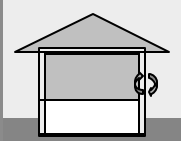


## Rain Penetration: Let the Enclosure be Your Umbrella

John Straube  
Civil Engineering & School of  
Architecture  
University of Waterloo

[www.civil.uwaterloo.ca/beg](http://www.civil.uwaterloo.ca/beg)



## This talk

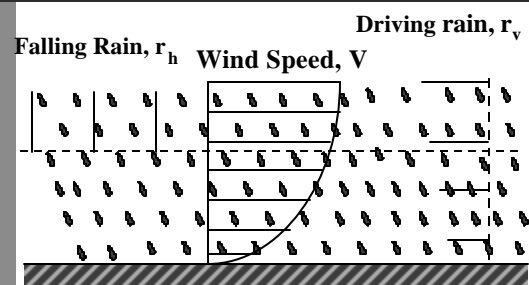
- ✍ Discuss rain control
  - Site and massing
  - Surface features
  - Enclosure wall strategy
- ✍ Applications
  - Wall types
- ✍ The OAA Exclusion
- ✍ After break ... *flashing*



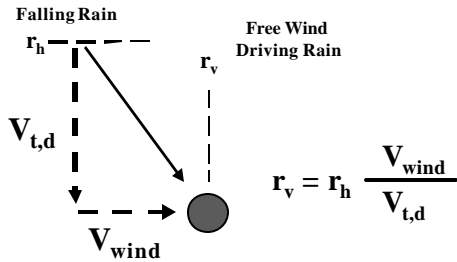
## Controlling Driving Rain Penetration

- ✍ Understand driving rain to control it
  - Result of wind and rain
  - Building shape and height affects it
  - Enclosure design choices

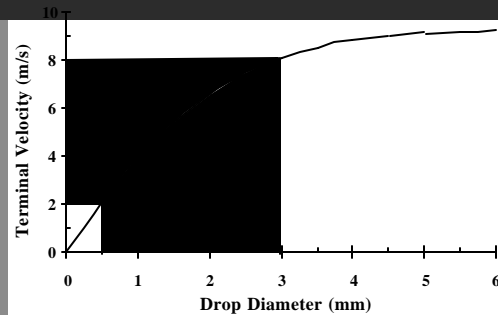
## Driving Rain



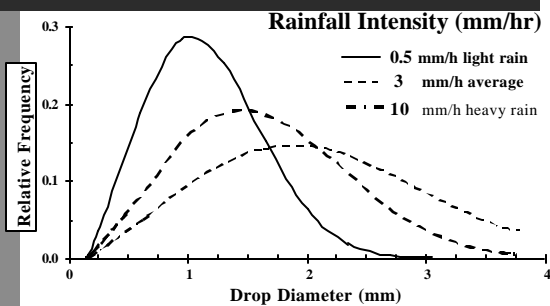
## Raindrop-Wind Interaction



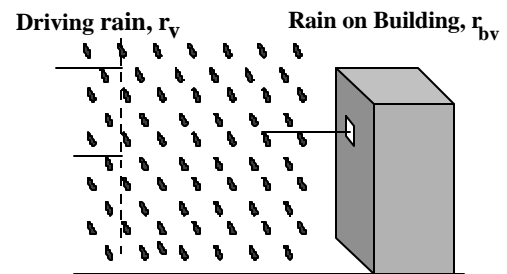
## Raindrop Terminal Velocity



## Raindrop Size Distribution



## Rain and Buildings



## Driving Rain Deposition on Buildings

⚠ If you care ...

