BOMA Georgia
MEMBER

Façade Inspection

BTO Building Envelope Safety Seminar
Thursday October 10, 2019

The Pinnacle of Structural Engineering

Innovative EngineeringInc.

Learning Objectives

- **Façade Inspection**
  - Why
  - Behavior
  - Inspection
  - Reporting

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

Innovative Engineering, Inc.

- Trey Thomas PE
  - BSCET, Southern Polytechnic State University
  - 15 Years in Design and Restoration Engineering
    - Co-author of Forensic articles
  - OSHA Qualified Fall Protection Engineer
  - OSHA Competent Person for Boom & Scissor Lifts
  - SPRAT Level 2 Rope Access Technician
  - FAA Part 107 Remote Pilot Certificate
  - FAA Part 107 Daylight Waiver
  - Level I Thermographer
  - Expert estimator (within 5% of actual)

Innovative Engineering, Inc.

- Keith Brasher PE SE
- BSCE Mississippi State University
- MSCE Georgia Institute of Technology
- Roofing Consultants Institute Certification

Façade Collapse - Cleveland

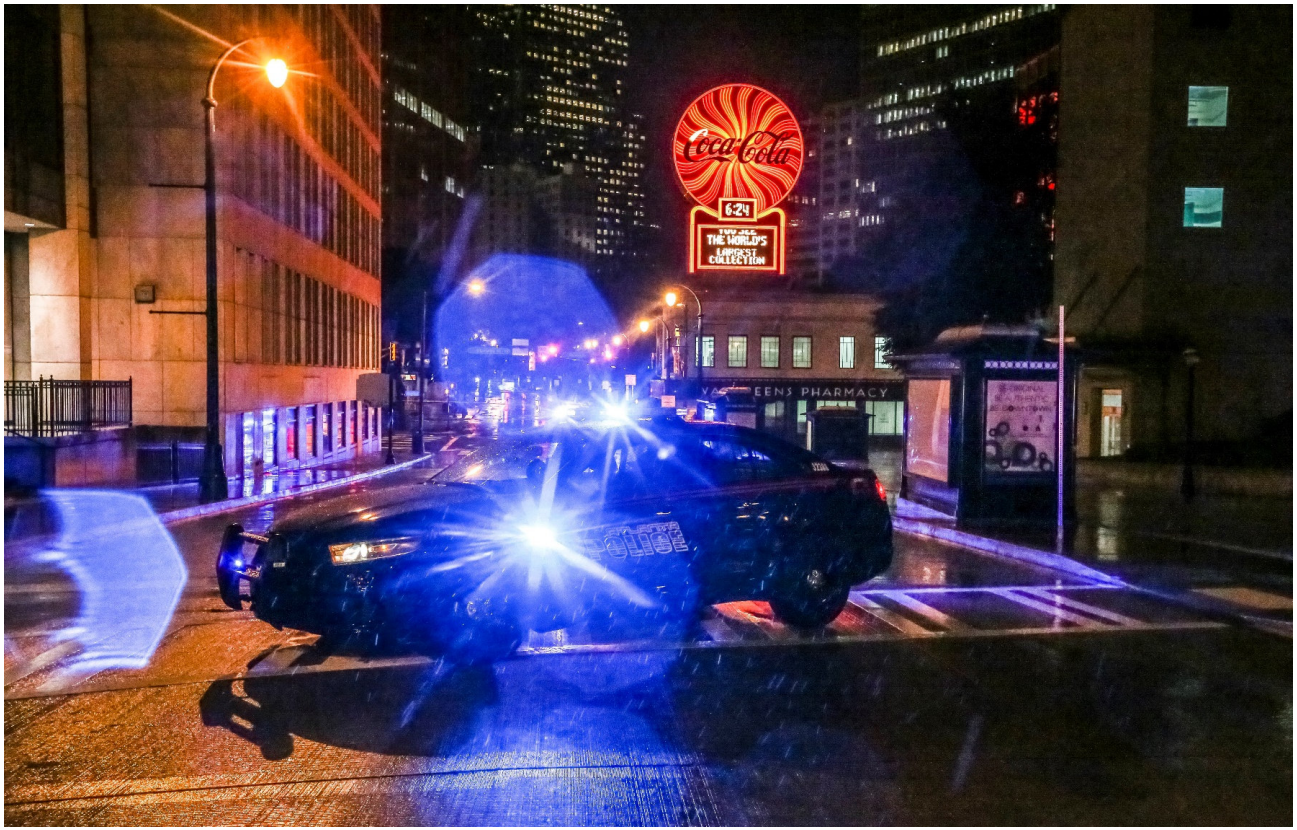
- 2015
- Father & 4 Boys had just left car parked 10 minutes before to have dinner.
- High Winds Blamed

