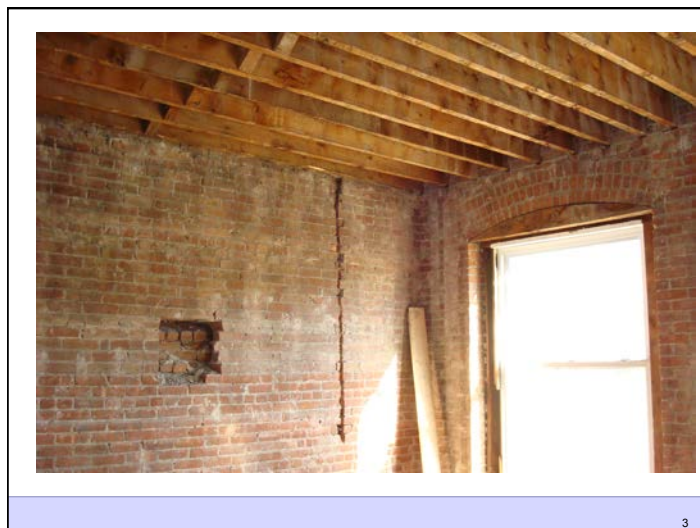


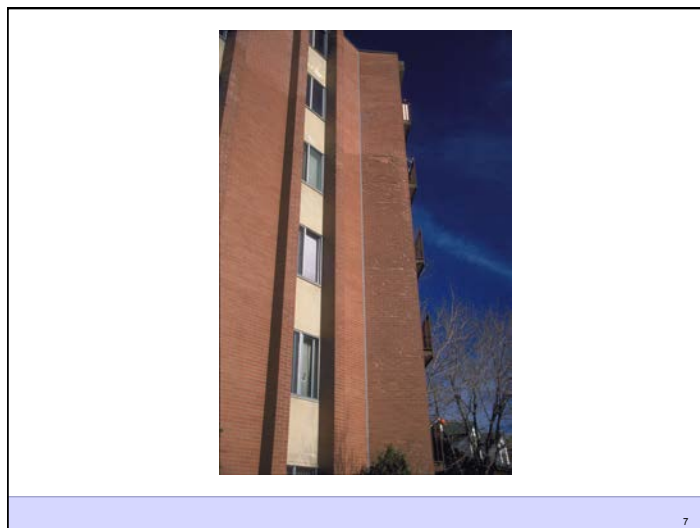
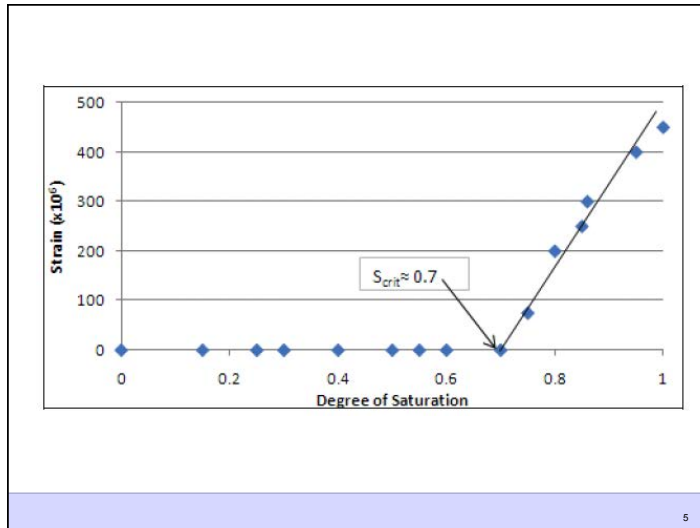
Joseph Lstiburek, Ph.D., P.Eng, ASHRAE Fellow

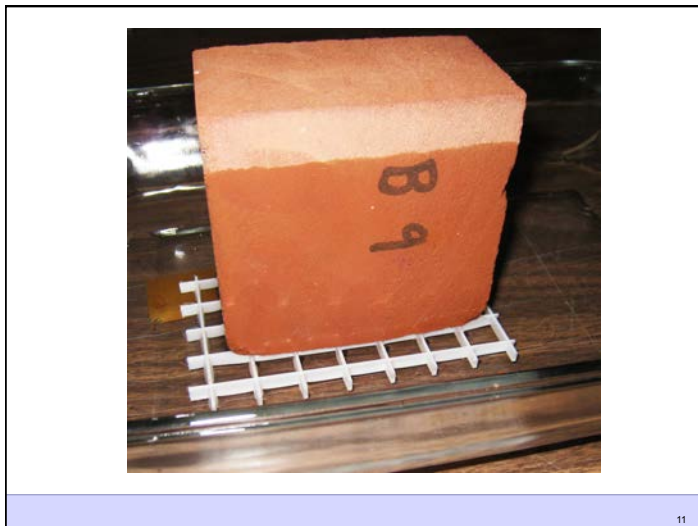
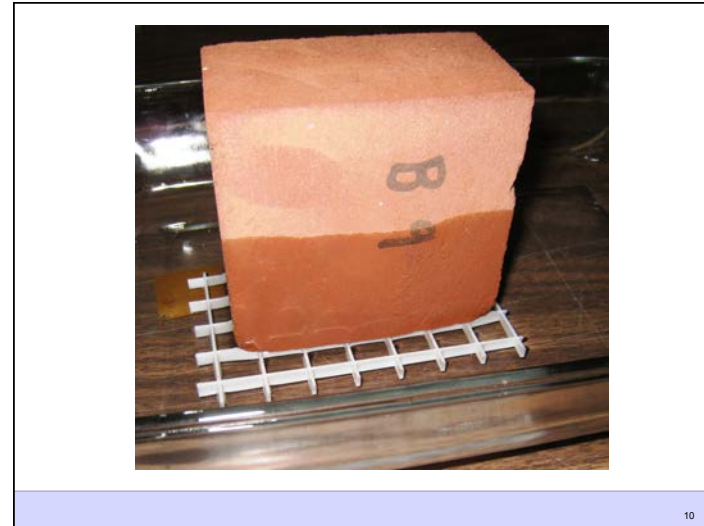
Building Science

