

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

# Building Science

Big City Adventures In Building Science

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"It isn't what we don't know that gives us trouble, it's what we know that ain't so"

Will Rogers

"There are known knowns. These are things we know. There are known unknowns. There are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know."

Donald Rumsfeld

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## What Is A Building?

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## Environmental Separator

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- 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

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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

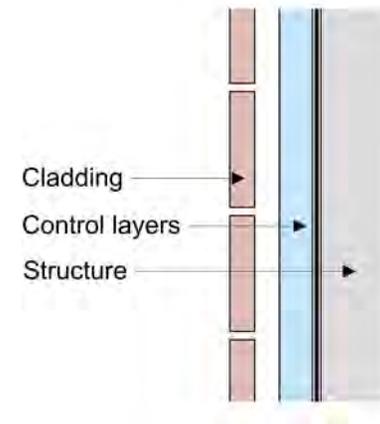
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Water Control Layer  
 Air Control Layer  
 Vapor Control Layer  
 Thermal Control Layer

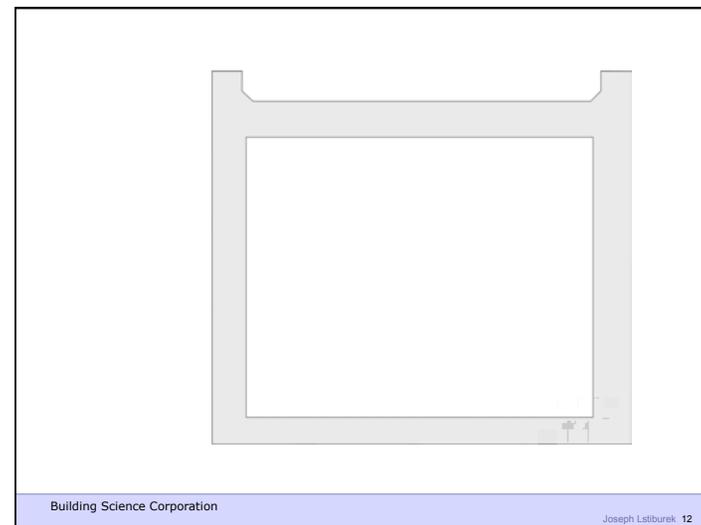
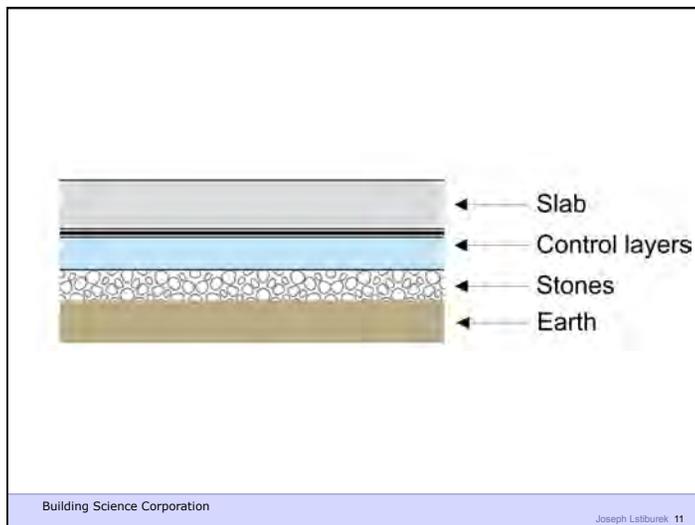
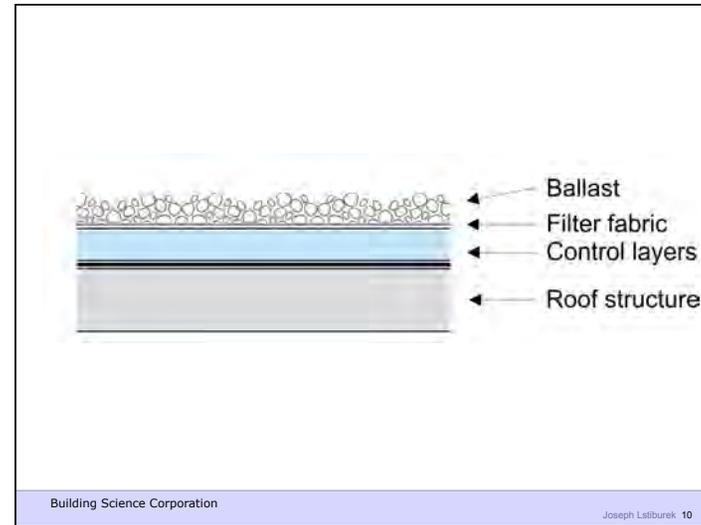
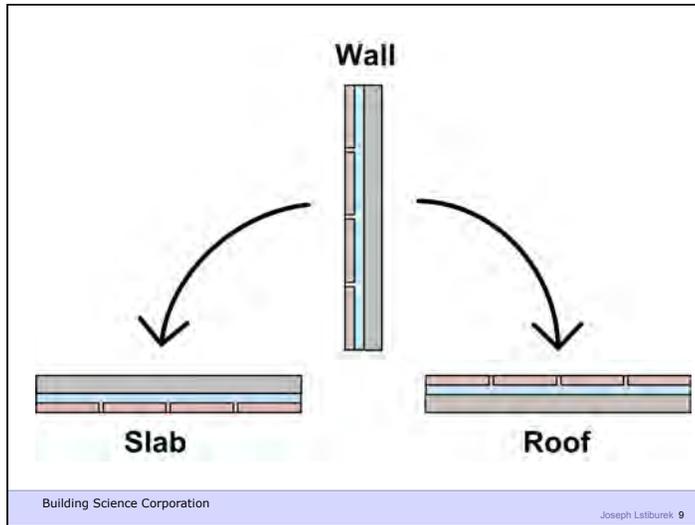
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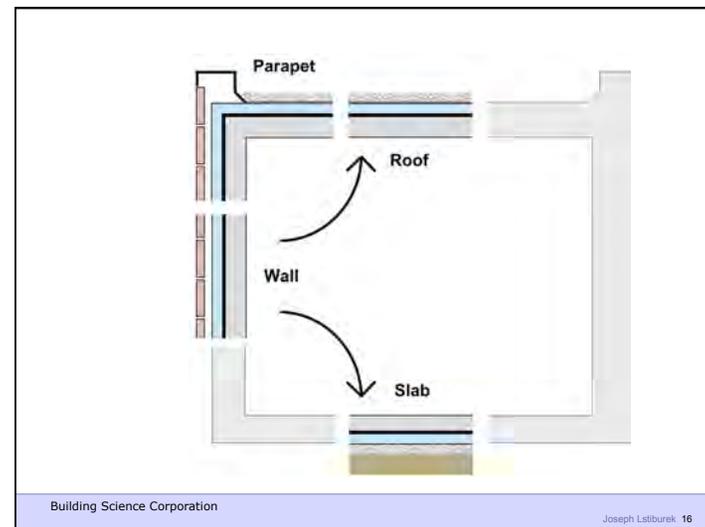
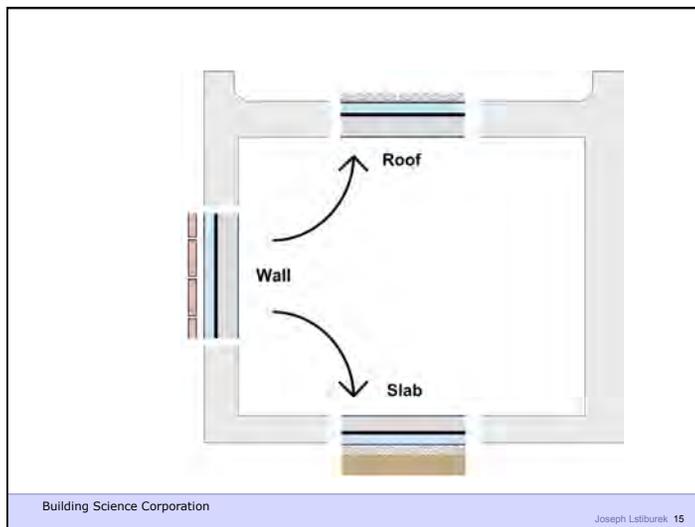
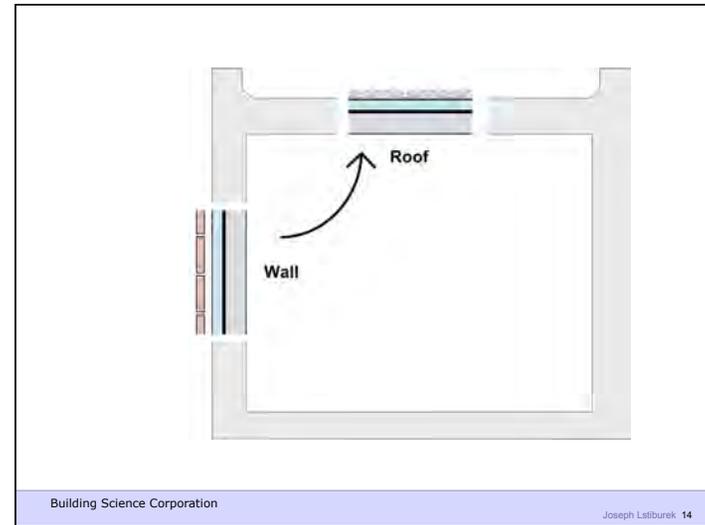
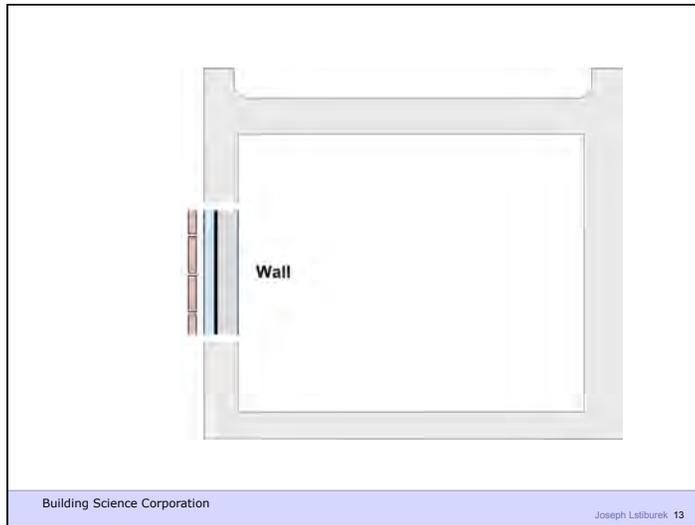
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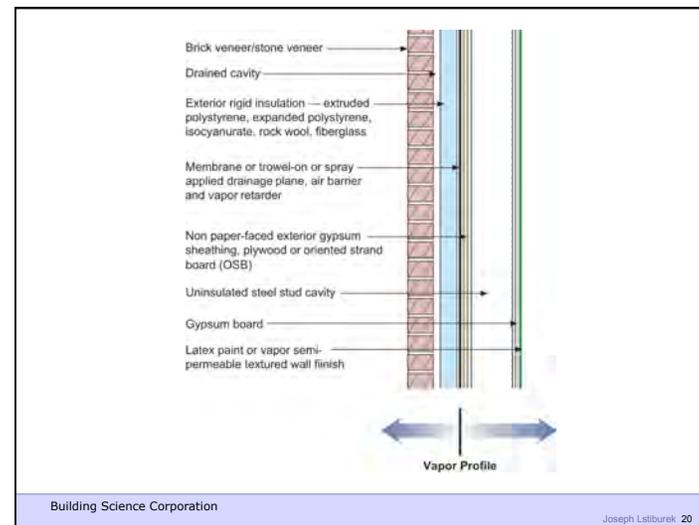
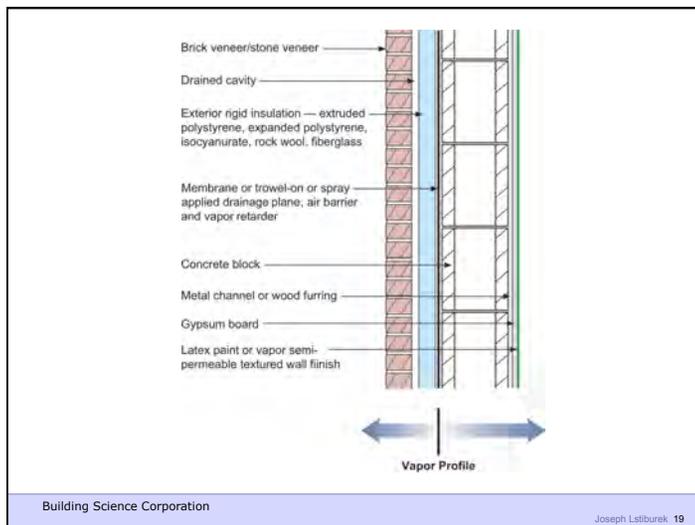
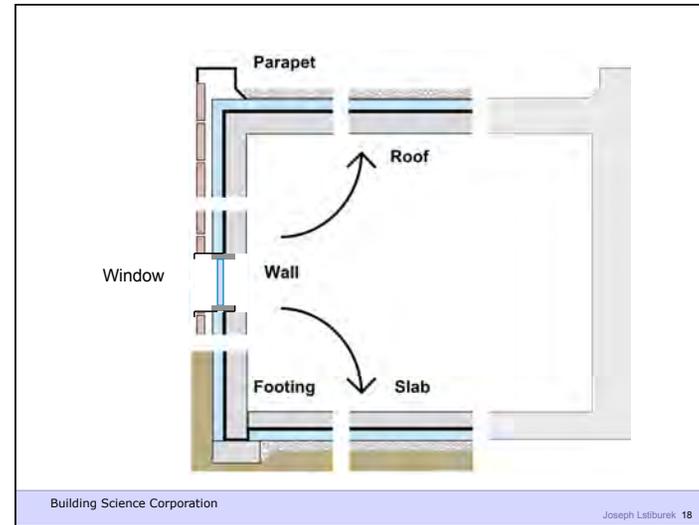
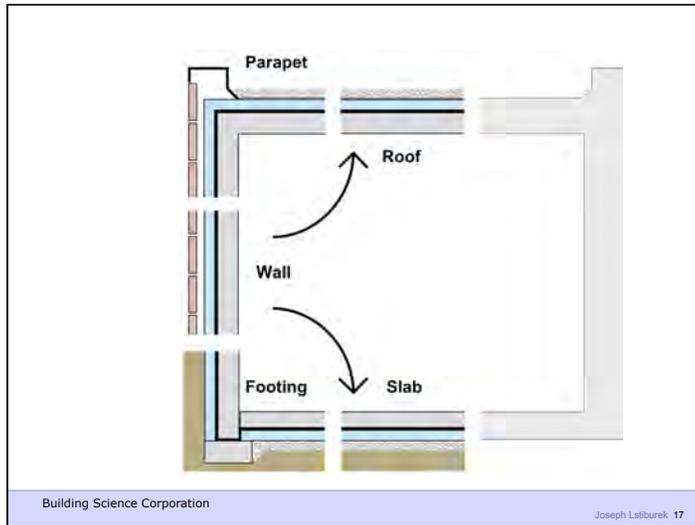


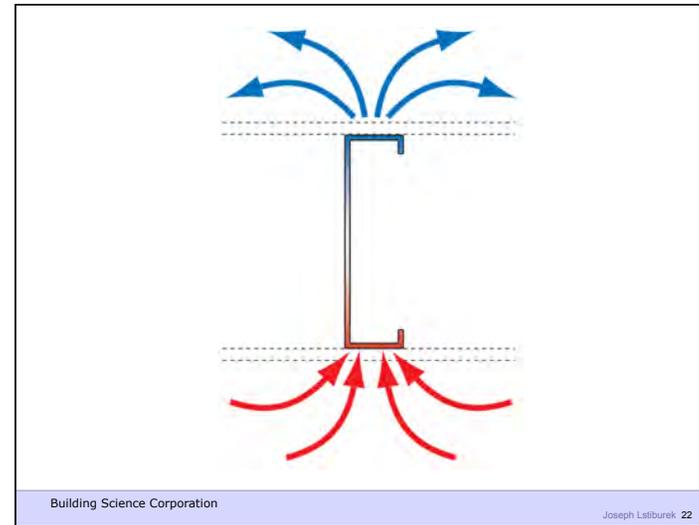
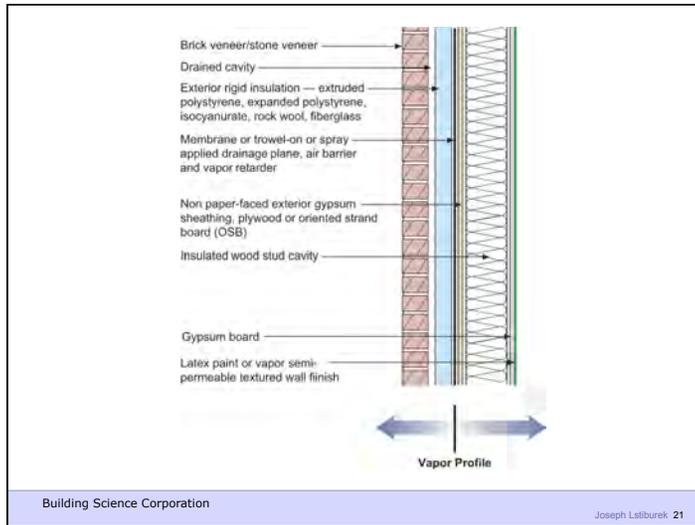
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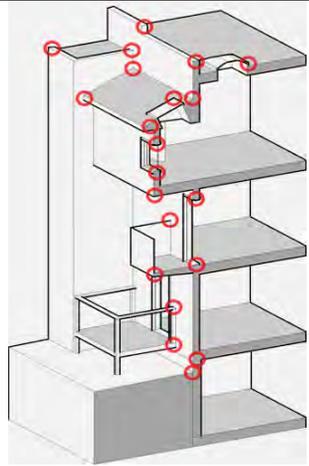
### Commercial Enclosure: Simple Layers

