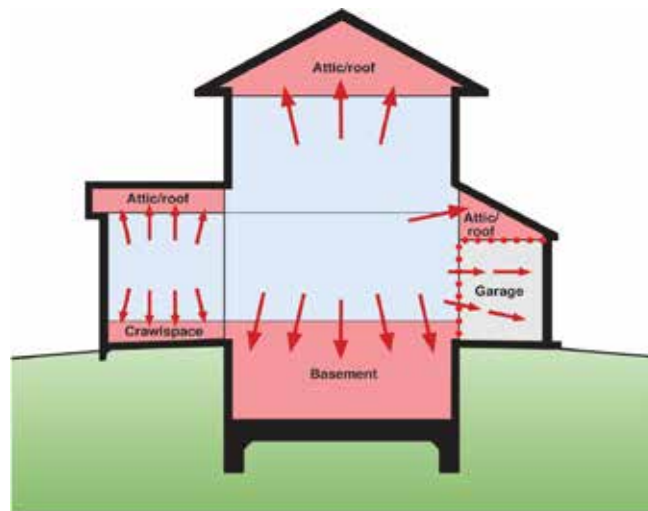


Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

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Foundations

presented by www.buildingscience.com



Expansion of Conditioned Space

- Conditioned space boundaries moving towards exterior surfaces of building
- Garage isolated from house by air barrier/pressure boundary
- Garage ventilated and conditioned independently of rest of conditioned spaces

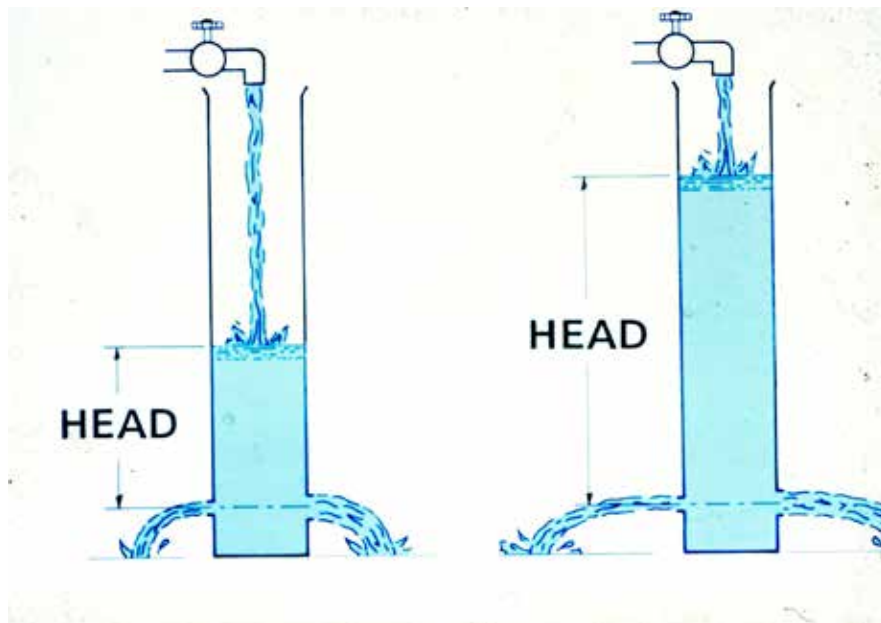
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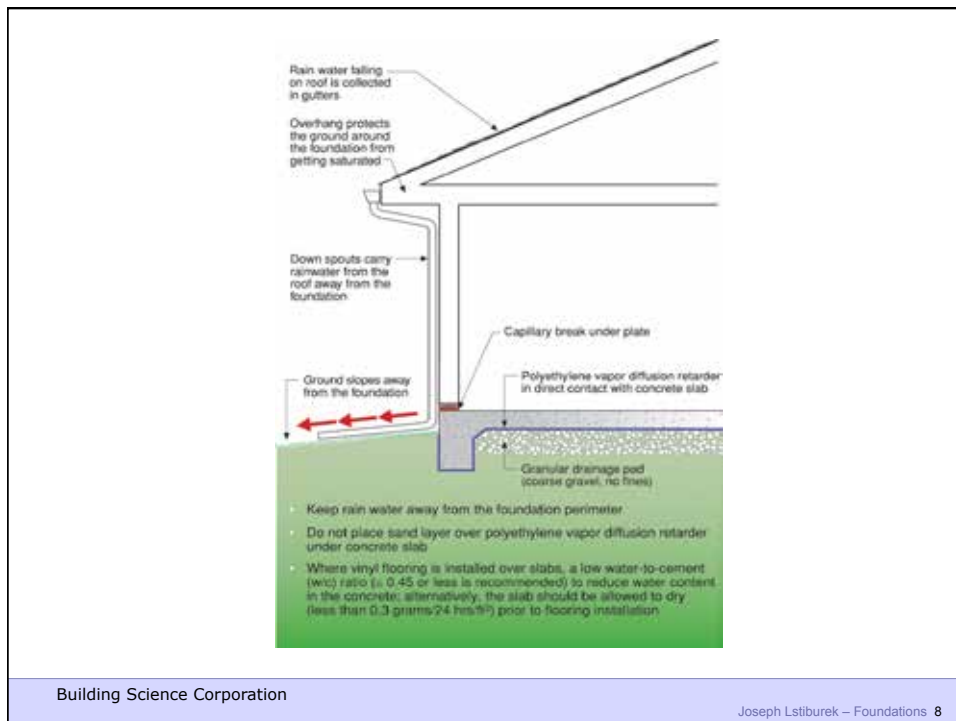
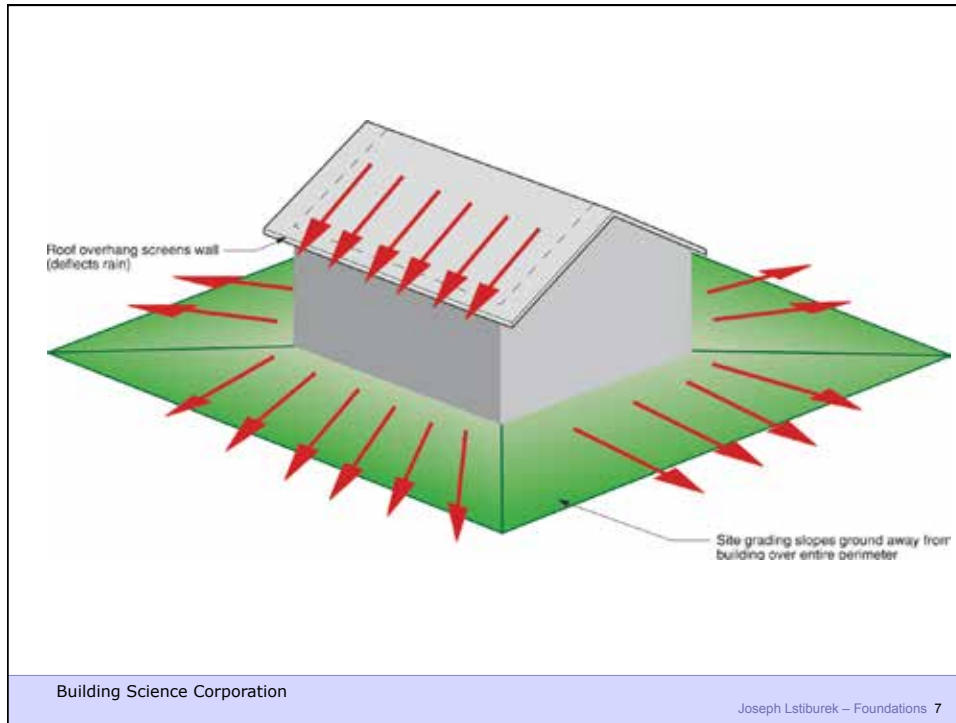
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Mechanisms of Flow

- Liquid
 - Bulk Hydrostatic Pressure
 - Capillary Concentration Gradient
 - Osmosis Concentration Gradient

- Vapor
 - Diffusion Vapor Pressure
 - Air Transport Air Pressure





Rain water falling on roof is collected in gutters

Overhang protects the ground around the foundation from getting saturated

Flush roof into gutter

Down spouts carry rainwater from the roof away from the foundation

Capillary break under plate

Conditioned space

Polyethylene ground cover acting as both an air barrier and a vapor barrier

Interior grade of crawlspace higher than surrounding grade

Ground slopes away from the foundation

- Keeps rain water away from the foundation perimeter
- If the interior crawlspace is lower than the exterior grade, a sub-grade perimeter footing drain is necessary as in a basement foundation
- The crawlspace is conditioned space; it is part of the "interior" of the building and should be heated, cooled and ventilated as part of the building's heating, cooling and ventilating strategy

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Rain water falling on roof is collected in gutters

Overhang protects the ground around the foundation from getting saturated

Flush roof into gutter

Down spouts carry rainwater from the roof away from the foundation

Ground slopes away from the foundation

Concrete foundation wall

Permeable top layer of backfill (clay need protection)

Groundwater flow is downward (not horizontal) under the influence of gravity in the perimeter drainage system

Free draining backfill (or drainage board)

Filter fabric allows water to flow over pipe

Capillary break over footing

Coarse gravel (or filter)

Slab isolation joint

Polyethylene vapor diffusion barrier

Perforated drain pipe located below filter with level sloped to pump or sump

Gravel drainage pad (coarse gravel, no filter)

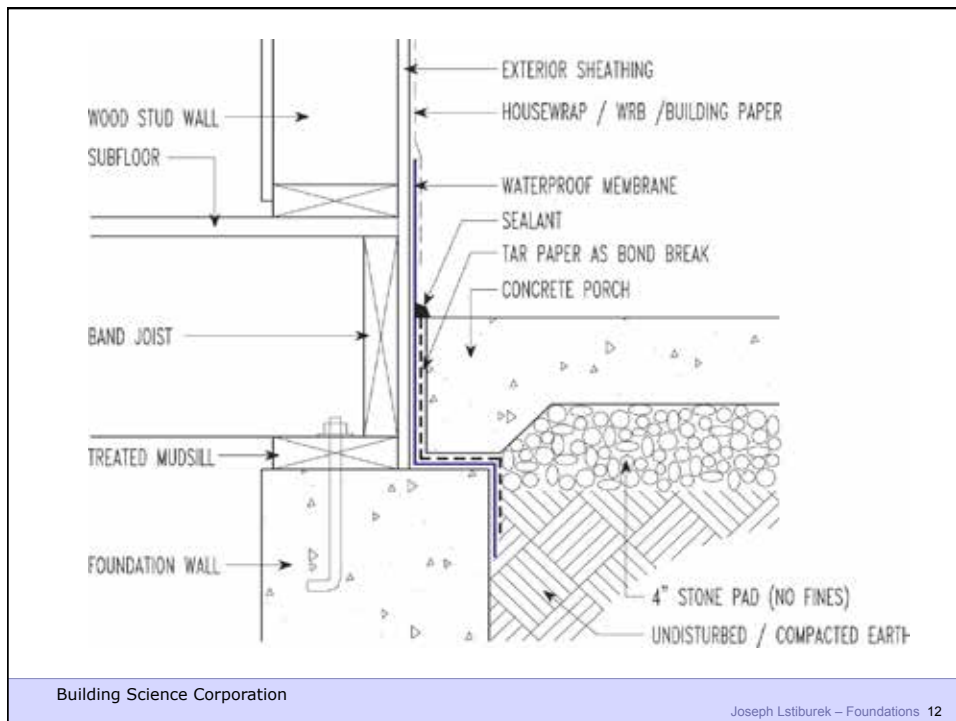
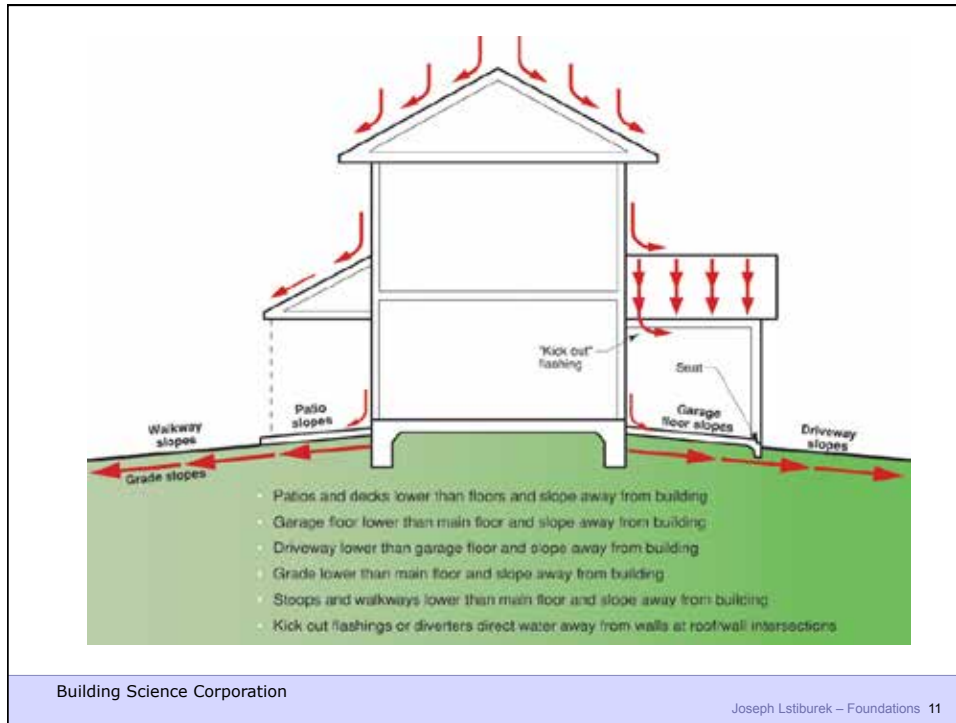
Pipe connection through footing connects exterior perimeter drain to perimeter drainage pad under basement slab

