Creative New Ways In Which Moisture Is Damaging Our Buildings

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Top Ten Warranty Callbacks

1. Managing consumer expectations
2. Shrinkage (nail pops, cracked concrete)
3. Water leakage (grading, cracks, bad flashing details)
4. Interior finish damage (stains, joint movement)
5. Ventilation and condensation
6. Flooring (squeaks, wet framing)
7. Air leakage
8. Exterior finish damage
9. Grading/landscaping (drainage, etc.)
10. Plumbing (leaks, septic systems)

The Most Important Thing You Will Ever Learn About Building Science…

"Except For Structural Errors, About 90% Of All Building Problems Are Associated With Water In Some Way."

(ASTM)

How Moisture Can Damage A Building

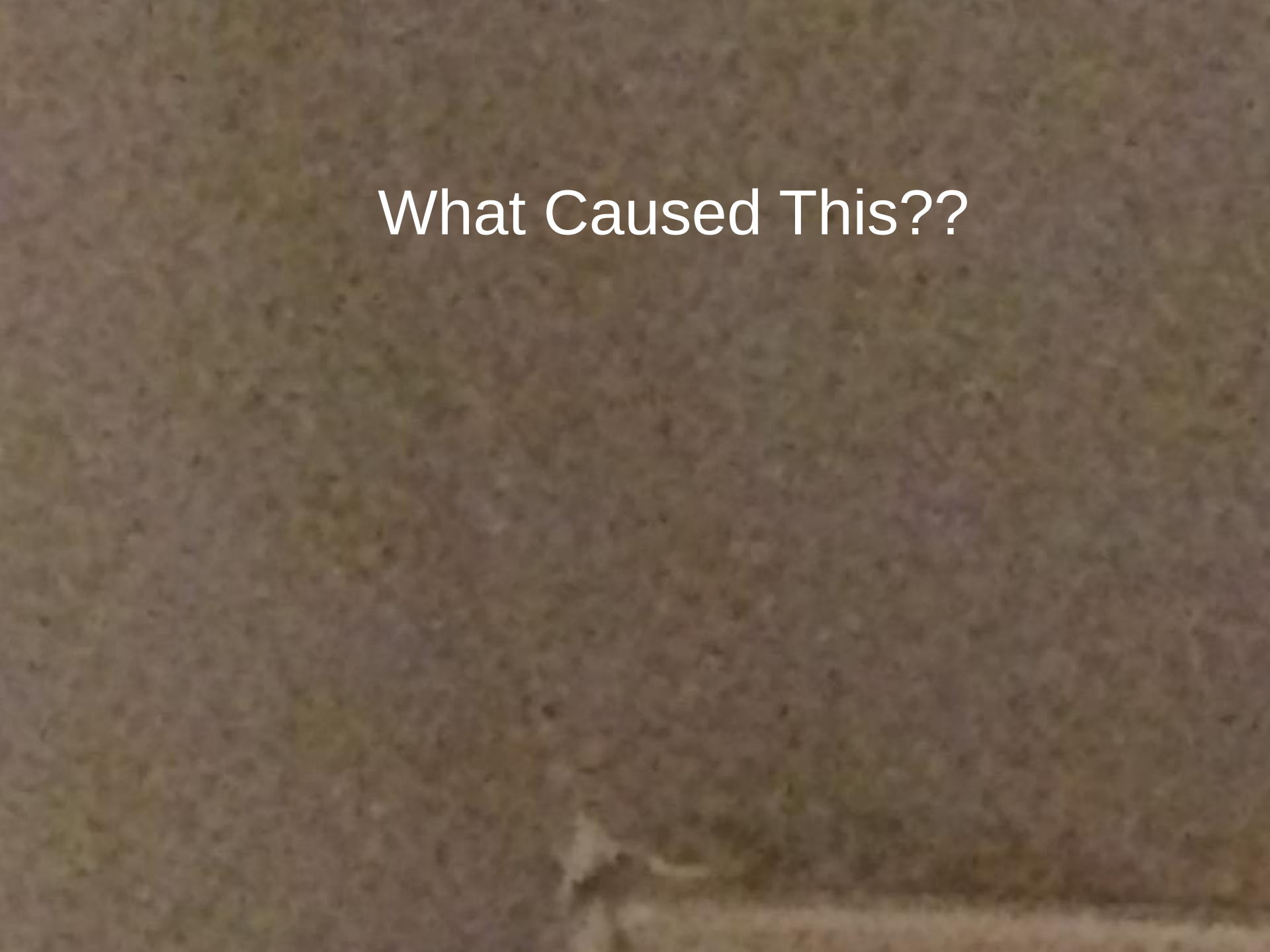
- Wood rot.
- Mould growth on exposed or hidden surfaces.
- Degradation of non-moisture resistant materials.
- Freeze/thaw damage.
- Delamination and paint peeling.
- Dimensional changes in materials.
- Efflorescence.
- Insulation wetting.

If We Can Control Moisture We Can Expect Our Buildings To Last For Centuries

Norwegian Stave Church
- All wood
- Built at end of 12th century
- No major reconstruction performed
- Still under warranty?

How To Control Moisture Flow

- Involves 3 strategies:
  - Producing less moisture indoors
  - Exhausting excess indoor moisture
  - Using construction techniques and building materials that keep moisture away from the structure.


What Caused This??

Condensation

- Occurs when air is cooled to its “dew point” temperature; the air is saturated and can not hold more water vapour.

- There are two types of condensation:
    1. Surface condensation (usually a minor problem).
    2. Interstitial condensation (usually a major problem this is the building science equivalent of cancer).

Surface Condensation

Interstitial Condensation

How Does Moisture Flow?

Moisture always flows from the wetter object to the dryer object – so, follow the water…

There are four mechanisms by which moisture can flow from a wet area to a dry area:

1. Vapour diffusion - minor
2. Air leakage - huge
3. Capillarity – usually moderate
4. Gravity – usually moderate, sometimes huge

The Major Threat Which Moisture Poses To The Building Envelope Is From Air Exfiltration / Interstitial Moisture Deposition

Moisture Transport Mechanism #1 - Vapour Diffusion

- This is the process by which water vapour diffuses through solid materials.
- The material or system which restricts this movement in a building is called the “vapour barrier”.