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

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## Enclosure Design: Details

- Details demand the same approach as the enclosure.
- Scaled drawings required at 



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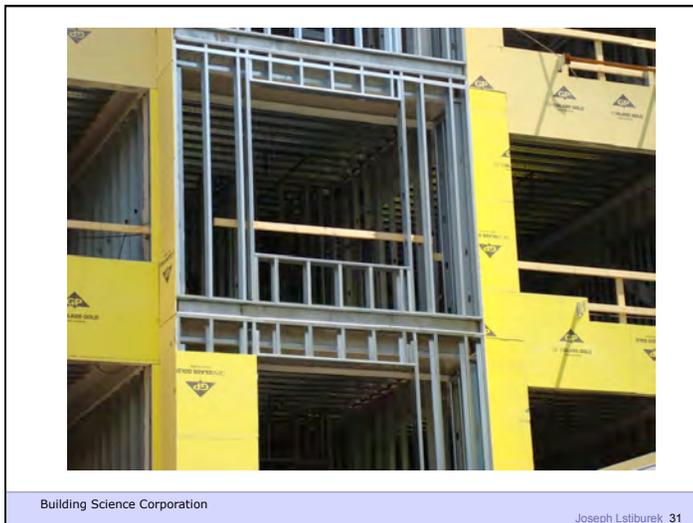
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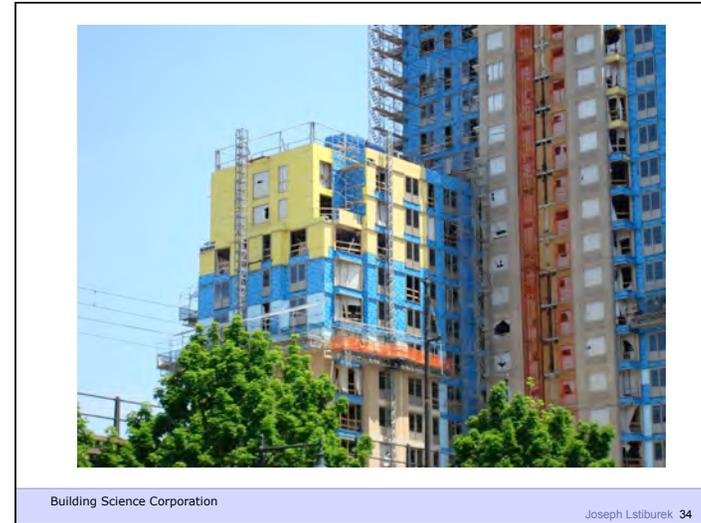
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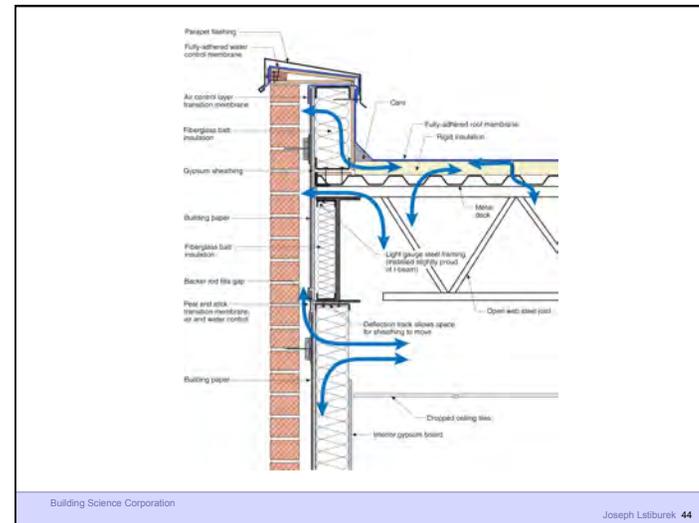
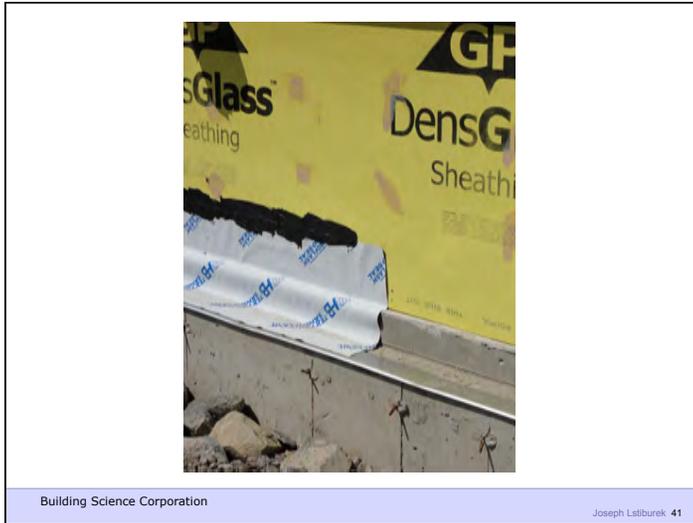
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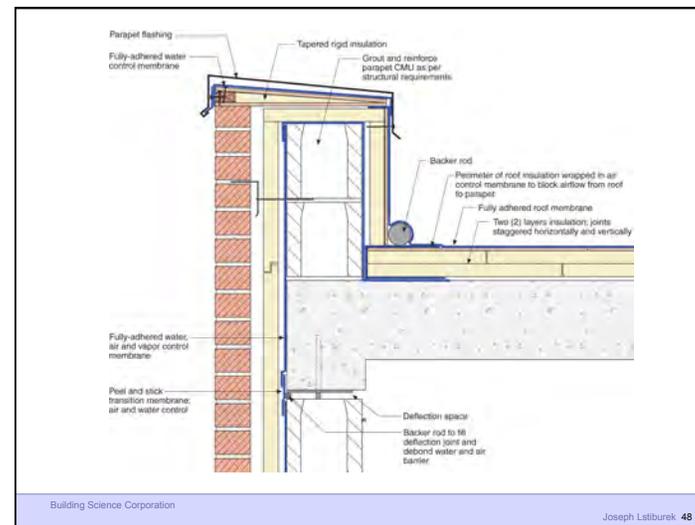
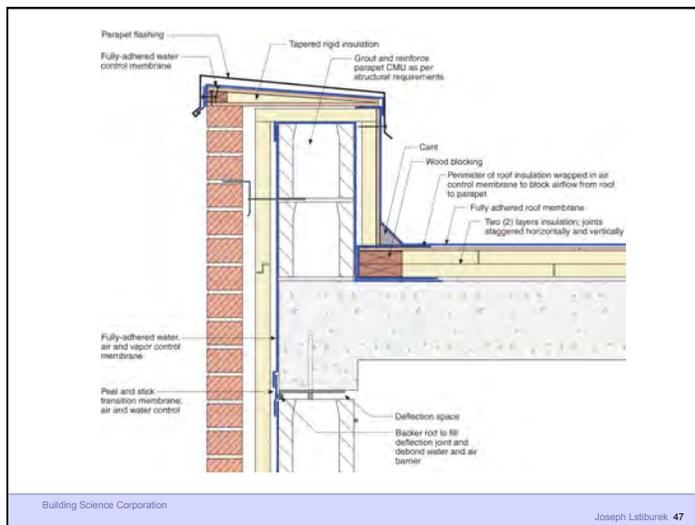
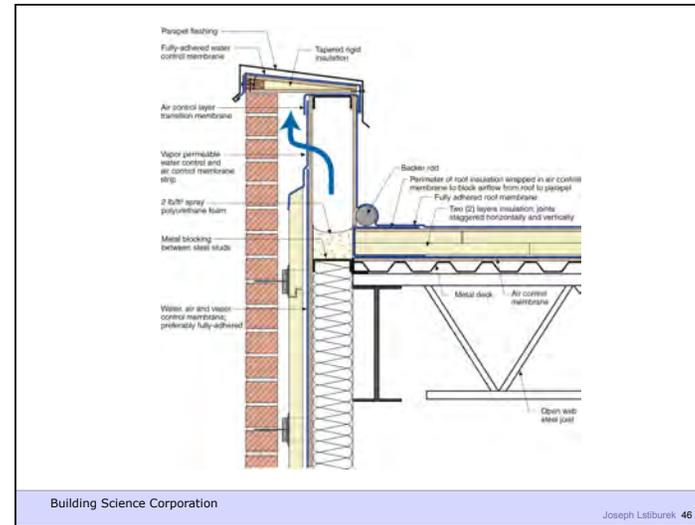
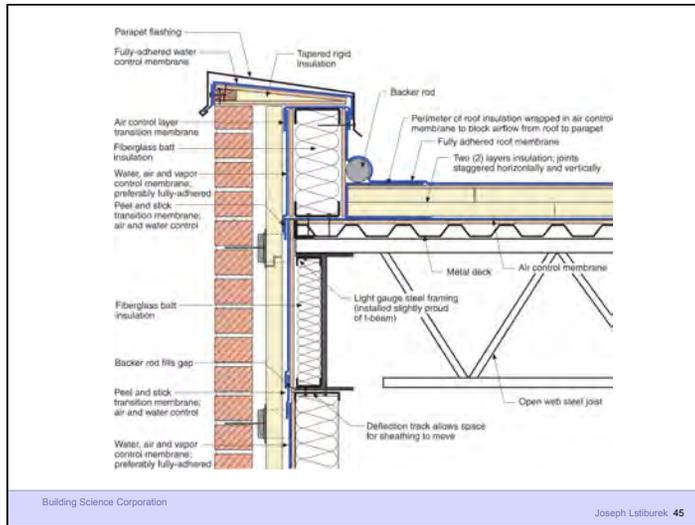
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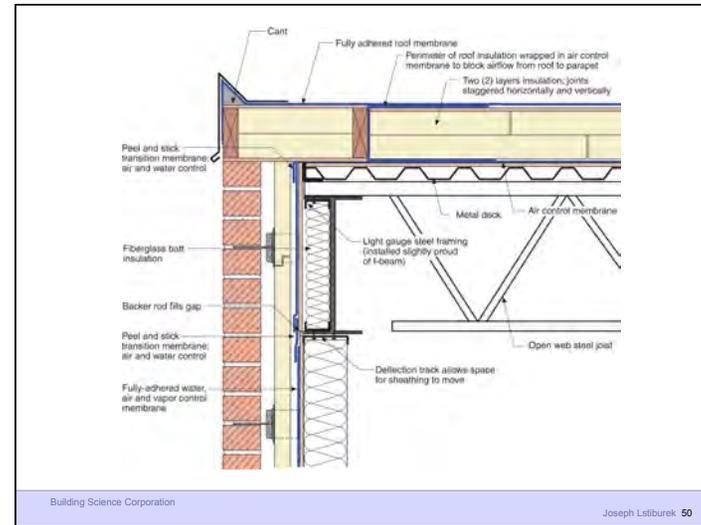
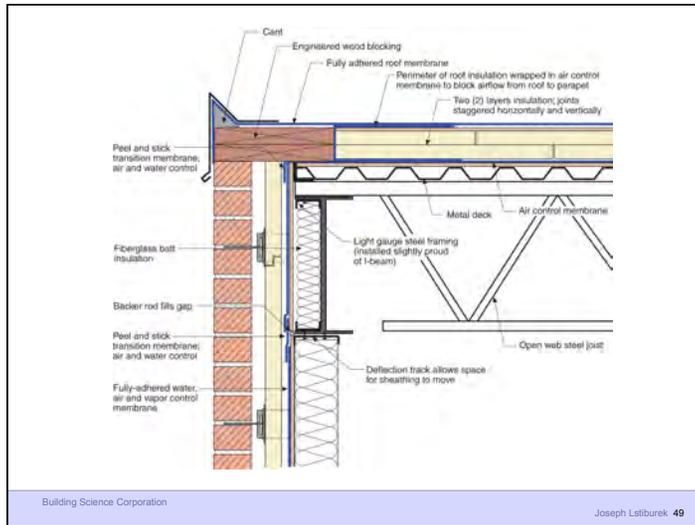




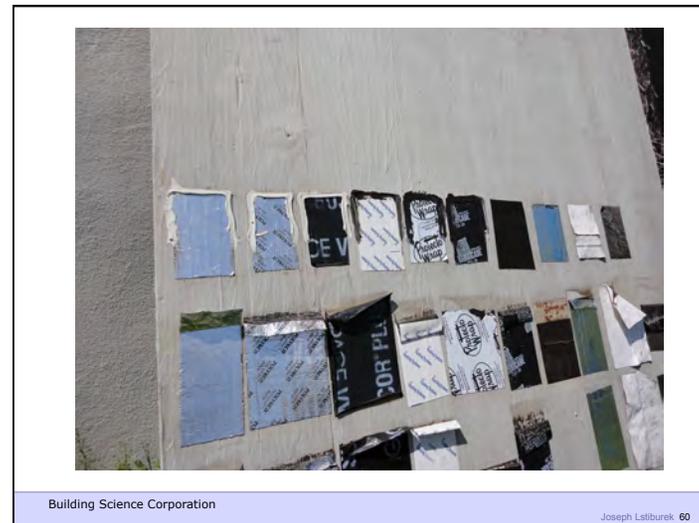
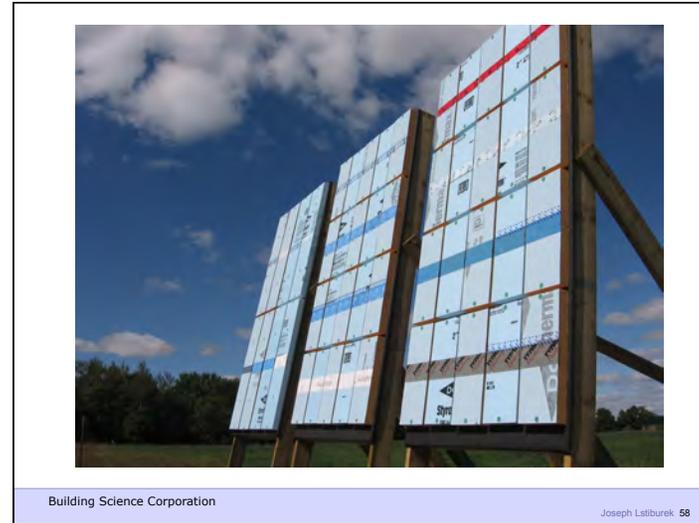


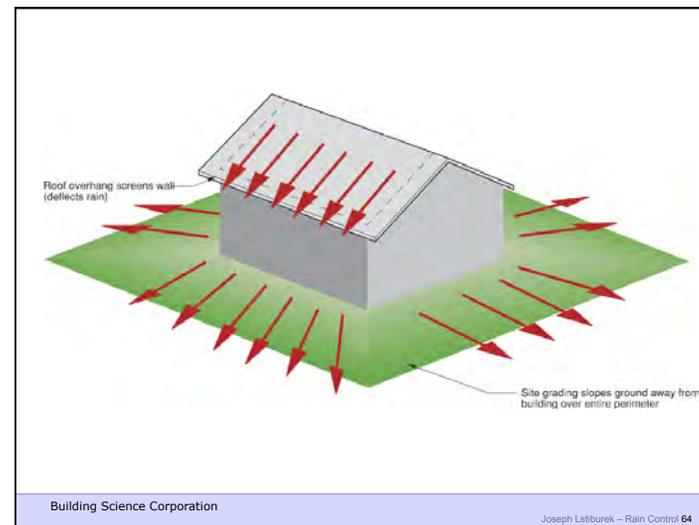
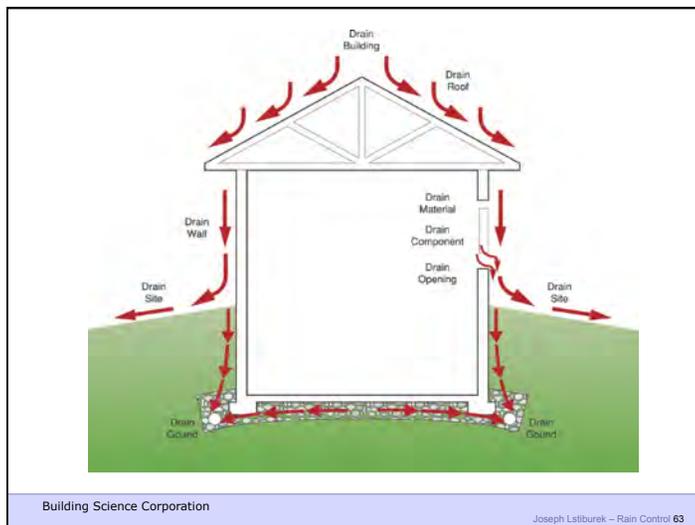
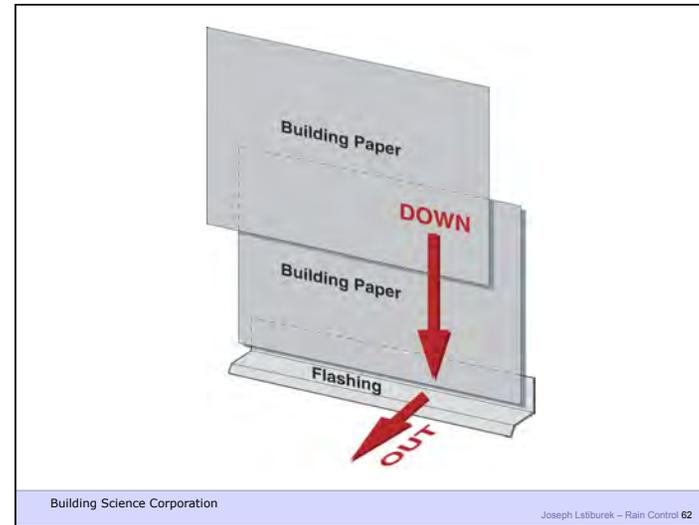
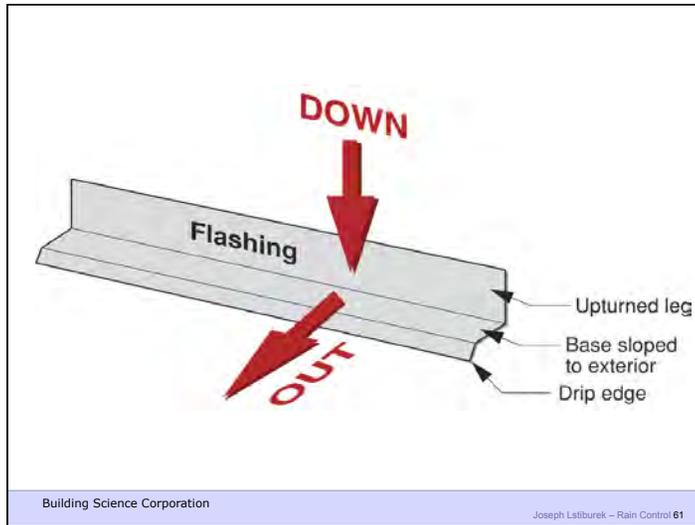