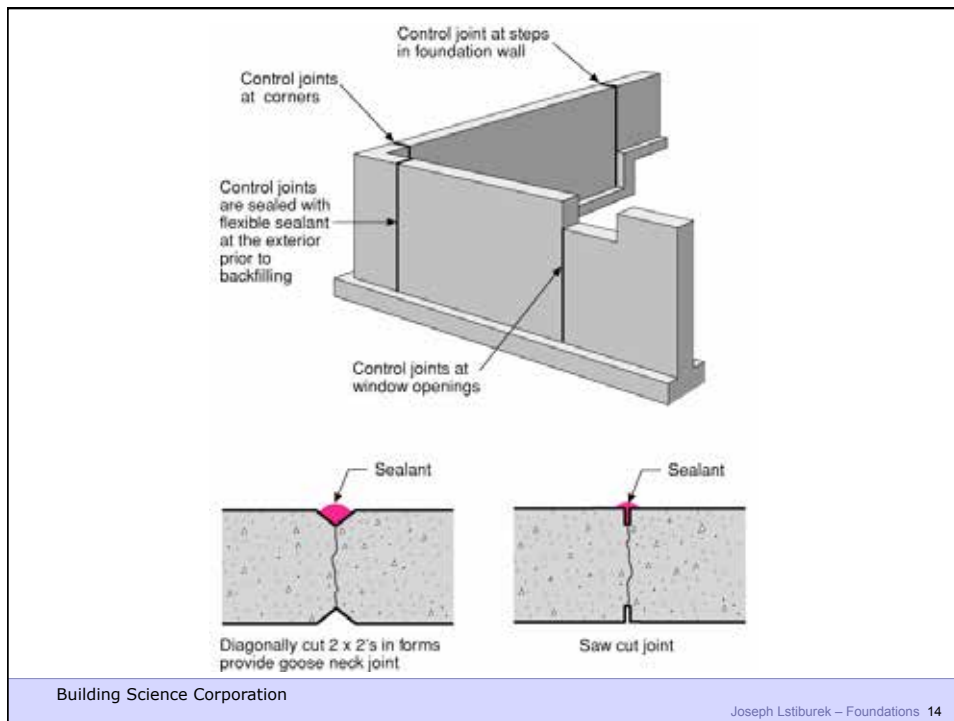
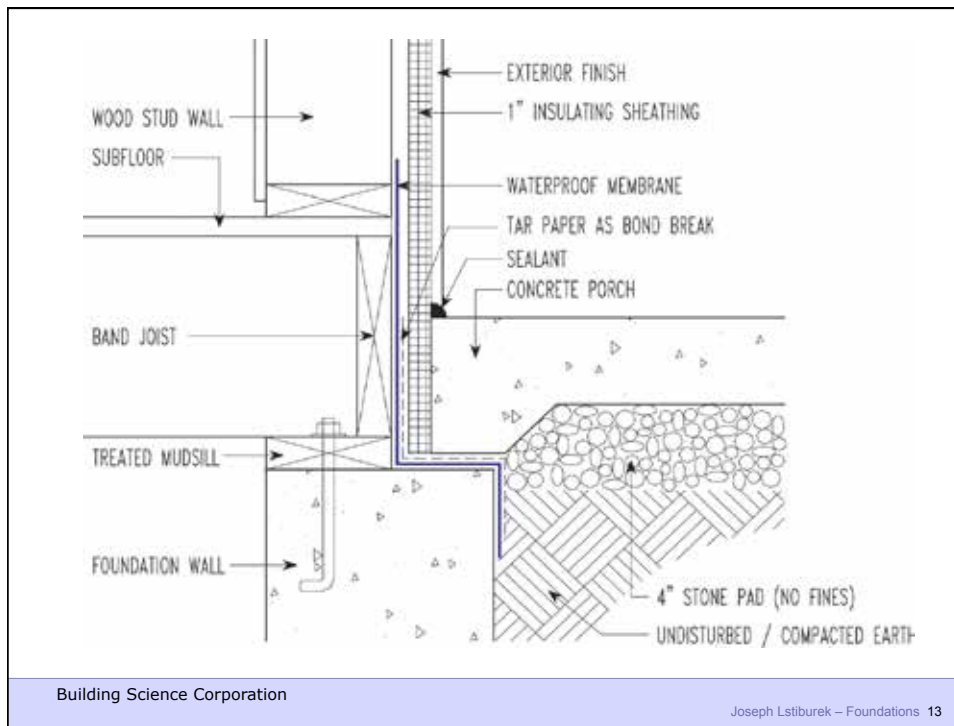
Gravel drainage pad (coarse gravel, no filter)

- Keeps rain water away from the foundation perimeter
- Drain groundwater away from grade perimeter footing drains system. A pipe to the foundation wall

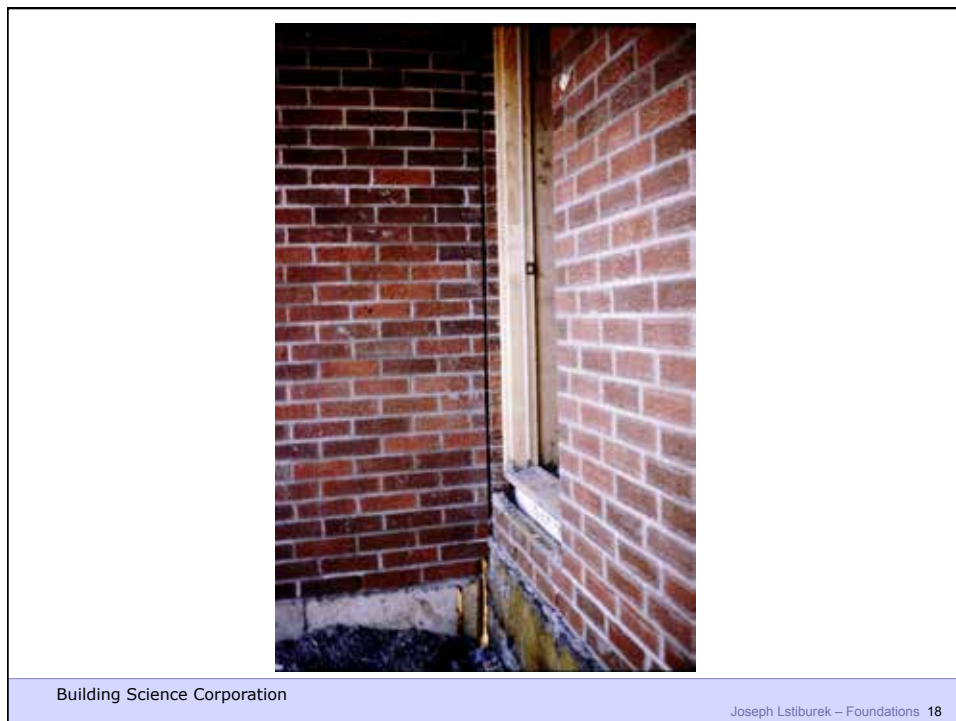
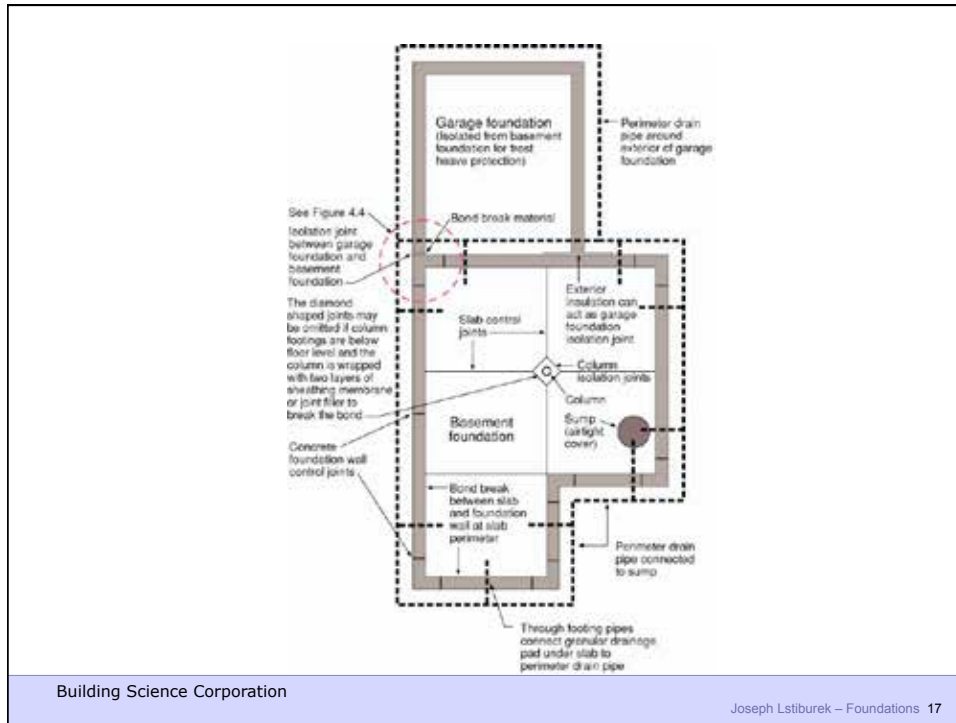
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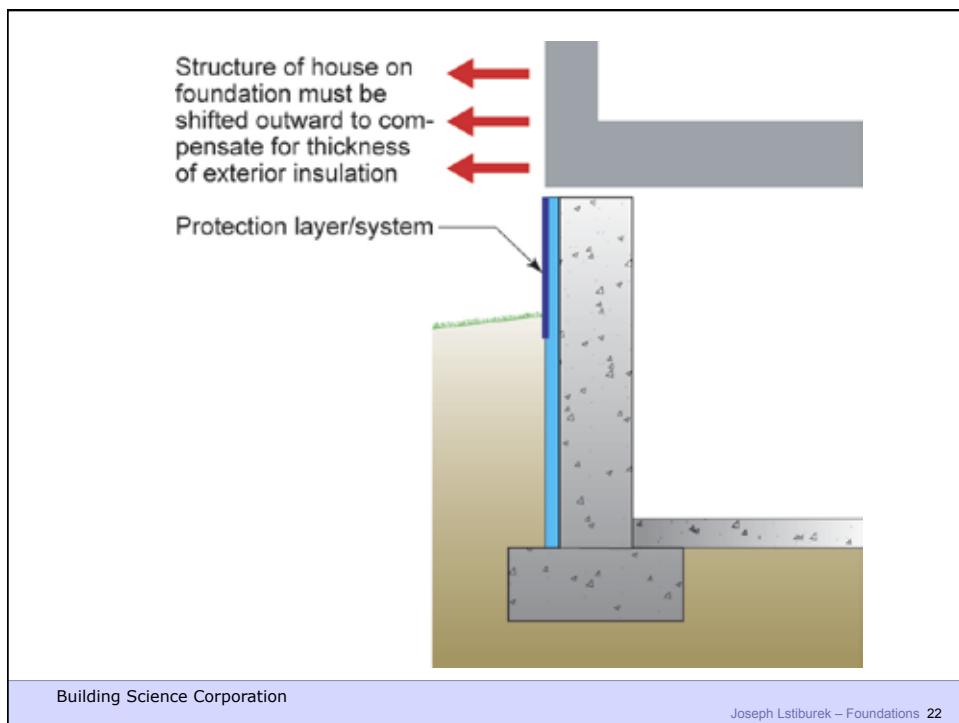
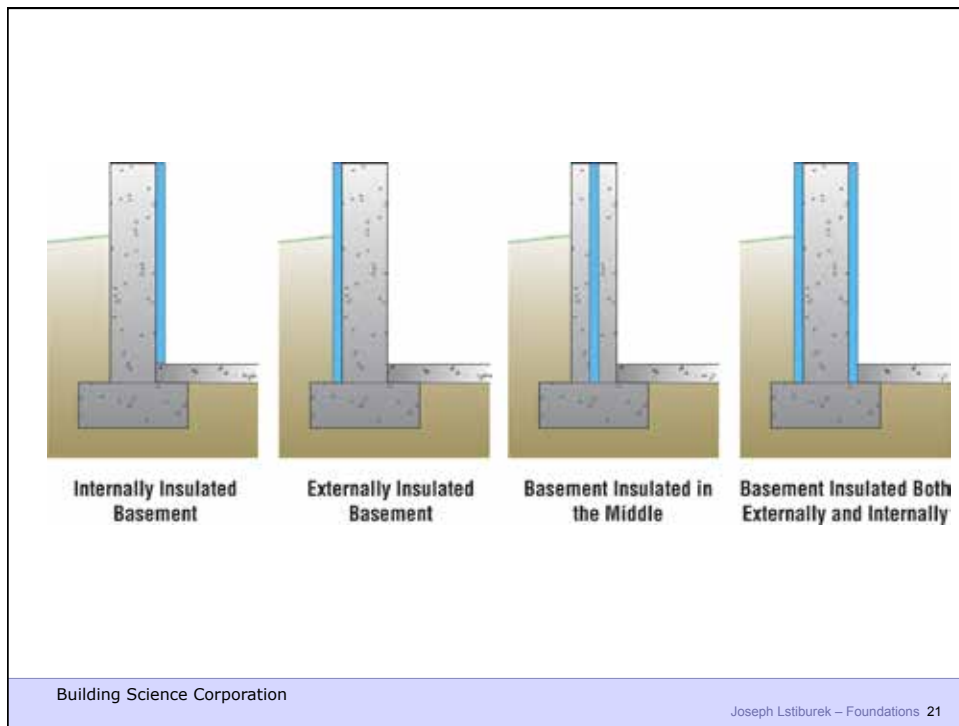