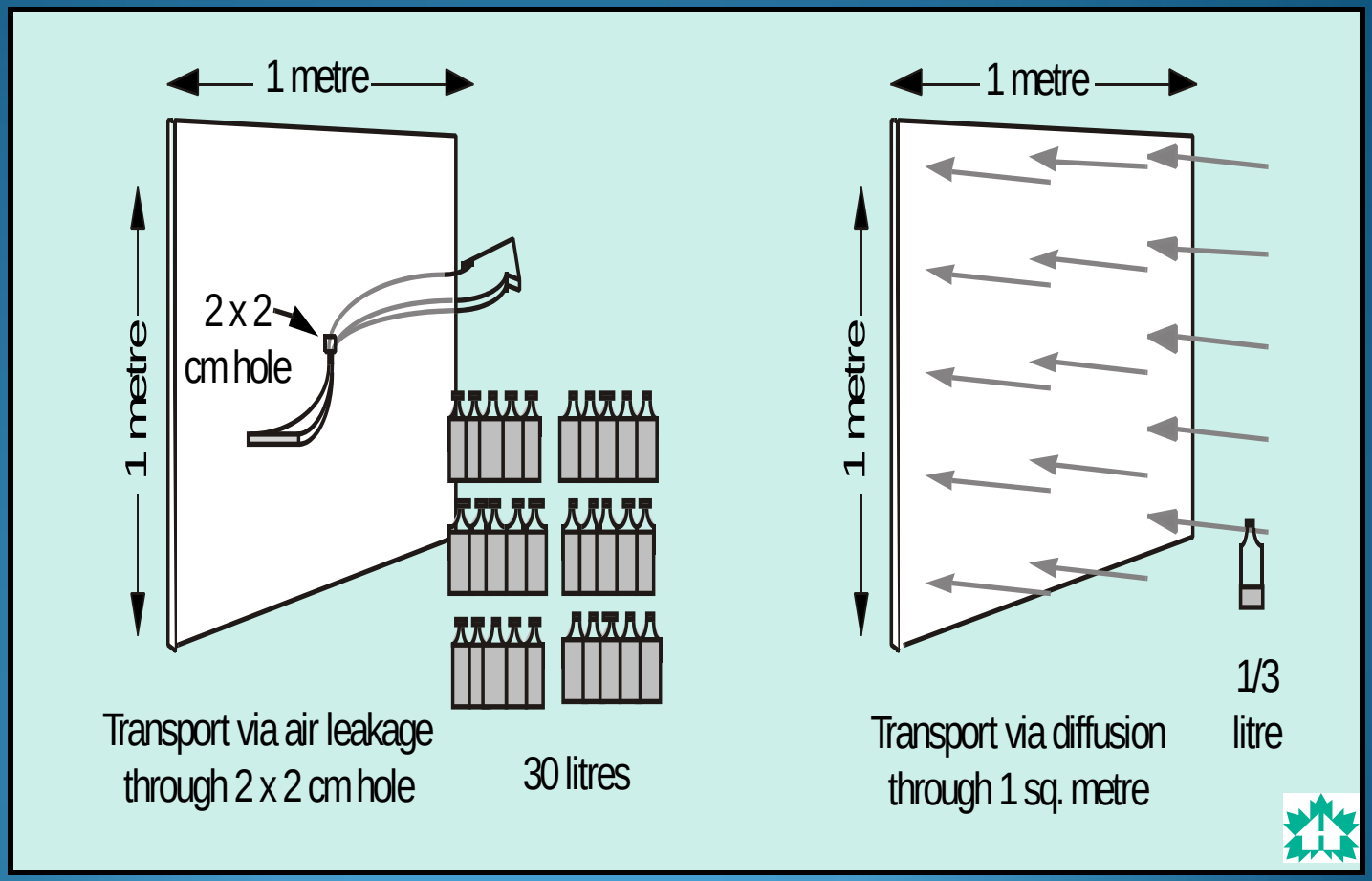
Factors Affecting Vapour Diffusion

Rate of diffusion is a function of:

- Vapour pressure
  - Influenced by moisture content of air
  - Influenced by indoor/outdoor temperature difference

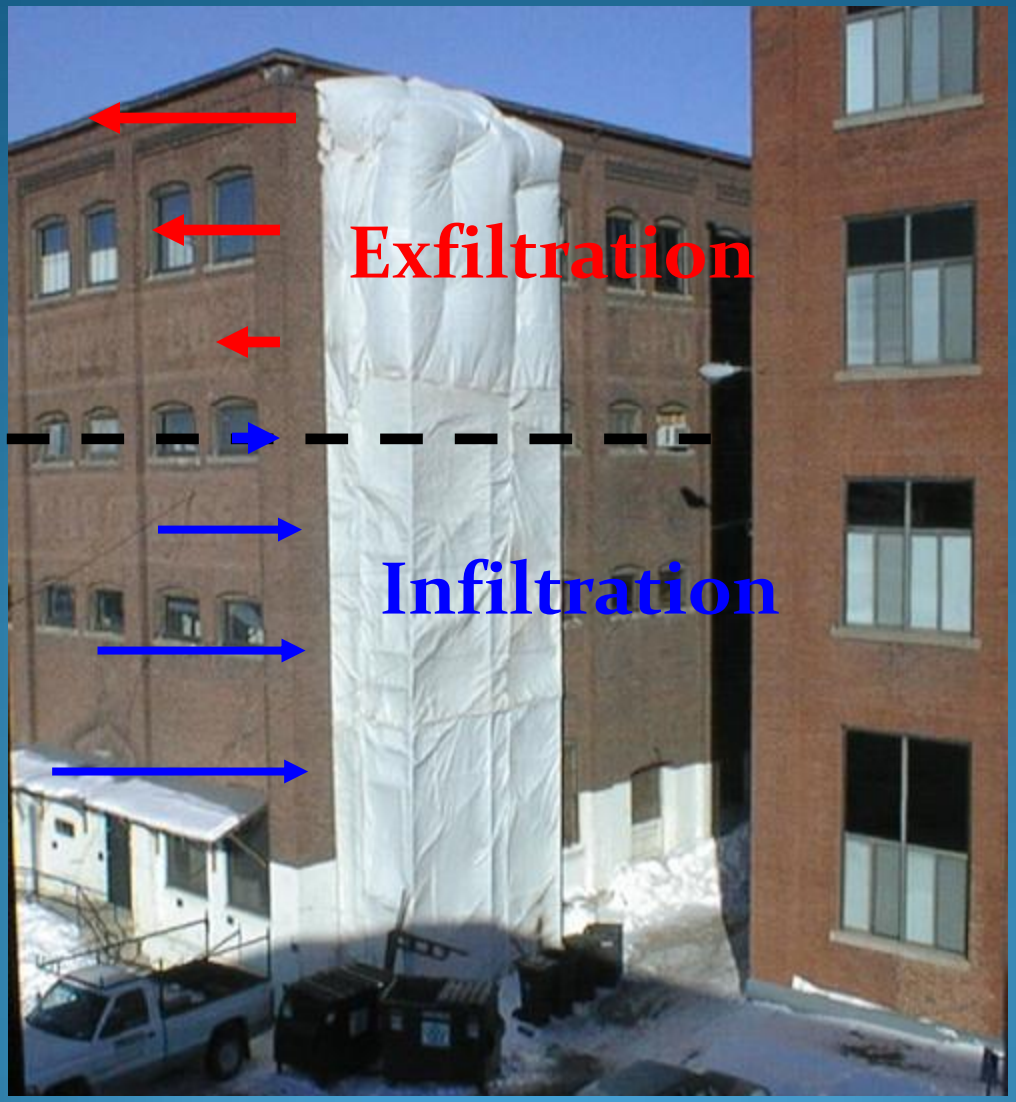
- The permeance (resistance to vapour pressure) of a material
  - The lower the perm rating the greater the resistance to vapour pressure

Moisture Transport Mechanism #2 - Air Leakage



Is The Stack Effect Real?

Neutral Pressure Plane



Air Barrier Essentials

The air barrier must be structurally supported and able to withstand wind pressures.

Must have a low permeability to air flow.

Must be durable and able to last the life of the building.

Must be continuous to restrict air leakage.

Must be rigid to provide pressure equalization behind the cladding.

Moisture Transport Mechanism #3 – Capillary Action

This is the process by which liquid water vapour moves (“wicks”) through the pores of solid materials.

Materials or systems which restrict this movement are called dampproofing.

