


**bsc** Detailing Toward Zero-Energy Buildings Part 1

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[www.buildingscience.com](http://www.buildingscience.com)  
 BUILD Boston  
 November 19, 2009, Boston, MA



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**bsc** **THE PERFECT ENCLOSURE DESIGN IS ONE THAT.....**

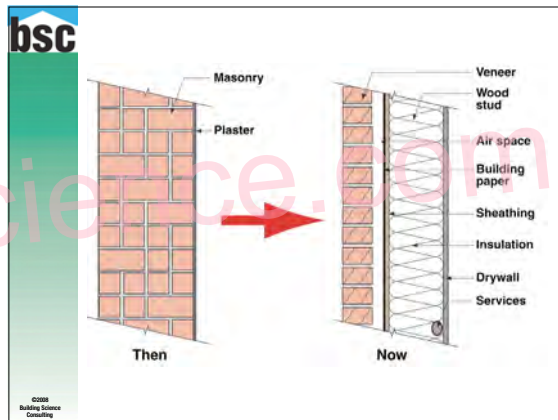
- Has an efficient structural frame
- Has thoughtful placement openings for light and ventilation including appropriate window to wall ratios
- Has exemplary levels of insulation to control heat flow
- Has an effective strategy to control air leakage
- Has an effective strategy to control liquid water and moisture in the vapor form

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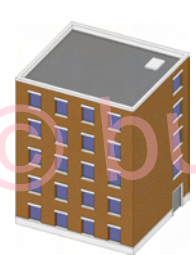
**bsc** **THE PERFECT ENCLOSURE DESIGN PROCESS .....**

- Defines areas for light and ventilation openings
- Defines layers (structure, heat flow, air flow, moisture flow)
- Defines boundaries
- Details joints between dissimilar materials

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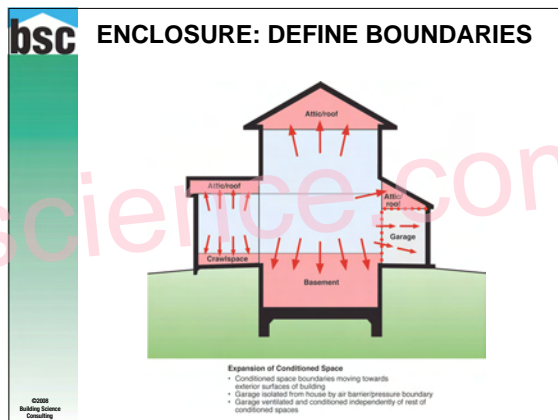


**bsc** **ENCLOSURE: SIMPLE LAYERS**




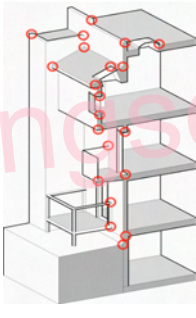
**STRUCTURE**  
**RAIN/AIR/VAPOR**  
**INSULATION**  
**FINISH**

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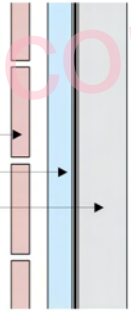
**bsc** **DETAILS: JOINTS**

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



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Enclosures No. 7

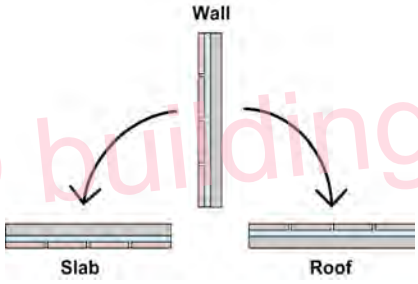
**bsc** **ENCLOSURE: SIMPLE LAYERS**



Cladding  
Control layers  
Structure

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**bsc** **ENCLOSURE: SIMPLE LAYERS**



Wall  
Slab  
Roof

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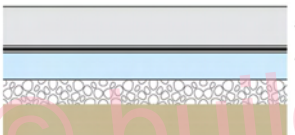
**bsc** **ROOF**