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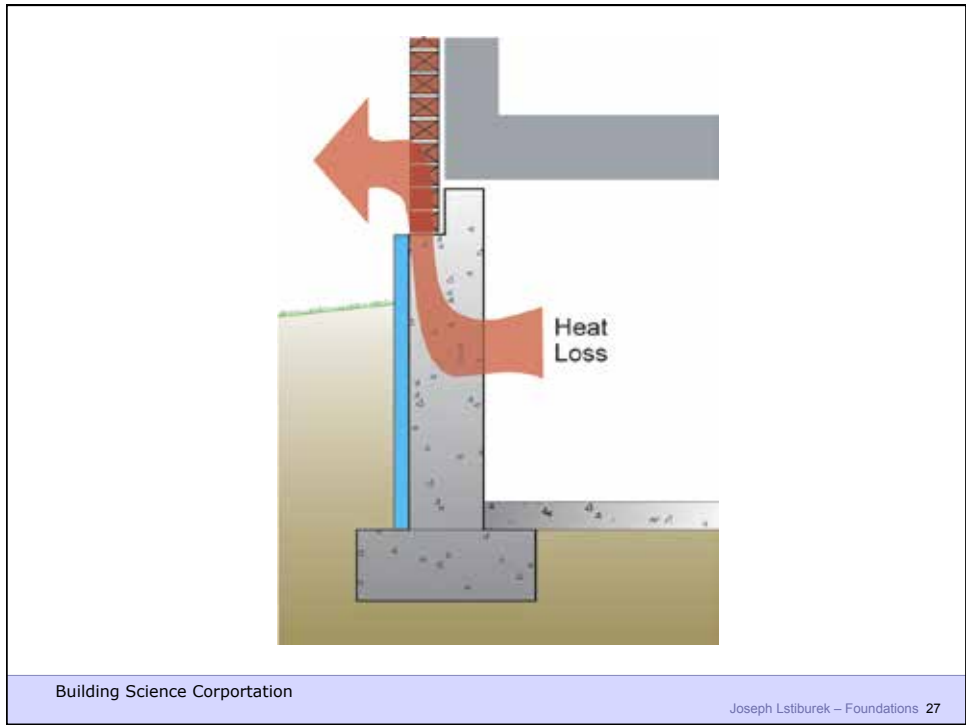
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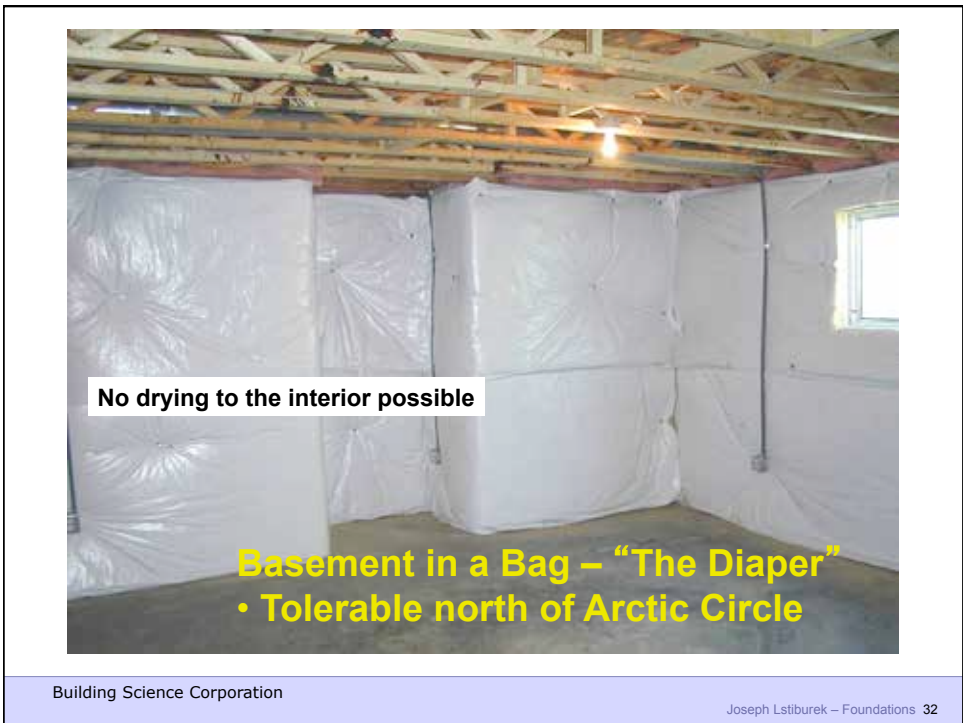




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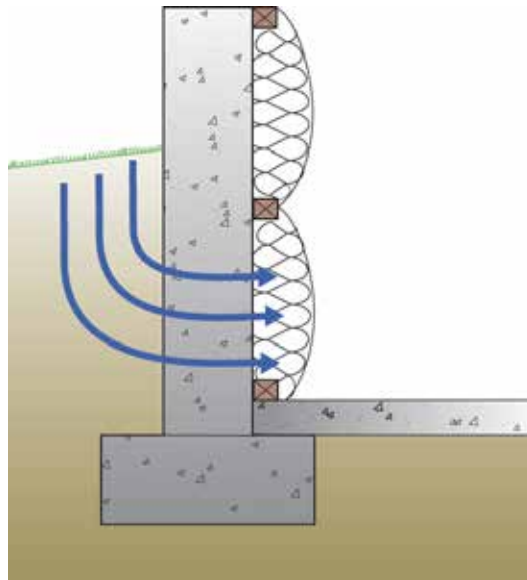


