

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

# Building Science

## More Case Studies

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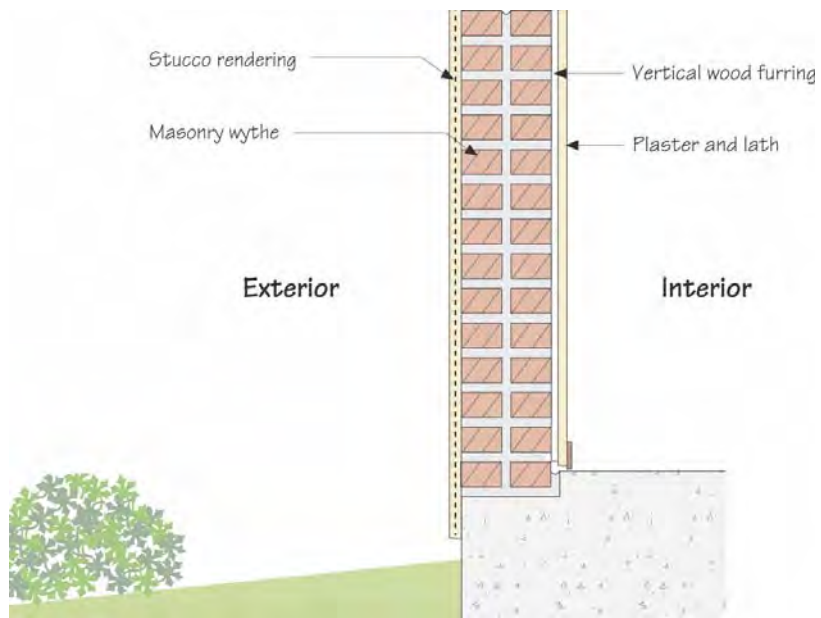
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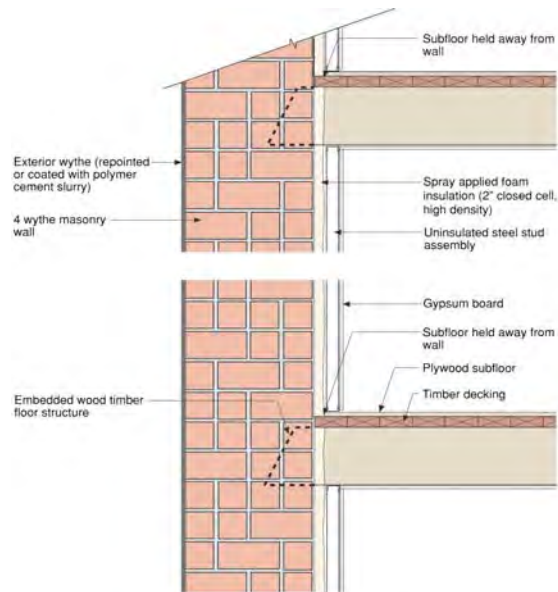
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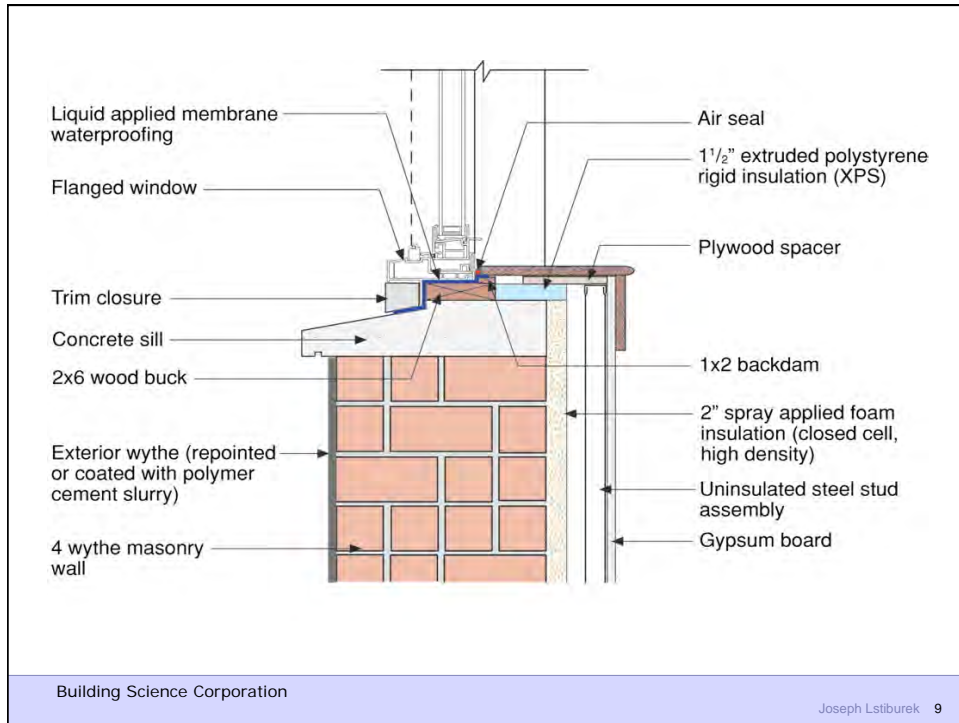
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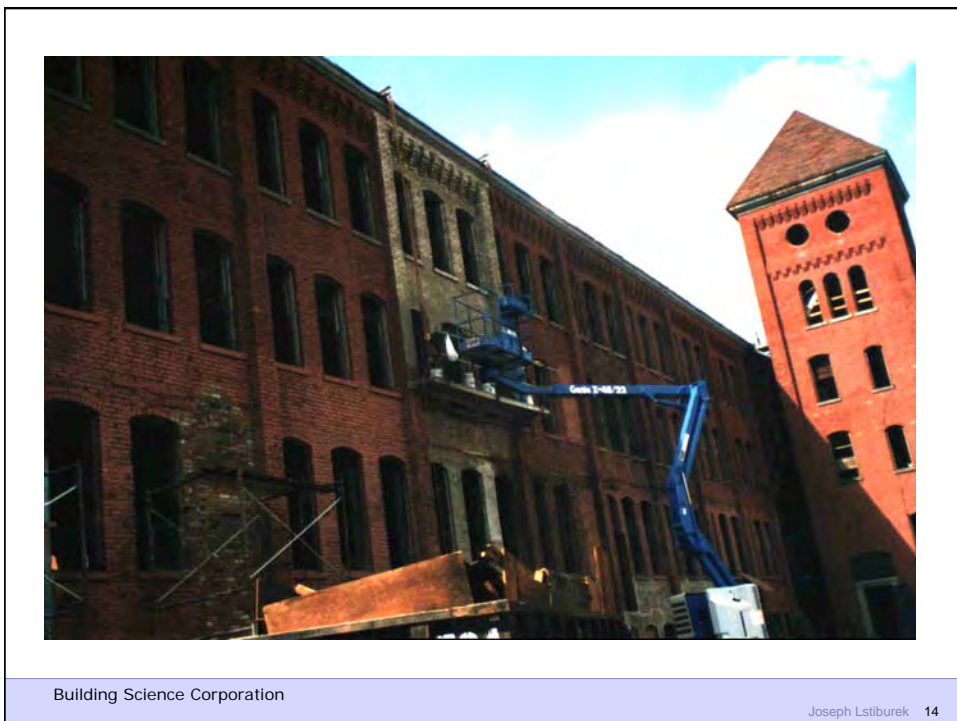
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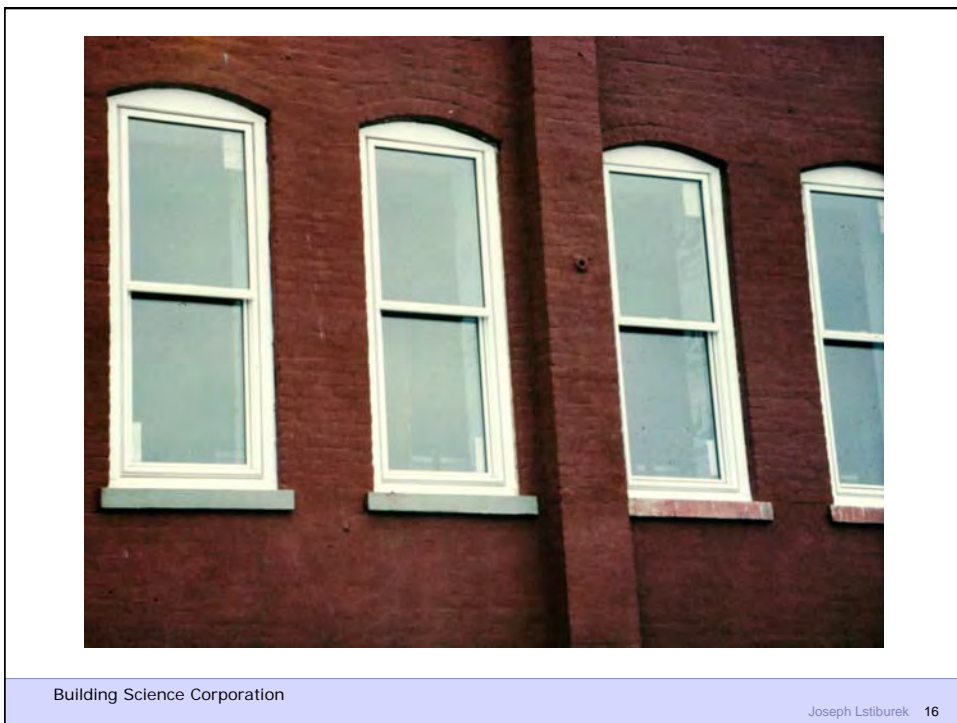
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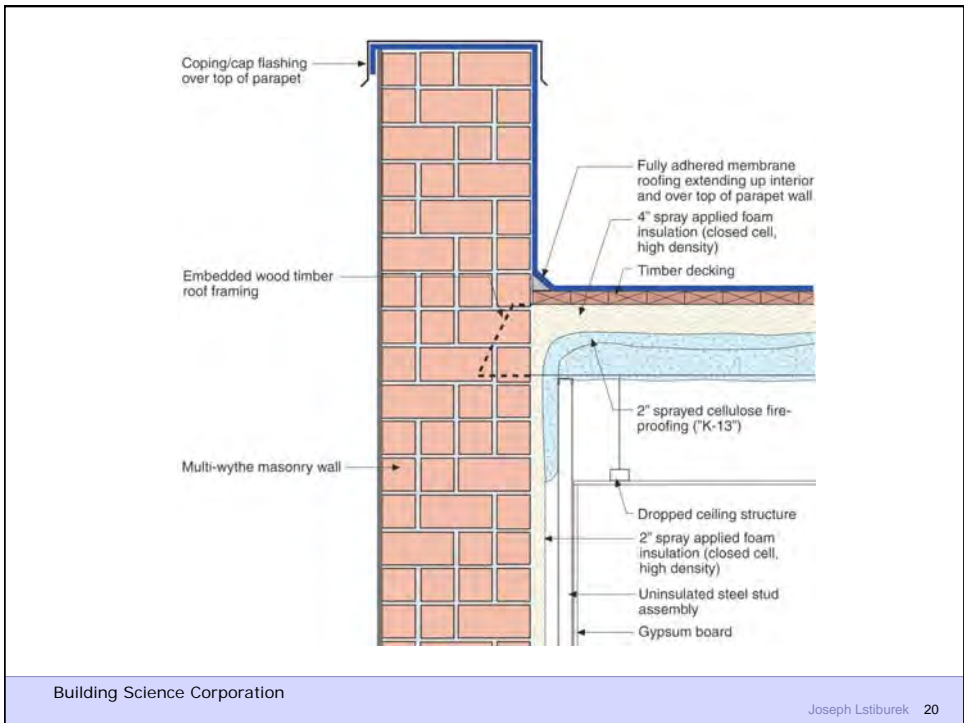
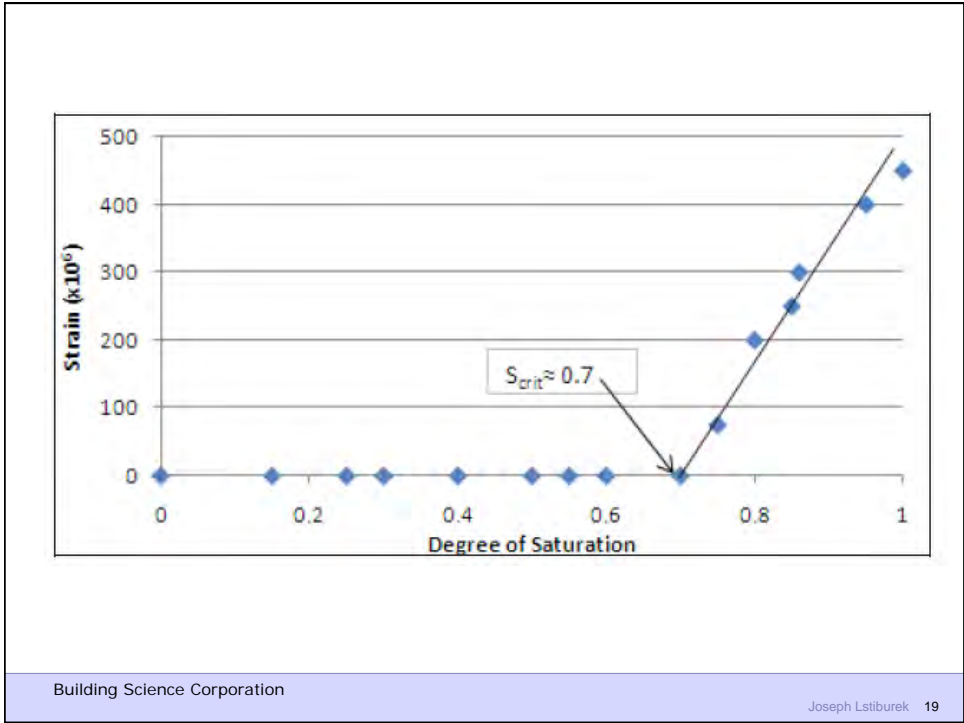
