



# **Building Envelope Inspection**

**How to Manage Risk and Reduce Liability**

**Online Class**

**Tuesday August 18, 2020**

# Learning Objectives

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- **Building Envelope Inspection**
  - Why
  - Behavior
  - Inspection
  - Reporting

**AIA**  
**Continuing**  
**Education**  
**Provider**

# Innovative Engineering, Inc.



- **Scott L. Weiland PE**
  - **BSCE University of Michigan**
  - **Graduate Studies:**
    - San Jose State University
    - Georgia Institute of Technology
  - **Level I sUAS Thermographer**
  - **Articles:**
    - Structure Magazine – Building Façade Inspection Part I & II
    - Georgia Engineer – Building Façade Inspection Part I & II
    - AIA Design Equilibrium – Building Façade Inspection
    - BOMA Georgia Insight Magazine - Falling Building Façade Closes Atlanta Streets

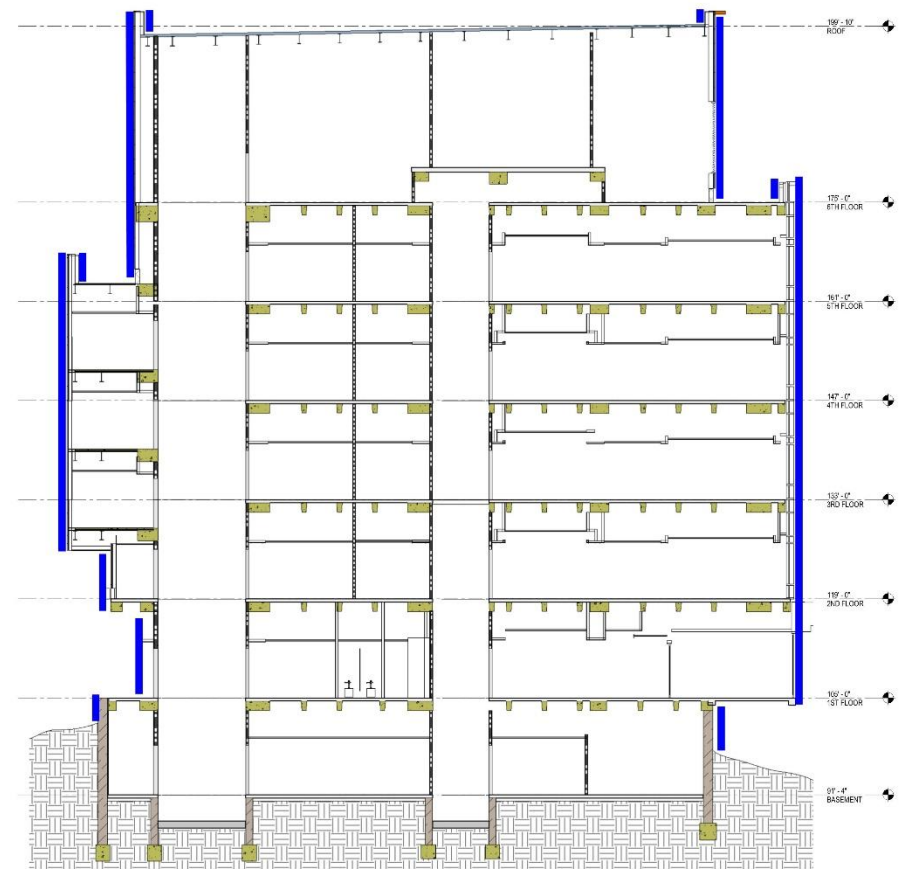


# Building Envelope - Definitions

## Envelope



## Facade



# Façade Collapse - Cleveland

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- 2015
- Father & 4 Boys had just left car parked 10 minutes before to have dinner.
- High Winds Blamed

# Façade Cornice Collapse – 2017 Atlanta Sidewalk



Note: The video and presentation can be watched in full on the Innovative Engineering Inc. YouTube channel.

# Falling Building Façade Closes Atlanta Streets



Façade & Building Envelope Inspection

# Falling Building Façade Closes Atlanta Streets

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- 2017 34 Story Building
- Basis of Façade Article

# Façade Ordinances



- New York, NY
- Columbus, OH
- Boston, MA
- Chicago, IL
- Milwaukee, WI
- Detroit, MI
- Pittsburg, PA
- St. Louis, MO
- Philadelphia, PA
- Cleveland, OH
- Cincinnati, OH
- San Francisco, CA

# The International Property Maintenance Code

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## SECTION 304 EXTERIOR STRUCTURE

**304.1 General.** The exterior of a structure shall be maintained in good repair, structurally sound and sanitary so as not to pose a threat to the public health, safety or welfare.

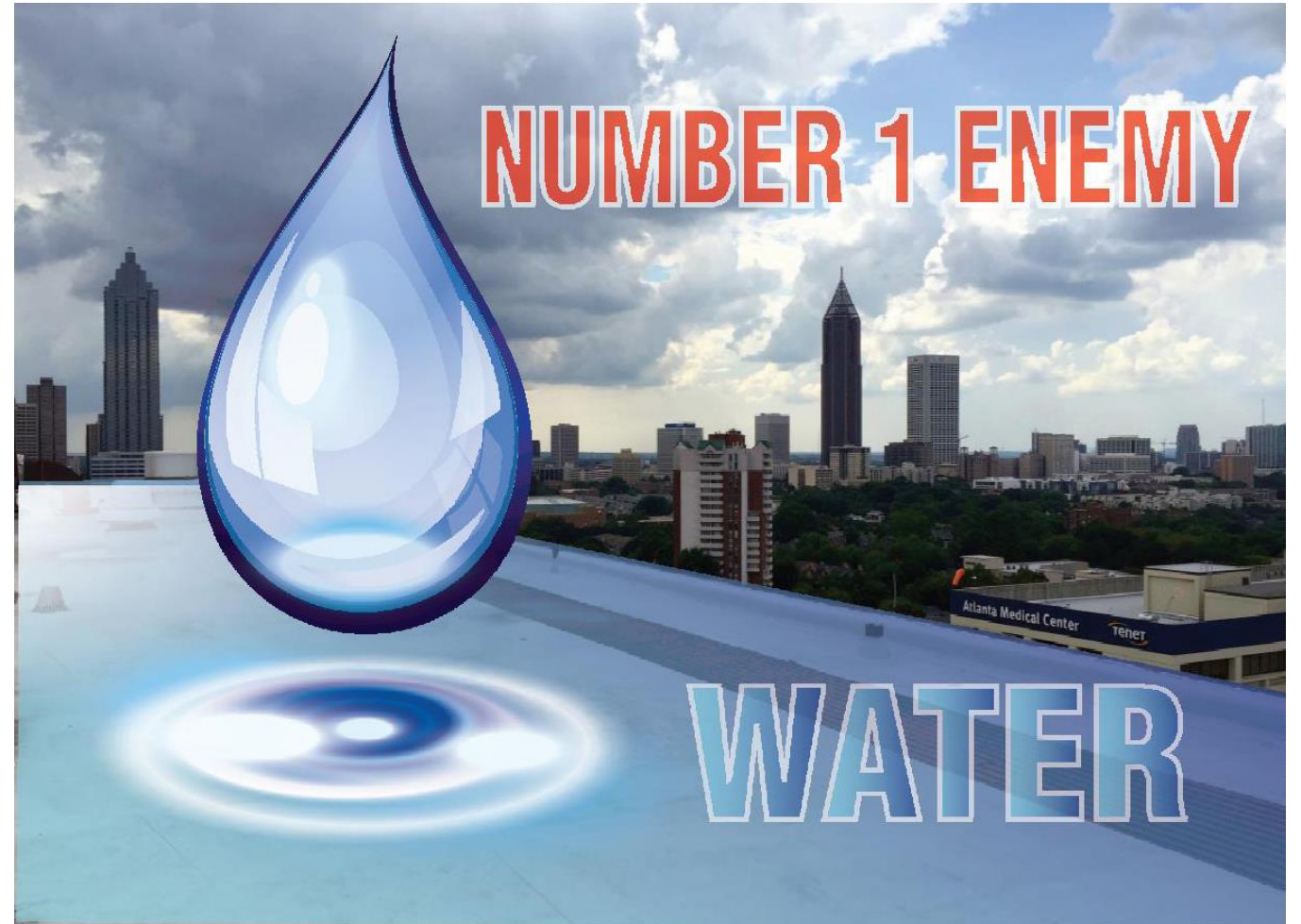
# Building Science – Environmental Separator



