Detailing for Durability

Paul R. Fisette, Professor
Department Head

Environmental Conservation

University of Massachusetts
Amherst, Massachusetts

pfisette@eco.umass.edu
Discussion

- Moisture Transport Mechanisms
- Relative Threats
- Primary Actions
- Prevention and Control
Why We Care

- Human Comfort
- Energy Consumption
- Occupant Health
- Maintenance
- Durability
Four Moisture Transport Mechanisms

- Vapor Diffusion (lowest threat)
- Air Transport
- Capillarity
- Bulk Transport (highest threat)
Vapor Diffusion

- **Primary Action**
  - moves in or out

- **Requirements**
  - permeance
  - driving force
  - time
  - surface area
  - source
Diffusion Control

- Easiest to control permeance of materials
- Examples of vapor barriers
  - foil
  - polyethylene
  - Kraft facing
  - vapor barrier paint
- Install on warm side
Perm Ratings of Common Building Materials
(Source: ASHRAE)

- Built up Roofing ...................................................... 0.00
- 0.35-mil Aluminum Foil ........................................ 0.05
- 6-mil Polyethylene .................................................. 0.06
- 1/2-inch Exterior Plywood ....................................... 0.35
- 3 Coats of Oil-based Paint ..................................... 0.65
- Kraft Paper ............................................................. 1.0
- 1-inch Expanded Polyurethane .............................. 1.0
- 15-lb asphalt felt .................................................... 1.0
- 1-inch Extruded Polystyrene ................................. 1.2
- 1-inch Molded Expanded Polystyrene .................. 3.9
- 3/8-inch Gypsum Wallboard ................................. 50
Vapor Pressure vs. Temperature

A = indoor 70°F 45% rh
B = outdoor 38°F 90% rh
Vapor & Capillary Control
Air Transport

- **Primary Action**
  - moves moisture in or out as vapor
  - second most dominant force ~ capillary drive

- **Requirements**
  - source of moisture
  - holes or pathway
  - pressure differential
Significance: Air vs. Diffusion

Painted Wall Section with 1" hole

Approx. 20 gal. of water per yr. moves through 1" hole via air leakage

20 Gallons

Painted Wall Section

Approx. 1 cup of water moves through 10' x 1 wall per yr. via diffusion

1 Cup
Air Transport Control

- Control each - 1 at a time or all together
- Easiest to control source or pressure
- Control temperature vs. dew point
Common air leakage sites in a home

1. Around plumbing vent stack
2. Attic hatch
3. Tops of interior walls
4. Recessed light
5. Behind built-in cabinets
6. Around door
7. Plumbing penetrations
8. Around bathtub
9. Sill plate
10. Around chimneys and flues
11. Fireplace damper
12. Furnace or air conditioner air handler box
13. Where additions join house
14. Around window
15. Behind baseboards
16. Around electrical sockets
17. Around duct boot and register
18. Ducts
19. Around dryer vent
Air & Bulk Moisture Control
Methods of Control

- Dehumidification
- Dilution - air changes in heating climates
- Depressurization in heating climates
- Controlled ventilation
- Point source ventilation
- Raise surface temperatures
- Control of #holes very difficult
Heat Recovery Ventilation
Air, Diffusion and Surface Temp
Capillary Movement
Second Most Serious Threat

- **Primary Action**
  - Moves moisture from outside into envelope

- **Requirements**
  - Surface tension
  - Pore size
  - Source of moisture
Surface Tension

- Water spreads into thin film on clean glass left.

- Water beads (cohesion of water-to-water) on oil-coated surface on right.
Capillary Rise

- **Examples**
  - blotter paper
  - solder in plumbing
  - wood siding

- Water wets glass (left) concave meniscus.

- Mercury doesn’t wet glass convex meniscus.
Capillary Control
Pore Size: = 0 or >1/4”

Below Grade

- Stone base
- Polyethylene (sealed)
- Drainage mats
- Parging/coatings
- Good drainage
Capillary Control

Above Grade

- Paint
- Small joints = pores
- Space joined materials
- Good drainage
- Rain Screen
Figure 2-15: Capillary Rise in Wood Siding
Bulk Movement
Most Significant Threat

• Primary Action
  ◦ Moves from outside into envelope
  ◦ Snow, rain, and ground water most significant
  ◦ Moves most moisture in the least time

• Needed to Control
  ◦ Bulk moisture (source)
  ◦ Hole (pathway)
  ◦ Driving force (pressure, gravity, etc.)
Above Grade Control

- Sheltered Location
- Rain Screen
- Caulking
- Flashing
- Redundancy
- Channel/Redirect
Above Grade Control
Below Grade Control
Structural Damage

- Peeling Paint
- Rotting Wood - 21% MC or 90% RH
- Mold - RH > 70%
- Condensation - cosmetic, health, & energy
- Corrosion
- Insects