
## Freeze-thaw

- Must be nearly saturated while freezing
- Factors
  - degree of saturation
  - how cold
  - rate of freezing
  - pores size distribution
  - liquid diffusivity




## Dissolution

- Water is the universal solvent
- Avoid capillary saturation
- e.g.:
  - EIFS finish re-emulsification
  - Gypsum becomes goo
  - paper unglues


# Rain Control Principles



## Wetting - Sources & Mechanisms

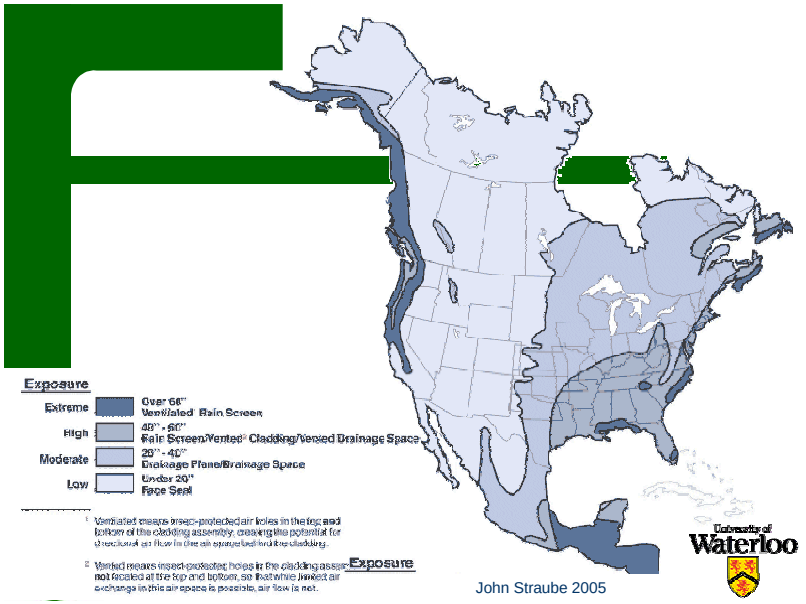
1. **Interior and Exterior Air (Vapour)**
   - transport by diffusion and air leakage *(convection)*
2. **Driving Rain (Liquid)**
   - Absorption ("wicking") and Liquid Penetration
3. **Soil Moisture (Vapour & Liquid)**
   - Diffusion, Absorption and Liquid Penetration
4. **Built-in Moisture (solid, liquid, vapour)**
   - not transported - stored in masonry/concrete, green lumber, construction rain/snow



## Driving Rain

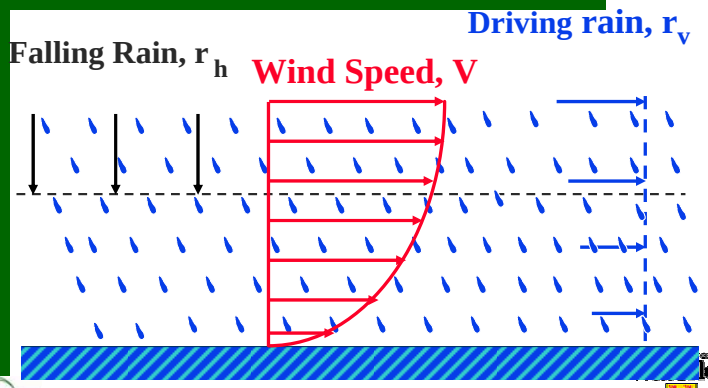
- **Site and Climate**
  - wind direction, rainfall intensity, duration, frequency
- **Building**
  - height, orientation, shape (i.e. RAF)
- **Wall**
  - shedding,
  - absorption
  - transmission





