

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

# Building Science

Adventures In Building Science

[www.buildingscience.com](http://www.buildingscience.com)

## What is a Building?

Building Science Corporation

Joseph Lstiburek 2

## A Building is an Environmental Separator

Building Science Corporation

Joseph Lstiburek 3

- 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

Building Science Corporation

Joseph Lstiburek 4

## 2<sup>nd</sup> Law of Thermodynamics

Building Science Corporation

Joseph Lstiburek 5

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

Rudolf Clausius

Building Science Corporation

Joseph Lstiburek 6

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

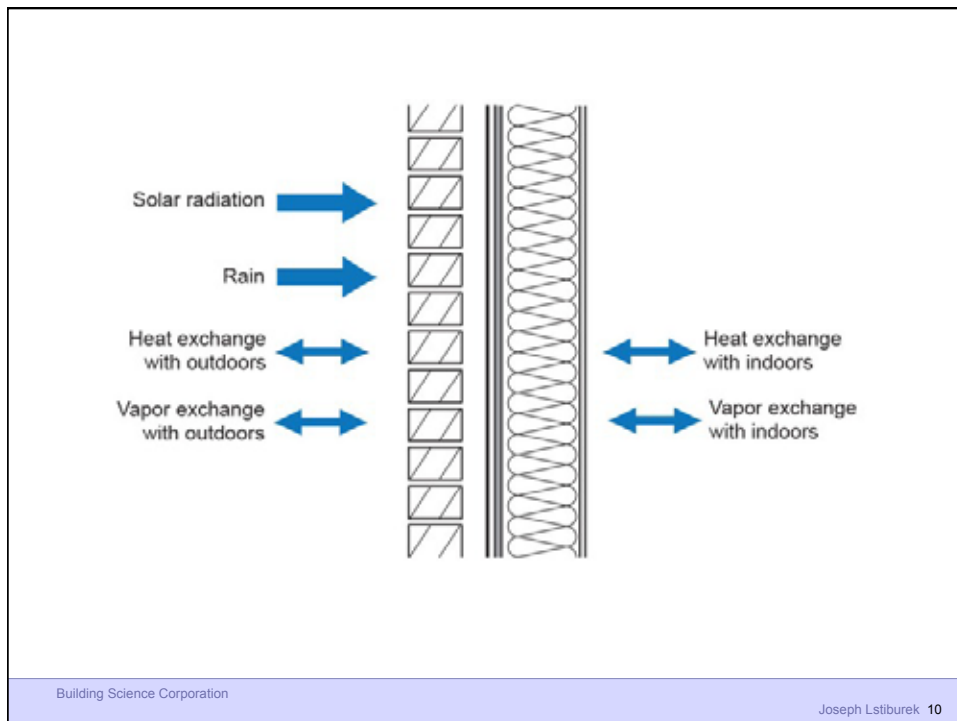
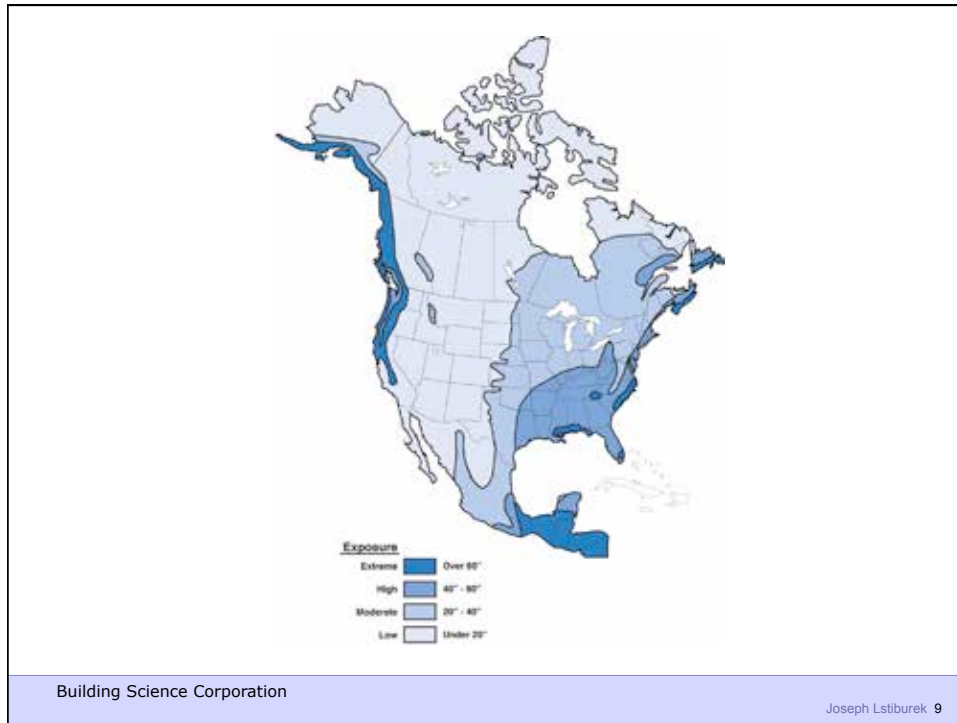
Building Science Corporation

Joseph Lstiburek 7

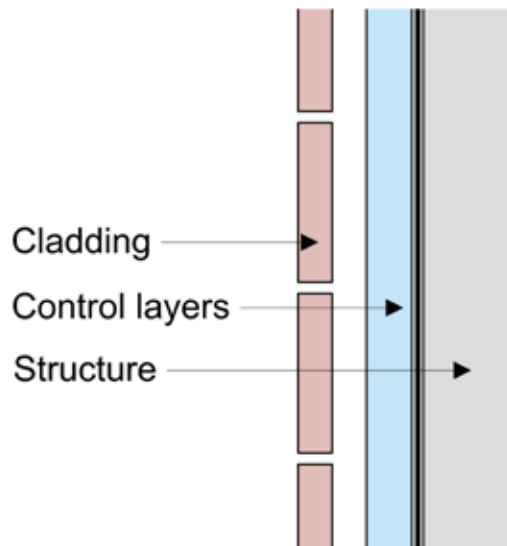


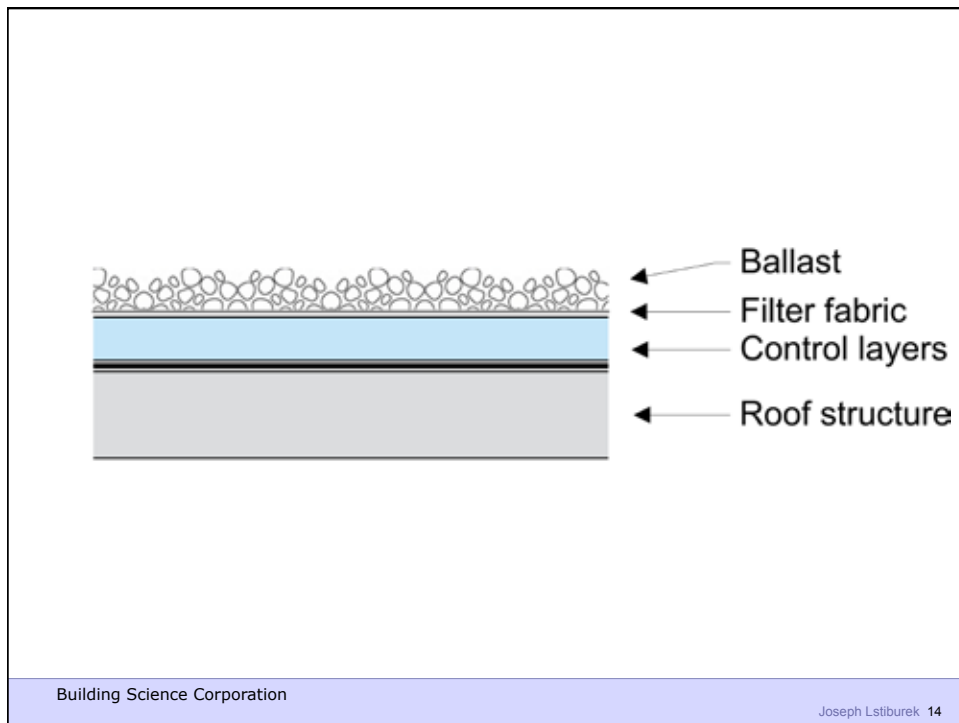
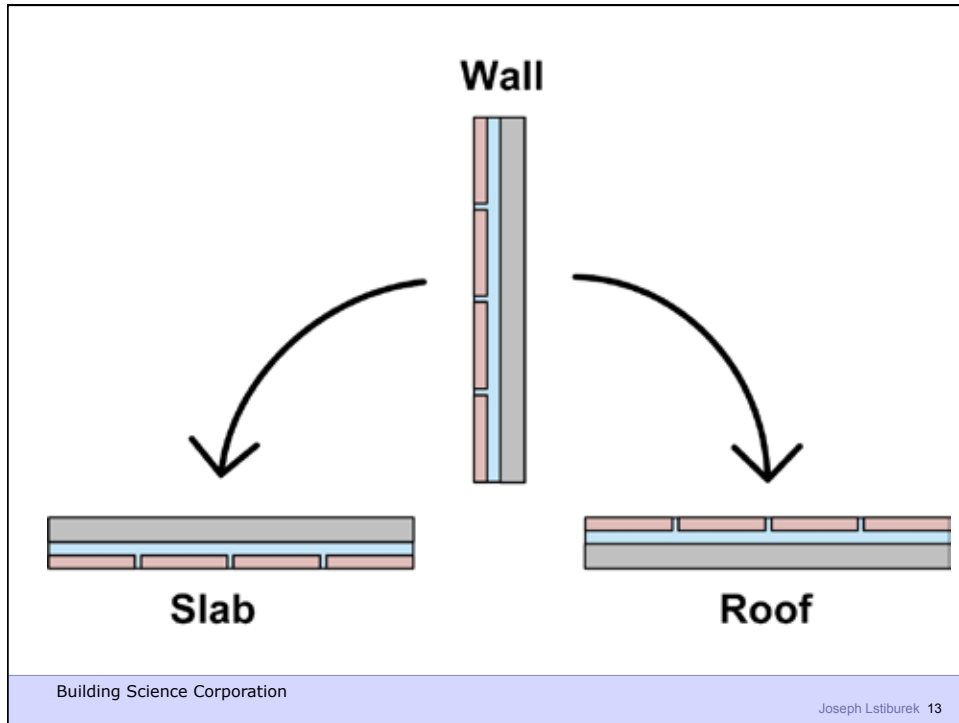
Building Science Corporation

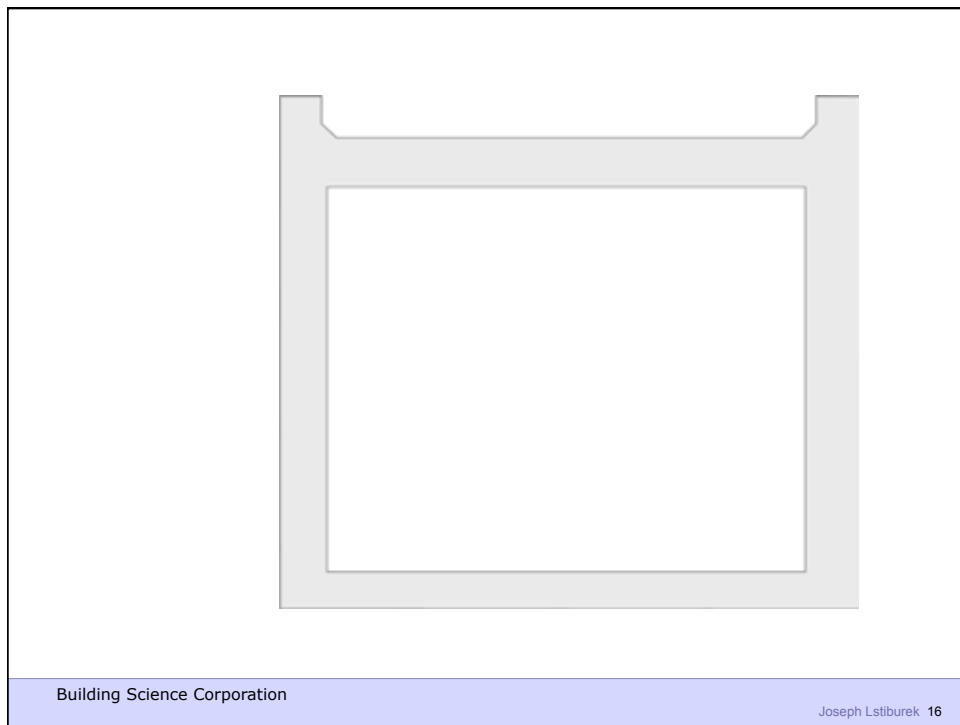
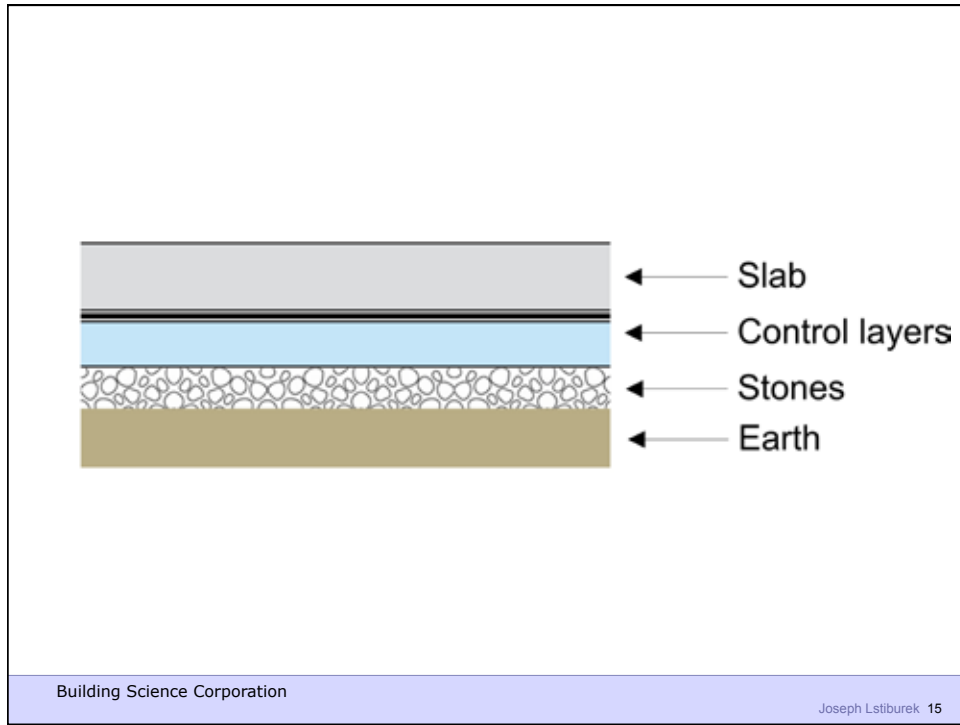
Joseph Lstiburek 8