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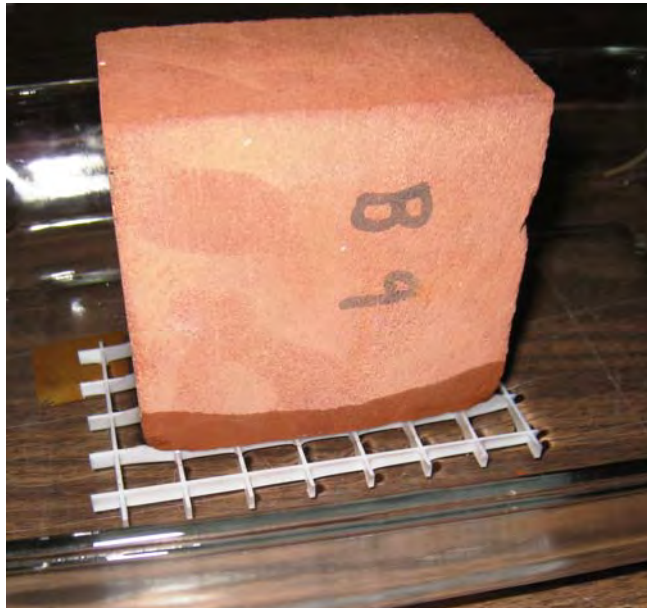
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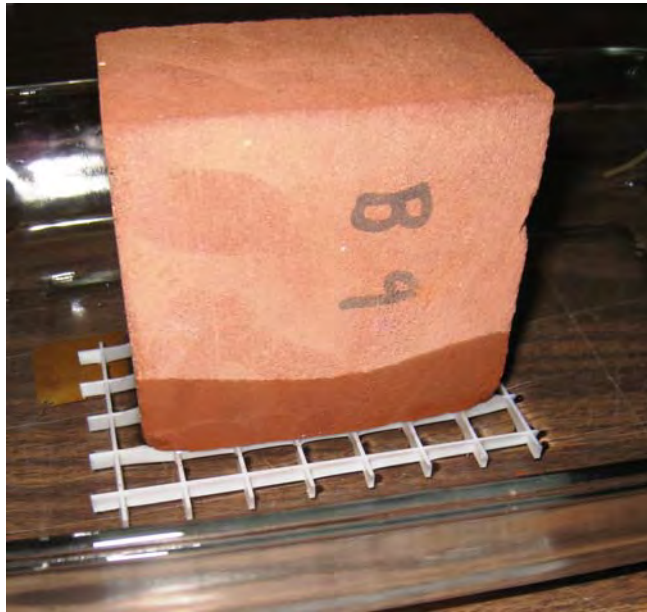
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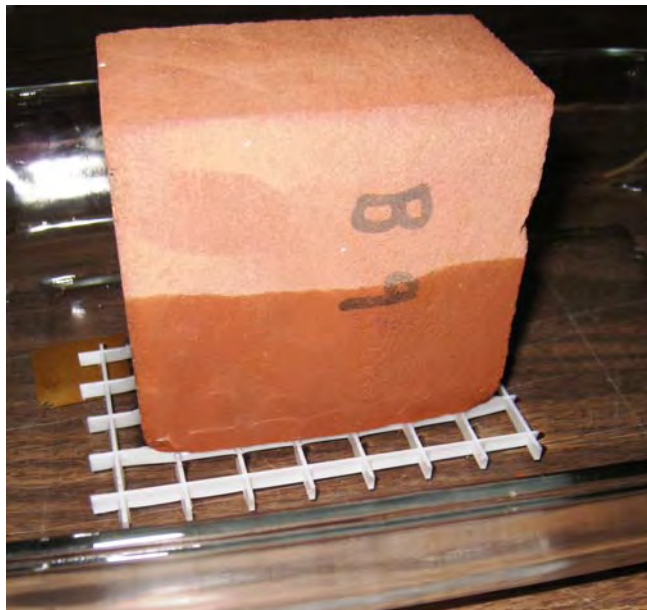
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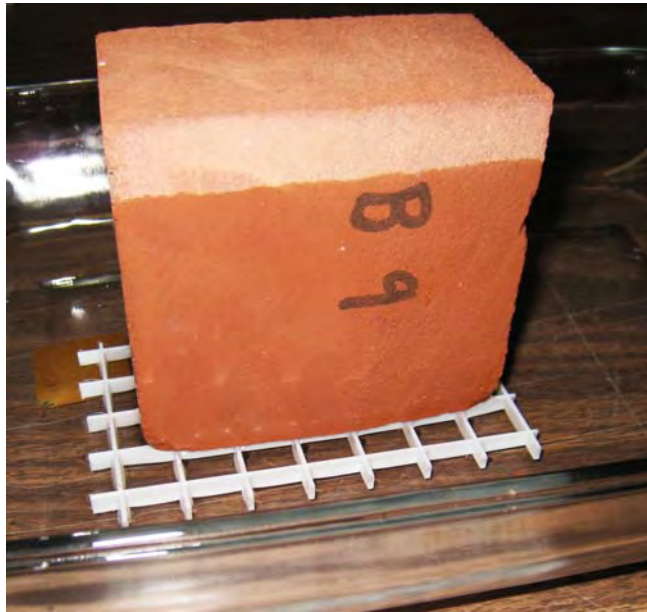
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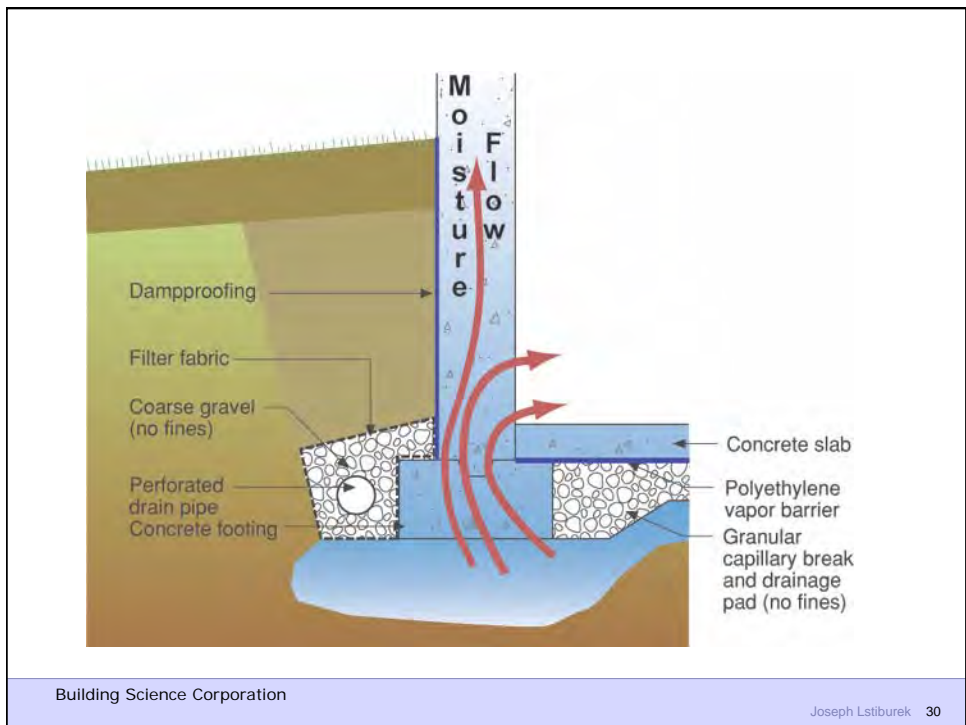
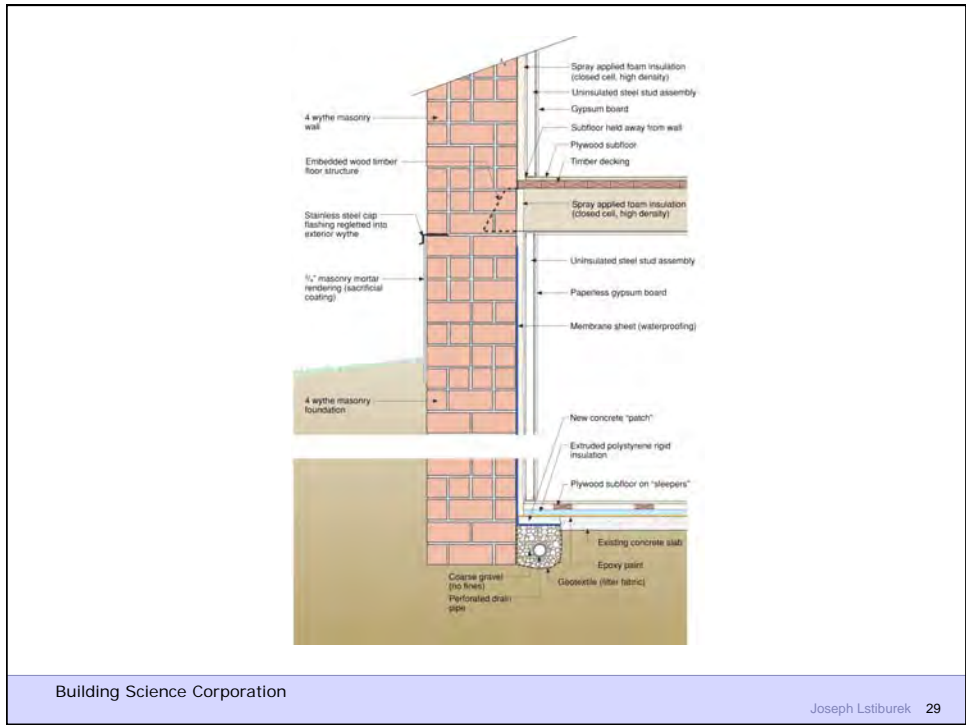
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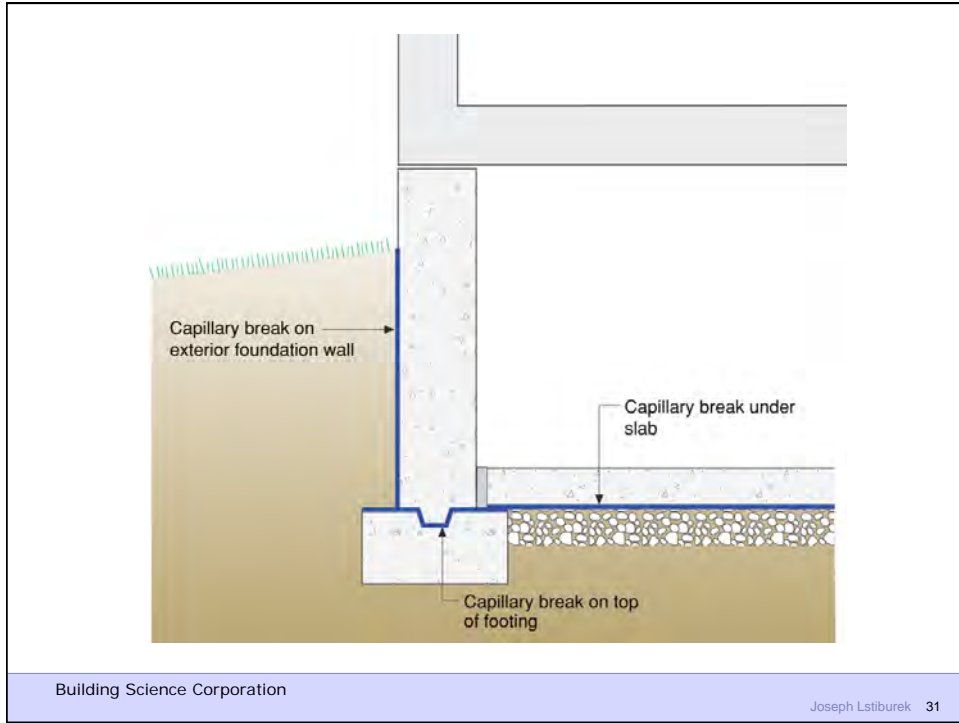
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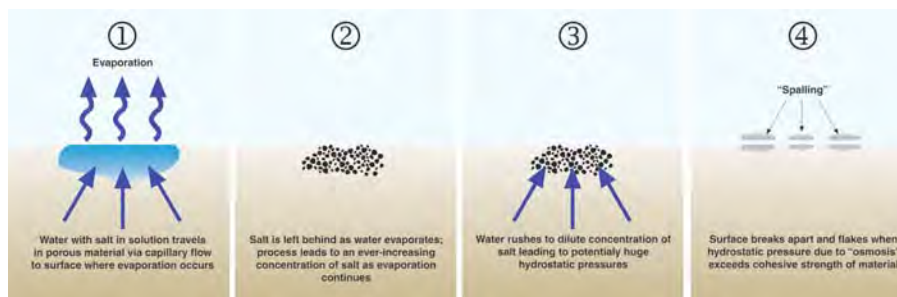