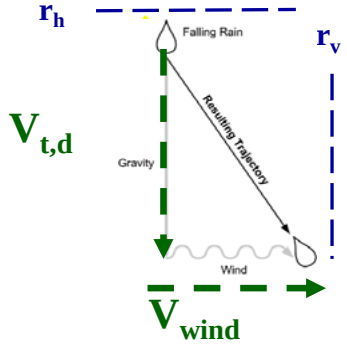



## Driving Rain



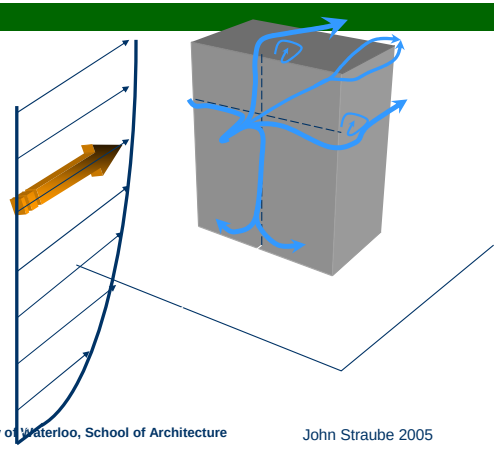



## Raindrop-Wind Interaction



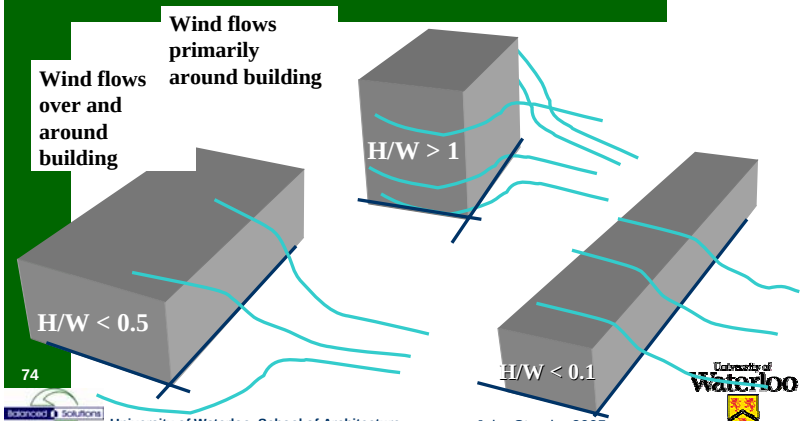

$$r_v = r_h \frac{V_{wind}}{V_{t,d}}$$

## Rain Deposition and Wind Flow Patterns



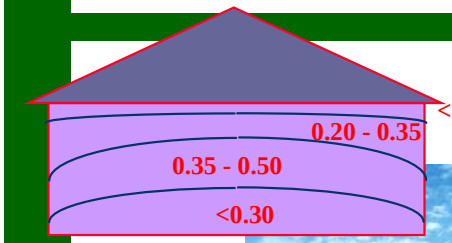


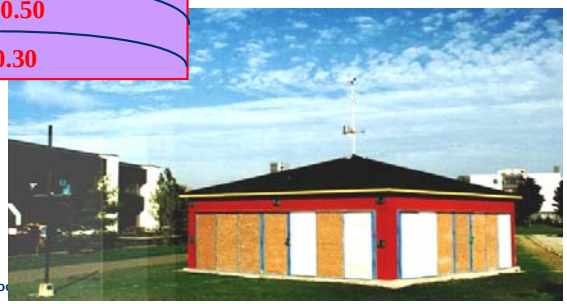
## Effect of Building Shape





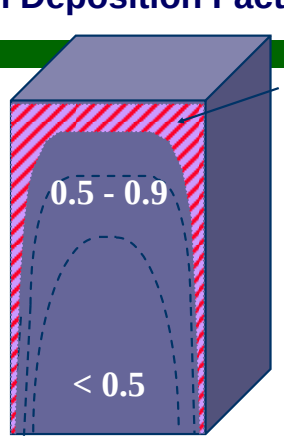