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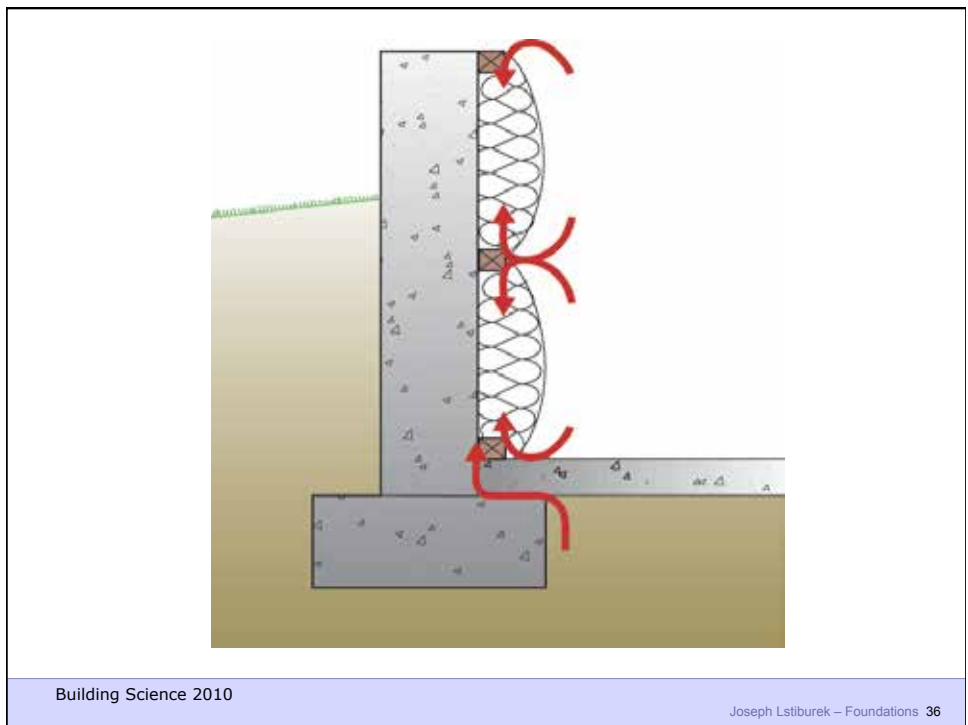
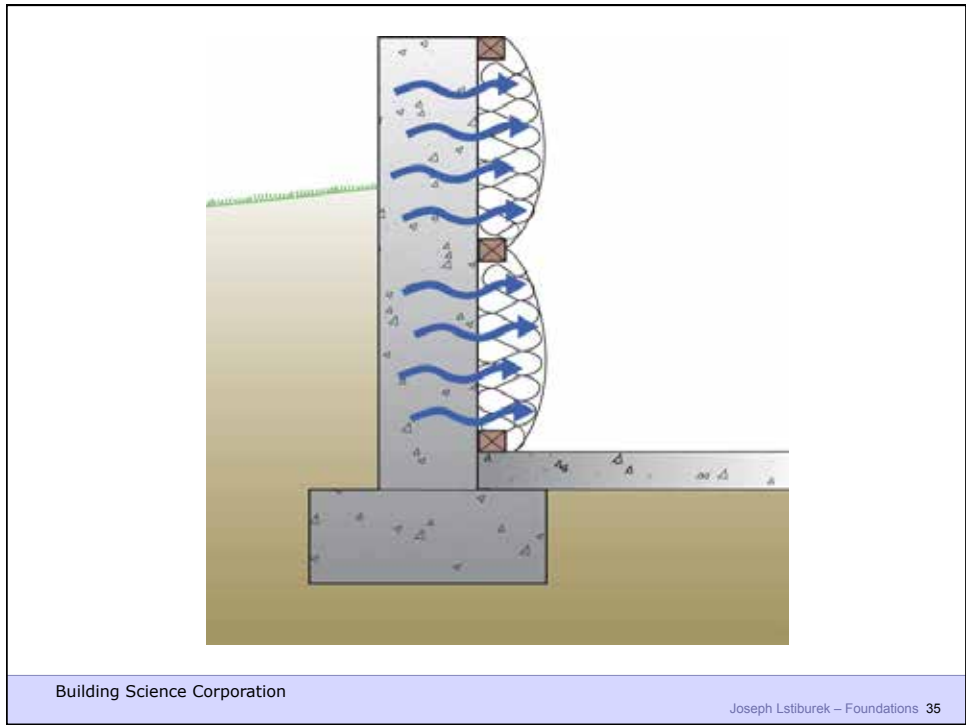


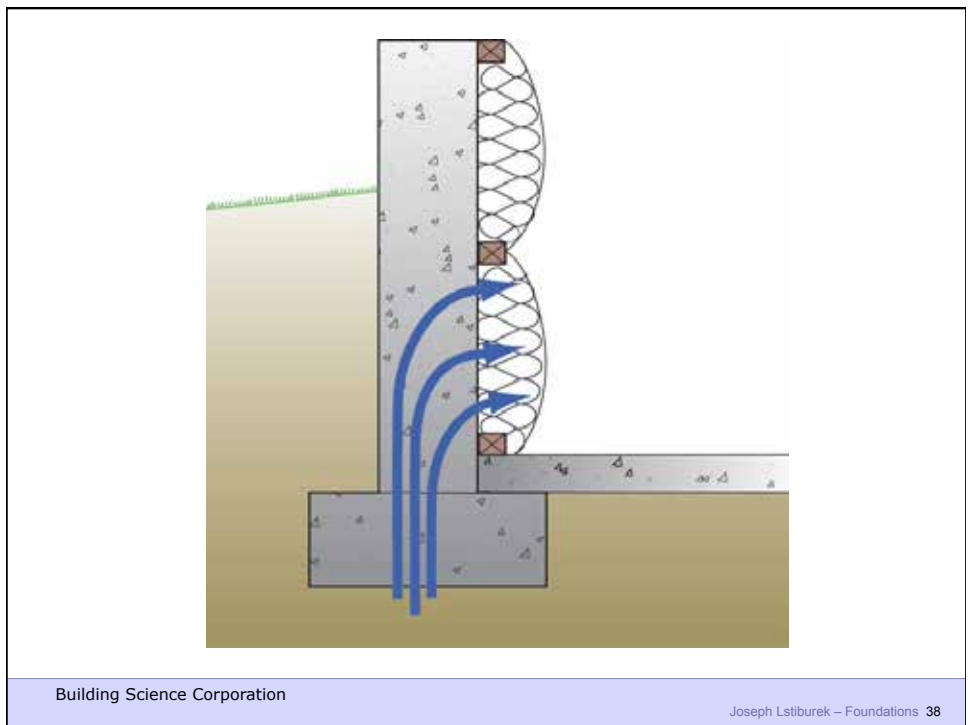
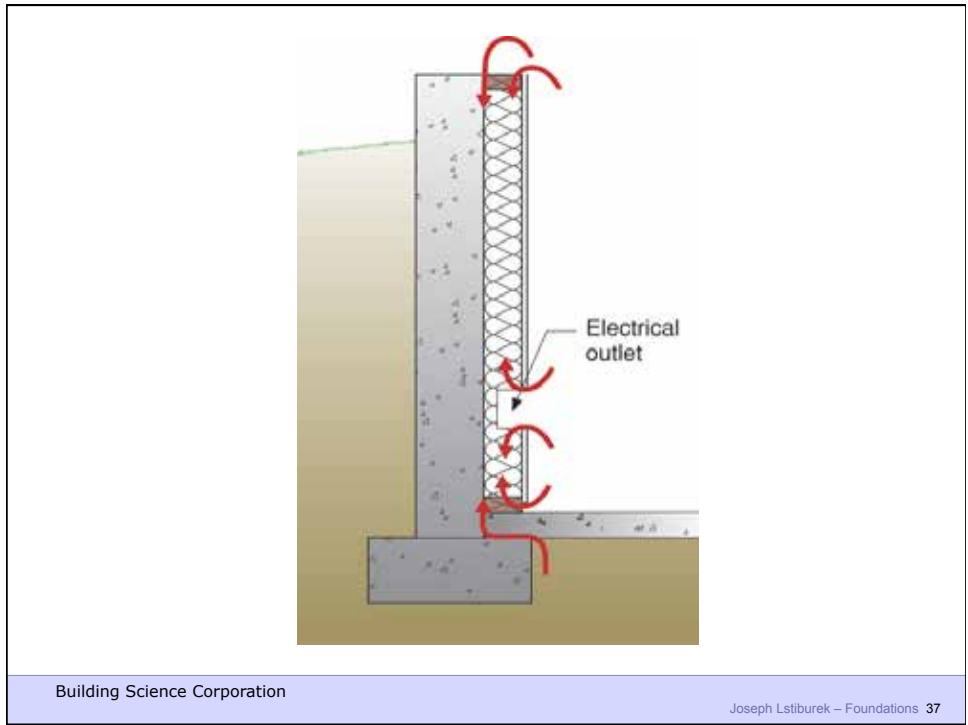


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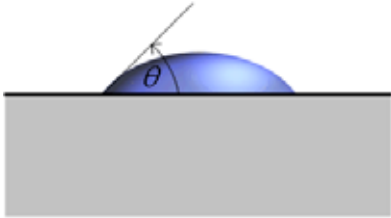




Surface Tension: Wettable

Water attracted to surface more than self

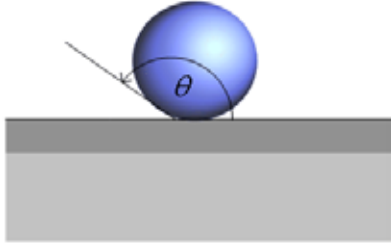
$\theta < 90^\circ$



normal material:
"wetable"

Water attracted to self more than surface

$\theta > 90^\circ$

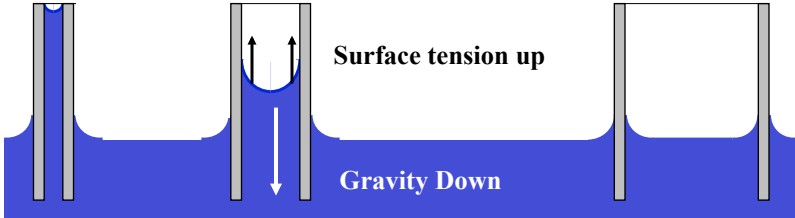


hydrophobically treated:
"non-wetable"

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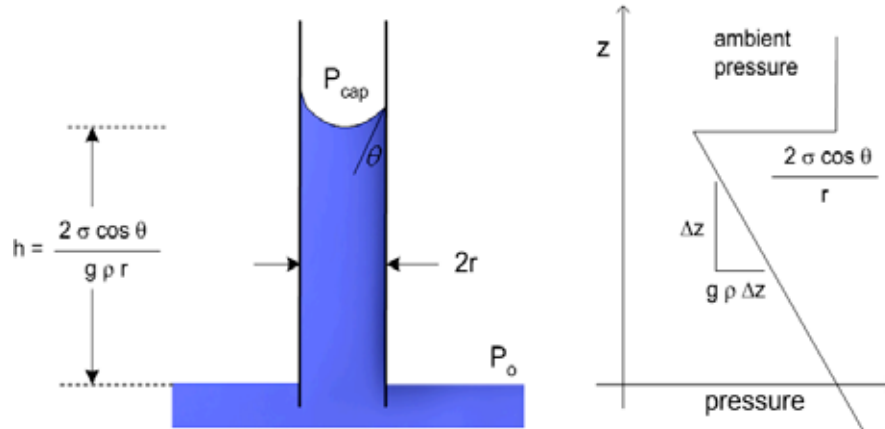
Capillary Pressures

- Result of surface tension = attraction to surfaces
 - pressure varies with pore size
 - e.g., height rise in a glass tube



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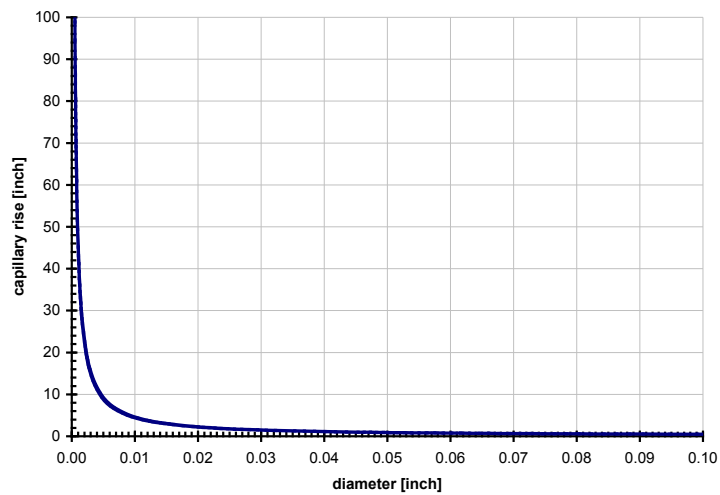
Calculating capillary rise



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Capillary rise versus diameter

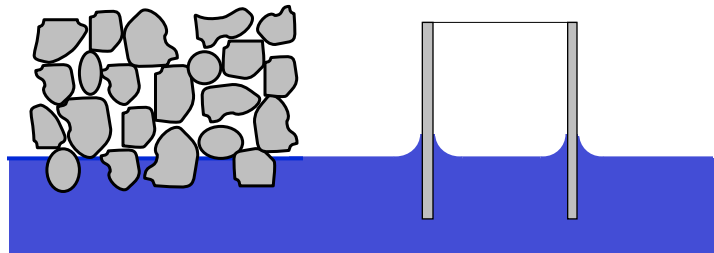


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Capillary Flow

- Eg. : Crushed stone, air gaps
- large pores - no suction (“wicking”)