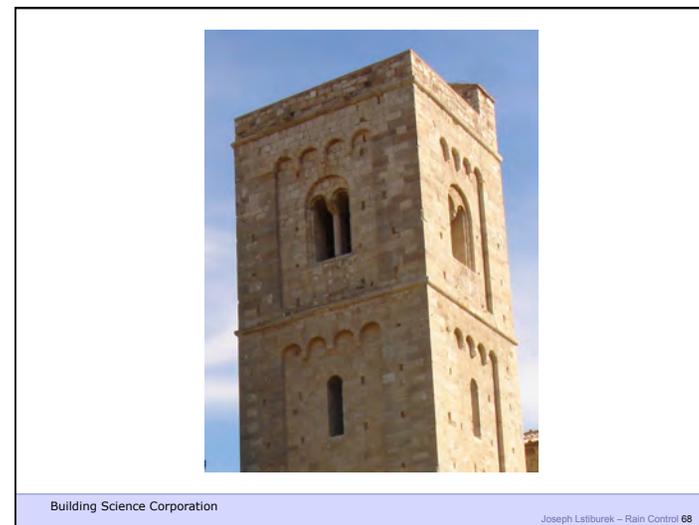
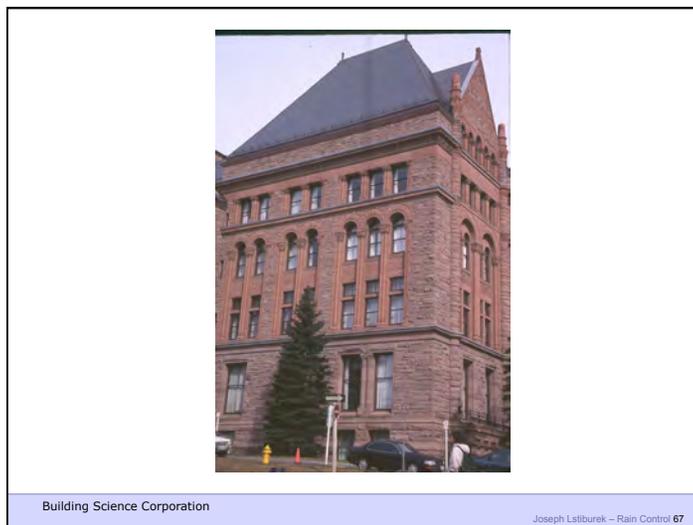
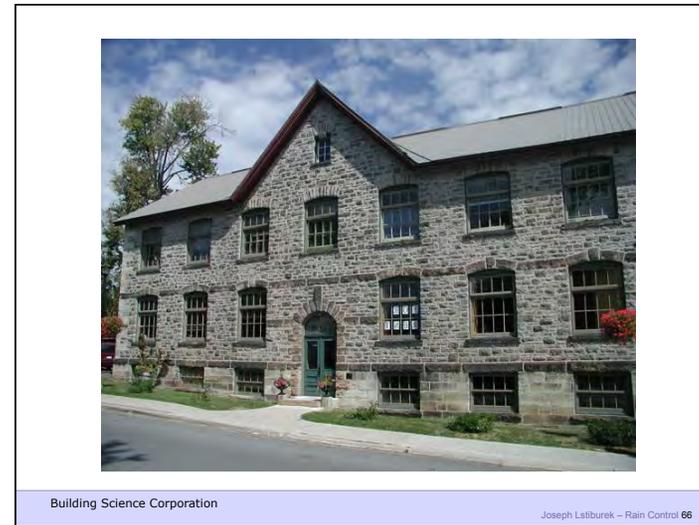
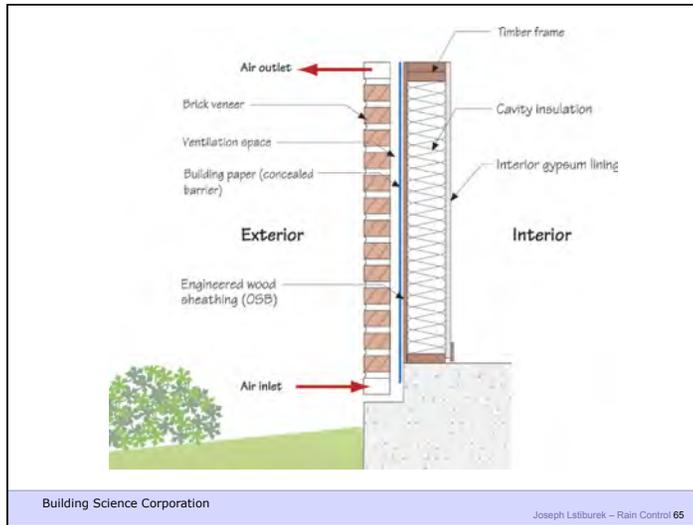


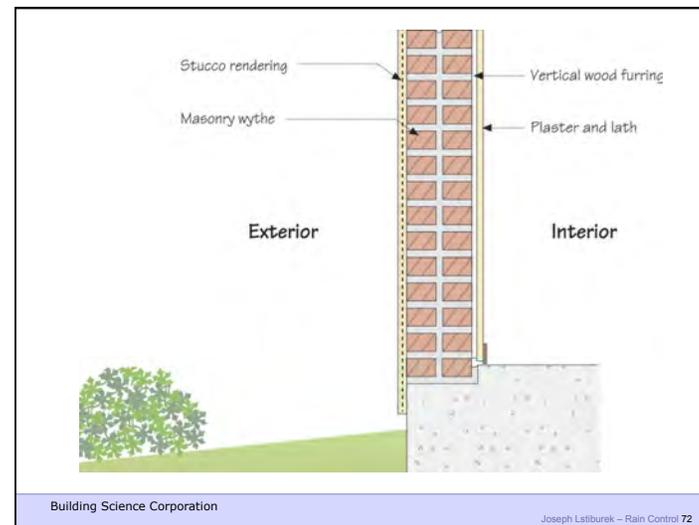
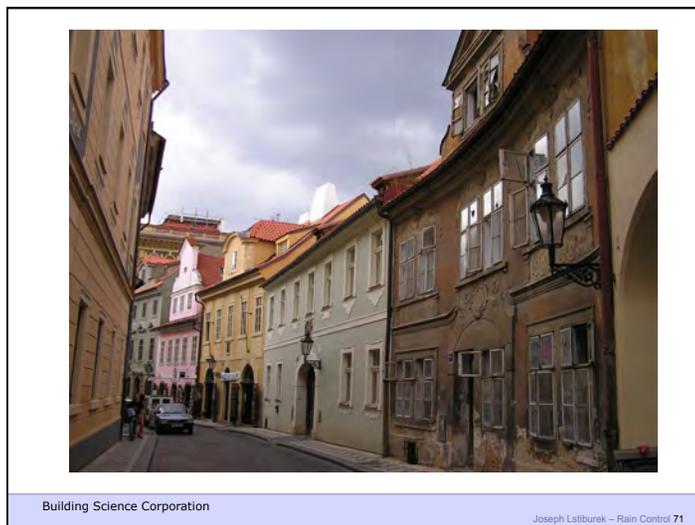


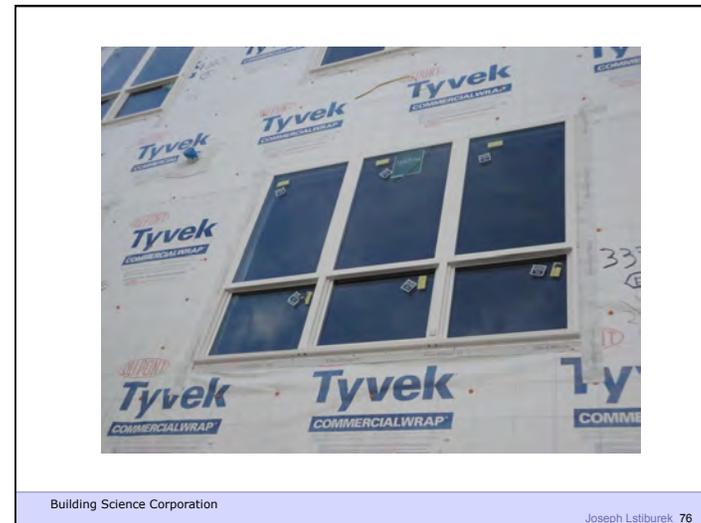
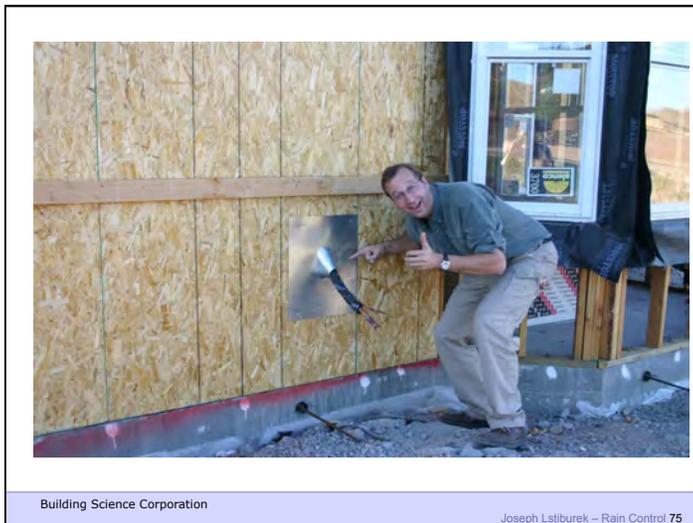


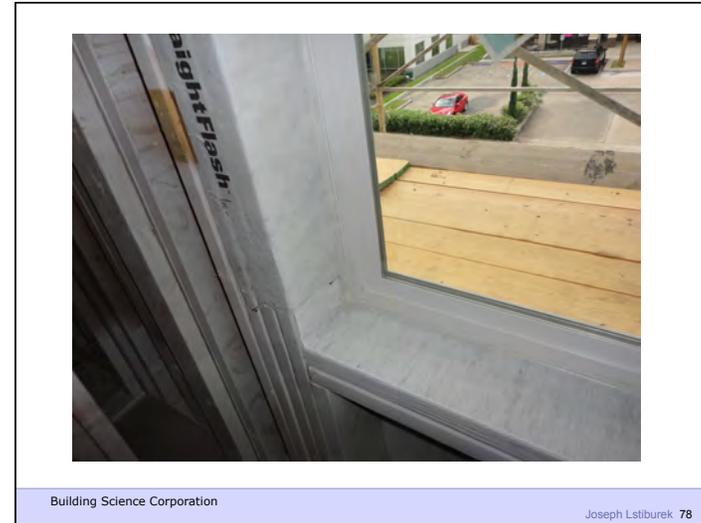
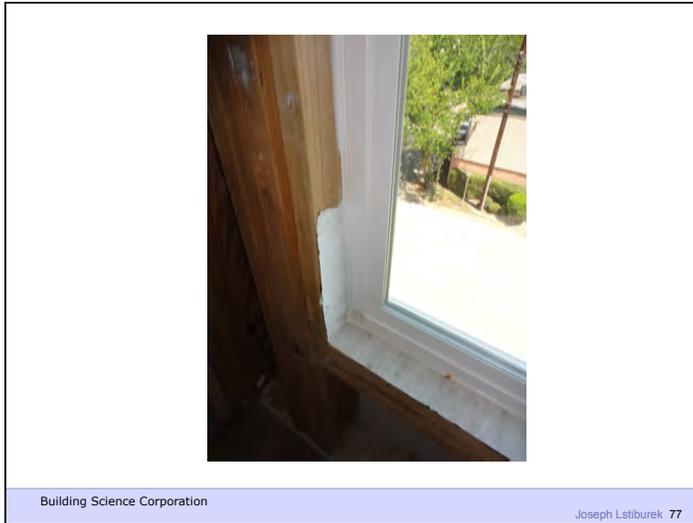


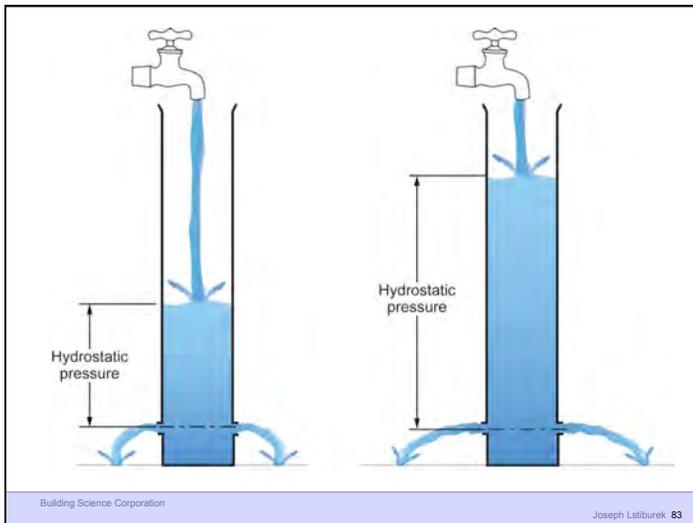


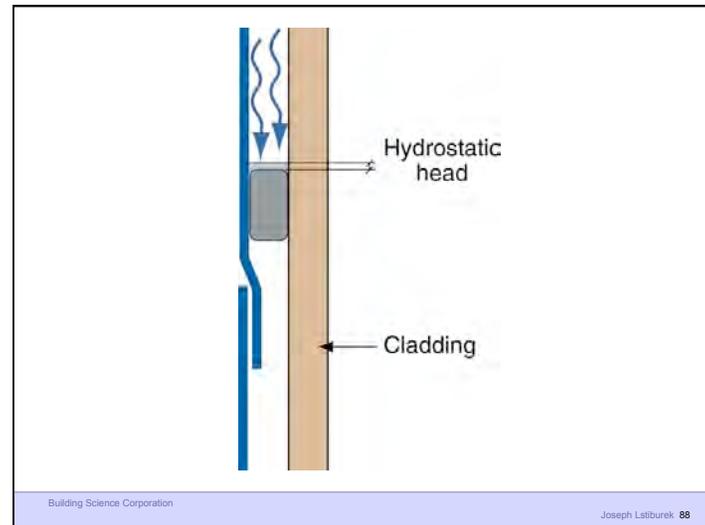
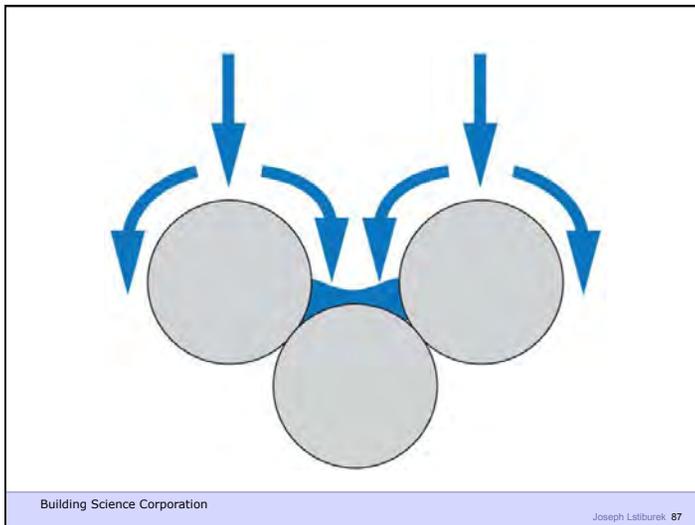
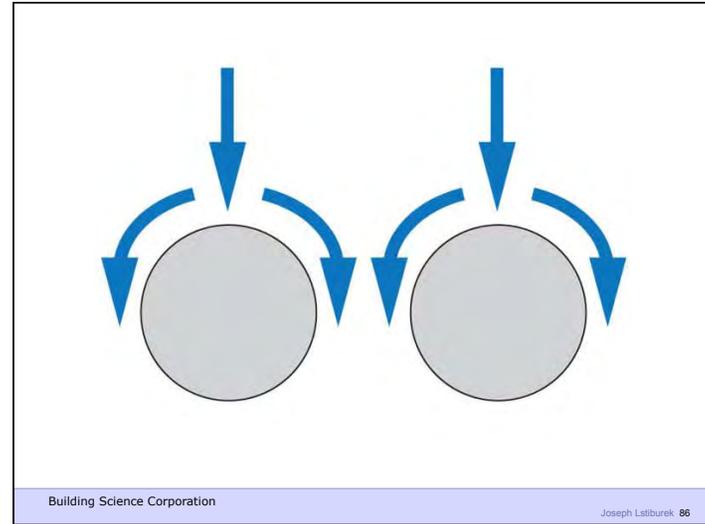
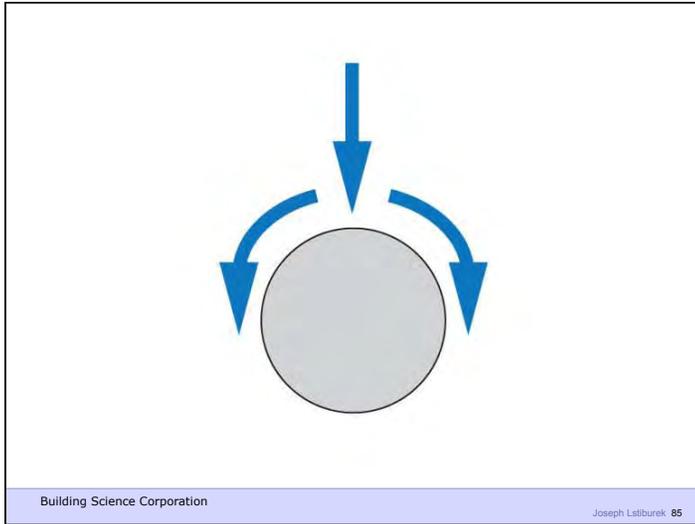