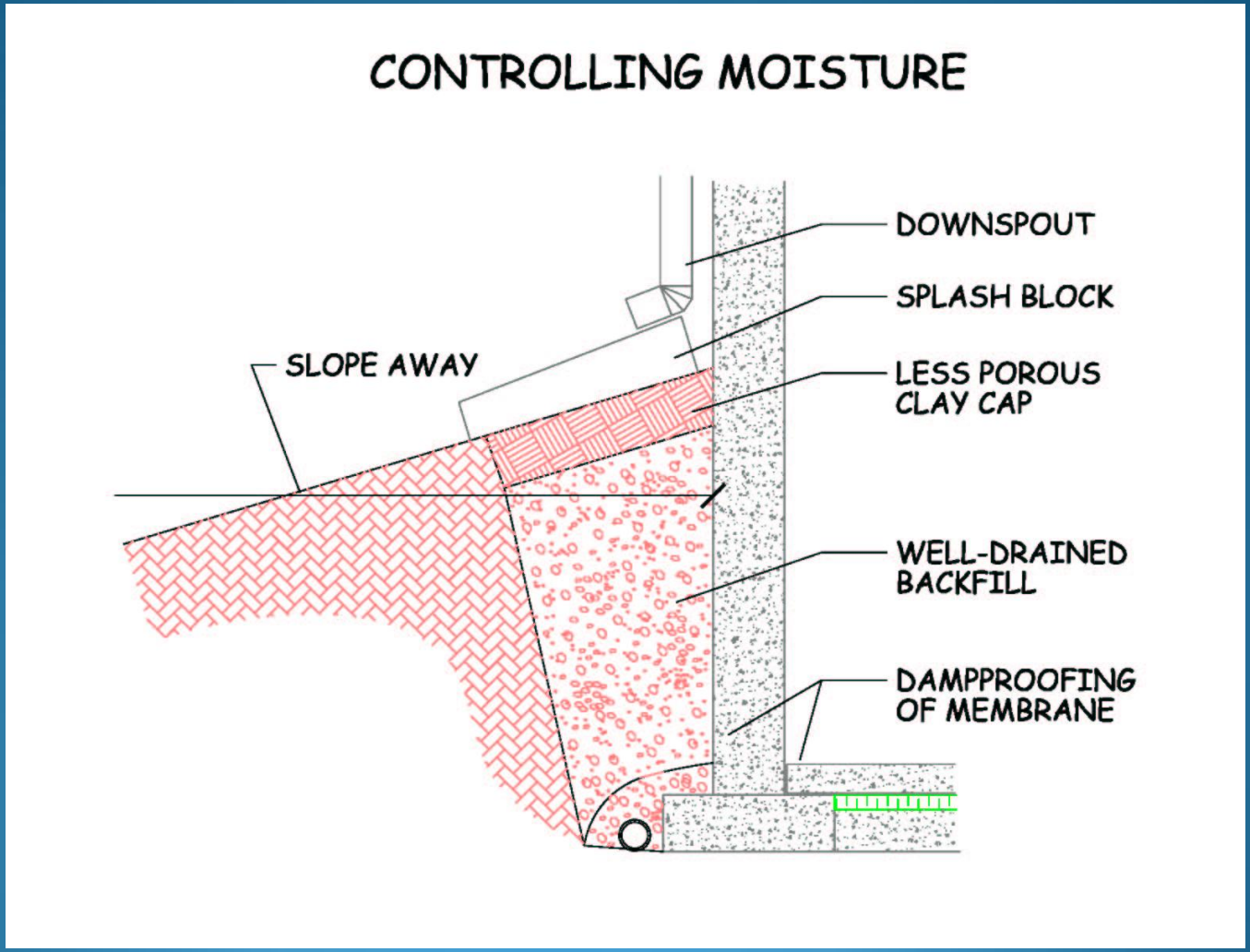
Moisture Movement By Capillary Action

While water can flow down by gravity it can also move sideways or upwards by capillary action.

For example, groundwater which is drawn upwards through concrete foundations and floor slabs.

Porous insulations have the ability to absorb water by capillary action.

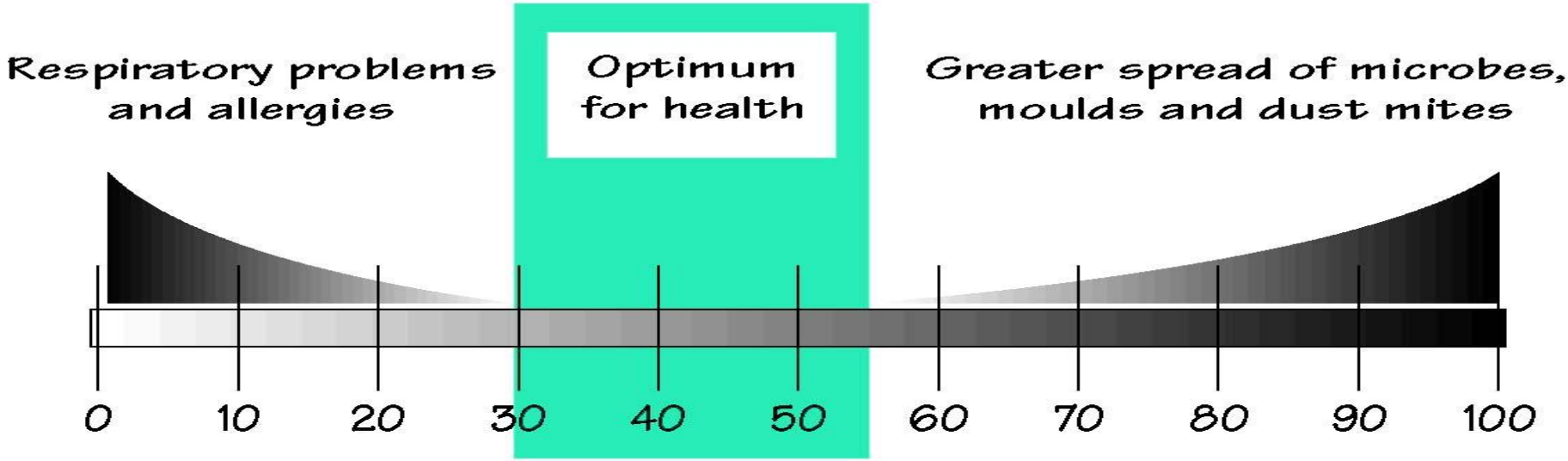
Controlling Capillary Flow



Moisture Transport Mechanism #4 - Gravity

Moisture Movement Concrete + Small Leak +

Relative Humidity And Comfort



- Too Dry
  - Static electricity
  - Cracking furniture
- Too Wet
  - Condensation on cooler surfaces
  - Binding doors

Mould Prevention Tips

- Fix plumbing leaks in the building envelope ASAP.
- Watch for condensation and wet spots.
- Vent moisture-producing appliances (dryers) to the outside.
- Maintain the relative humidity between 30% and 55%.
- Clean and dry wet or damp spots within 48 hrs.
- Don’t let foundations stay wet.
- Attack the cause of the problem, not just the symptoms.