Ballast  
Filter fabric  
Control layers  
Roof structure

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**bsc** **FLOOR**



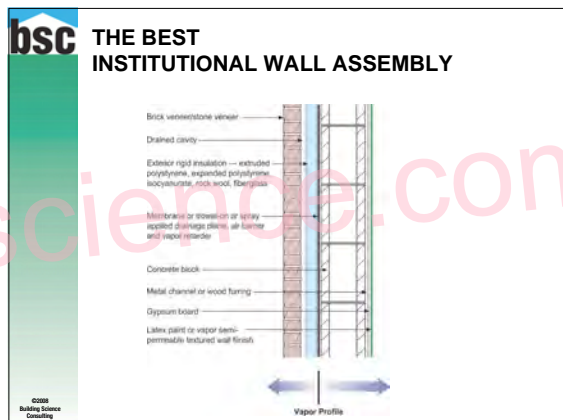
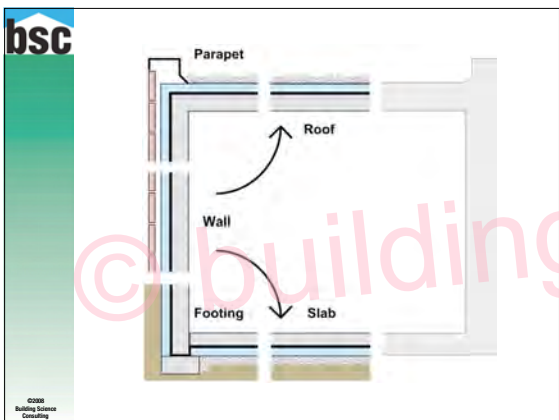
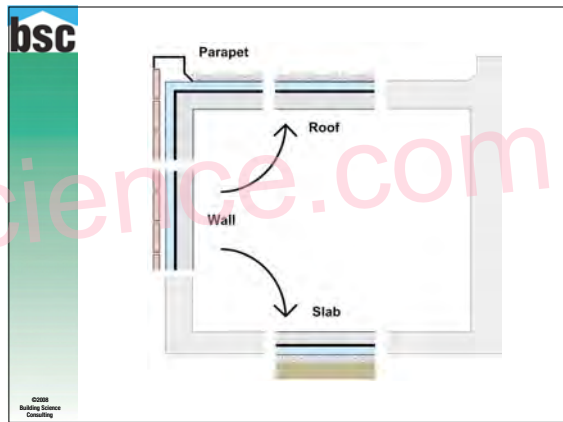
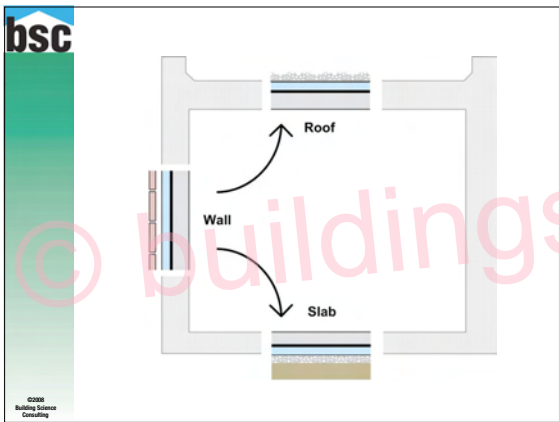
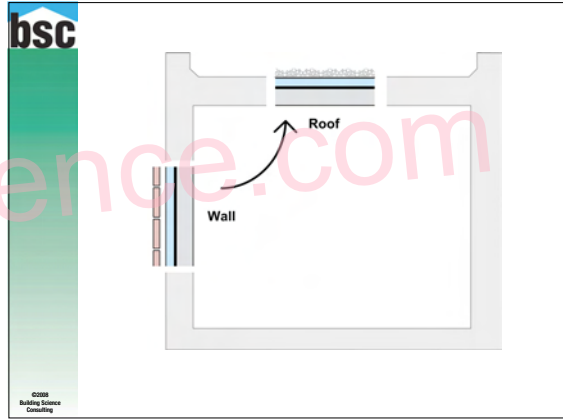
Slab  
Control layers  
Stones  
Earth

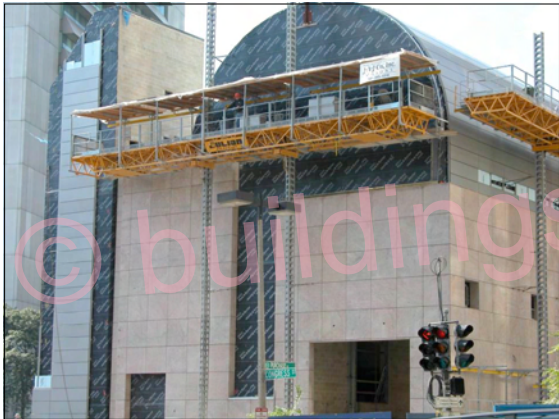
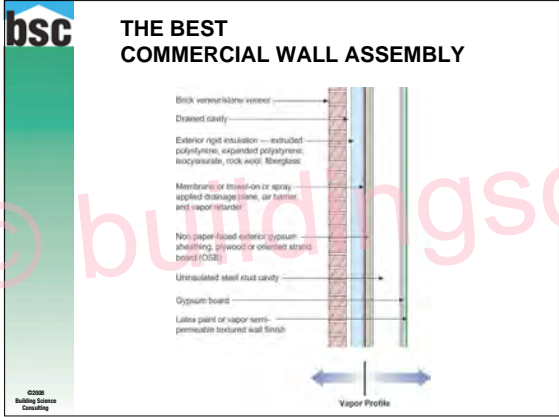
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## INSULATION CONSIDERATIONS