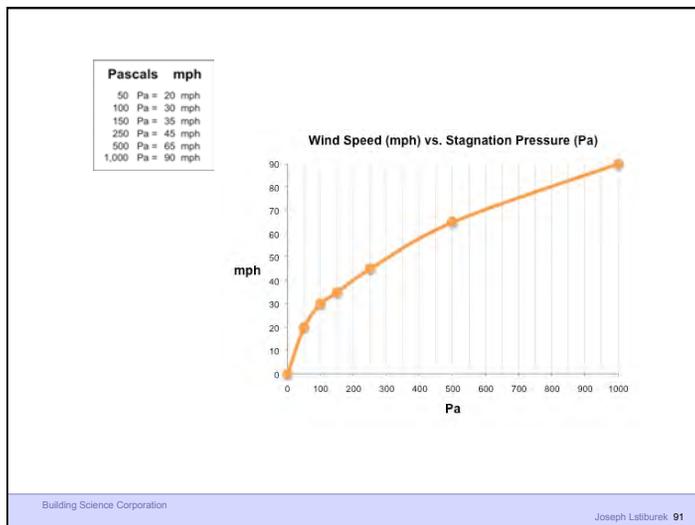
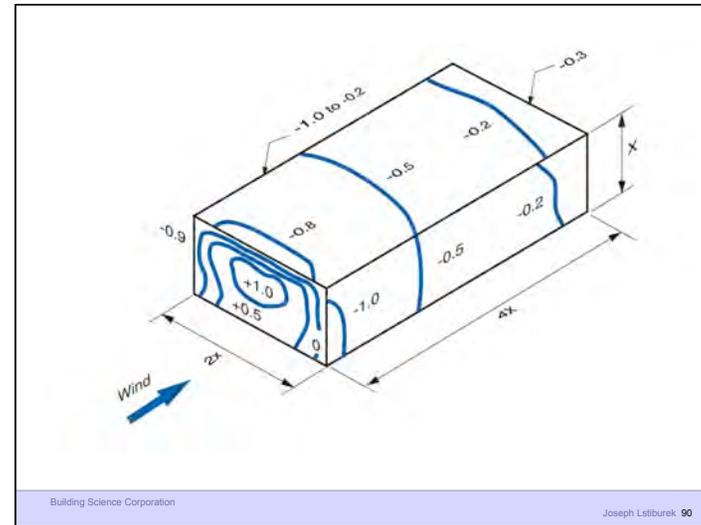
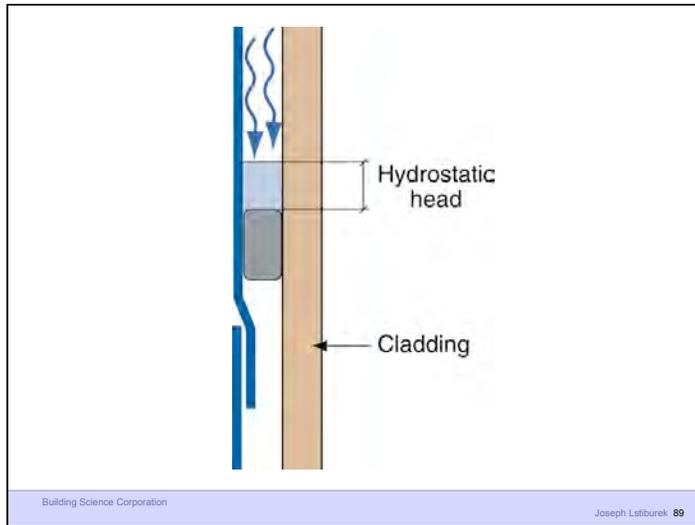


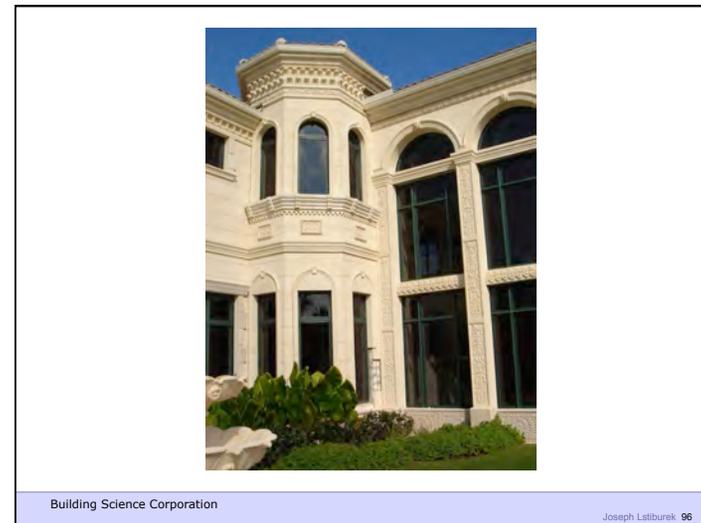
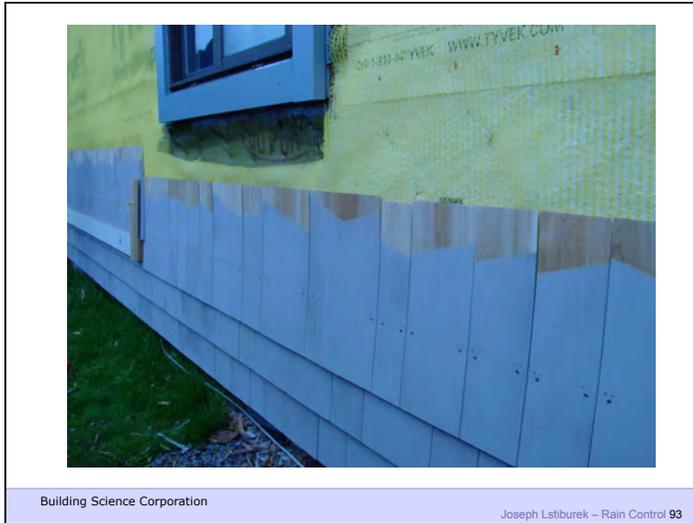


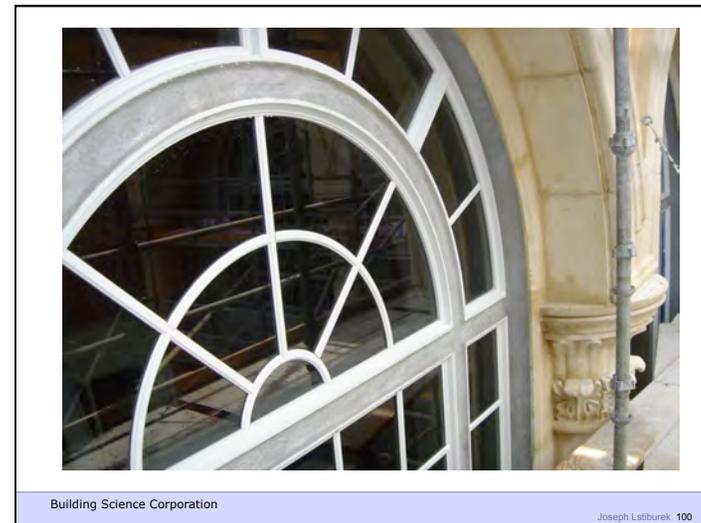
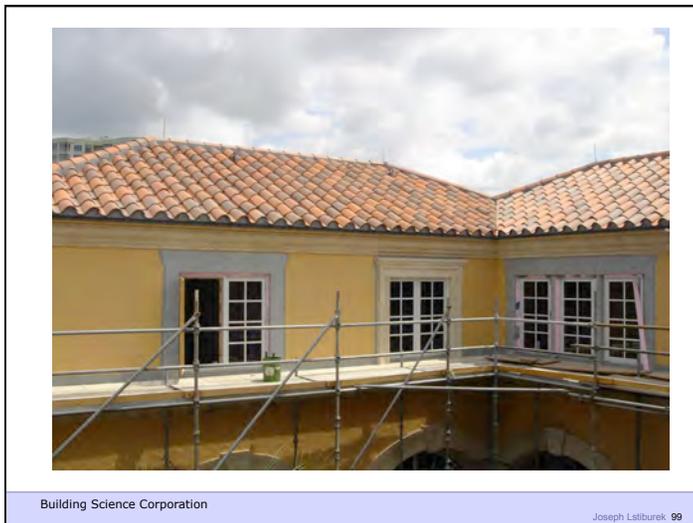
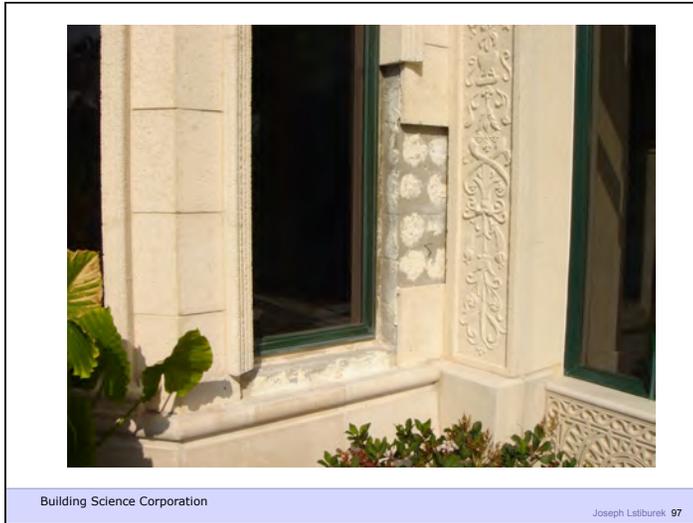


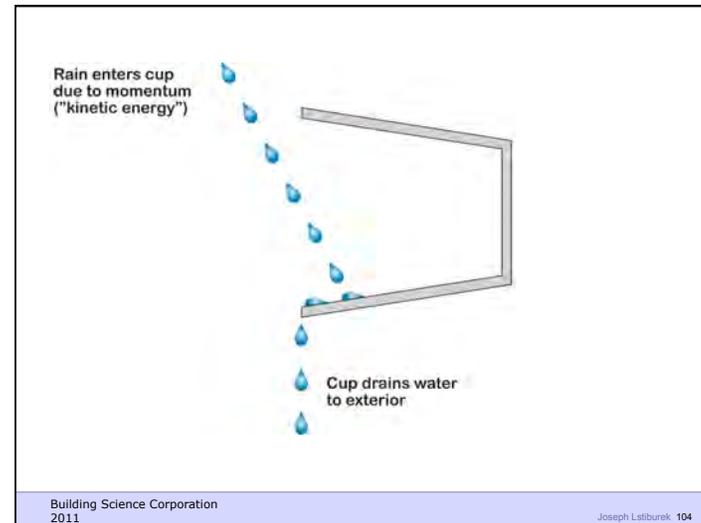
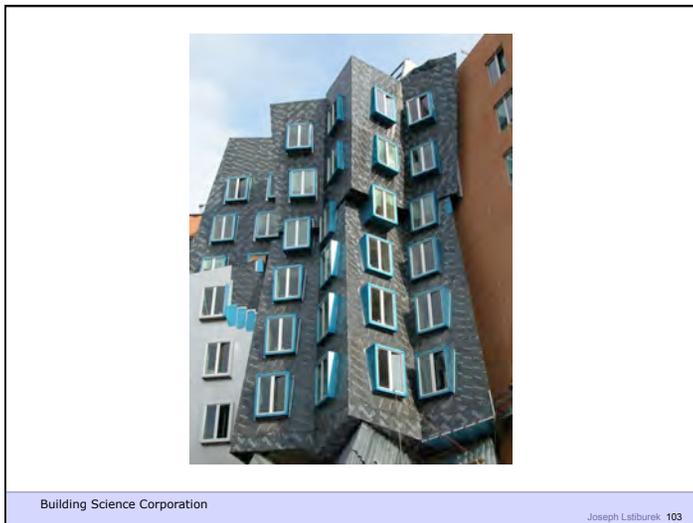
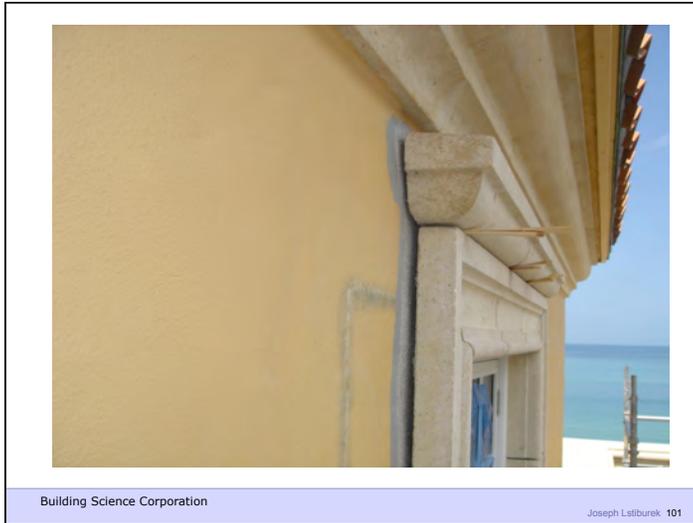


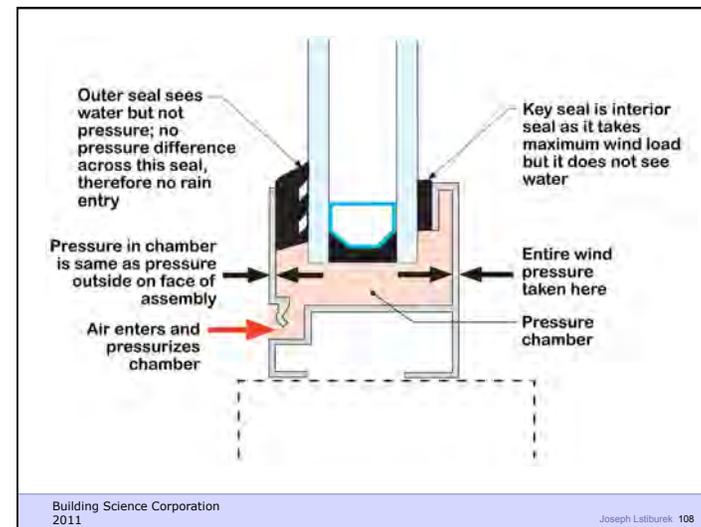
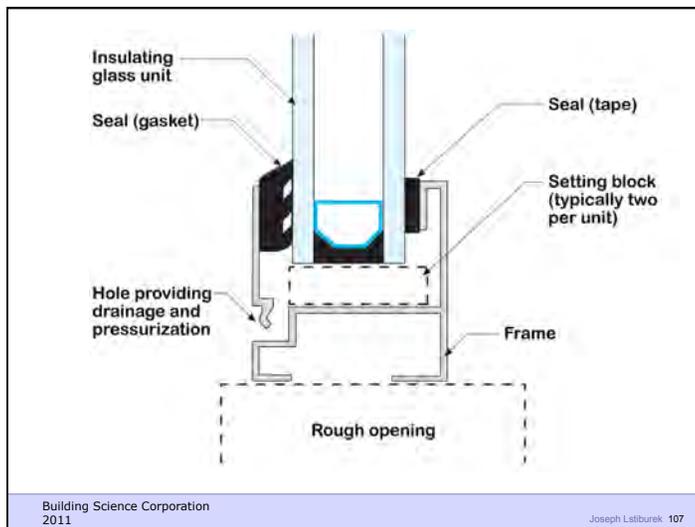
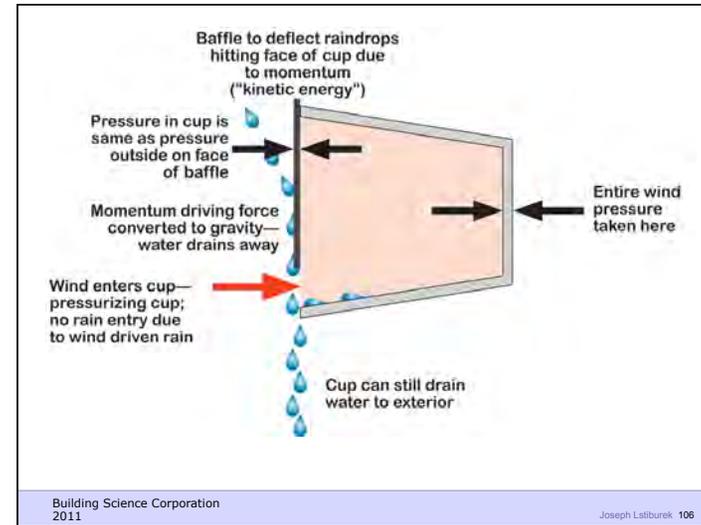
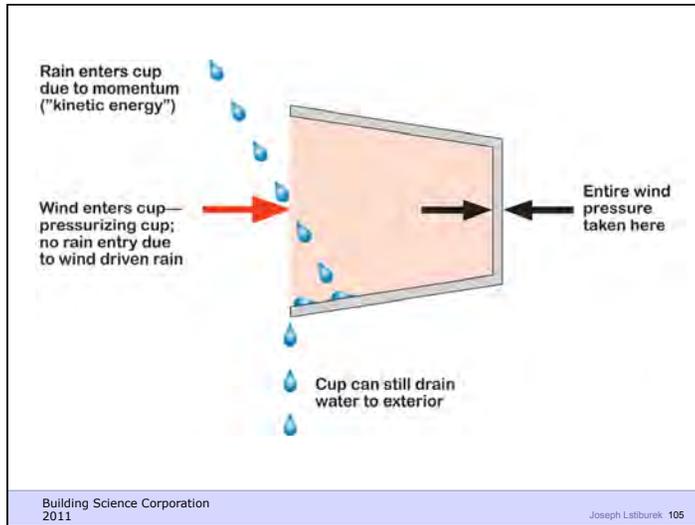