Midtown Façade Collapse - Atlanta

- 2016 Façade Collapse
- Woman Transported to Grady
- People Trapped Inside

Façade Cornice Collapse – 2017 Atlanta Sidewalk

Fall Building Façade Closes Atlanta Streets



Façade & Building Envelope Inspection

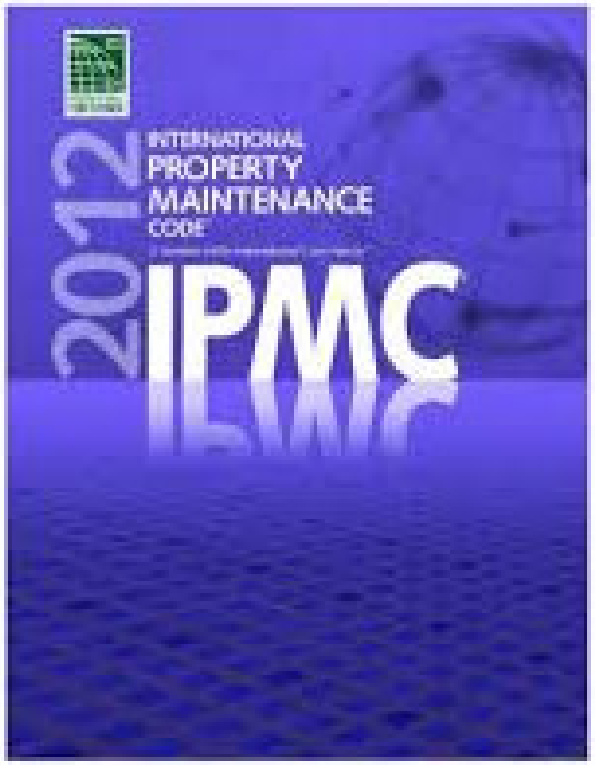
Falling Building Façade Closes Atlanta Streets

- 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



SECTION 304
EXTERIOR STRUCTURE

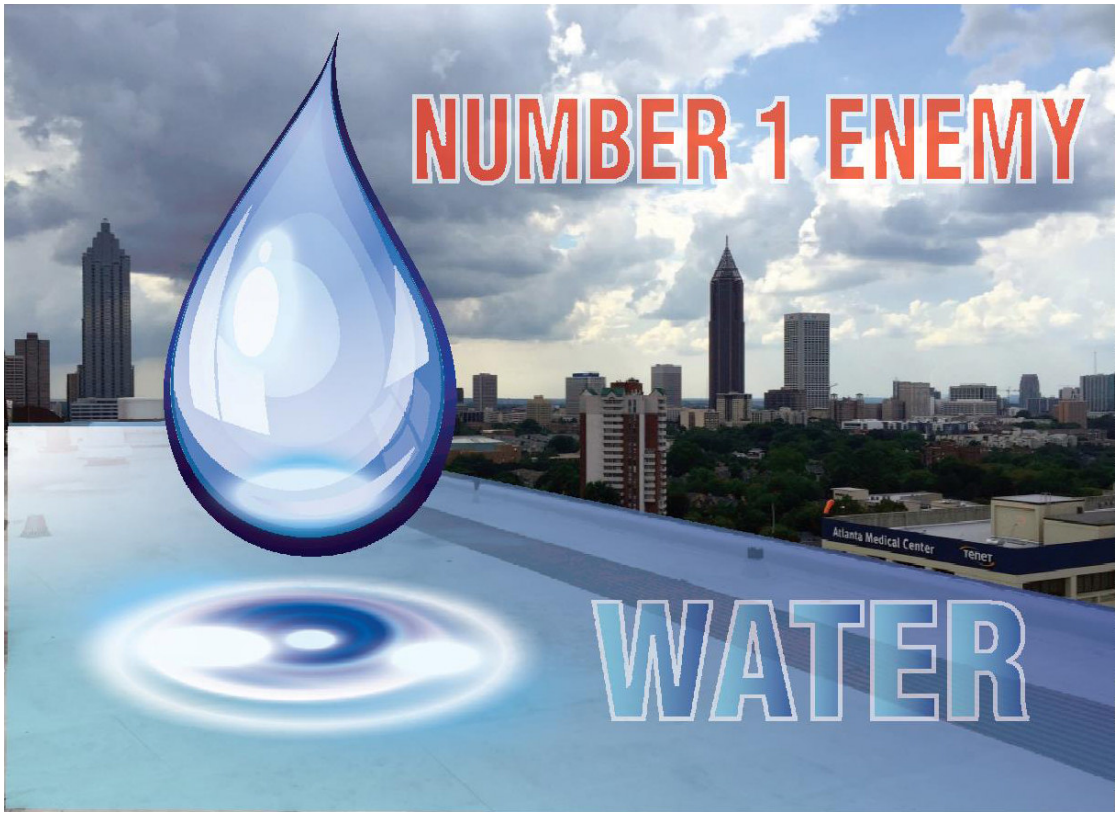
304.1 General. The exterior of a structure shall be maintained in good repair, structurally sound and sanitary so as not to pose a threat to the public health, safety or welfare.

