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Rainscreens: A Builder's Experience

Ventilated Rainscreens for Improved Moisture Management

AIA CES Course Number: WEB713

AIA CES Provider Number: G138

Tuesday, July 13, 2021

Peter Barrett

Dörken Systems Inc.

• Corporate History

- Privately held, family-owned company
- Founded in Germany in 1892 by two brothers:
  - Dr. Carl Dörken, chemical engineer
  - Ewald Dörken, businessman
- Initial DELTA® products: Paints and corrosion protection coatings
- Introduced 1st roofing membrane for railway carriages in 1925

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DELTA® Product Applications

North America

- Water-resistive Barriers
- Rainscreen Products
- Air Barriers
- Vapor Barriers
- Roof Underlayments
- Garden Roof Systems
- Foundation Moisture Protection

Commercial and Residential Construction

This presentation was prepared for Dörken Systems Inc. by:

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Rainscreens: A Builder's Experience

Ventilated Rainscreens for Improved Moisture Management

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Course Description

This presentation will:

- Discuss moisture management of new stucco (and adhered stone) assemblies compared to traditional mass walls.
- Explore common failures in walls with stucco cladding to understand the importance of drainage and drying.
- Explain building science principles behind rainscreen strategy for rain control
- Examine wetting and drying mechanisms
- Review some typical details
- Suggest best practices for the ventilated rainscreen approach

Common Failures in Stucco Wall Assemblies

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“Ideal World” vs. “Real World”

Ideal World:

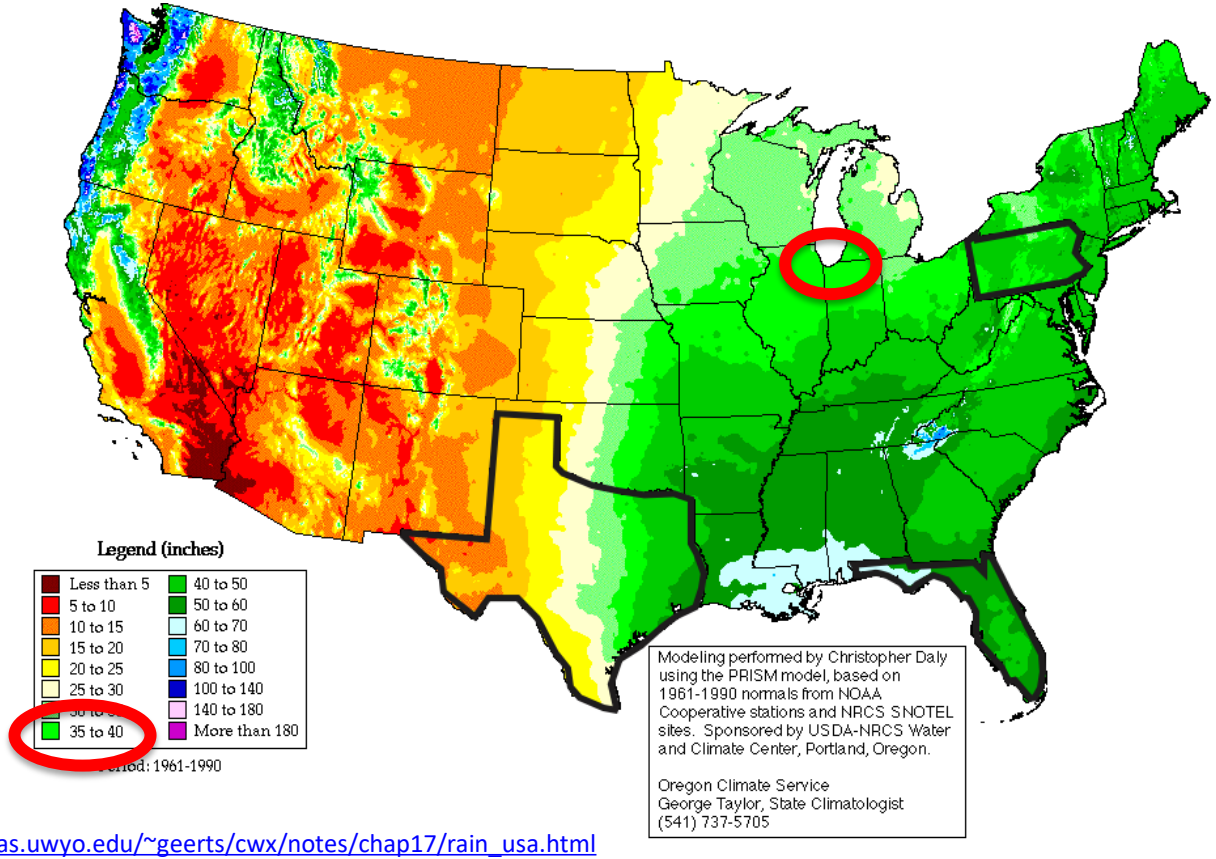
No bulk water intrusion!

Real World:

Bulk water intrudes behind the water-resistive barrier through:

- penetrations
- flashing details
- other imperfections

Average Annual Precipitation in the US



Footnote: http://www-das.uwyo.edu/~geerts/cwx/notes/chap17/rain_usa.html

Rain Exposure and Climate Region

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Some Key Stucco Failure Regions in North America

- Pennsylvania
- Texas
- Florida
- …

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Why do Stucco Assemblies Fail?

- **Too much water gets in** through:
  - cracks in the field of the stucco
  - unsealed penetrations and accessory joints
  - improper transitions and insufficient flashing
- Assembly **blocked from draining:**
  - lack of weeps or drip screeds, or incorrect accessories
  - lack of through-wall flashing at floor line
  - adhesion of stucco to WRB or weep screed

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* Adding a drainage cavity behind stucco is much cheaper than replacing rotting sheathing!