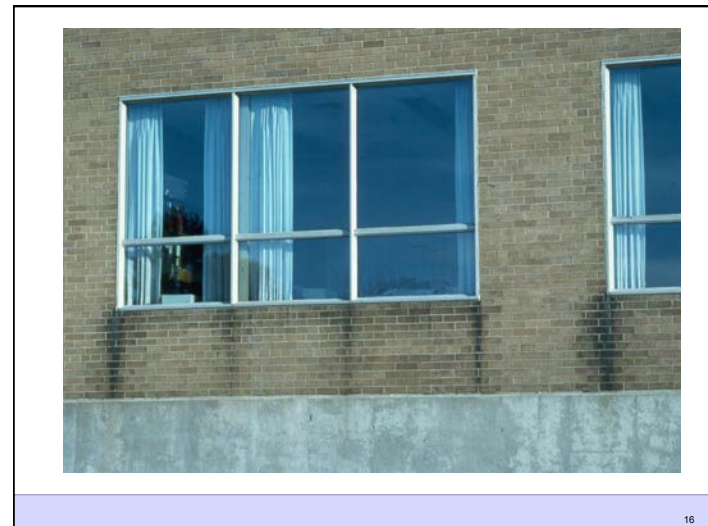
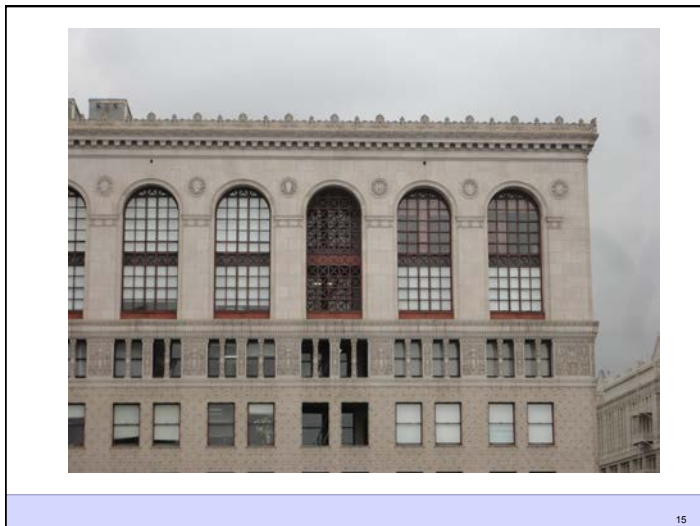
Insulating Mass Assemblies

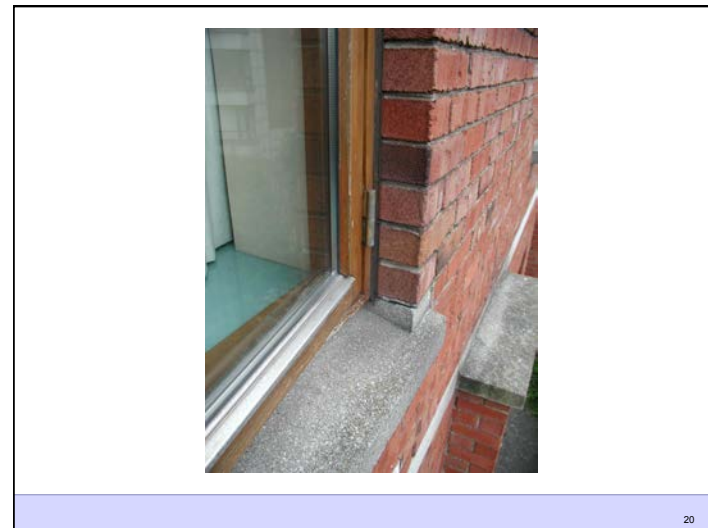
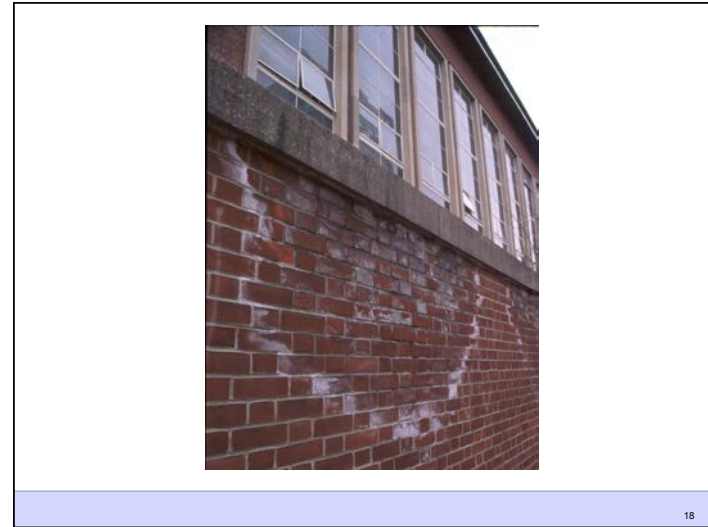
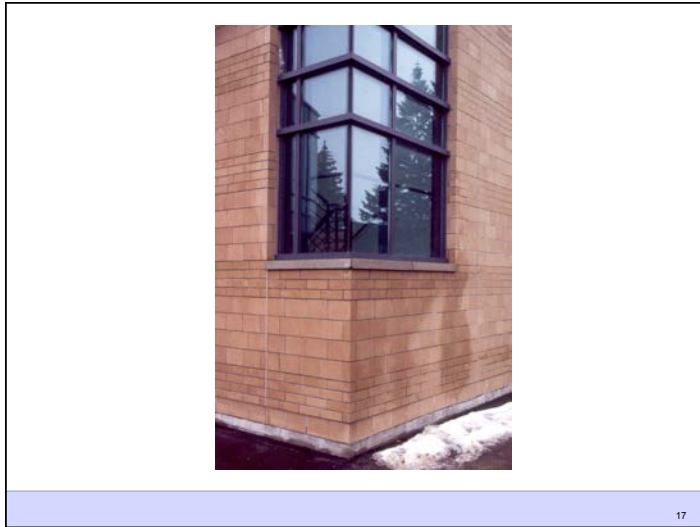
www.buildingscience.com