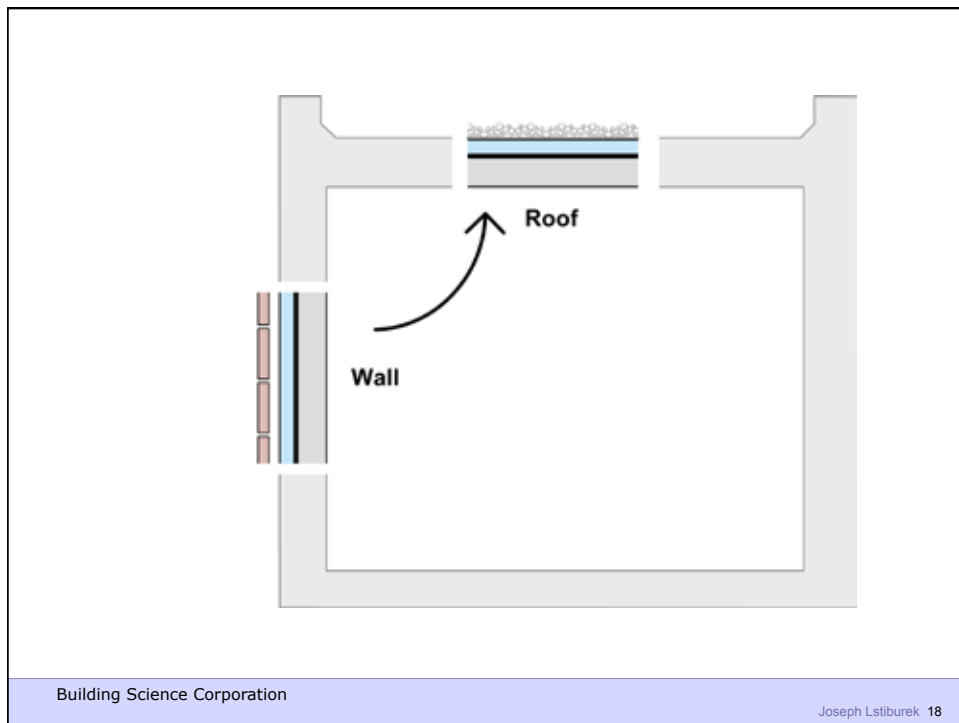
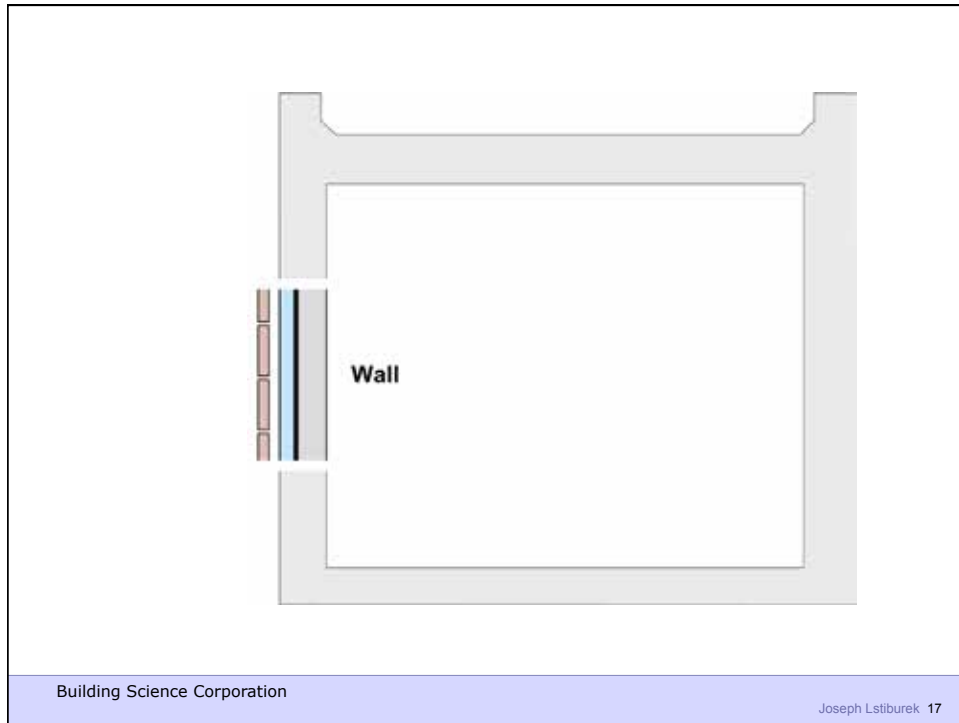
Water Control Layer  
Air Control Layer  
Vapor Control Layer  
Thermal Control Layer

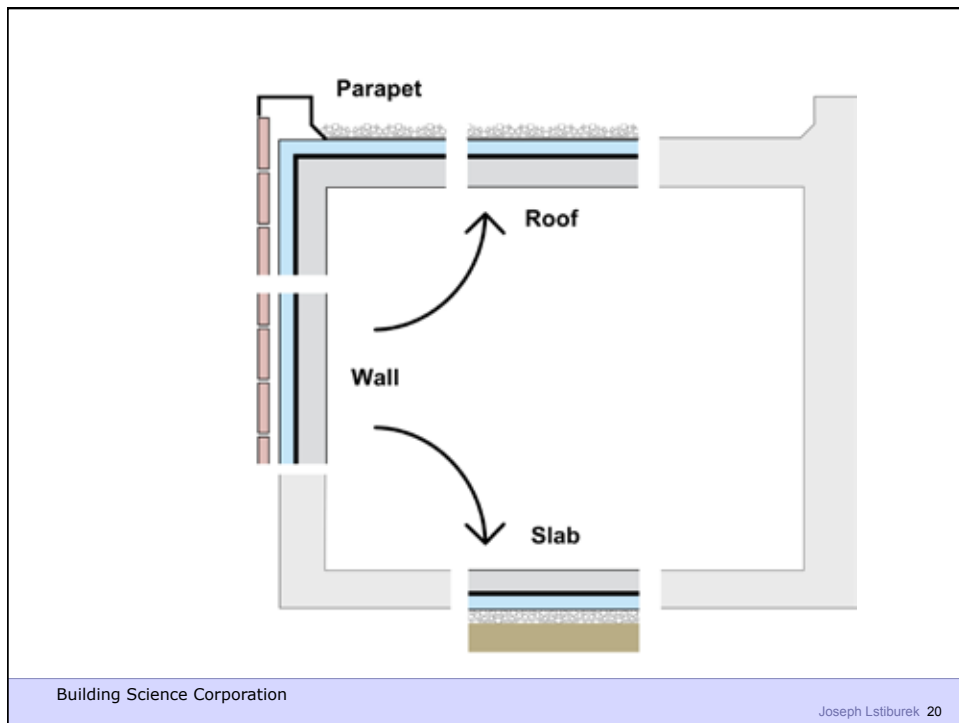
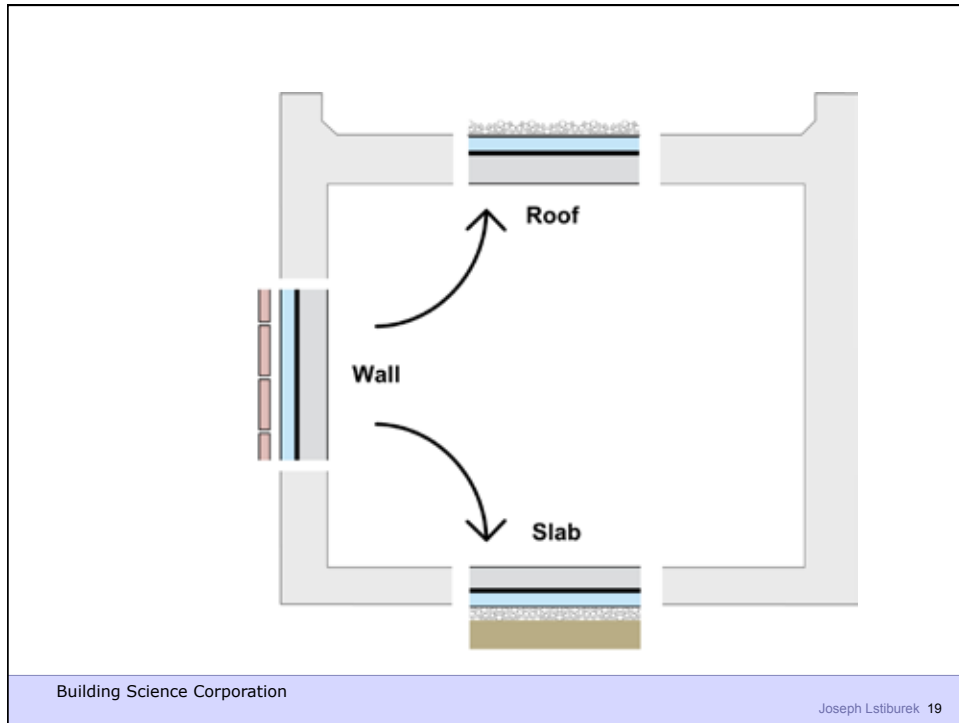


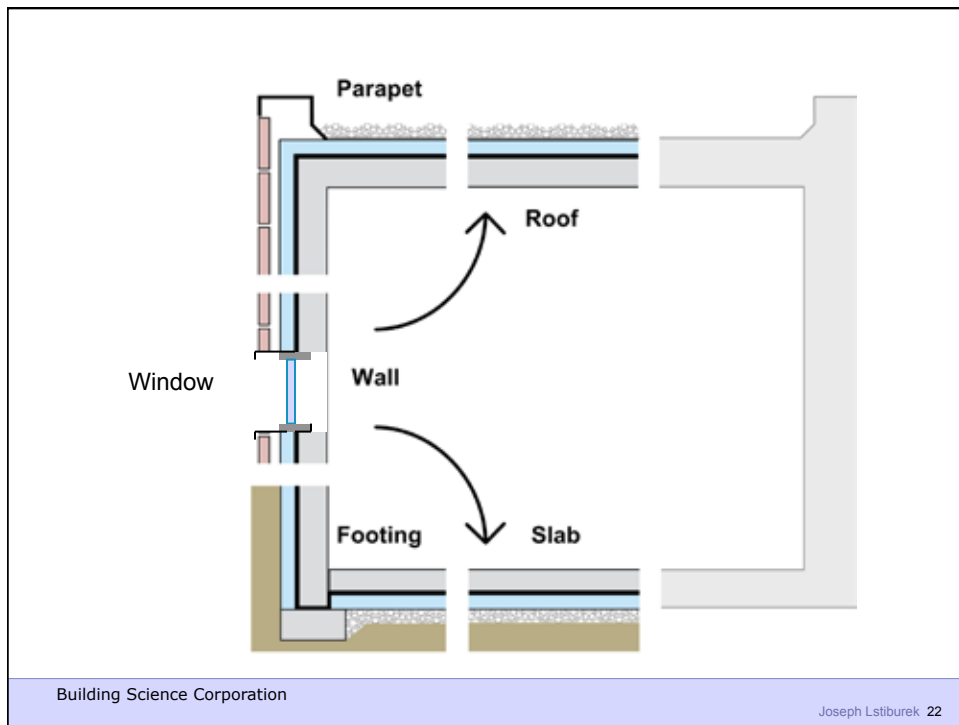
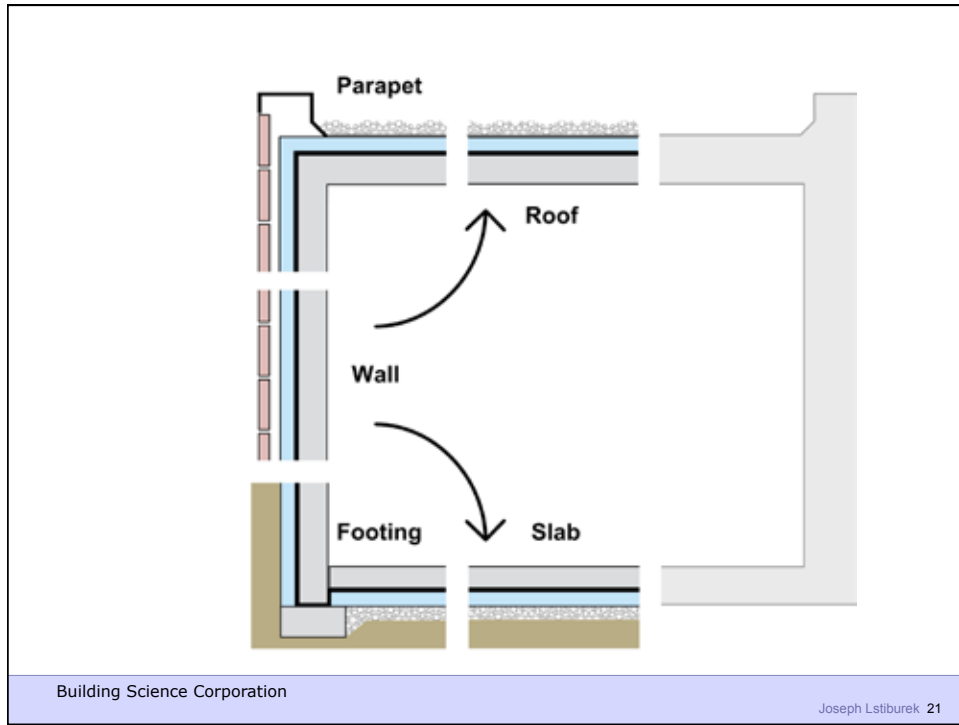