Introducing the Rainscreen Strategy

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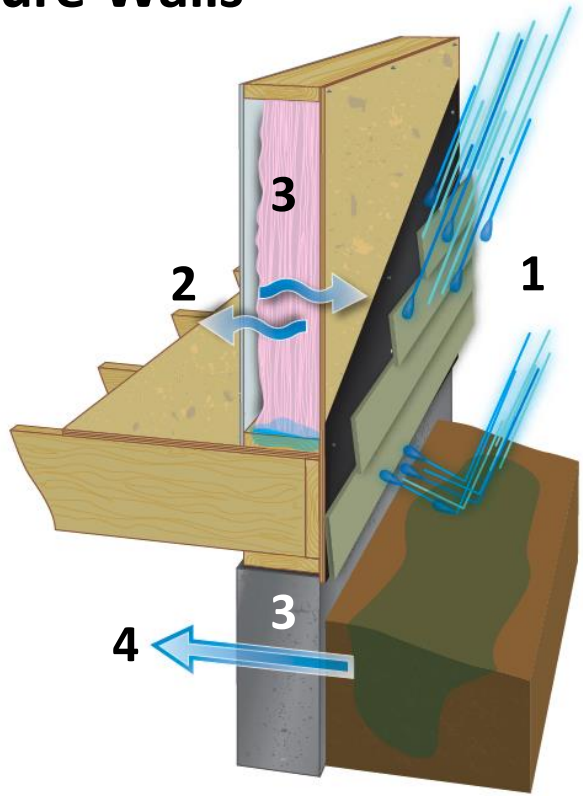
Exterior Moisture Sources in Enclosure Walls

1. Rain/Snow
2. Water Vapor
3. Built-in Moisture
4. Ground Moisture



Interior Moisture Sources in Enclosure Walls

Built-in Moisture

- Moisture in materials as they arrive to site
- Water intrusion/leakage into building during construction
- Drying of materials during finishing

Operational Moisture

- Transpiration from human body
- Evaporation from plants
- Pets
- Cleaning of dwellings
- Personal hygiene
- Laundering, drying, cooking, heating water
- Broken water pipes, backed up drainage
- Humidification
- Seasonal absorption

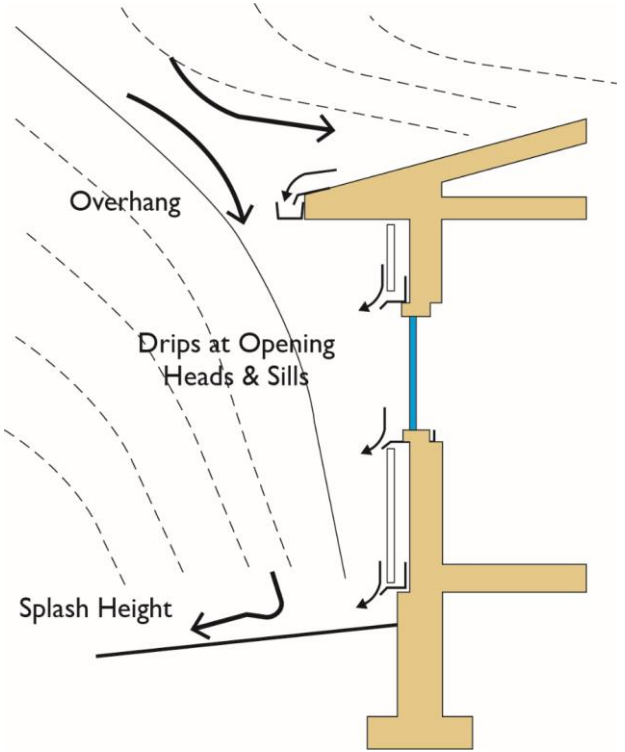
Moisture Management

Rain Control

- Four fundamental D's of Rain Control:
  - **D**eflection – Keep water away
  - **D**rainage – Drain water out
  - **D**rying – Allow water to dry (ventilation)
  - **D**urability – Use durable materials

Condensation Control

- Reduce thermal bridges
- Avoid air leakage
- Manage interior RH



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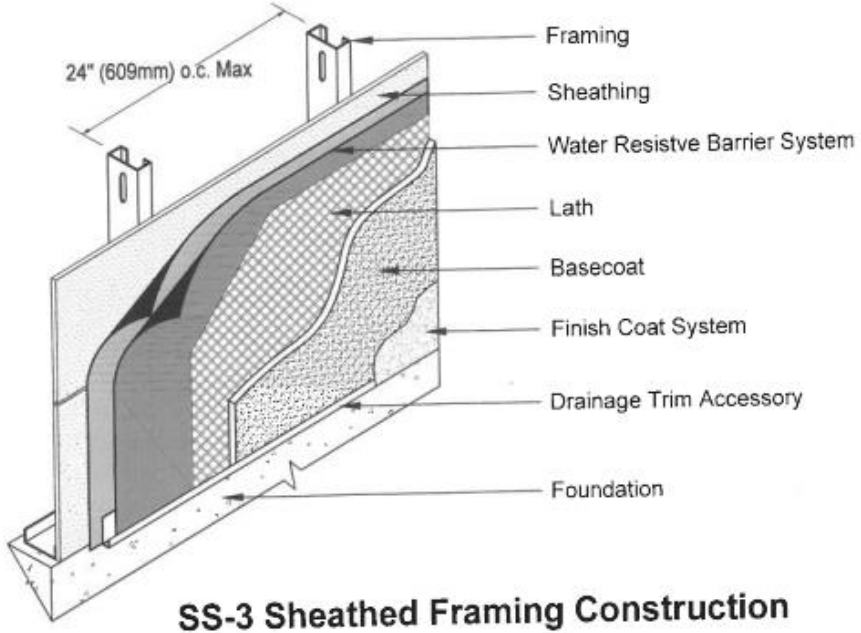
Why do Concealed Barriers Fail?



SS-3 Sheathed Framing Construction

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* A ventilated rainscreen is the most robust rain control strategy

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Drainage and the Building Code

International Residential Code (IRC)

- Section R703.1.1 was modified in 2006 to require *“a means of draining water that enters the assembly to the exterior”*
- The code does not define what constitutes **drainage**
- Same wording in 2018

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Drainage and IRC 2018 Building Code

R703.7.3 Water-resistive barriers.

Water-resistive barriers shall be installed as required in Section R703.2 and, where applied over wood-based sheathing, shall include a water-resistive, vapor-permeable barrier with a performance at least equivalent to two layers of Grade D paper. The individual layers shall be installed independently such that each layer provides a separate continuous plane and any flashing, installed in accordance with Section R703.4 and intended to drain to the *water-resistive barrier*, is directed between the layers.

