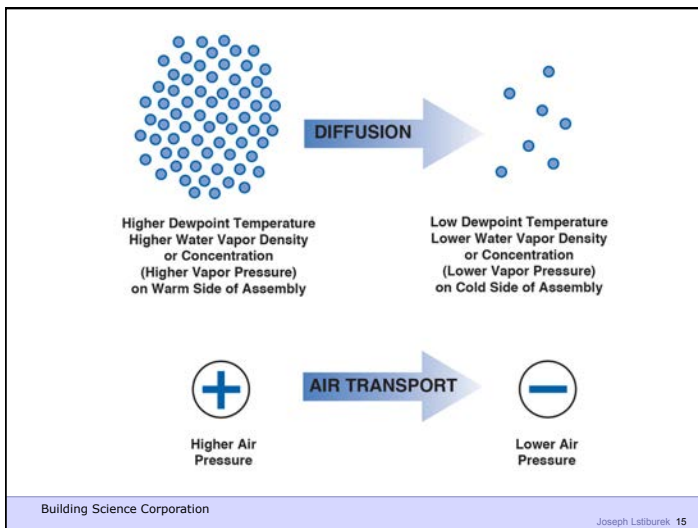
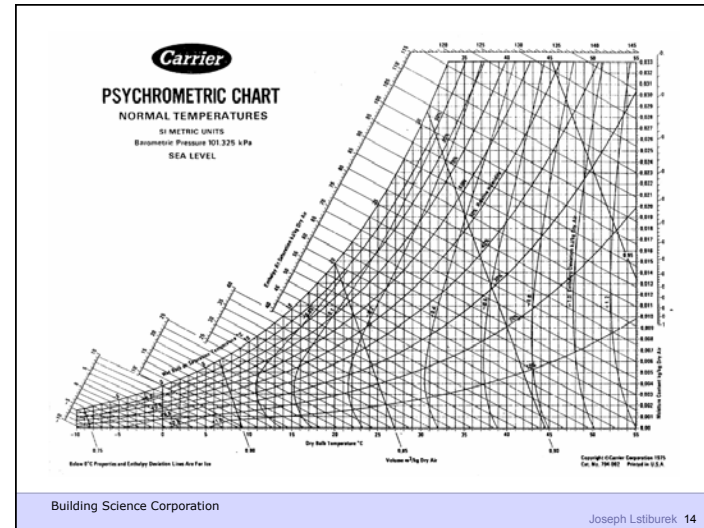
Thermal Gradient – Thermal Diffusion
Concentration Gradient – Molecular Diffusion

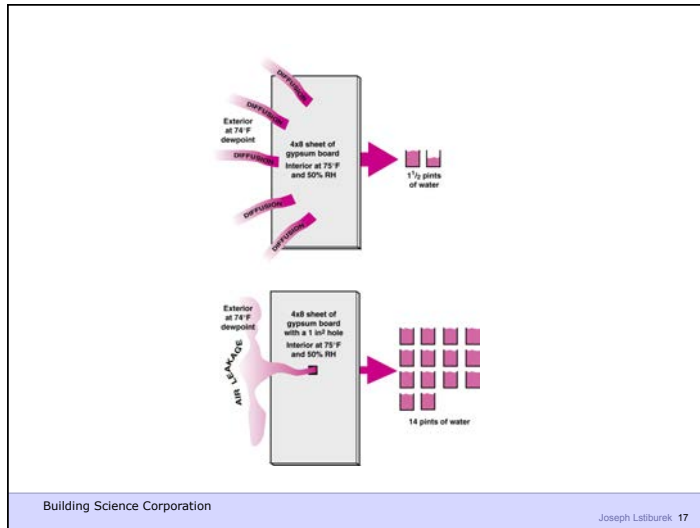
Vapor Diffusion

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Thermodynamic Potential

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Damage Functions

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Damage Functions
Water
Heat
Ultra Violet Radiation

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Damage Functions
Water
Heat
Ultra Violet Radiation
Oxidization (Ozone)
Fatigue (Creep)

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The Three Biggest Problems In Buildings Are
Water, Water and Water...

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80 Percent of all Construction Problems are
Related to Water

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Heat
Air
Moisture

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HAM

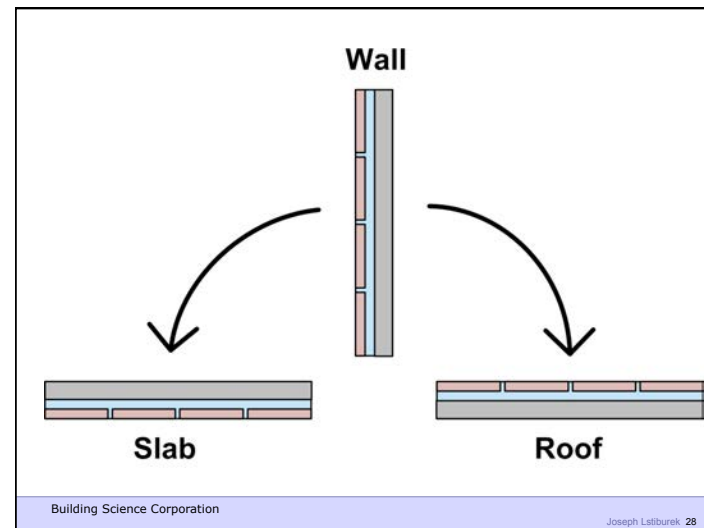
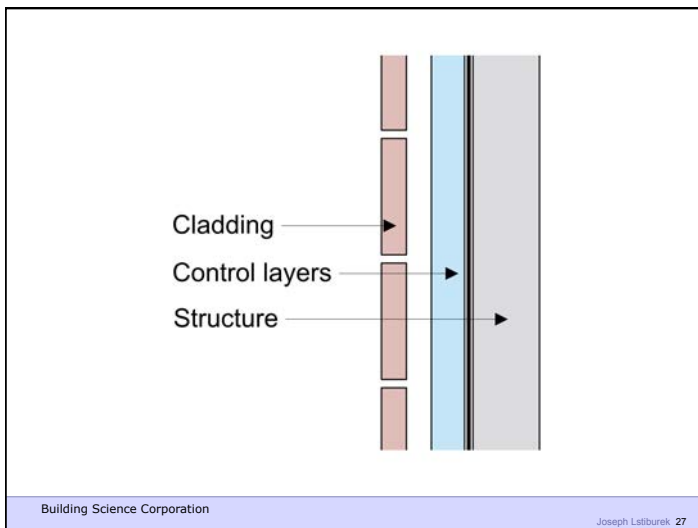
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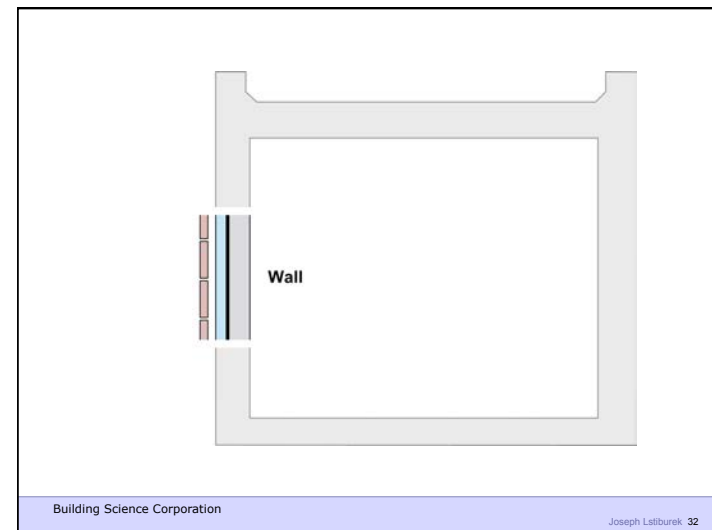
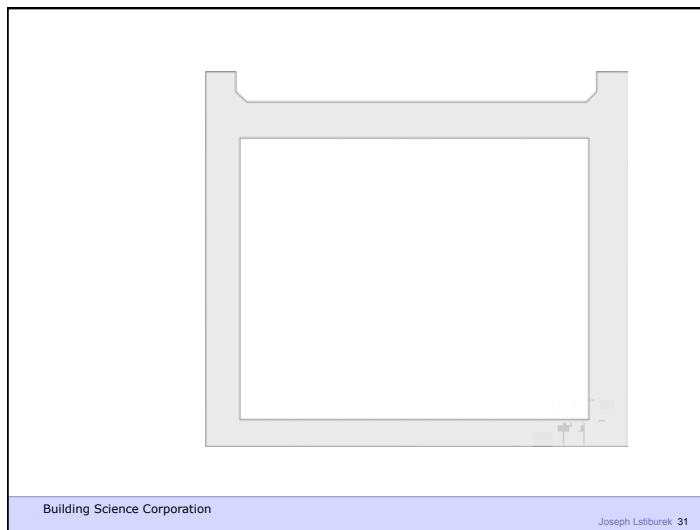
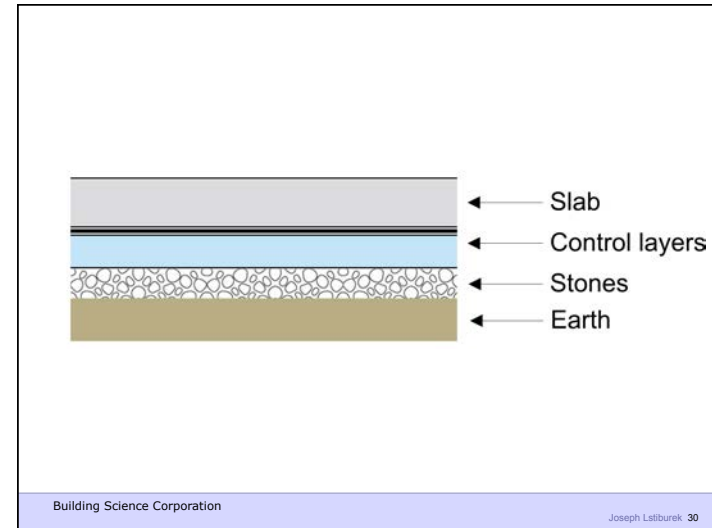
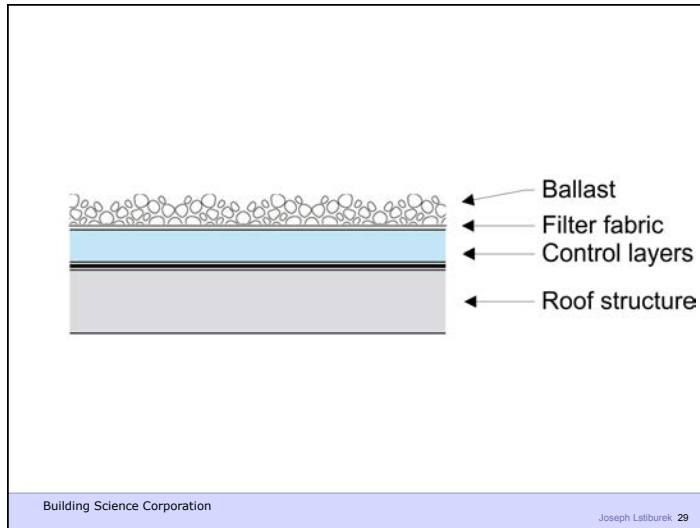
Hygrothermal Analysis