- **Structural resistance to wind.**
- **Environmental protection from the elements, including moisture & temperature.**
- **Architectural appearance and aesthetics.**

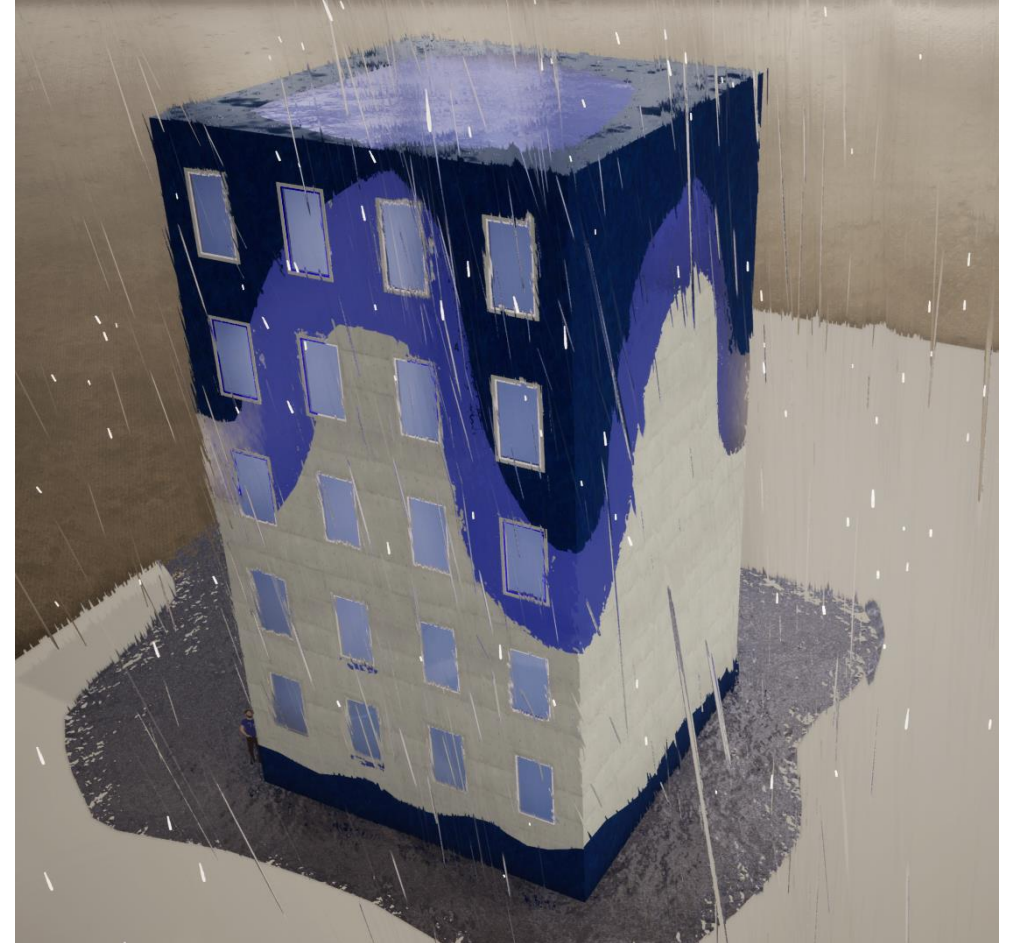
# Building Science – Sources of Deficiencies

- **Natural Aging**
- **Leakage**
  - Roofing
  - Walls
  - Windows
  - Joints
- **Movement of Materials**
  - Thermal
  - Moisture
  - Elastic Deformation
  - Creep
- **Other**
  - Impact Damage
  - Lightning Strike



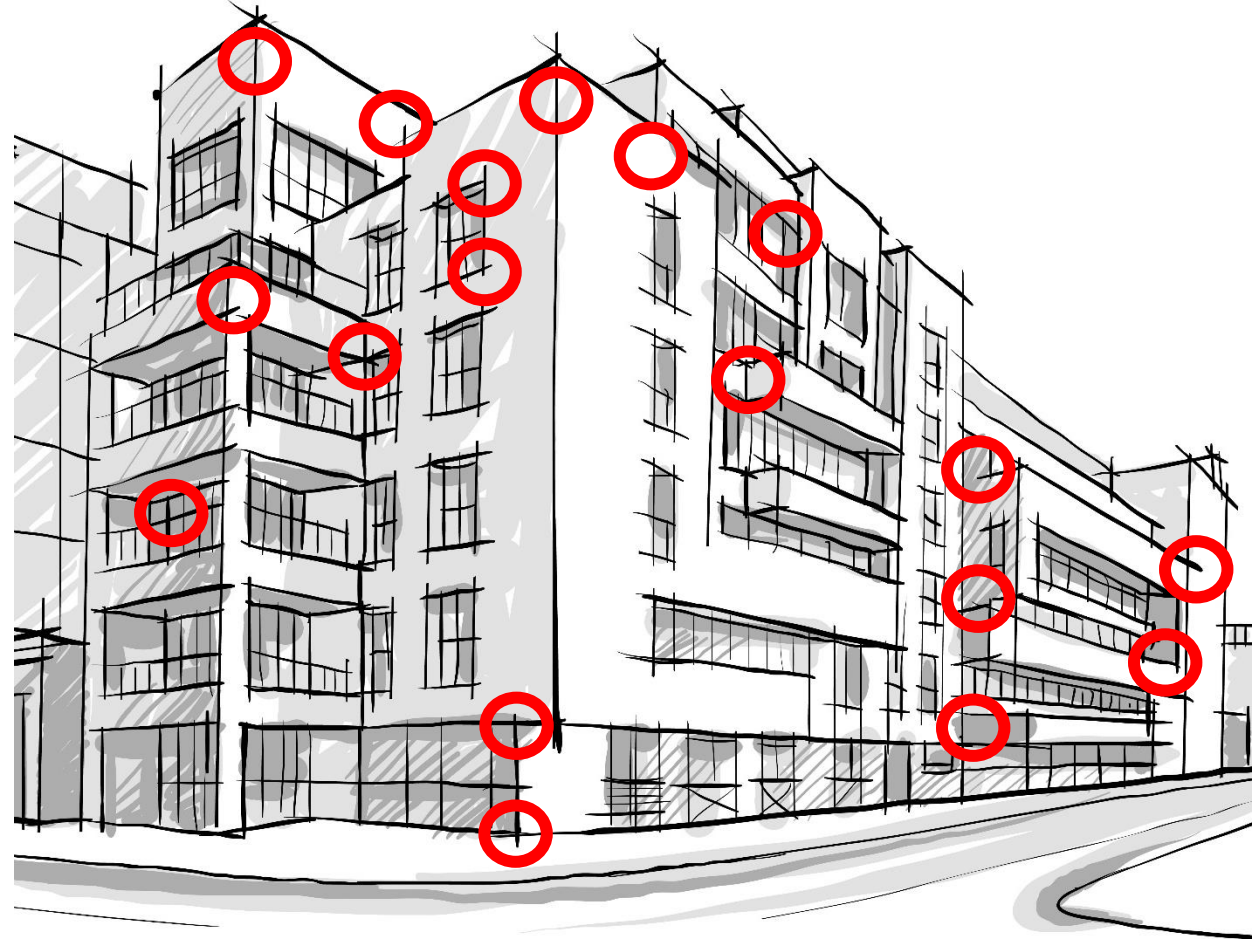
# Building Science – Moisture Exposure

- **Water Intrusion: 70% of construction litigation**
- **Damage Functions**
  - Water
  - Heat
  - Ultra-Violet Radiation