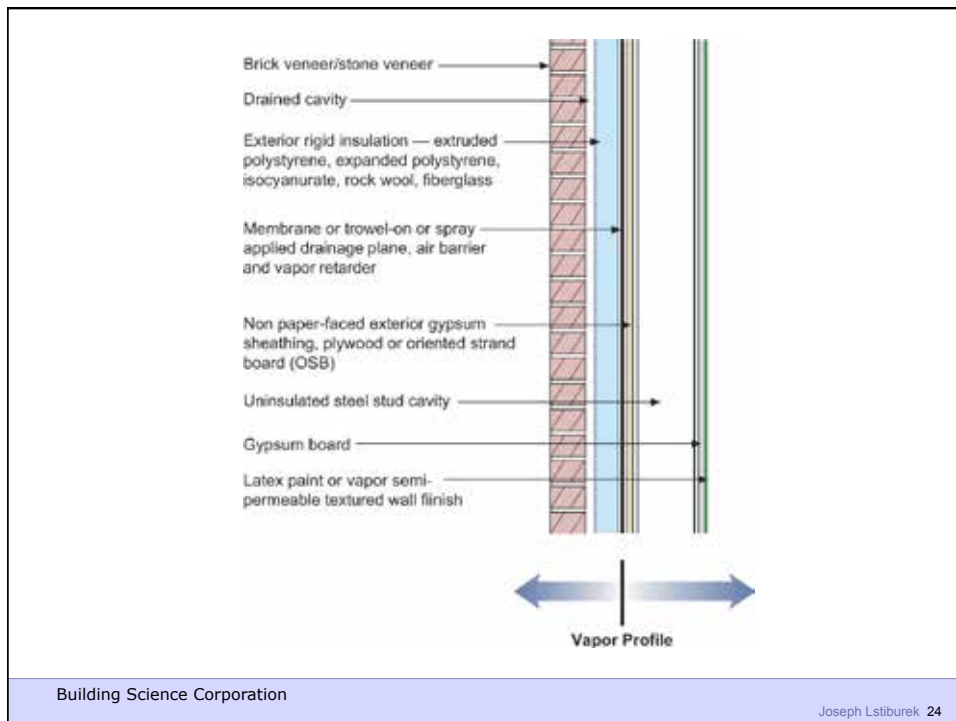
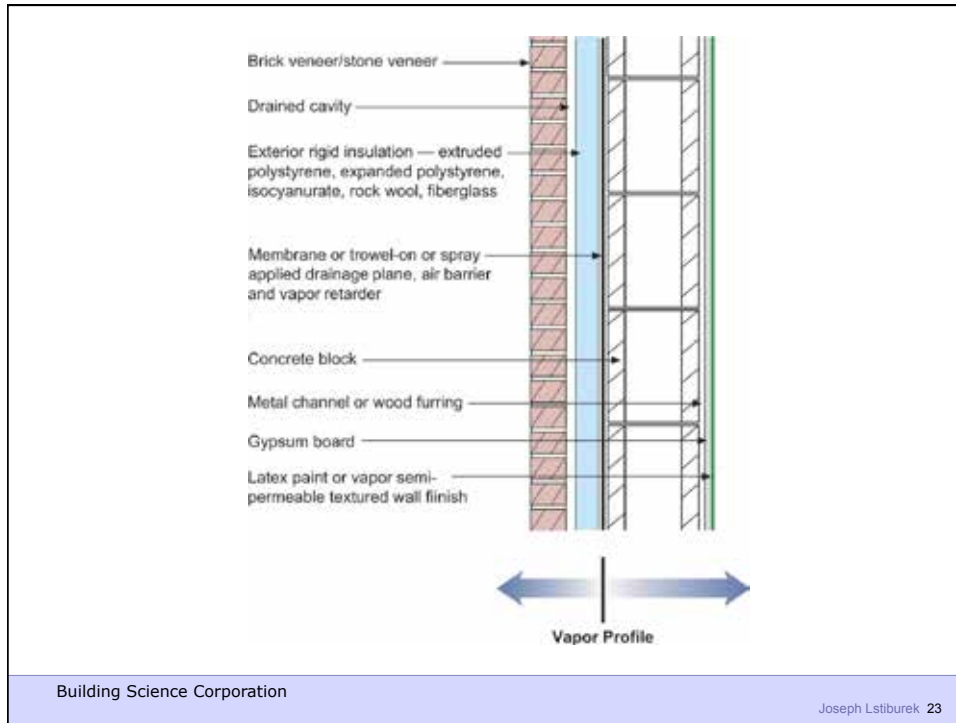