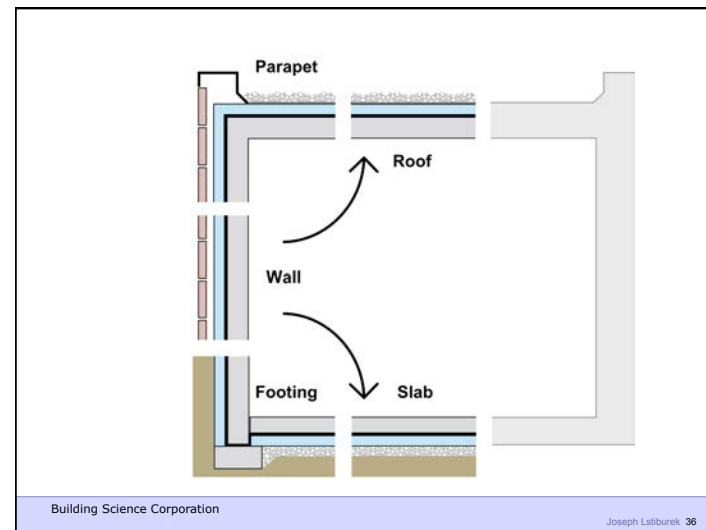
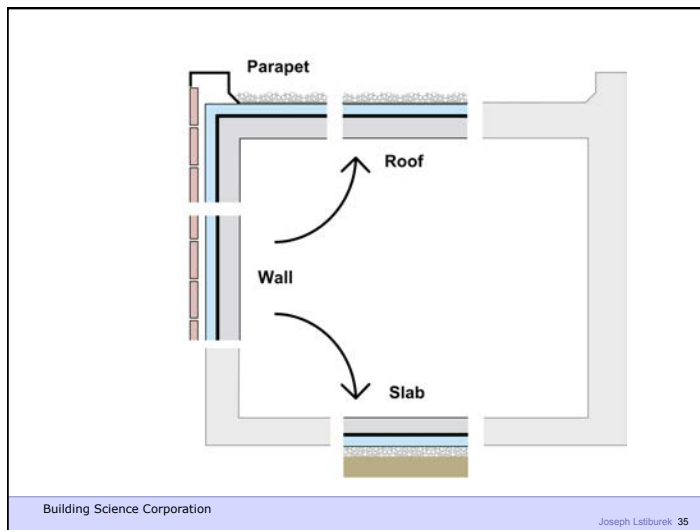
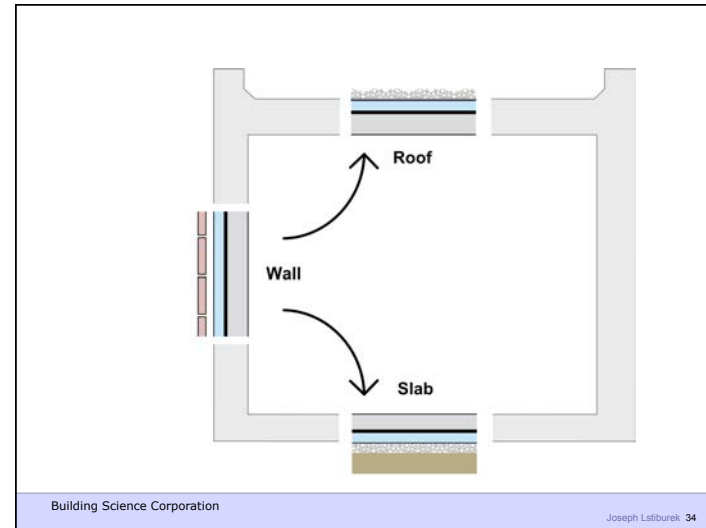
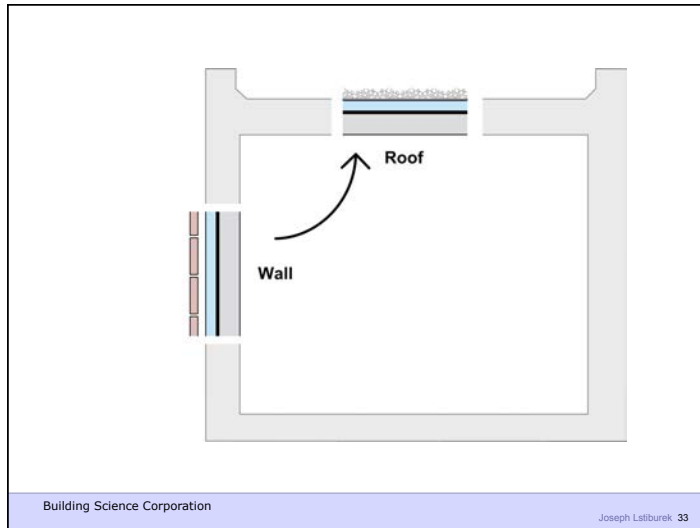
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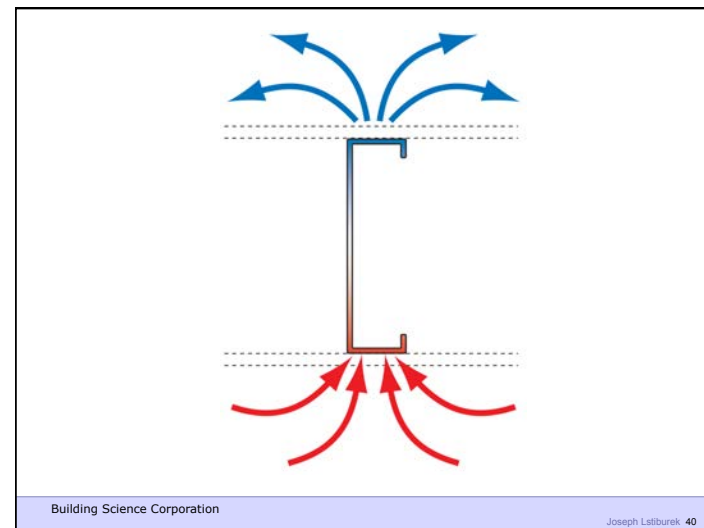
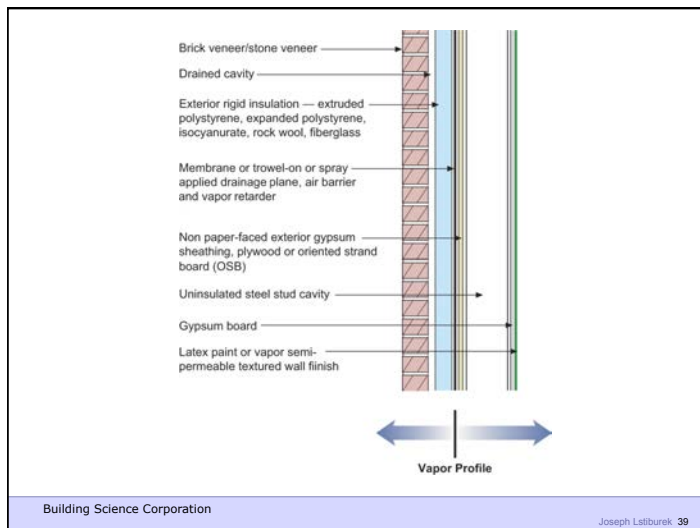
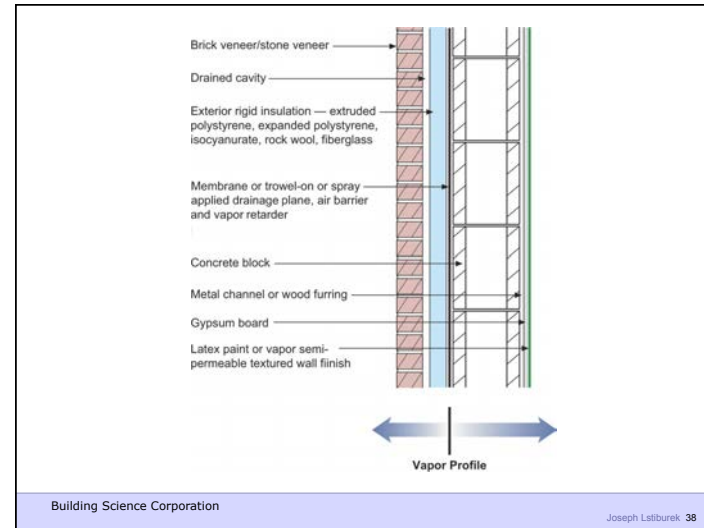
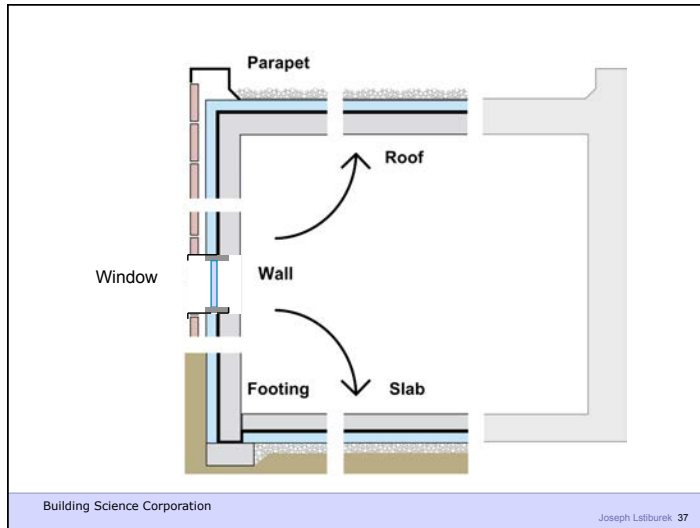
Water Control Layer
Air Control Layer
Vapor Control Layer
Thermal Control Layer

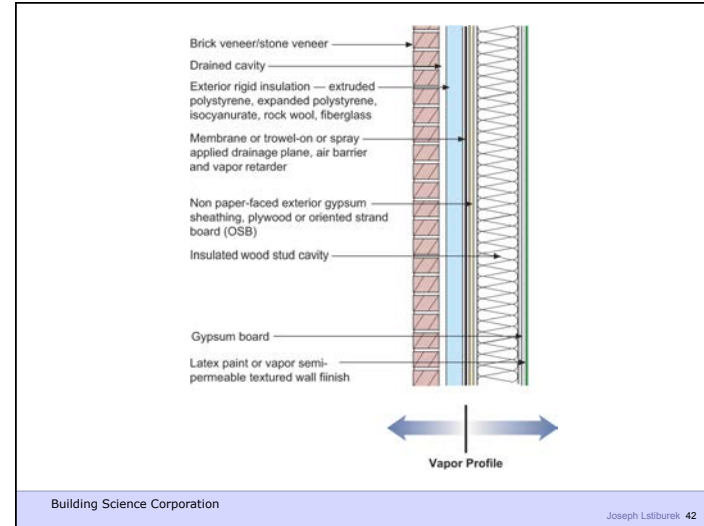
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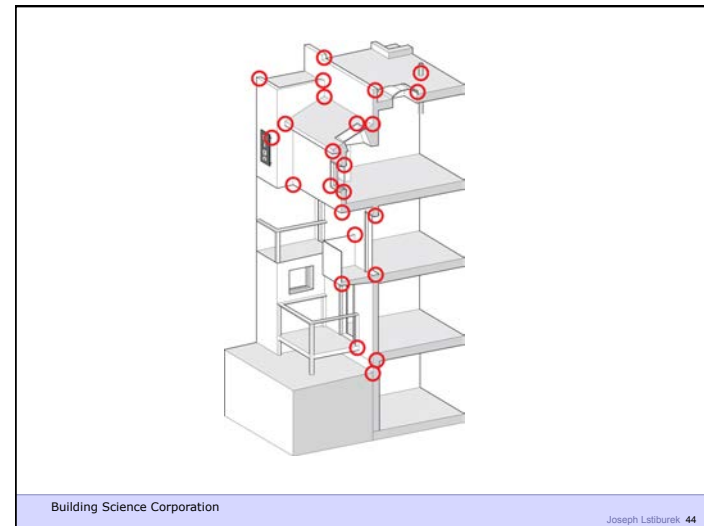