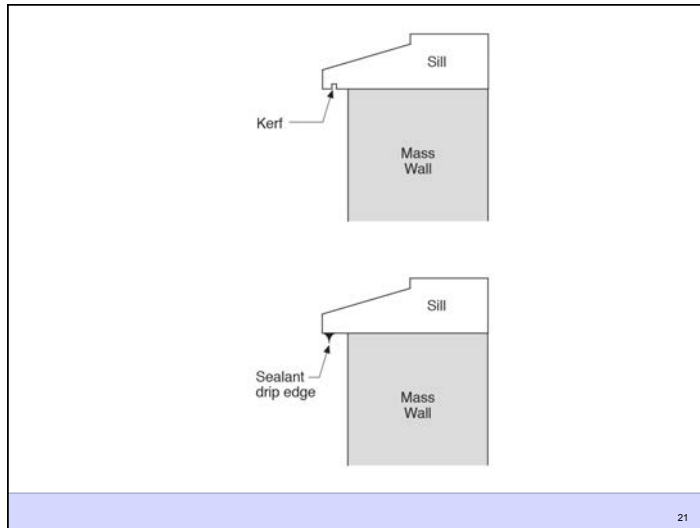








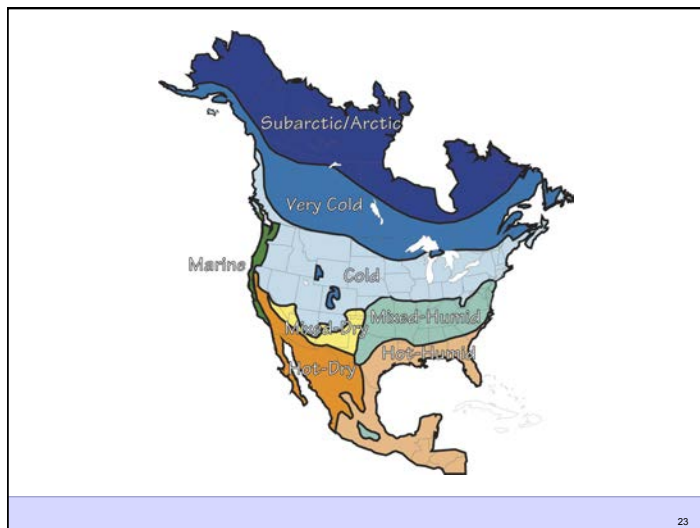




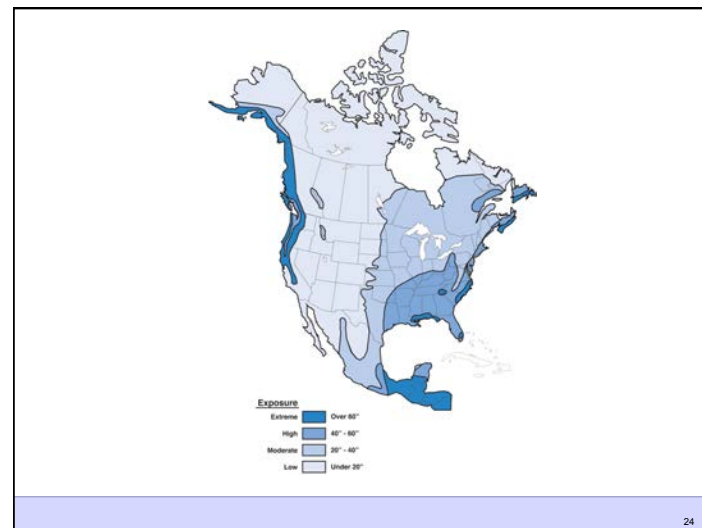
21



22



23

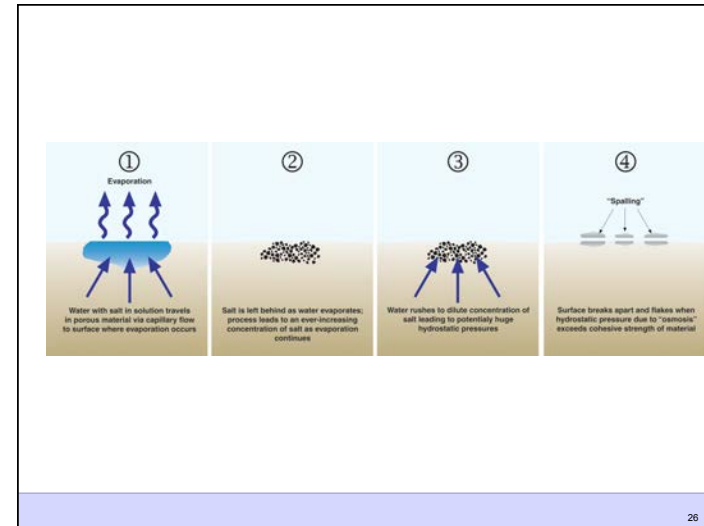


24

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

25



26

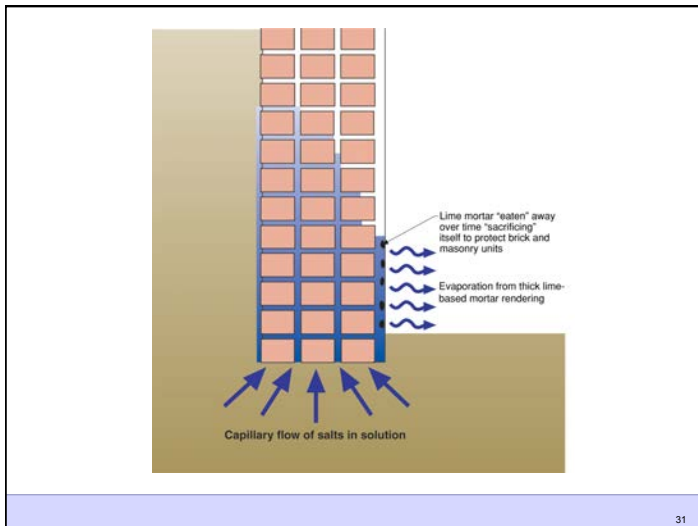