## RDF-Rain Deposition Factor





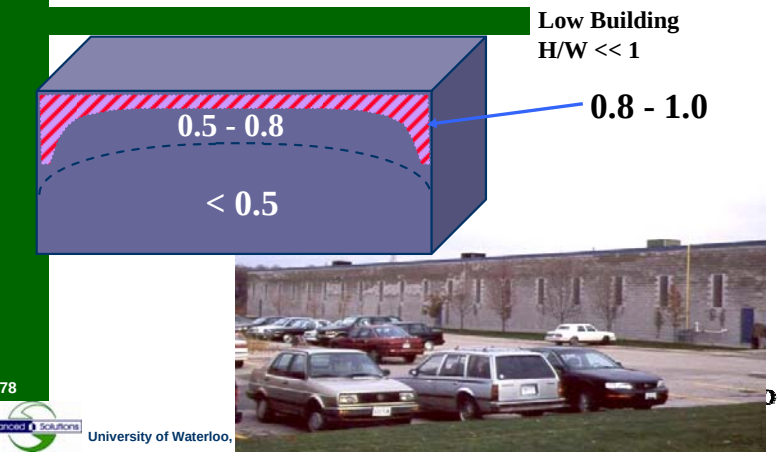
## Rain Deposition Factors




Tall Building H/W >> 1



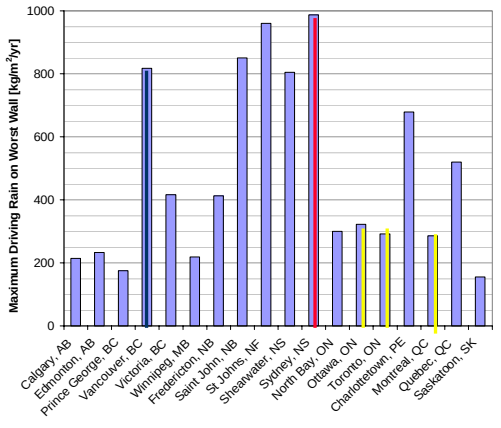
## Rain Deposition Factor



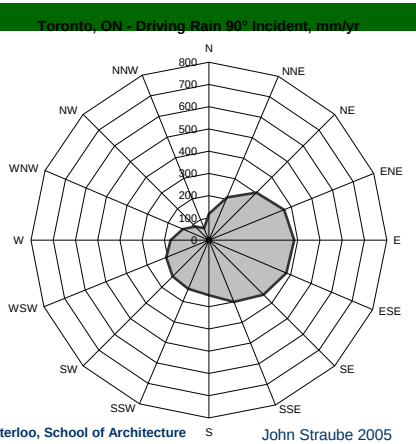





## Max Driving Rain vs City



## Total Rain Deposition: Toronto






## Rain Control Philosophy

- **The Three D's**
  - **Deflection**
  - **Drainage/Exclusion/Storage**
  - **Drying**