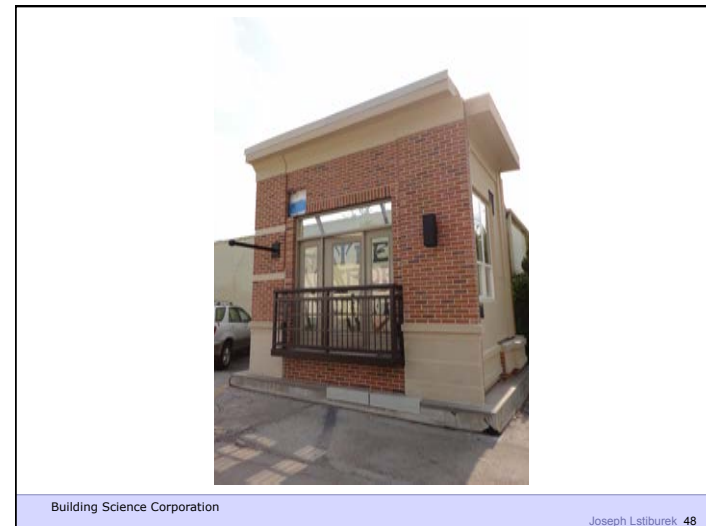


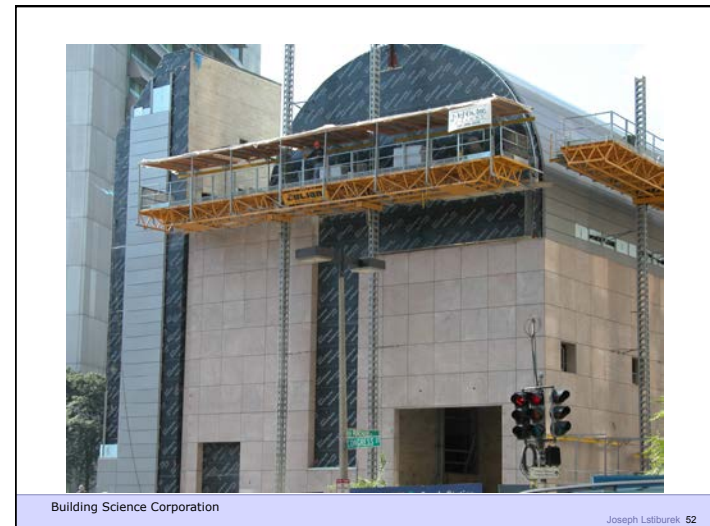
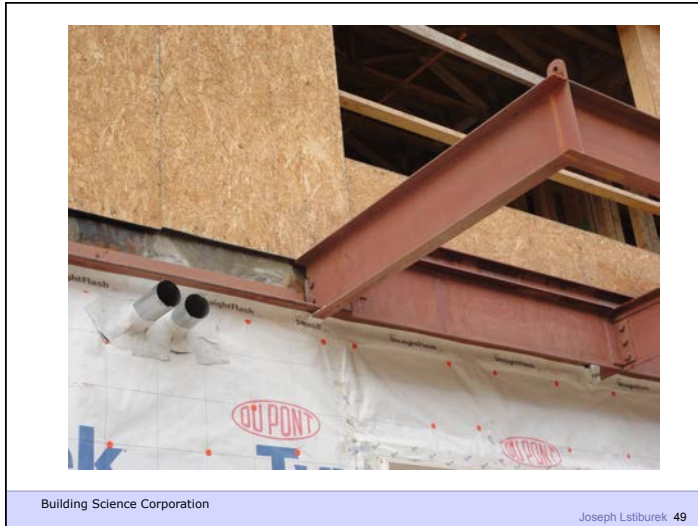
Commercial Enclosure: Simple Layers

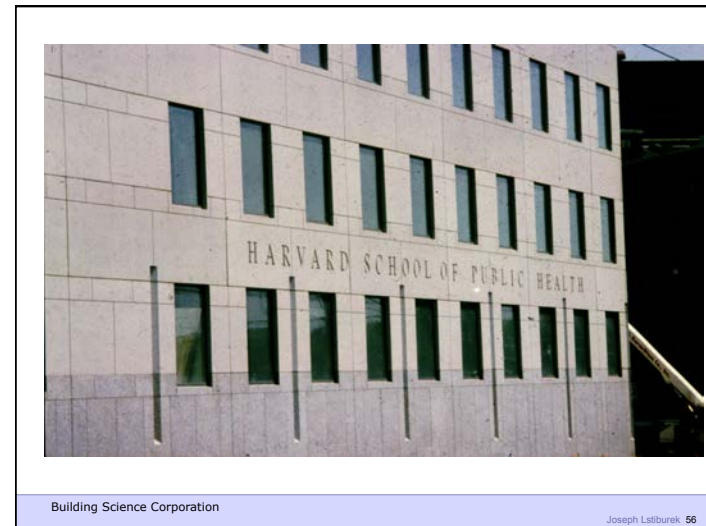
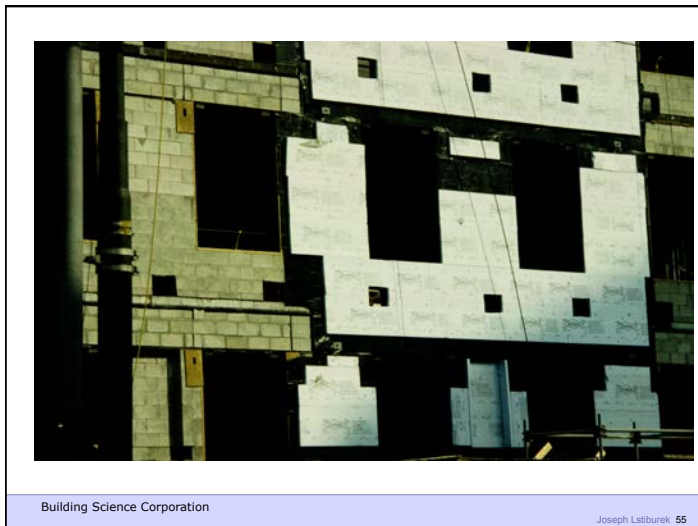
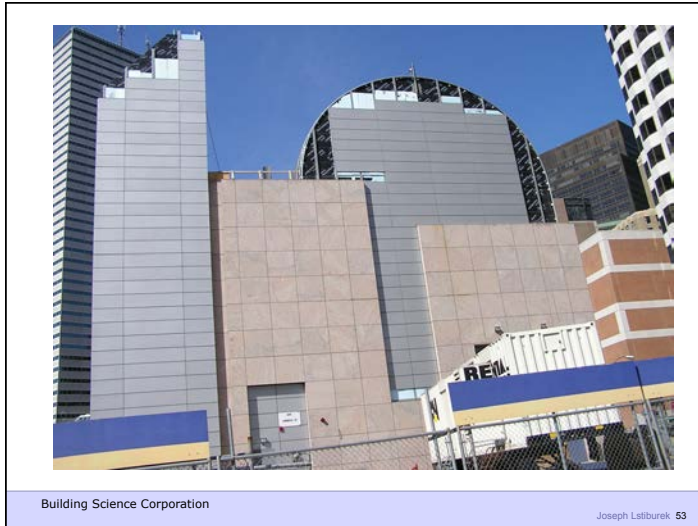
- Structure
- Rain/Air/Vapor
- Insulation
- Finish

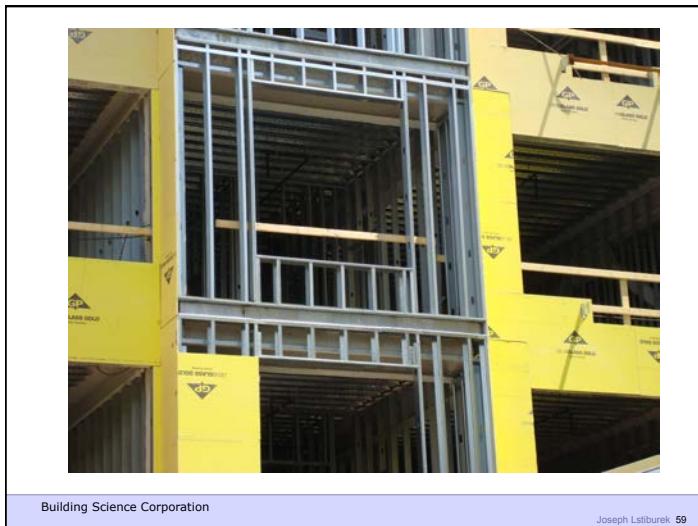
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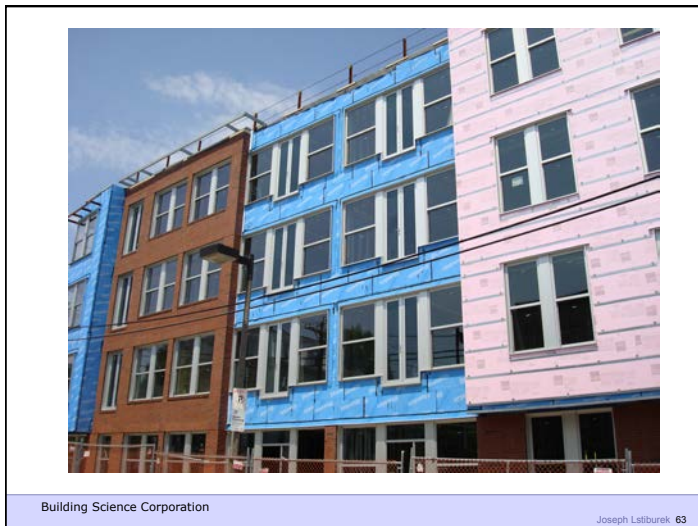