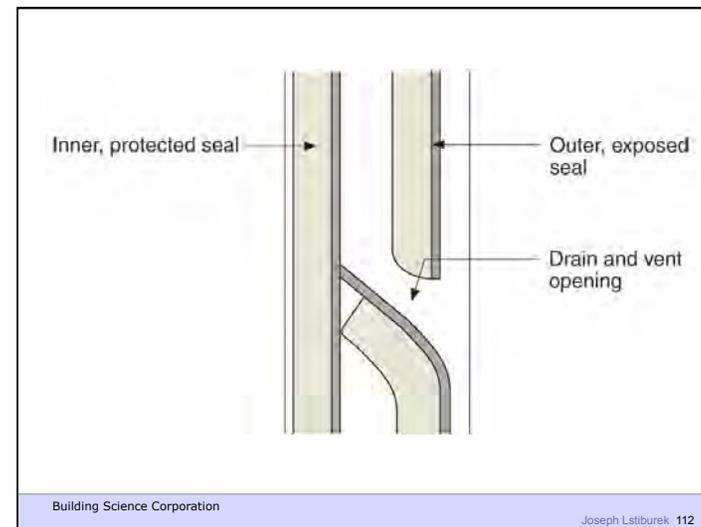
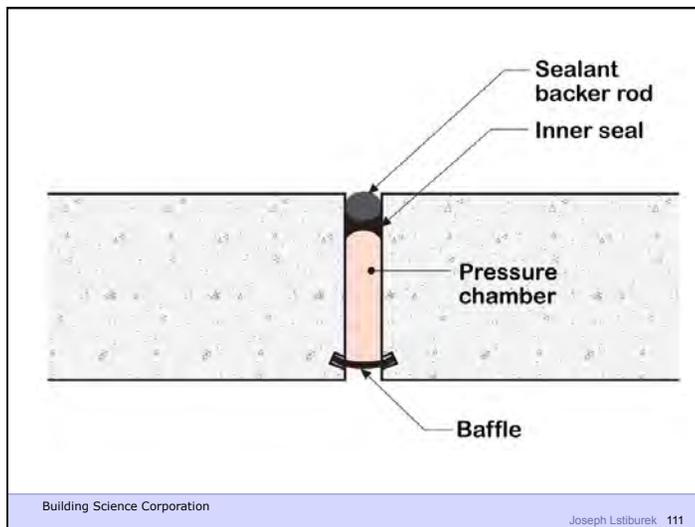
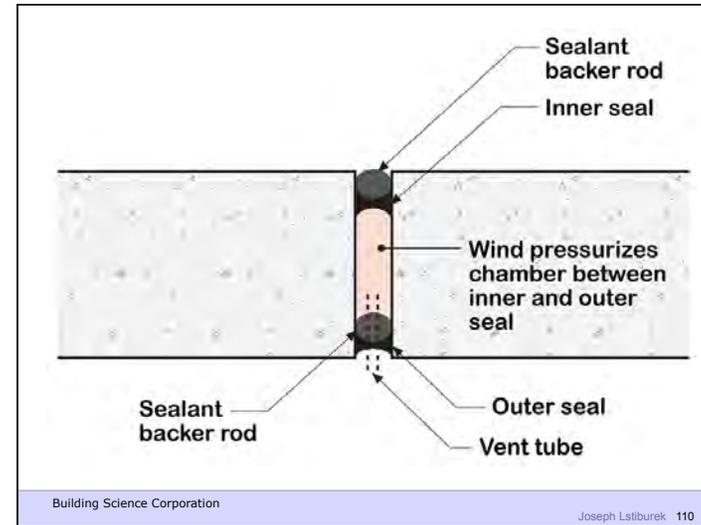
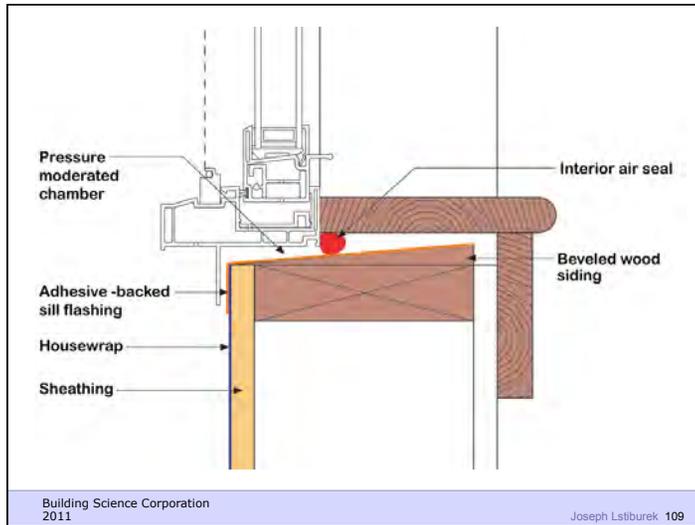


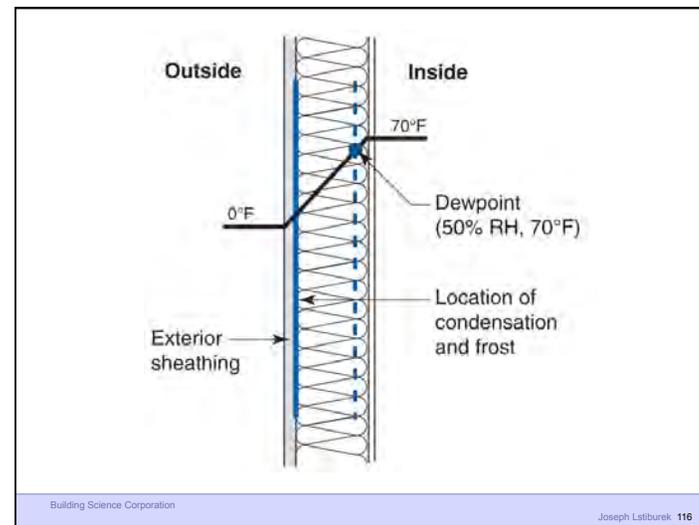
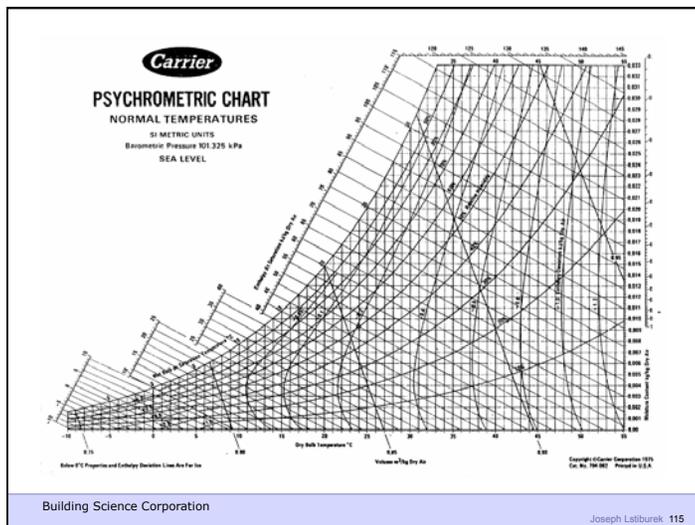
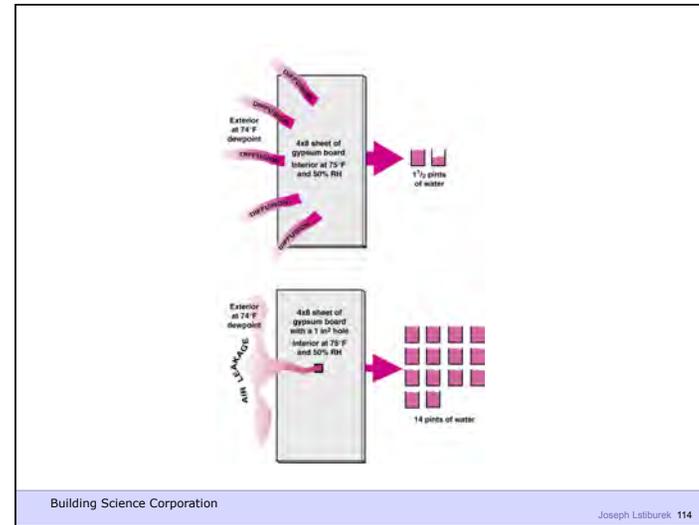
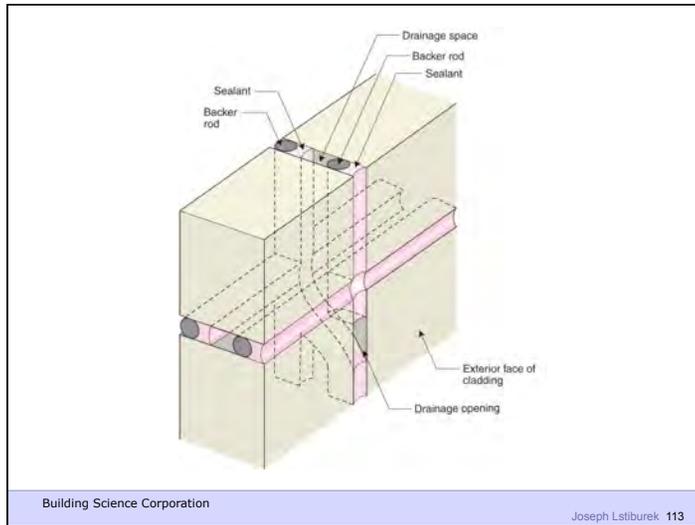


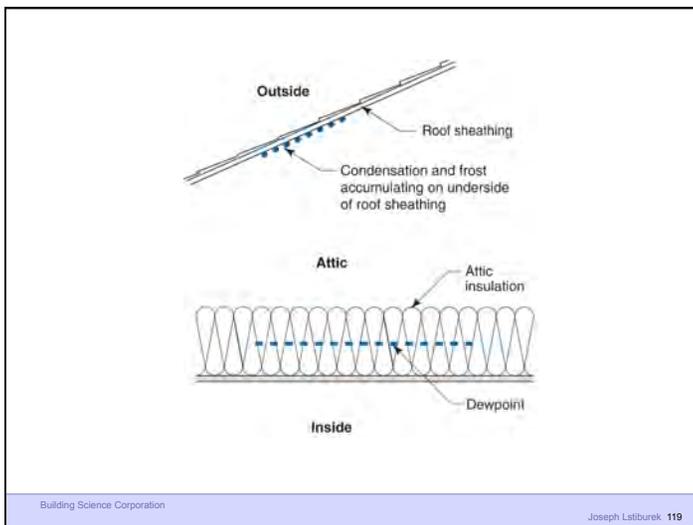


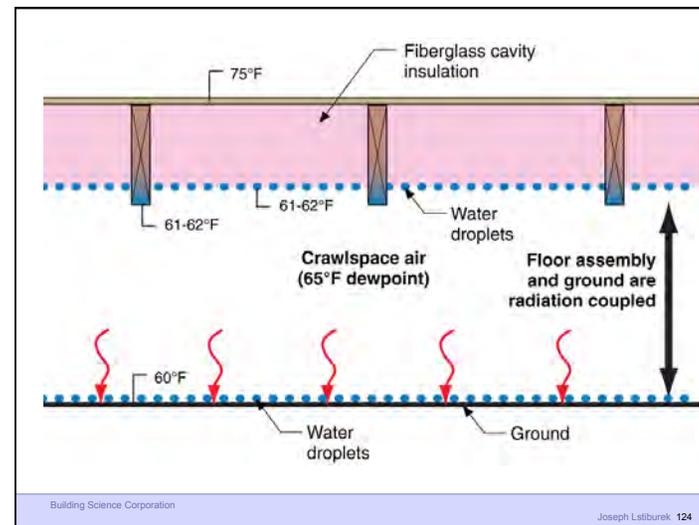
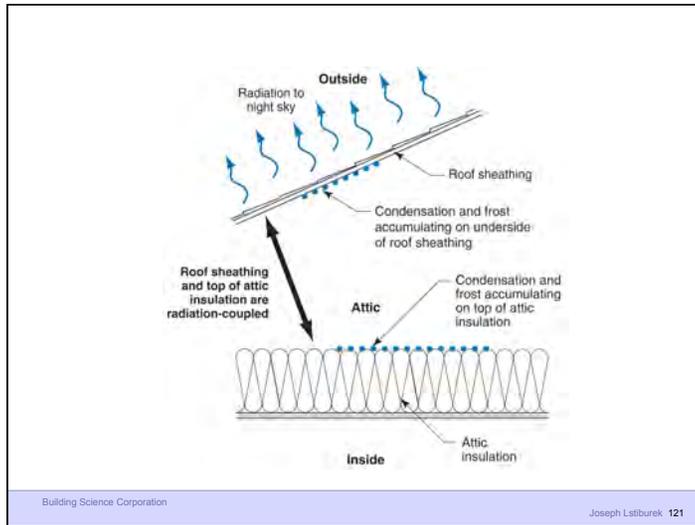


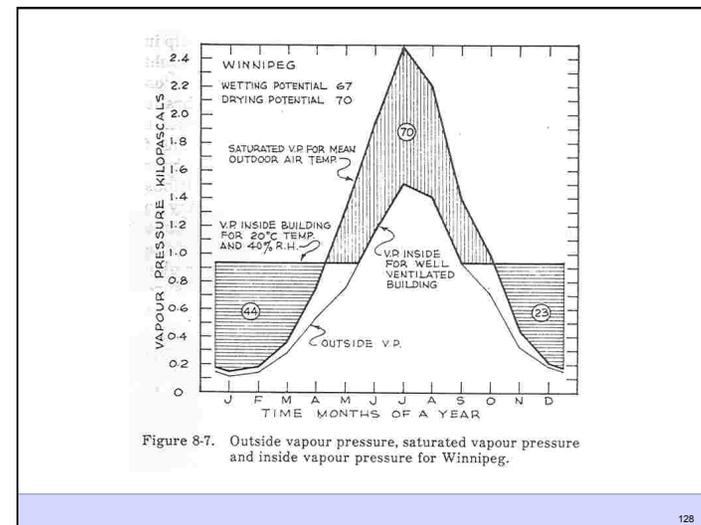
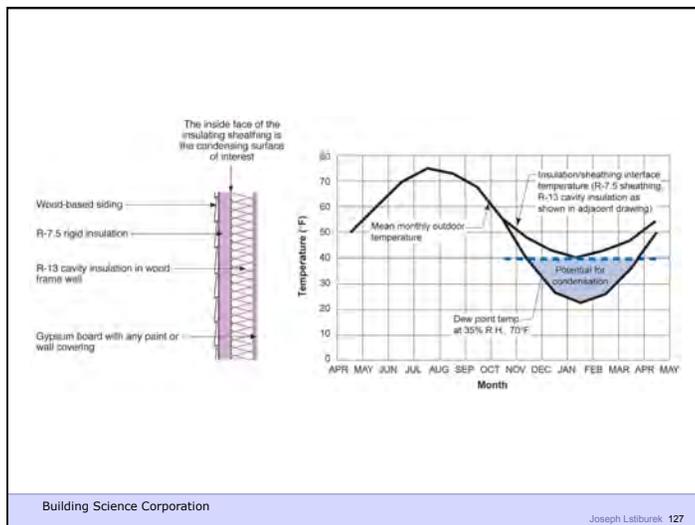
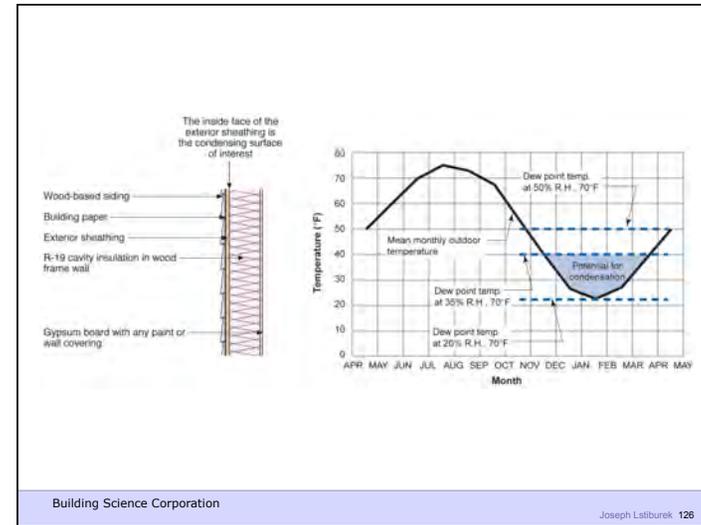
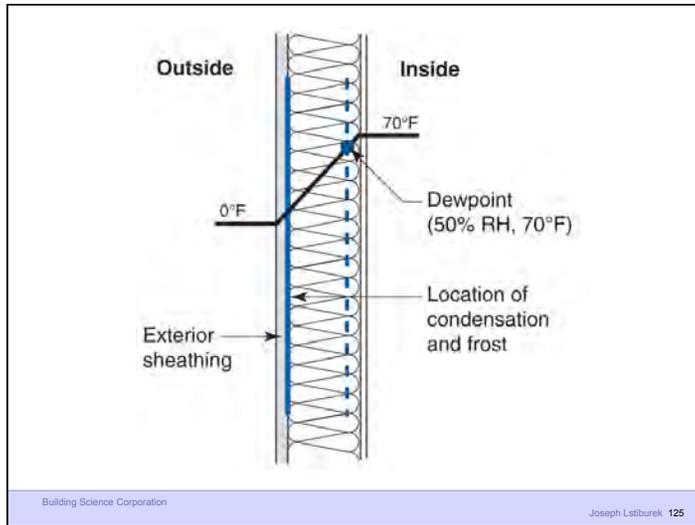