## Capillarity + Salt = Osmosis

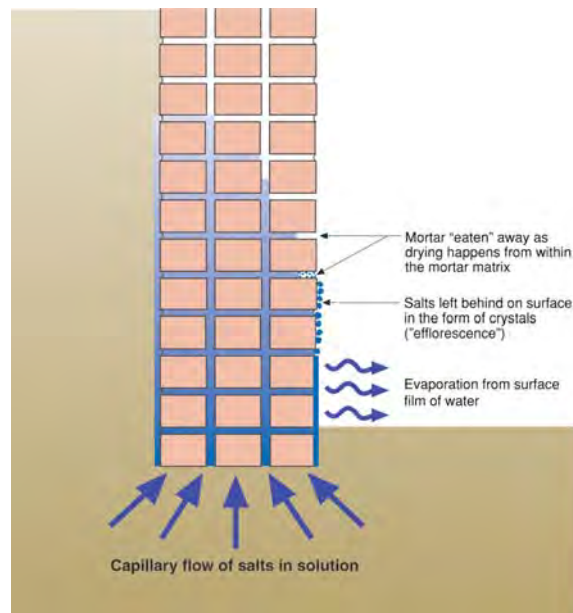
- Mineral salts carried in solution by capillary water
- When water evaporates from a surface the salts left behind form crystals in process called efflorescence
- When water evaporated beneath a surface the salts crystallize within the pore structure of the material in called sub-efflorescence
- The salt crystallization causes expansive forces that can exceed the cohesive strength of the material leading to spalling

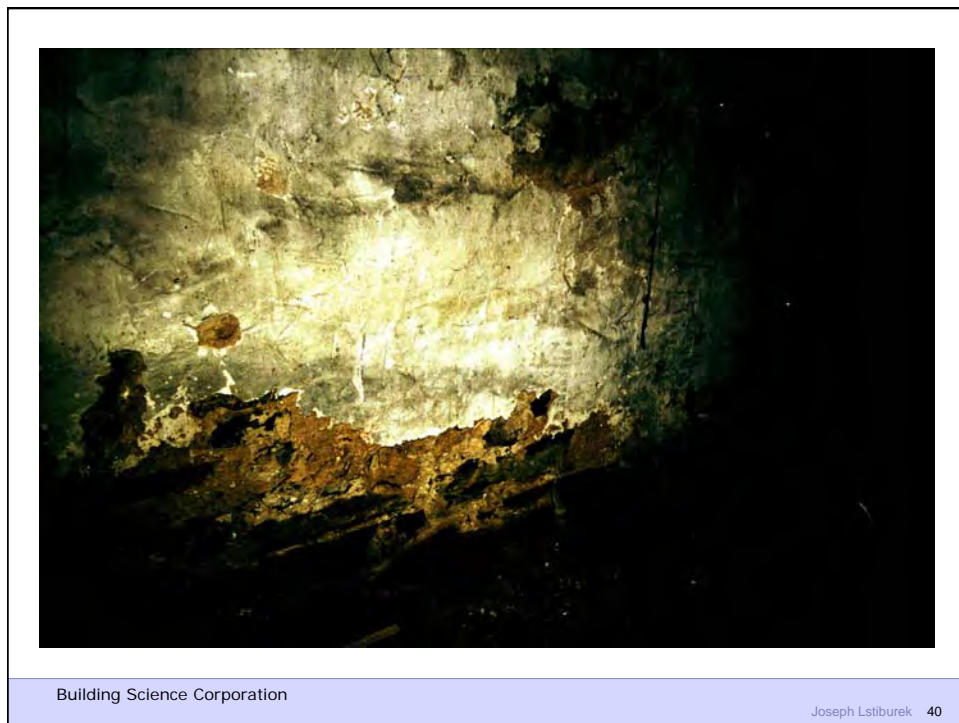
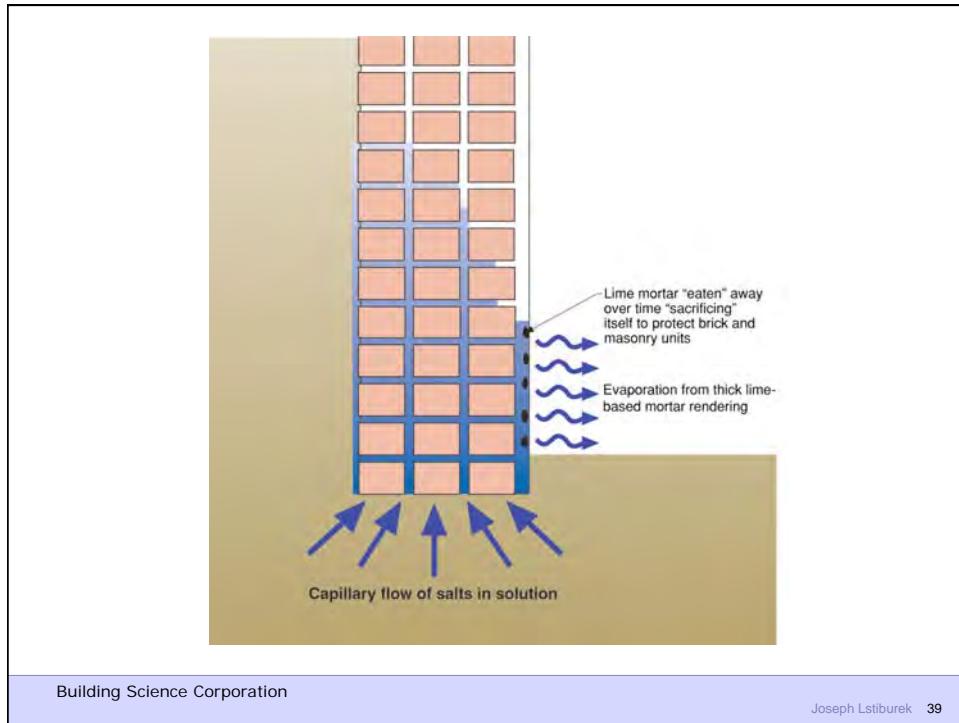


