Moisture Sources and Movement

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Old Buildings = durable? buildings

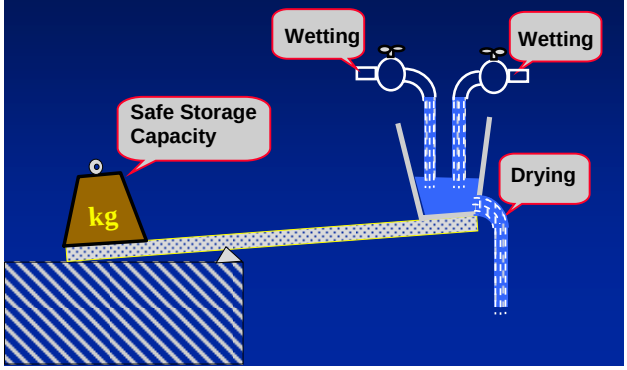
Moisture and Buildings

- Moisture is involved in almost all building enclosure performance problems
  - In-service .... Durability
- Examples:
  - rot,
  - corrosion,
  - mould (IAQ)
  - termites, (!),
  - staining
  - shrinkage/swelling
  - etc.

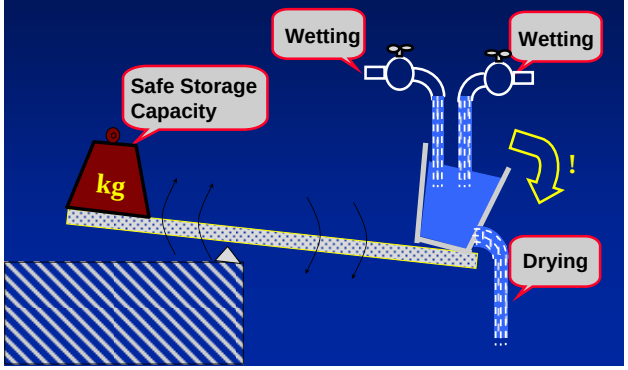
Moisture Control

- Moisture-related Problems
  1. *Moisture* must be available
  2. There must be a *route* or *path*
  3. There must be a *force* to cause movement
  4. The material must be *susceptible* to damage
- Theory: eliminate *any one* for complete control
- Practise: control *as many as possible*

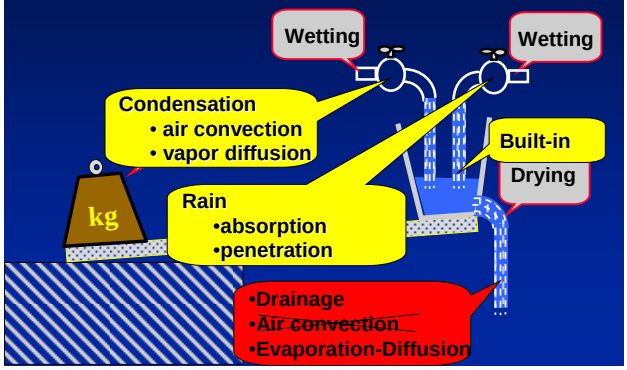
Moisture Balance

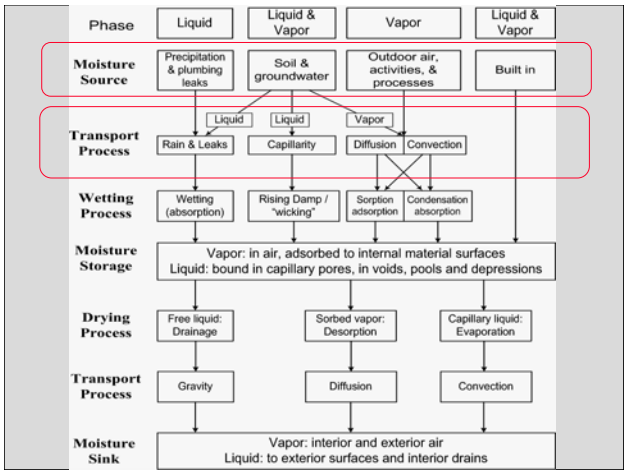


Moisture Balance



Moisture Balance





Design Choices

- Avoid wetting
- Provide enough drying to accommodate wetting
- Provide enough storage

- The balance has shifted over time

Design Solutions

- Balance wetting, drying, and storage
- Practical Rules
  - Provide a continuous plane of rain control including each enclosure detail
  - Provide continuous air barriers and insulation to control water vapor condensation problems
  - Allow drying of built-in and accidental moisture – beware drying retarders