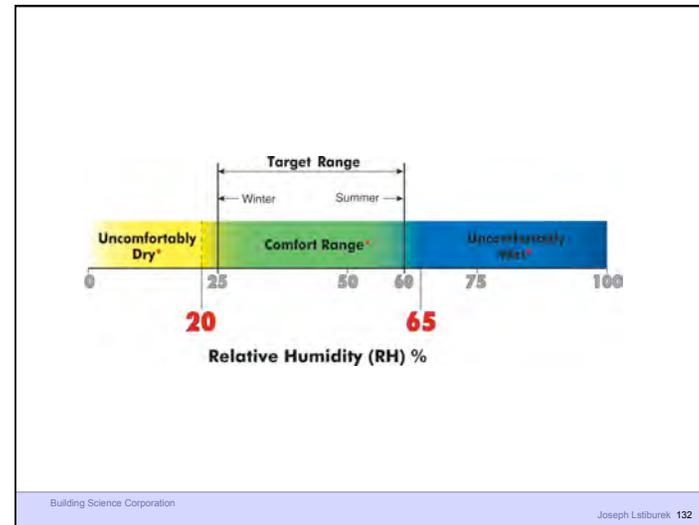
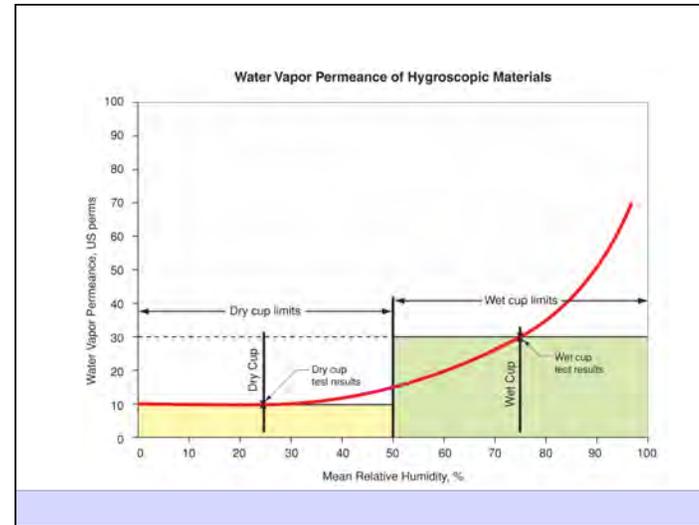
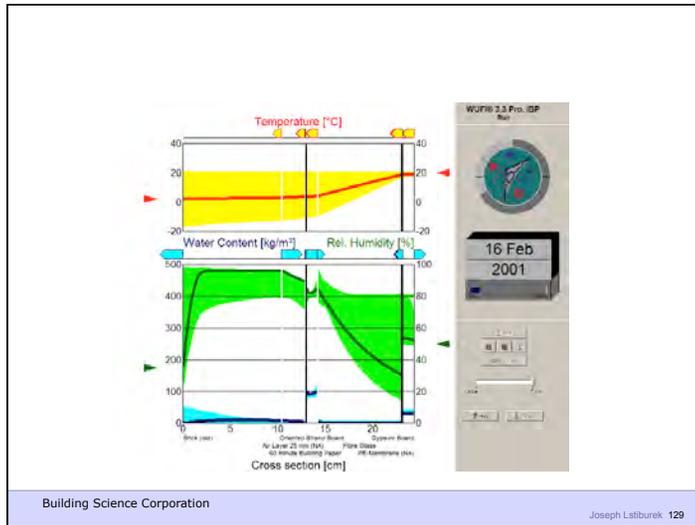


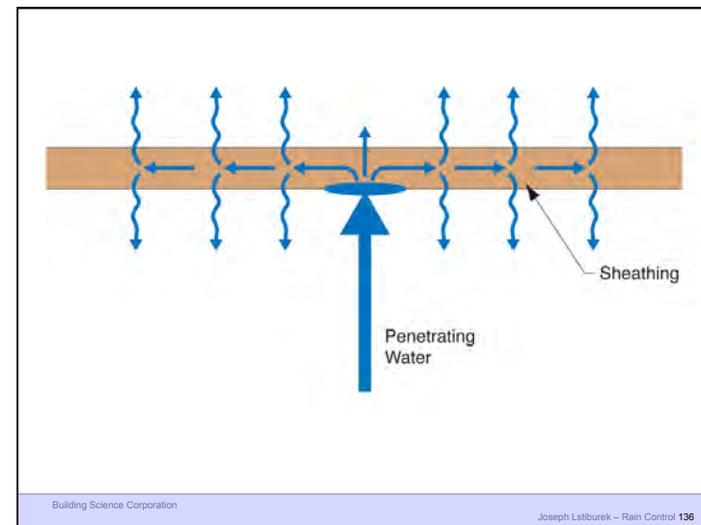
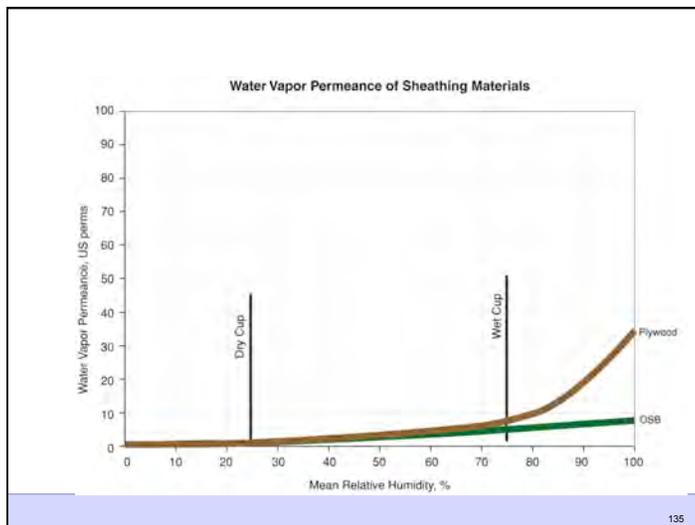
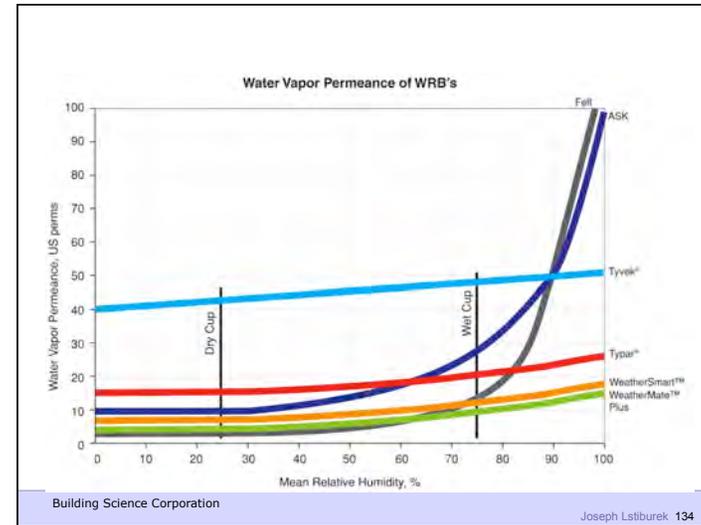
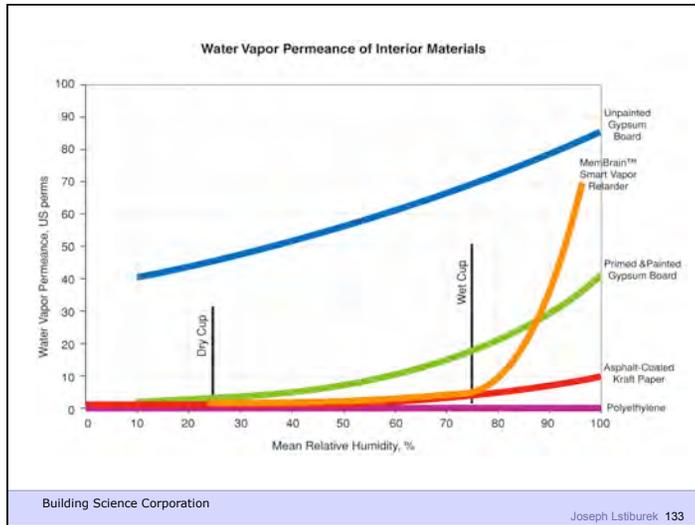


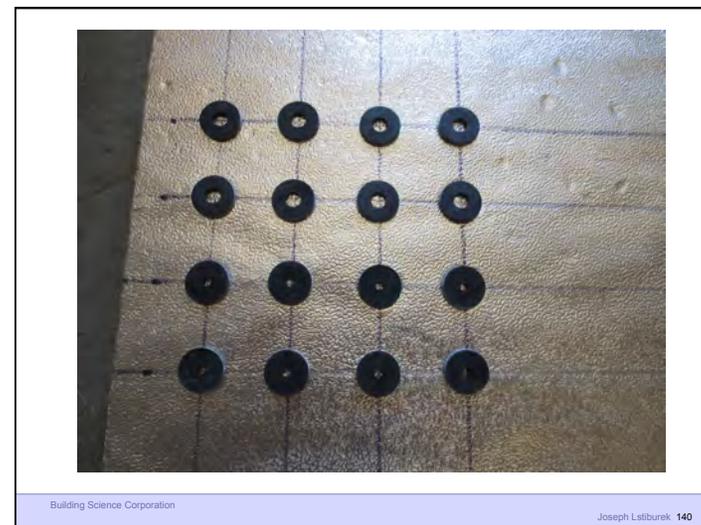
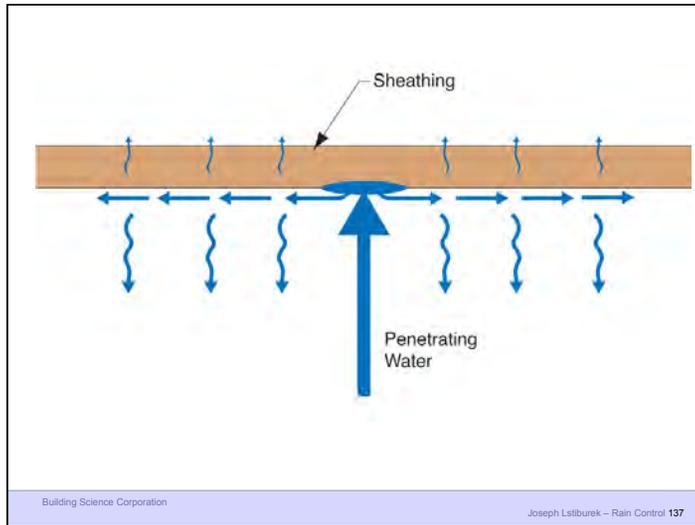






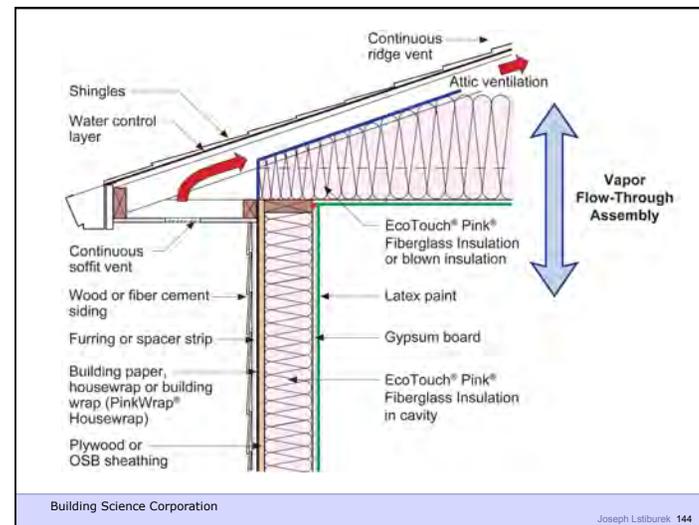
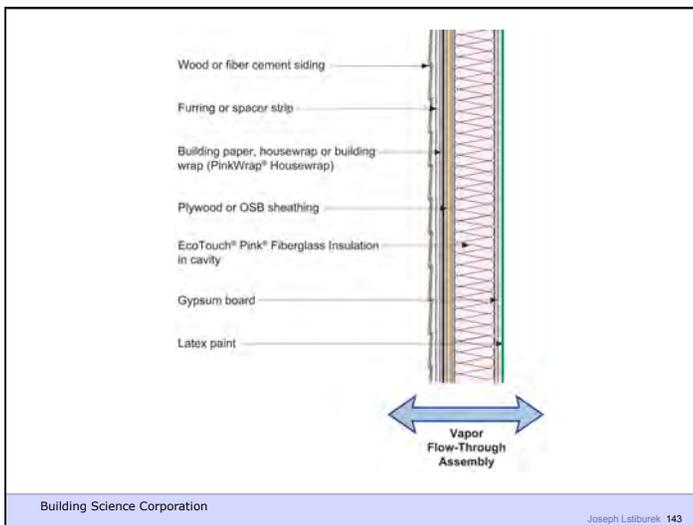
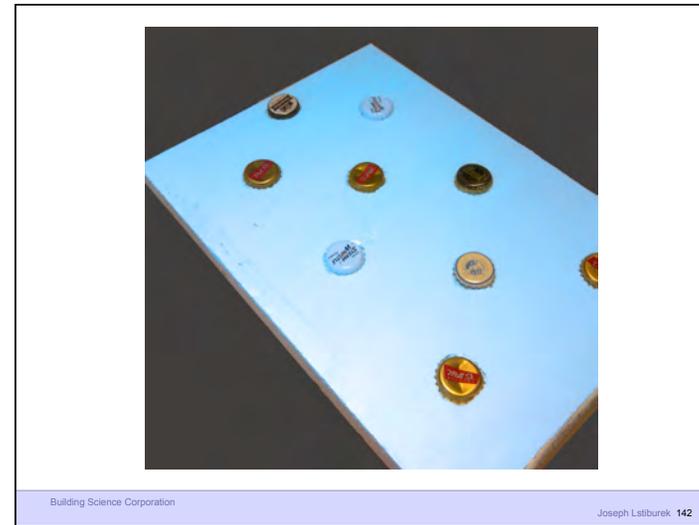


