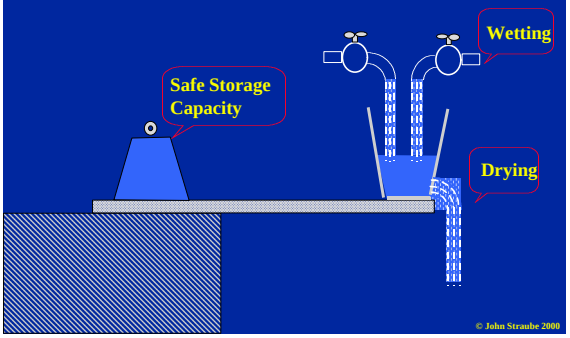
Rain, Driving Rain & Rain Control

Dr John F. Straube

Moisture Control

- Moisture is involved in almost all building envelope performance problems
  - In-service .... Durability
- Examples:
  - corrosion,
  - freeze-thaw,
  - rot, mould (IAQ)
  - staining
  - etc.

The Moisture Balance



The Moisture Balance

- **Wetting**
  - Exposure: Rain, Wind, Sun, RH, temperature
  - Interior conditions: RH, temp., pressurization
  - Design to avoid? Or balance?
- **Drying**
  - Same exposure/ interior conditions concerns as above
  - Which mechanisms?
  - Which direction?
- **Storage**
  - How much? How safe?

Wetting

1. **Vapor** ⇒ **Condensation**
   - air leakage (*convection*)
   - diffusion
   - source: interior *or* exterior
2. **Liquid** ⇒ **Driving Rain**
   - absorption
   - penetration
3. **Built-in Moisture**
   - e.g. green lumber, concrete, masonry
4. **Capillary suction / Rising Damp**

Wetting

- **Driving Rain is not the ONLY source of wetting (recall Part 3)**
- **Usually the largest**
- **Other wetting mechanisms may tip the balance**
- **Gross leakage overwhelms**
- **HVAC? Operation? Occupancy?**

Drying

1. Liquid
   - drainage *free liquid water only*
   - emergency relief valve
2. Vapor ⟹ Evaporation
   - air leakage (convection)
     - ventilation (e.g. for vapour resistant cladding)
   - diffusion
     - vapour barriers slow inward drying
     - vapour resistant claddings slow outward drying

Storage

- Bridges gap in time between wetting and drying
- How much and for how long before damage
- *Safe* storage
  - mold, freeze-thaw, corrosion
- *Amount* of storage
  - e.g. steel stud, vs wood stud vs concrete block
- Basic mechanisms
  - capillary pores (*bound liquid*)
  - sorption (*vapour*)
  - pools and puddles (*free liquid*)

Rain Penetration Control

Rain is largest moisture source

Control …

- 1. Surface staining
- 2. Moisture damage to wall materials
- 3. Through-wall penetration

Rain Control

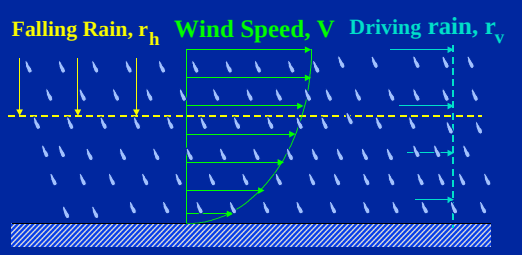
First Understand, then Control:

- Deflection
  - reduce water on building
  - redirect water away
- Drainage
  - slope surfaces, use flashing
  - provide drained walls and joints
- Drying
  - allow any remaining water to dry

Driving Rain

- Site and Climate
  - wind direction, rainfall intensity, duration, frequency
- Building
  - height, orientation, shape
- Wall
  - shedding,
  - absorption
  - transmission