## Diffusion + Capillarity + Osmosis = Problem

- 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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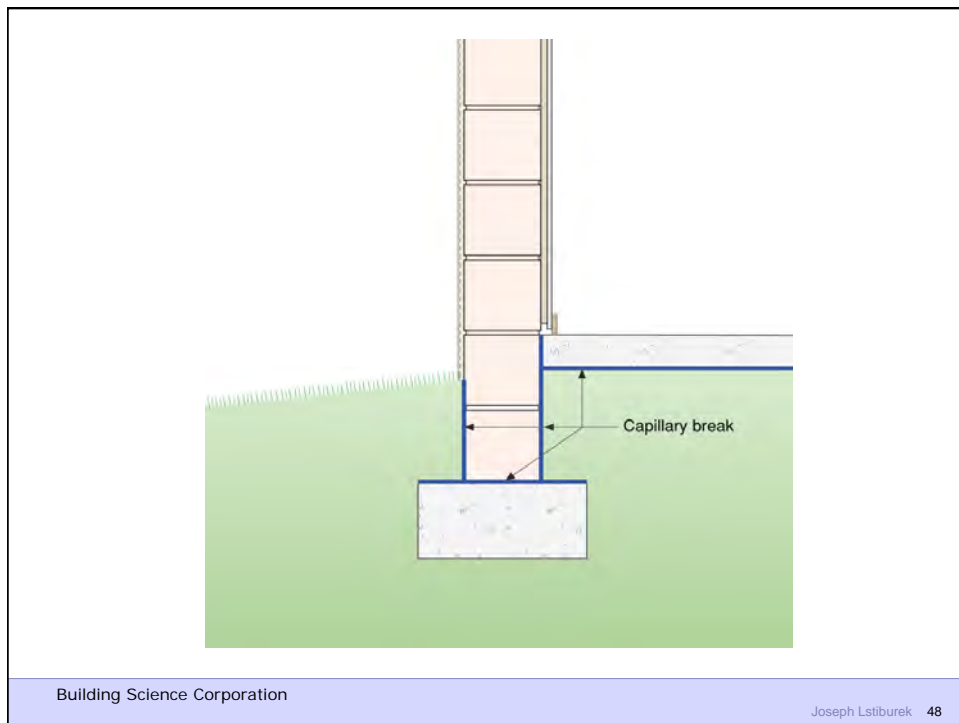
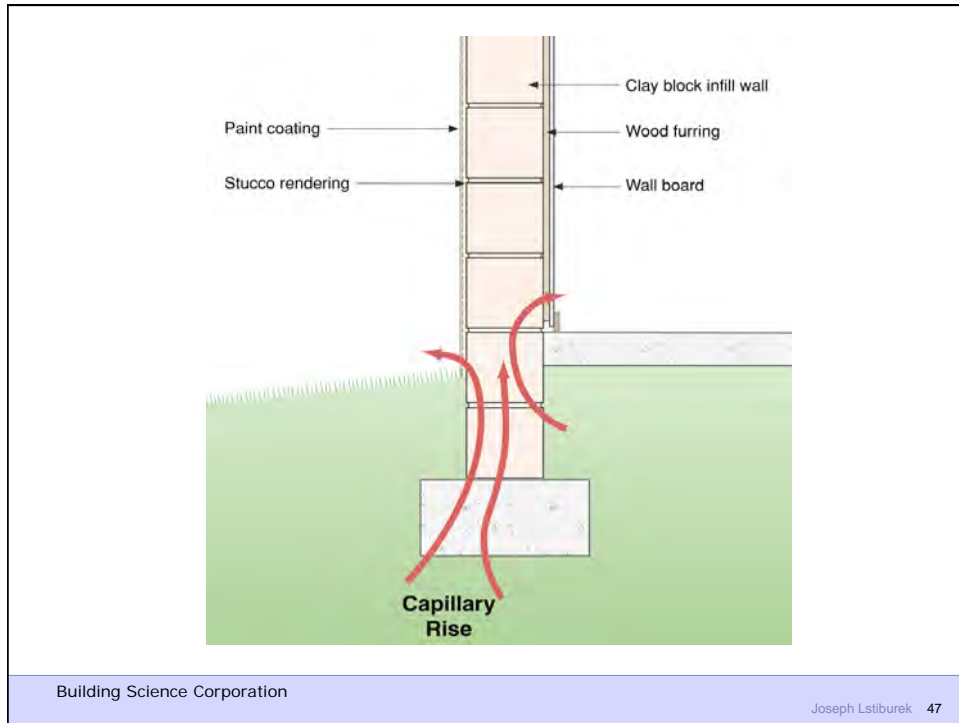
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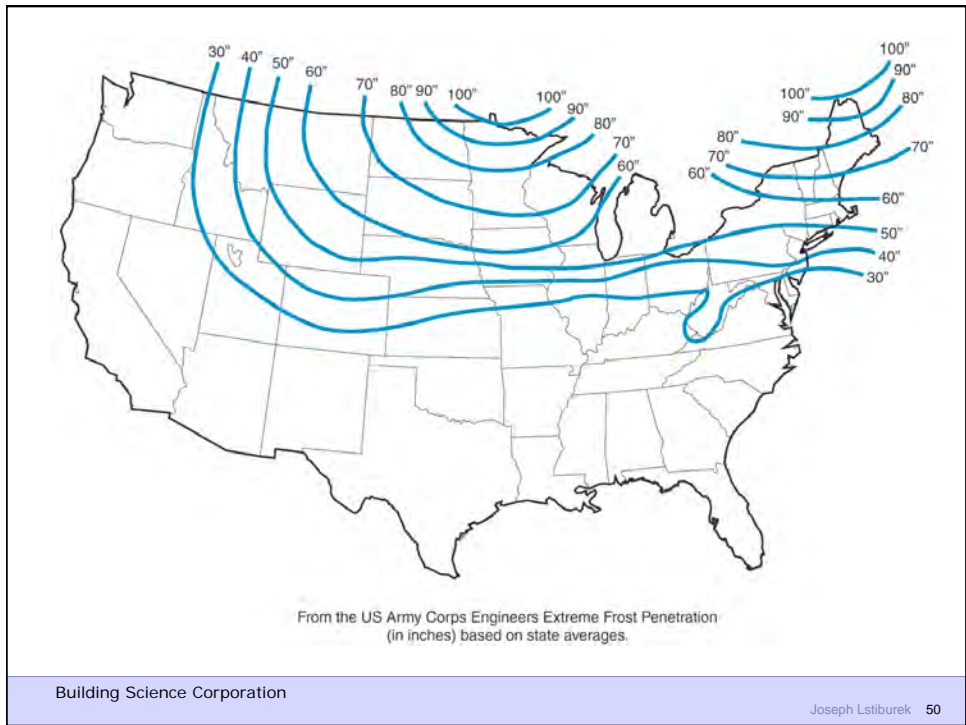
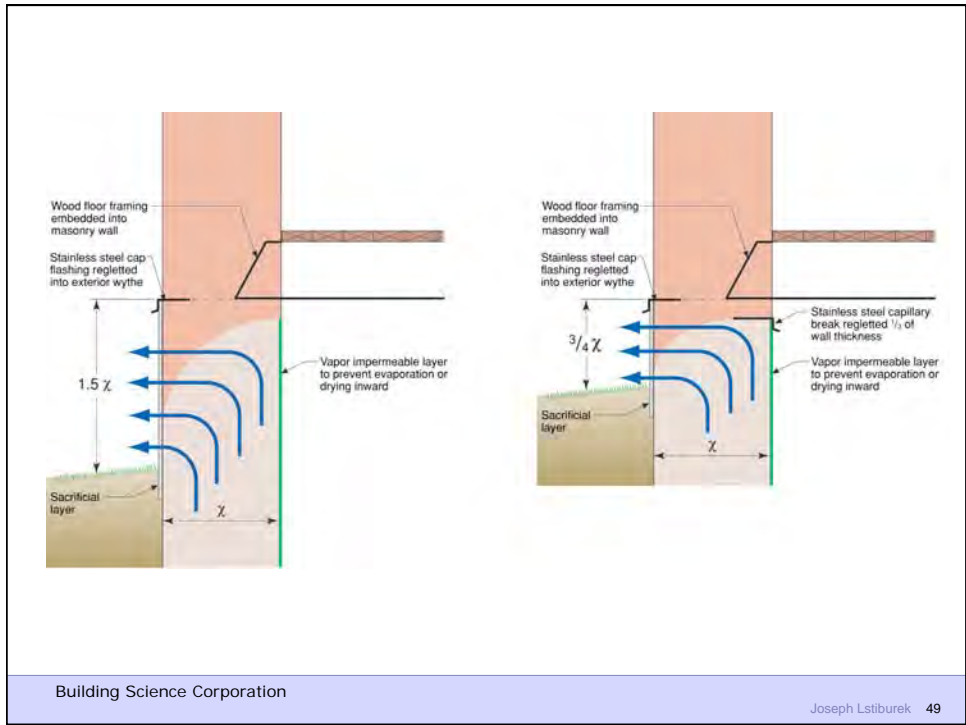
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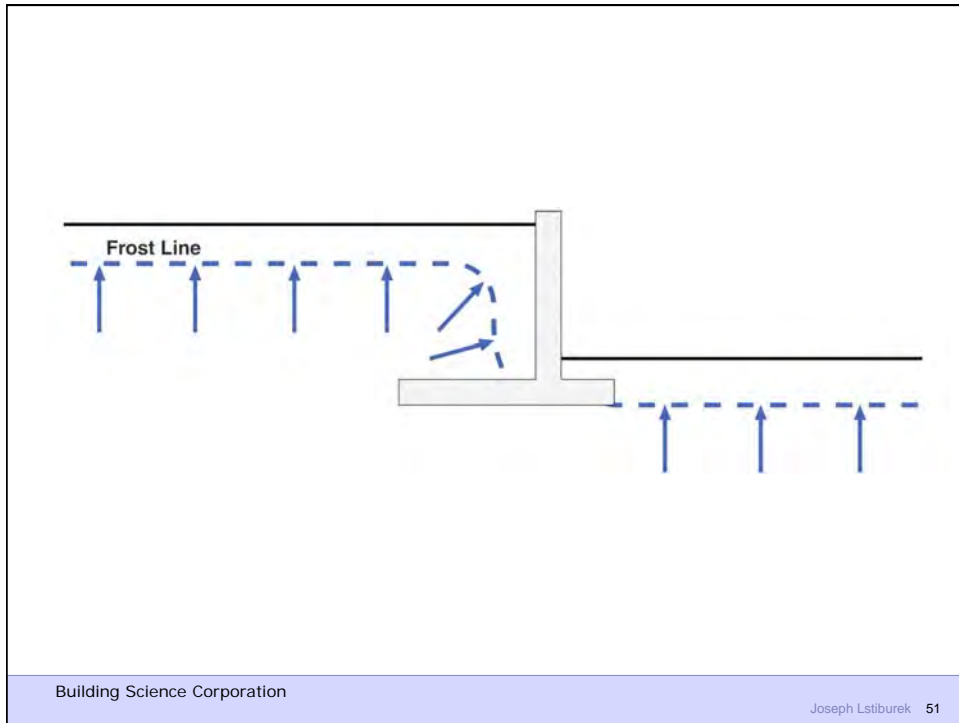


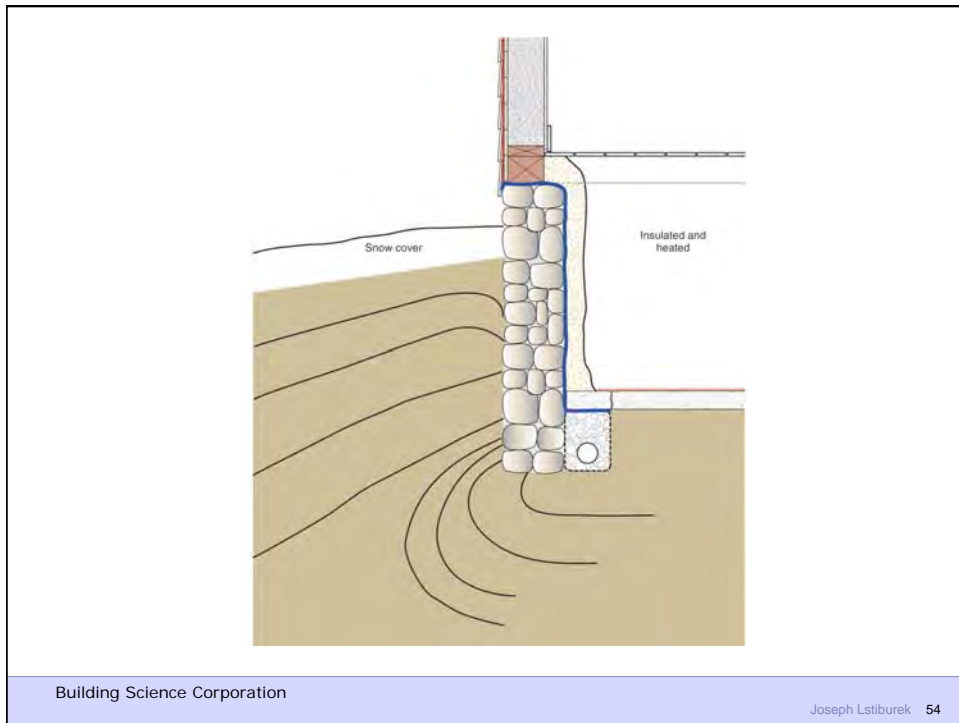
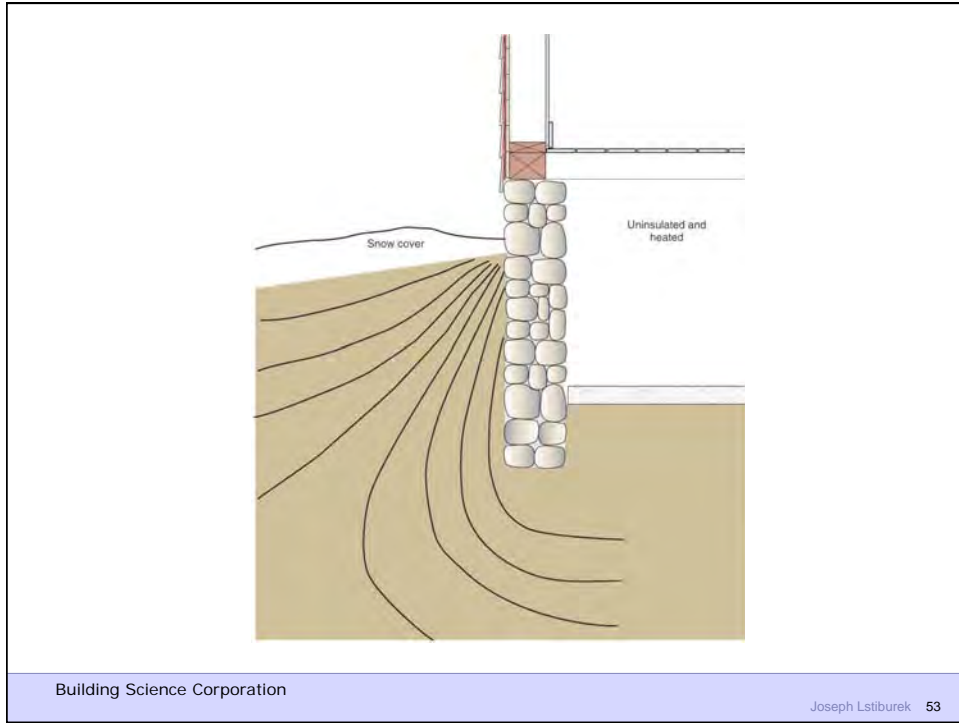
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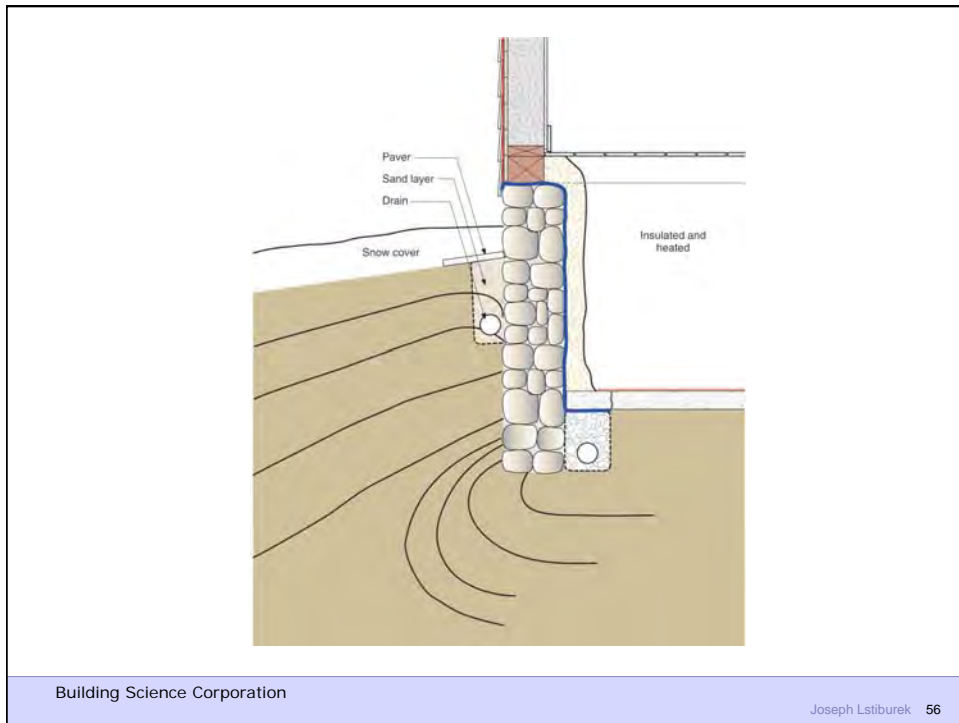
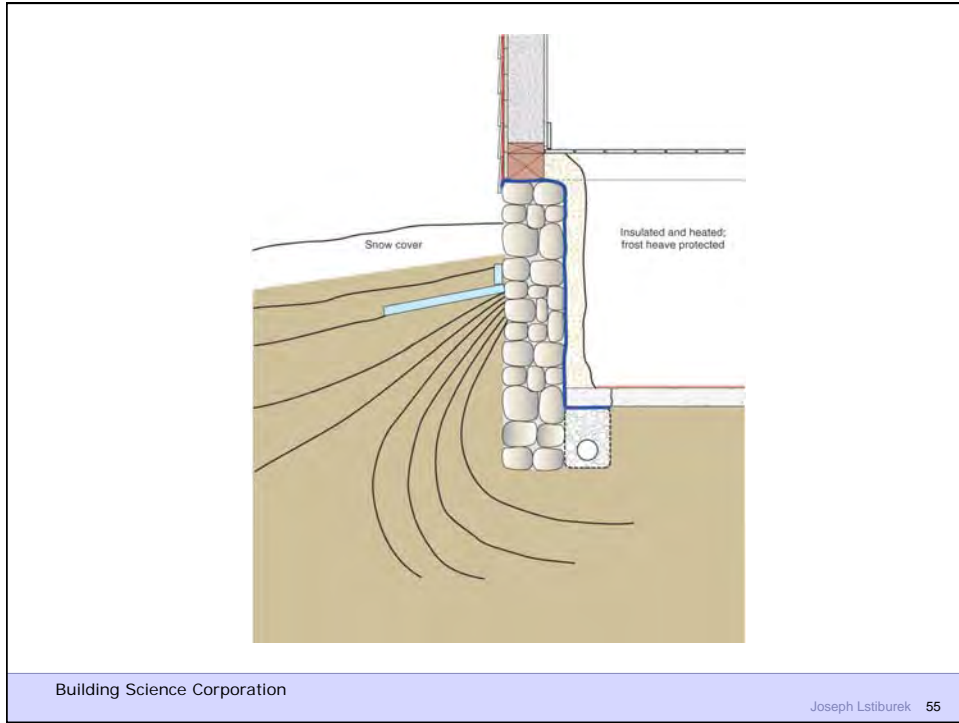