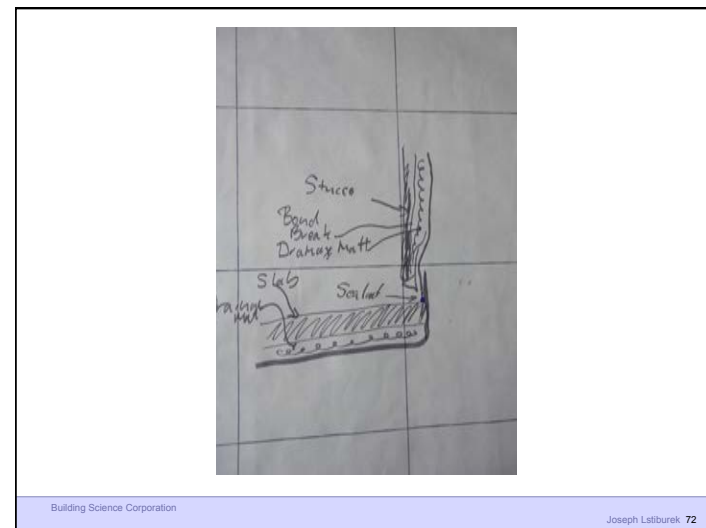


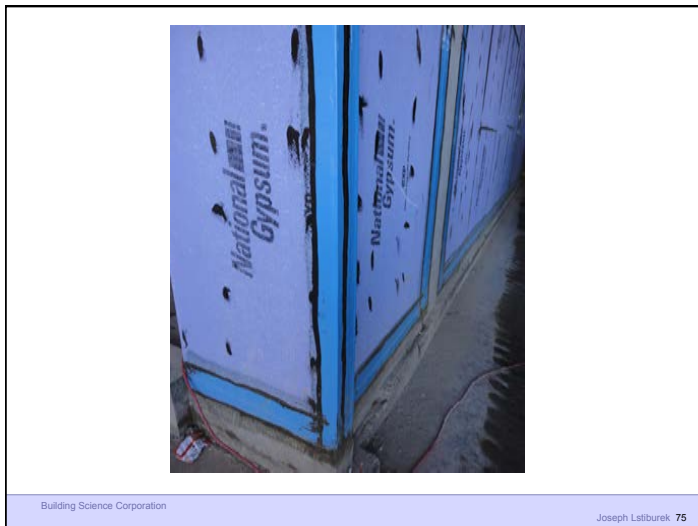




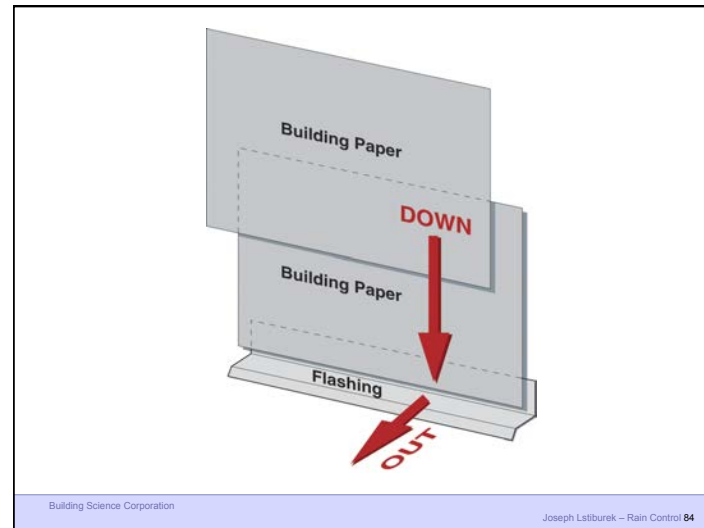
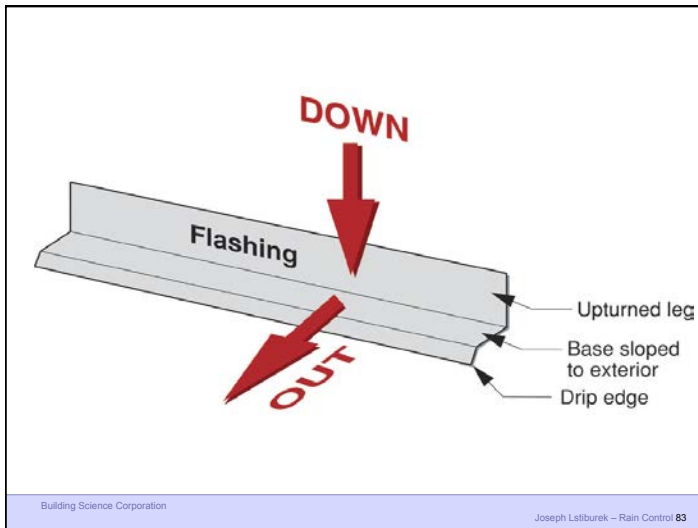
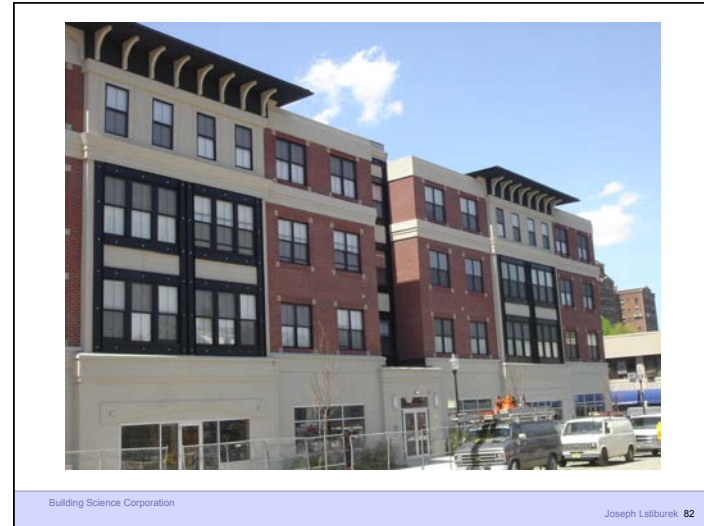
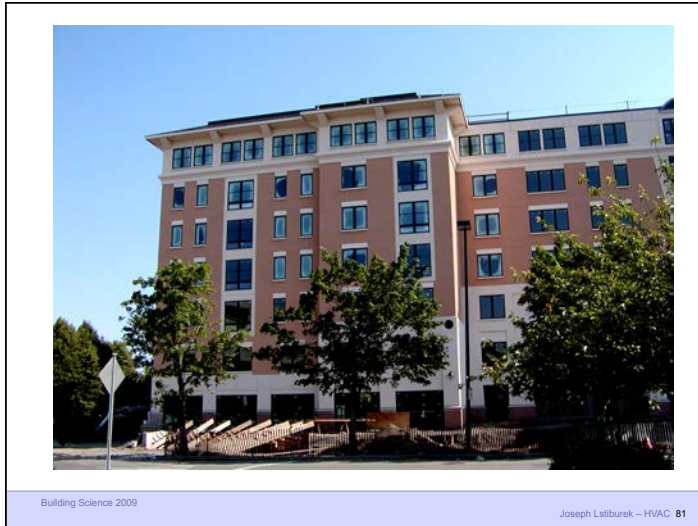


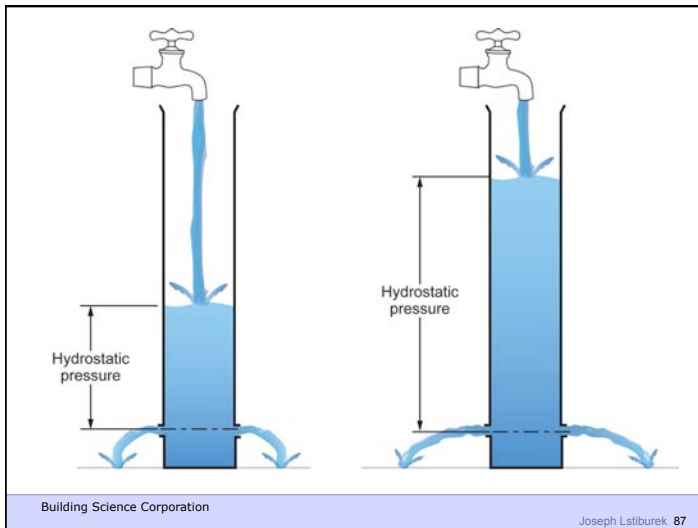


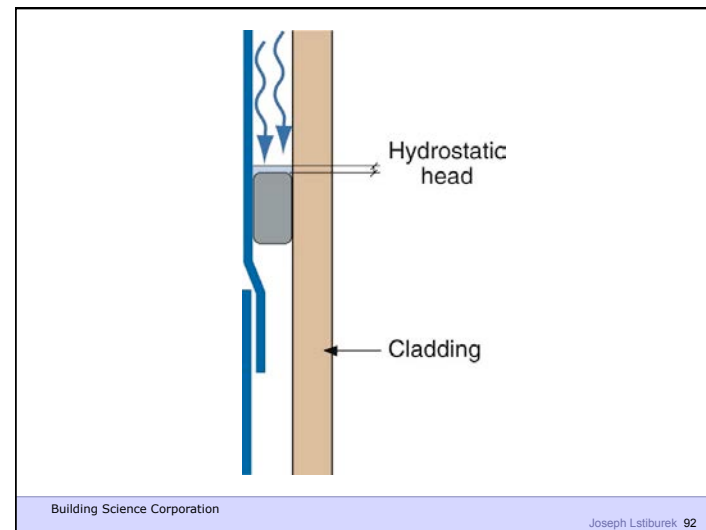
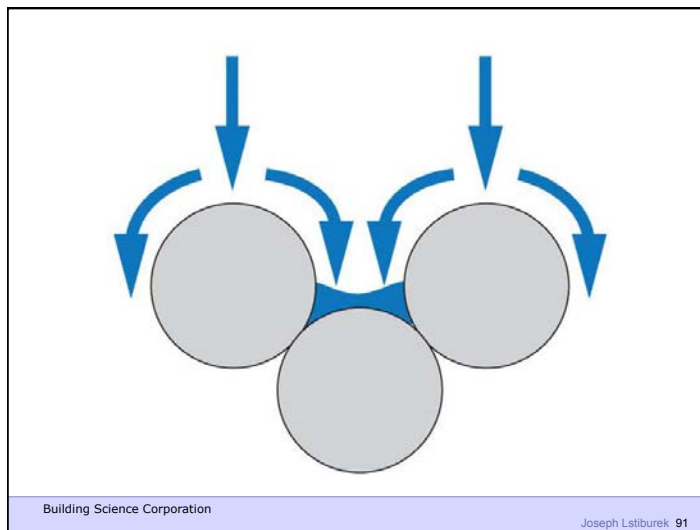
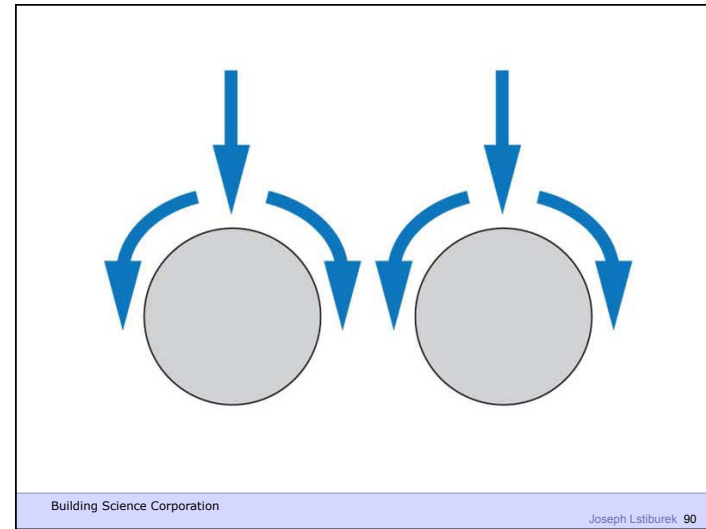
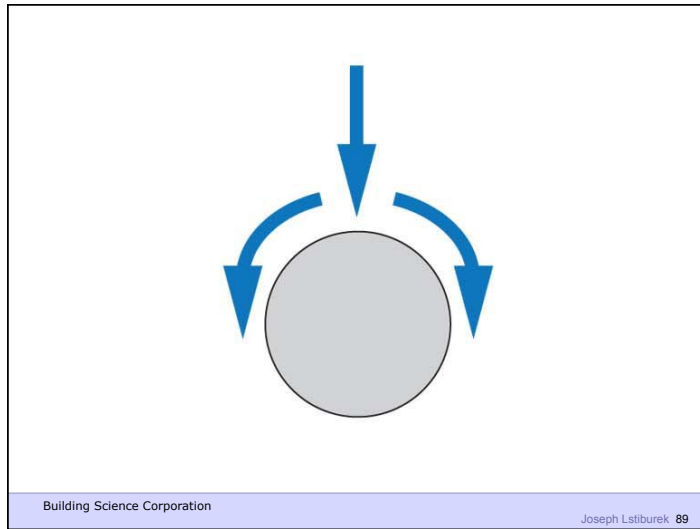


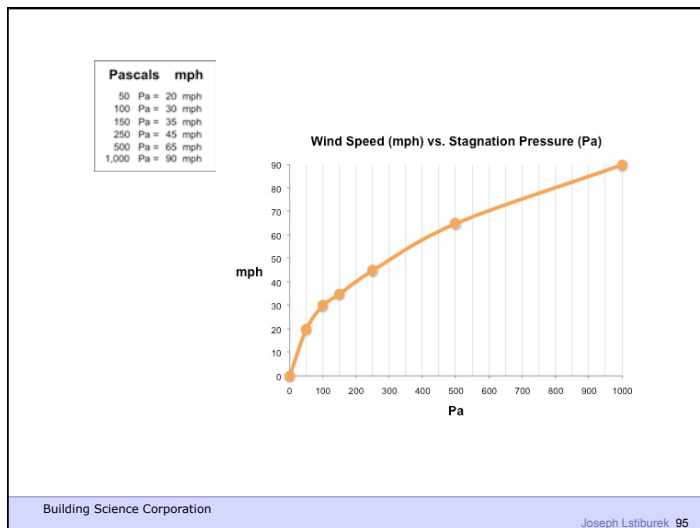
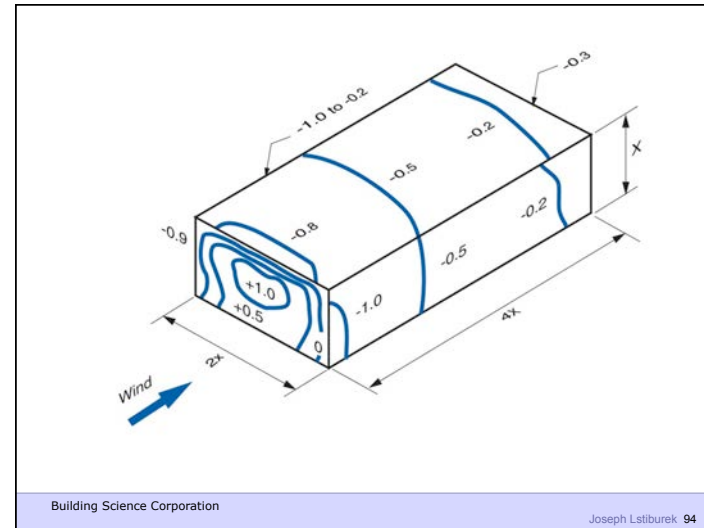
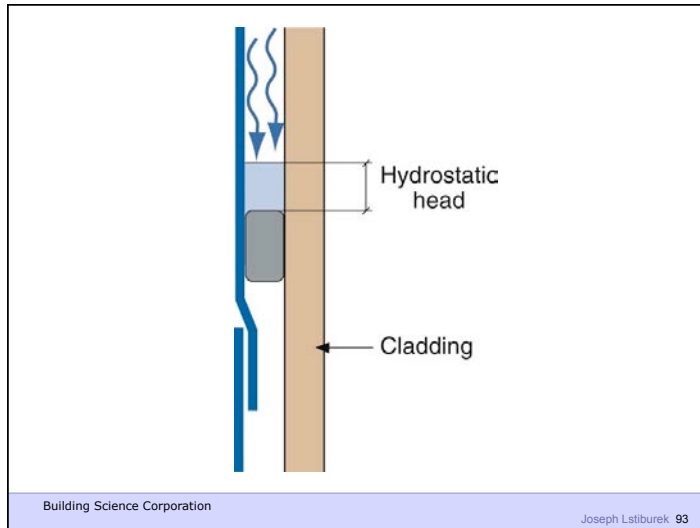