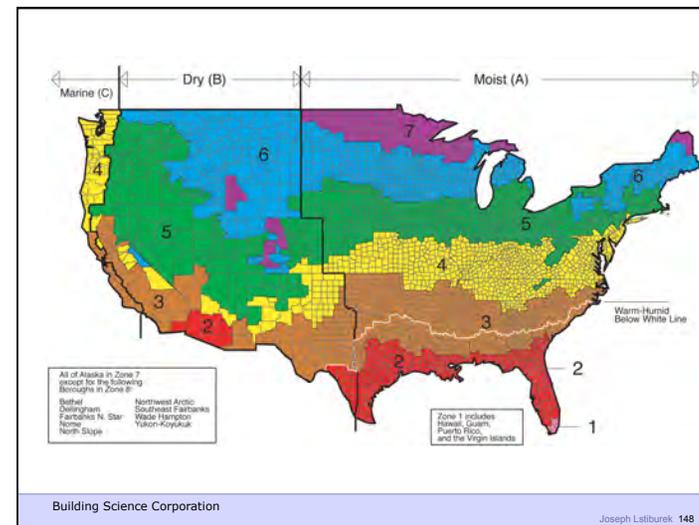
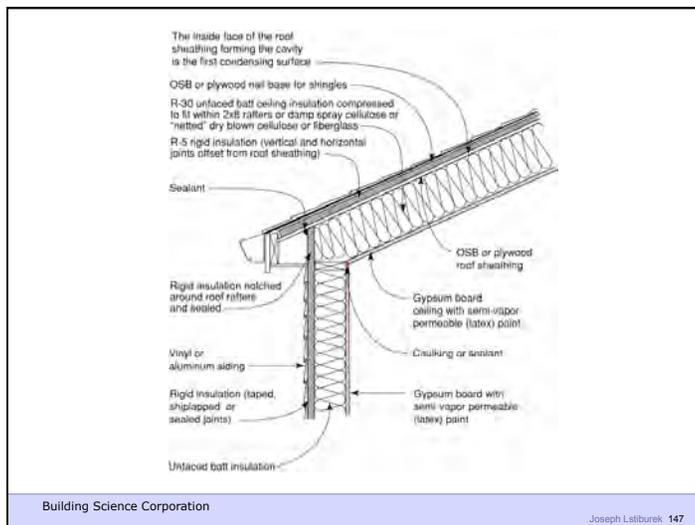
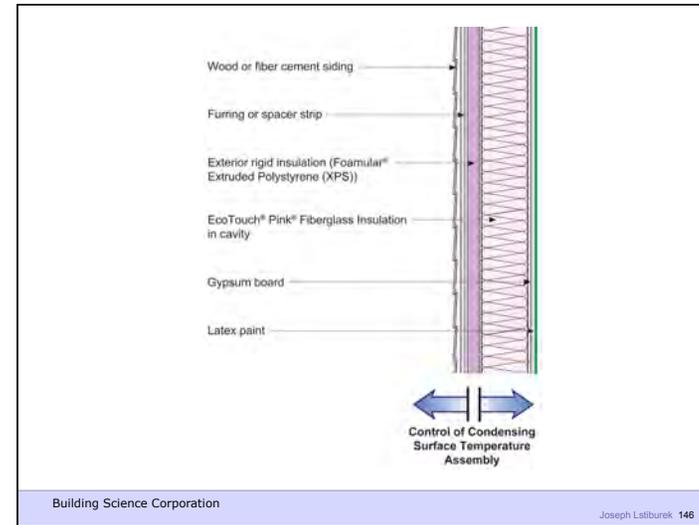
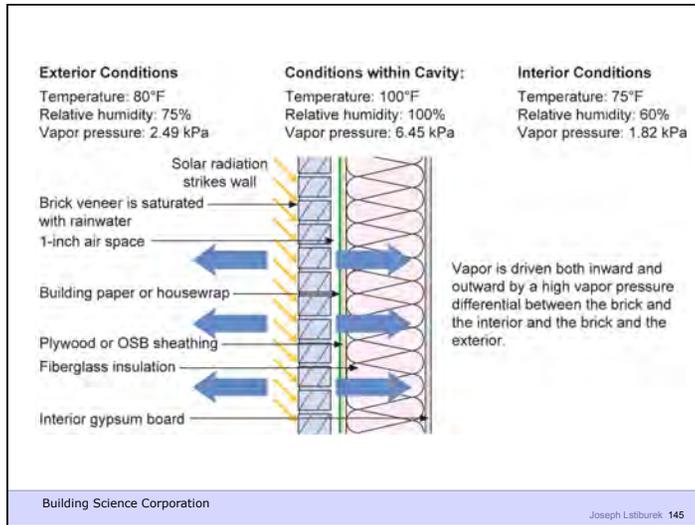


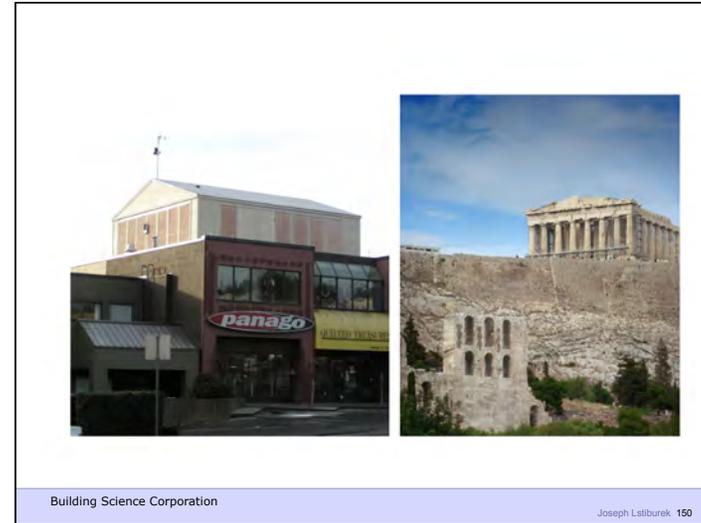
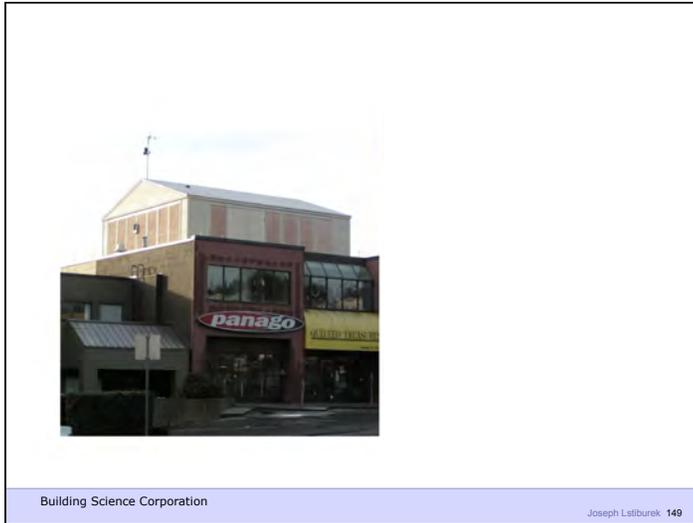


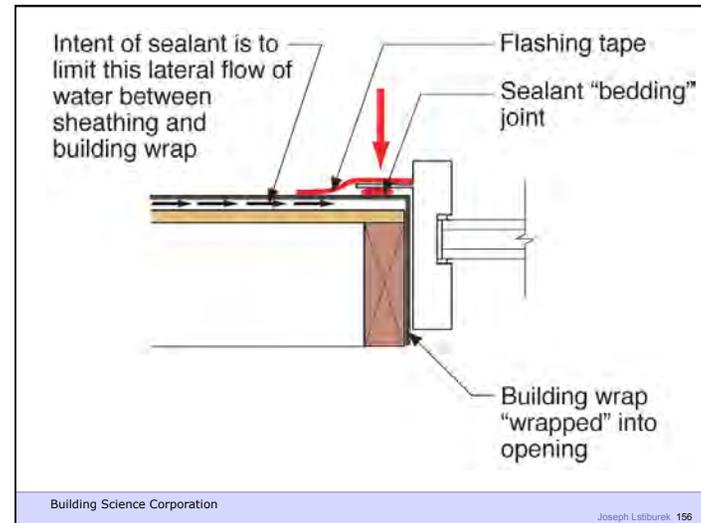
Beer Screen?

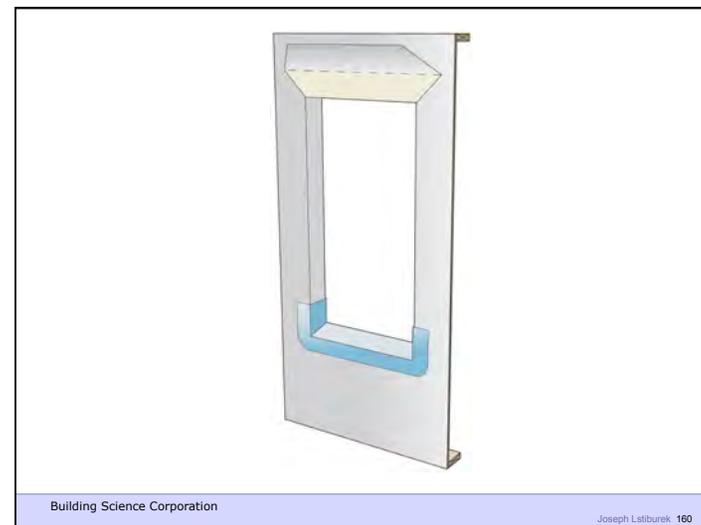
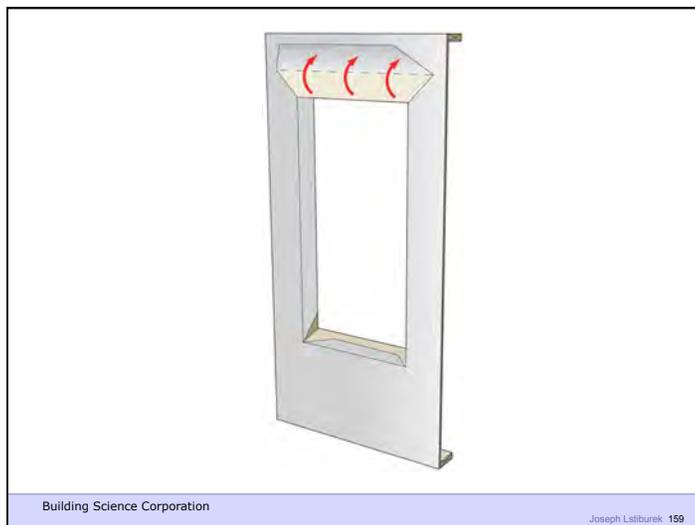
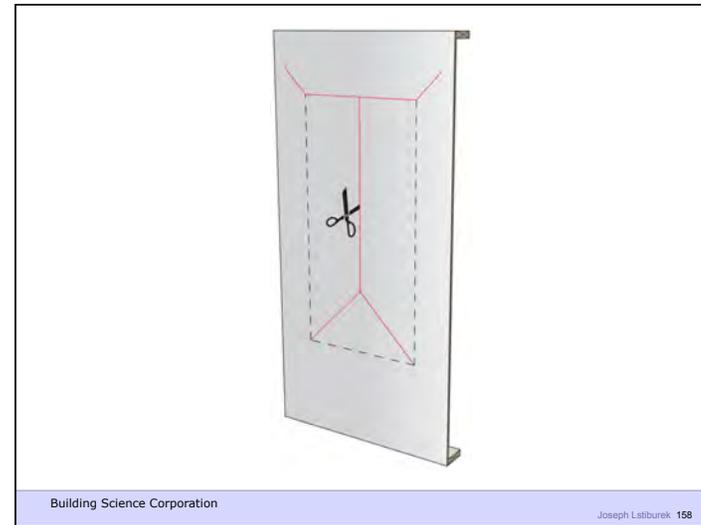
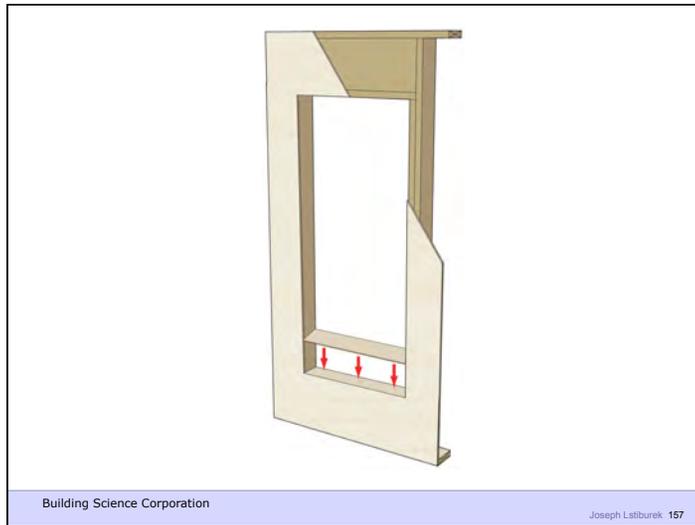
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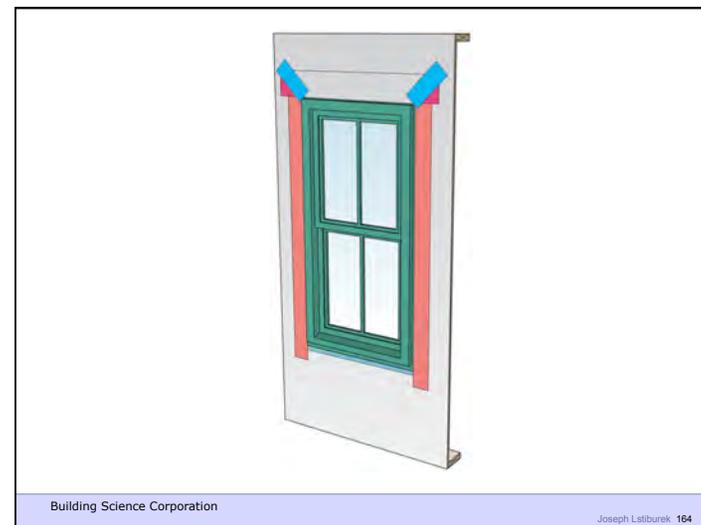
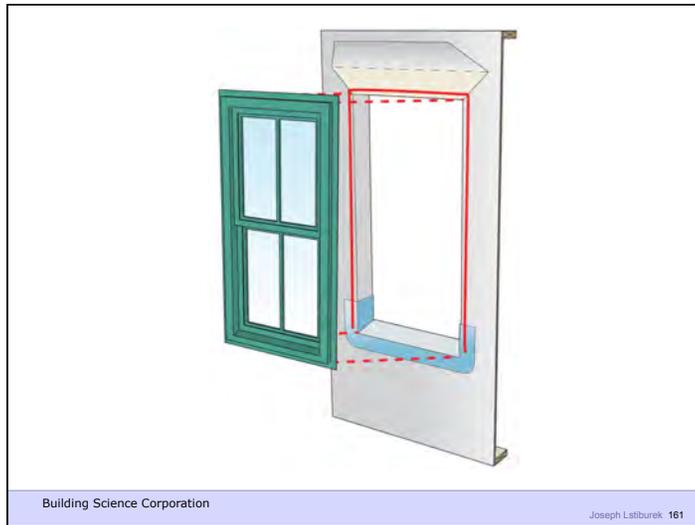


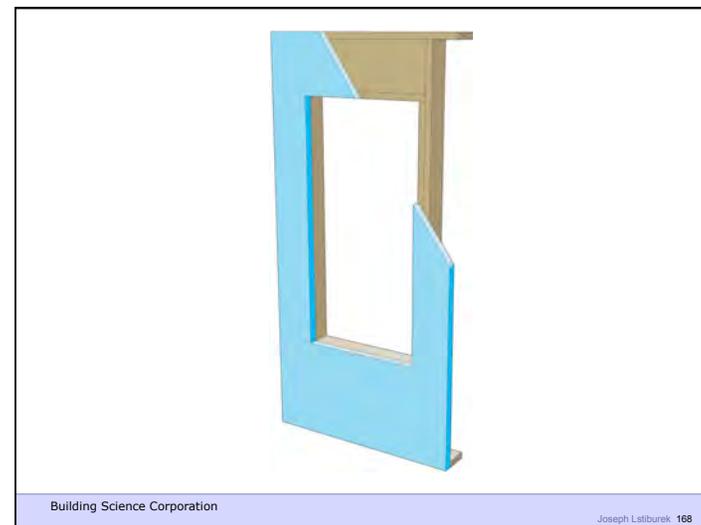


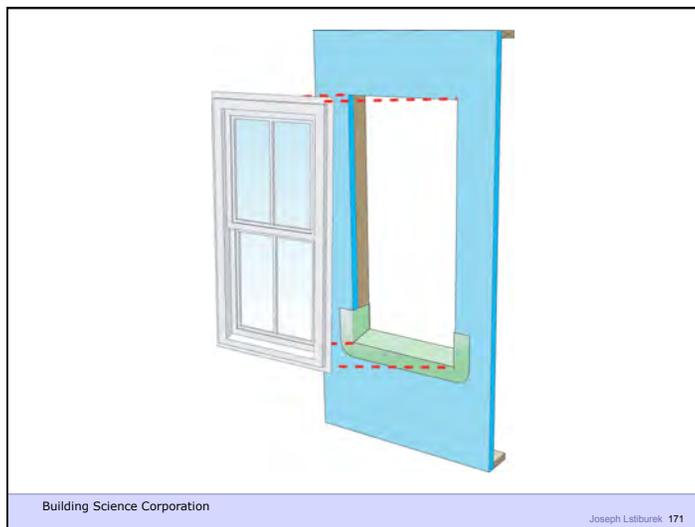
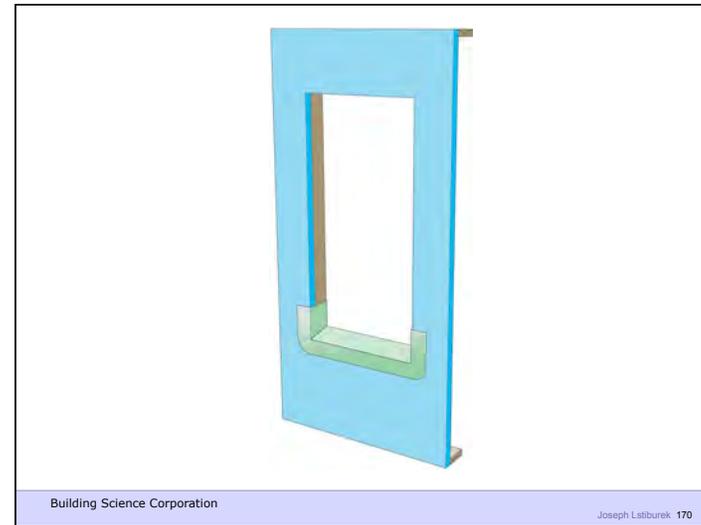
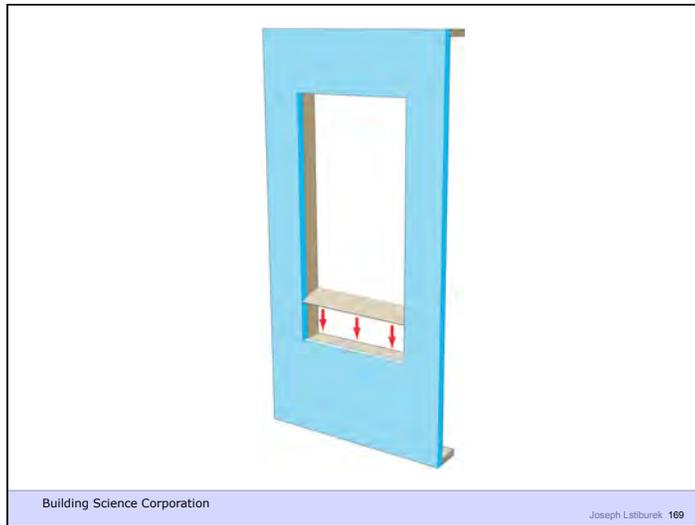