Driving Rain



Driving Rain

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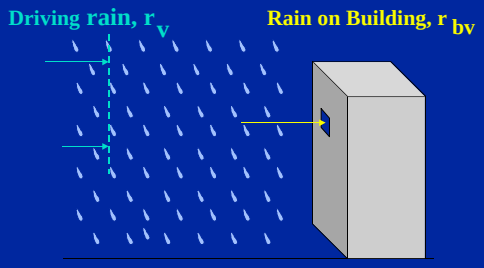
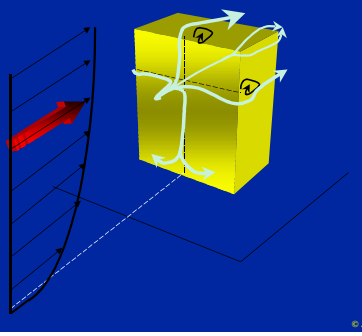
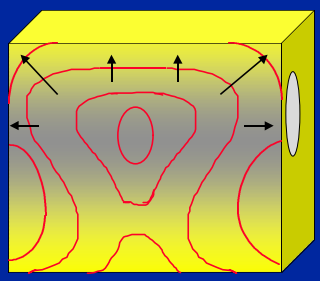
Rain and Buildings



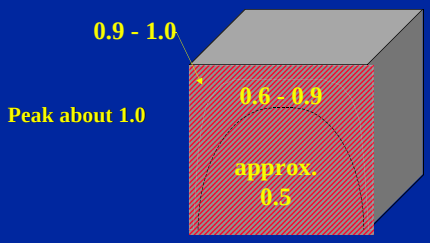
Wind Flow Patterns



Pressure Distribution on Building

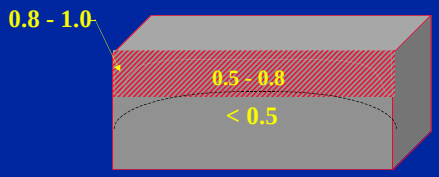


Rain Deposition



For wind perpendicular to wall

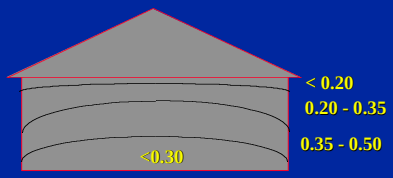
Rain Deposition



Low Building H/W < 1

Rain Deposition

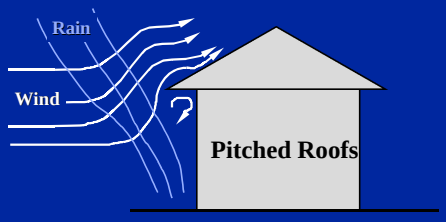
Peak about 0.5



Low Building with Peaked Roof & Overhang

Overhangs

- Overhangs change building aerodynamics
- Rain deposition can be significantly affected



Base Splash

Highrise vs Lowrise

r_{bv} = RAF DRF V r_h
= RAF r_v

For 50m High rise

- V = Two times fully exposed lowrise
- most lowrise protected by neighbouring buildings

- Highrise: Max RAF= 1
- Lowrise /overhang: RAF = 0.5
- Driving rain minimum four times greater

Driving Rain

- Site and Climate
  - wind direction, rainfall intensity, duration, frequency
- Building
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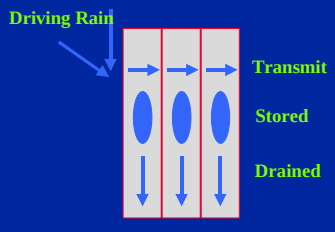
- Wall
  - shedding,
  - absorption
  - transmission