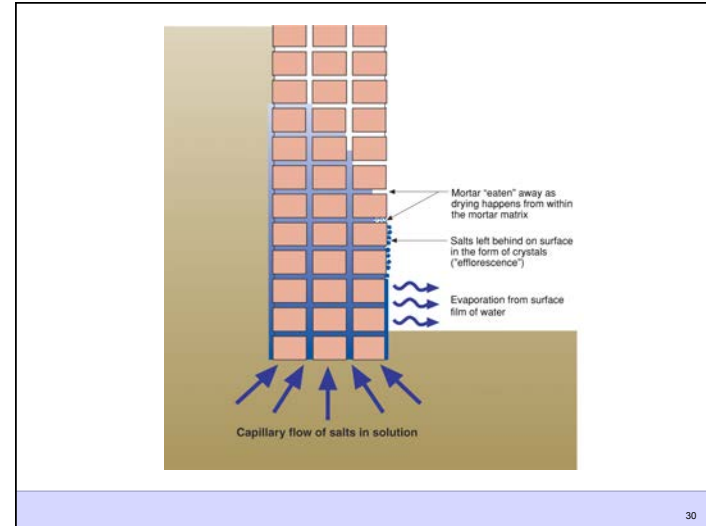
Diffusion + Capillarity + Osmosis = Problem

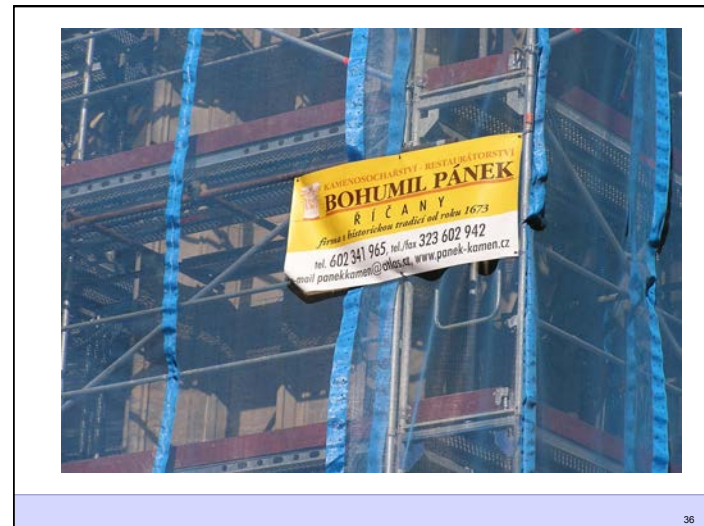
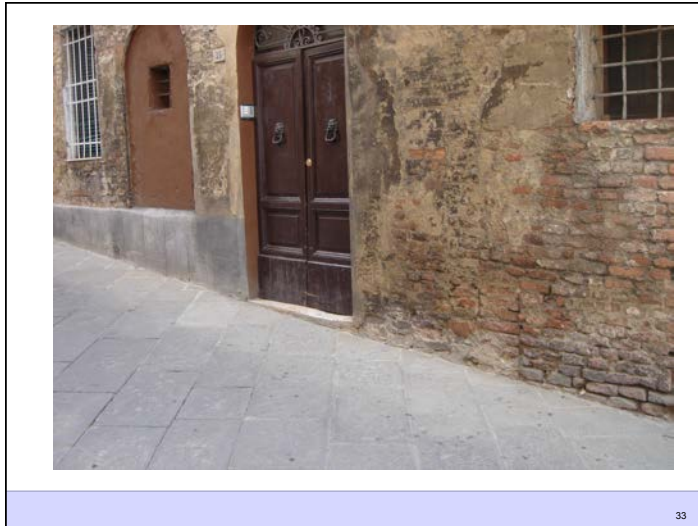
- Diffusion Vapor Pressure 3 to 5 psi
- Capillary Pressure 300 to 500 psi
- Osmosis Pressure 3,000 to 5,000 psi