⚠ Prediction methods are available, e.g.,

$$r_{bv} = RDF \cdot V / V_{d,t} \cdot r_h$$

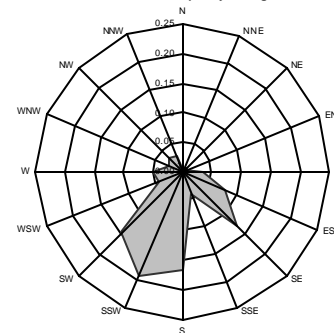
$$= RDF \cdot r_v$$

RDF, Rain Deposition Factor:

- converts free wind to rain on building
- accounts for airflow around building
- increases near top, edges, and corners
- normally < 1.0, except over small areas

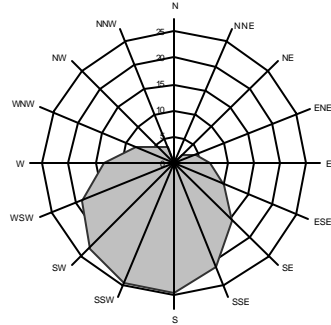
## Wind During Rain: Portland

Portland, OR - Wind Frequency During Rain

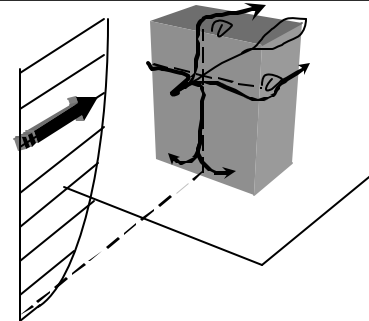


## Total Rain Deposition: Portland

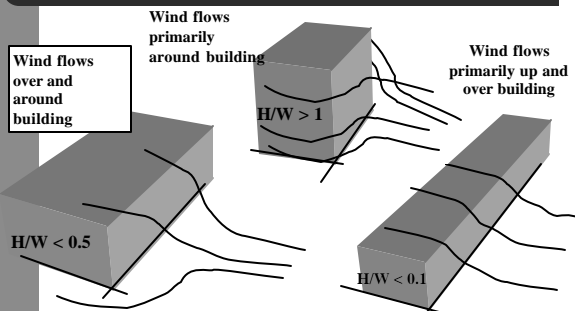
Portland, OR - Driving Rain 90° Incident, in/yr



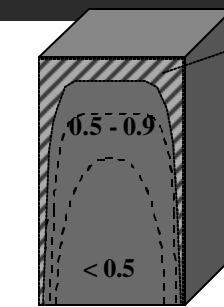
## Rain Deposition and Wind Flow Patterns



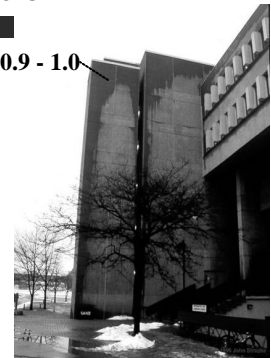
## Effect of Building Shape



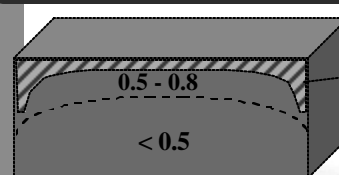
## Rain Deposition Factors



Tall Building  $H/W \gg 1$



## Rain Deposition Factor



Low Building  
 $H/W \ll 1$





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## Rain Deposition Factor

Low Building ( $H/W \ll 1$ ) with Peaked Roof & Overhang

- $< 0.20$
- $0.20 - 0.35$
- $< 0.30$
- $0.35 - 0.50$

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## Windspeed + Exposure = Driving Rain

☞ Tall exposed buildings exposed to more wind = more rain

Height (m)

Open Country Suburban City Center

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## Driving Rain Summary

- ☞ Driving rain
  - driven directly by wind and rainfall
  - may come from different directions than prevailing wind
- ☞ Rain Deposition
  - Affected by aerodynamics
- ☞ A significant amount of driving rain deposition is possible

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## Rain Control Philosophy

☞ The Three D's

- Deflection
- Drainage/Exclusion/Storage
- Drying

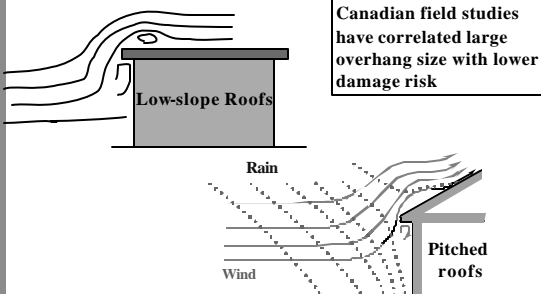
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## Controlling Rain Penetration