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

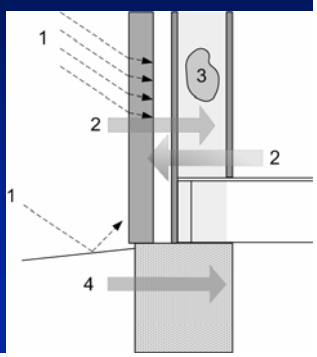
Wall Wetting Mechanisms

1. Rain
- absorption
- penetration
- splash and drips

2. Water Vapour
- Diffusion
- Convection (air leaks)

3. Built-in
- vapor, liquid

4. Ground
- capillary, diffusion



Wetting means we need drying

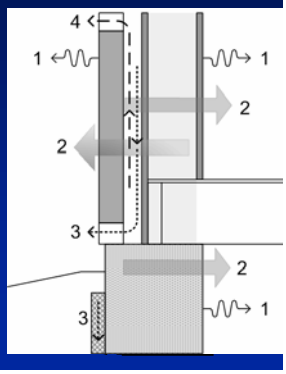
- We are not perfect.
- Our buildings are not perfect.
- Therefore, our buildings get wet
- So provide drying

Drying - Where to and How

1. To Exterior (liquid)
   - drainage *free liquid water only*
   - stops leaving materials saturated
2. To Exterior or Interior Air (vapour)
   - first, evaporation then:
   - air leakage (convection)
     - ventilation (e.g. for vapour resistant cladding)
   - diffusion
     - vapour barriers slow drying

Wall Drying Mechanisms

1. Surface Evaporation
2. i) Diffusion
   ii) Convection
3. Drainage
4. Ventilation



Storage

- Bridges gap in time between wetting and drying
- How much moisture for how long before damage
- *Safe* storage
  - mold, rot, freeze-thaw, corrosion
- *Amount* of storage
  - e.g. steel stud, vs wood stud vs concrete block
  - 1: 10 : 100+
- Basic mechanisms
  - capillary pores (*bound liquid*)
  - sorption (*vapour*)
  - pools and puddles (*free liquid*)

Safe Storage Capacity

- Different materials react differently
- Primary environmental variables
  - temperature, time of wetness, RH (=MC)

Approximate Thresholds

- Mould, fungi, corrosion, etc.:
  - Over 80%RH, > 5 C/40 F "for some time"
- Freeze-thaw, dissolution:
  - from 100%RH to saturated

Transport

- Vapour
  - Air movement
  - Diffusion
- Liquid
  - Wicking
  - Gravity
- Solid
  - Wind blown snow