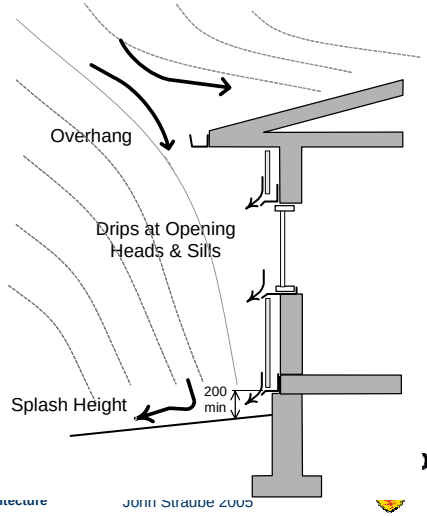


## Controlling Rain Penetration

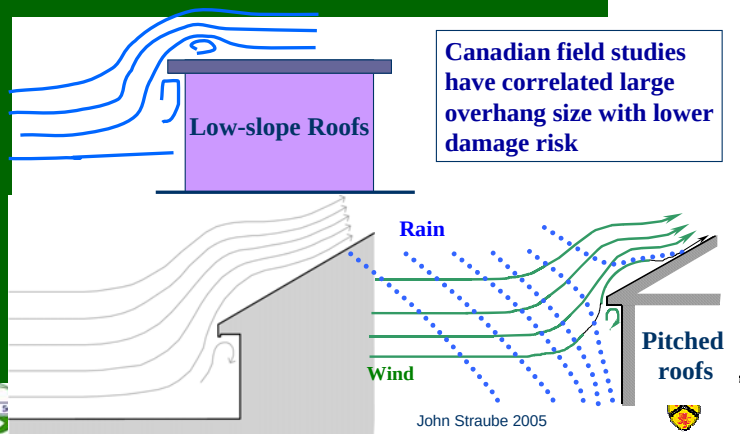
- ***Deflection***
  - reduce water on building (overhangs)
  - redirect water away (drips, shape)
  - slope surfaces, use flashing
- ***Drainage / Exclusion / Storage***
  - enclosure design
  - provide drainage, or storage or barrier
- ***Drying***
  - allow any remaining water to dry



## Deflection



# Effect of Overhangs



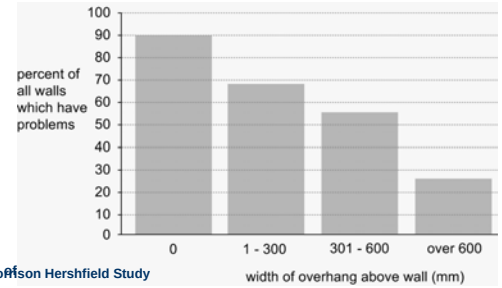

Canadian field studies have correlated large overhang size with lower damage risk





# CMHC Morrison-Hershfield Study

- Over 60% of problems were assigned to design or construction
- Effect of overhangs appeared to be significant

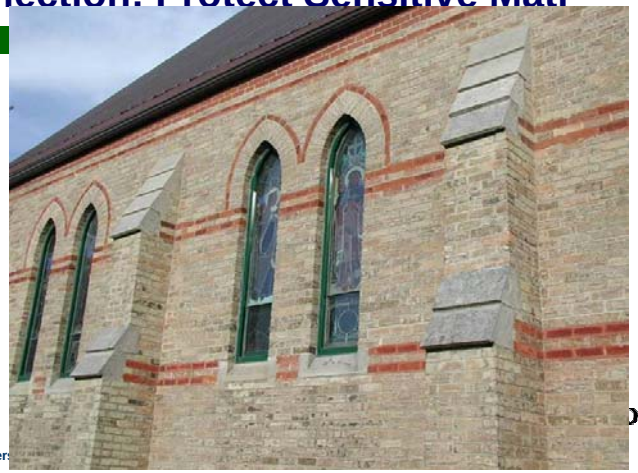









# Deflection: Protect Sensitive Matl







# Base Splash

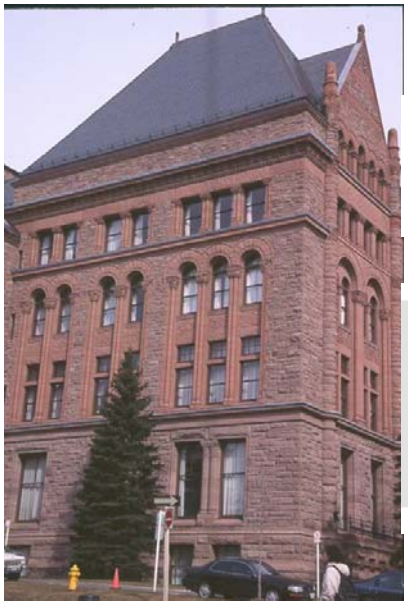
## Base Splash

## Shedding: Surface Drainage

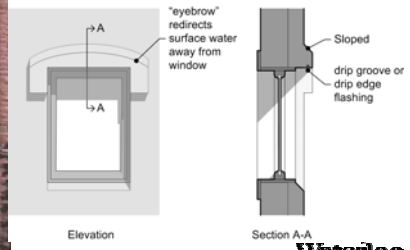
- Surface Drainage Accumulates
- Redistribute and Control via
  - Drips
  - Overhangs
- Protect Windows, Saddles, etc.