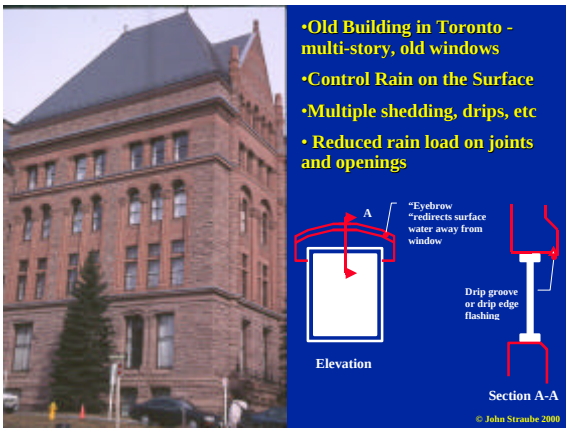
Rain Control Theory

- Rain Deposition: Drained, Stored, or Transmitted



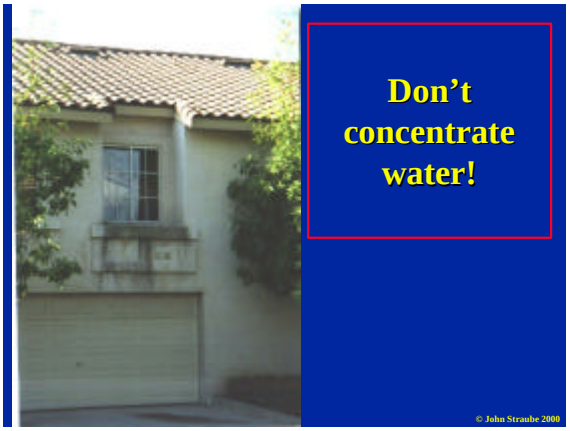
Shedding: Surface Drainage

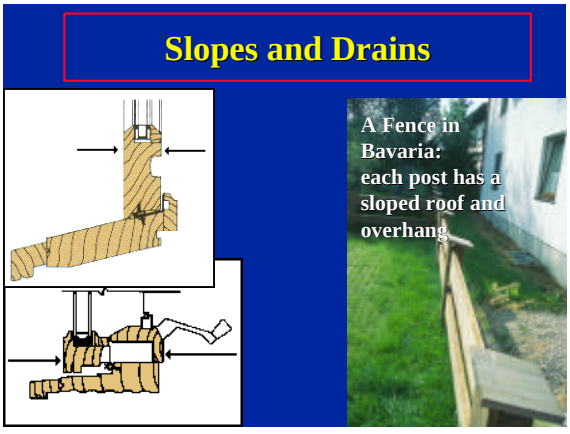
- Surface Drainage Accumulates on Tall Buildings
- Redistribute and Control via
  - Drips
  - Overhangs
- Protect Windows, Saddles, etc.
- If it doesn't get wet, it wont leak


•Old Building in Toronto - multi-story, old windows
•Control Rain on the Surface
•Multiple shedding, drips, etc
• Reduced rain load on joints and openings
A
"Eyebrow "redirects surface water away from window
Drip groove or drip edge flashing
Elevation
Section A-A
© John Straube 2000


Overhangs Surface - Drainage - Shelter


Deflection: Protect Wall Openings


Don't concentrate water!
© John Straube 2000

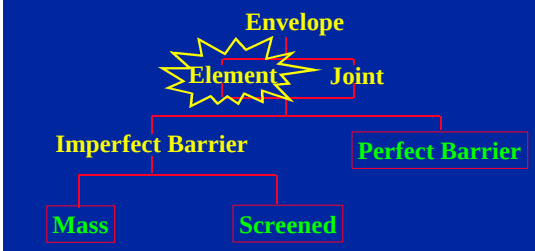

Slopes and Drains
A Fence in Bavaria: each post has a sloped roof and overhang


Modern Buildings often do not respect need for surface drainage

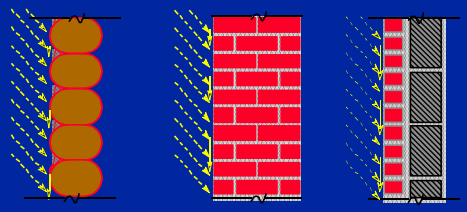
Drainage / Transmission

- Shedding always important to reduce rain load (Deflection)
- Internal drainage and transmission: differentiation of rain control approach

Envelope Classification



Mass Walls



Log | Solid Brick | Composite w/ filled collar joint

Ulm, Germany

Mass or Storage (Reservoir)