Insulation is compressed creating voids when inset stapling is used

Kraft or foil-facing

Void

Face stapling is recommended where faced batt insulation is installed

Wire installed too high or wrapped in front of insulation

Clip from compressed unfaced batt insulation

Unfaced batt insulation

Back of batt split properly around wire

Unfaced batt insulation

Walls cut in bottom of stud

Alternate Wiring with Batt Insulation Detail

**Proper Insulation Practices**

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## Air Flow

- Easy to understand
- Before you can control air you must enclose air
- Concept of building enclosures – no big holes
- Air barriers
- Air sealing

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## Air Flow

- Air flow depends on size of hole
- Air flow depends on pressure difference
- Air flows from higher pressure to lower pressure

Pressure difference

Flow Rate (CFM)

Area of opening

Air Flow

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## Establish Enclosure Tightness

- Same metric everywhere – What metric?
- Not too tight, not too leaky, just right
- Between 1.5 and 3 ach@ 50 Pa
  - Leakier than the Canadian R-2000
  - Tighter than the typical American home
  - Achievable- Over 16,000 built to this standard under this program

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## Criteria

- Practice Source Control
  - Moisture metric
    - Design to exclude water
    - Design to dry should it get wet
  - Combustion Appliances
    - Uncoupled from the conditioned space
    - Dedicated combustion air
    - Power-vent exhaust of combustion products
  - Spot Ventilation
    - Baths, kitchens, points of pollution generation
  - Control Duct Leakage
    - All ducts must be tight
    - Duct must be located within the conditioned space so they don't leak to the outside

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## Air Drywall Approach

Ceiling drywall sealed to wall or joist

Drywall caulked, gasketed or gasketed to top plate

Drywall caulked, gasketed or gasketed to bottom plate

Bottom plate caulked or gasketed to wall studs

Scrim tape caulked or gasketed to rim joist/stud

Film plastic moisture barrier caulked or gasketed to rim joist

Drywall caulked, gasketed or gasketed to top plate

Drywall caulked, gasketed or gasketed to bottom plate

Bottom plate caulked or gasketed to wall studs

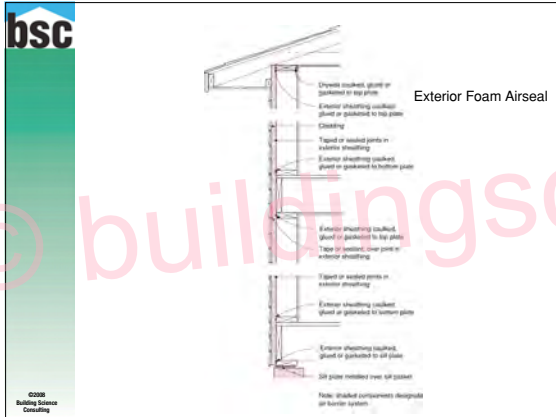
Scrim tape caulked or gasketed to rim joist/stud

Film plastic moisture barrier caulked or gasketed to rim joist

Sill plate installed over sill gasket

Note: Unshaded components designate air barrier system

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### Moisture Movement - Air Leakage vs. Diffusio

In most cold climates over an entire heating season:

- 1/3 quart of water can be collected by diffusion
- 30 quarts of water can be collected by air leakage

### Moisture Flow

- Most difficult to understand
  - Can be easy to understand
  - Drainage of liquid water
- “Moisture goes from warm to cold”
- “Moisture goes from more to less”
- Vapor barriers vs. vapor retarders
- Venting vs. non-venting of roofs, crawl spaces and walls
- Positive or negative pressures

### Moisture Balance

- Building assemblies get wet from the outside, get wet from the inside and start out wet.
- We must control wetting from the outside, control wetting from the inside, and let assemblies dry to the inside, or to the outside, or to both.

### Moisture Control

- Various strategies can be implemented to minimize the risk of moisture damage
- The strategies fall into following three groups:
  - Control of moisture entry
  - Control of moisture accumulation
  - Removal of moisture

### The Big Four of Moisture Control

- Controlling rain entry
- Controlling ground water
- Controlling water vapor via air transport
- Controlling water vapor via vapor diffusion

**bsc** Shed the water from the face of the building

- Floors and decks lower than stairs and slope away from building  
 - Garage floor lower than main floor and slope away from building  
 - Driveway lower than on-site floor and slope away from building  
 - Slope lower than main floor and slope away from building  
 - Slope and walkways lower than main floor and slope away from building  
 - Run full thickness of concrete across water away from point of discharge

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**bsc** Moisture Movement through Air Leakage vs. Diffusion

In most cold climates over an entire heating season, 1/3 quart of water can be collected by diffusion, 30 quarts of water can be collected by air leakage

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**bsc** Vapor Diffusion Control

Diffusion

- Migration of moisture by means of vapor pressure differential
- Occurs in either direction based on climate conditions and interior levels of humidity

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