**If it doesn't get wet, it wont leak**



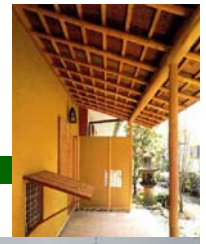


- Control Rain on the Surface
- Multiple shedding, drips, etc
- Reduced rain load on joints and openings

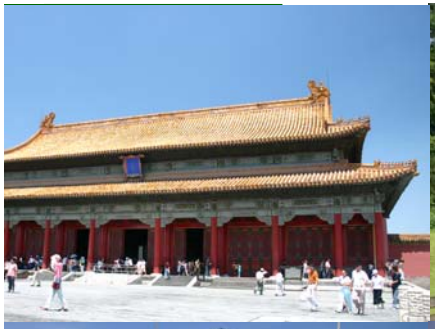





## Don’t concentrate water!



chitecture




## We still can

## Enclosure Wall Strategies

- Some water is likely on the wall
- Water can penetrate in many ways

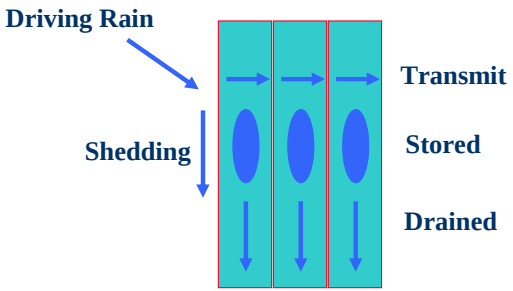
*Once rain is on the wall …*

- Drainage
- Exclusion
- Storage



## Rain Control

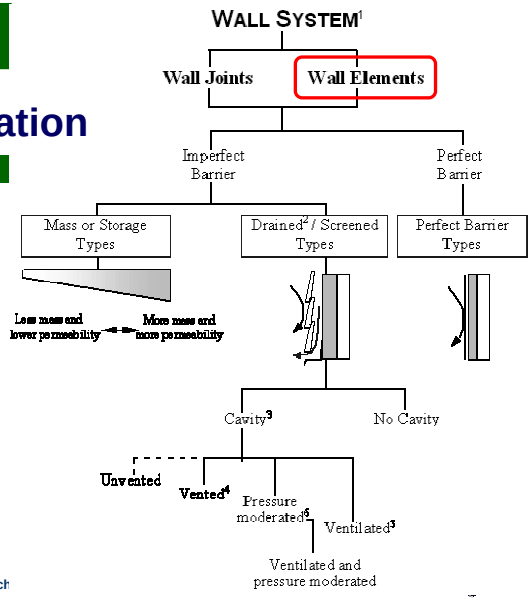
- Rain Deposition: Drained, Stored, or Transmitted