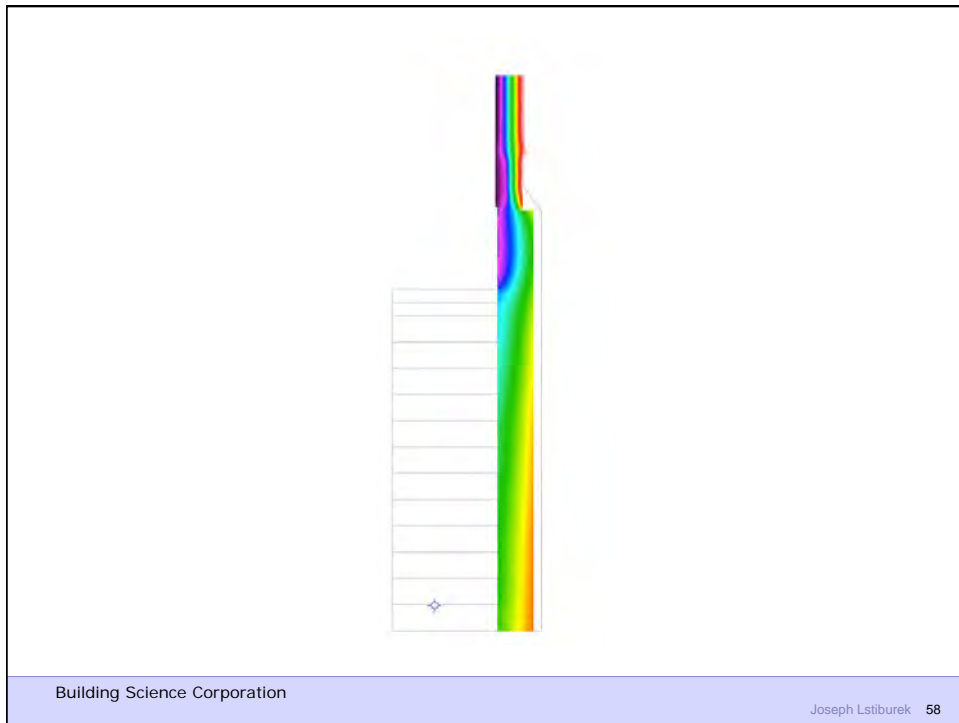
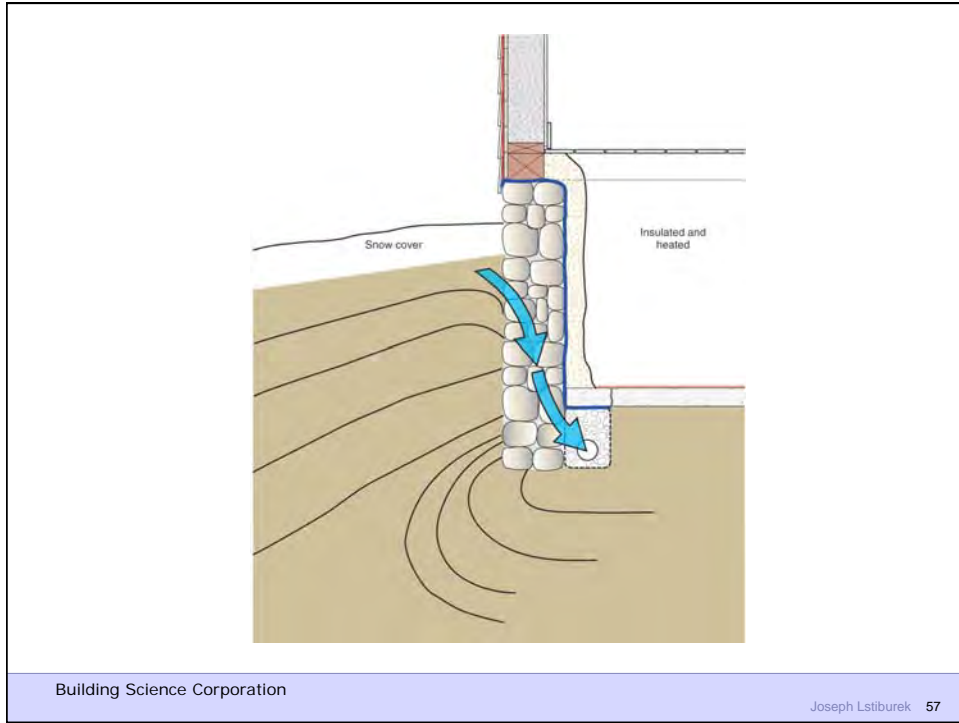


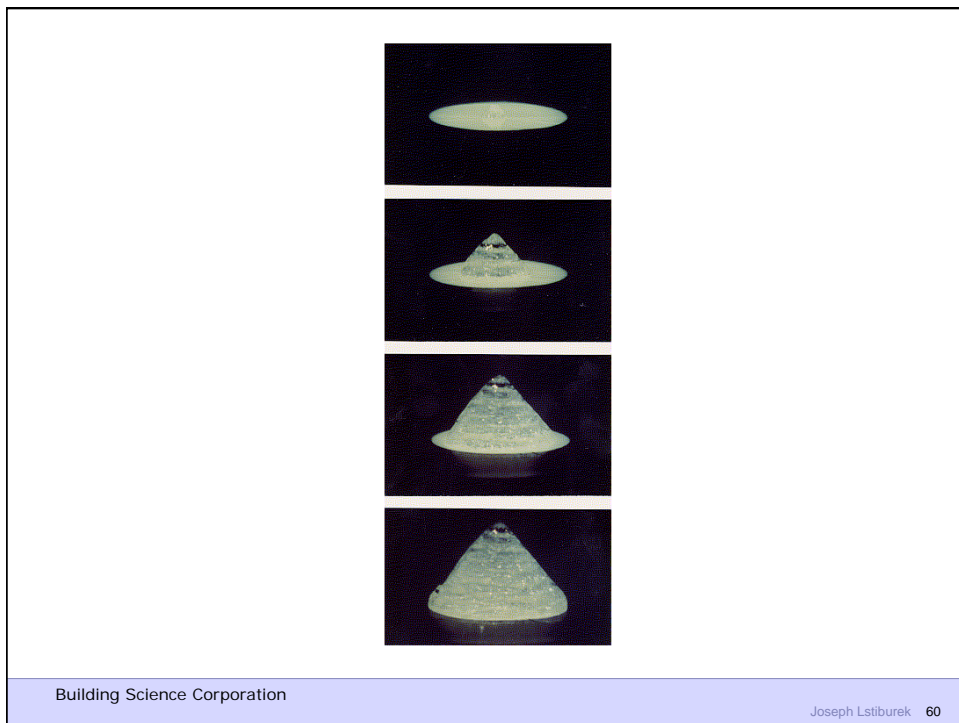
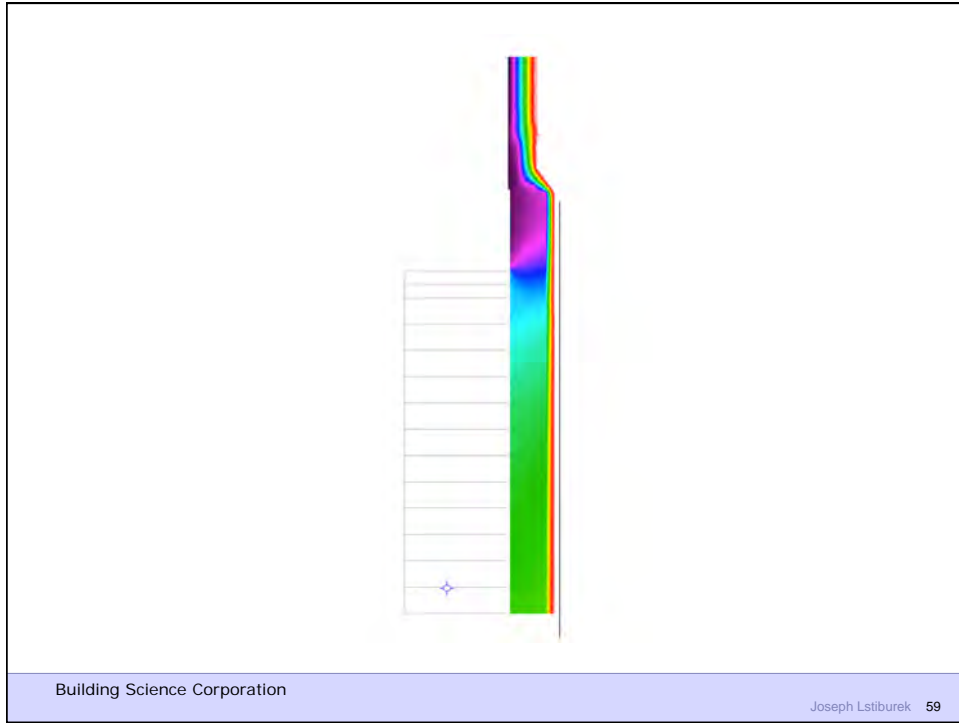