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

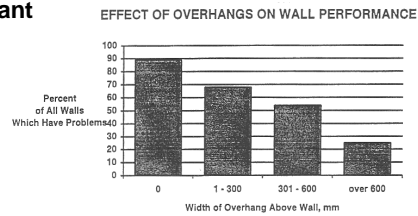


## Effect of Overhangs

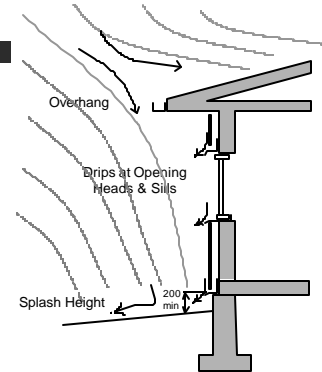


## Results

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



## Deflection



## Deflection: Protect Sensitive Matl



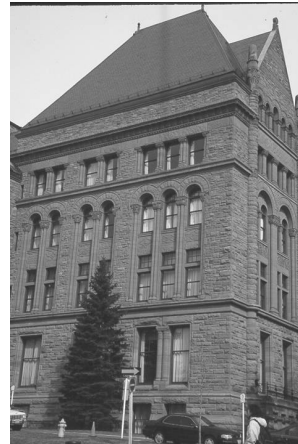
## Base Splash



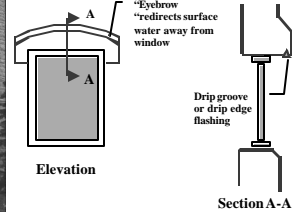
## Shedding: Surface Drainage

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

✍ If it doesn't get wet, it won't 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



**Don't concentrate water!**



Overhangs Surface - Drainage - Shelter



**Deflection: Protect Wall Openings**



Modern Buildings often do not respect need for surface drainage



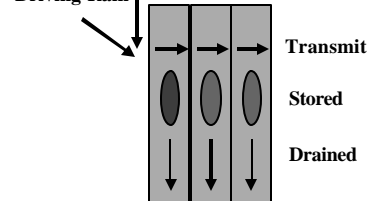
## Enclosure Wall Strategies

*Once on the wall ...*

- ✍ Drainage
- ✍ Exclusion
- ✍ Storage

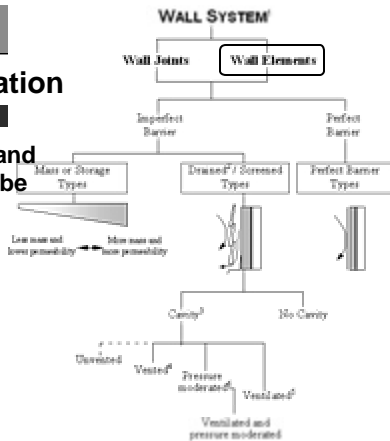
## Rain Control

✍ Rain Deposition: Drained, Stored, or Transmitted

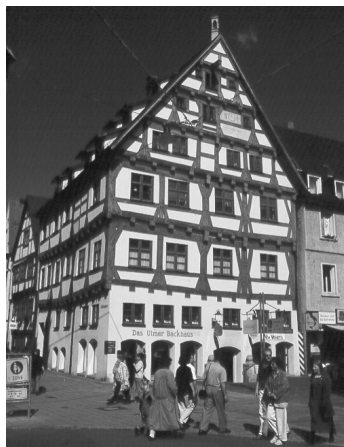
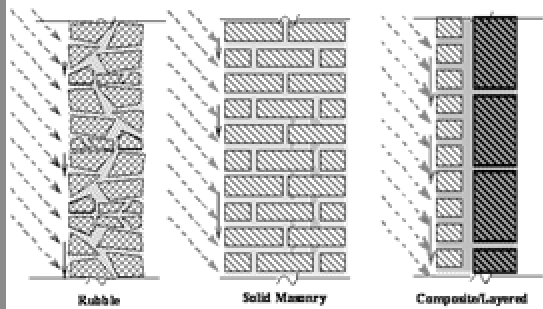