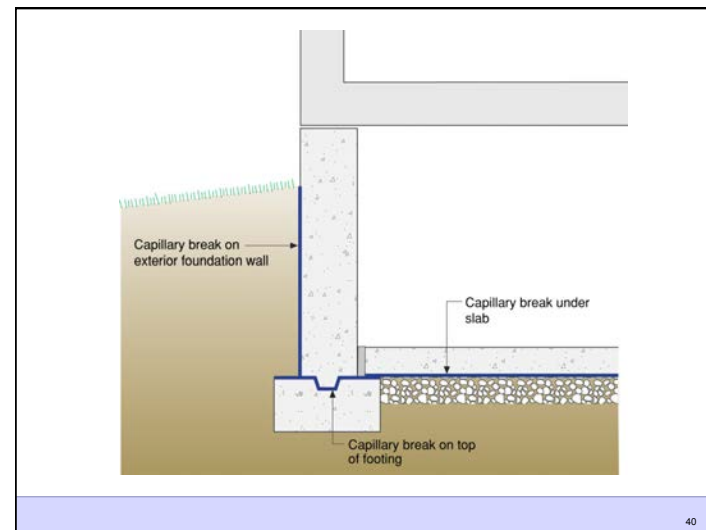
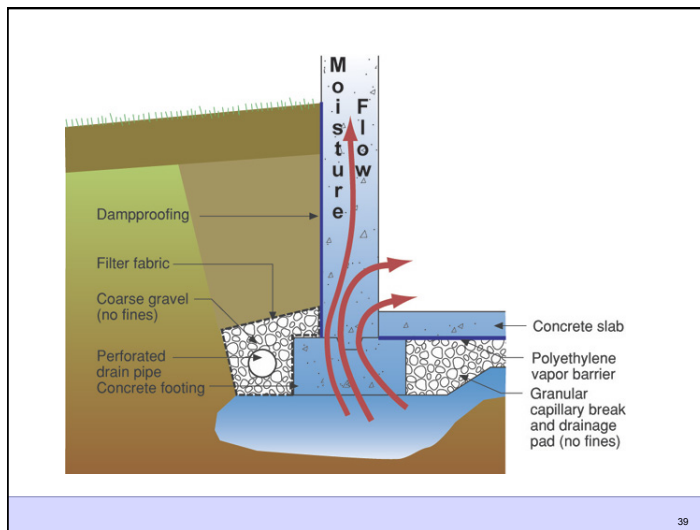
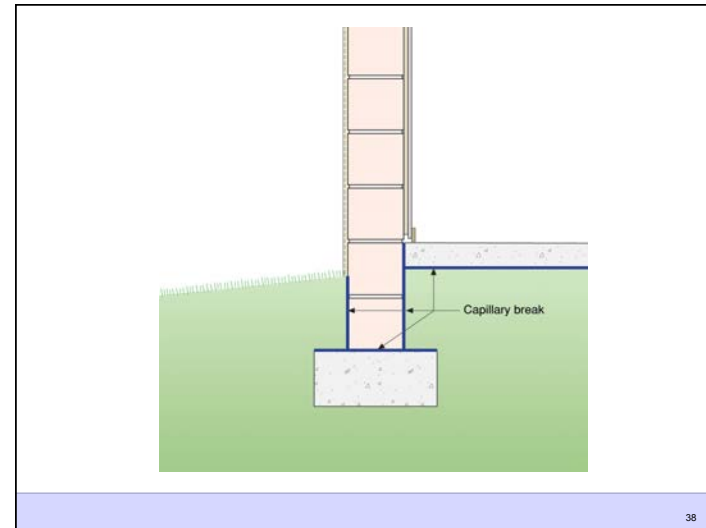
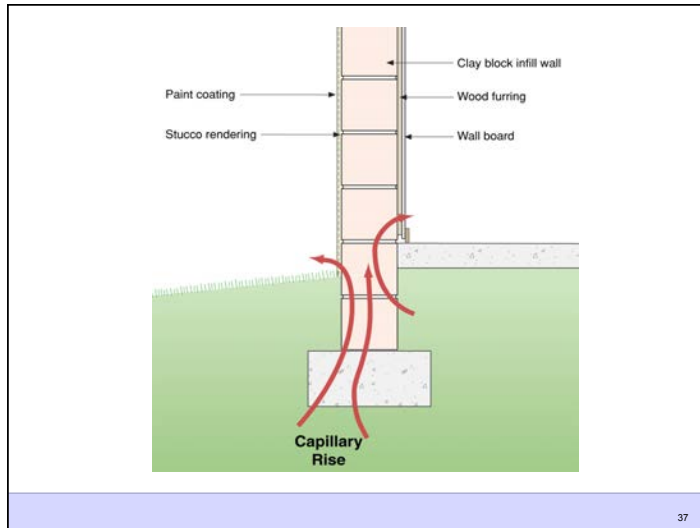
27

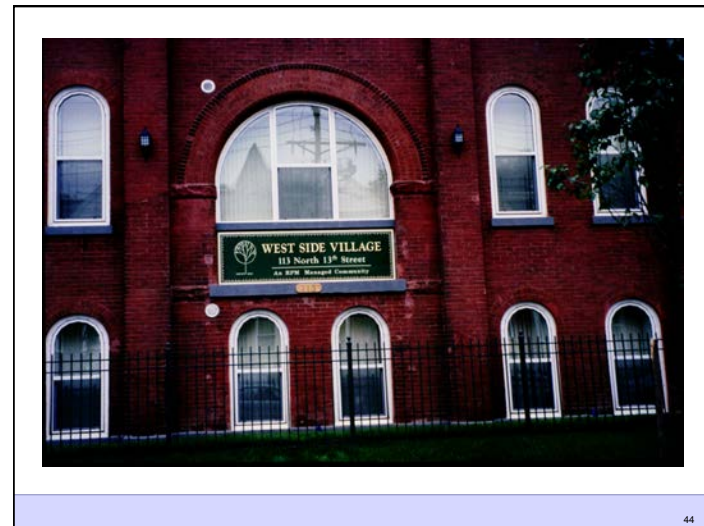
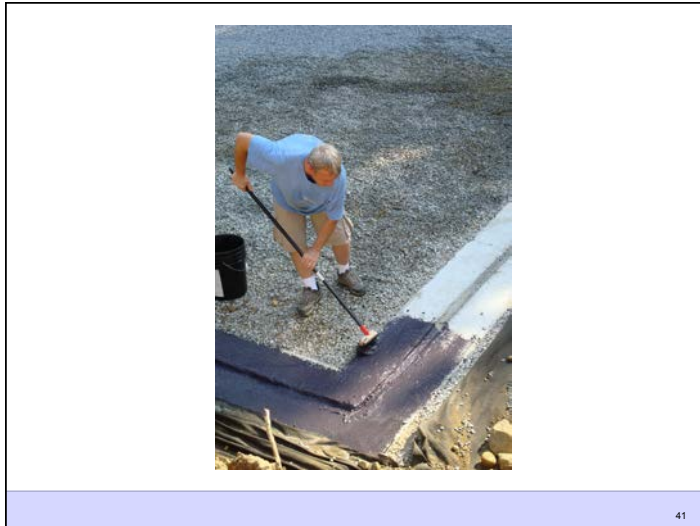