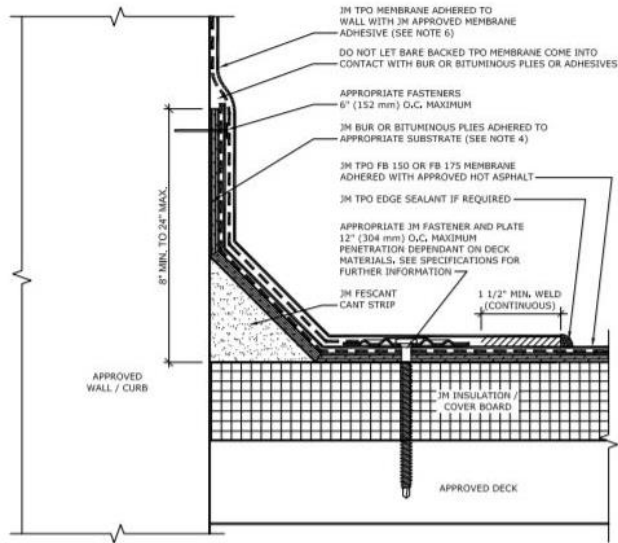


# Building Science - Principles

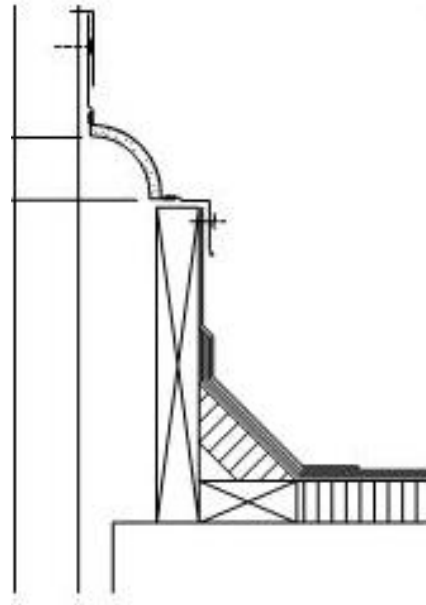
- **90%/1%**
  - 90% of the water intrusion problems occur within 1% of the total building exterior. Usually at terminations and transitions
- **99%**
  - 99% of water intrusion problems are attributable to human error including detailing, specifications, or installation. Not material or system failures.