Exception: Where the *water-resistive barrier* that is applied over wood-based sheathing has a water resistance equal to or greater than that of 60-minute Grade D paper and is separated from the stucco by an intervening, substantially nonwater-absorbing layer or designed drainage space.

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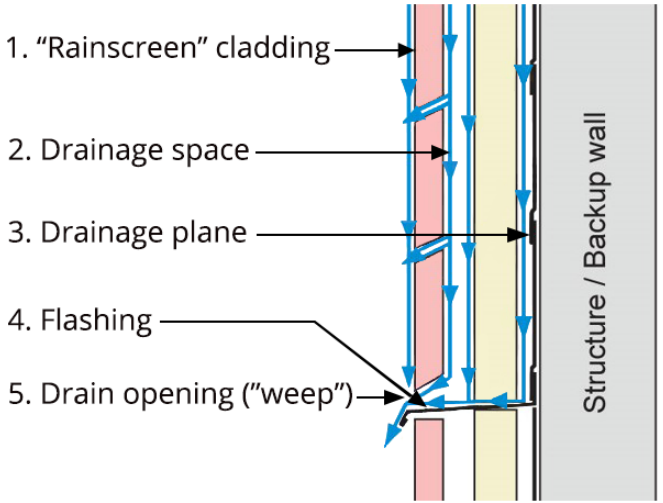
Rainscreen Strategy

- Rain shedding
- Drained system
- Integrate with flashing and drain openings
- Overlap everything
- Avoid holes



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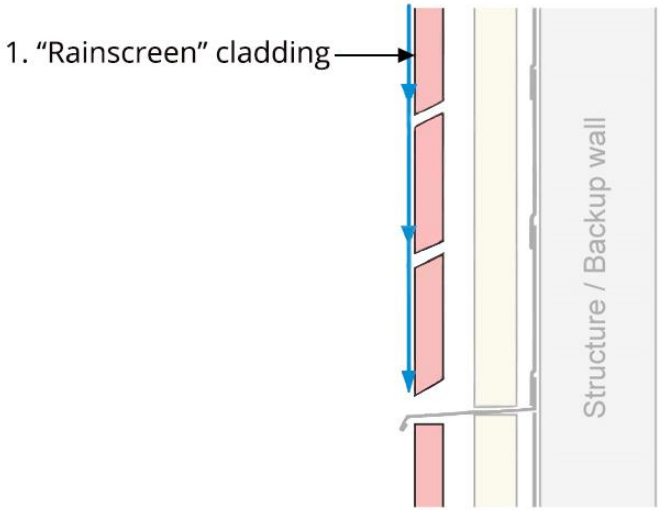
Rainscreen Cladding

- Rain shedding surface/cladding
- Integrate with flashing



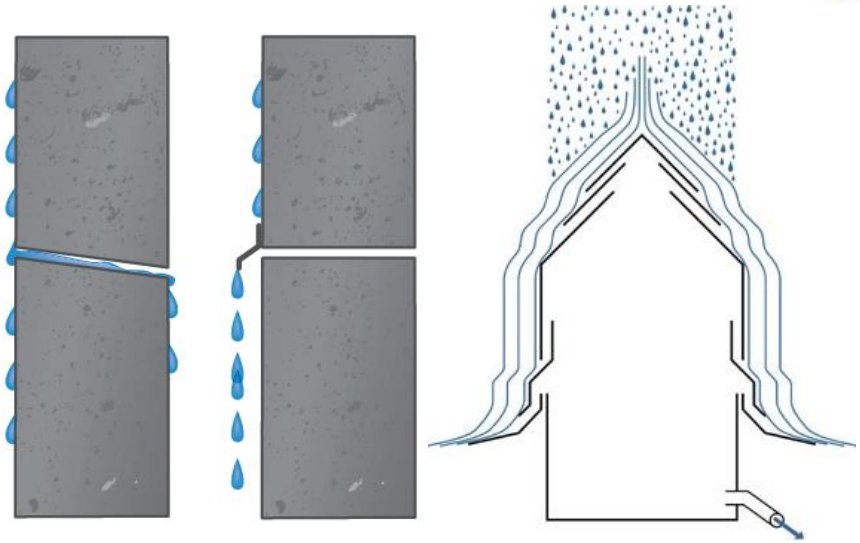
BUILDING SCIENCE ASIDE:

How does water move?

Water moves because of

Gravity

- Redirect water
- Shingle to outside



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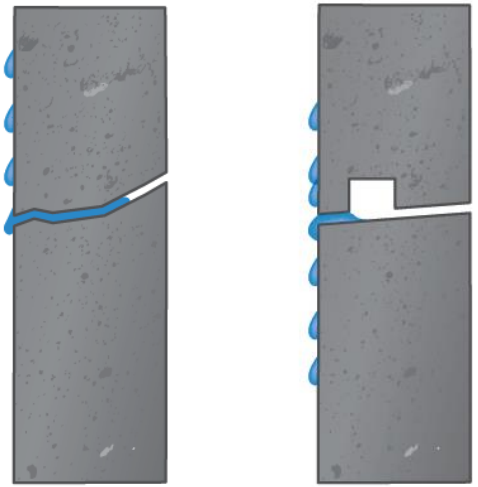
BUILDING SCIENCE ASIDE:

How does water move?