## Categorization

✍ Elements and joints can be different



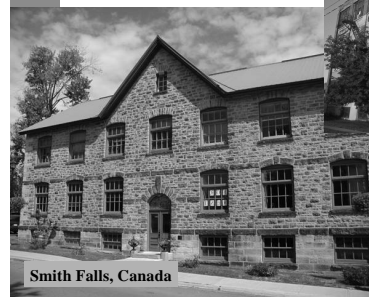
## Mass/Storage/Reservoir Walls



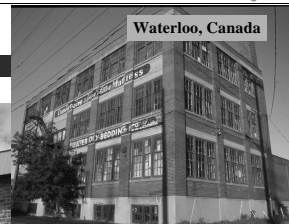
**Mass or  
Storage  
(Reservoir)**

**Note: Surface  
Drainage Control**

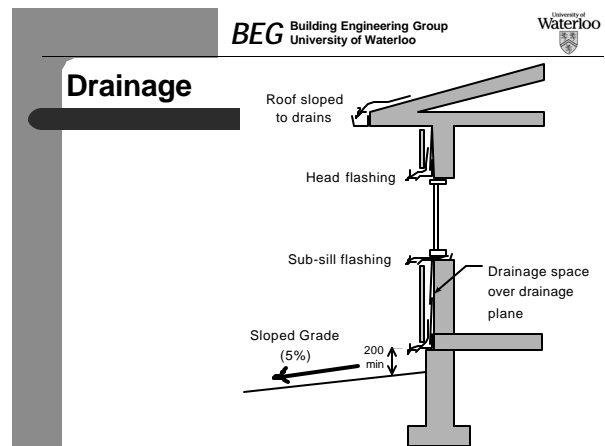
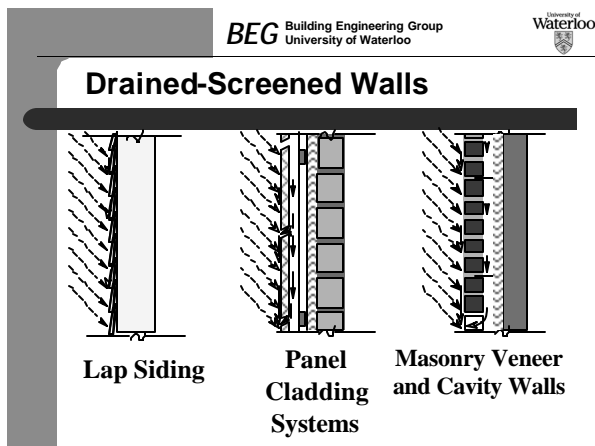
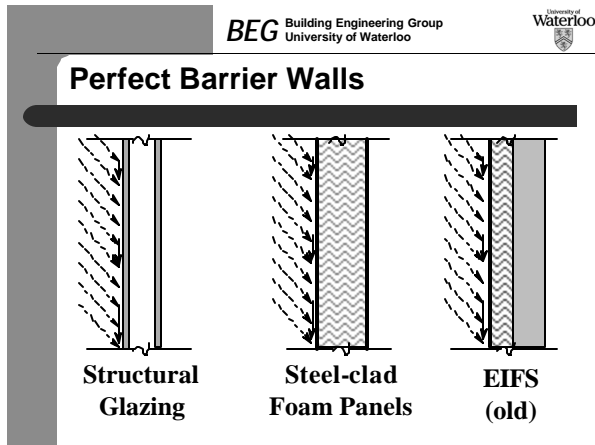
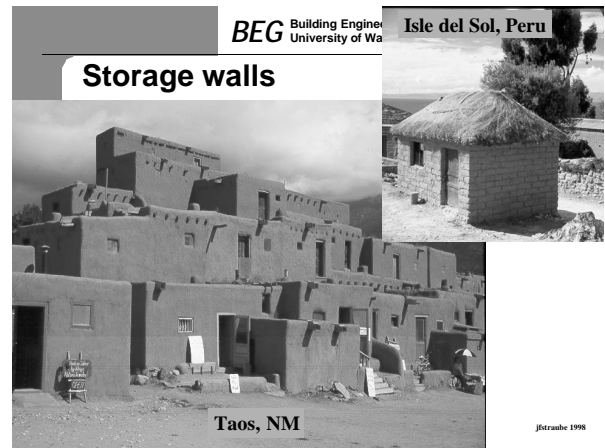
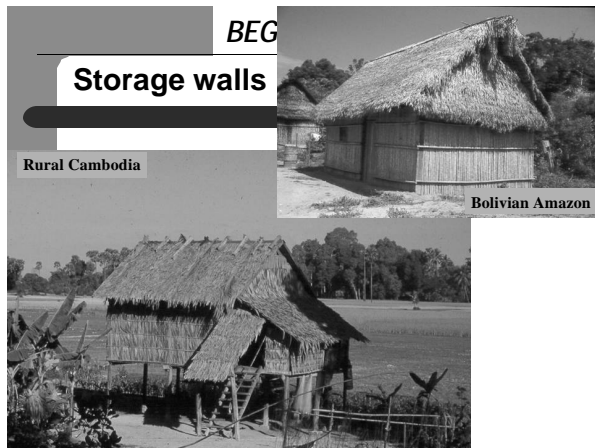
## Storage walls