Some Diagnostic Tools For Investigating Basement Moisture

1. Long-Term R/H Test

The higher the R/H, the greater the chance that moisture problems exist

Spot R/H measurements can be deceptive, we need long-term data

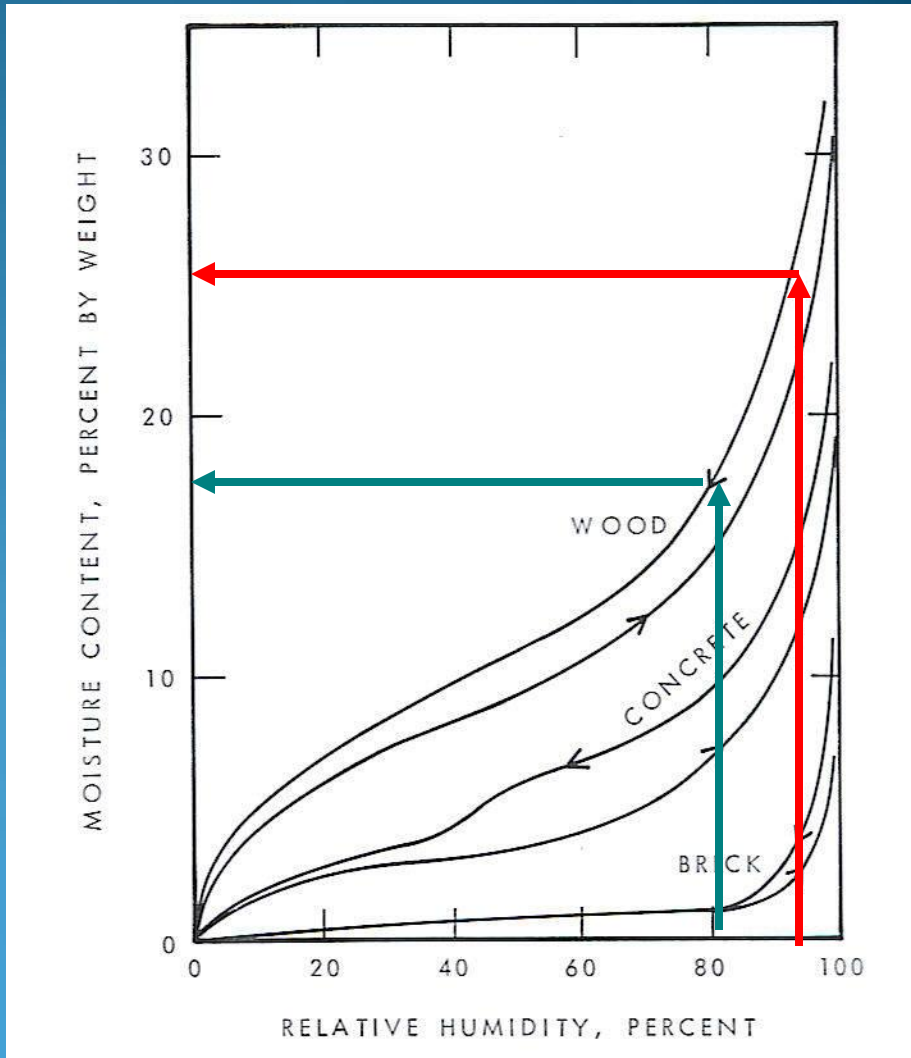
Solution is to use existing, exposed wood (e.g. floor joists)as a Duff Gauge to measure the EMC (Equilibrium Moisture Content) – by measuring the EMC, we can determine the long-term R/H of the air

Long-Term R/H Test

Some Diagnostic Tools For Investigating Basement Moisture

Moisture Threat For Wood:

EMC ≤ 19%	Low risk
19% < EMC < 28%	Medium risk
EMC ≥ 28%	High risk



Some Diagnostic Tools For Investigating Basement Moisture

2. Capillary Transport Test

- Determines whether moisture is moving through the slab by capillary action
- Tape 1’ x 1’ pieces of poly to the slab (4 or 5 per house)
- Leave for two or three days
- If moisture is present under the poly, then moisture is moving through the slab by capillary action
- If moisture is present on top of the poly, then it originated inside the house and condensed on the poly

Capillary Transport Test

Some Diagnostic Tools For Investigating Basement Moisture

3. Standing Water Test

- Determines whether moisture is moving through the slab by bulk transport (water leakage)

- Observe the slab for damp areas (which appear darker) or areas with standing water present

- Capillary action can make the slab damp, but is not capable of transporting sufficient water for standing water to develop

- Therefore, standing water indicates water leakage, somewhere

Moisture Problems

What Do We Know About Basements and Moisture Problems?

- 20% to 50% of existing home basements visited by home evaluators displayed some type of moisture problem
- Prairie basements tended to be drier while those in coastal regions tended to be wetter
- Older houses had more problems than newer houses

Reducing Moisture Problems

Grading and surface drainage (usually very effective)

- grade away from house (and remember settlement)
- terminate downspout leaders out of the backfill
- add clay cap around foundation

Ventilation (moderately effective)

- drying capability of ventilation depends on the humidity ratios of the indoor and outdoor air
- exhaust-only ventilation can increase soil gas entry rates
- combustion devices in the basement (other than direct vent units) also provide mechanical ventilation

Reducing Moisture Problems

- Mechanical dehumidification (very effective in summer)
  - air-conditioners remove moisture, however oversized units are not very effective
  - dehumidifiers can be used in the summer but their effectiveness declines rapidly below 70% R/H

- Adding a sump pit (very effective – in some cases)
  - works best if the soil under the slab is free-draining (may not work well if clay is present)
  - use a pit with side perforations to allow water to drain below the level of the leaders
  - can solve moisture problems caused by perched foundations

Window Rough-Opening Treatment

NBC Requirements For Window Installations (Part 9)
Installations shall conform to CSA A440 .4 “Window, Door and Skylight Installation” (9.7.6.1.1)

“Windows, doors and skylights shall be sealed to air barriers And vapour barriers (9.7.6.1.3)”

Acrylic Stucco

Acrylic/synthetic stucco is a manufactured product which can have widely varying permeabilities

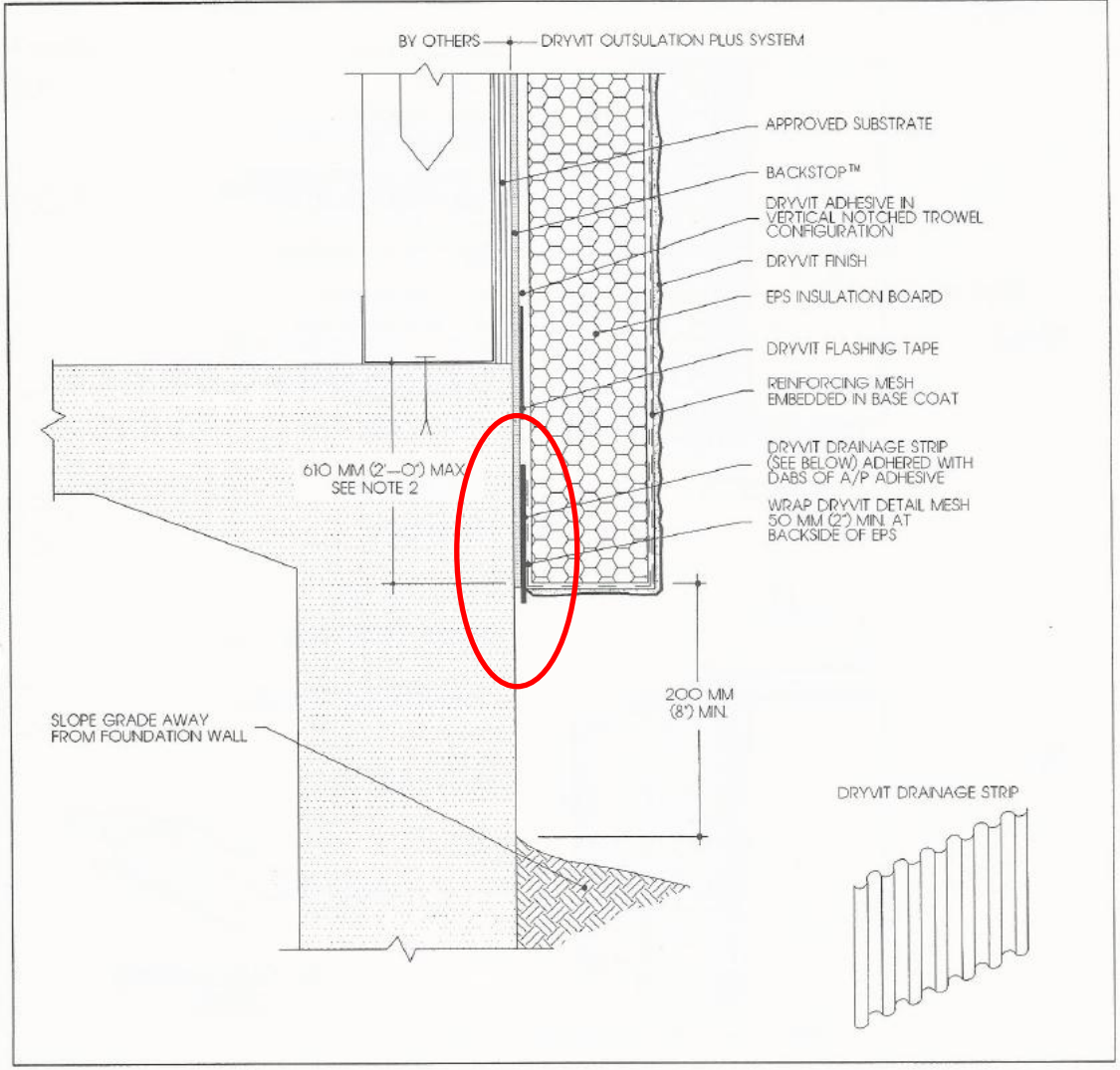
The National Research Council has started a review of the Current (2015) requirements for stucco