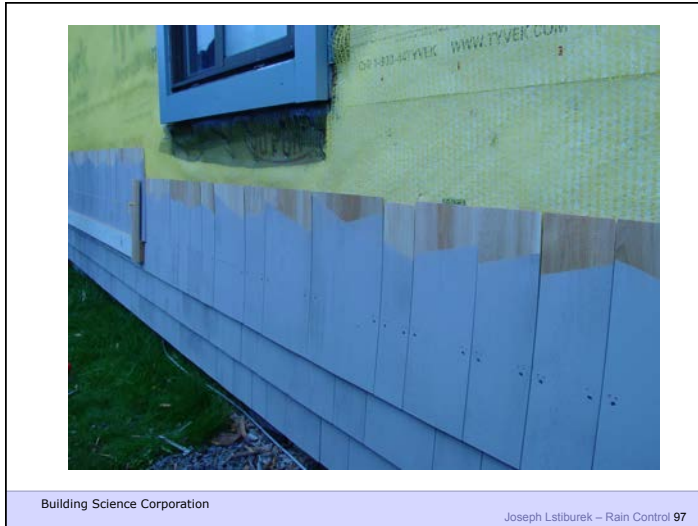


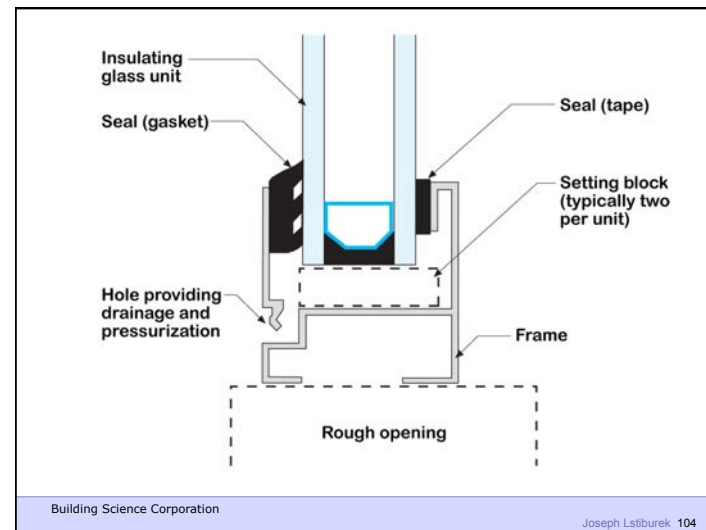
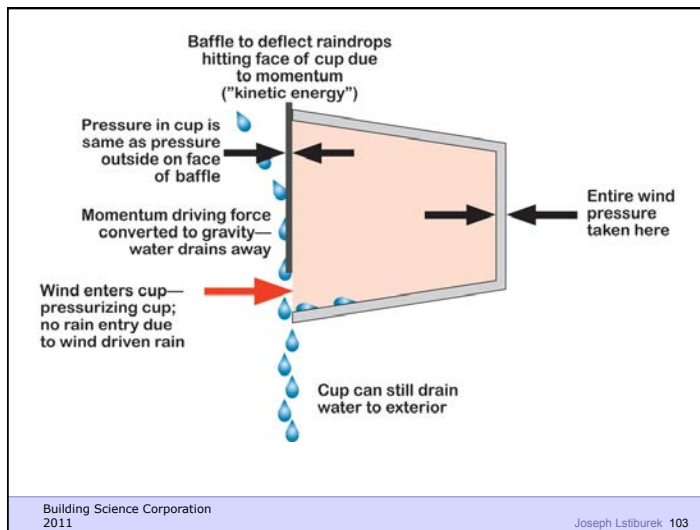
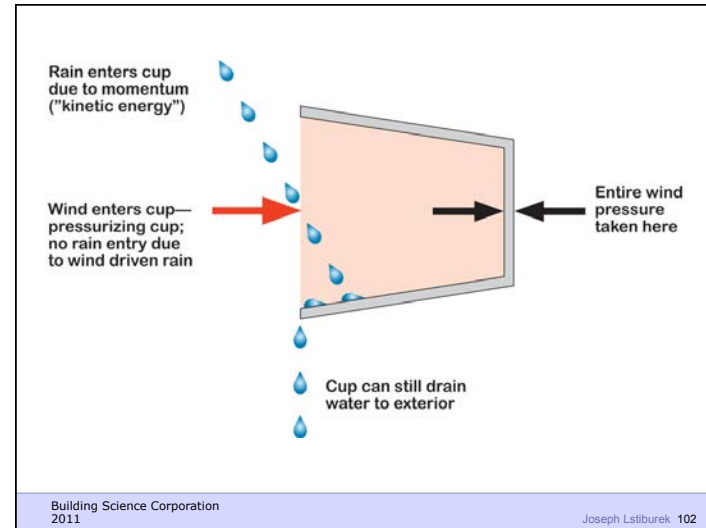
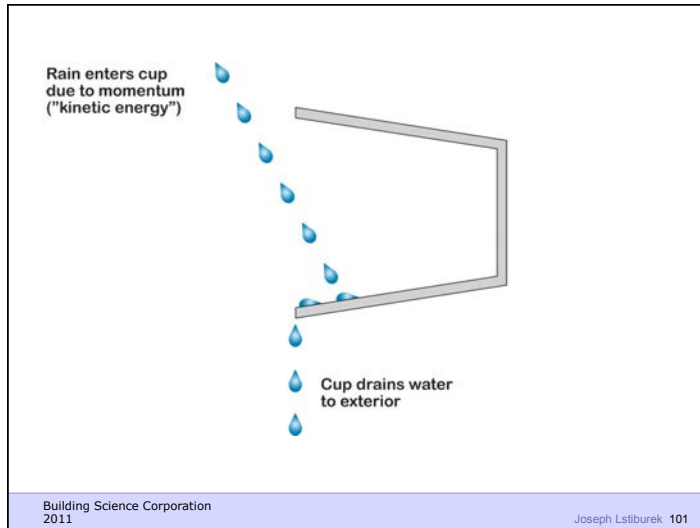


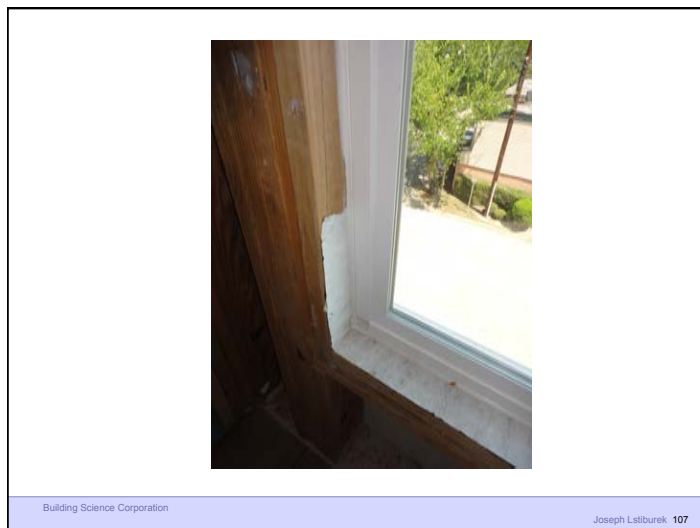
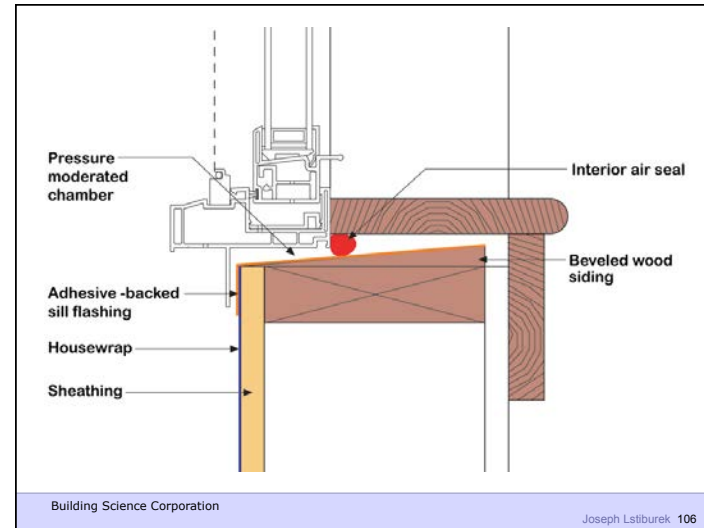
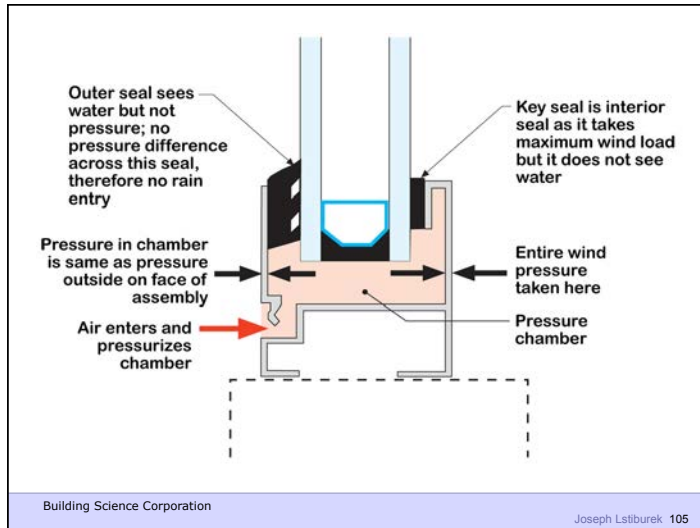