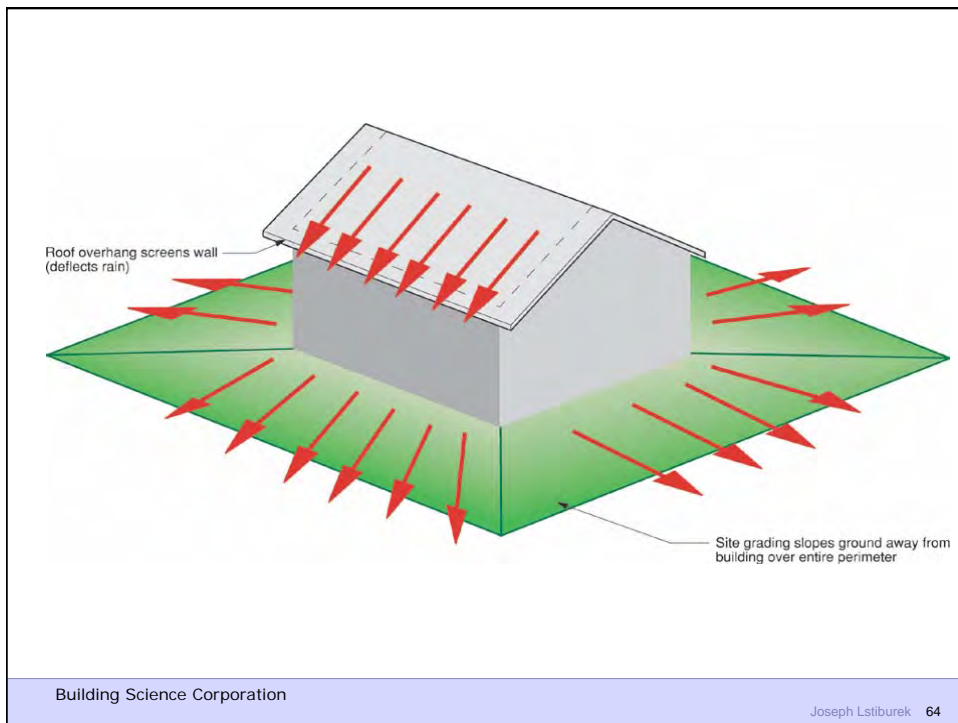
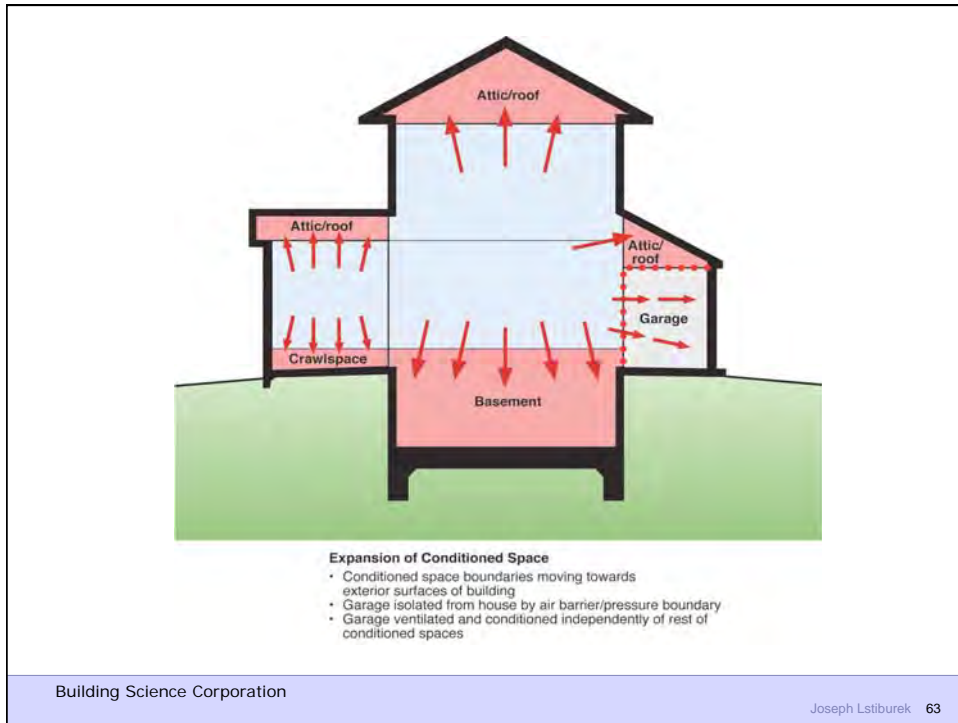
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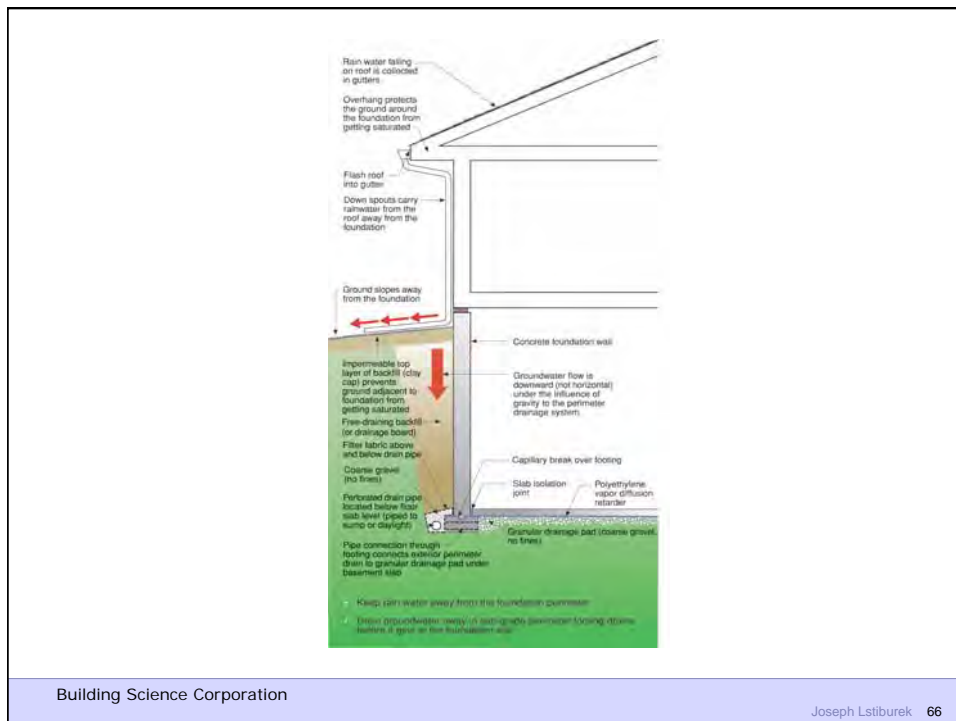
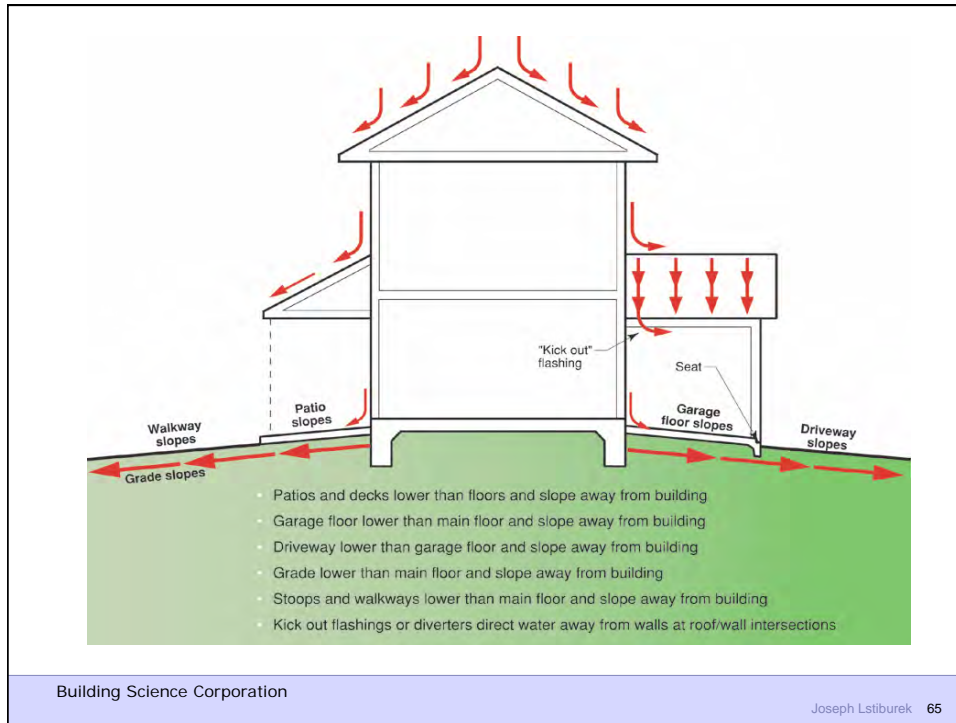