Water moves because of

Capillary Wicking

- Cohesion
- Adhesion



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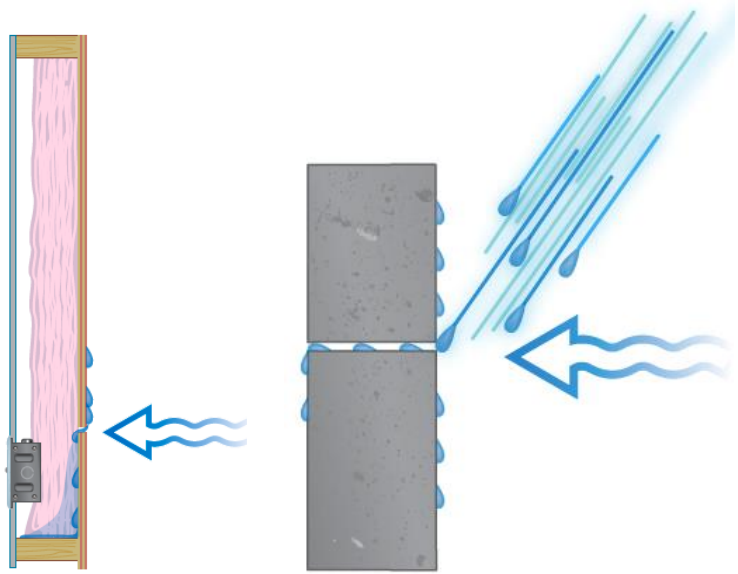
BUILDING SCIENCE ASIDE:

How does water move?

Water moves because of

Pressure Differentials



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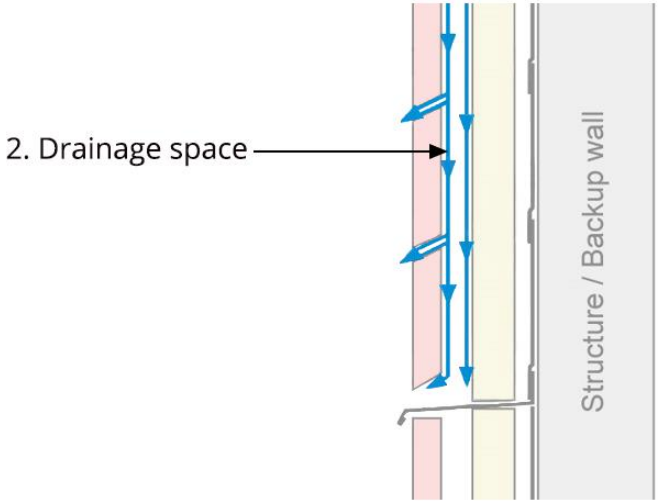
Drainage Space

- Reduce hydrostatic pressure
- Drainage gap allows
  - water flow (drainage)
  - air flow (ventilation)
- Only small gaps required to provide drainage (1/8” to 1/4”)
- Larger gap required to allow ventilation (airflow)



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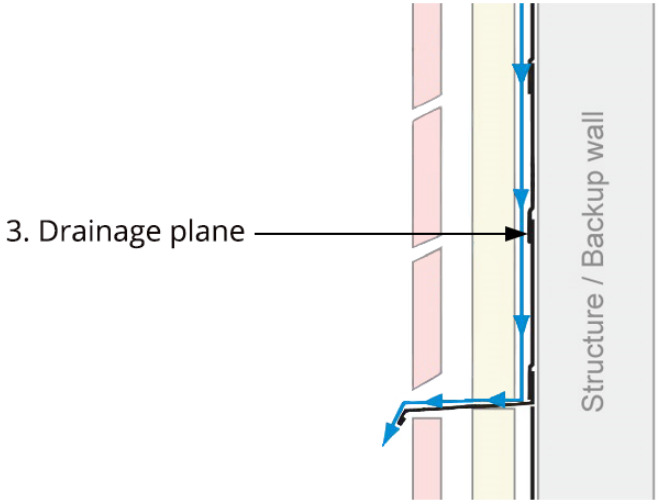
Drainage Plane

- Vertical substrate to direct water downward
- Integrated with water-resistive barrier (WRB) , flashing, and weep holes
- Overlap everything



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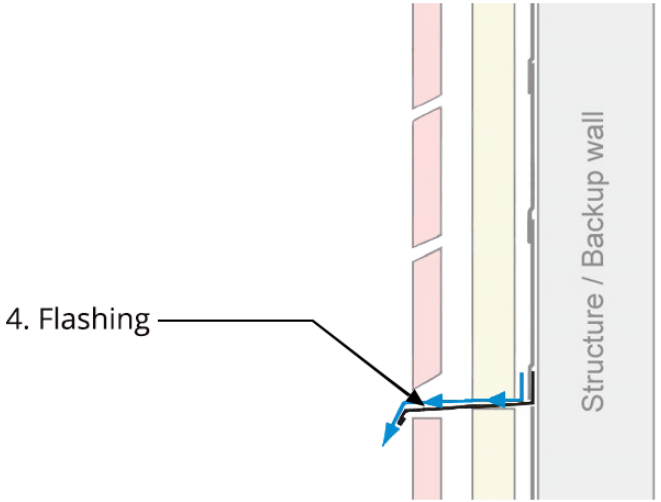
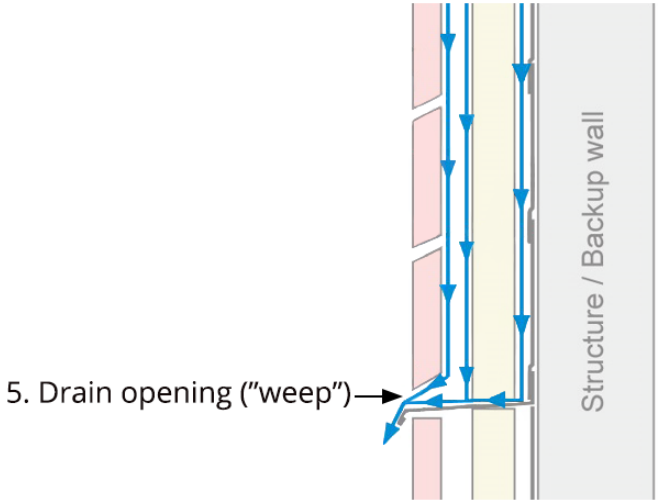
Flashing

- Integrate with drainage plane and rain screen cladding
- Shed bulk rainwater
- Direct/drain water out



Drained Opening (“weep”)

- Allows water to get out (drain)
- Improves drying
- Promotes venting and ventilation



BUILDING SCIENCE ASIDE:

Solar-Driven Moisture

After a rain period absorptive cladding is soaked with water.