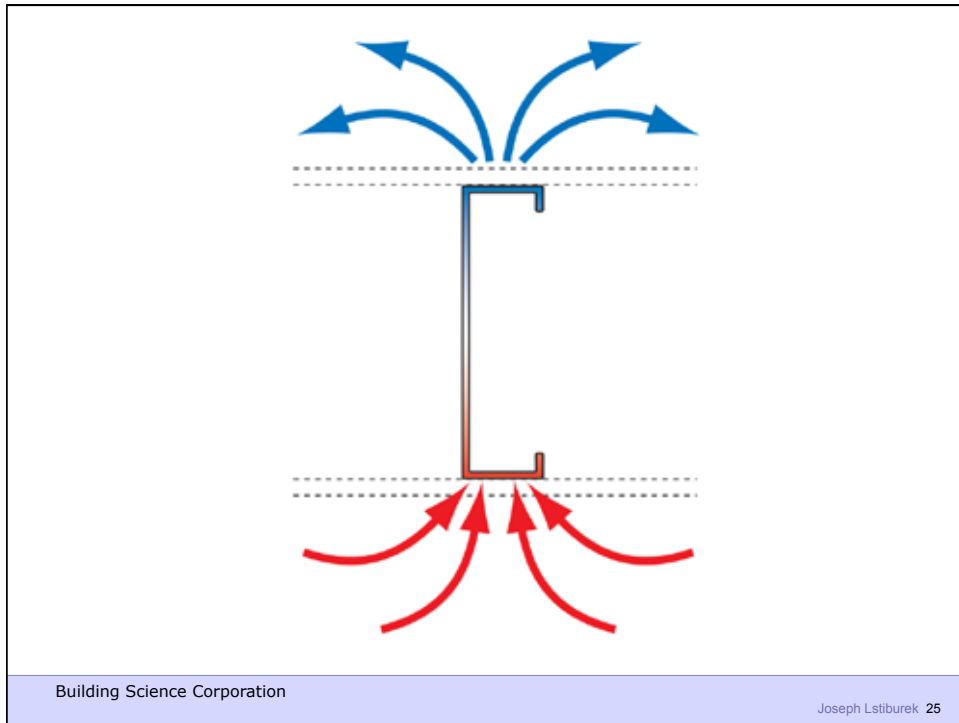


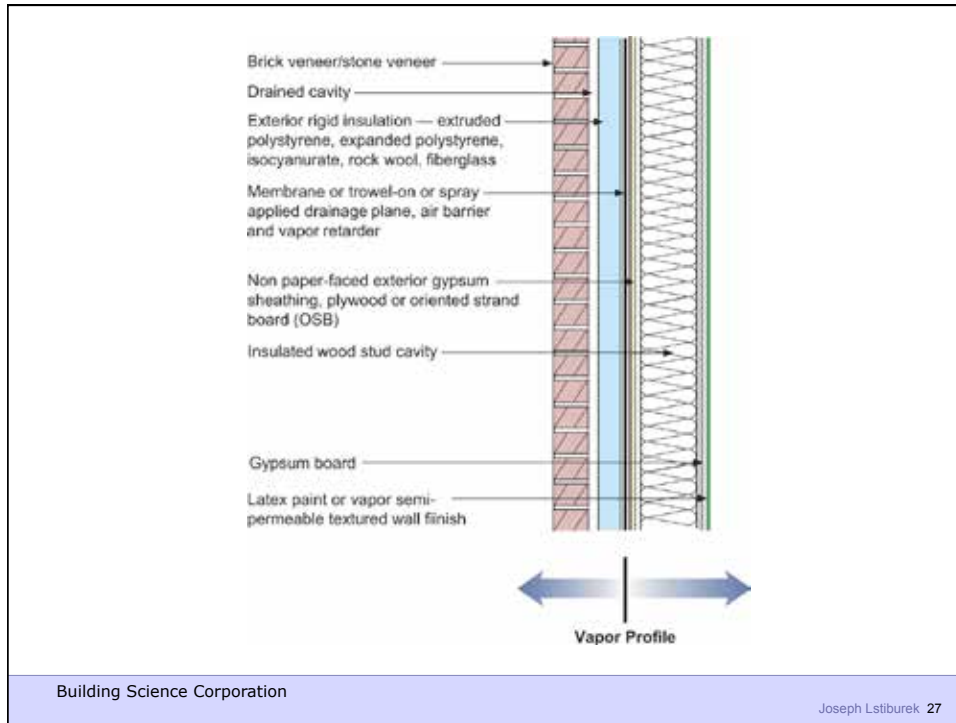








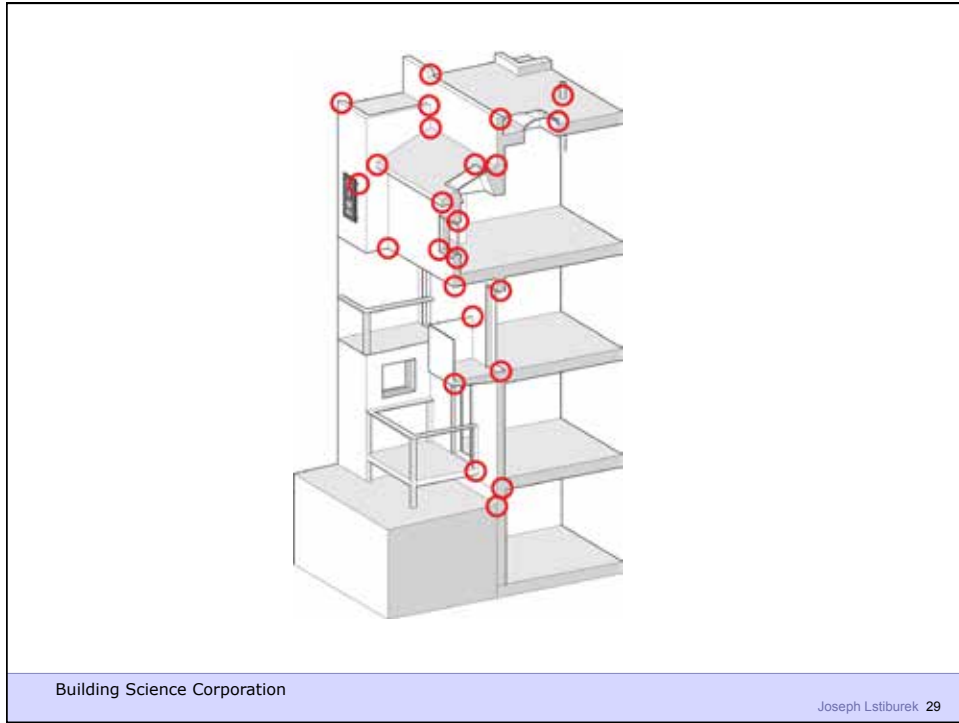




## Commercial Enclosure: Simple Layers



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





Building Science Corporation

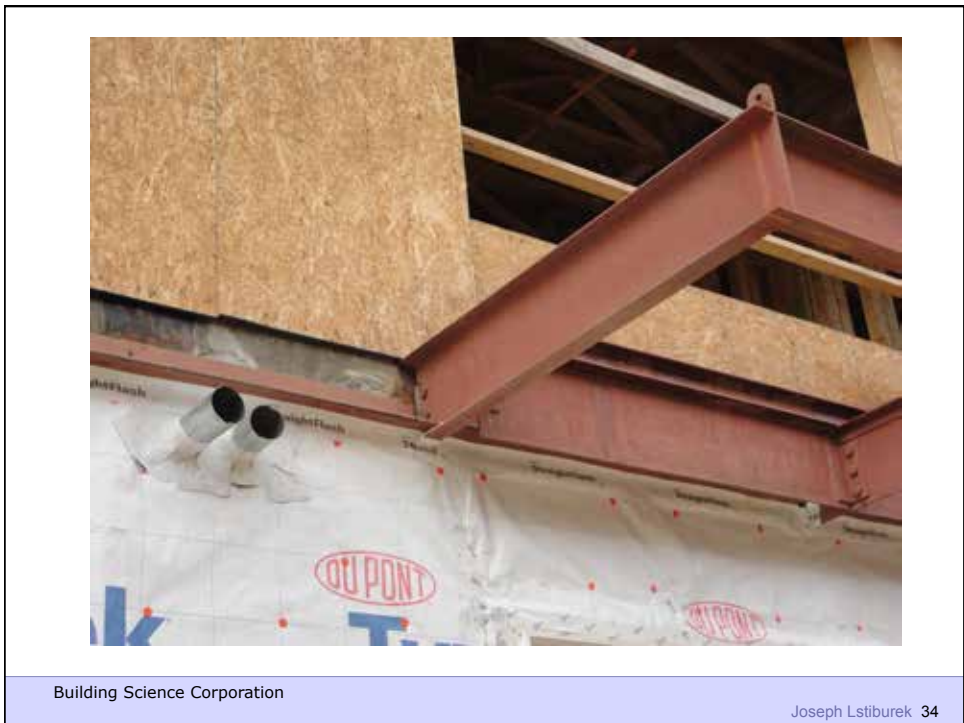
Joseph Lstiburek 31



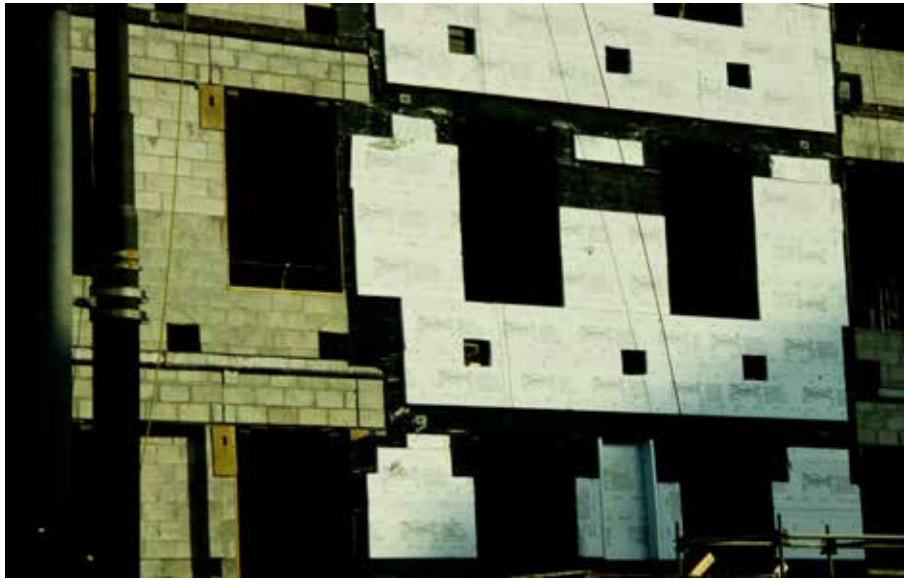
Building Science Corporation

Joseph Lstiburek 32









Building Science Corporation

Joseph Lstiburek 37



Building Science Corporation

Joseph Lstiburek 38







Building Science Corporation

Joseph Lstiburek 41



Building Science Corporation

Joseph Lstiburek 42



Building Science Corporation

Joseph Lstiburek 43



Building Science Corporation

Joseph Lstiburek 44



Building Science Corporation

Joseph Lstiburek 45



Building Science

Joseph Lstiburek 46



Building Science Corporation

Joseph Lstiburek 47



Building Science Corporation

Joseph Lstiburek 48







Building Science Corporation

Joseph Lstiburek 51



Building Science Corporation

Joseph Lstiburek 52







Building Science Corporation

Joseph Lstiburek 57



Building Science Corporation

Joseph Lstiburek 58





Building Science Corporation

Joseph Lstiburek 59



Building Science 2009

Joseph Lstiburek – HVAC 60





63



64







Building Science 2009

Joseph Lstiburek – HVAC 67



Building Science Corporation

Joseph Lstiburek 68



Building Science Corporation

Joseph Lstiburek 69



Building Science Corporation

Joseph Lstiburek 70



Building Science Corporation

Joseph Lstiburek 71



Building Science Corporation

Joseph Lstiburek 72





Building Science Corporation

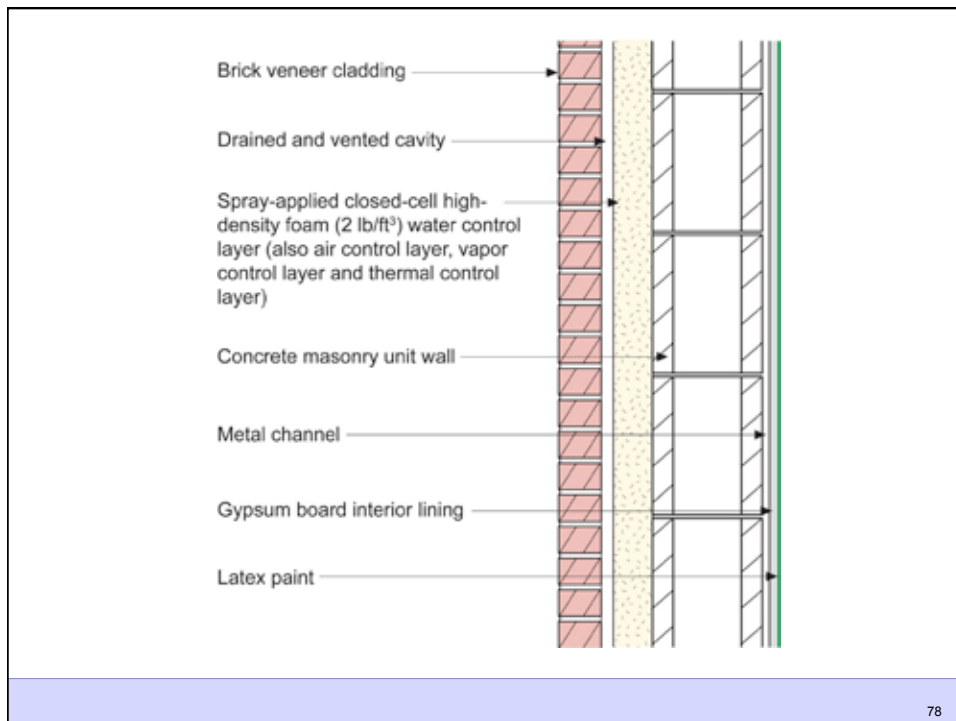
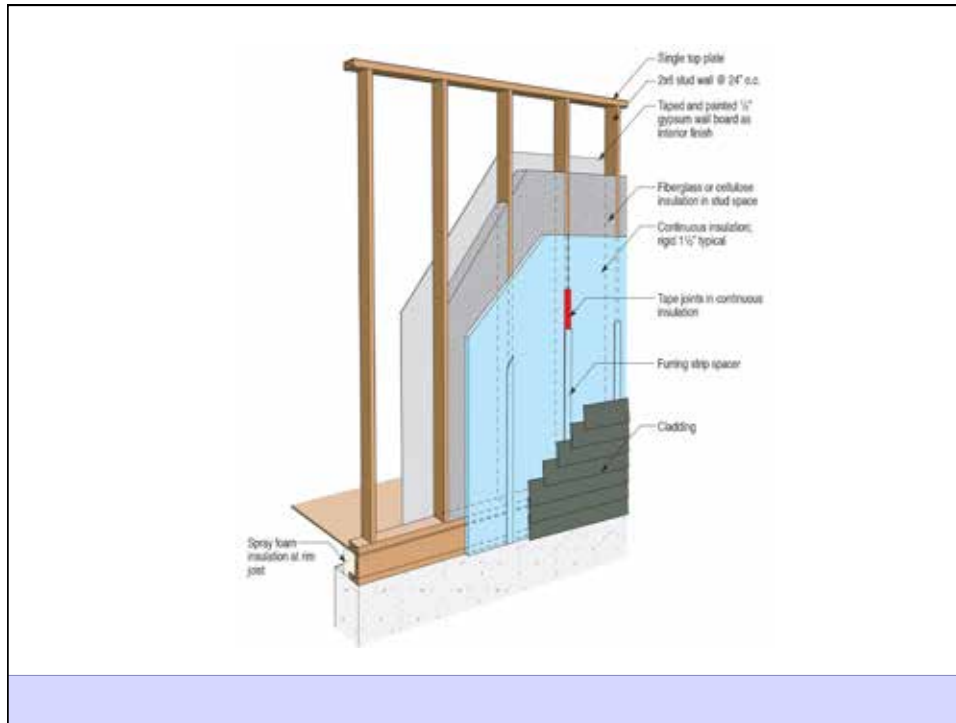
Joseph Lstiburek 73

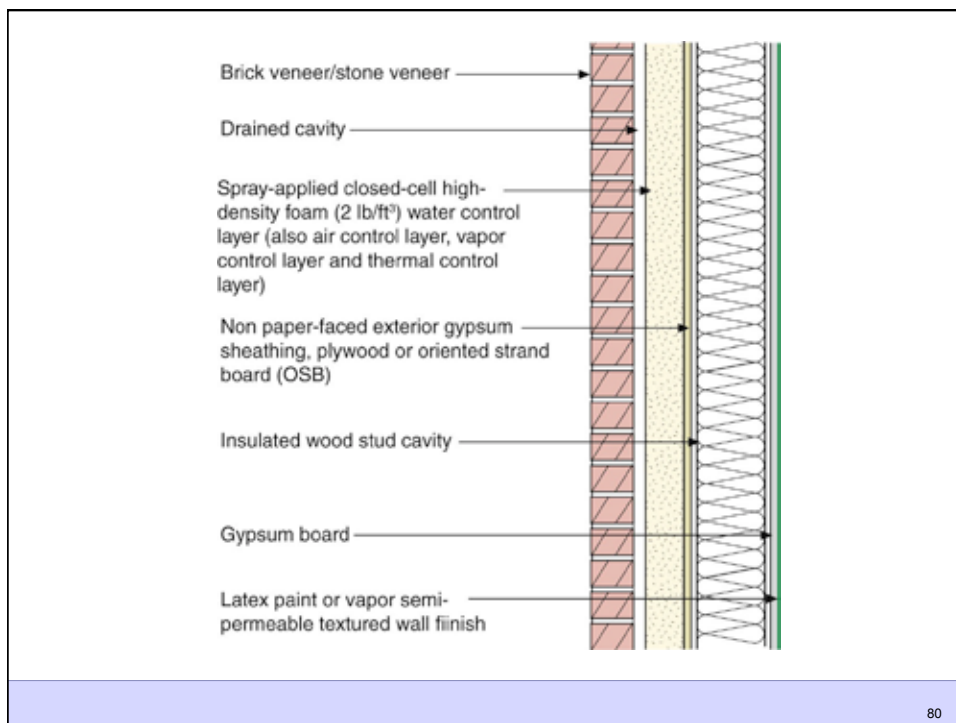
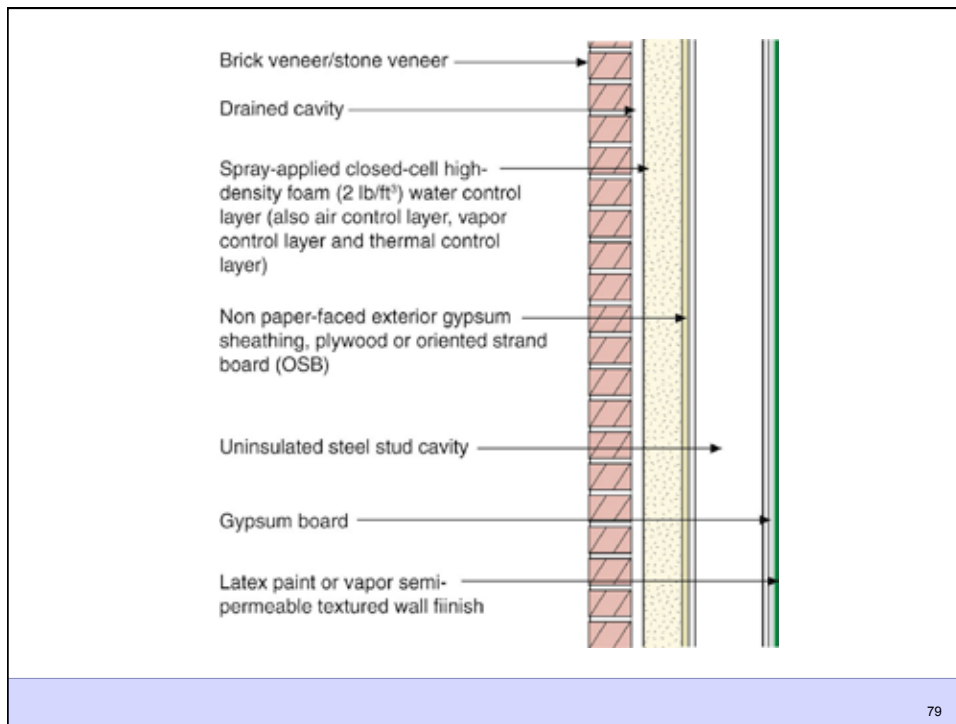