Purpose of Façade & Building Envelope

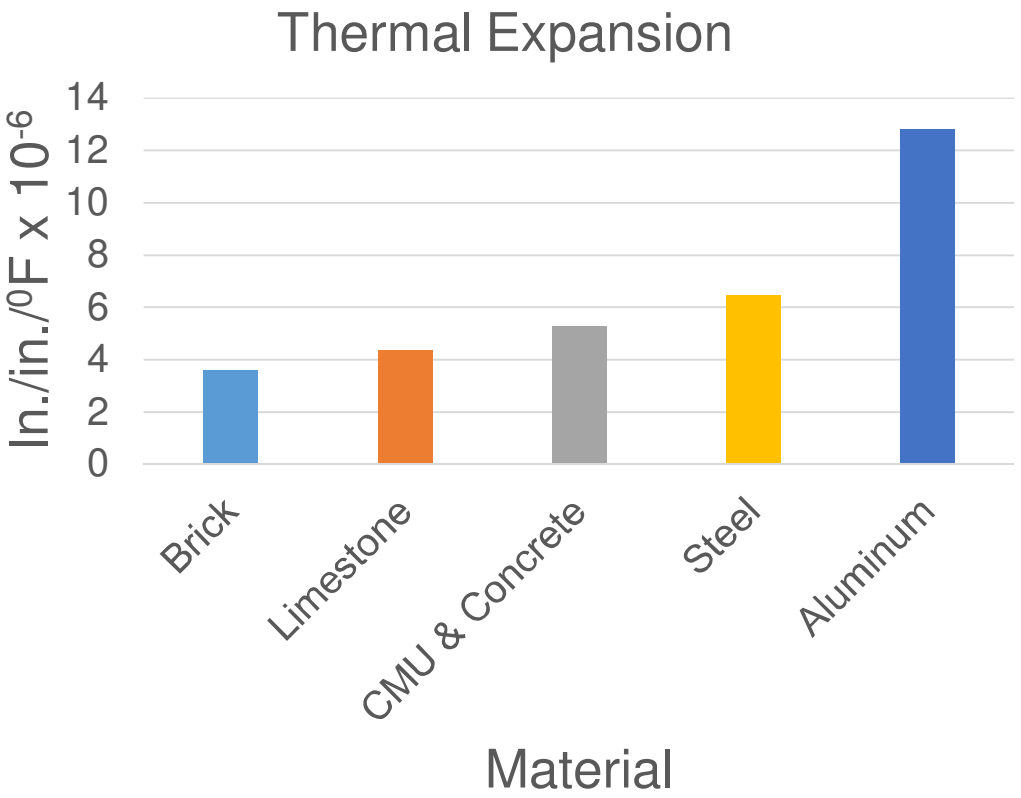
- Structural resistance to wind, seismic & gravity loads.
- Environmental protection from the elements, including moisture & temperature.
- Architectural appearance and aesthetics.