Acrylic Stucco

Acrylic Stucco is a very different material than traditional stucco

Traditional stucco has as relatively high permeability to water vapour.

If water gets into the wall, can it dry??



Outsulation® Plus

Foundation With Drainage Strip

NOTE:

1. DRYVIT RECOMMENDS THAT GROUND FLOOR APPLICATIONS AND ALL FACADES EXPOSED TO ABNORMAL STRESS, HIGH TRAFFIC, OR DELIBERATE IMPACT HAVE THE BASE COAT REINFORCED WITH PANZER® MESH PRIOR TO STANDARD™ OR STANDARD PLUS™ MESH. LOCATION OF HIGH IMPACT ZONES SHOULD BE INDICATED ON CONTRACT DRAWINGS.
2. EXPANSION JOINT IS REQUIRED ALONG TOP OF FOUNDATION IF 610 MM (2'—0") DIMENSION IS EXCEEDED.

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Will This Provide Adequate Drainage???

No!

Cracks May Not Be Readily Apparent

Inside

Cultured Stone Finish – Without A Rain Screen

Case Studies Of Moisture Problems In Buildings

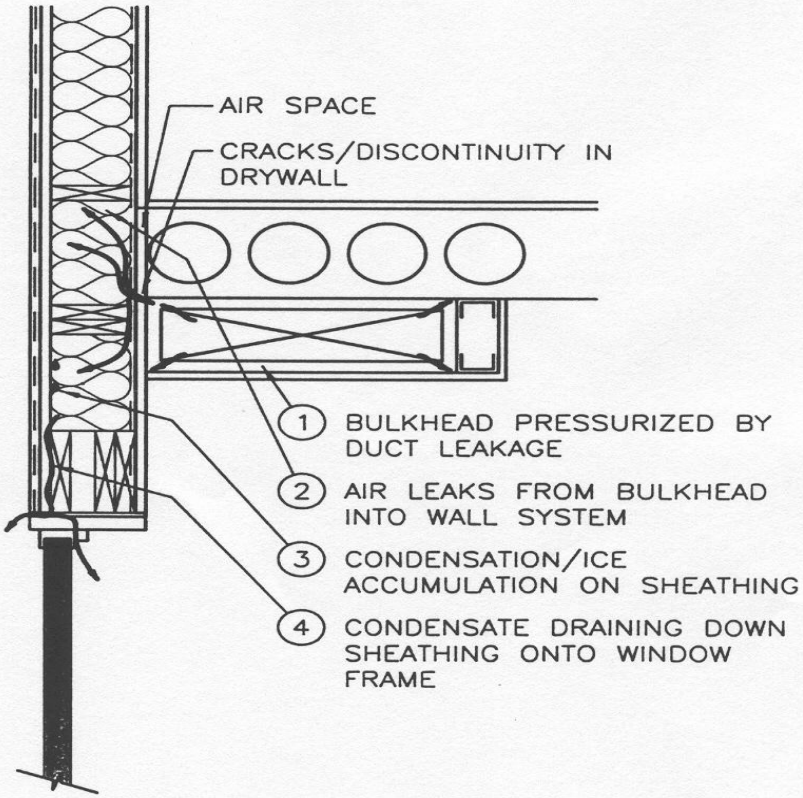
Example #1 – Multi-Storey Condo

Problem: water was observed leaking out of a newly constructed wall system above the windows. Contractor replaced several “defective” windows at considerable $$$.

Observation: the windows appeared OK.

Analysis: the ΔP across the wall system and mechanical chase were measured to determine if there was a driving force which could be pushing moisture-laden air into the wall system.

Example #1 - Condo



Example #1 - Condo

Solution: install “relief grilles” in the ductwork chases to reduce the pressure differential created by operation of the furnaces. If necessary, open up the chases and seal the wall/floor intersection to reduce air leakage.

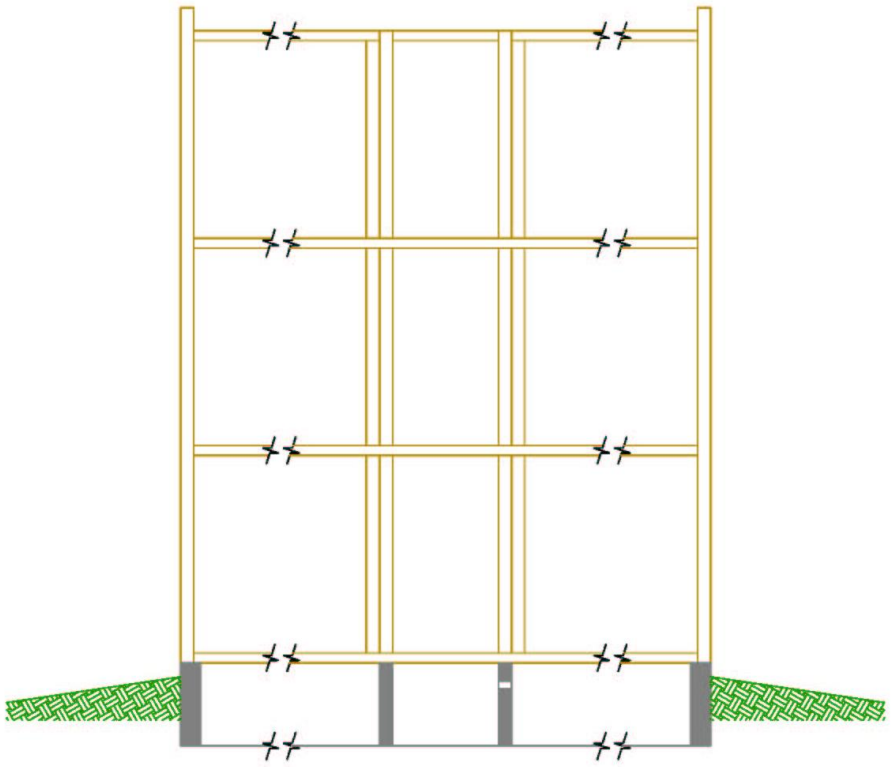
Example #2

Problem: the wooden deck of an older, three storey apartment was rotting above one suite (only); damage was also observed within the suite. The deck was repaired, mould remediation was carried out in the suite and…..the problem persisted.

Observation: the only significant source of moisture in the building was in the crawl space.

Analysis: using pressure differential analysis, the ΔP between the crawl space and the suite was measured.