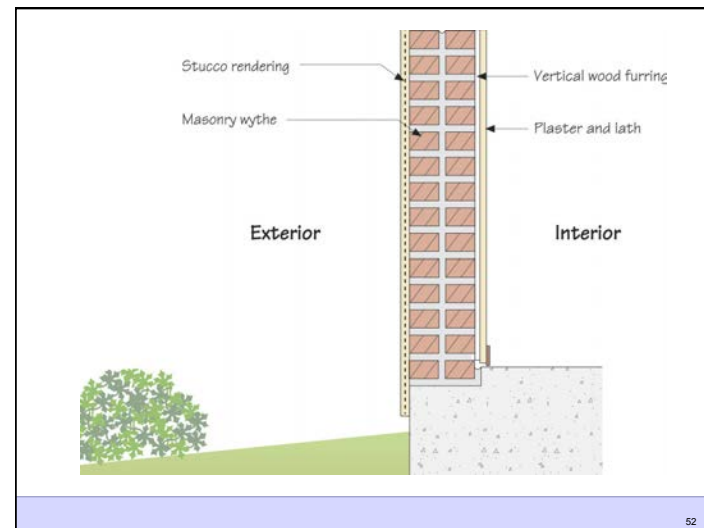
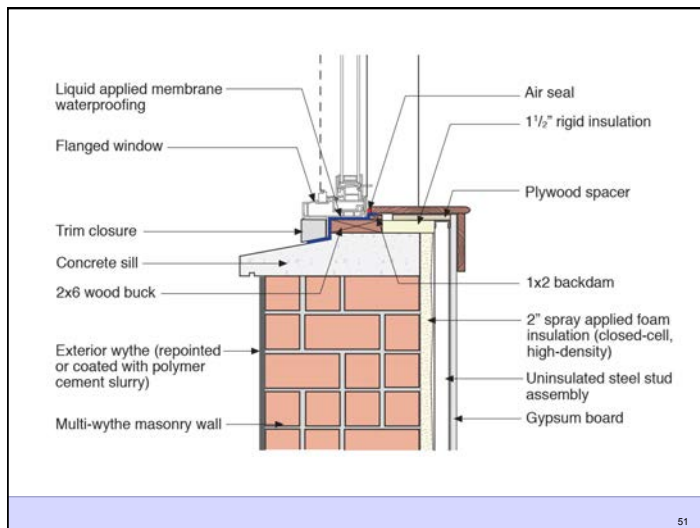
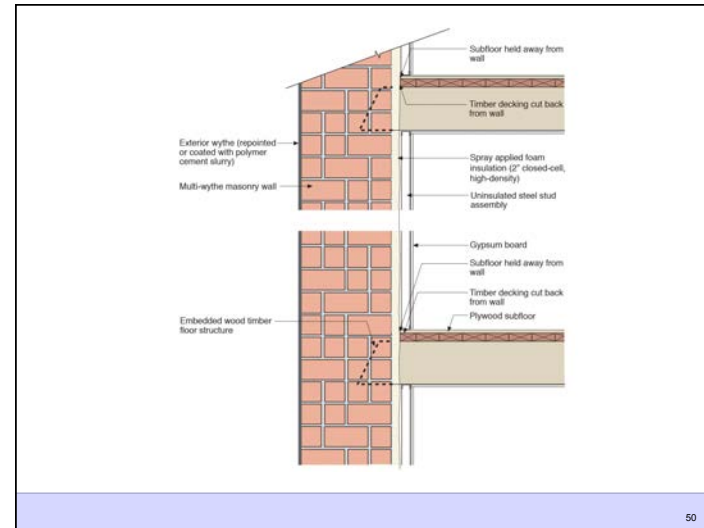
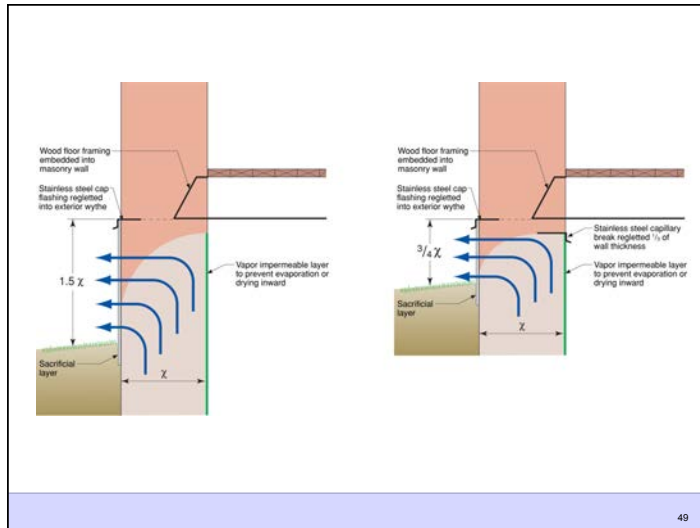
28