Building Science Corporation

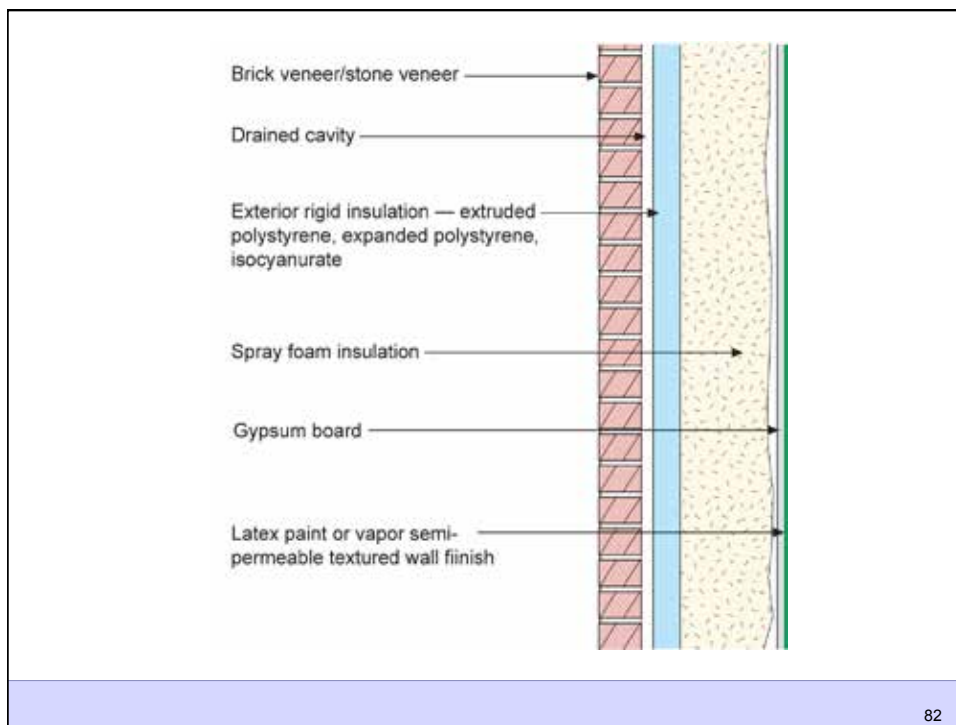
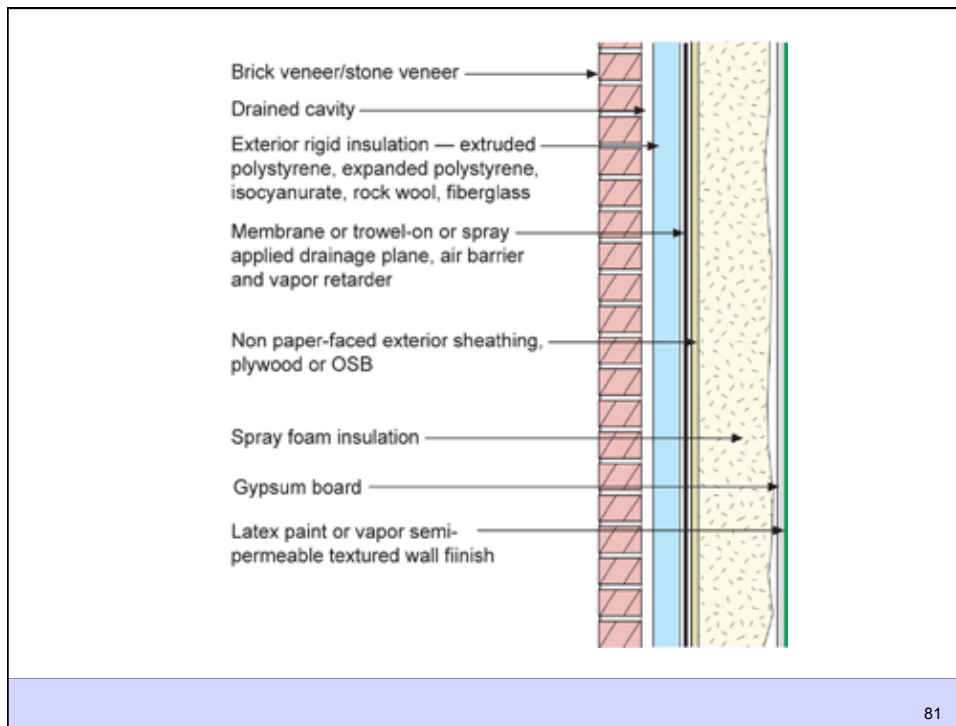
Joseph Lstiburek 74

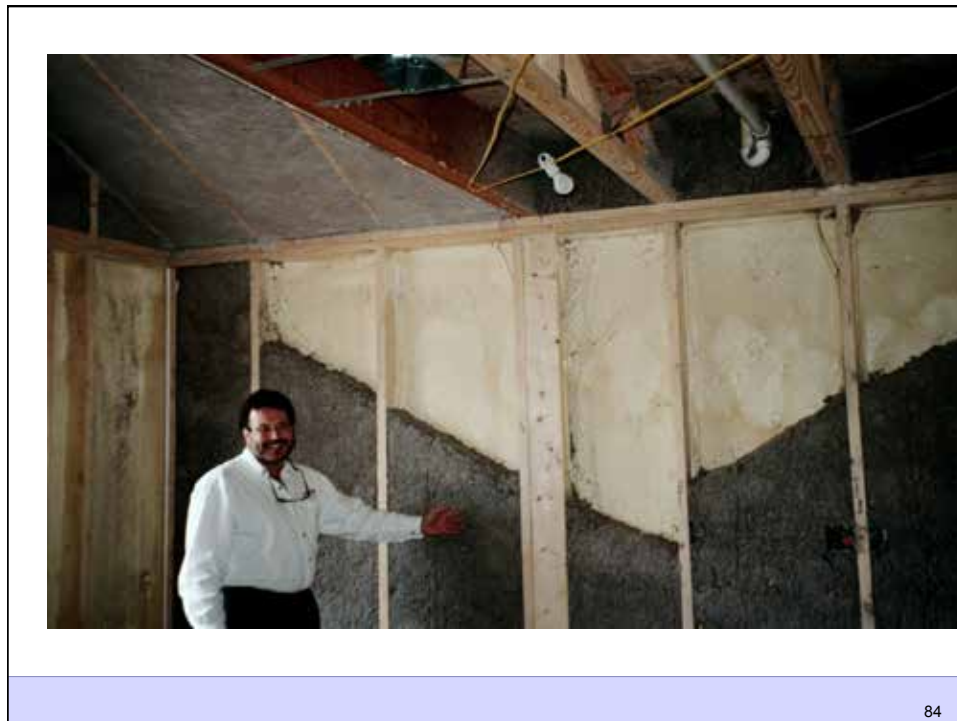
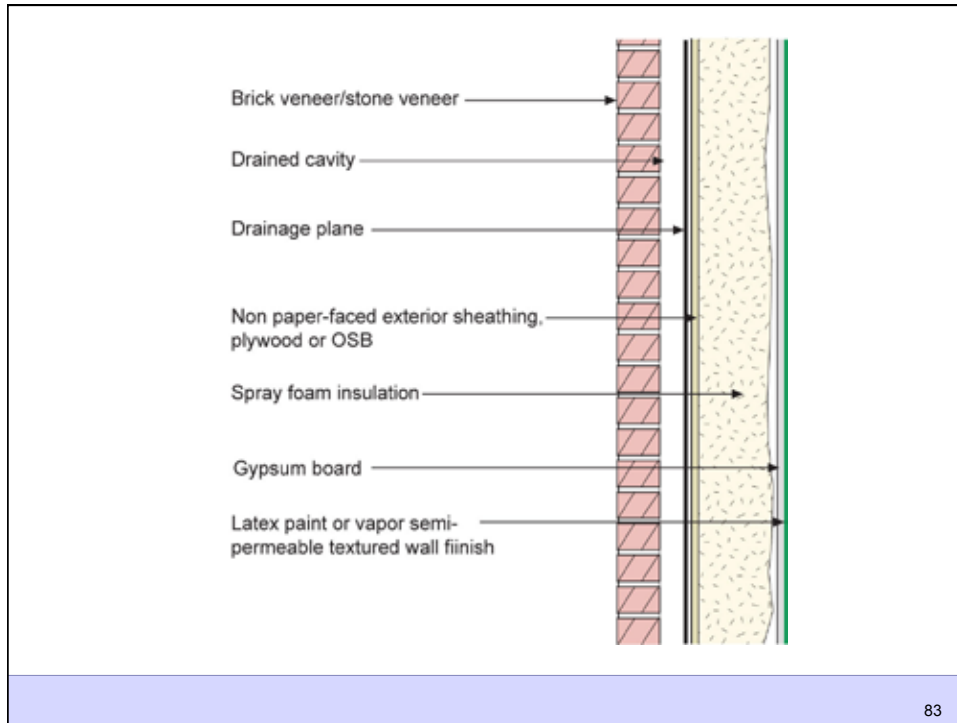


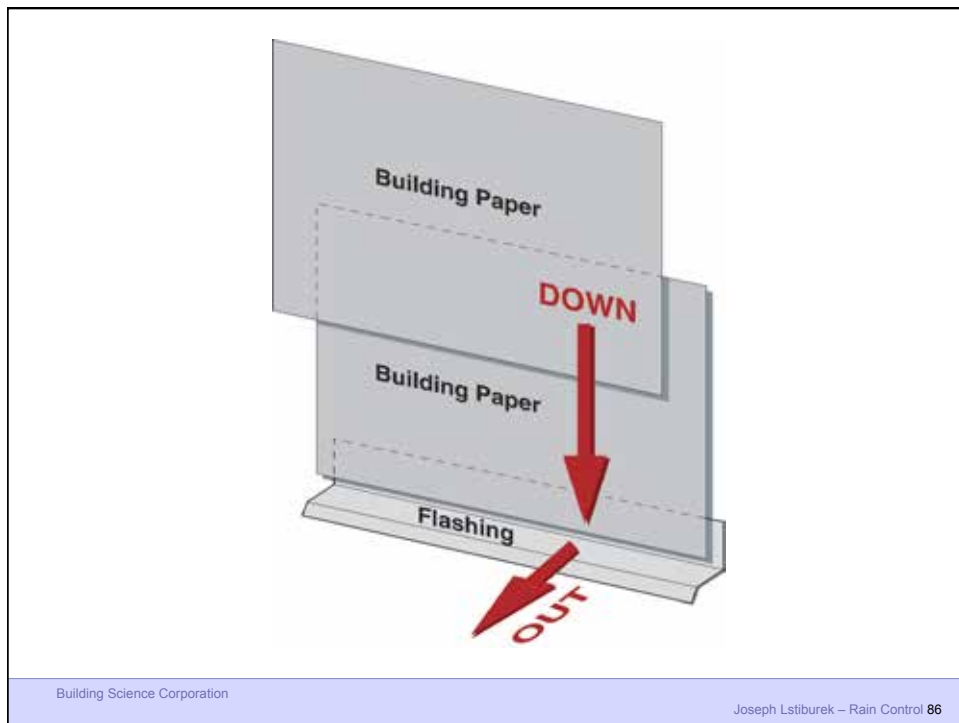
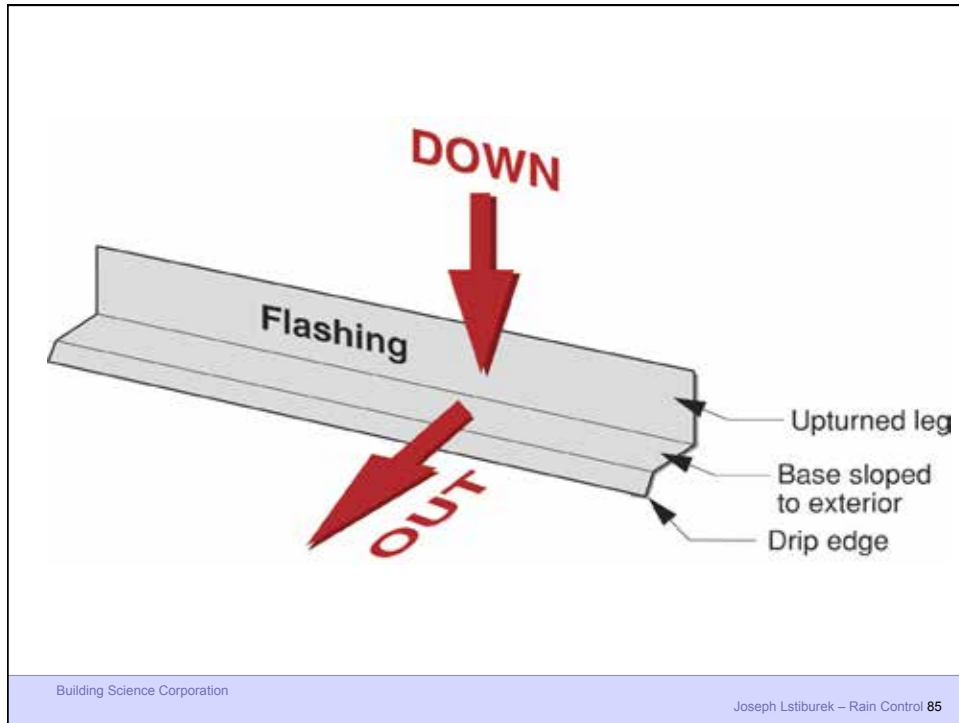