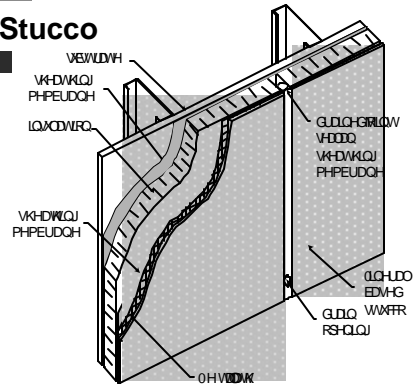
Smith Falls, Canada



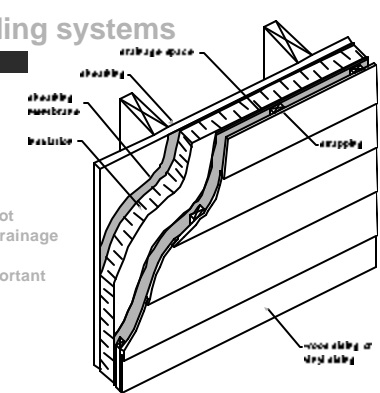
Waterloo, Canada



## Drained Stucco

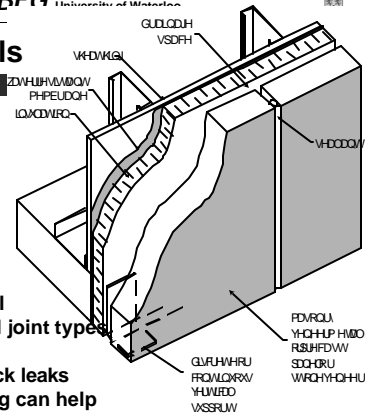


## Light cladding systems



- Can perform well
- Cladding leaks a lot
- Strapping helps drainage and drying
- Flashing very important

## Heavy Panels

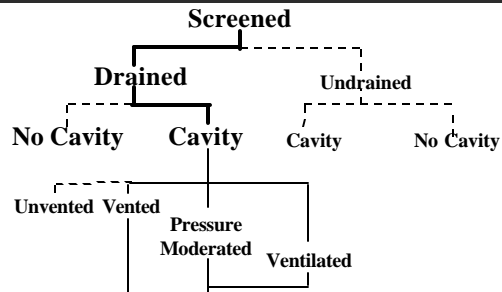


- Can perform well
- Open and sealed joint types available
- Joints leak – brick leaks
- Ventilation drying can help