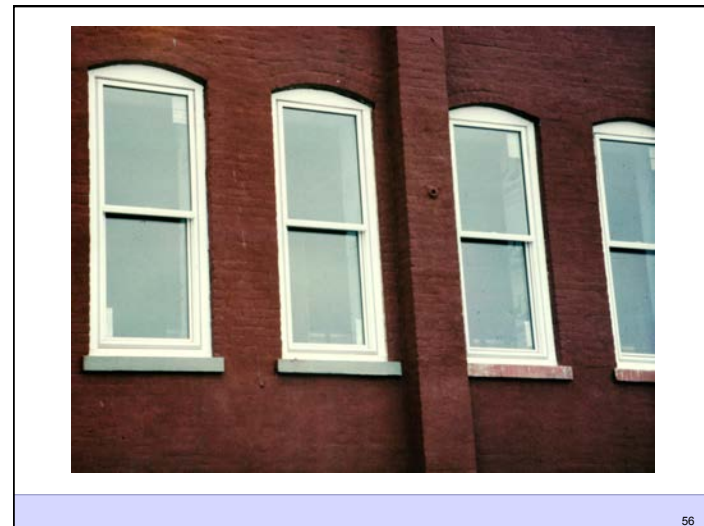
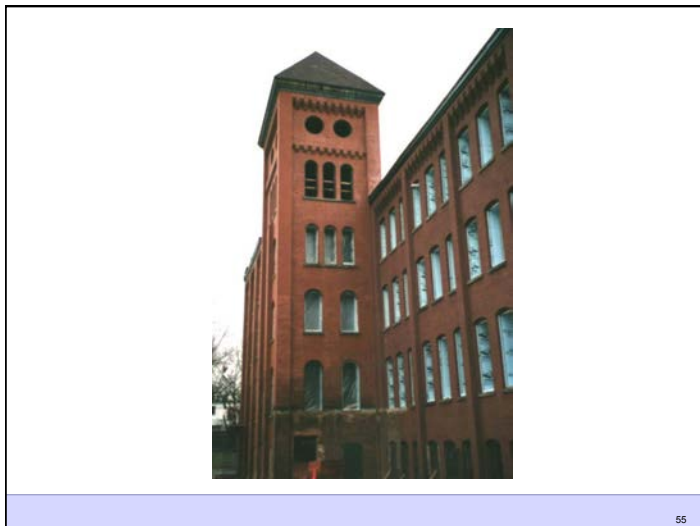
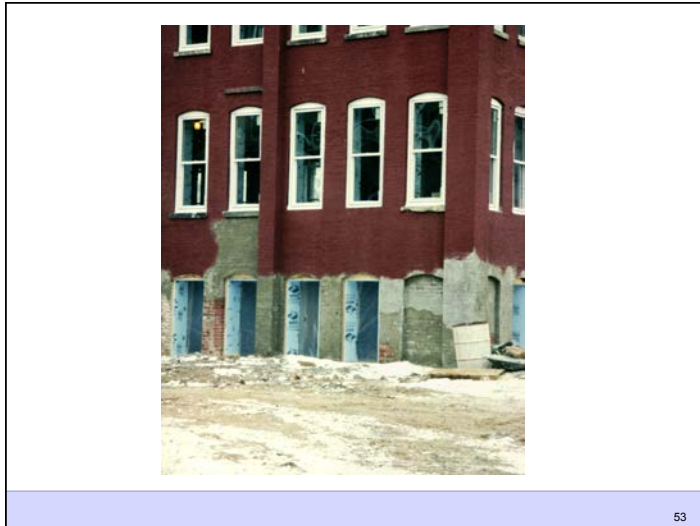