Source of Deficiencies

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

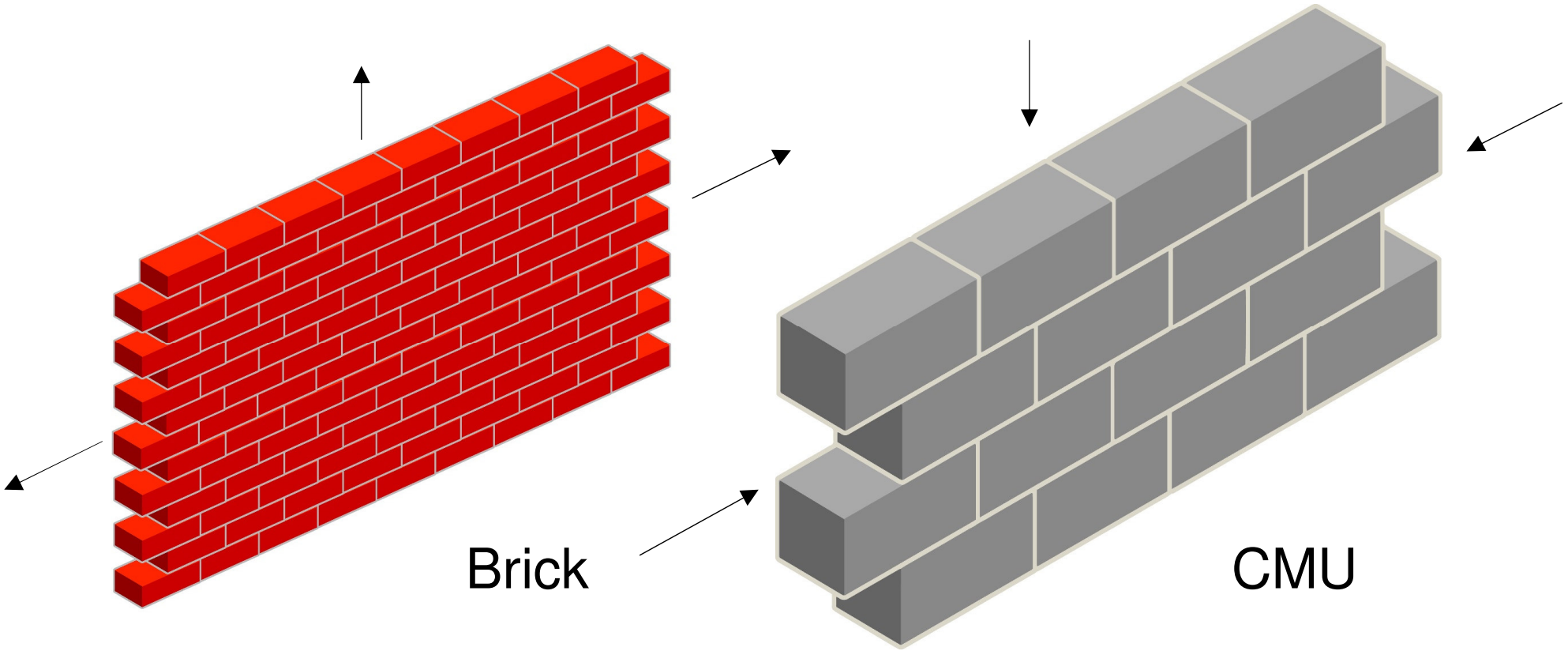


Thermal Expansion

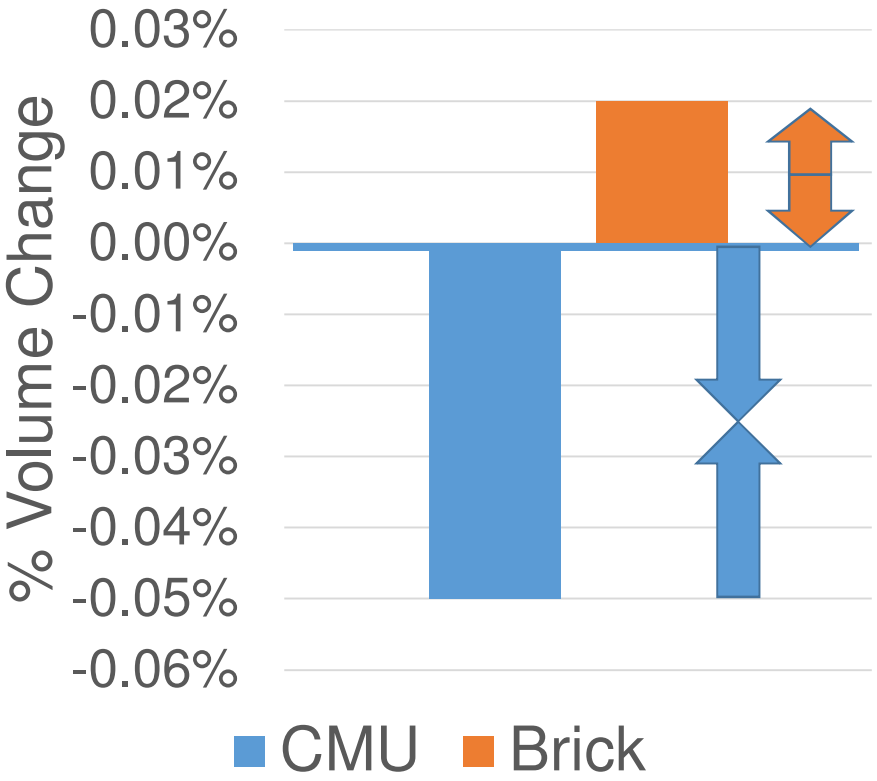


Coefficients of Thermal Expansion	
Material	in./in./^{0}F x 10^{-6}
Wood	
Pine (parellel to grain)	3.0
Pine (perpendicular to grain)	19.0
Masonry	
Brick	3.6
Limestone	4.4
Granite	4.7
Concrete Masonry Unit (CMU)	5.2
Marble	7.3
Concrete	