Solar Energy can:

- evaporate moisture
- push vapor inward

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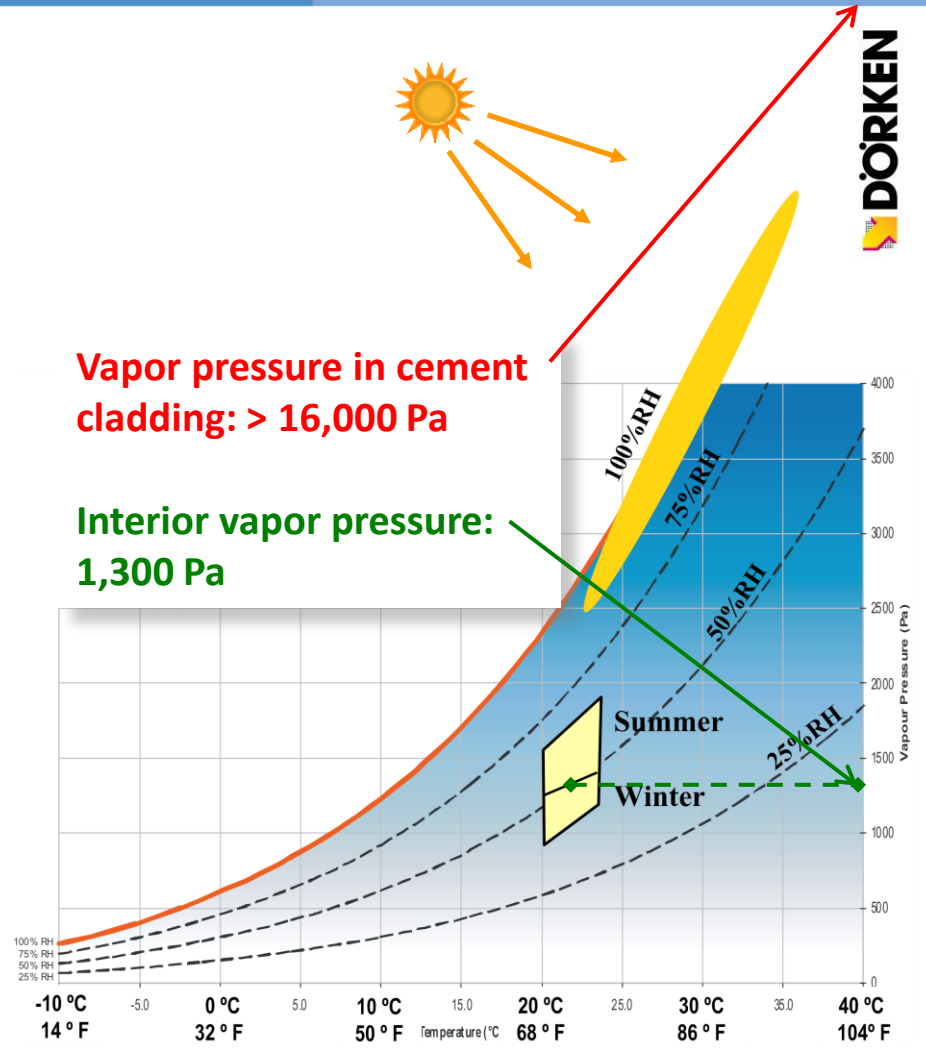
BUILDING SCIENCE ASIDE:

Solar-Driven Moisture

Example:

- Sunny Day in February
- Puyallup, WA
- Outdoor Temp: 32°F
- Structural Sheathing: 158°F*
- Indoor Temp: 70°F @ 50% RH

**Temperature measured behind dark painted cement cladding on south-facing wall*



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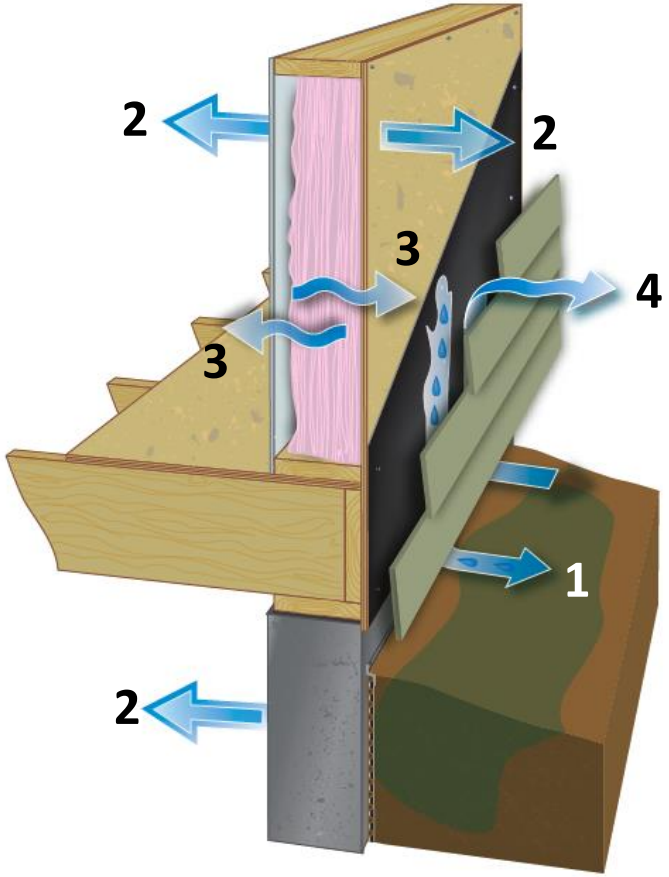
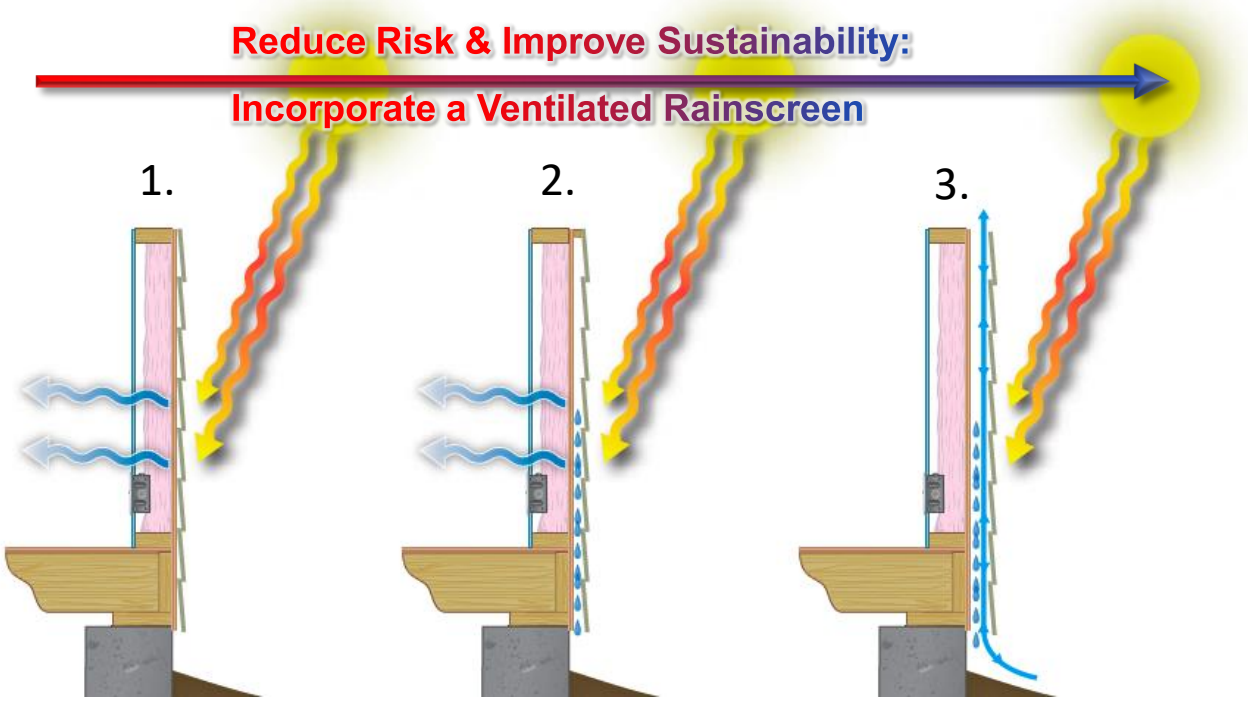
Wall Drying Mechanisms