Example #2 – Apartment



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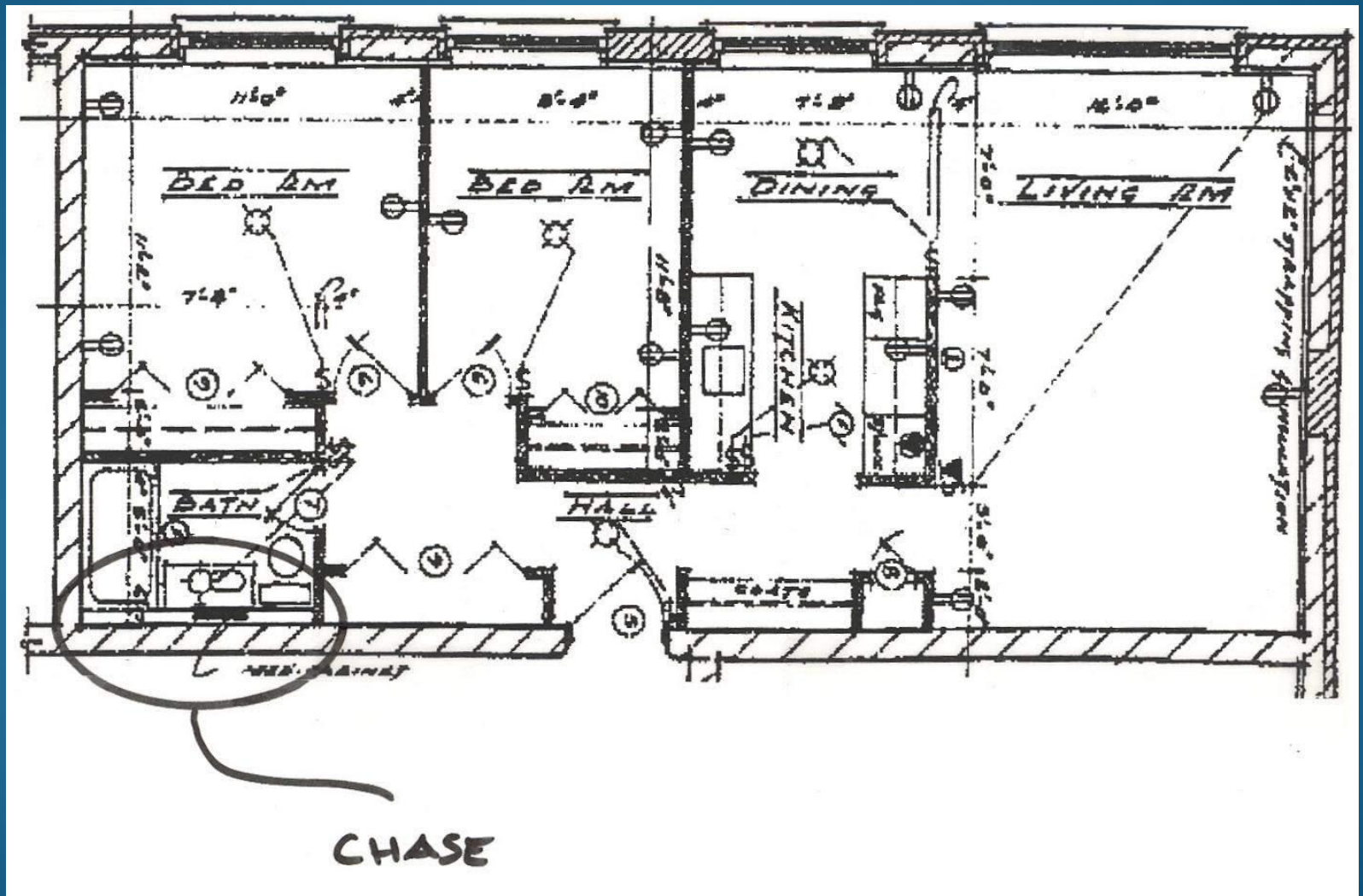

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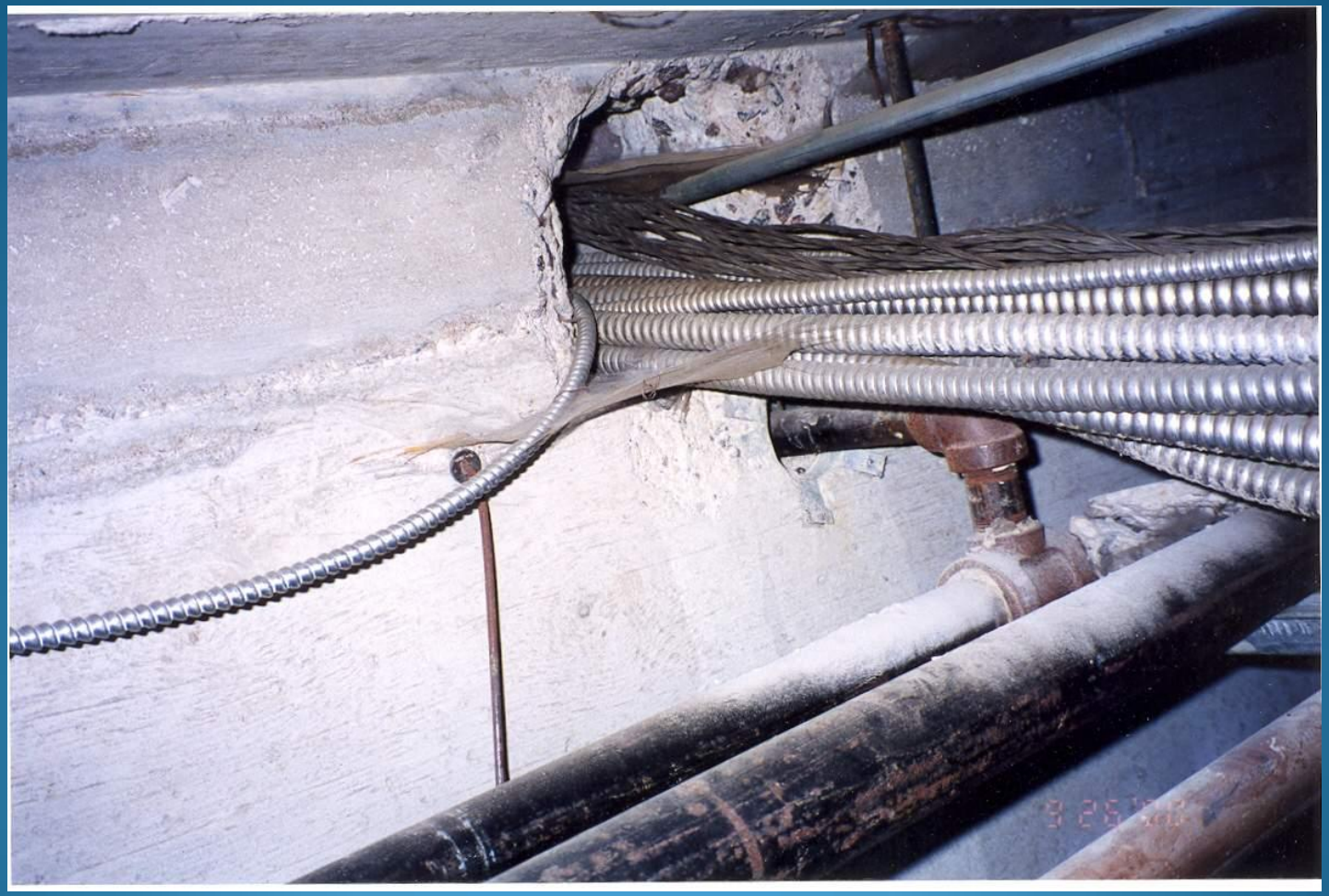