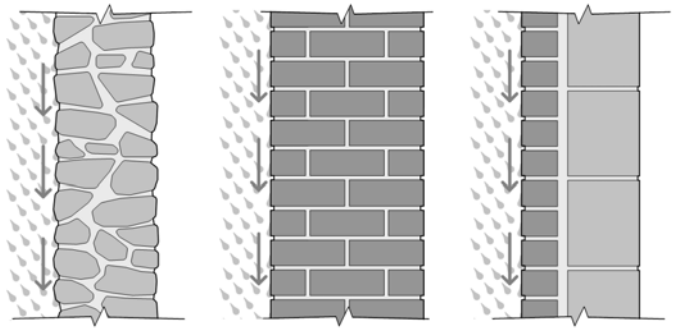



## Categorization

- Elements and joints can be different



## Mass/Storage/Reservoir Walls

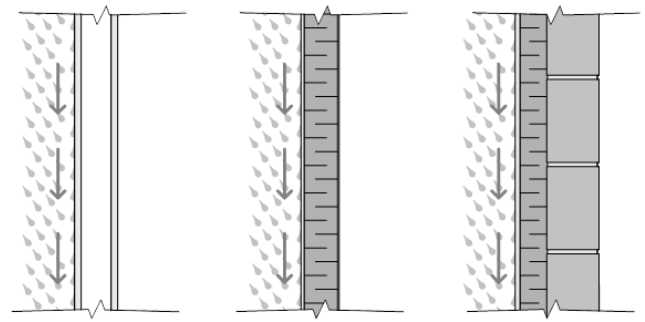


rubble  solid masonry  composite/layered





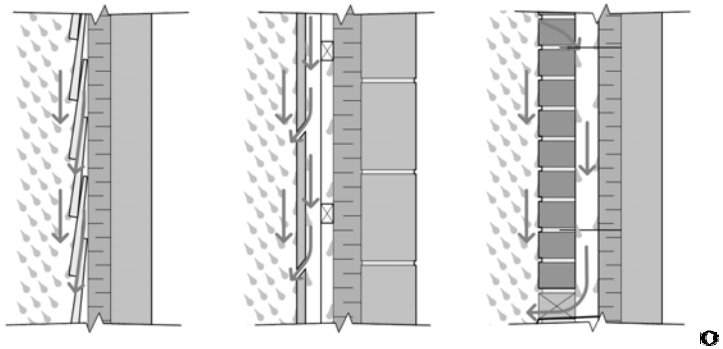

## Perfect Barrier Walls



structural glazing  steel-clad foam panels  face-sealed EIFS



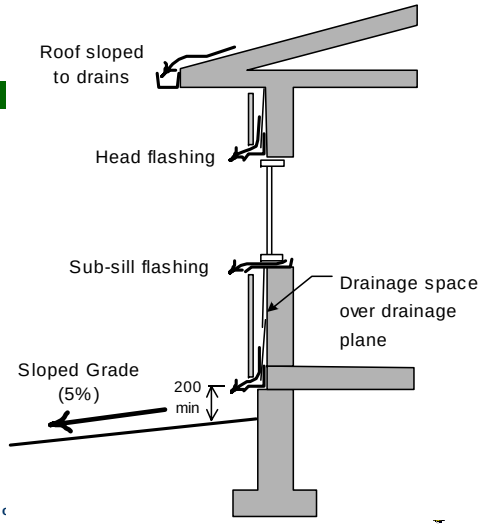
## Drained-Screened Walls








## Drainage

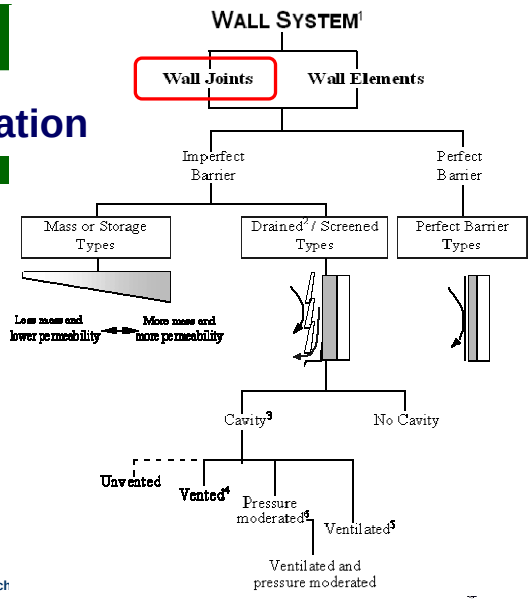





## Joints

- Can be
  - mass (log chink)
  - perfect barrier (sealant)
  - screened drained (two-stage joints)
- Surface Drainage means joints are exposed to water
- Sealants fail
- Window-wall, stucco-masonry etc