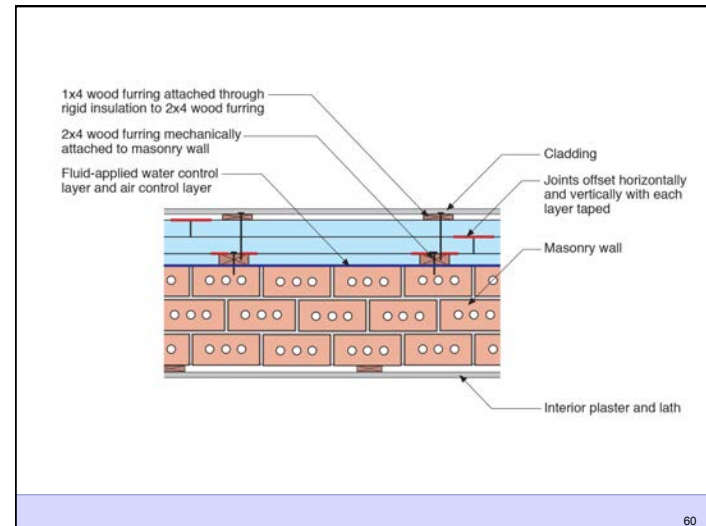
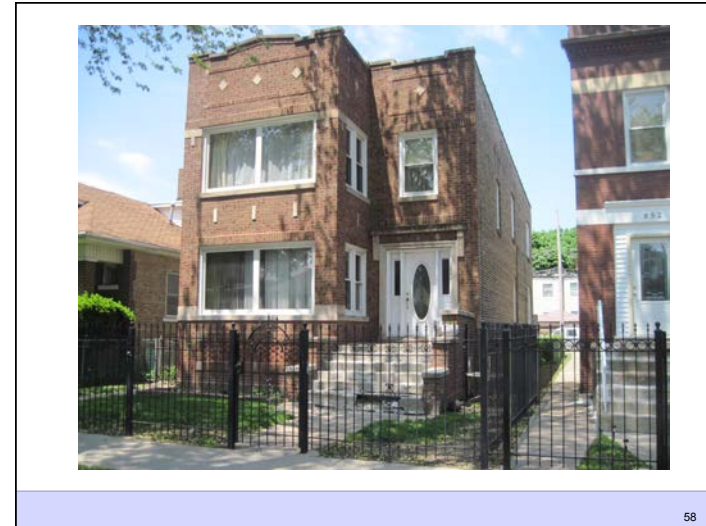
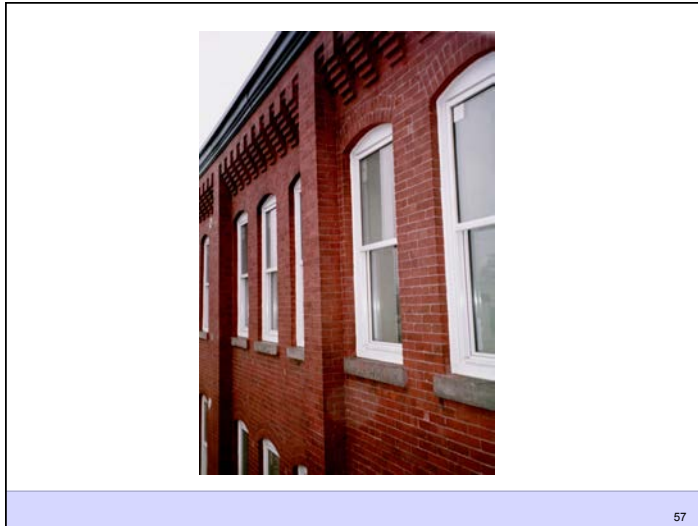






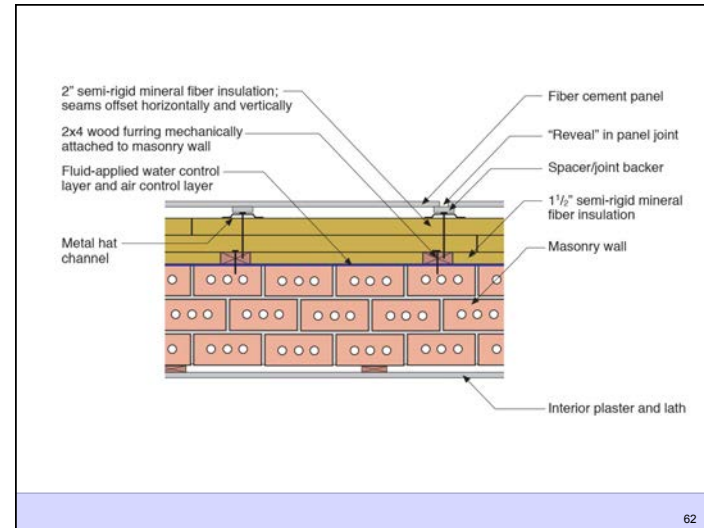




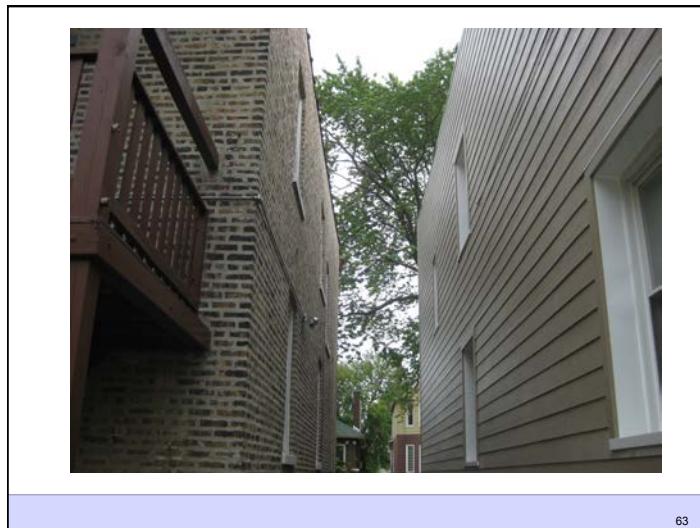




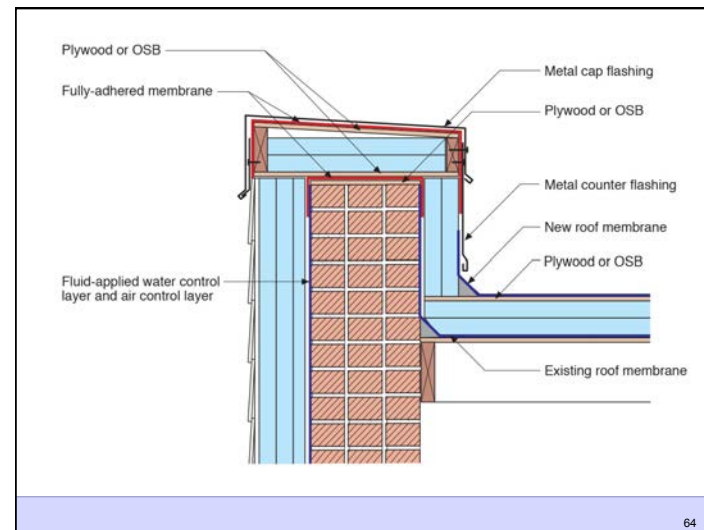
61



62



63



64