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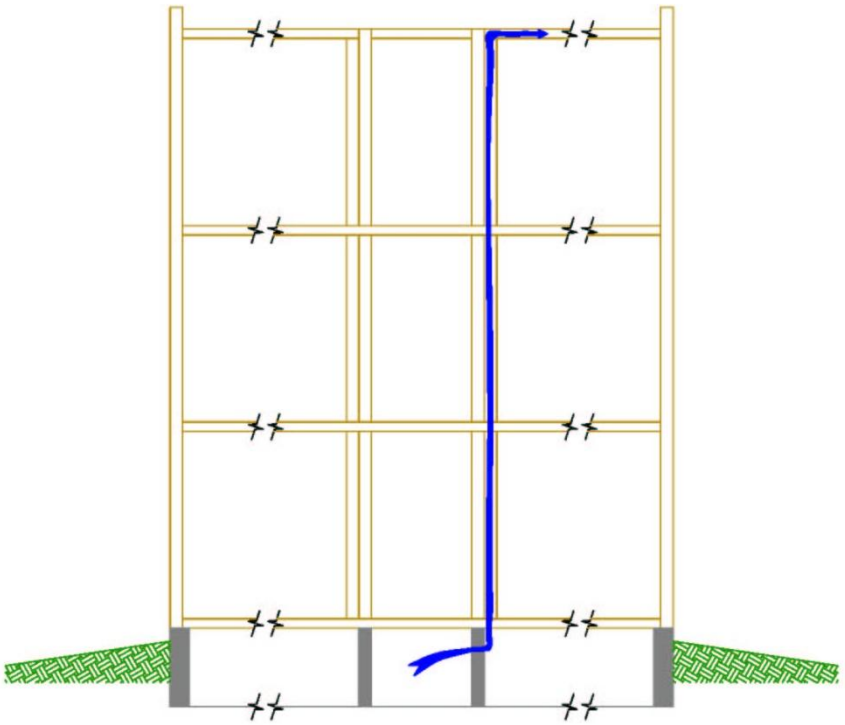

Example #2

Solution: seal the wiring penetration into the mechanical chase (top and bottom). Material cost about $10; labour cost slightly more.

Example #3 – Military Hotel

Problem: wet spots were observed on the main floor ceilings (only) of a newer, three-storey military residence. No plumbing leaks or other obvious problems were evident. Otherwise, the building was in excellent shape.

Observation: the only significant source of moisture was in the crawl space.

Analysis: an air leakage examination was conducted to determine if there could be a pathway from the crawl space to the interior of the hollow core slabs from which the floors were constructed.

Example #3

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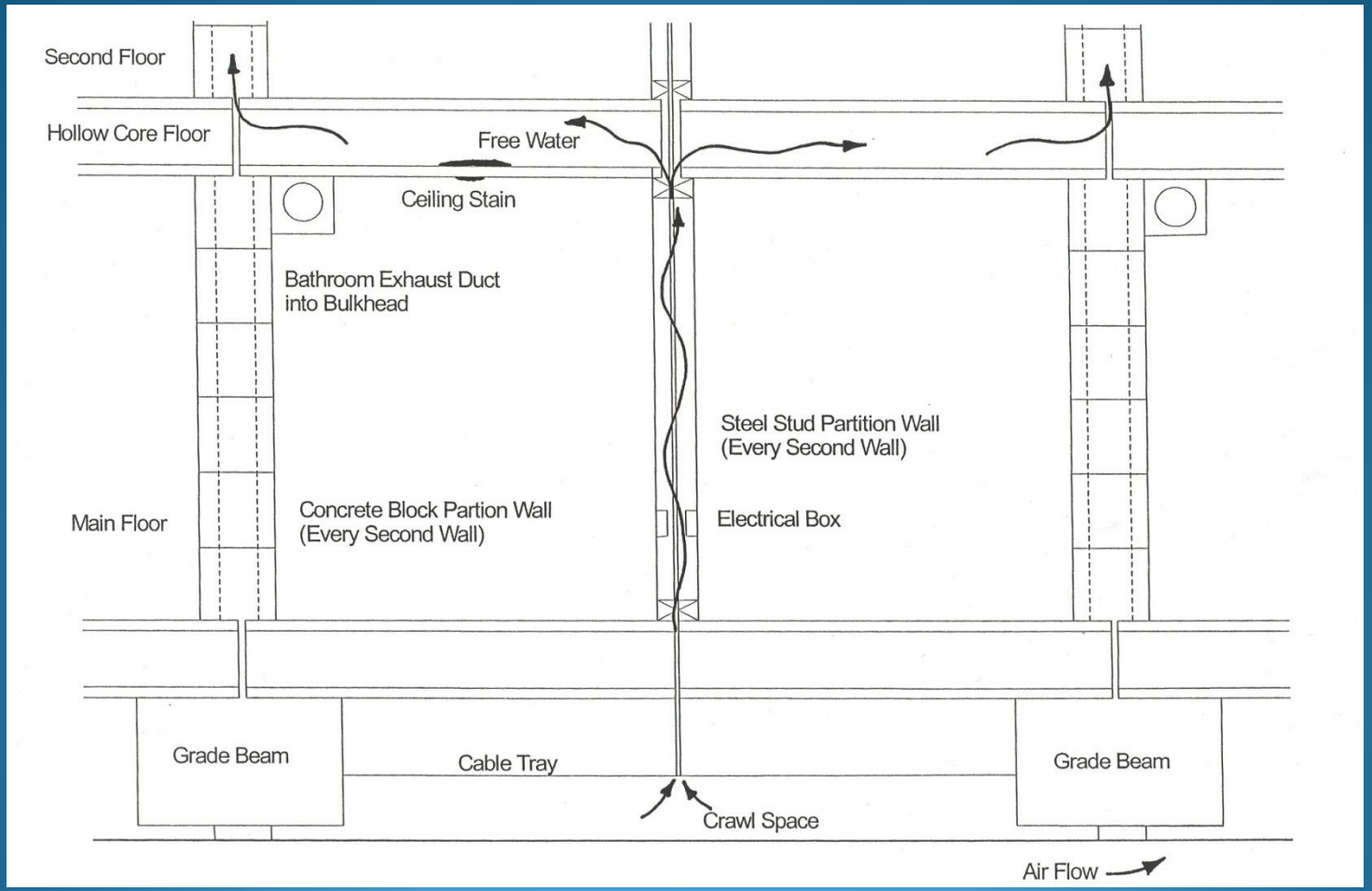

Second Floor
Hollow Core Floor
Free Water
Ceiling Stain
Bathroom Exhaust Duct
into Bulkhead
Steel Stud Partition Wall
(Every Second Wall)
Main Floor
Concrete Block Partion Wall
(Every Second Wall)
Electrical Box
Grade Beam
Cable Tray
Grade Beam
Crawl Space
Air Flow