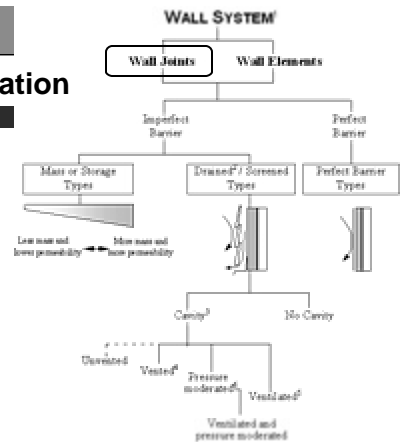


## Screened and Drained

## Screened-Drained Wall Classification

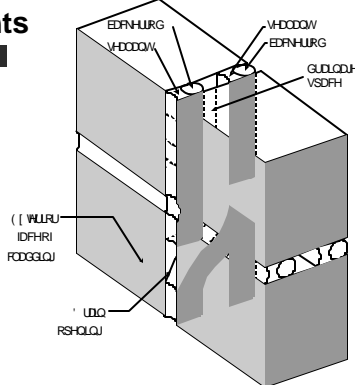


## Categorization



## Drained Joints

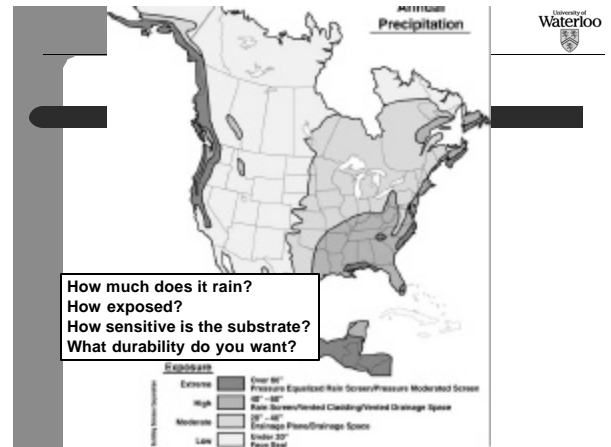
- Inner stage could be
  - sealant
  - gaskets
  - peel and sticks
  - trowel-on
- Must be drained
- Vented helps



## Which Strategy to Use?

- ✗ Depends on Exposure to Rain
- ✗ Which depends on
  - Climate
  - Height of building
  - Orientation
  - Shape
  - Surface Features
  - Complexity

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



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## Drying

Important 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

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## Wall Drying Mechanisms

1. Drainage
2. Surface Evaporation
3. Through-wall
  - i) Diffusion
  - ii) Convection
4. Within-wall Convection = Ventilation

**EIFS & Rain Control:**  
A more recent specific concern

Kitchener, ON

Grand Rapids, MI

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## Substrate + moisture = problem

Moisture sensitive substrates are a problem

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## EIFS & the OAA

- ✍ Rain control problems increasing in the US
- ✍ Need to control insurance costs
- ✍ Pro Demnity issues exclusion
- ✍ No coverage if:
- ✍ “no provision for drainage of precipitation that penetrates the wall system, or as otherwise provided in Practise Bulletins by the Association”.

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## EIFS & the OAA

- ✍ Practise Bulletin E1
- ✍ Two pages, 23 & 24, deal with EIFS
- ✍ Does NOT require drainage in EIFS!
- ✍ Bulletin encourages Dual Barrier with Drained Joints over DensGlas
- ✍ Only Drained Joints over masonry, concrete

## Application to EIFS

- Face Sealed specifically not covered
- Drained joints required for all systems
- Dual Barrier sufficient for most applications
- “Quality Control” and “Exposure” are defined by designer

## That “Table”: Recommendations!

**Exposure** - a combination of the climate and the shape, size, orientation, and siting of the building  
**System Quality** - a combination of design, materials (including the moisture tolerance of the substrate), workmanship, the confounding effects of weather during installation and the economic situation.  
**Performance Expectations** - a function of the clients' expectations, minimum code requirements, etc.