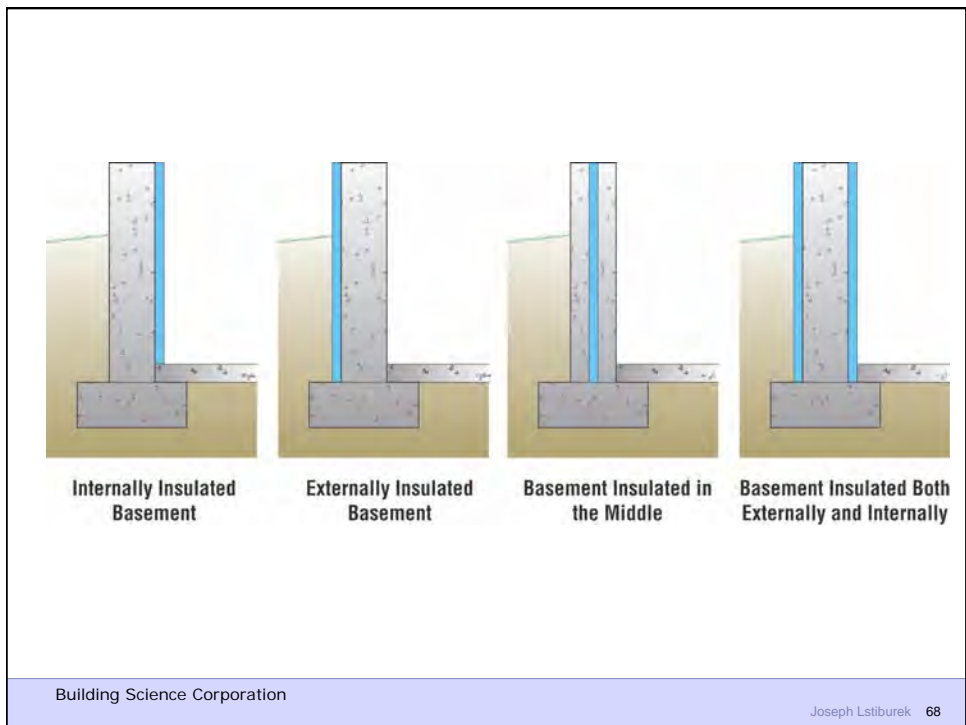
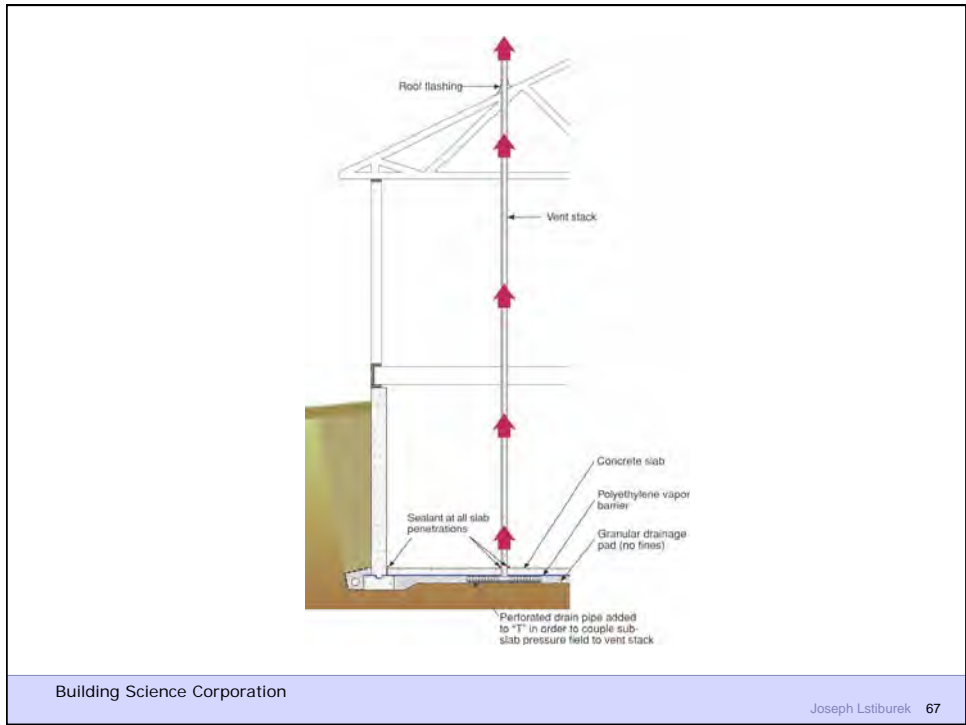
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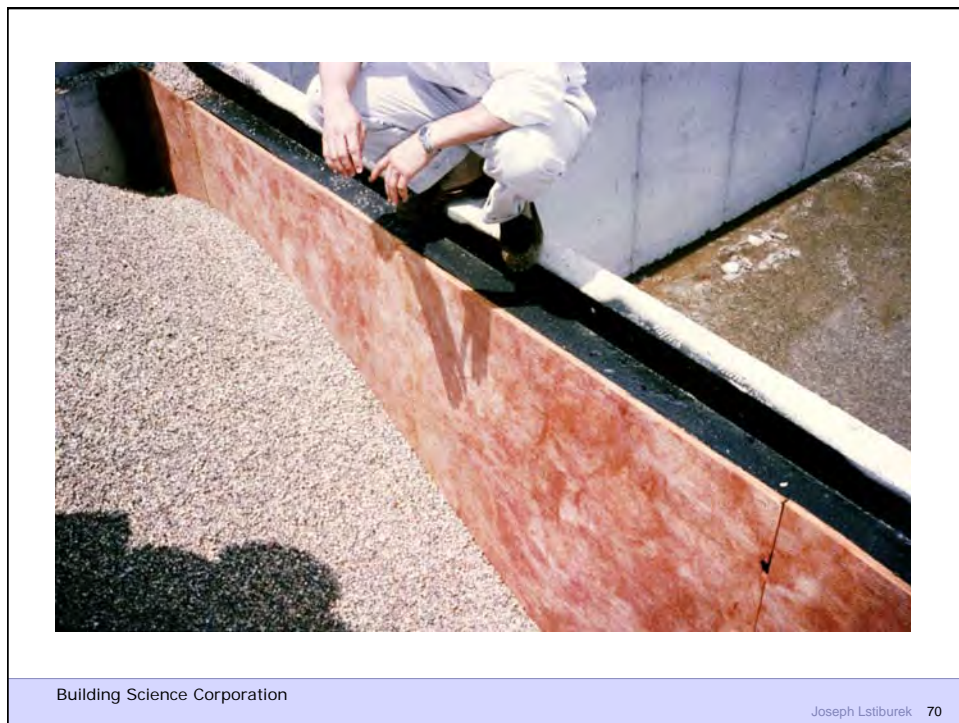
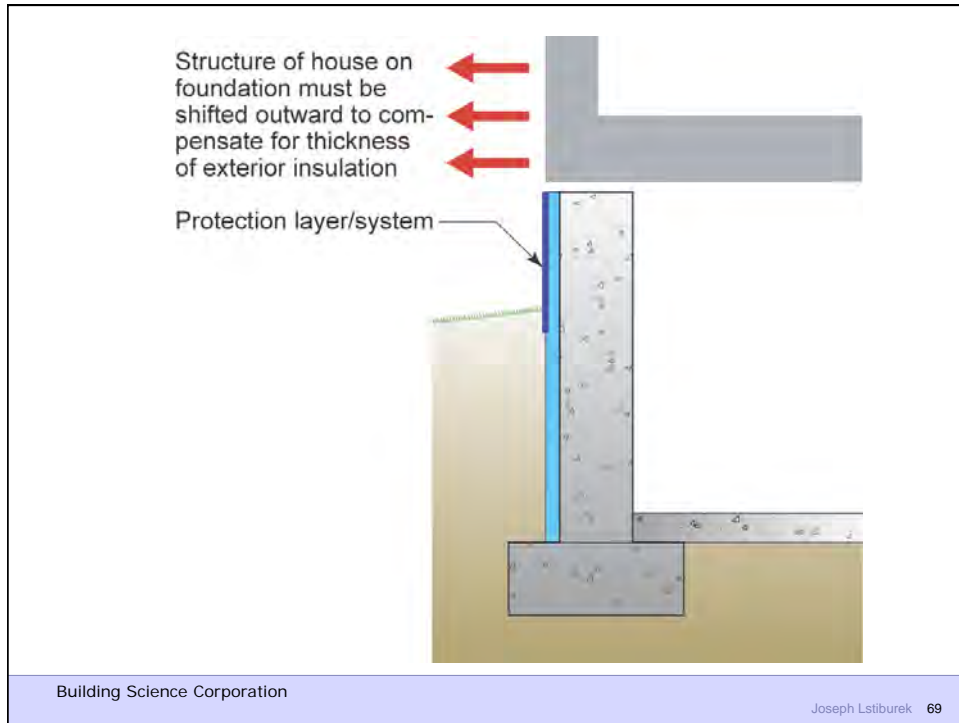
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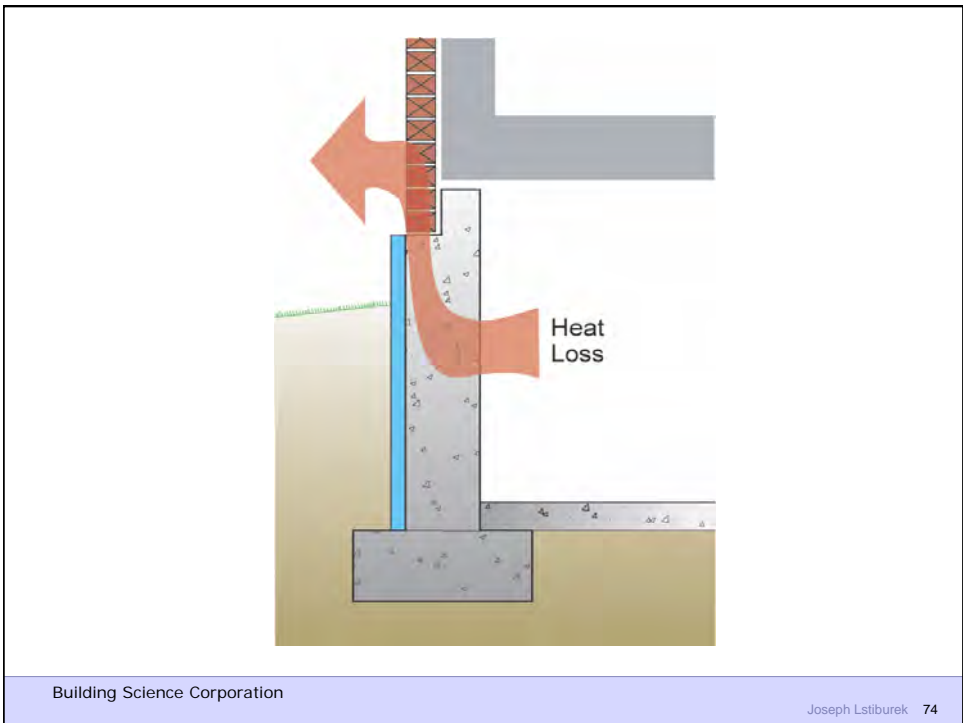
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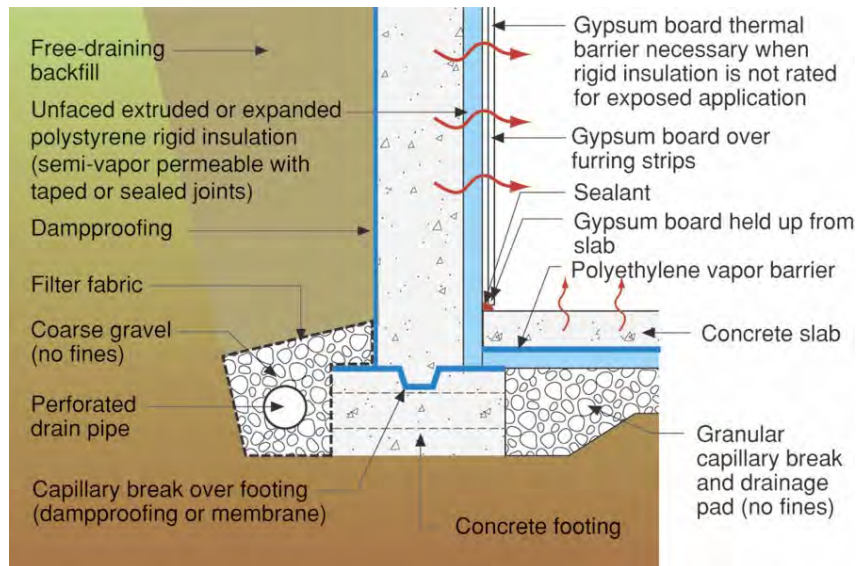
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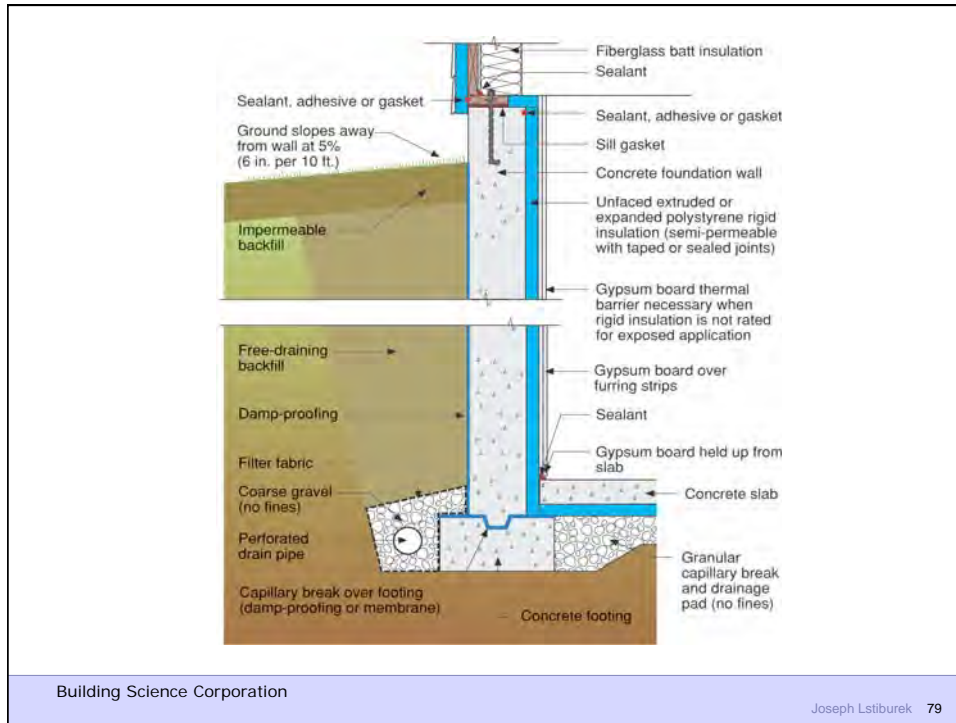
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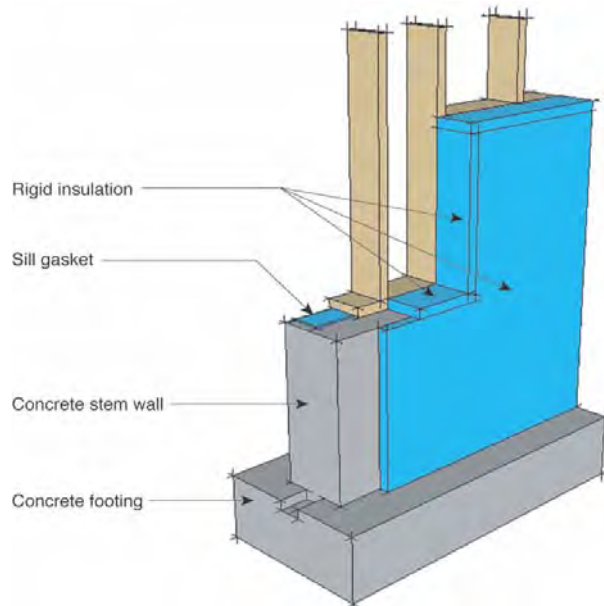
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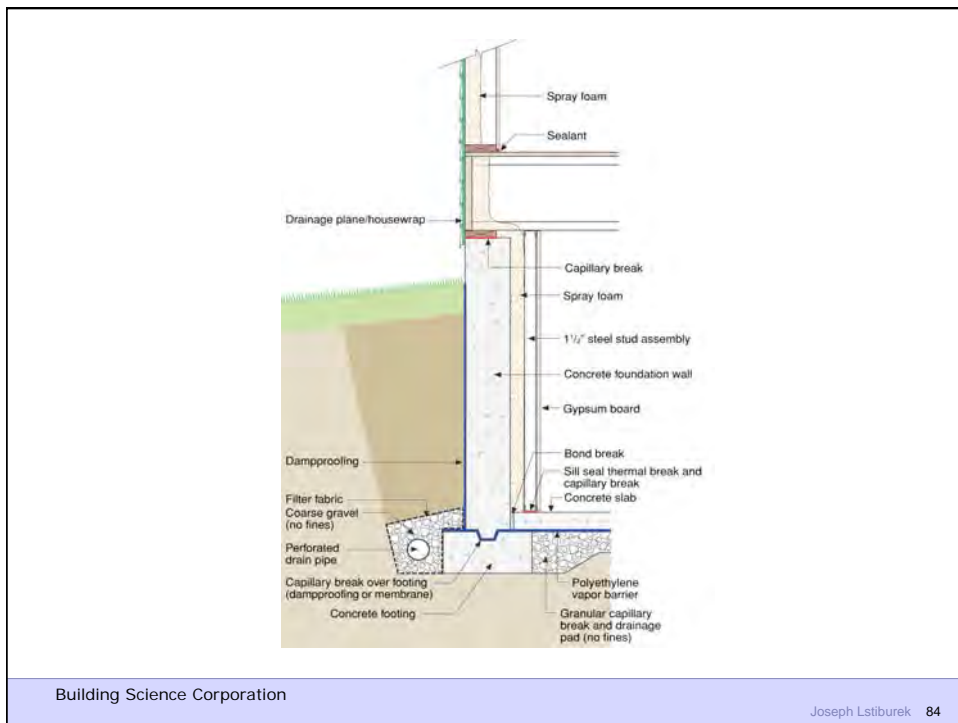
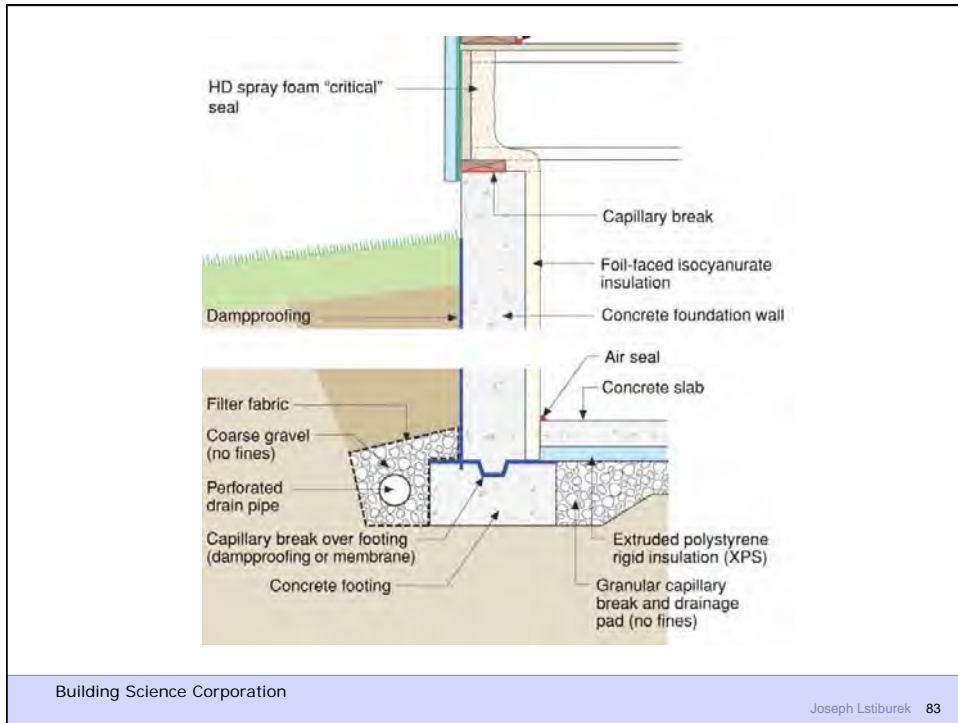