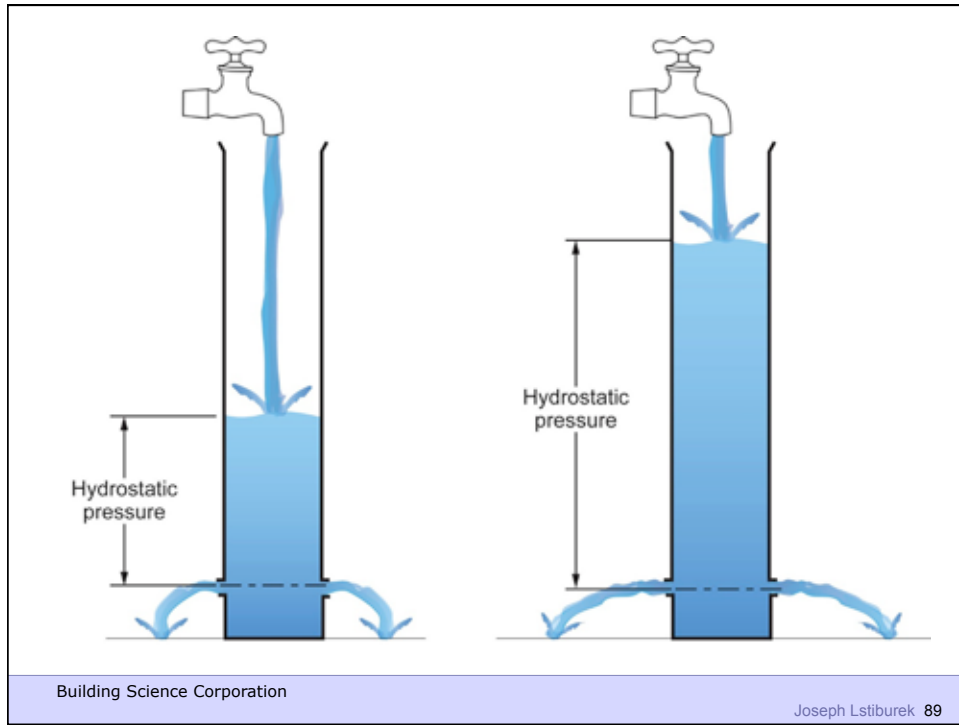


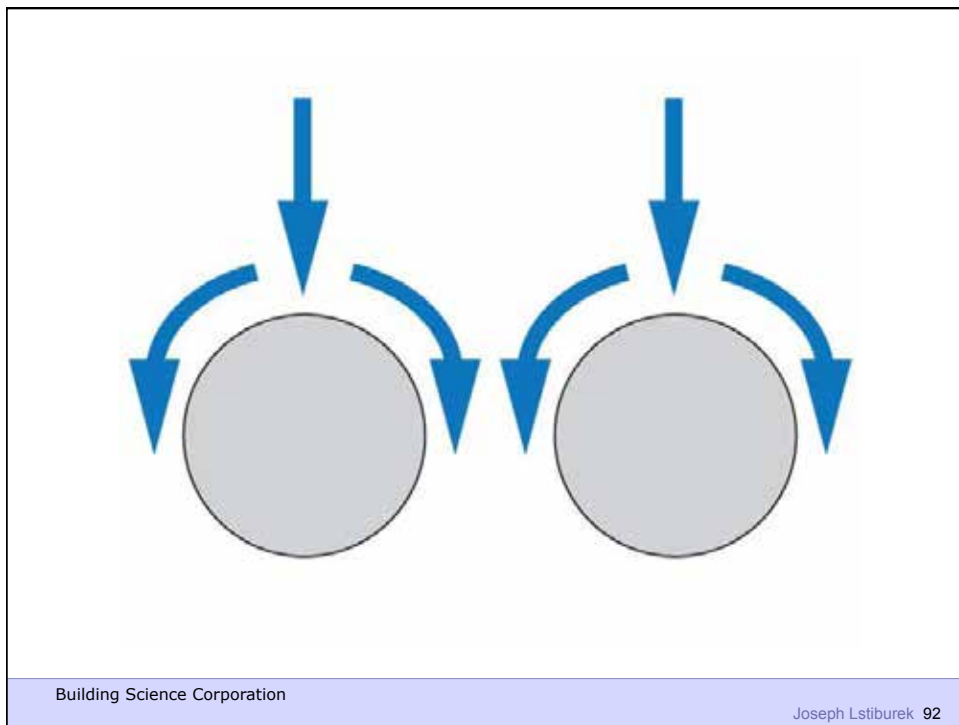
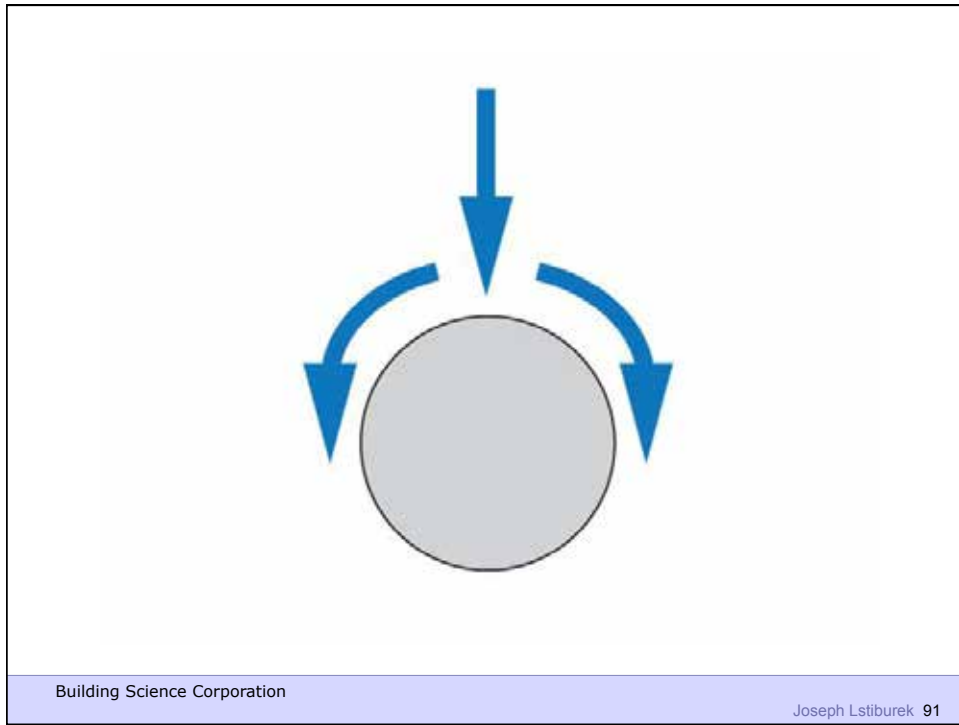




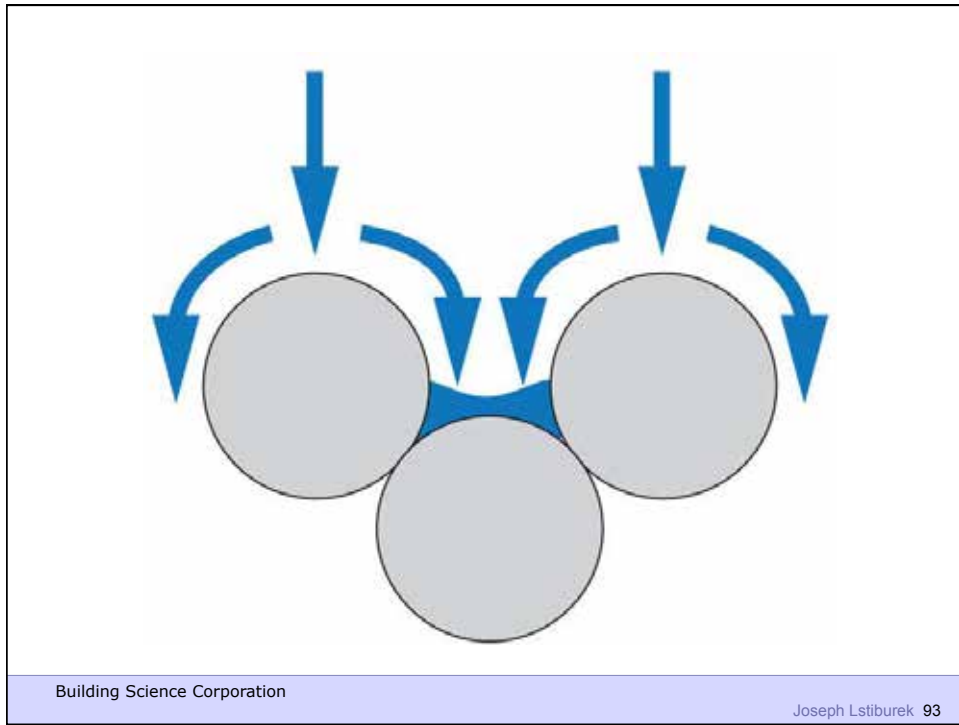


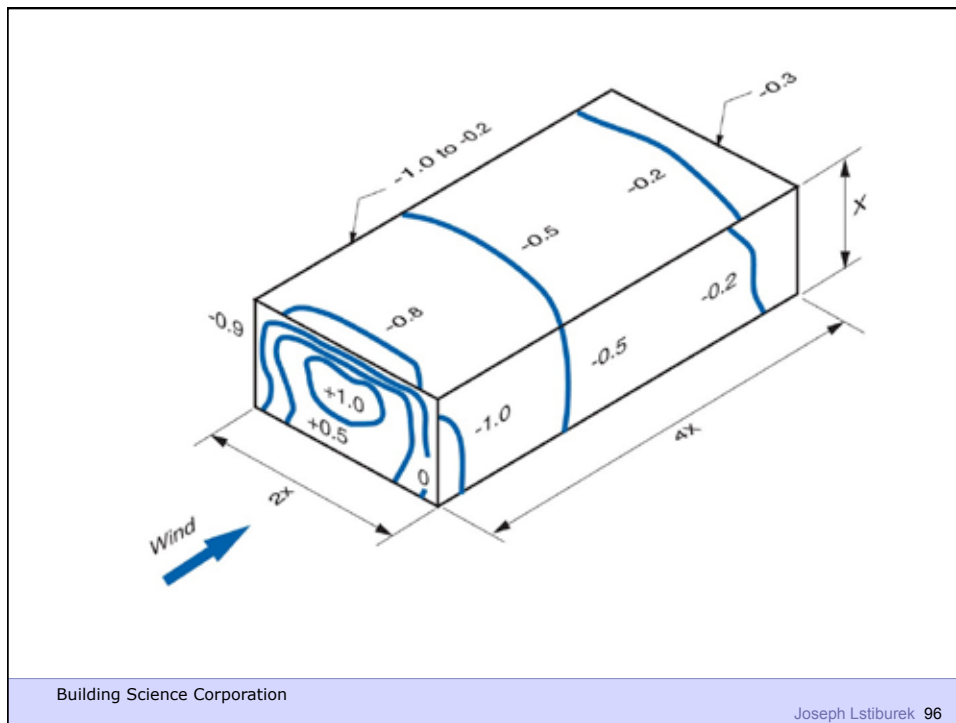
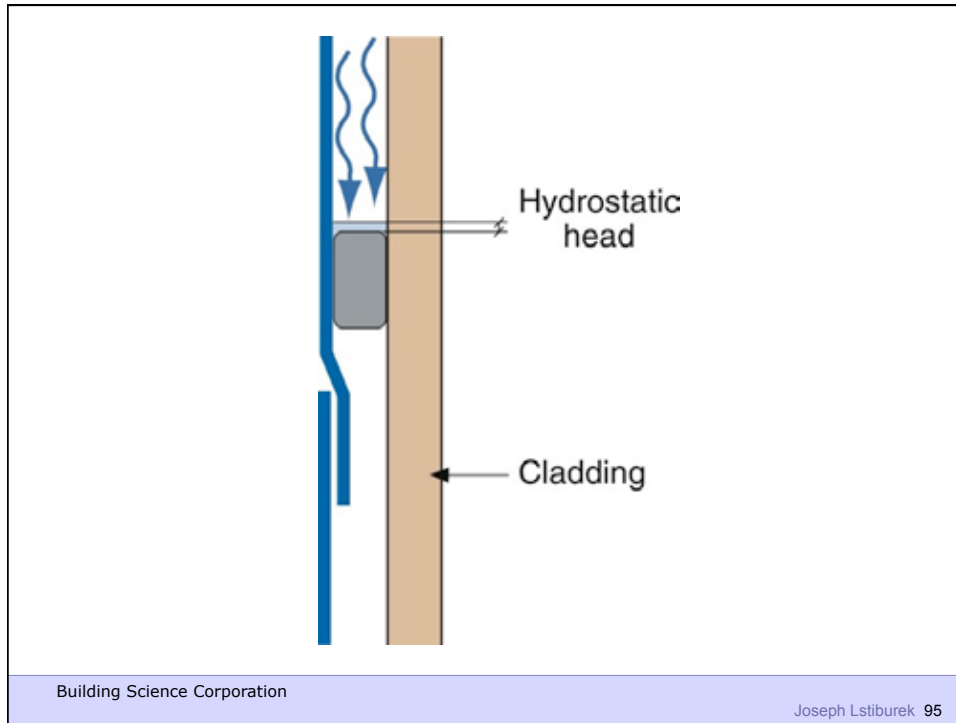