Minimum Recommended EIFS Wall Rain Control Strategies

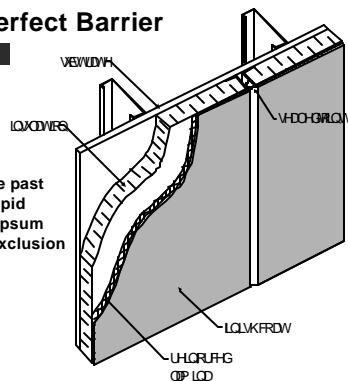
	Exposure A	Exposure B	Exposure C
Quality 1	FS	DB/DJ	DB/DJ
Quality 2	DB/DJ	DB/DJ or D	D
Quality 3	DB/DJ	D	PM

† Face-sealed EIFS are not recommended for any architecturally-designed applications, and will not be covered by the OAA Indemnity Plan.  
**Exposure Classes**

A - Two-stories or less, with good overhangs and suburban or urban exposure  
 B - Low-rise without overhangs, mid-rise suburban or urban exposure. Open or seaside exposure for A  
 C - high-rise, all exposures. Open or seaside exposure for B

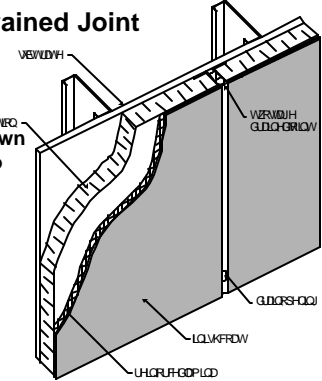
## Face Sealed Perfect Barrier

- The problem wall of the past
- Relies on sealant = stupid
- Often used exterior gypsum
- Not allowed by OAA Exclusion



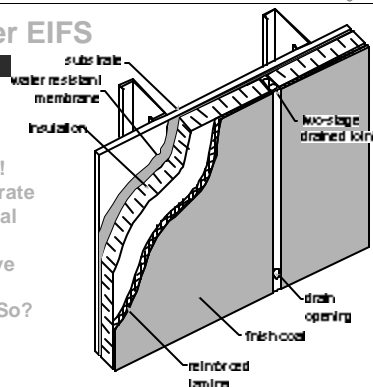
## Face Sealed - Drained Joint

- Sometimes called “Source Drained”
- Implies source is known
- Substrate exposed to incidental moisture
- Slow drying



## Dual Barrier EIFS

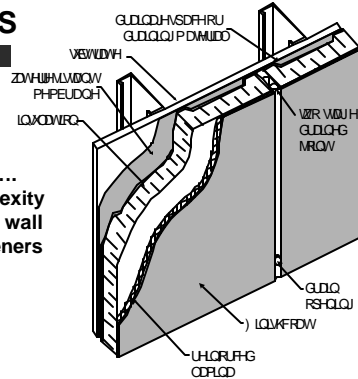
- Drained Joints!
- Protects substrate against incidental water
- Allows adhesive attachment
- Slow drying .. So?





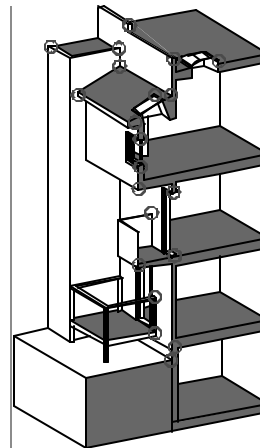
## Drained EIFS

Feels good, but ....  
Additional complexity  
May trap water in wall  
May require fasteners



## Drained Joint details needed where problems occur

- Windows / Doors
- Balconies
- Wall to roof
- Penetrations



## EIFS Conclusions

- ✍ Rain
  - Penetration occurs at joints
  - Damage is mostly to substrate
- ✍ So ...
  - Drain joints
  - Protect substrate

## Conclusions

- ✍ Rain Control is complex and requires consideration in design process
  - EIFS is not "special" all systems deserve attention
- ✍ Deflection – site, building, surface features
- ✍ Drainage/Exclusion/Storage
  - Drainage is not the simple answer
- ✍ Details should be developed for intersections
  - Windows, balconies, etc.