## Categorization





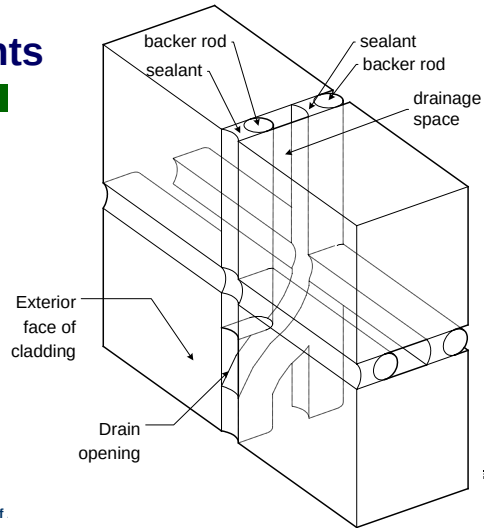



## Drained Joints

Inner stage could be
- sealant
- gaskets
- peel and sticks
- trowel-on

Must be drained

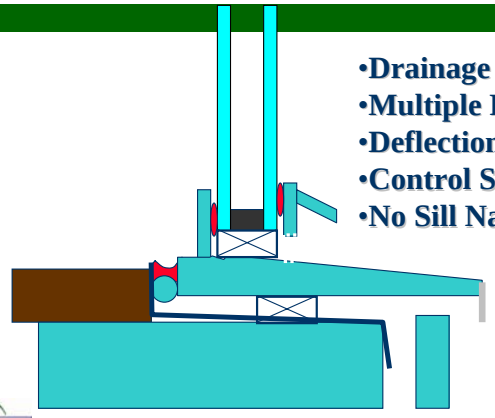
Vented helps







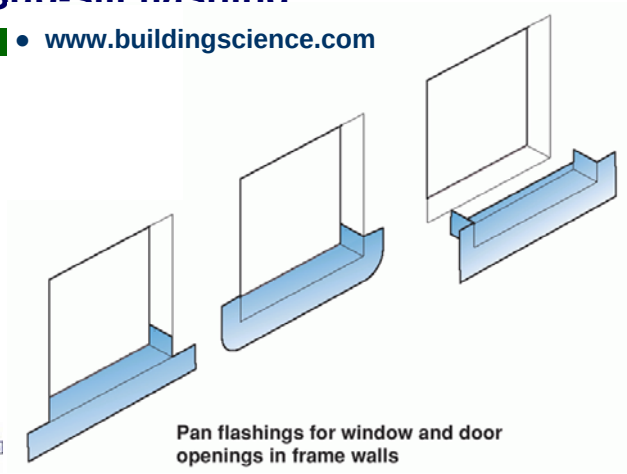

## Window Joints



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

## Sub-sill flashing

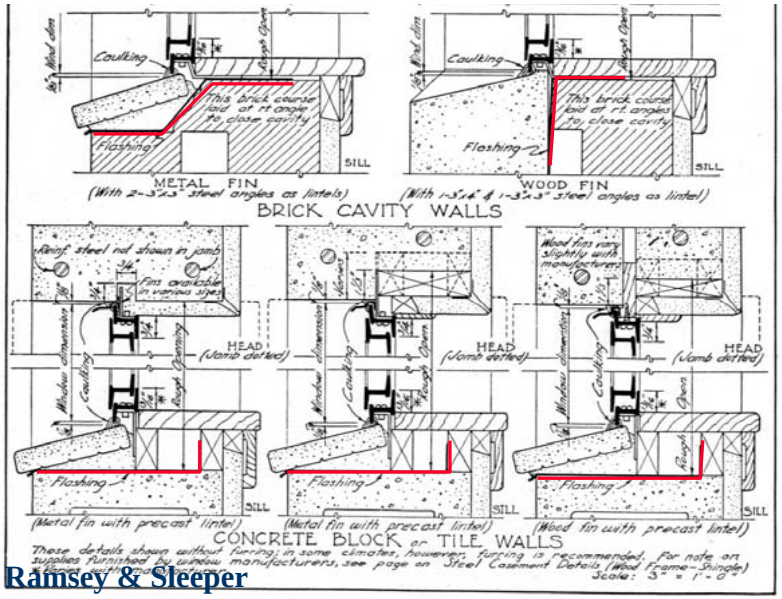
- www.buildingscience.com



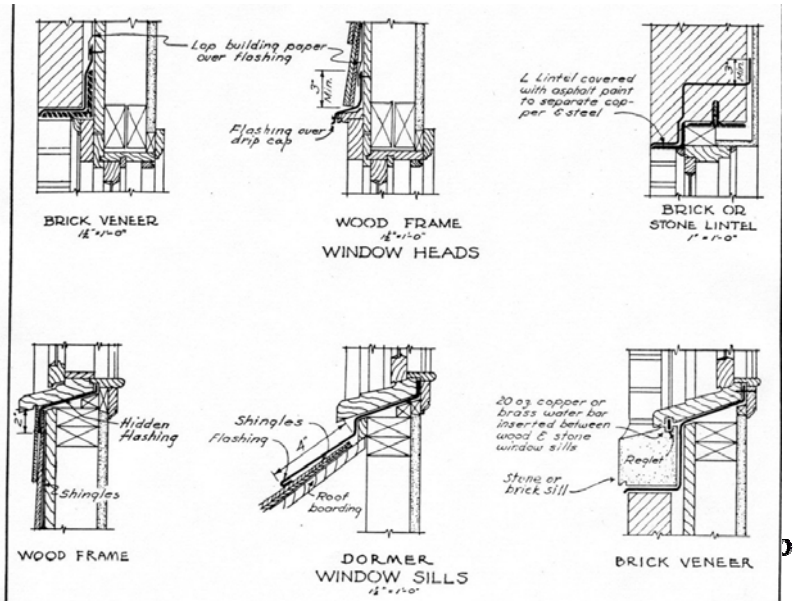
Pan flashings for window and door openings in frame walls



## Subsill


Ramsey & Sleeper



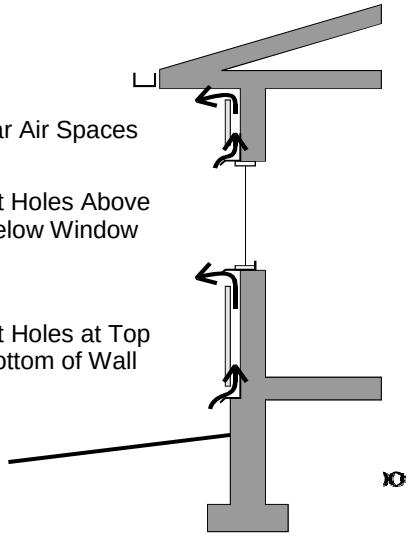
# Drying

- **Important for some systems that retain drain water**
- **Helps for small leaks**

Clear Air Spaces