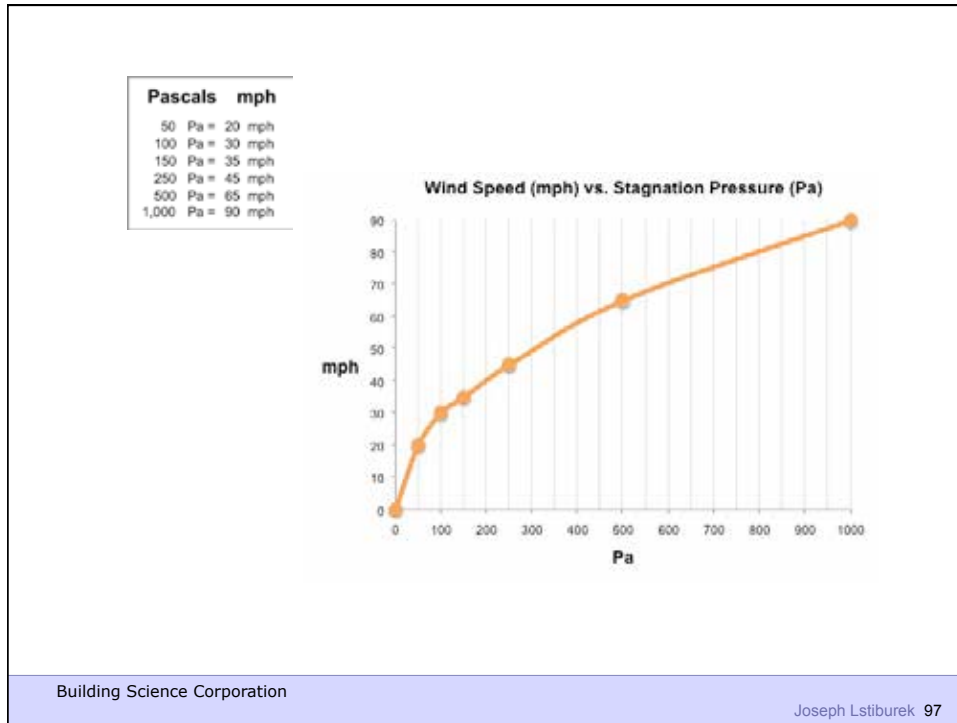










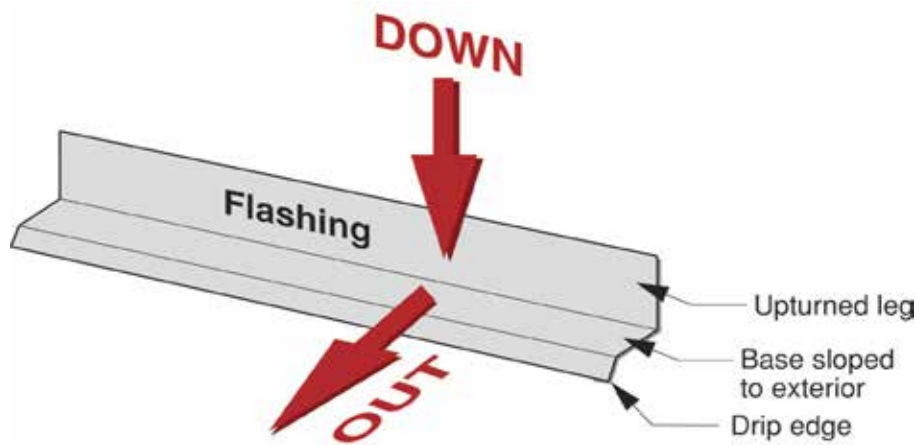






Building Science Corporation

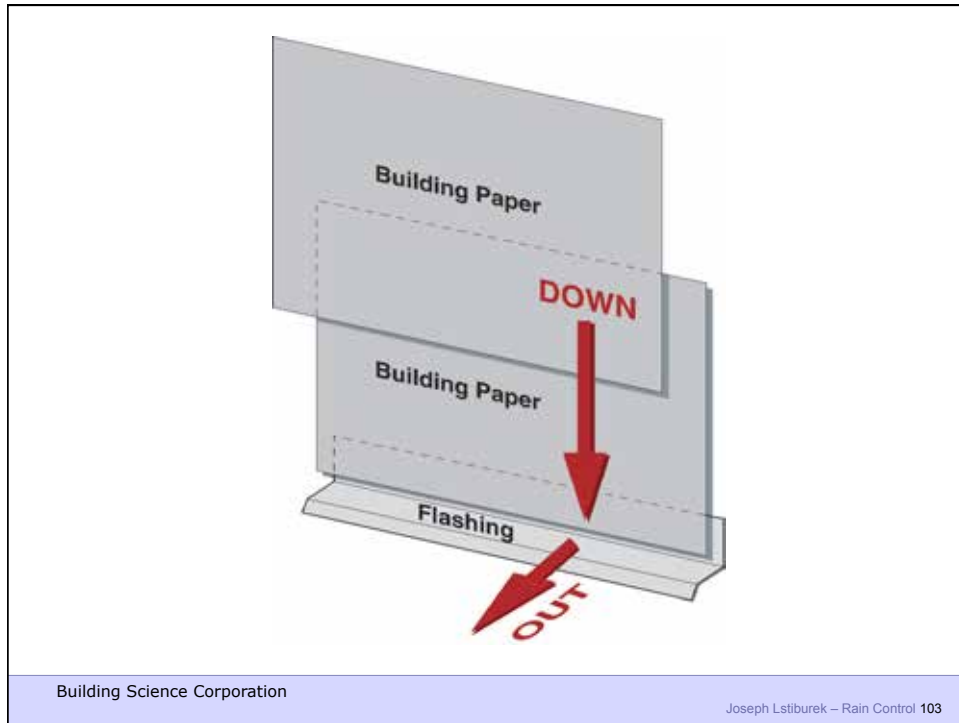
Joseph Lstiburek – Rain Control 101



Building Science Corporation

Joseph Lstiburek – Rain Control 102



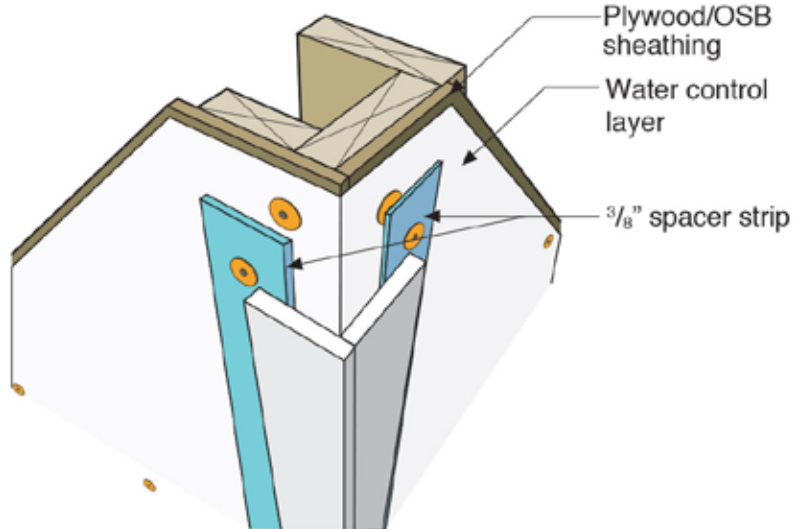






Building Science Corporation

Joseph Lstiburek – Rain Control 105



Building Science Corporation

Joseph Lstiburek 106



Building Science Corporation

Joseph Lstiburek 107



Building Science Corporation

Joseph Lstiburek 108



Building Science Corporation

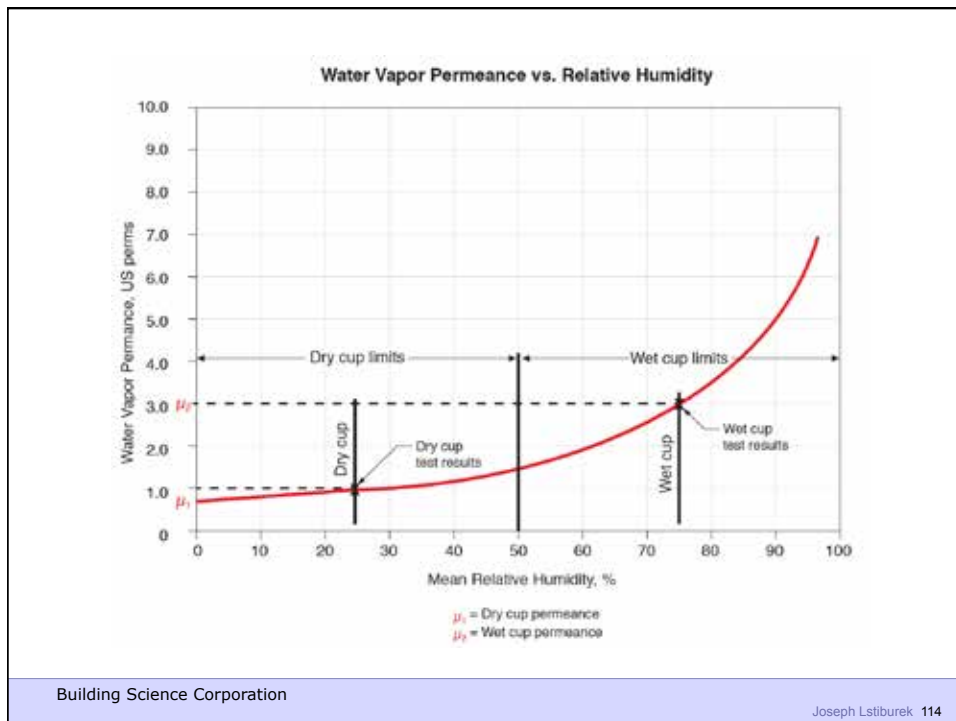
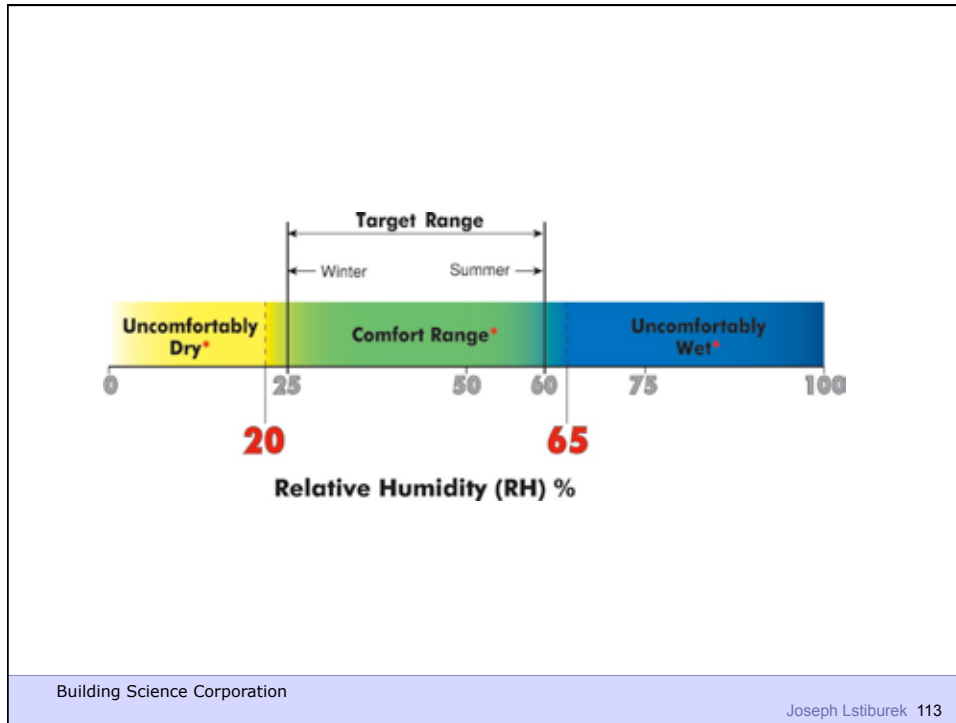
Joseph Lstiburek 109