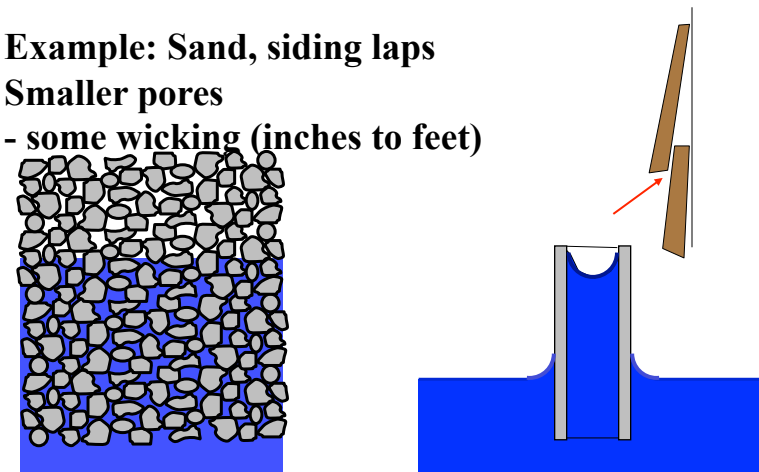


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Capillary Flow

Example: Sand, siding laps
Smaller pores
- some wicking (inches to feet)

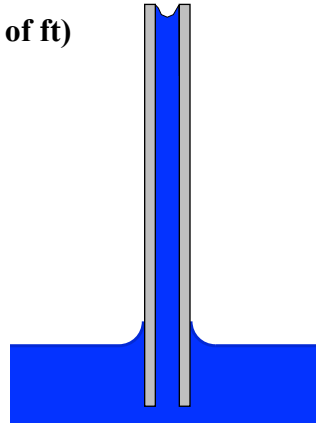
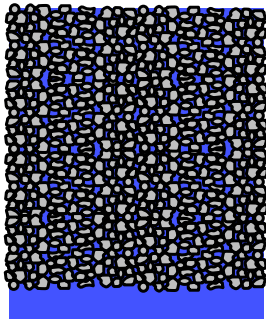


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Capillary Flow- concrete sucks

Example: Clay or silt
Wicking (dozens - hundreds of ft)



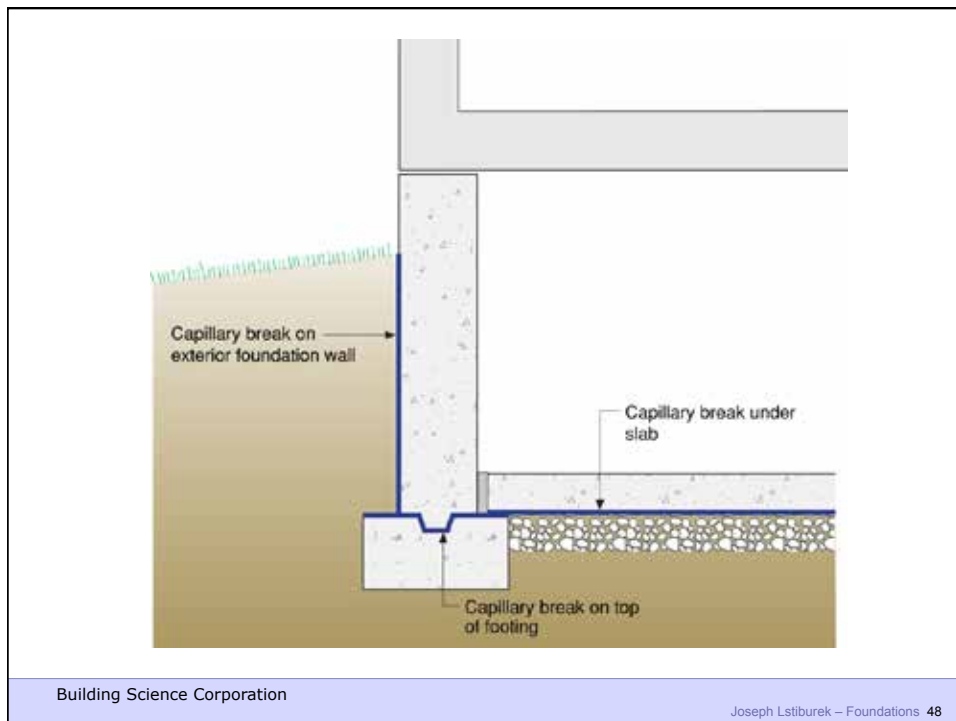
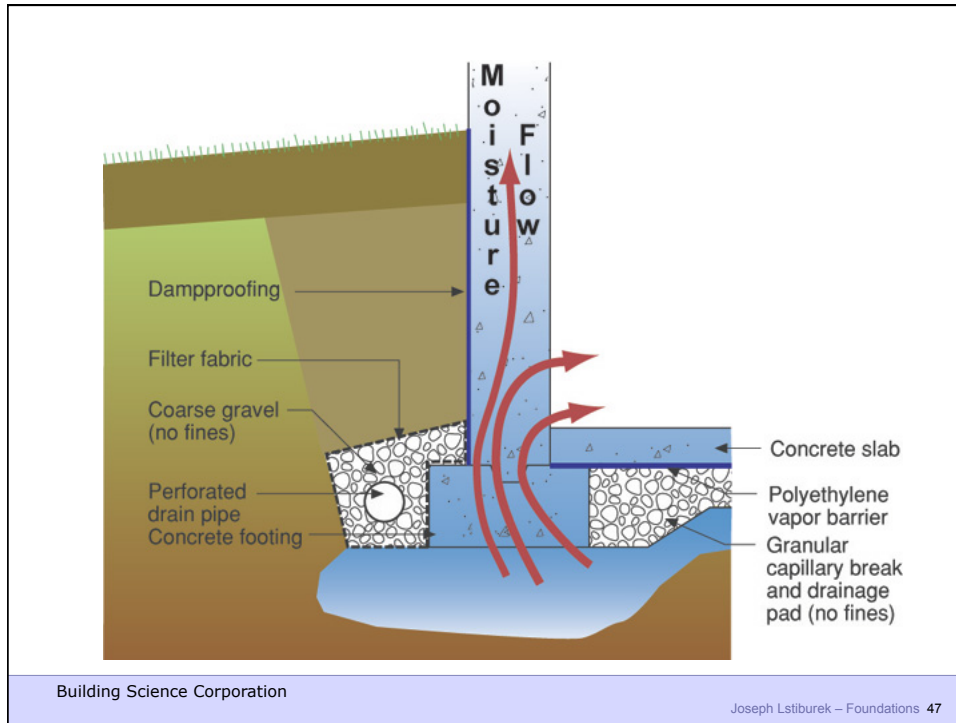
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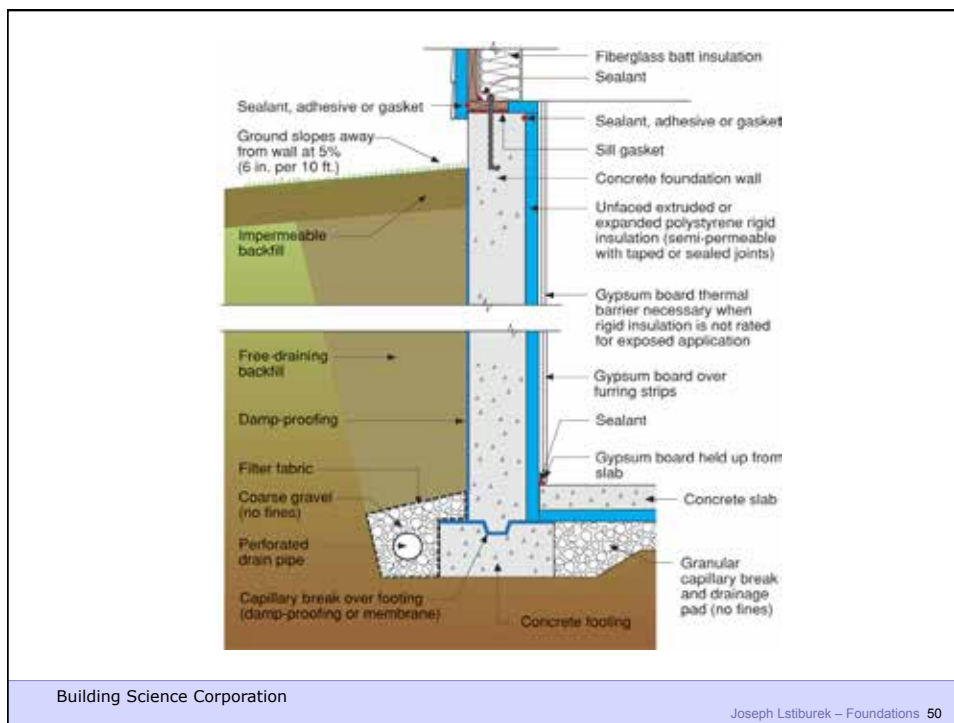
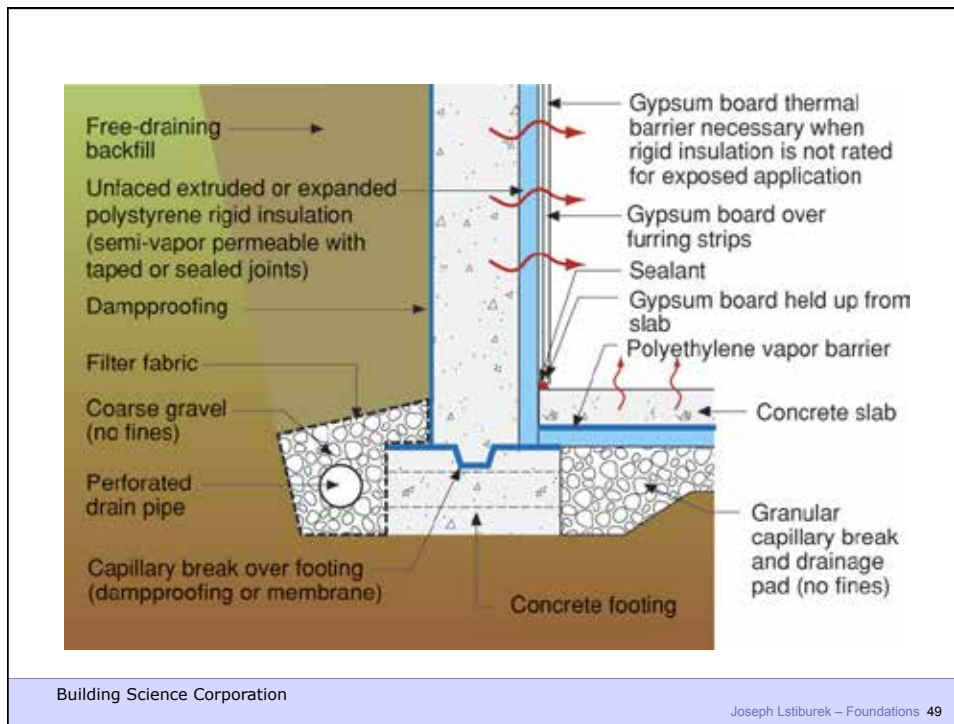
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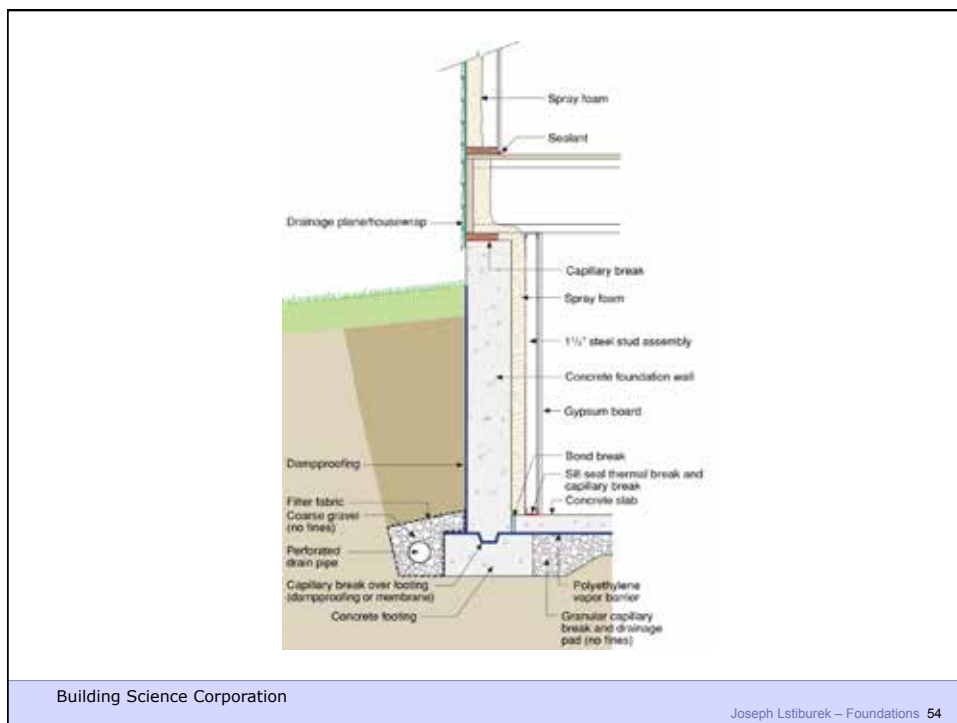
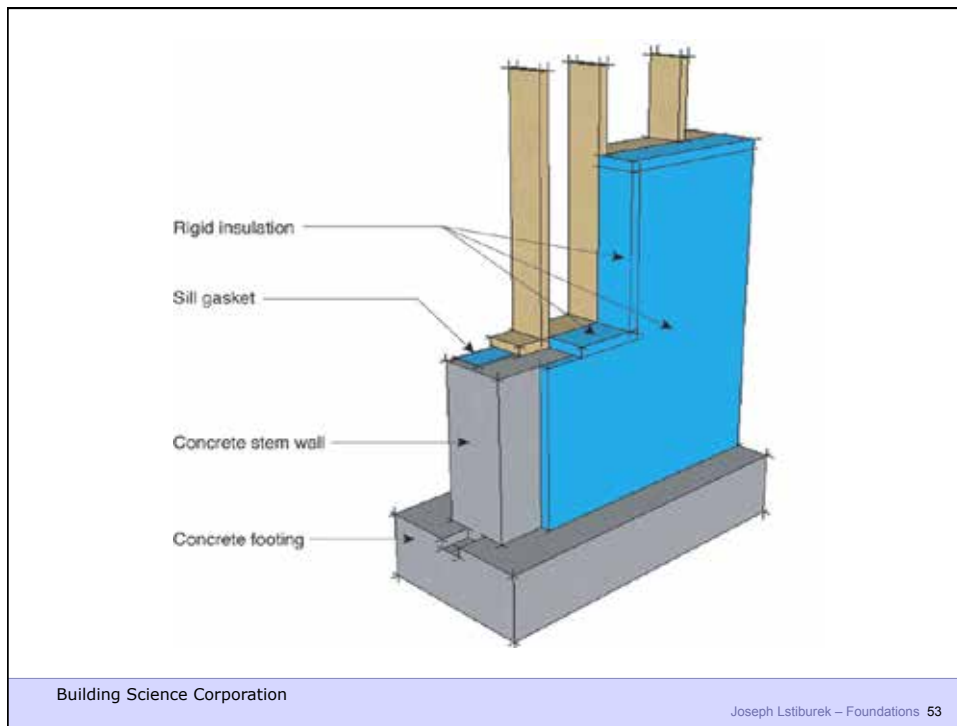