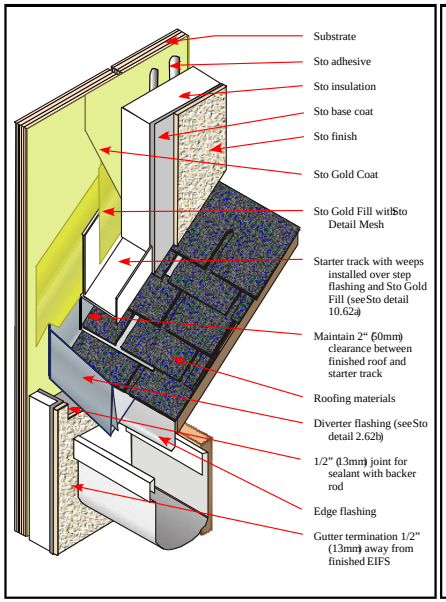
Vent Holes Above & Below Window

Vent Holes at Top & Bottom of Wall








**Notes:**

1] Coordinate installation of Gold Guard system and EIFS with the roof installation. Typically, the step and diverter flashings are installed as part of the roof assembly.

2] Refer to Sto detail 10.62a for integration of Gold Guard system with the step and diverter flashings.

3] Install the starter track 2" (50mm) above the finished roof and butting against the diverter flashing so water draining down the starter track will not flow over into the wall.

4] Install Sto GoldFill™ over the upper edge of the starter track and coat with Sto Gold Coat™.

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