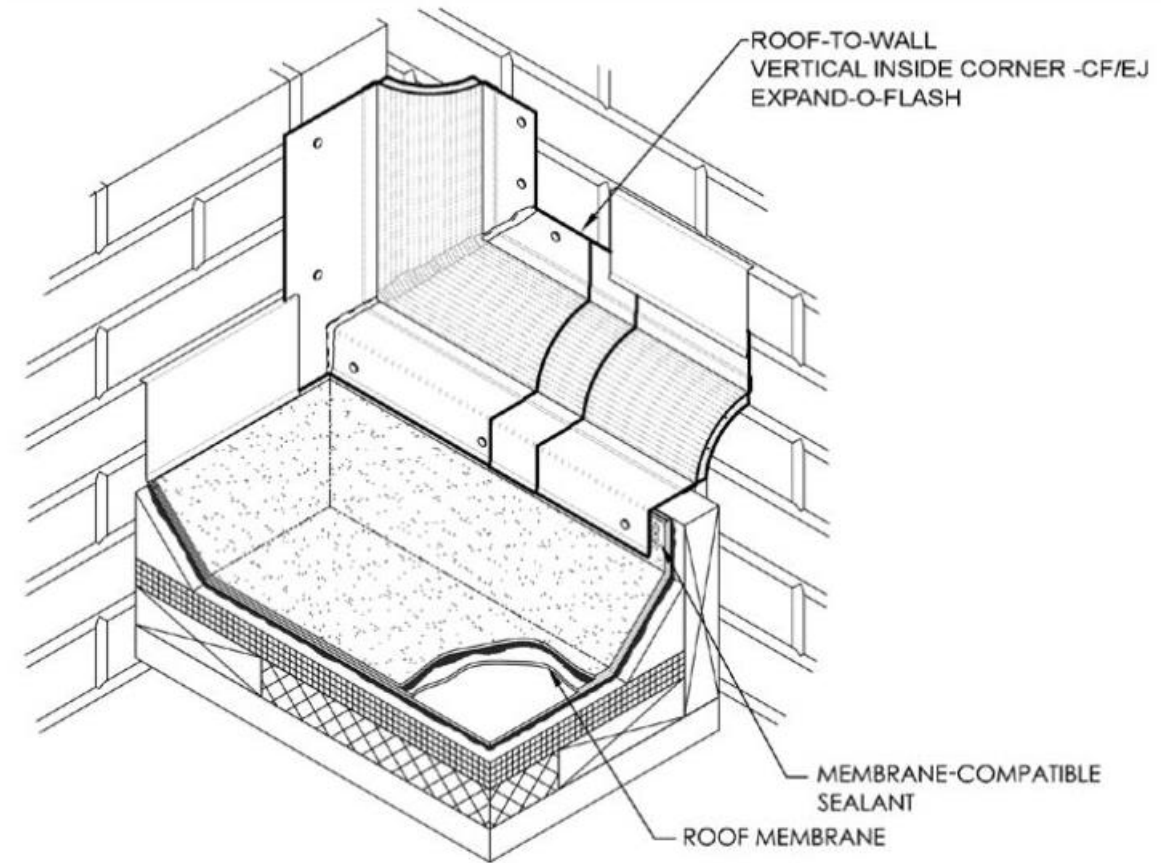
# Building Science - Transition Details



2 D



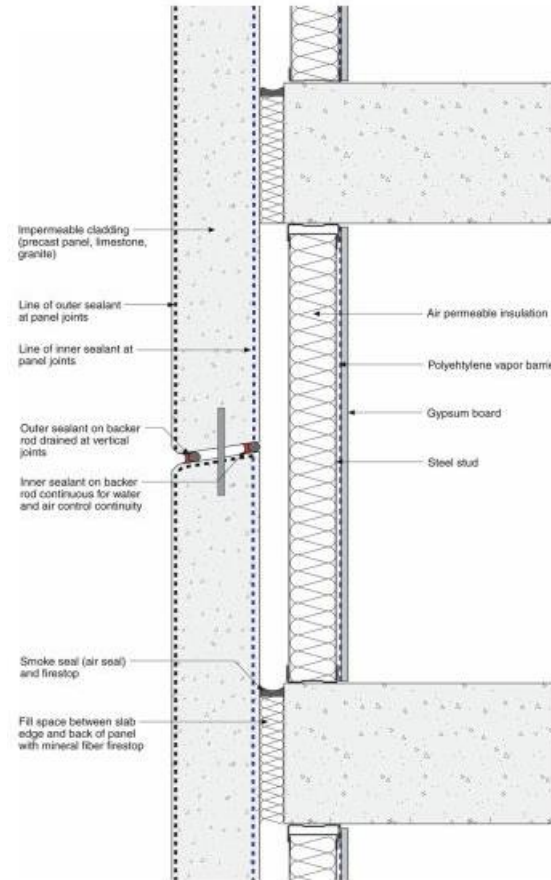
3 D



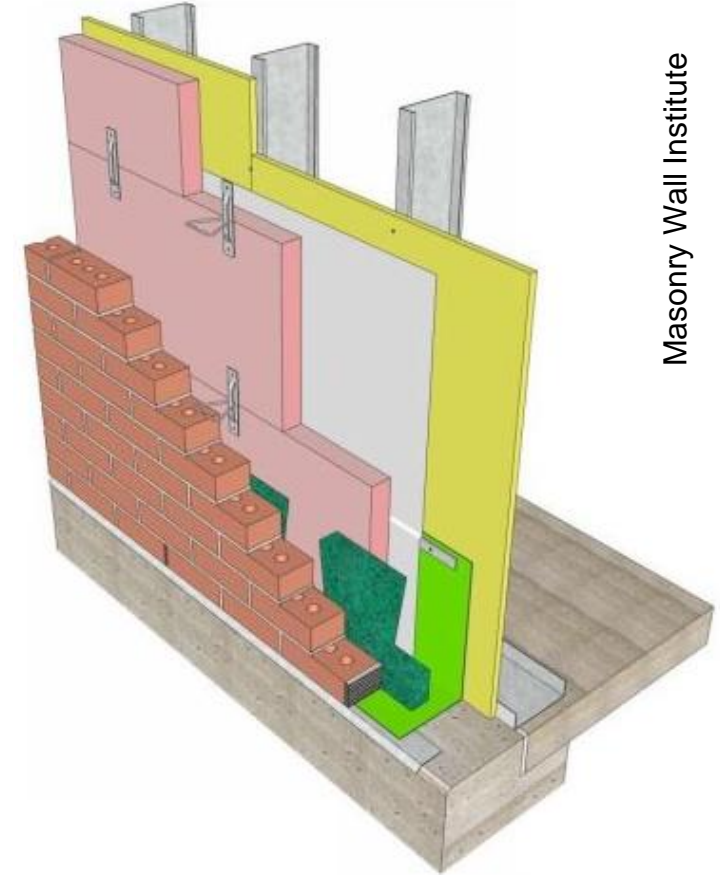
# Façade – 3 Wall Types



Mass Wall

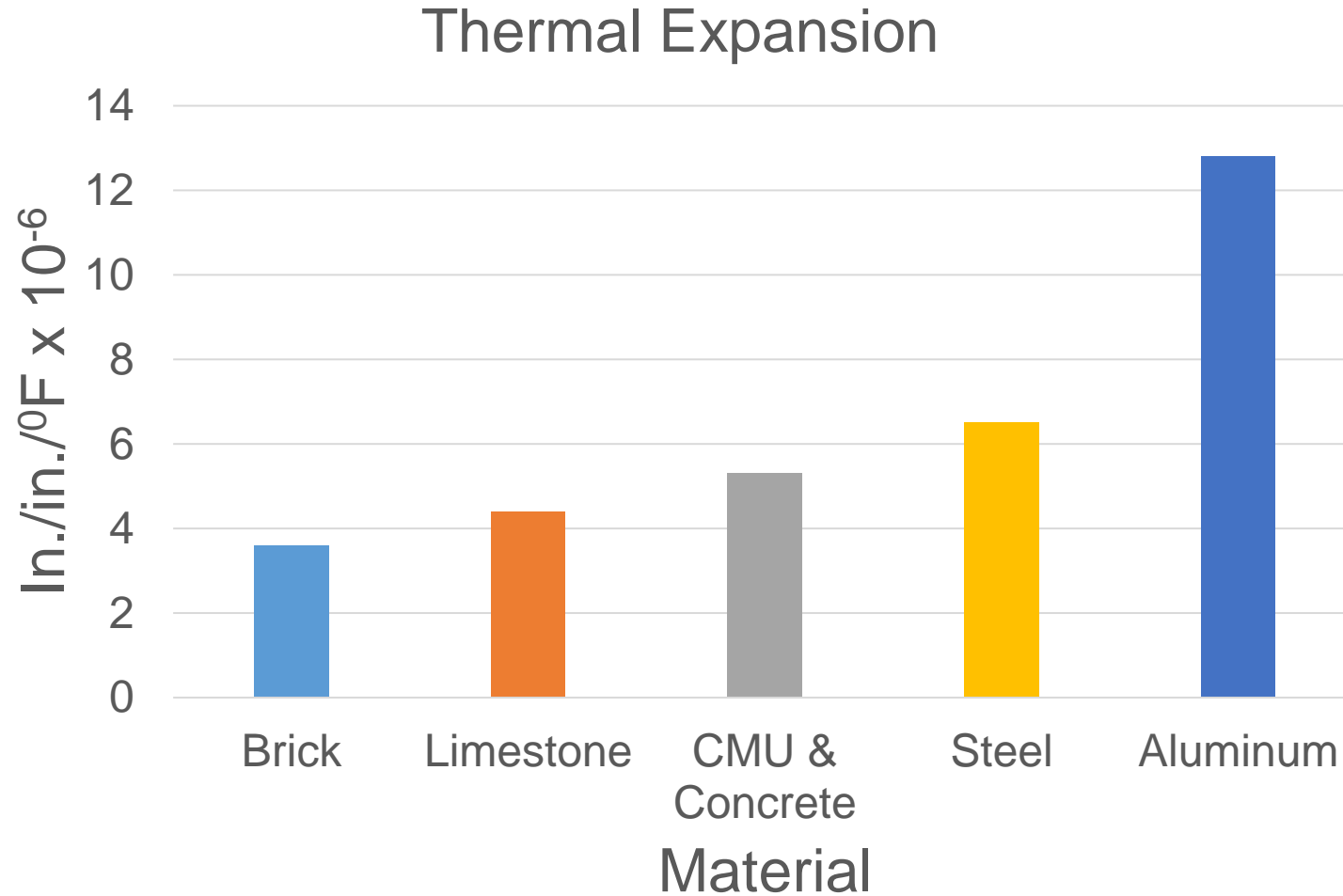


Barrier Wall



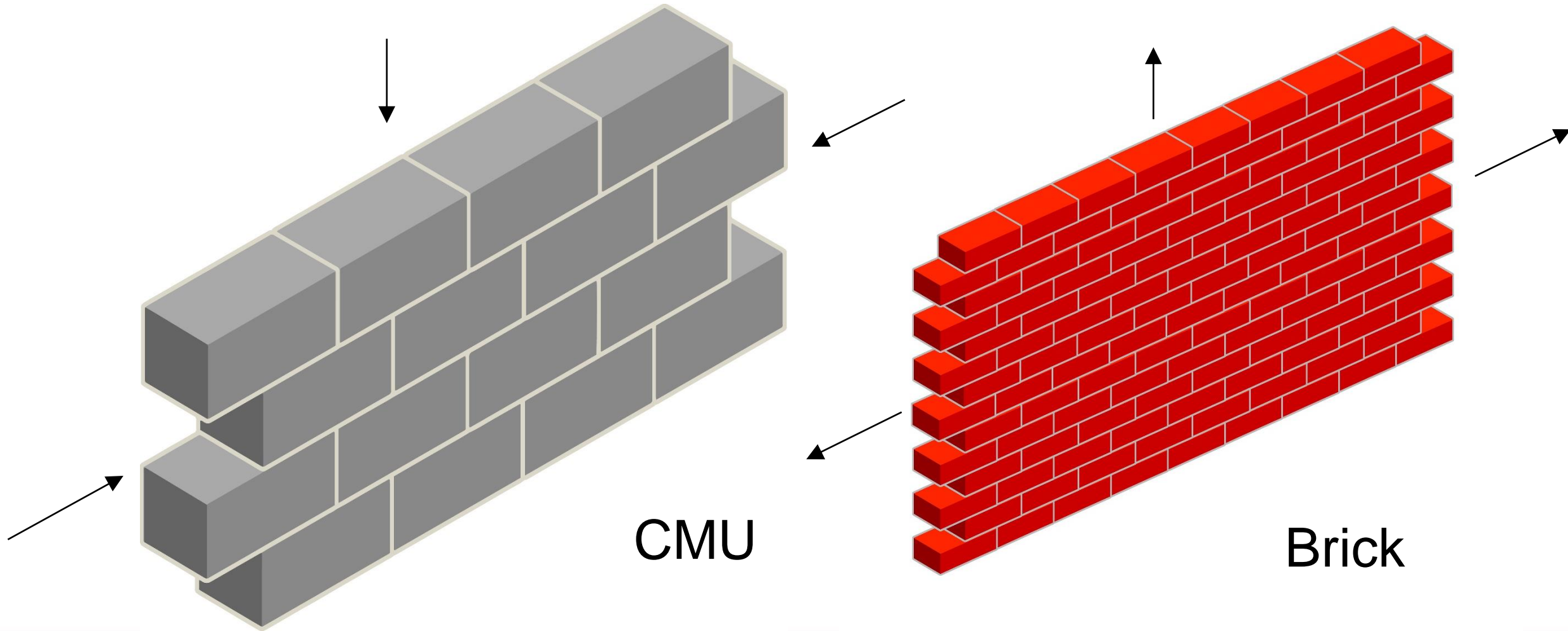
Cavity Wall

# Facade - Thermal Expansion

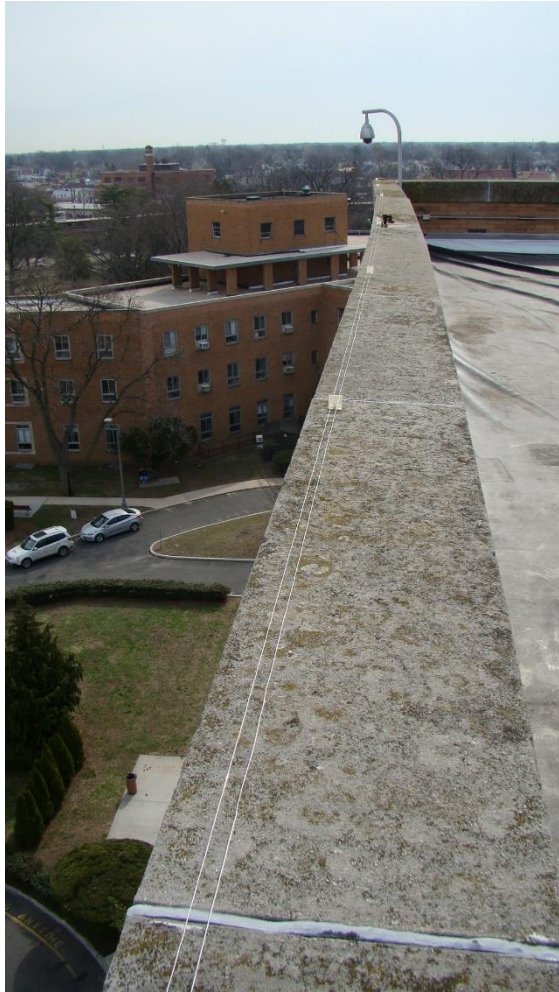


Coefficients of Thermal Expansion	
Material	in./in./°F x 10 <sup>-6</sup>
<b>Wood</b>	
Pine (parallel to grain)	3.0
Pine (perpendicular to grain)	19.0
<b>Masonry</b>	
Brick	3.6
Limestone	4.4
Granite	4.7
Concrete Masonry Unit (CMU)	5.2
Marble	7.3
<b>Concrete</b>	
Concrete (Normal Weight)	5.5
<b>Metals</b>	
Steel	6.5
Copper	9.3
Aluminum	12.8
<b>Finishes</b>	
Glass	5.0
Gypsum Plaster, Sand	7.0
Gypsum Board	9.0

