Designing for Moisture Management

- Why the concern?
- Suggestions to address the concern
- Why *these* measures and not others
- Summary of suggestions

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The mold concern is about the strength of buildings...

- Fact 1 - Buildings don’t fall down very often.. A good thing.

- Fact 2 - More often, buildings grow mold… a bad thing.

- Mold claims in commercial buildings between $3 and $12 billion in 2003
Mold cannot grow without moisture

1. **Moist food source**
   - Spore lands on a moist surface
   - Enzymes use surface moisture to dissolve food

2. Spore germinates, producing filaments (hyphae)
   - Hyphae extend both reach and area of absorptive surface
   - Fungal metabolism generates more surface moisture to accelerate growth

3. Hyphae grow thickly, digging into the surface and forming a protective mat (mycelium) that keeps the surface moist even if surrounding air is dry

4. The mold grows conidia, which generate and release spores to the air
Typical mold growth sequence in buildings

1. Rain or ground water gets in through cracks
2. Humidity gets in through cracks and ventilation
3. HVAC system fails to dry the air
4. Indoor moisture migrates into organic materials
   - Capillary suction (from water leaks)
   - Condensation on cooled surfaces (from high dew point)
   - Sorption (from high dew point)
5. Then... mold grows wherever moisture collects
WHY so many mold problems NOW?

- **Fragile building envelopes**
  - Lots of water on the exterior wall
  - Lots of cracks
  - Poor flashing or none at all

- **No second line of defense**
  - Walls can’t get rid of moisture
  - No safe moisture storage capacity (wood)
  - HVAC systems often pull in excess moisture
  - HVAC systems don’t dry the air

- **Ignorance during design decisions**
  - Assumption that the shape of building does not matter
  - Window and door flashing not understood to be critical
  - HVAC not understood to be a necessary line of defense
  - No laws or codes force better practices
Basic Strategy - Build fault-tolerant buildings, not fragile ones

- **1st principle: Design a dry building**
  - Architect - a building which sheds water (rather than collecting it)
  - HVAC designer - a ventilation system which dries the building (rather than adding moisture)
  - Builder - keep it dry during construction

- **2nd principle: When moisture gets in anyway... drain it out and dry it out, quickly.**
  - Architect - Walls which drain water outwards (rather than trapping it).
  - HVAC designer - HVAC system which pushes dry air into walls (rather than sucking in humid air)
Keeping rain off the walls

- Rain lands on the edges, carried there by wind
- Higher wind = more rain deposition
- Higher wind speed at higher altitudes = more rain at the top of the building

Solution
- Cornices to create “wind bumper” which keeps rain-laden wind from contacting the wall
- Overhangs and projections to force water OFF the wall

Photos from Prof. John Straube
University of Waterloo, Canada
Even small overhangs make big improvements
“If you want to save cash... flash” (Joe Lstiburek, Ph.D, P.Eng)
The importance of dedicated ventilation dehumidification

Miami 6-Story Office Moisture Load Estimate (lb/h)

- People: 60
- Ventilation (PPL): 229
- Ventilation (VOCs): 76
- Infiltration (Walls): 25.0
- Door Activity: 3.5
- Humid Products: 406
- Wet Carpet: 406
- Permeation (Walls): 406

Total Load = 799 lb/h, or 96 gallons/hour

Negative Pressure: 0.3 air changes/hr

400 People 20 cfm/person
Representative peak hour ventilation moisture loads in U.S. locations
Dedicated ventilation dehumidification

1. Moisture Removal Capacity
   Dehumidification capacity of the pretreatment unit must be quantified at the peak dew point design condition.

2. Drying Ventilation Air Deeply
   Avoids Additional Equipment Cost
Duct leaks cause mold?… YES!

- Humid outdoor air leaks in...
- ...and is pulled through cool walls, where its moisture condenses
- ...feeding mold and mildew

All because leaking exhaust duct connections create suction inside building cavities
The importance of sealing ALL duct work
(How much air could really be infiltrating?)

About 50% of total flow, in one measured test by Florida Solar Energy Center

Total Exhaust - 2799 cfm
1316 l/s

- From Cavities - 1475 cfm
  693 l/s

- From Toilets - 1324 cfm
  622 l/s
The Federal Government is Being Proactive…
Chapter 5 of the P-100 Facility Standard now requires:

- 1. Dedicated ventilation system which dries air to 50°F dew point, all the time
- 2. Positive internal air pressure (until outdoor temperature falls below 37°F).
- 3. 24-7 dehumidification (at reduced air volume during unoccupied hours)
Summary - Architect & Engineer

- 1. Keep rain off the walls
- 2. Keep water away from the foundation
- 3. Make the flashing effective
- 4. Dry all ventilation air, all the time
- 5. Think positive
- 6. Seal all air duct connections
Information Resources

- ASHRAE Humidity Control Design Guide ($125.00 Purchase at www.ASHRAE.org)

- ASHRAE Electronic publication “Mold & Moisture Management in Buildings” ($45.00 PDF only - purchase and download at www.ASHRAE.org)

- Federal Facility Standard (P-100 Chapter 5) - Search internet using:
  - “P100 Federal Facility Standard”