Example #3

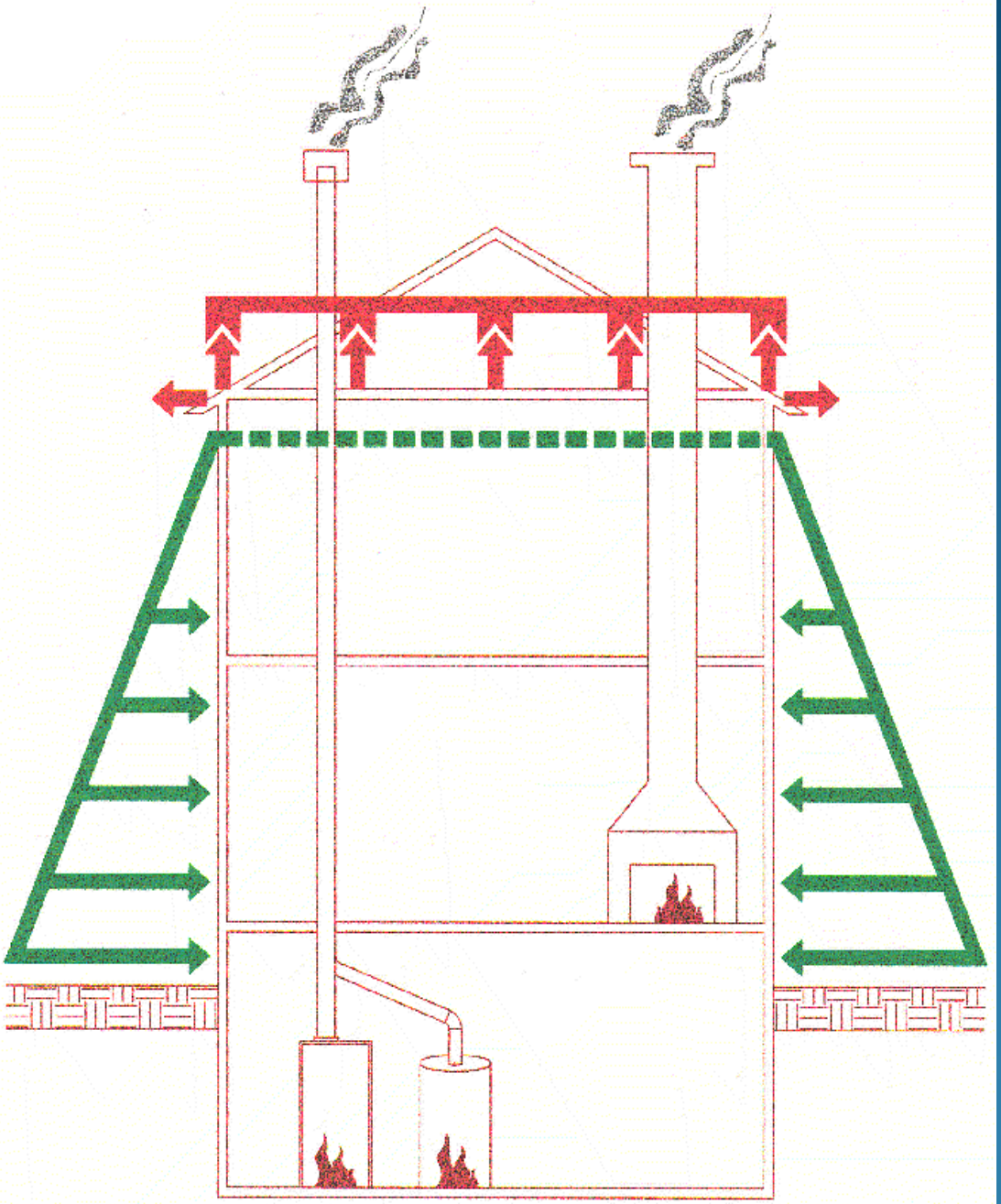
Solution: fix the downspouts damaged by (drunken) persons unknown, repair the backdraft dampers damaged by (sober) squirrels and seal all openings in the crawl space (especially the wiring conduits).

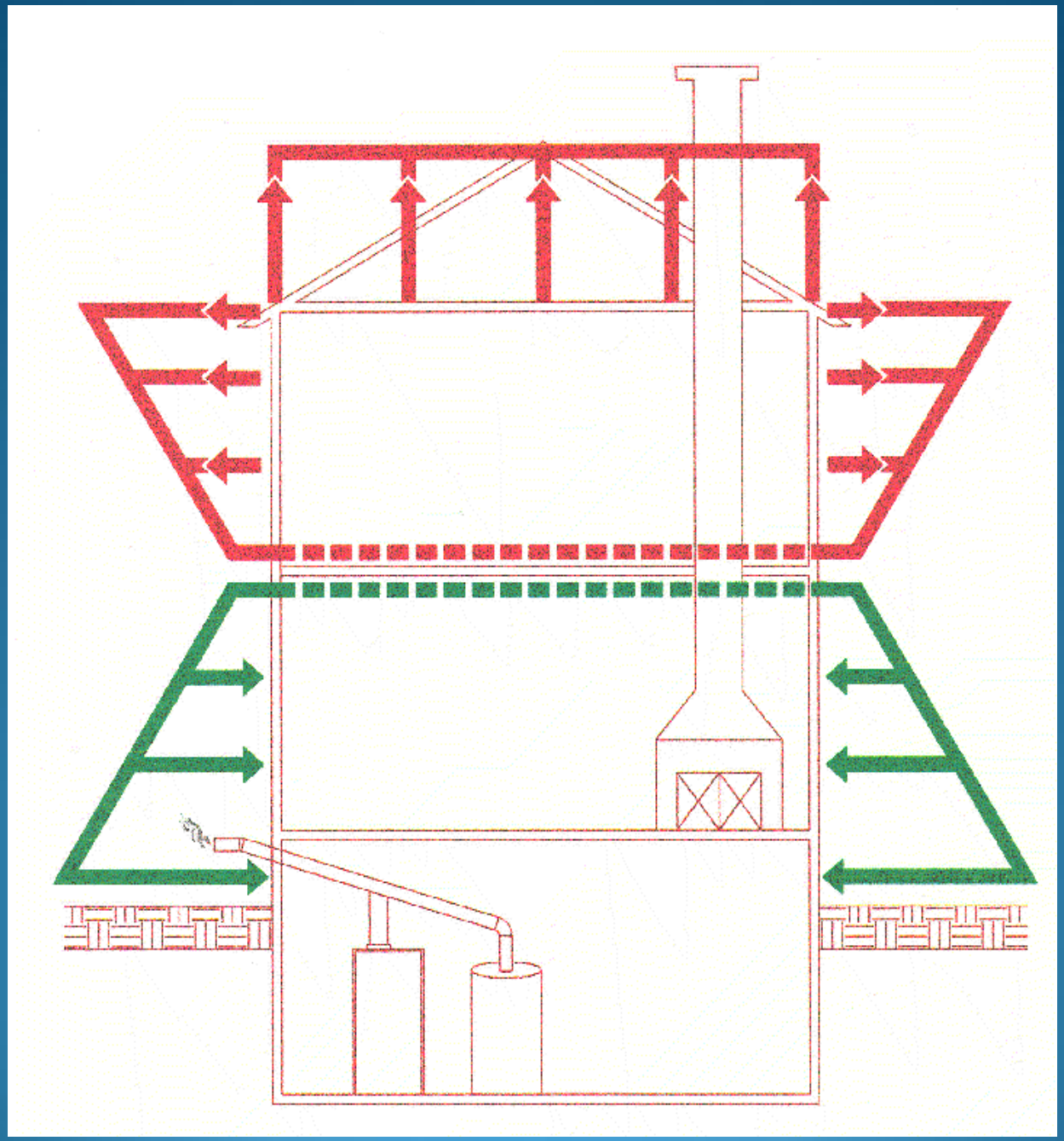
Example #4 - House

Problem: a little old lady living in a 100 year old, 2-storey house had the ceiling on the third floor collapse. The roof was fine – no leaks.

Observation: the only significant change made to the house in recent memory was that the old, naturally aspirated furnace was replaced by a direct-vent model.

Analysis: what was the effect of the heating system on the building's neutral pressure plane?





But With Proper Design & Construction, Moisture Damage Can Be Minimized

For Example - The cost of repairing damage to existing sheathing ranged from \$5 to \$11 /m^2 (\$0.50 to \$1.00 /ft^2), which represented 2% to 6% of the total wall retrofit cost.

Before

After

Any Questions??