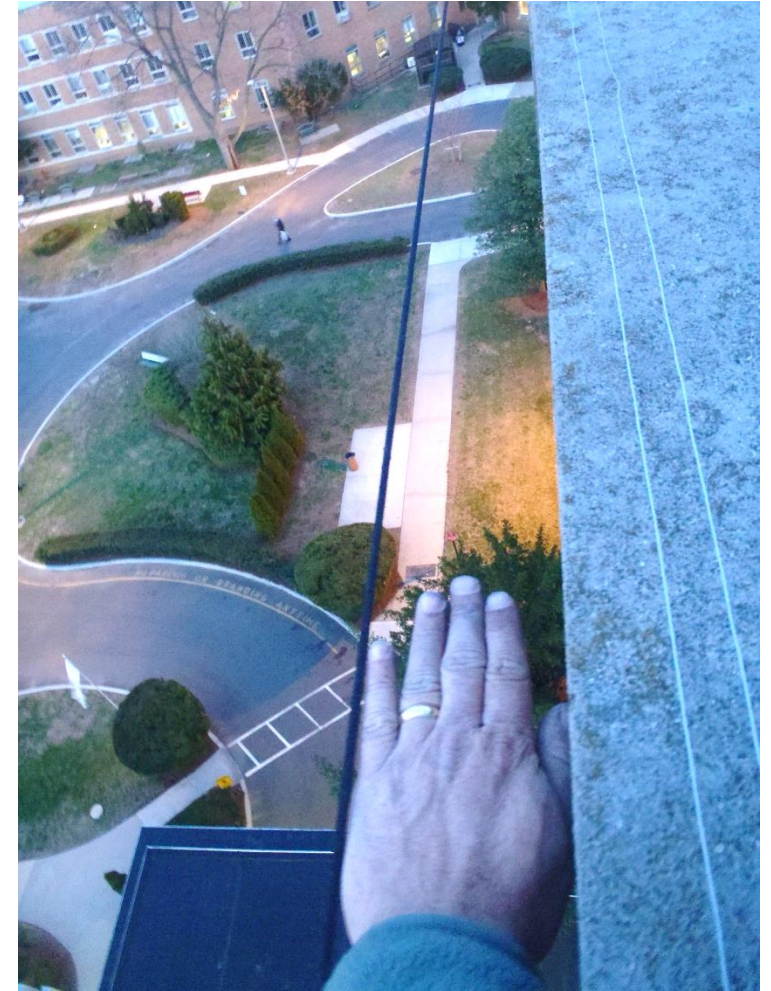
# Facade - Moisture Expansion/Shrinkage



# Façade - Thermal Expansion



Bond Break  
at Roof Line



# Façade – Thermal Expansion

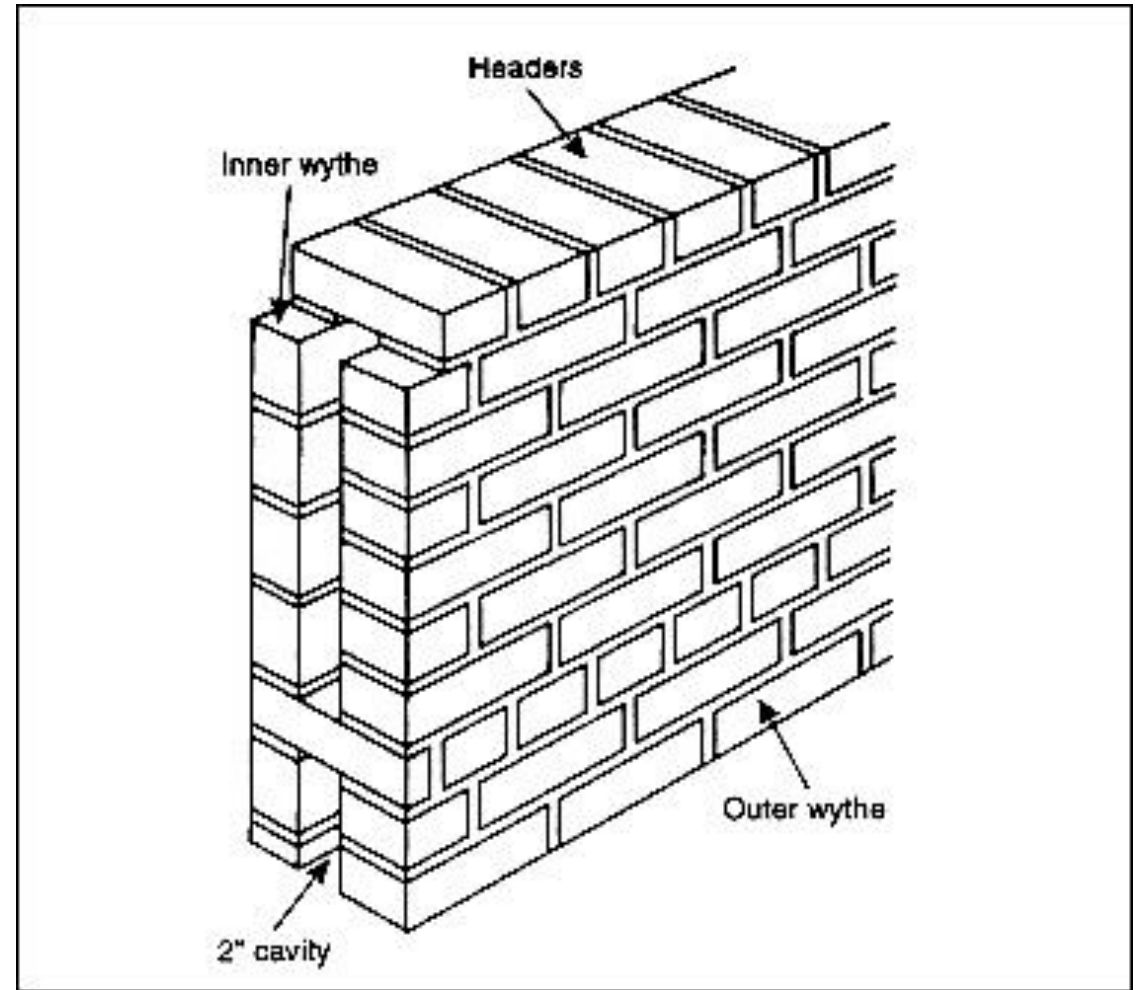


No Expansion Joints



Creates Hinge at Corner

# Façade – Moisture/Thermal Expansion/Contraction



# Façade – Moisture & Thermal Expansion/Contraction



# Façade – Moisture Damage

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# Façade – Corrosion Expansion

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# Facade – Elastic Deformation & Creep



# Facade – Impact Damage



# Facade - Lightning Strike



# Facade Inspection Procedure

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- User interviews
- Document Research
- General Inspection
- Detailed Inspection
- Watertight Integrity
- Classifying Deficiencies
- Reporting
- Estimating

# Façade Inspection - Visual



Façade & Building Envelope Inspection

# Façade Inspection - Detailed Close-Up



Boom Lift



Rope Access

# Façade Inspection - Bore Scope (Brick Veneer)



# Façade Inspection

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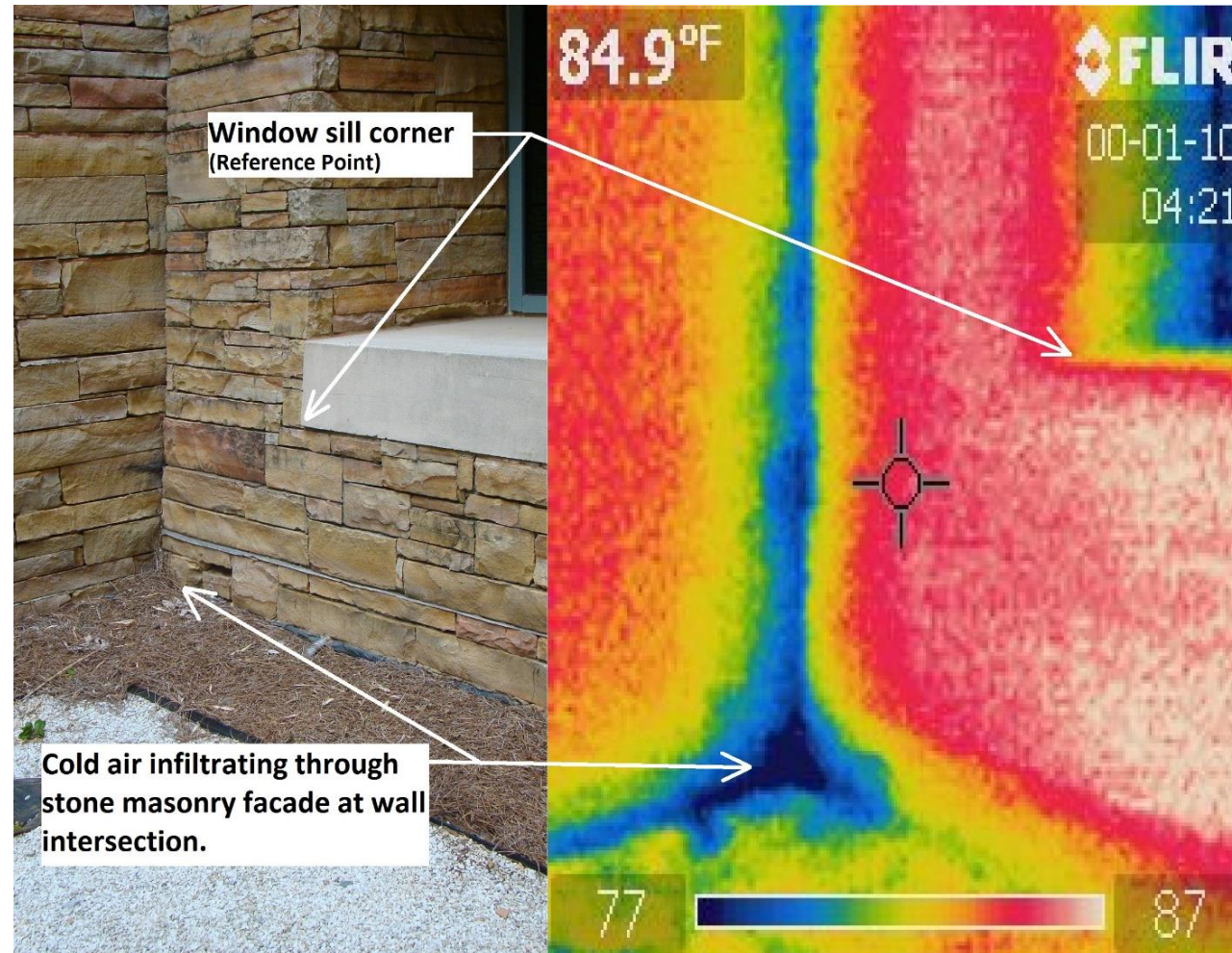