1. Drainage
2. Surface Evaporation
3. Through-wall:
    I. Diffusion
    II. Convection
4. Air Exchange (Ventilation)



Cladding Application Methods

1. Direct
2. Vented
3. Ventilated



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Summary

- Water will find its way behind the water-resistive barrier
- Depending on climate region, rain load could be higher
- Most stucco failures involve:
  - Cracks, penetrations, sealant joints, blocked drainage paths
- Adding drainage gives water a place to go and venting helps drying
- **A drained and ventilated rain screen is the most robust rain control strategy for stucco wall systems**

Ventilated Rainscreens with Stucco Cladding

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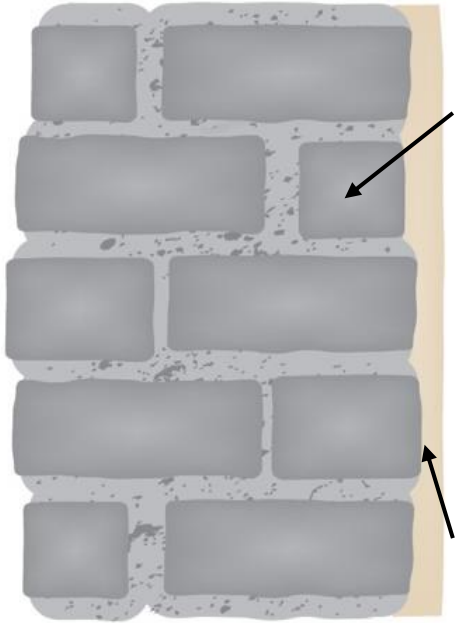
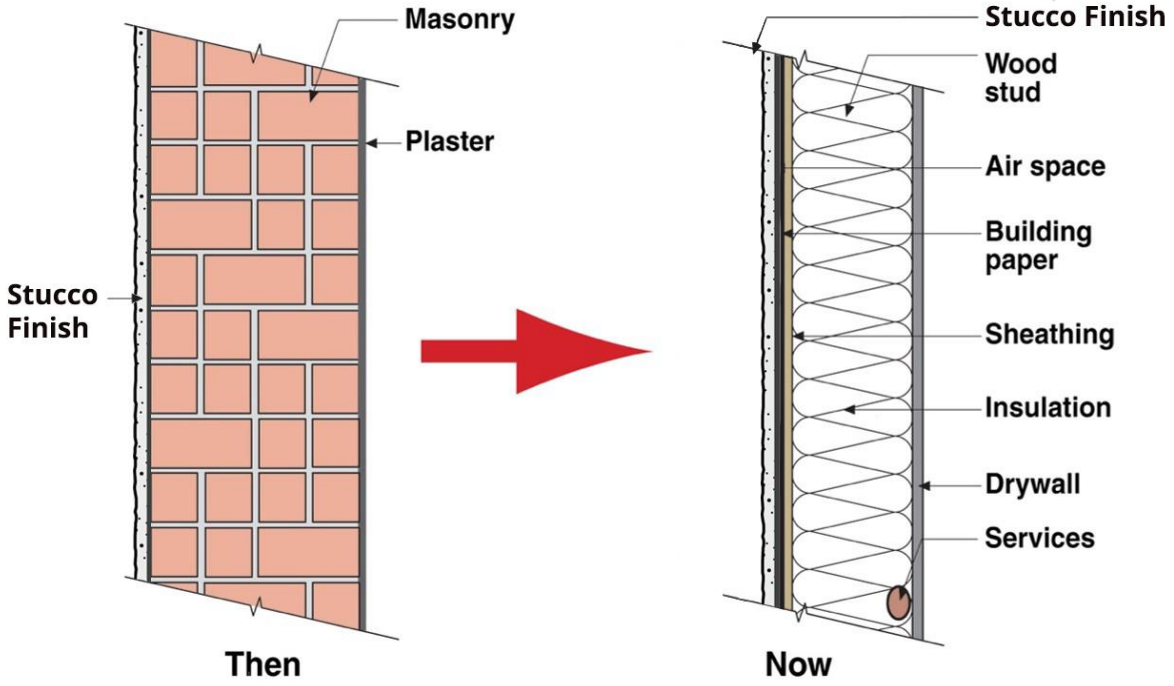
Moisture in Mass Buildings