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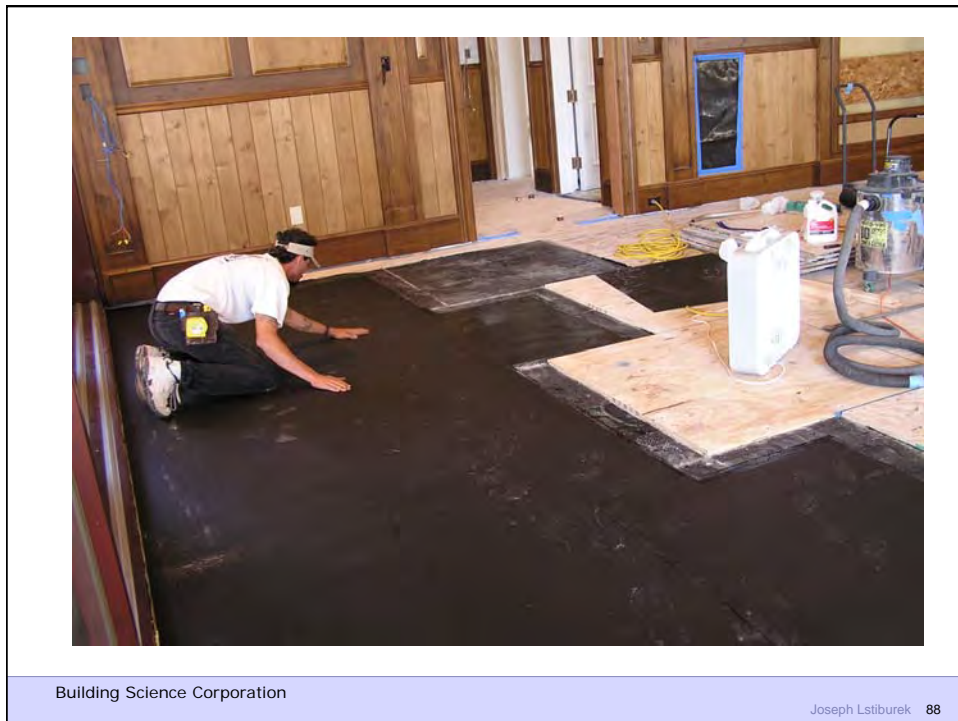
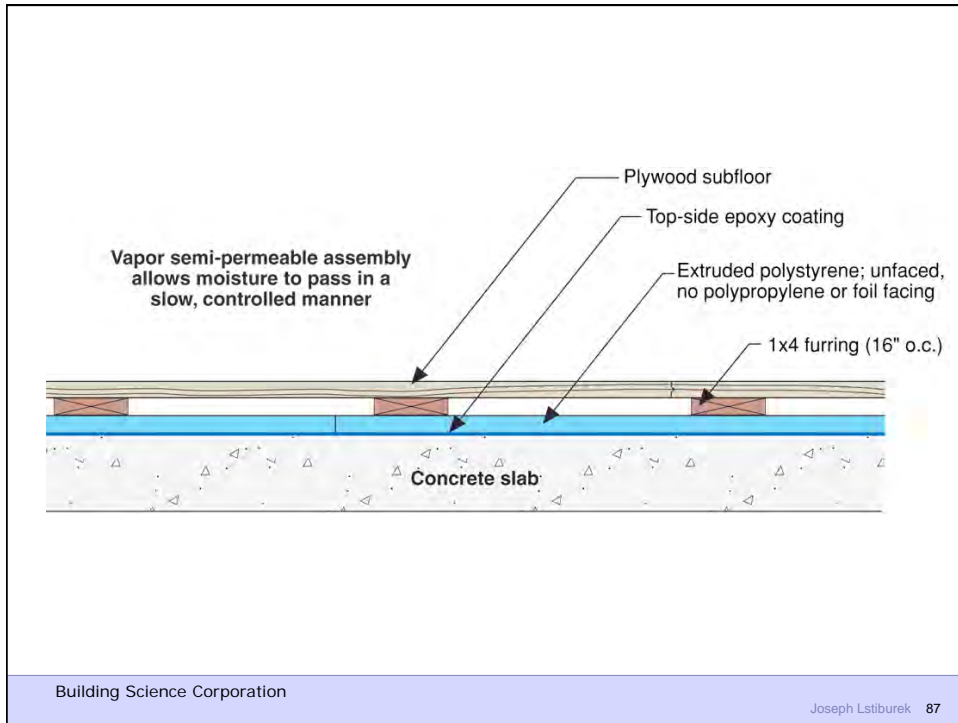




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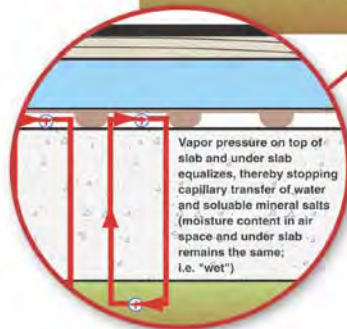
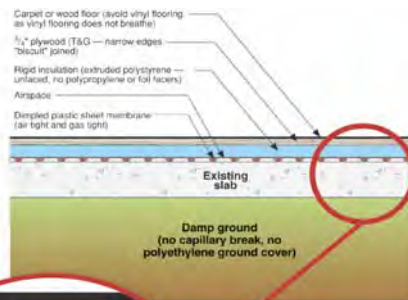


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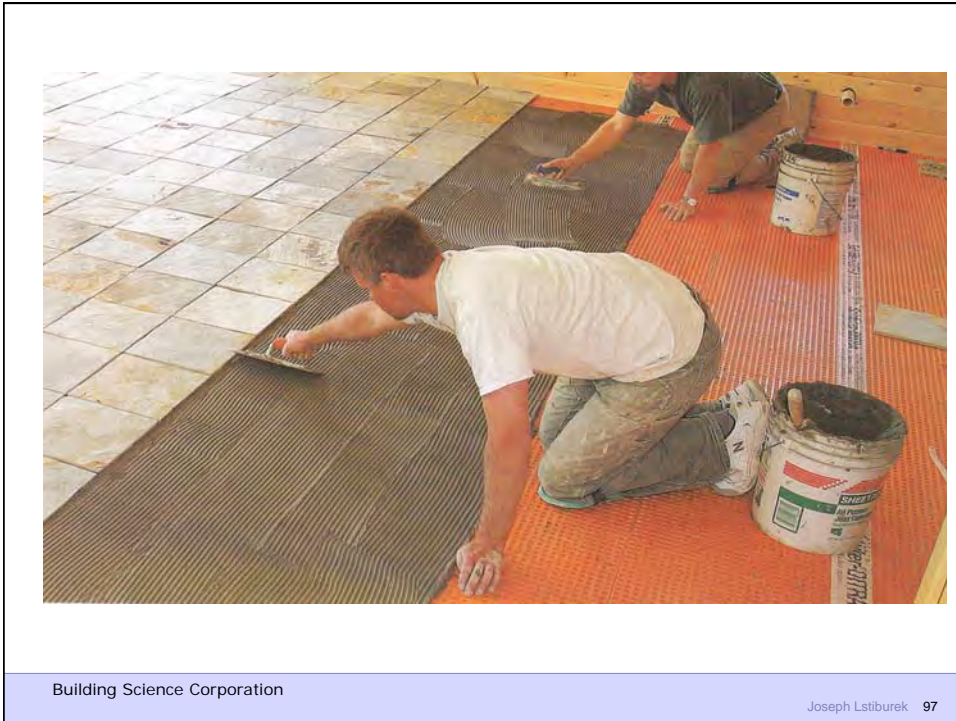
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