Sealants

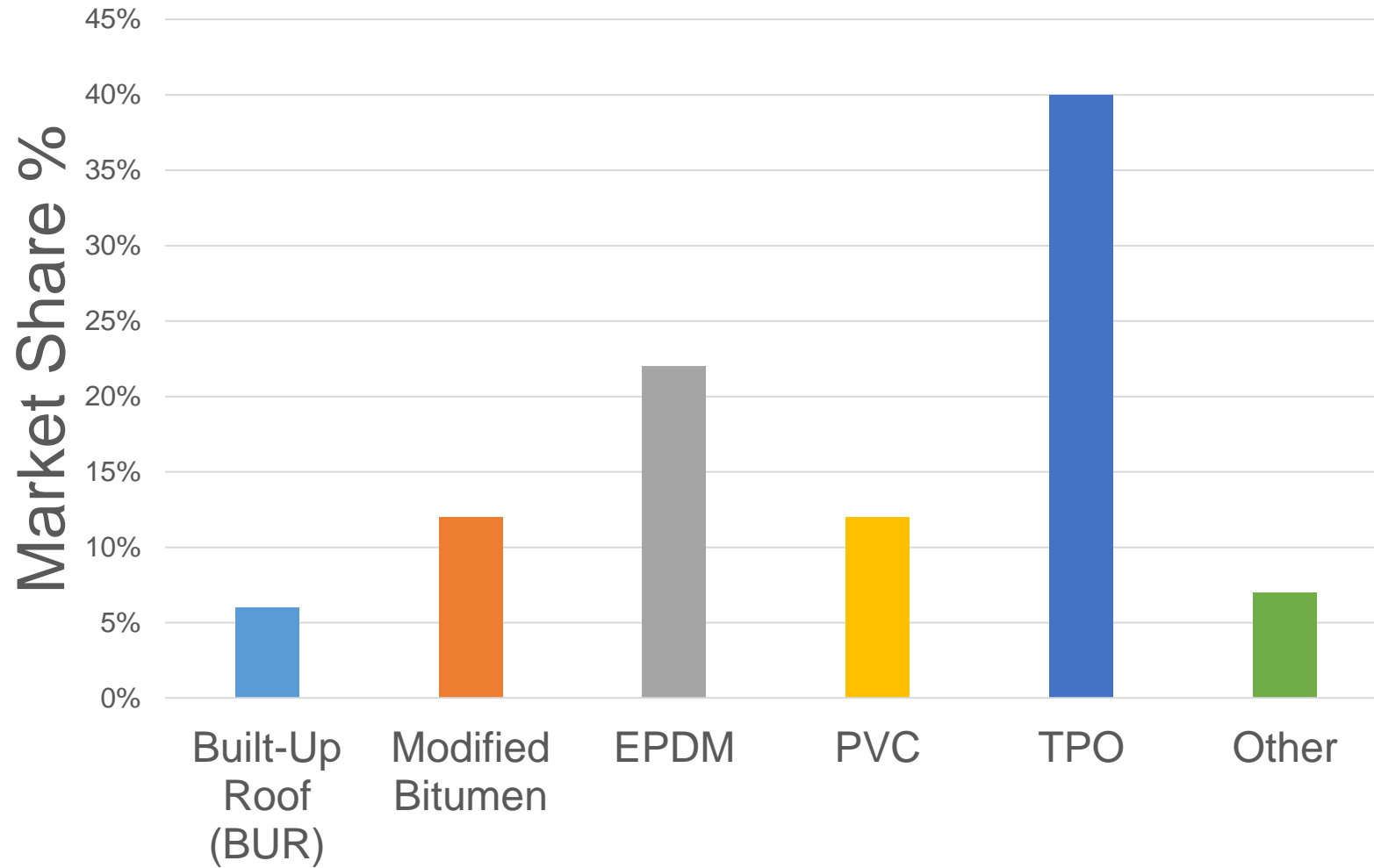


Sounding

# Façade Inspection - Air Infiltration

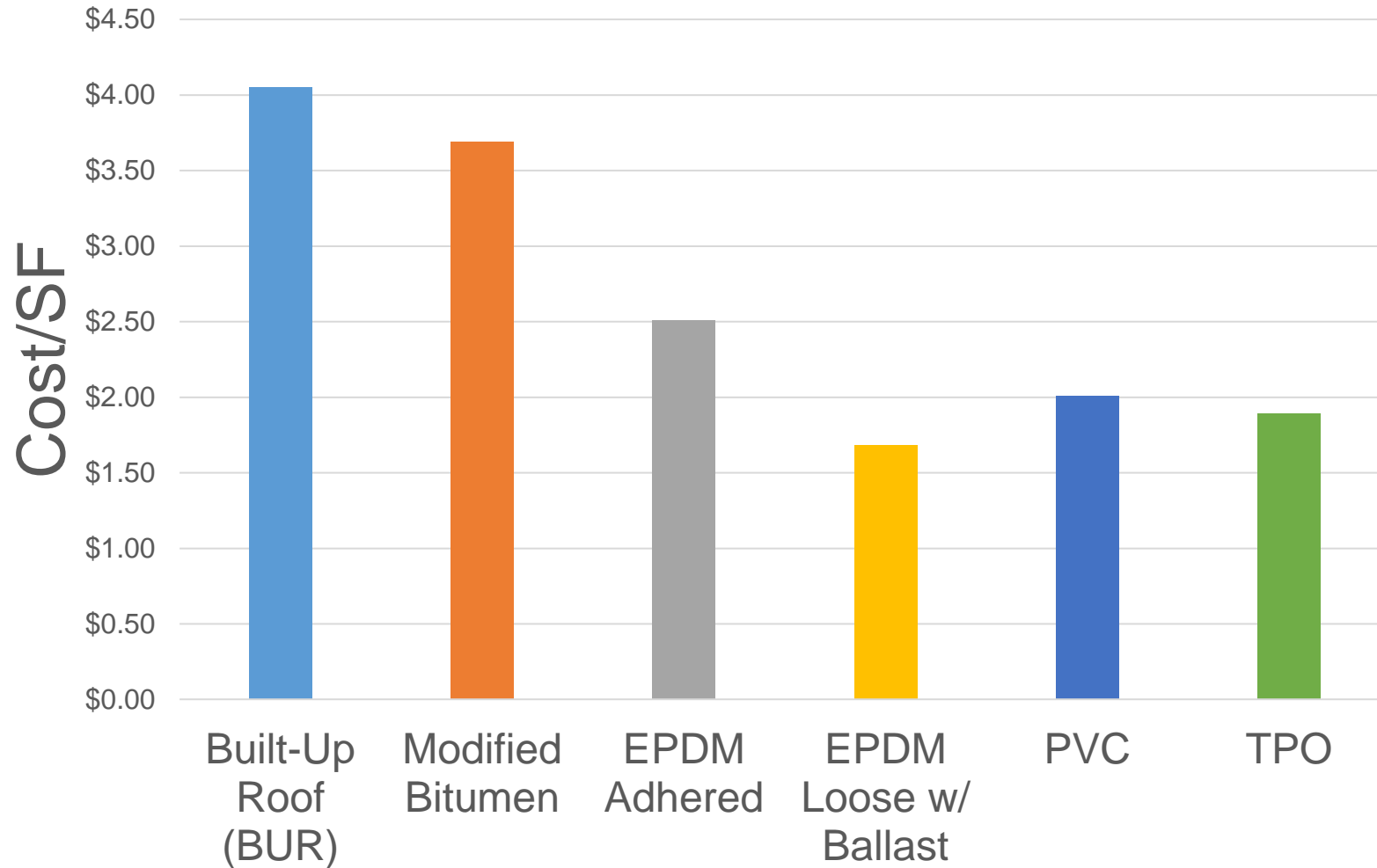


# Roofing - Common Material Market Share



- Built-Up Roof (BUR)
- Modified Bitumen
- EPDM
- PVC
- TPO
- Other

# Roofing - Common Material Cost Data



- Built-Up Roof (BUR)
- Modified Bitumen
- EPDM
- PVC
- TPO
- Other

# Roofing - Ponding



Ponding > 48 Hours

- **Ponding:** Most common factor in roofing failure
- **Water Shedding:** Can make up for shortcomings in design, construction, durability, & maintenance.
- **Degradation:** Asphalt & Polymeric materials
- **Freezing:** Erodes surface aggregate
- **Voids:** Manufacturers warranty

# Roofing - Built-Up Roofing (BUR)



**Blistering**



**Slippage**

- **Blistering**
- **Splits**
- **Ridging/  
Wrinkling**
- **Slippage**

# Roofing - Modified Bitumen

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- **Defective Lap Seams**
- Shrinkage
- Checking
- Blistering
- Delamination
- Slippage
- Spitting

# Roofing - EPDM

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- **Lap-Seam Failure**
- Flashing
- Other Common Problems – 8%
  - Puncture
  - Shrinkage
  - Wind Uplift
- Minor Problems @<3%
  - Fastening
  - Blistering
  - Embrittlement

# Roofing - PVC

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- **Embrittlement**
- **Puncture**

Photo by RCI

# Roofing - TPO

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Image by RCI

- **Premature Aging**
  - Erosion of Top Surface
  - Small Holes/Slits
  - Cracking
  - Separation
- **Seam Failures**
- **Newest Roofing Material**