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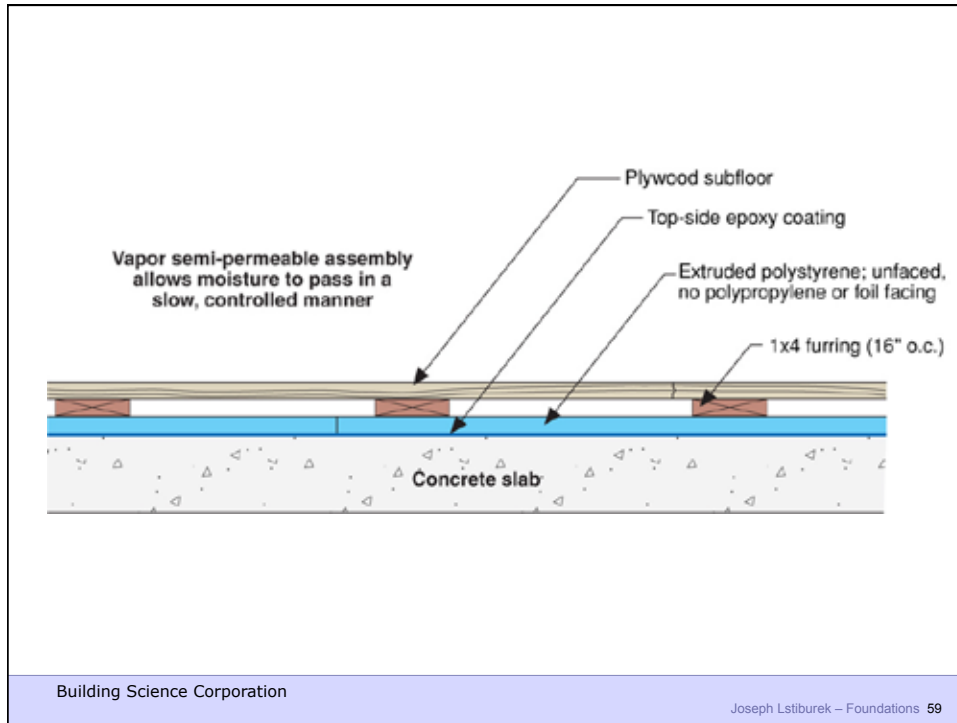
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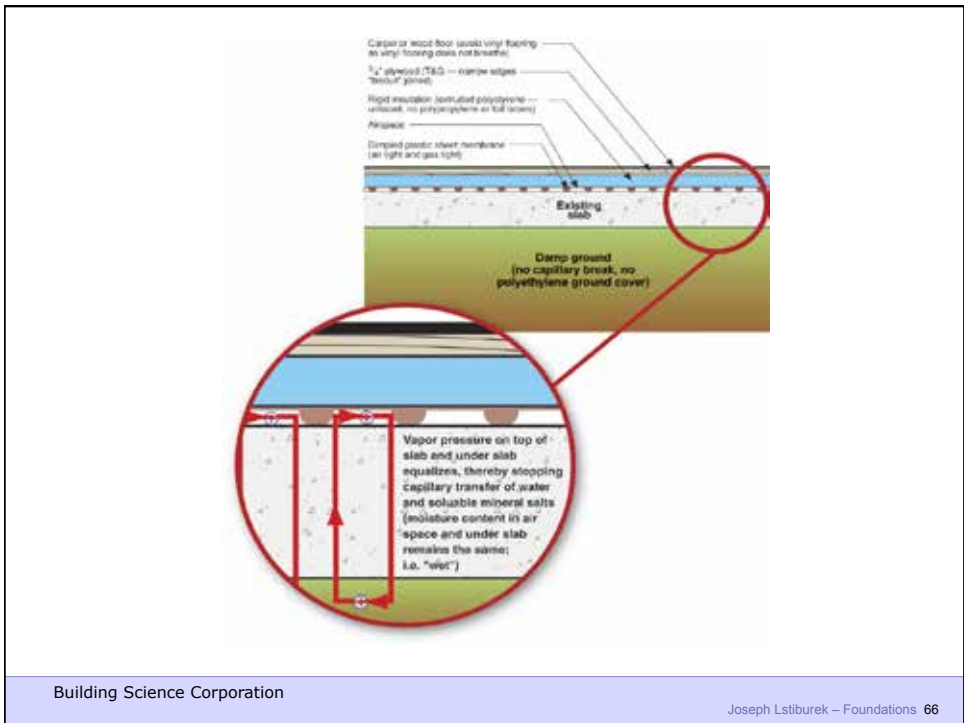
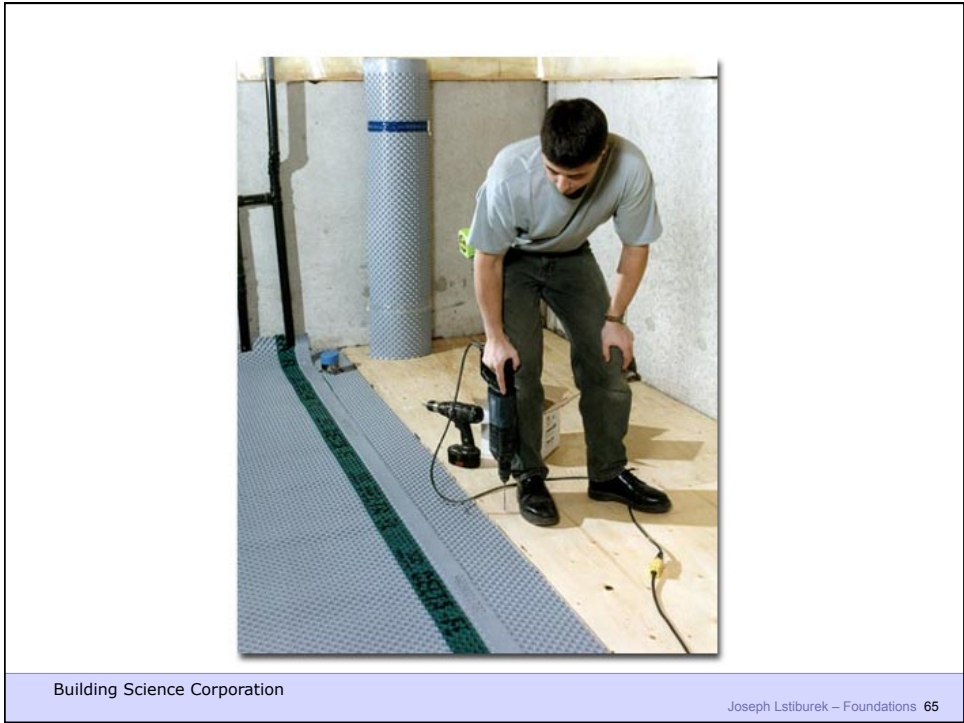
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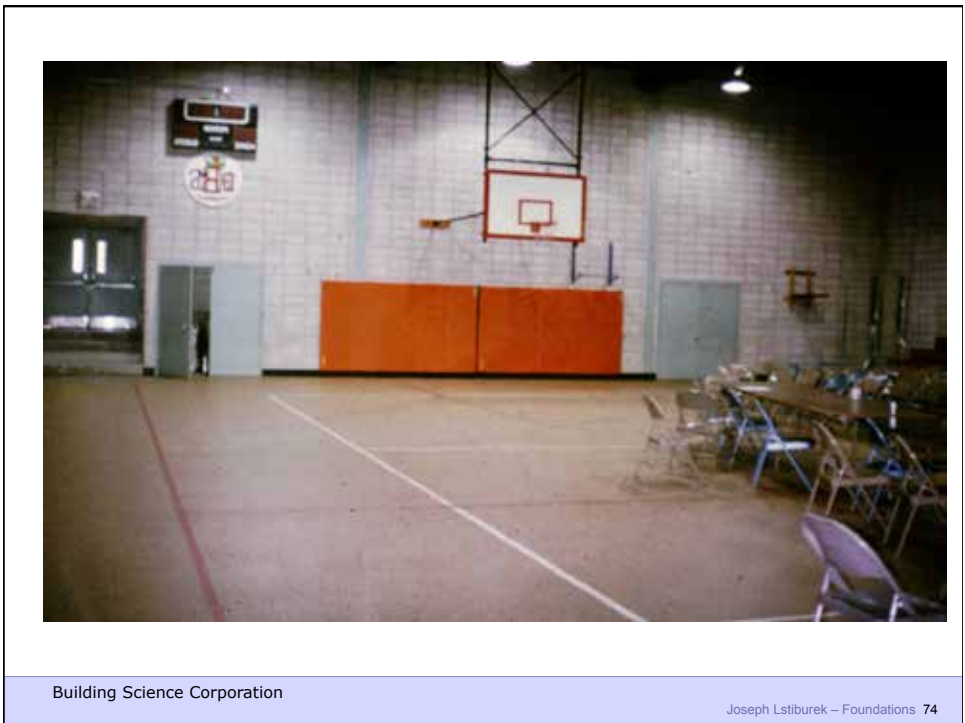
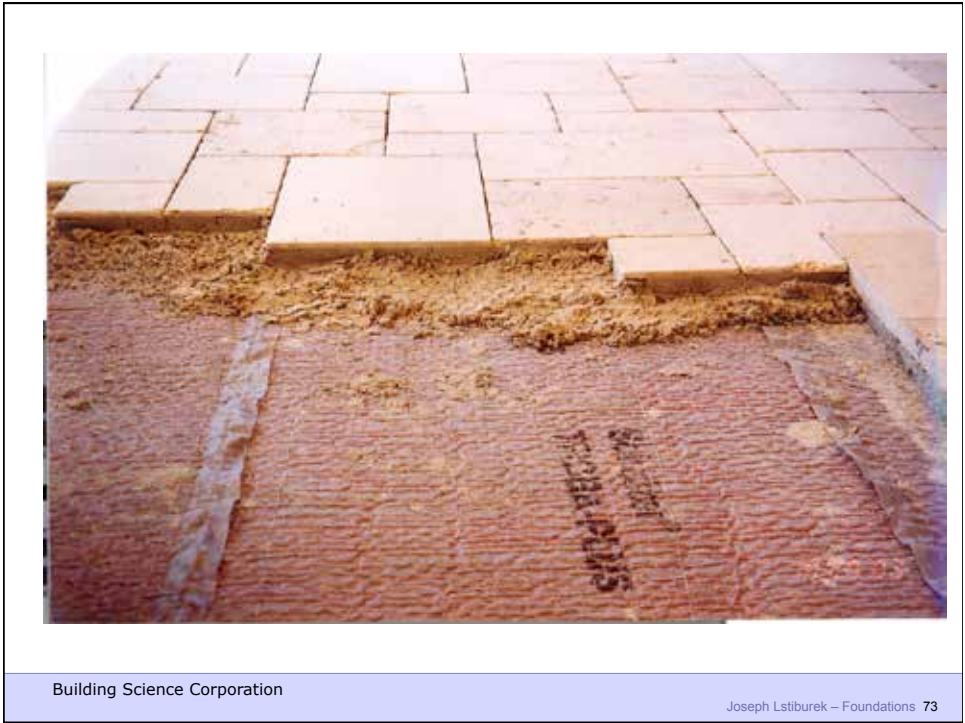
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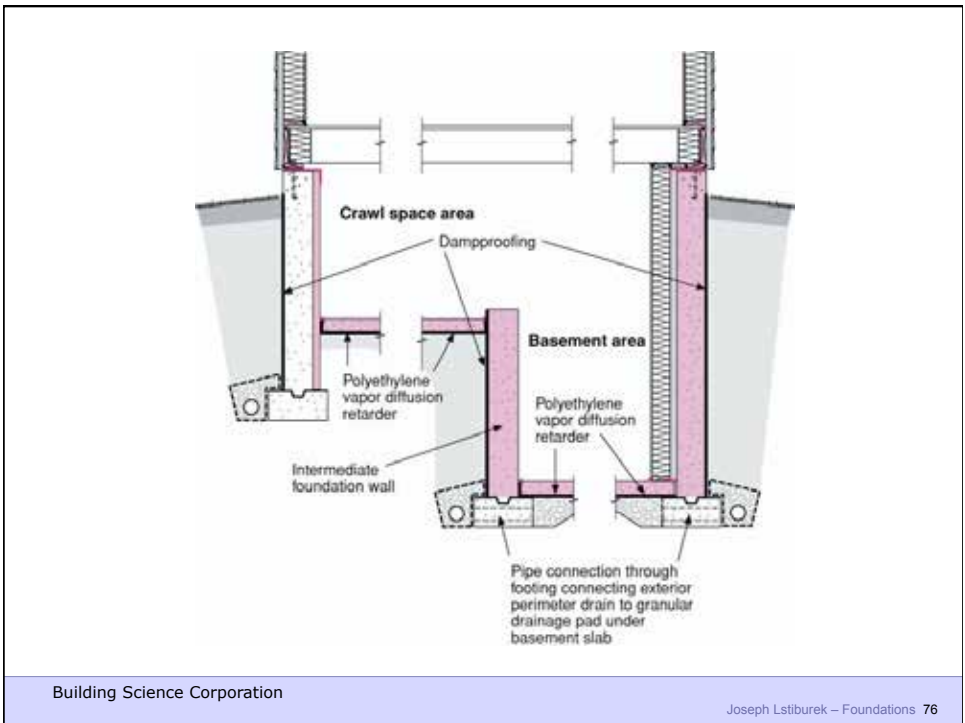