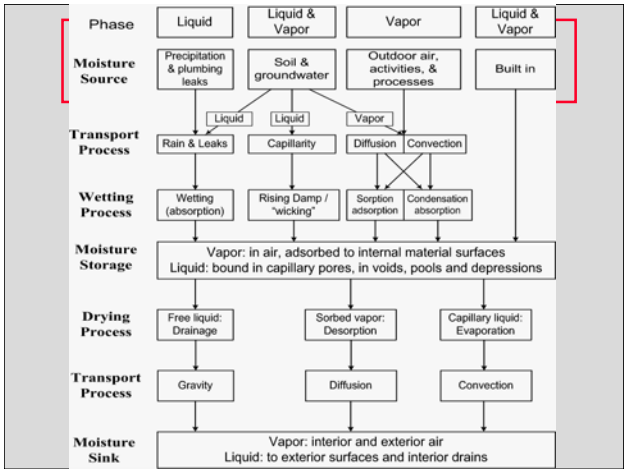
Applications

- Moisture Sources and transport
- Many stages, changes pahse

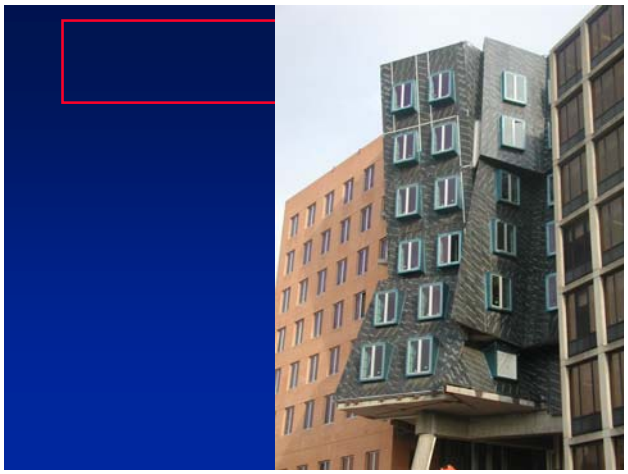
Wetting

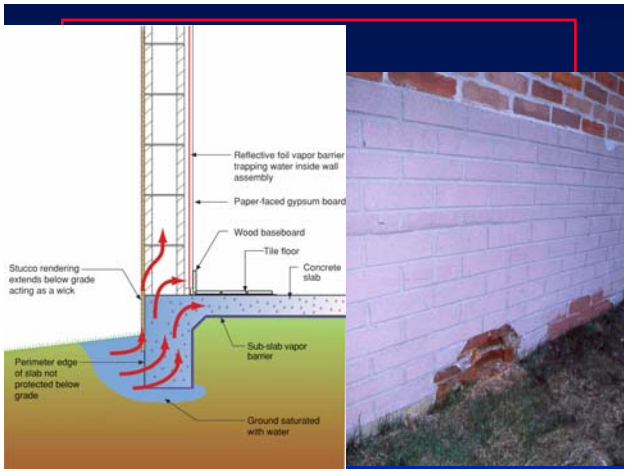
- HVAC condensate
- Plumbing leaks

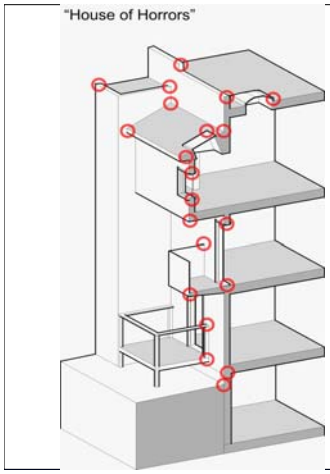
Crawlspace below grade



Gravity

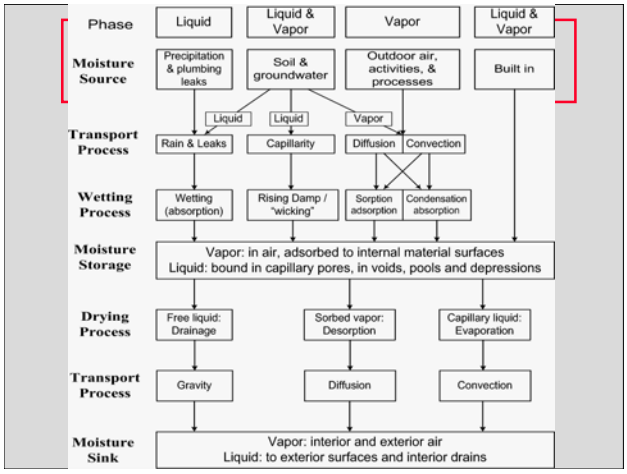


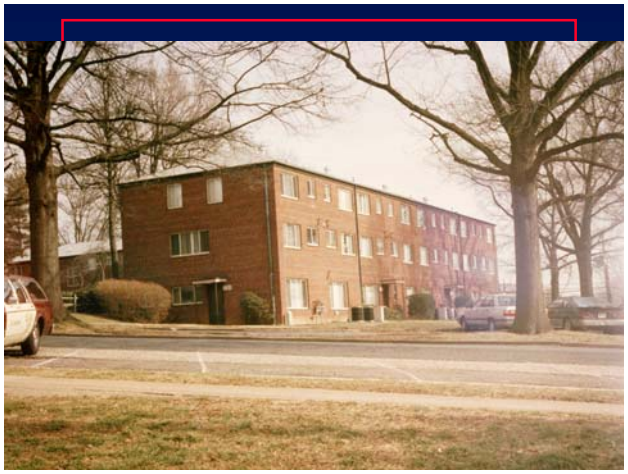




Details demand the same approach as the enclosure.

Scaled drawings required at ◯


Phase
Liquid
Liquid & Vapor
Vapor
Liquid & Vapor
Moisture Source
Precipitation & plumbing leaks
Soil & groundwater
Outdoor air, activities, & processes
Built in
Liquid
Liquid
Vapor
Transport Process
Rain & Leaks
Capillarity
Diffusion
Convection
Wetting Process
Wetting (absorption)
Rising Damp / "wicking"
Sorption adsorption
Condensation absorption
Moisture Storage
Vapor: in air, adsorbed to internal material surfaces
Liquid: bound in capillary pores, in voids, pools and depressions
Drying Process
Free liquid: Drainage
Sorbed vapor: Desorption
Capillary liquid: Evaporation
Transport Process
Gravity
Diffusion
Convection
Moisture Sink
Vapor: interior and exterior air
Liquid: to exterior surfaces and interior drains



Enclosure Design for Durability

- Balance wetting, drying and storage potentials
- Durability:
  - choice of materials and
  - their arrangement for
  - the microclimates expected

Material Performance

- How to predict performance?
- We test materials and are interested in homes Must know loads, microclimate=exposure
- "No Bad Material,
  Just Materials Used Badly"

Material Performance Thresholds

- Corrosion
- Mould
- Decay
- Freeze-thaw
- Dissolution/Dissassociation
- Shrinkage/Swelling
- All are temperature and moisture

Moisture

- Need to understand more to deal with it
  - Durability
  - Health
  - Energy

The Conclusions

- Moisture

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