# Roof Inspection Procedure

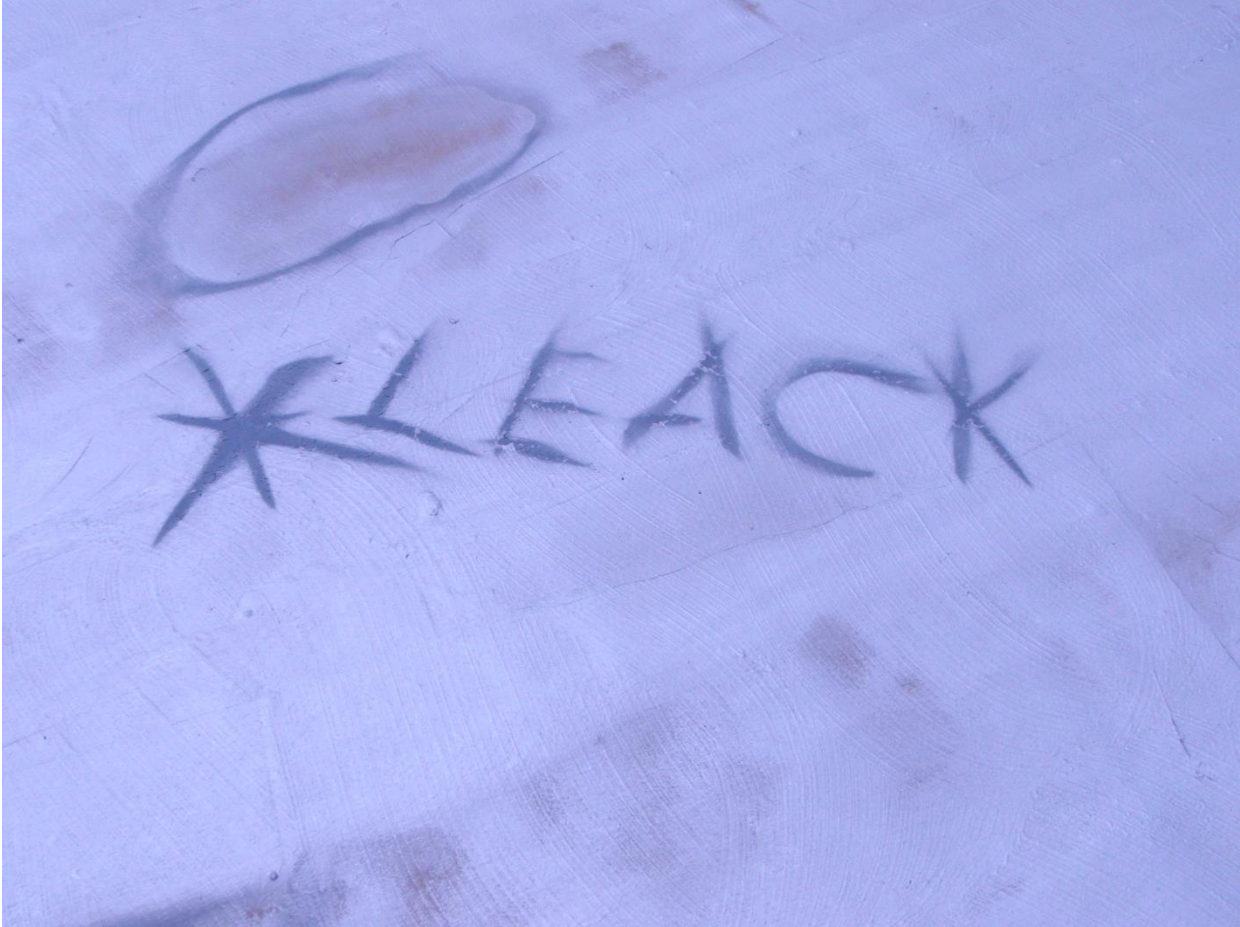
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- User interviews
- Document Research
- Visual
- Moisture Survey
- Reporting
- Estimating

# Roofing Inspection - Visual

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- Easiest when someone finds it for you.

# Roof Inspection - Drone Infrared

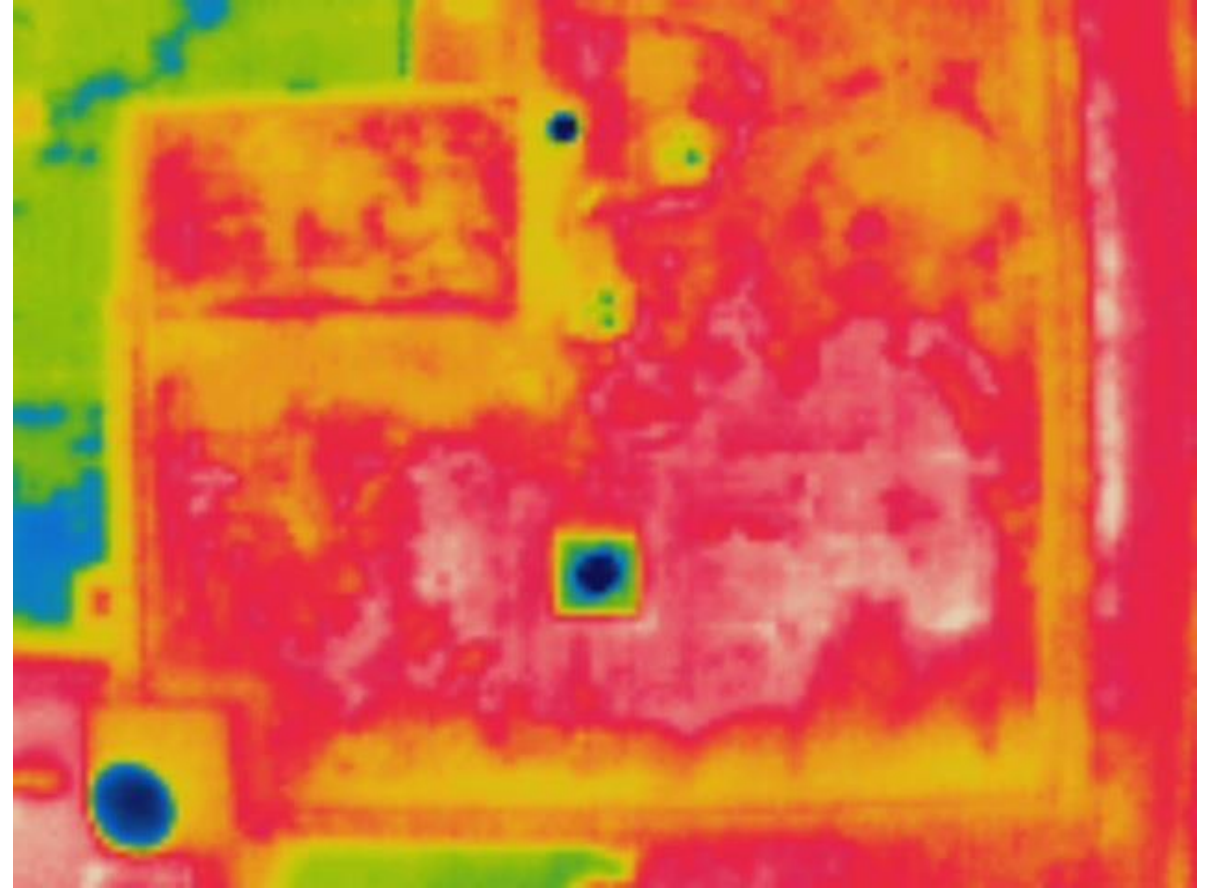
- Infrared Camera (IR)
- Best After Dusk
  - Insulation and Moisture Heats Up During the Day
  - Dry Insulation cools off faster than Wet Insulation
- Daylight Waiver Required
- Height to See Major Portions of Roof
- Safer and More Accurate than Handheld



# Roofing Inspection – Thermal Imaging



Visual Red-Green-Blue (RGB)



Infrared (IR)

# Roof Inspection – IR Confirmation



Impedance Meter



Pin-Type Meter

# Roofing Inspection – IR Confirmation



Roofing Core



Sample

# Reporting

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- **Project Information**
- **General Building Description**
  - Original Construction
  - Renovations
  - Additions
- **General Building Condition**
- **Findings & Recommendations by Deficiency level**
- **Detailed Description of Building Structural, Façade & Waterproofing Systems**
- **Building Footprint w/ Deficiencies**
- **Elevation Photos**
- **Methods Used to Conduct Investigation**
- **Detailed Findings & Recommendations w/ Plans, Elevations, & Photos**
- **Estimate**
- **Classification of Deficiencies**
  - Unsafe Condition
  - Requires Repair/Stabilization
  - Ordinary Maintenance

# Learning Objectives

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- **Building Envelope Inspection**
  - Why
  - Behavior
  - Inspection Process
  - Reporting

# Questions?

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