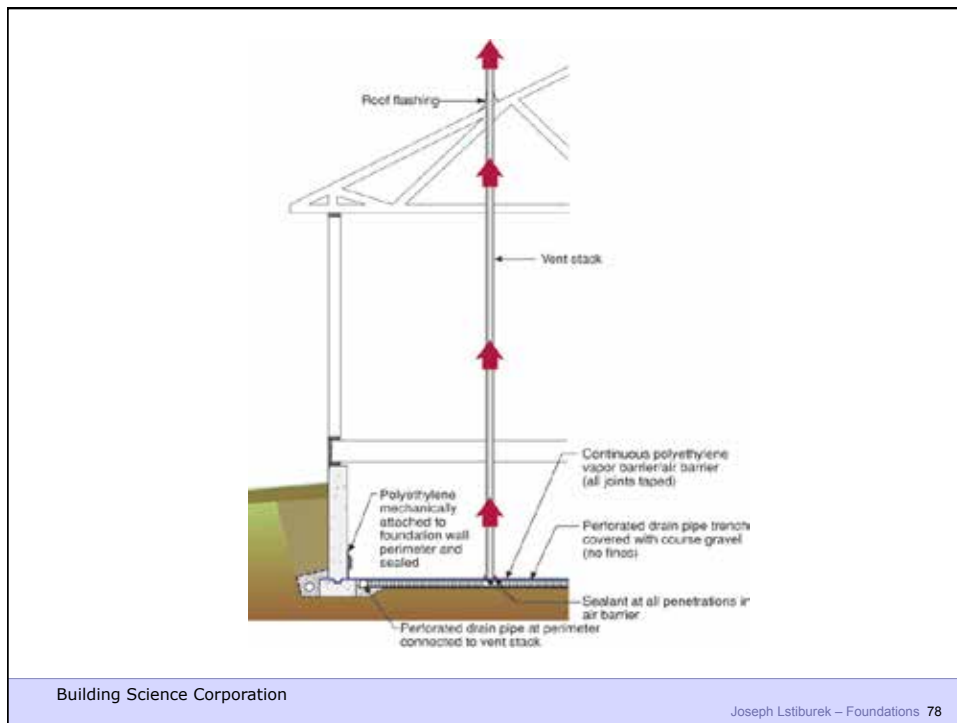
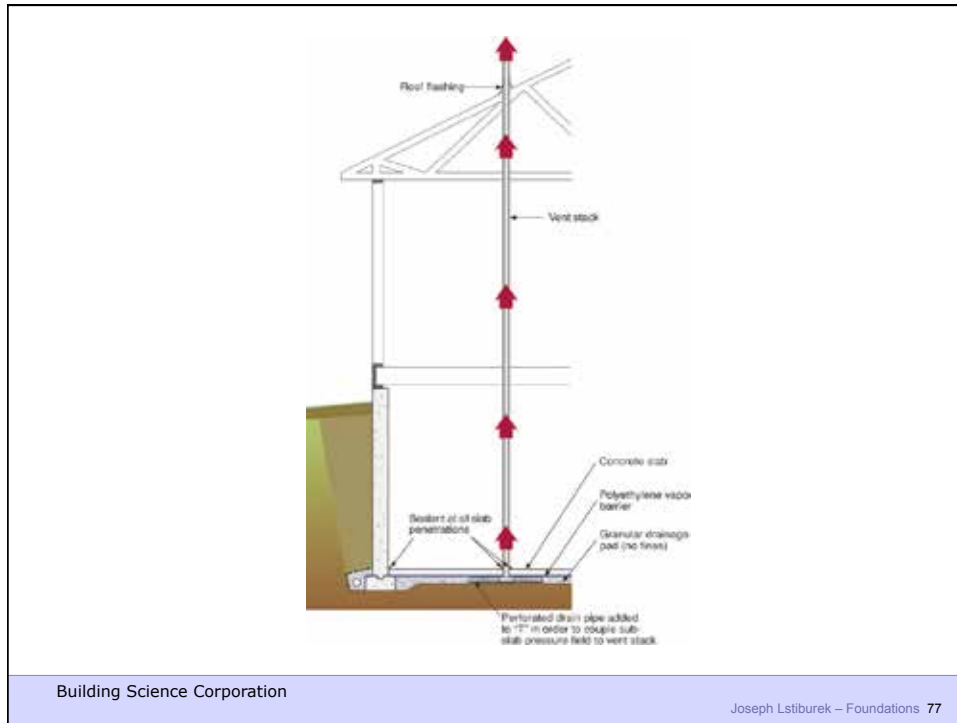
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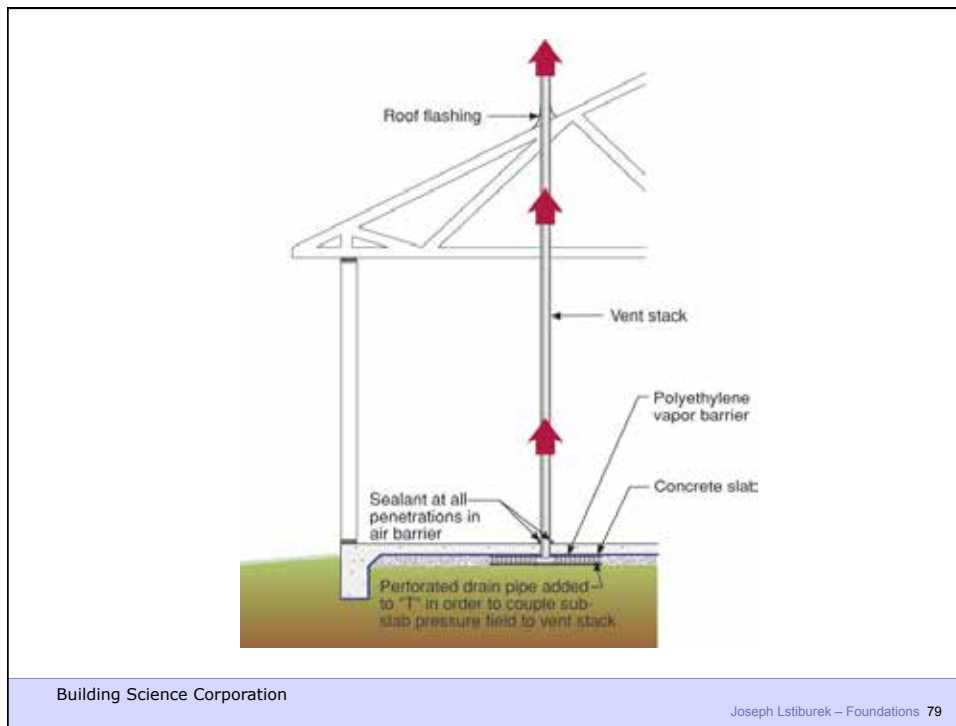
