Note: Surface Drainage Control and reduced exposure are important

Khzia, Russia

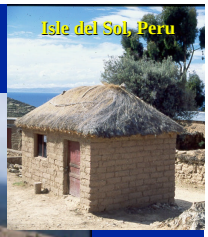
Waterloo, Canada

Storage walls

Bolivian Amazon

Rural Cambodia

Storage Walls



jlstraube 1998
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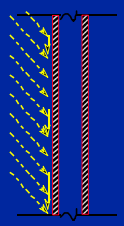
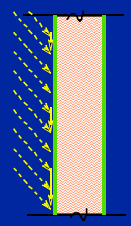
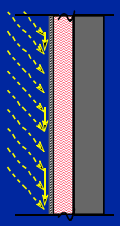
Perfect Barrier Walls



Structural Glazing



Steel-clad Foam Panels



EIFS (maybe)

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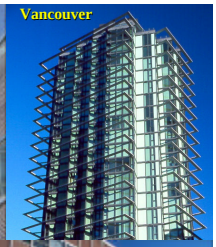
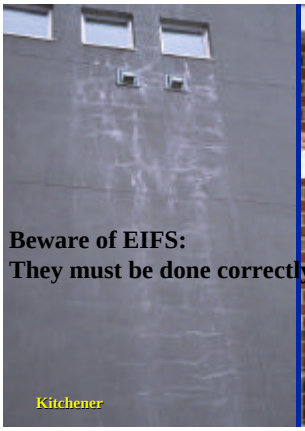
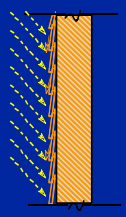
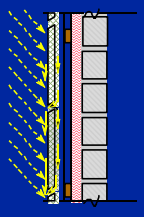




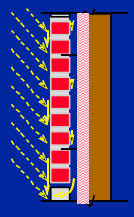
Screened Drained Walls



Lap Siding



Panel Cladding Systems



Masonry Veneer and Cavity Walls

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Screened and Drained

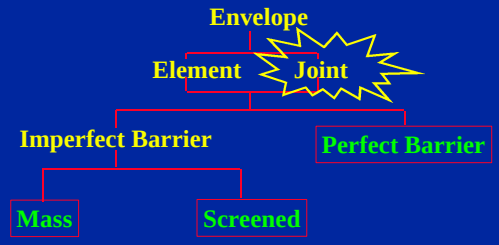
"Rainscreen Walls"

- Usually the preferred approach
- Assume water leaks through cladding
- provide clear, uninterrupted drainage
- water barriers important
  - Housewraps, building paper
  - membranes, etc
- Flashing at base and windows is critical

Ottawa

- Rain control strategies are often mixed
- Should be done with intent and consideration of exposure

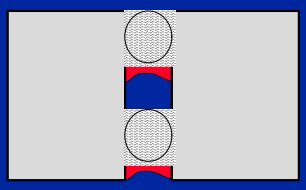
Envelope Classification



Joints

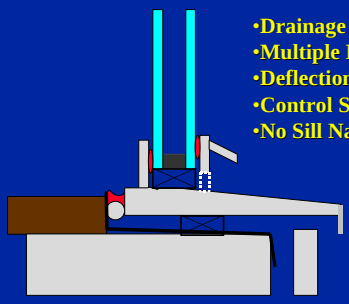
- Can be:
  - mass (e.g., log chink)
  - perfect barrier (e.g., sealant)
  - screened drained (e.g., two-stage joints)
- Surface drainage means joints are exposed to water
- Sealants fail
- Window-wall, dryer vent, balcony penetration, electrical service, etc. are critical

Two Stage Joint



These work!

Window Joints



- Drainage
- Multiple Rain tightening
- Deflection
- Control Surface Drainage
- No Sill Nailing Flange

Vancouver, BC

Sun Valley, ID

Rain Control Conclusions

- Deflection, Drainage and Drying
- Provide overhangs, surface features to control water on surface
- Provide drainage and slopes to remove rain
- Provide drying to remove any water that stays