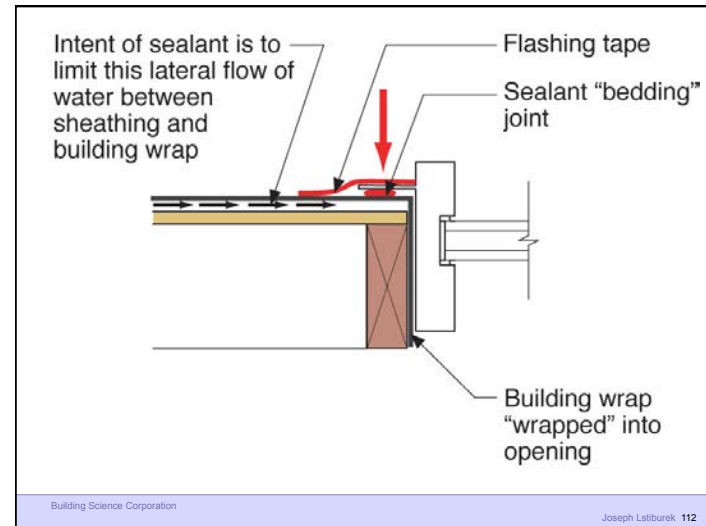
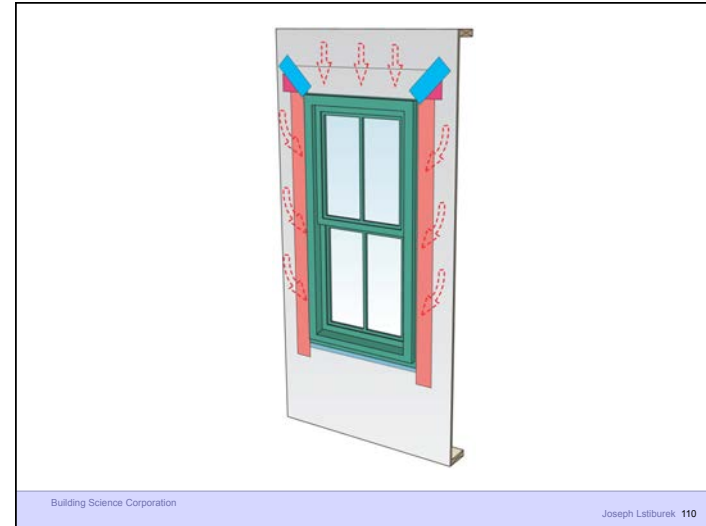


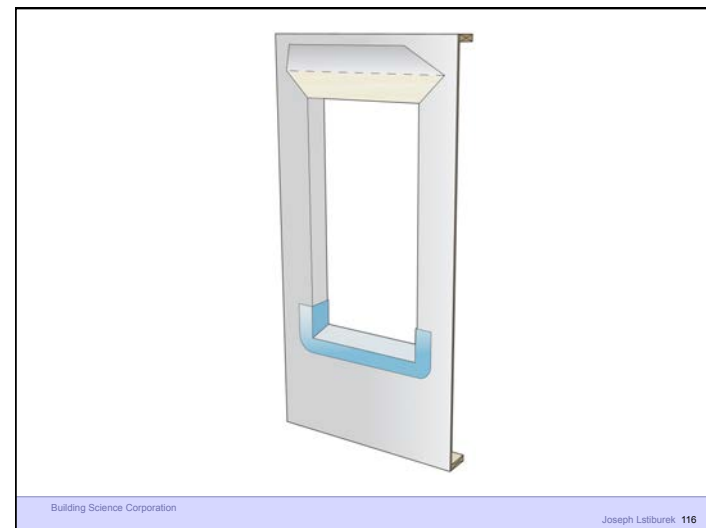
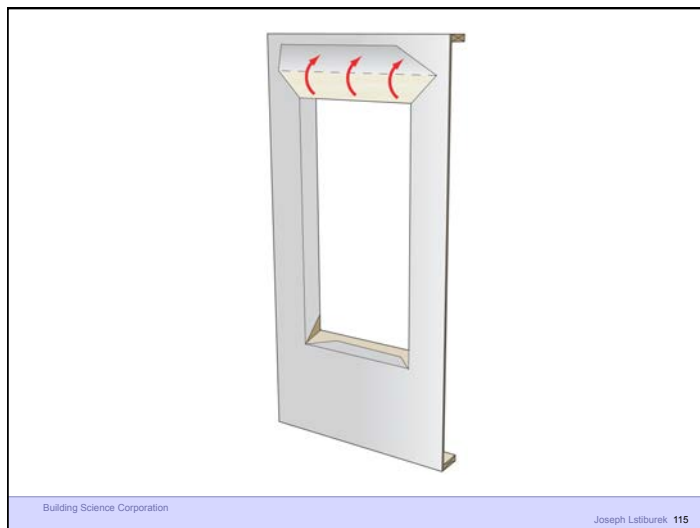
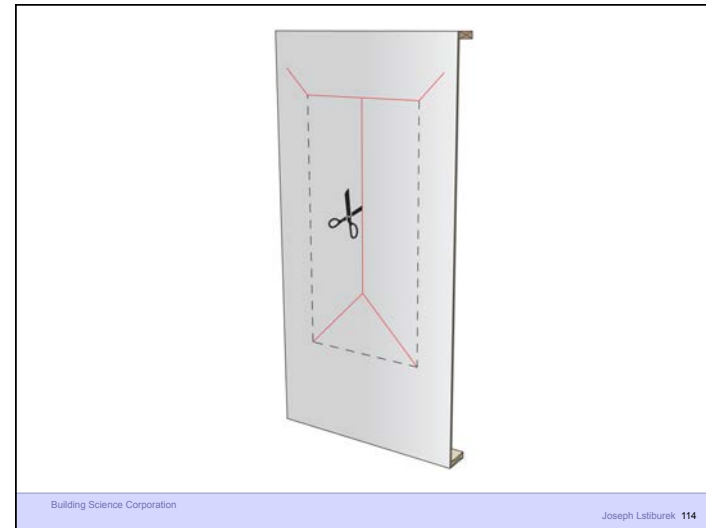
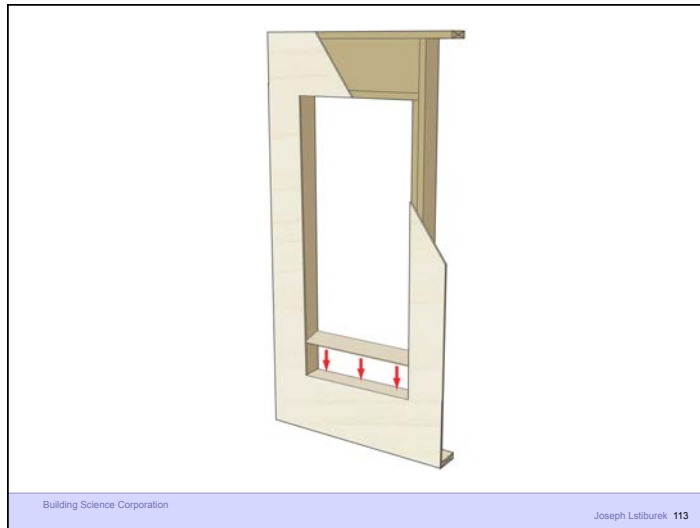


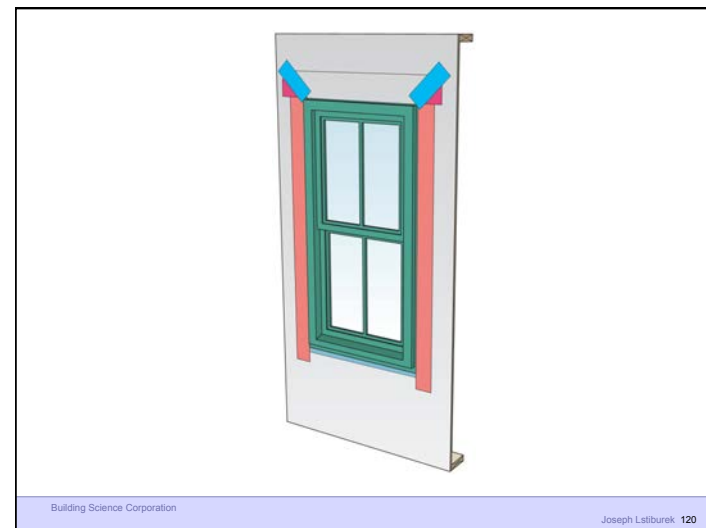
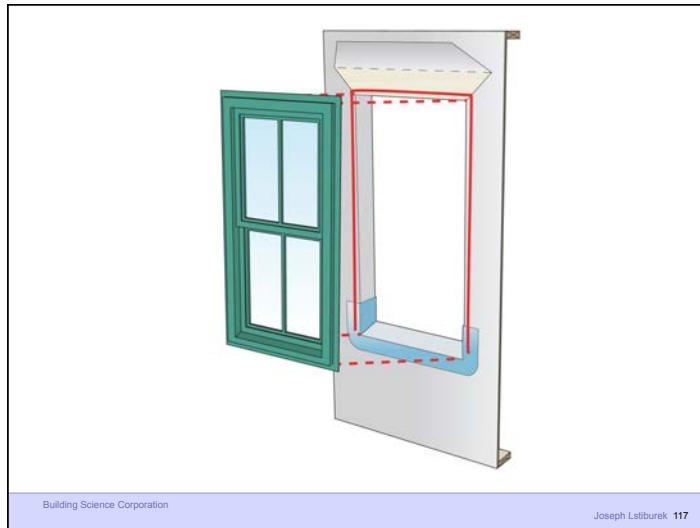


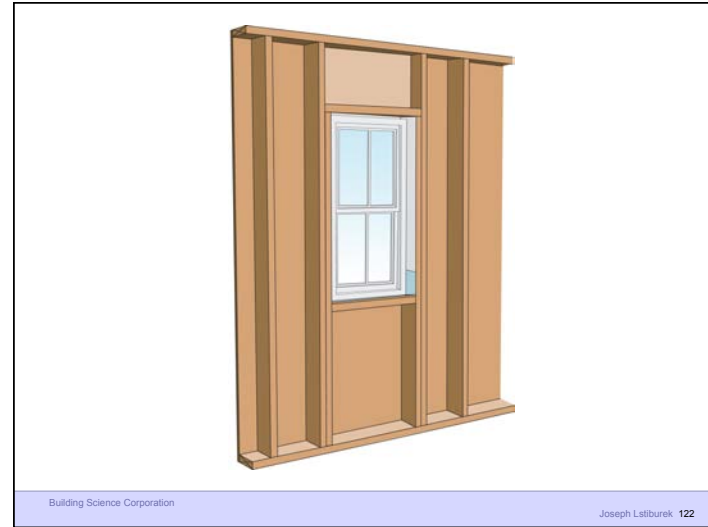
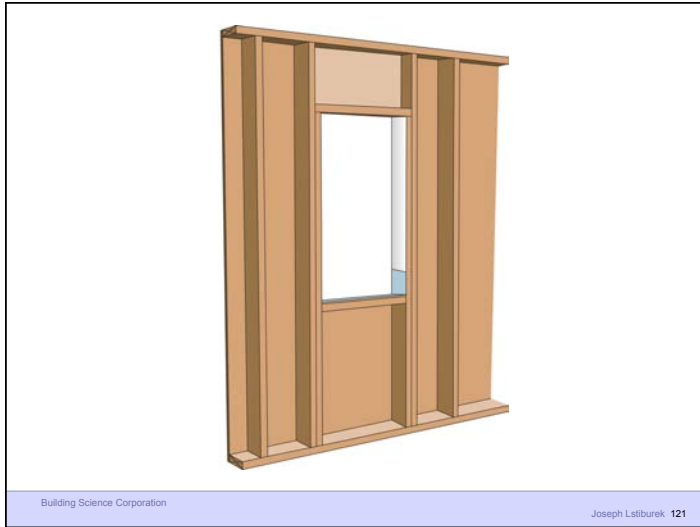