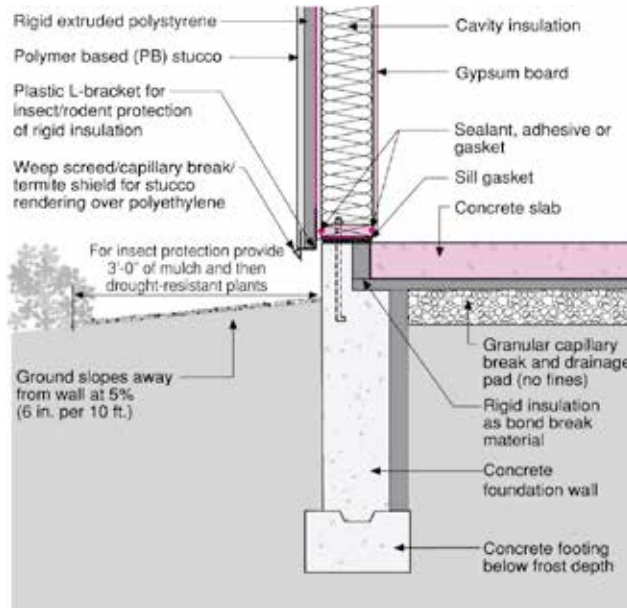
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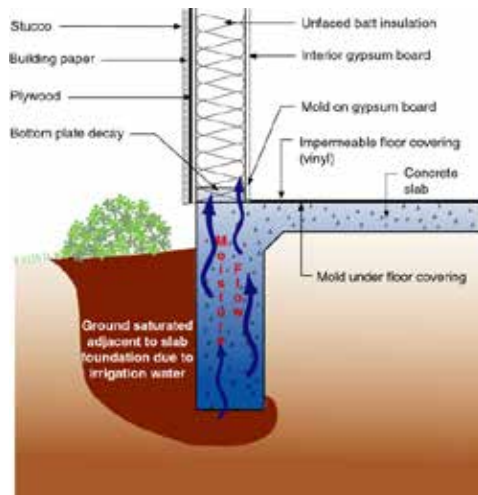


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Capillary Moisture Flow



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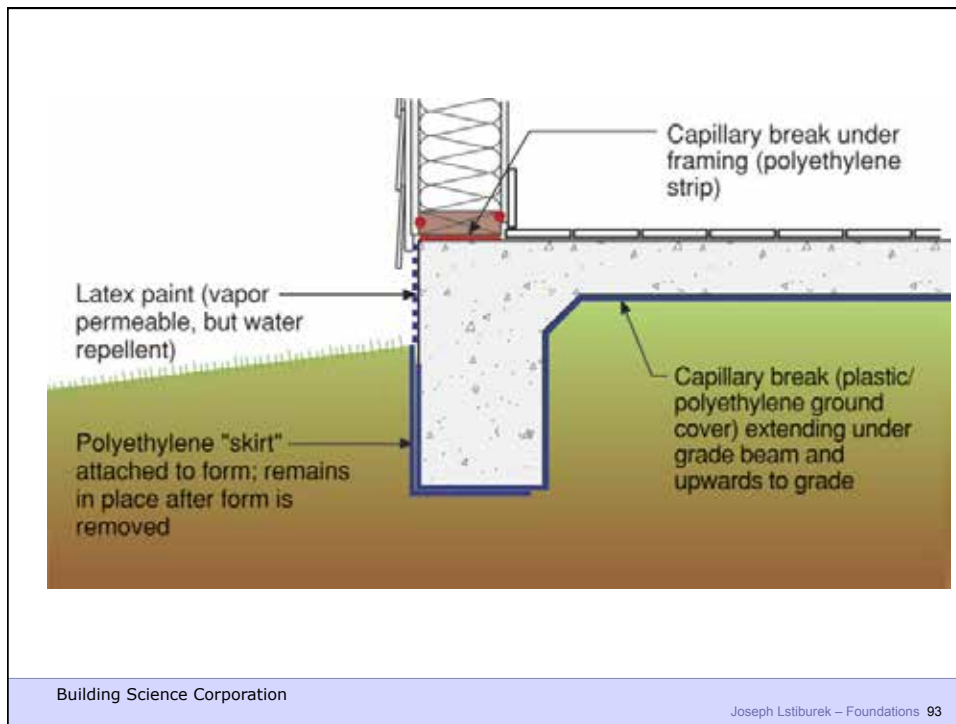
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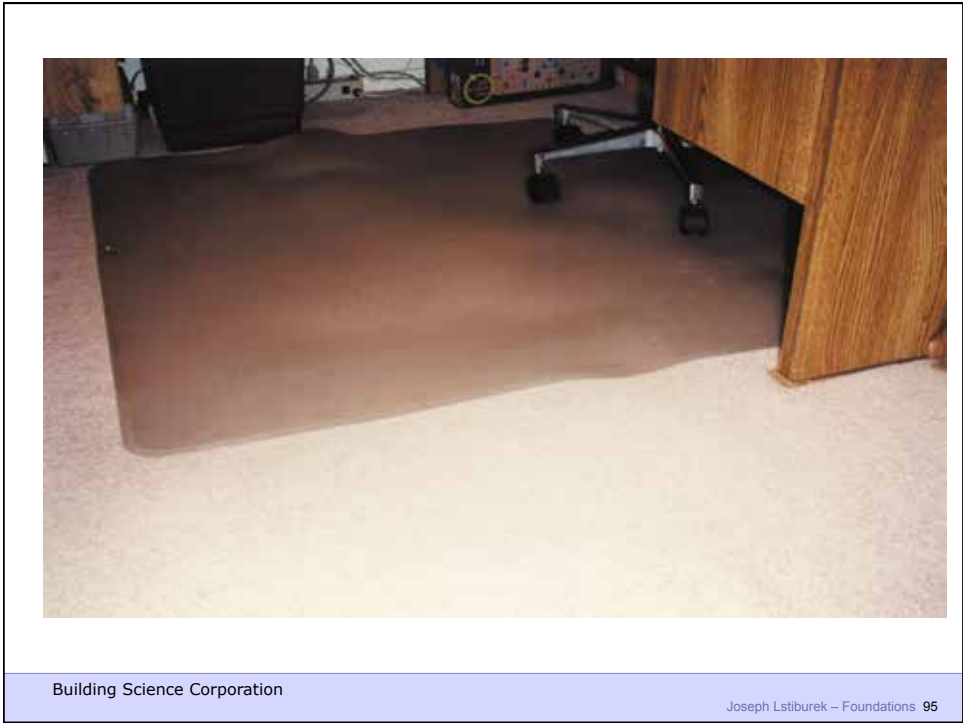
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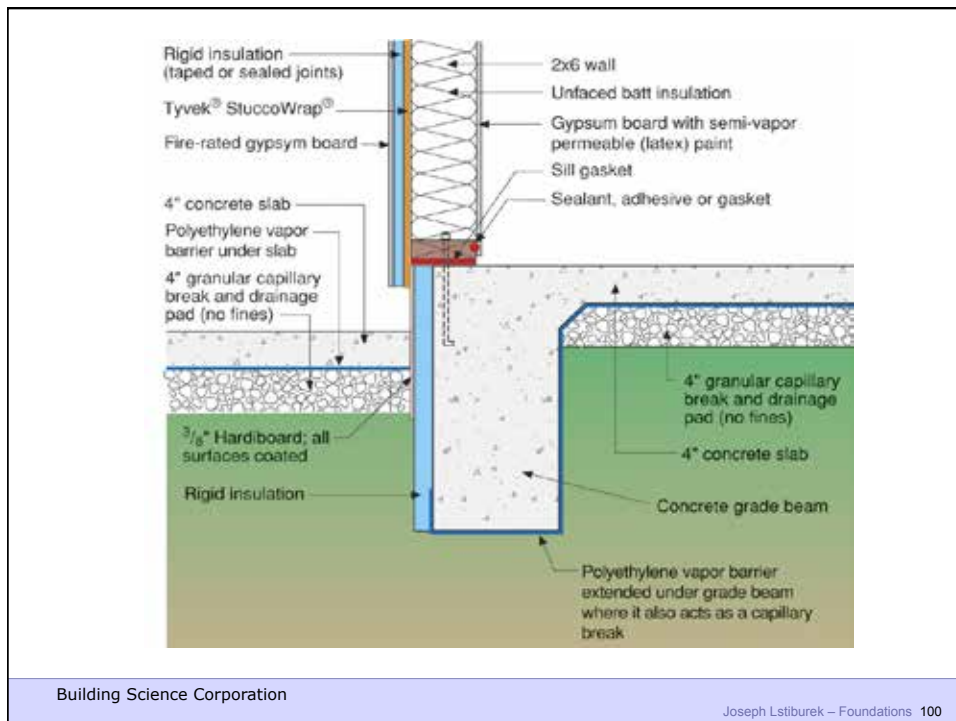
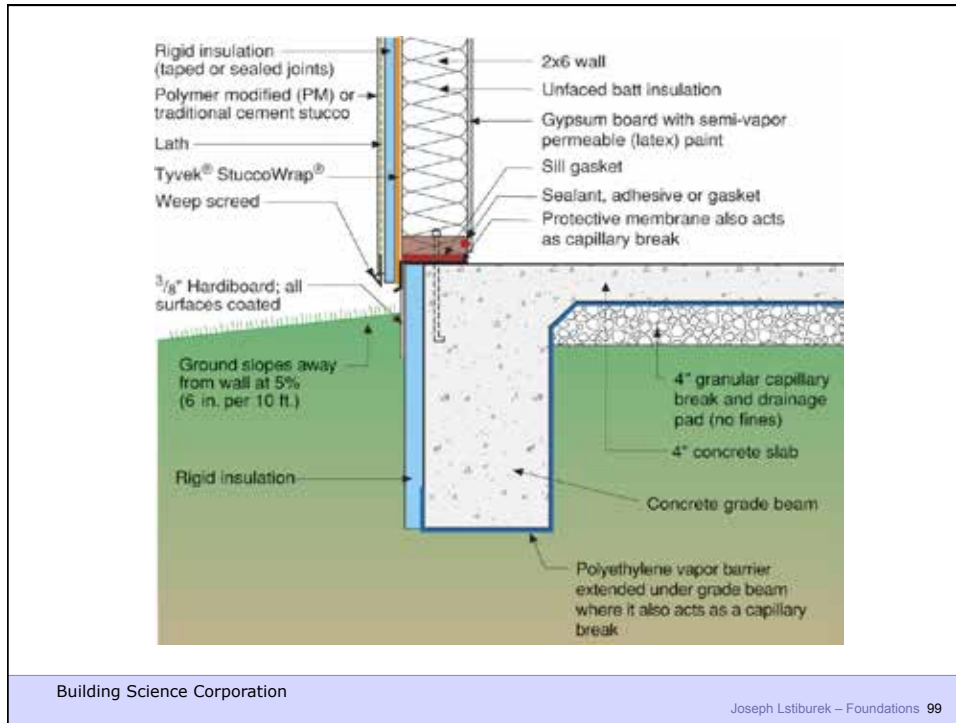




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