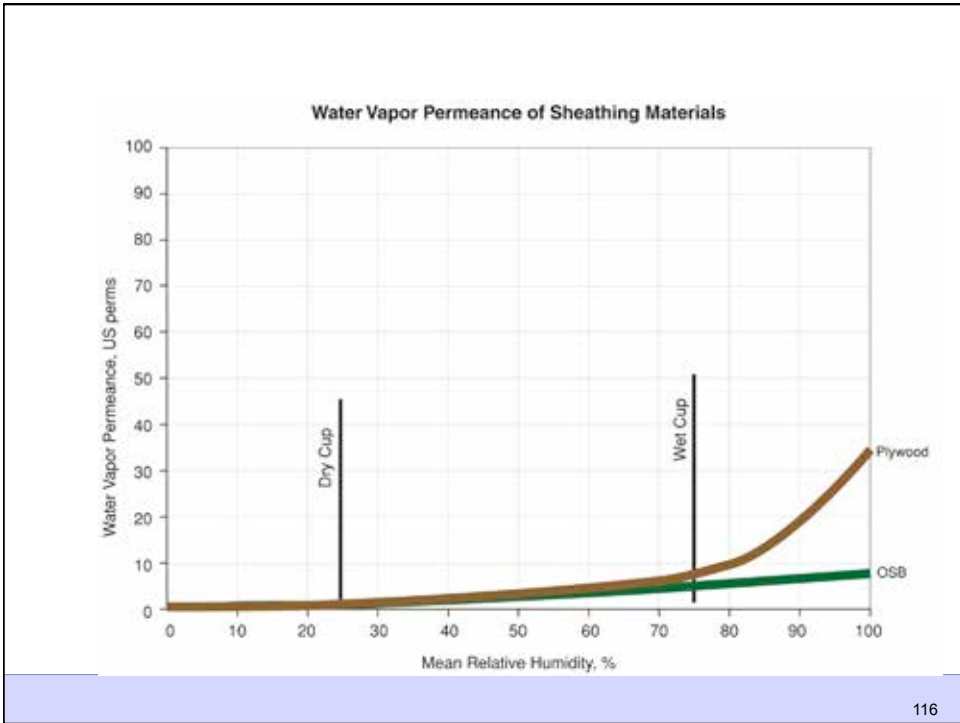


Building Science Corporation

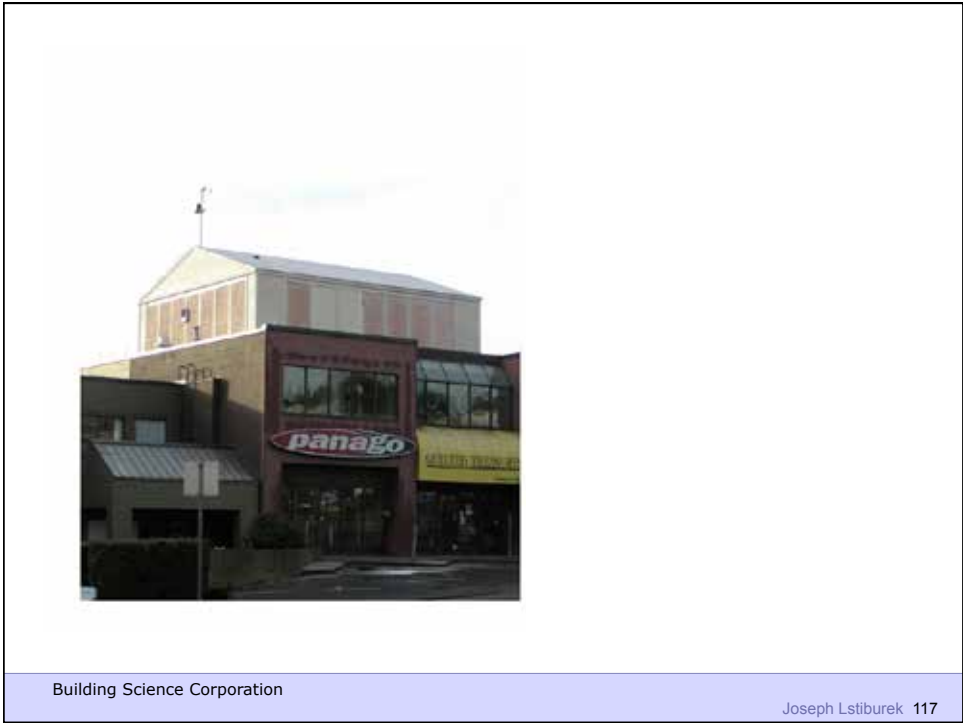
Joseph Lstiburek 110













Building Science Corporation

Joseph Lstiburek 119



Building Science Corporation

Joseph Lstiburek 120



Building Science Corporation

Joseph Lstiburek 121



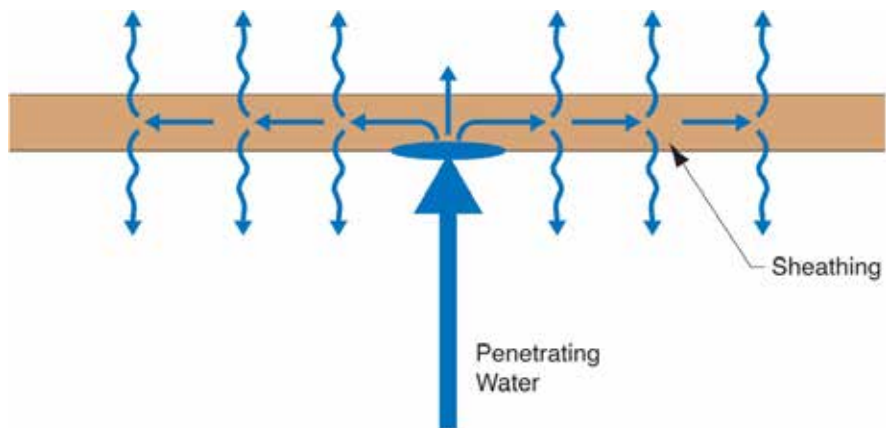
Building Science Corporation

Joseph Lstiburek 122



Building Science Corporation

Joseph Lstiburek 123

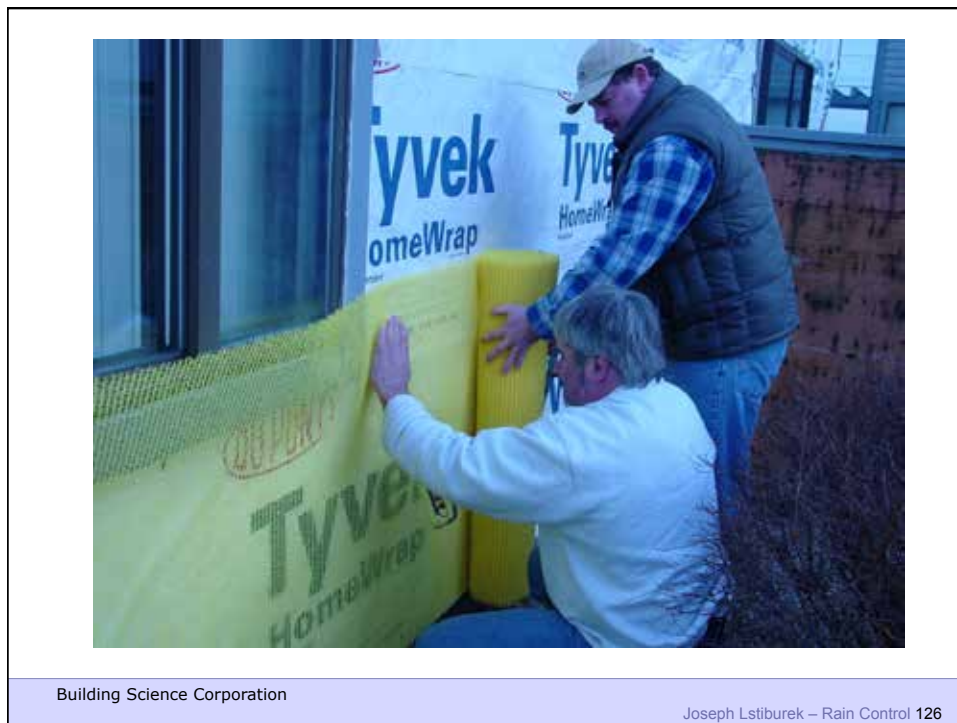
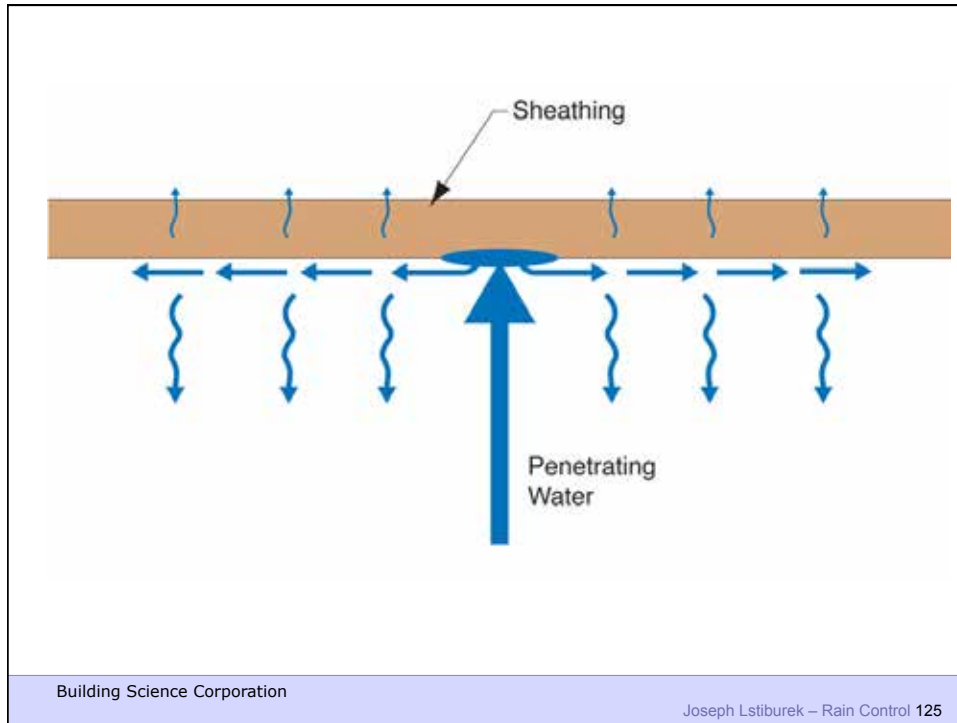


Sheathing

Penetrating Water

Building Science Corporation

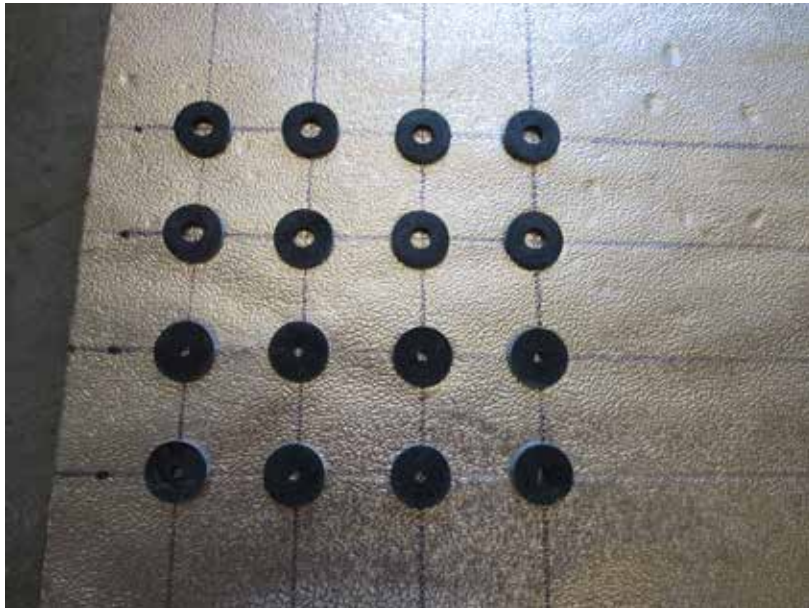
Joseph Lstiburek – Rain Control 124



# Rain Screen

Building Science Corporation

Joseph Lstiburek 127



Building Science Corporation

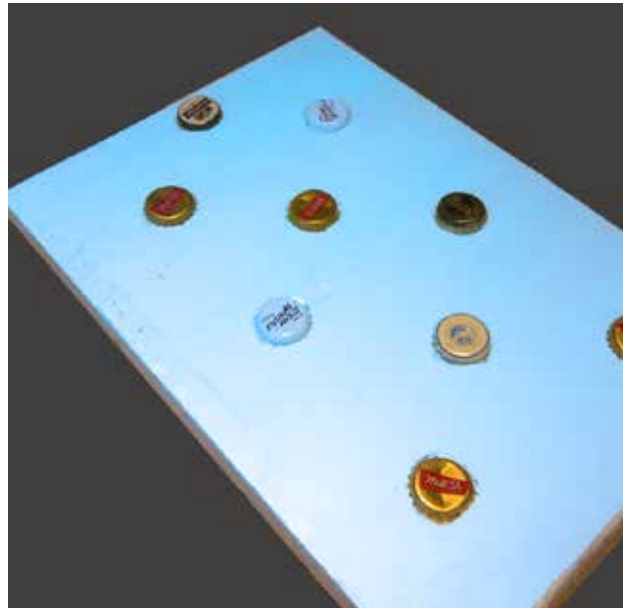
Joseph Lstiburek 128



# Beer Screen?

Building Science Corporation

Joseph Lstiburek 129



Building Science Corporation

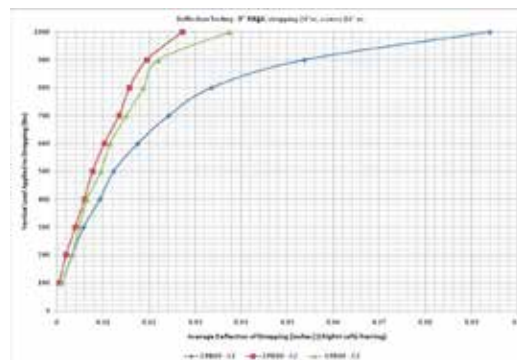
Joseph Lstiburek 130





## Rockwool

1x3 furring @ 24" o.c.  
 #10 screws @ 16" o.c. vertically  
 Result: 20 psf cladding weight  
 with <math>2/100''</math> deflection





Building Science Corporation

Joseph Lstiburek 135



136