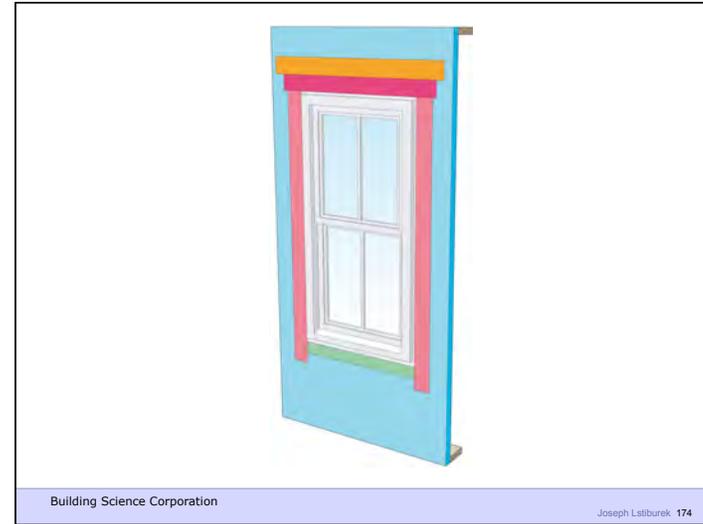
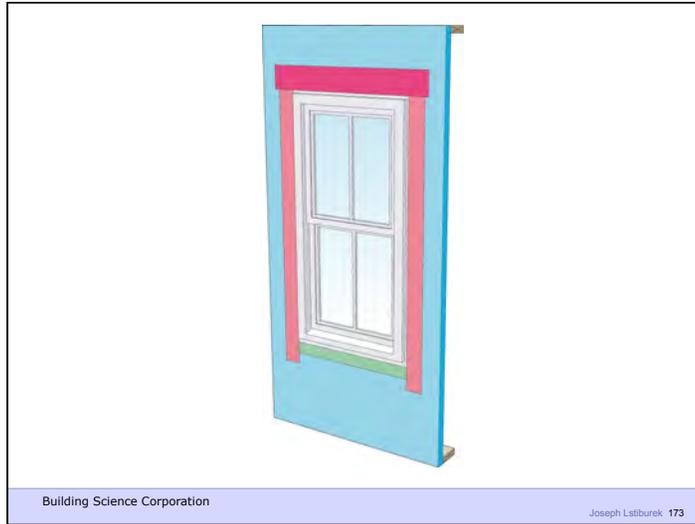










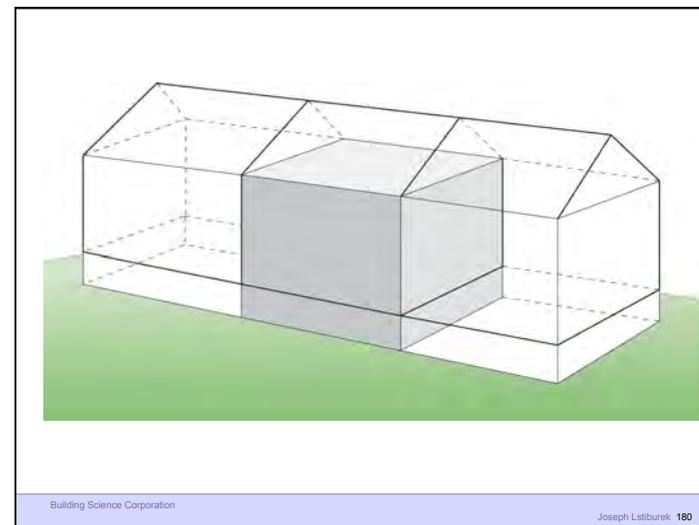
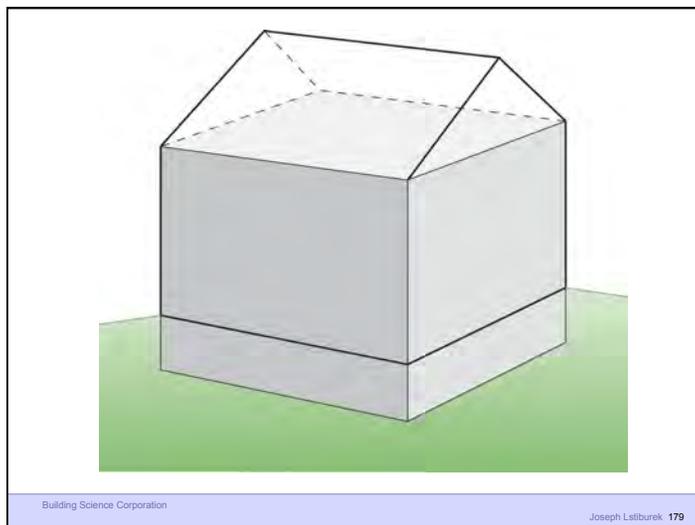


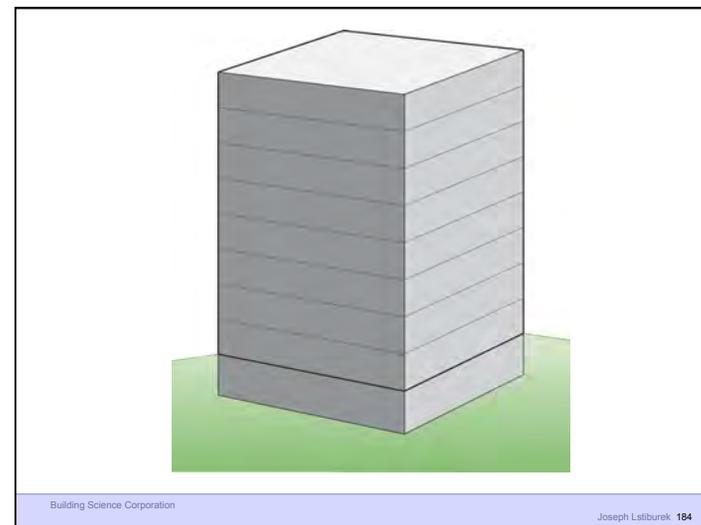
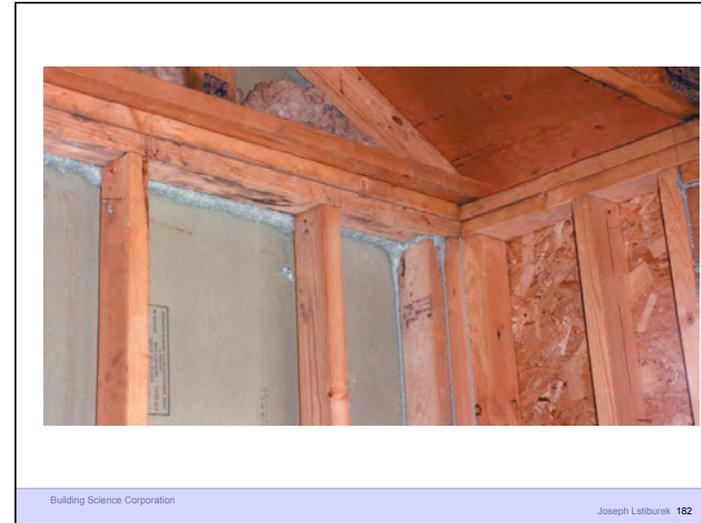
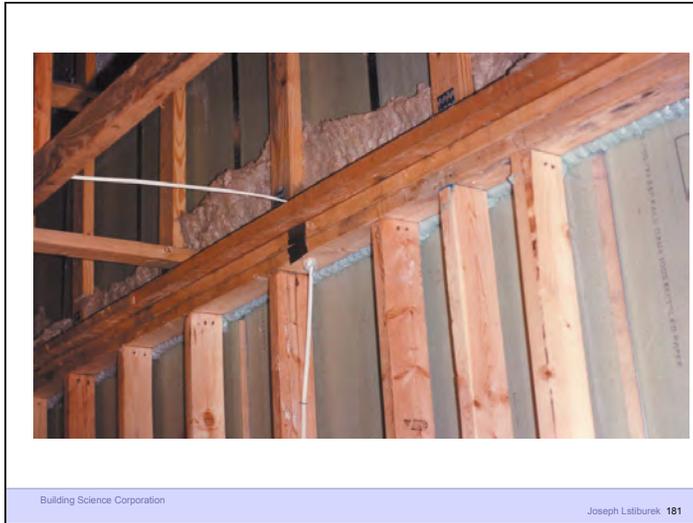


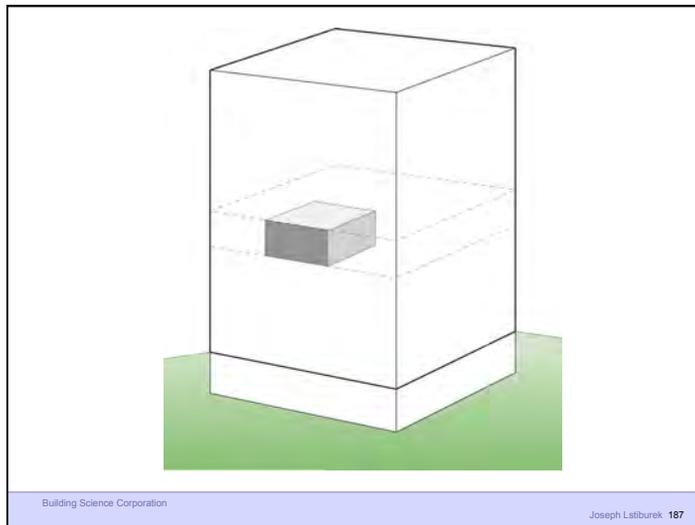
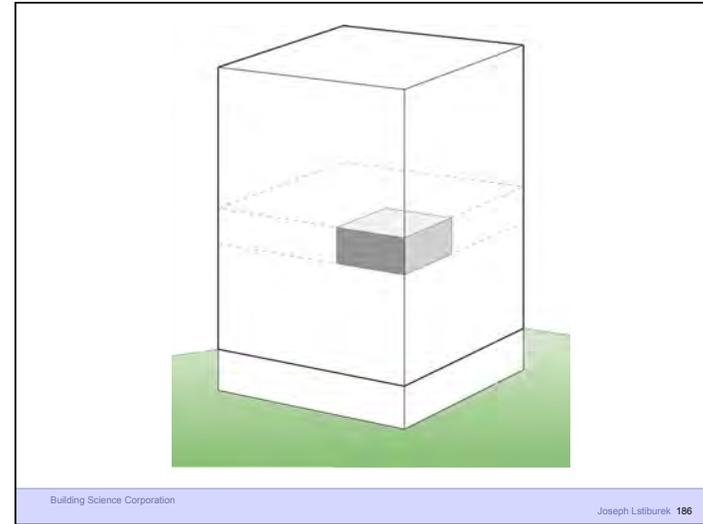
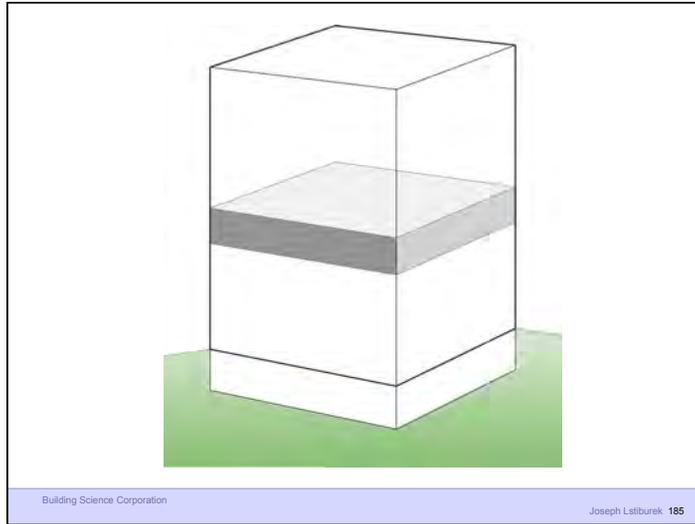
### Air Barrier Metrics

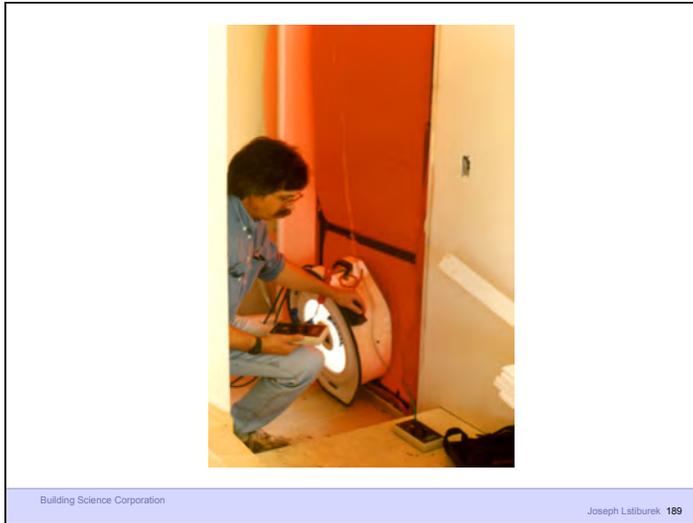
Material	0.02 l/(s-m2)@75 Pa
Assembly	0.20 l/(s-m2)@75 Pa
Enclosure	2.00 l/(s-m2)@75 Pa

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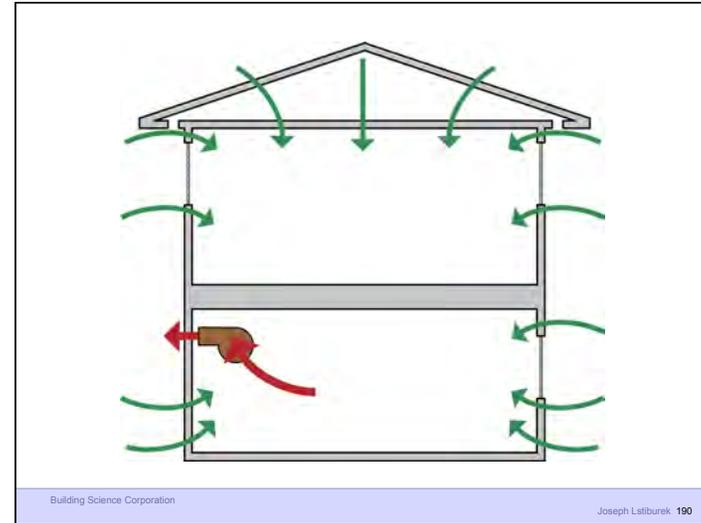






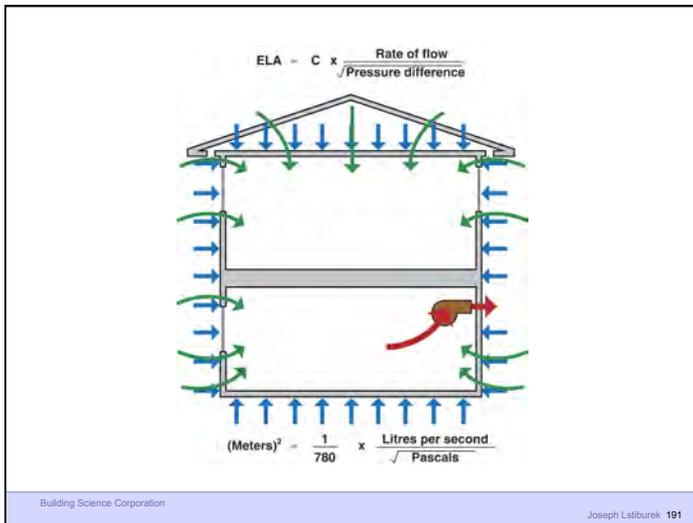
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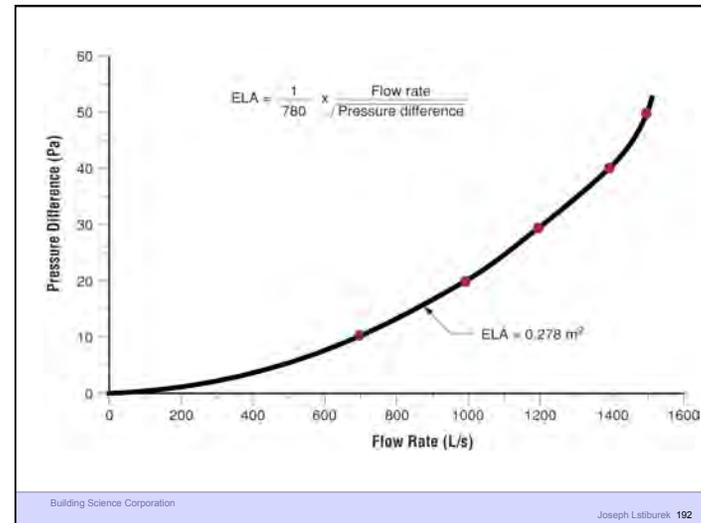
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