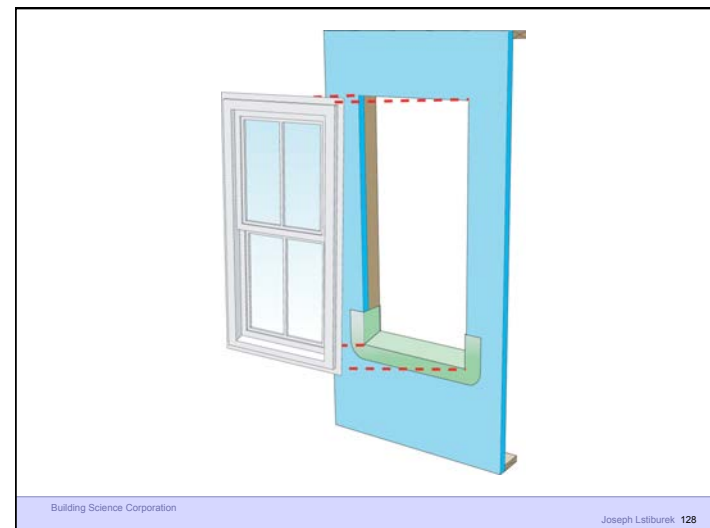
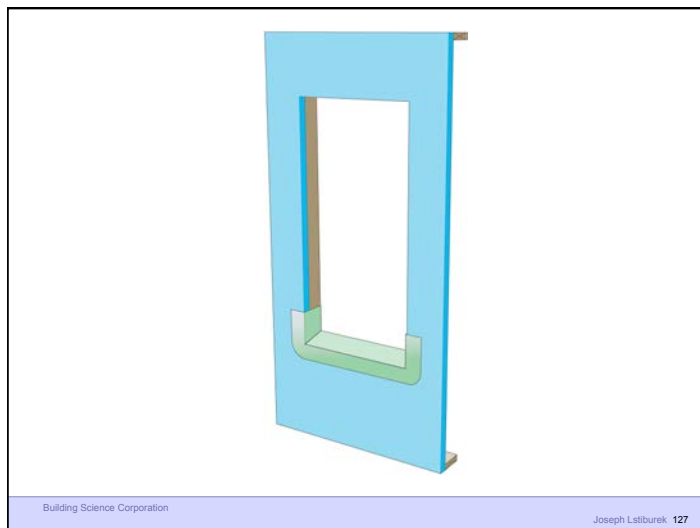
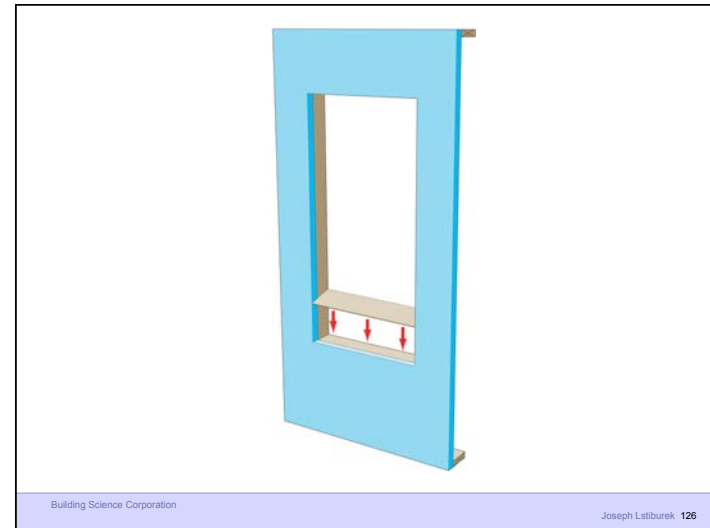
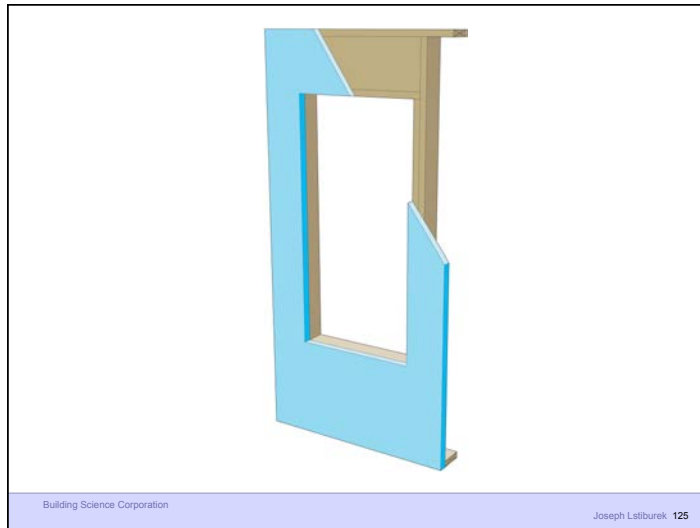




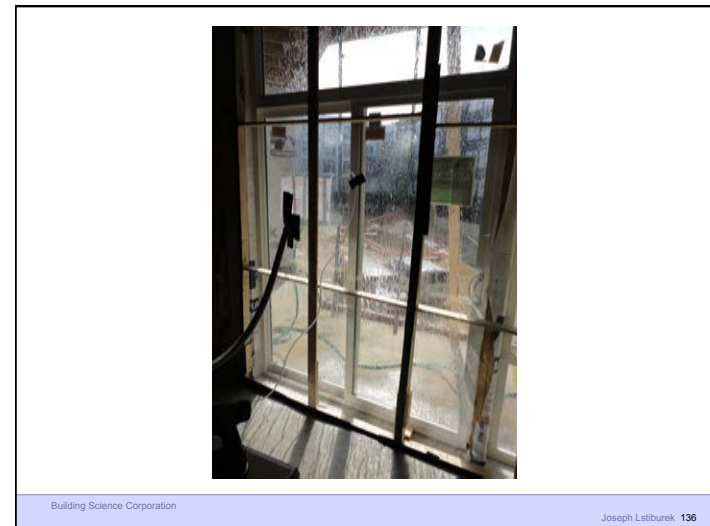


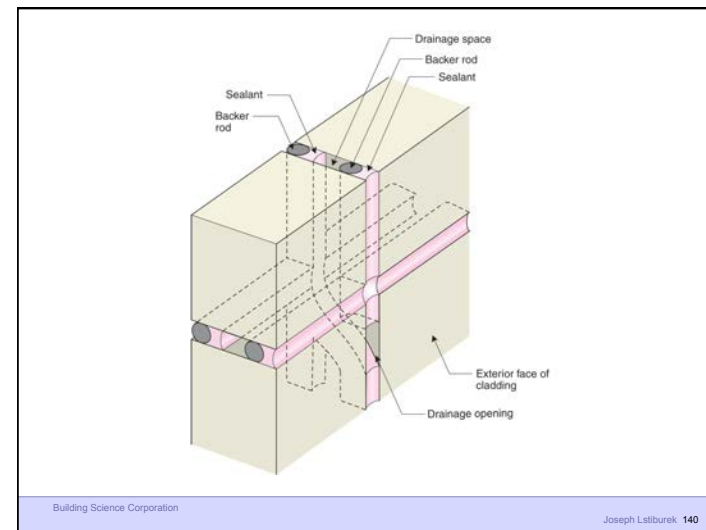
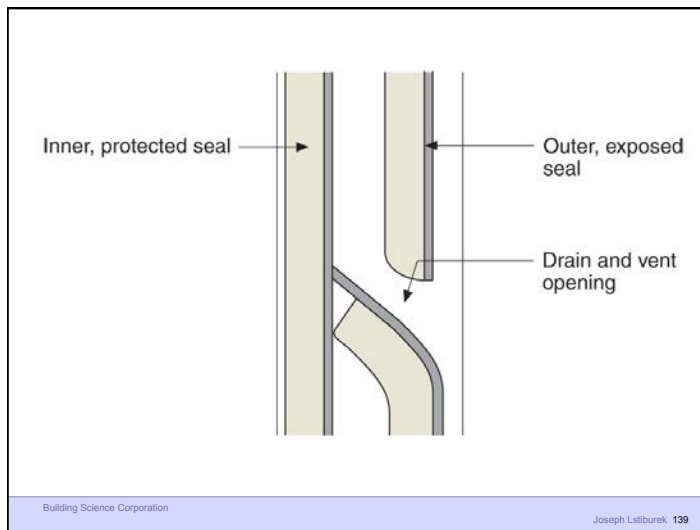
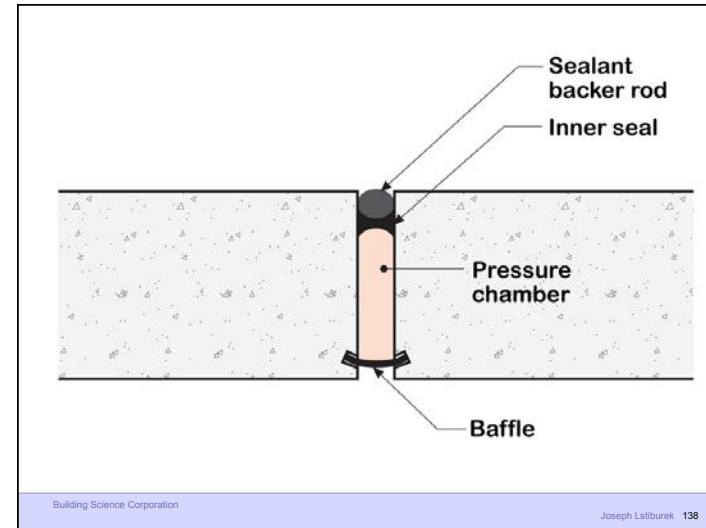
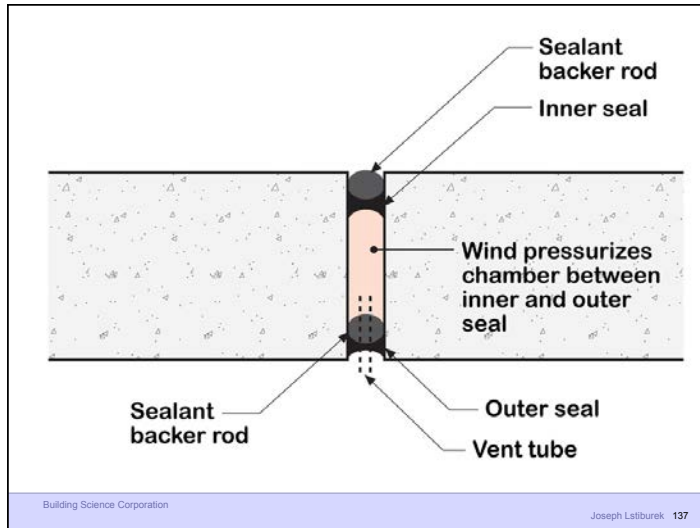