- Mass buildings from the past were less sensitive to moisture
- Integral vapor resistance
- Massive moisture storage capacity



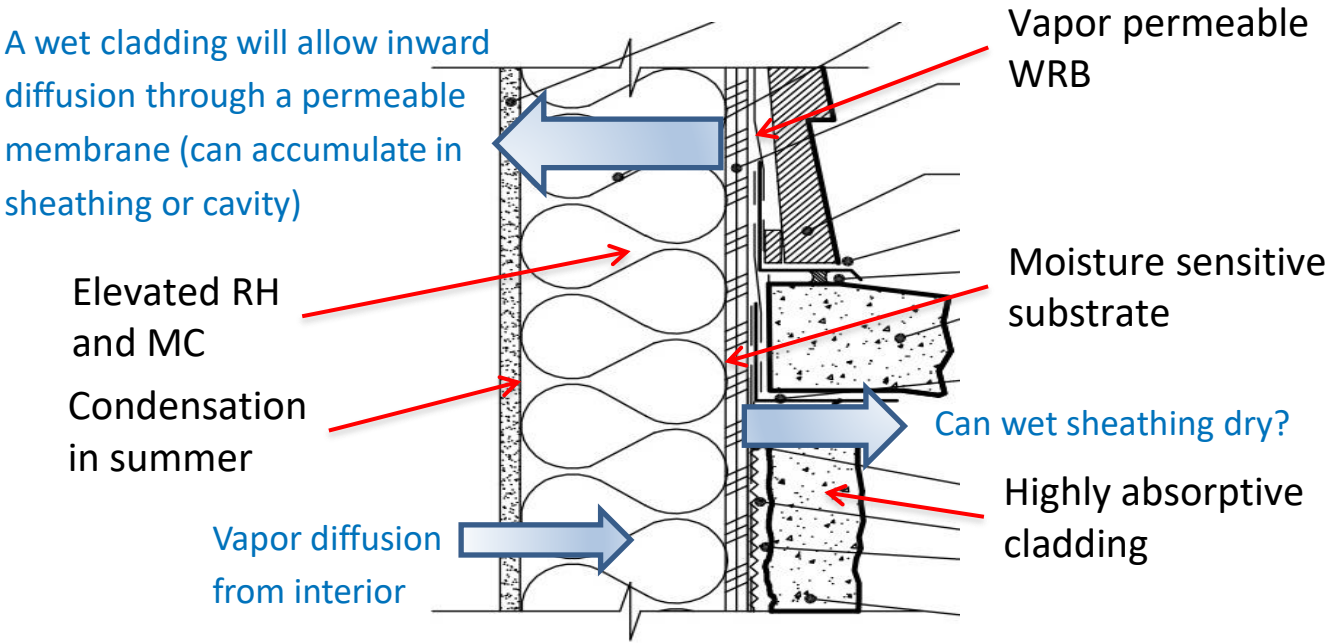
Mass Buildings: Then and Now



Moisture in Insulated Buildings with Absorptive Cladding

- Absorptive Claddings
  - Stucco
  - Adhered stone
- Not EIFS!

Moisture in Insulated Buildings with Absorptive Cladding



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Considerations for Moisture Management with Highly Absorptive Claddings

Poor Drainage (Leaks)

- Solution: small gaps or drainage layer
- ‘Creped’ WRB, two layers of building paper

Inward Vapor Drive

- Stucco & Adhered Veneers = very high moisture storage
- Wet cladding + undrained water + solar heating = rising vapor pressure

Drives vapor inward!

BUILDING SCIENCE ASIDE:

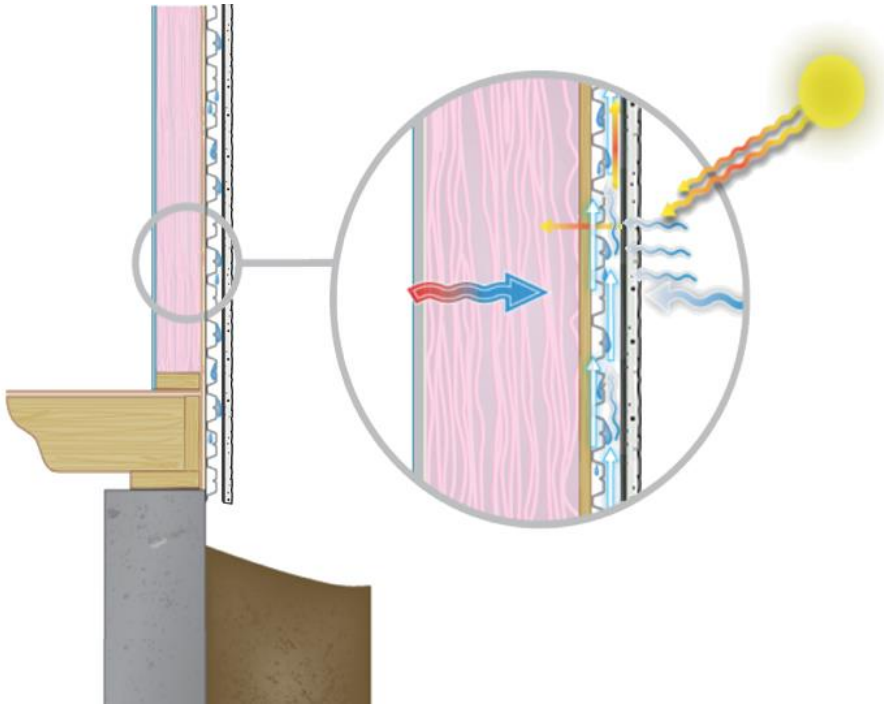
Heat, Air & Moisture Flow in Ventilated Air Gap

Outside

- Deflects and drains bulk water

Inside

- Drains condensate moisture and possible bulk water
- Enables ventilation to dry sheathing board



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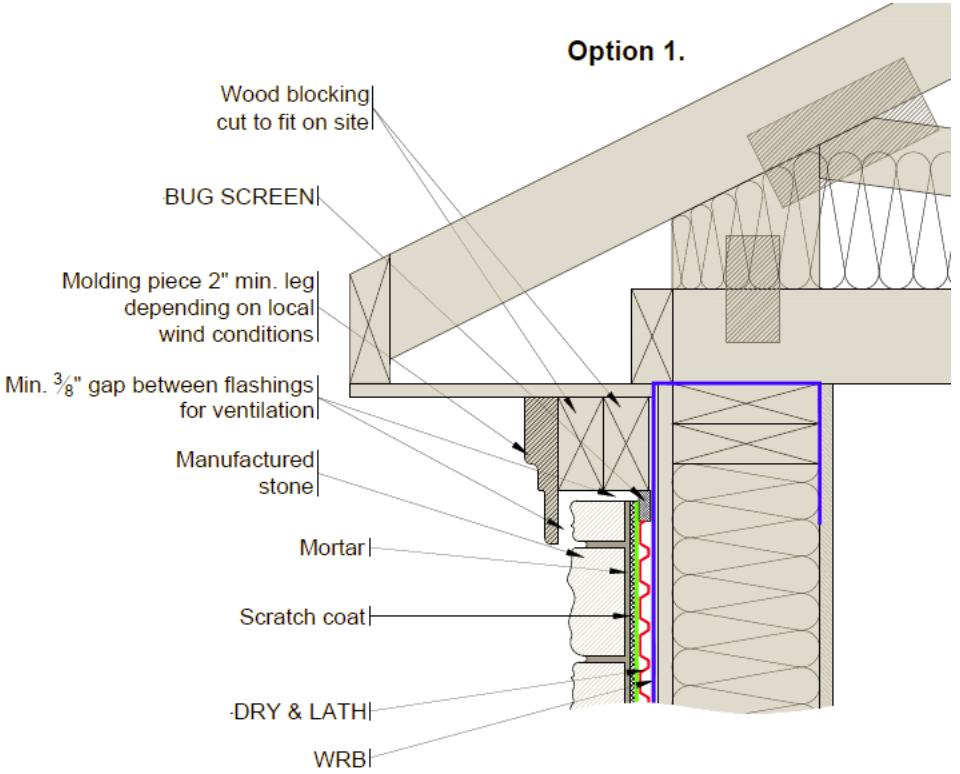
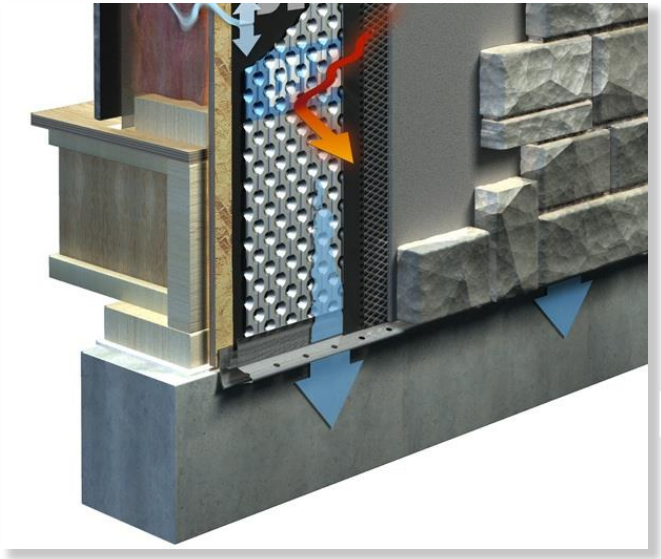
Ventilated Rainscreen Details for Absorptive Claddings

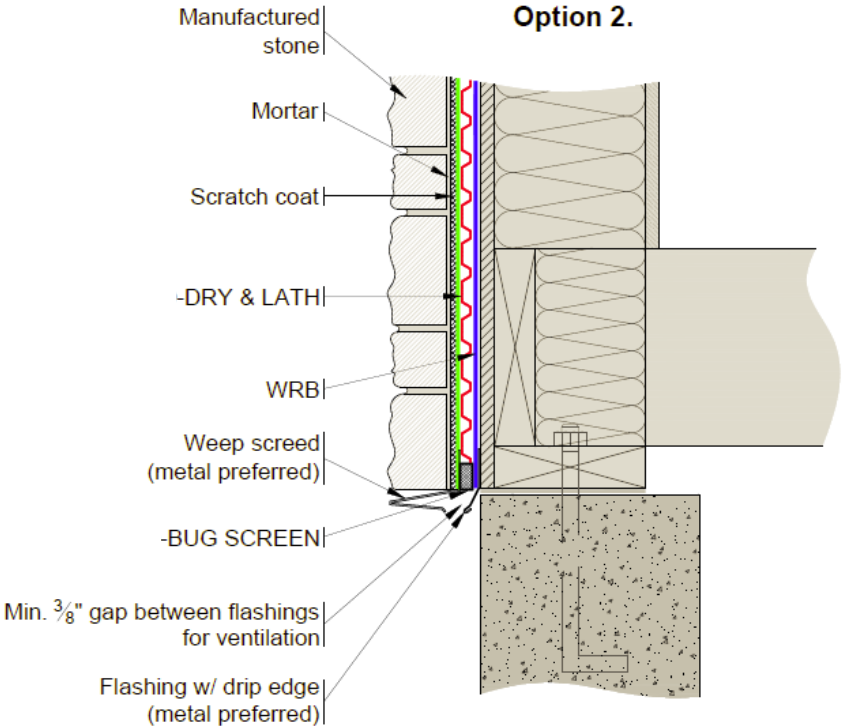
Detail 1: Top of Wall to Roof



Ventilated Rainscreen Details for Absorptive Claddings

Detail 2: Base of Wall to Foundation





Summary:

- Old stucco walls are not like new stucco walls
- New stucco walls need to be detailed to allow both drainage and drying
- A drained and ventilated rain screen is the most robust rain control strategy for stucco wall systems