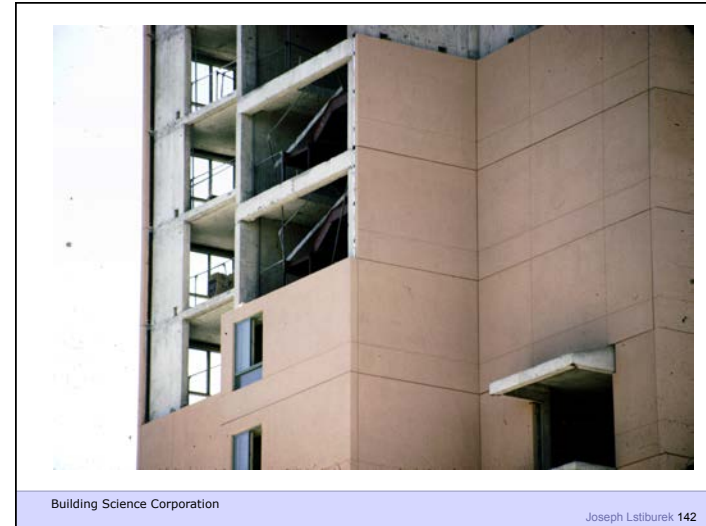


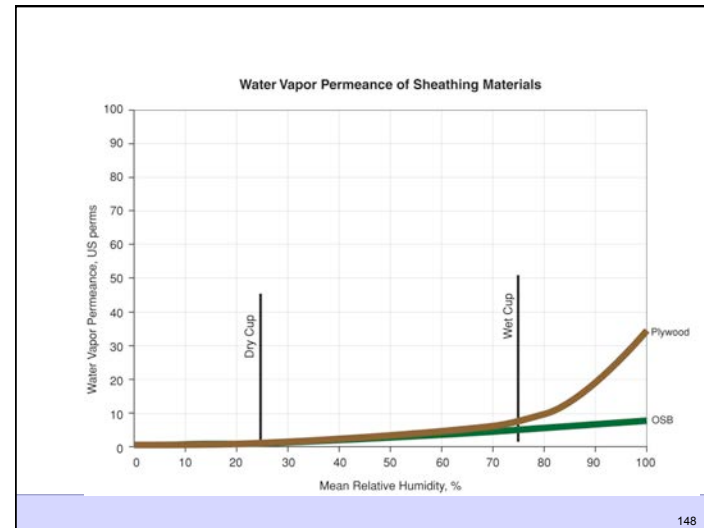
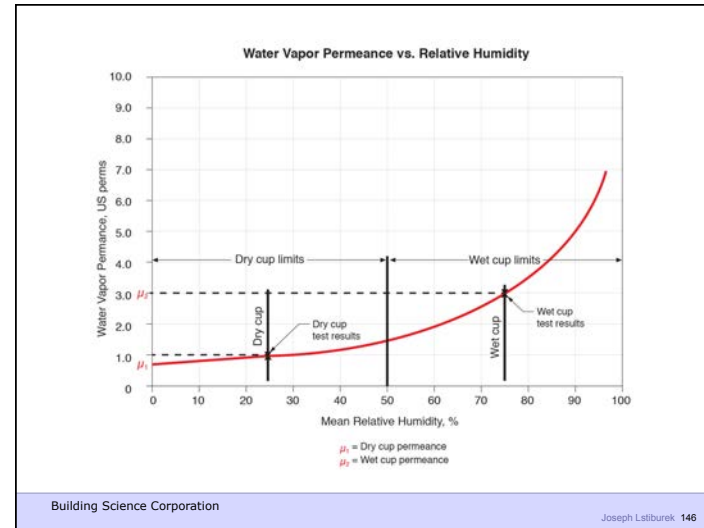
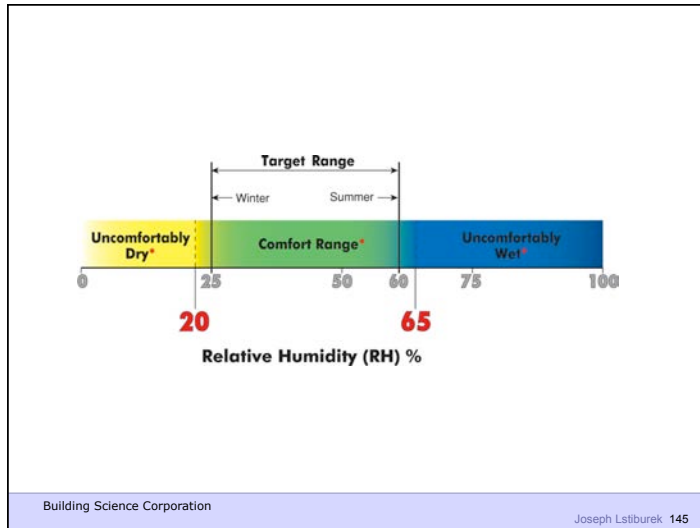


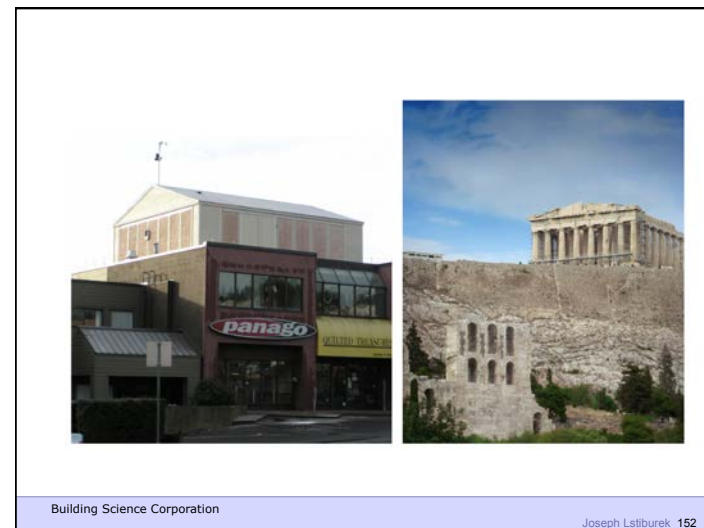
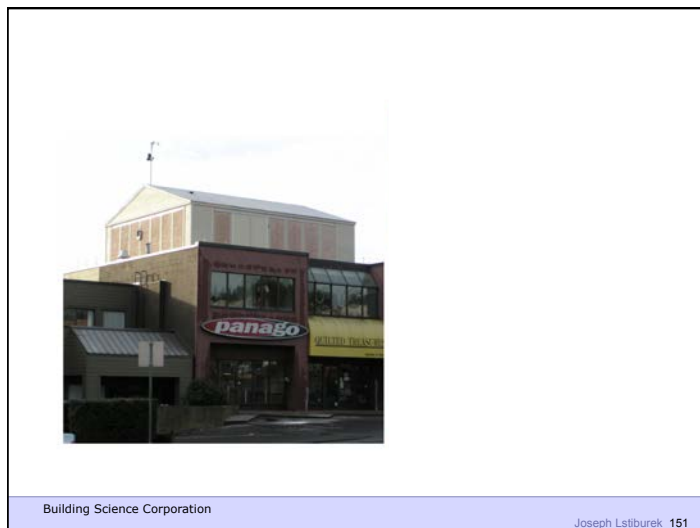
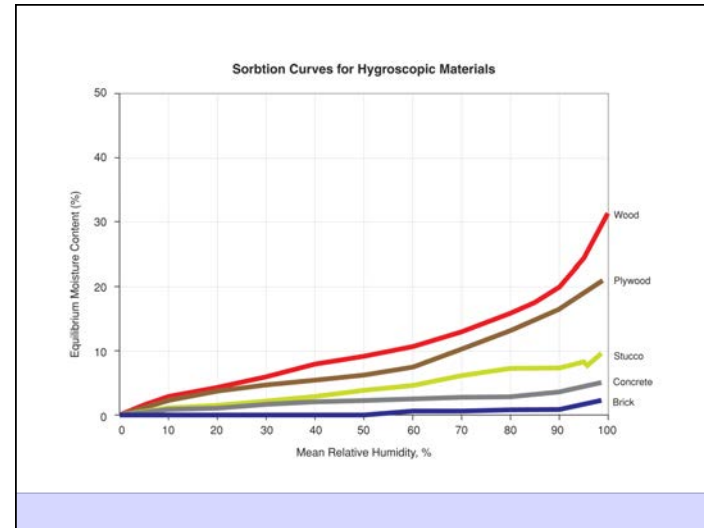
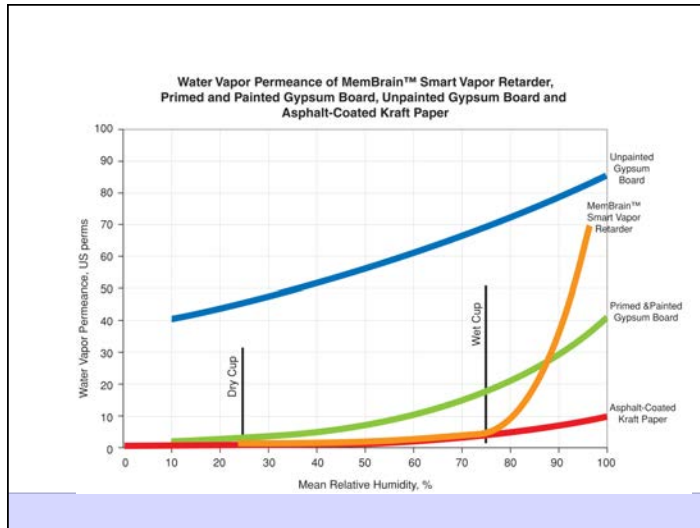


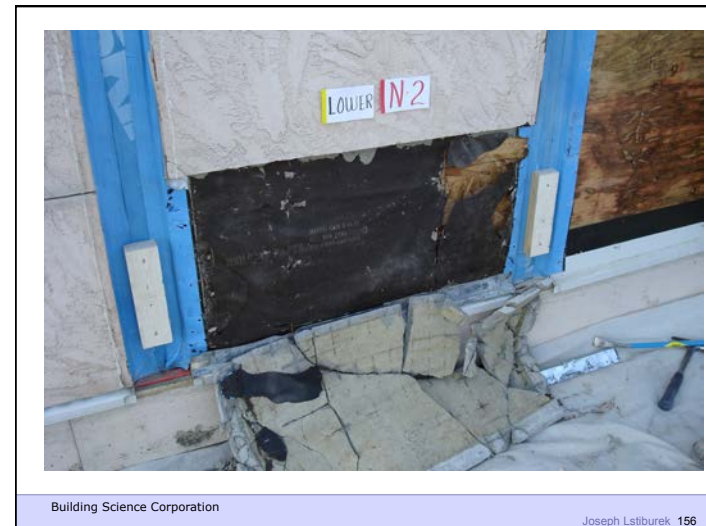


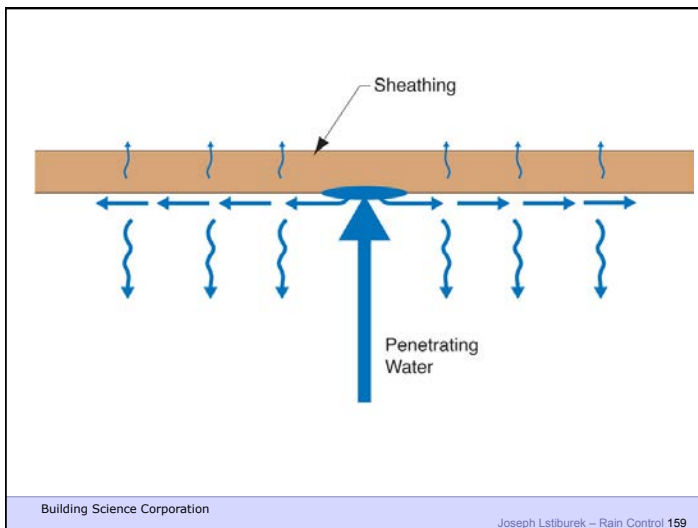
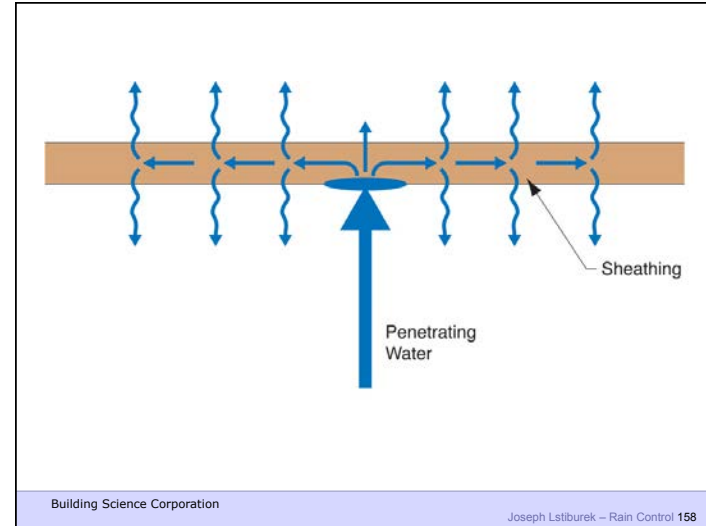






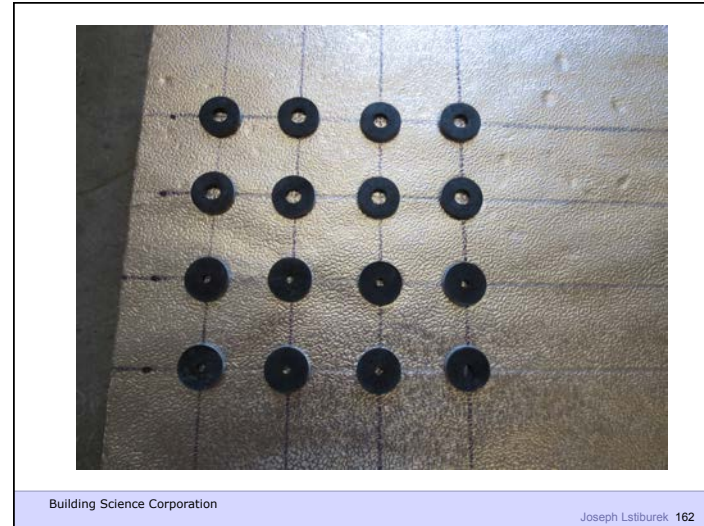






Rain Screen

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Beer Screen?

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