Concrete (Normal Weight)	5.5
Metals	
Steel	6.5
Copper	9.3
Aluminum	12.8
Finishes	
Glass	5.0
Gypsum Plaster, Sand	7.0
Gypsum Board	9.0

Moisture – Expansion/Shrinkage



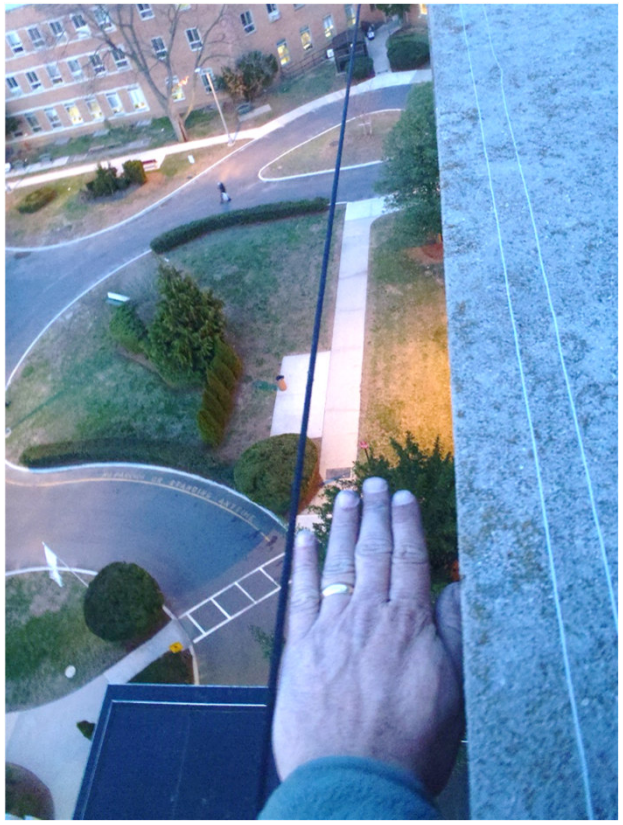
Moisture – Volume Change



- **Brick (& Terra Cotta)**
  - Smallest after fired
  - Expands as absorbs moisture
- **CMU (& Concrete)**
  - Largest after cast
  - Shrinks from Hydration & Evaporation

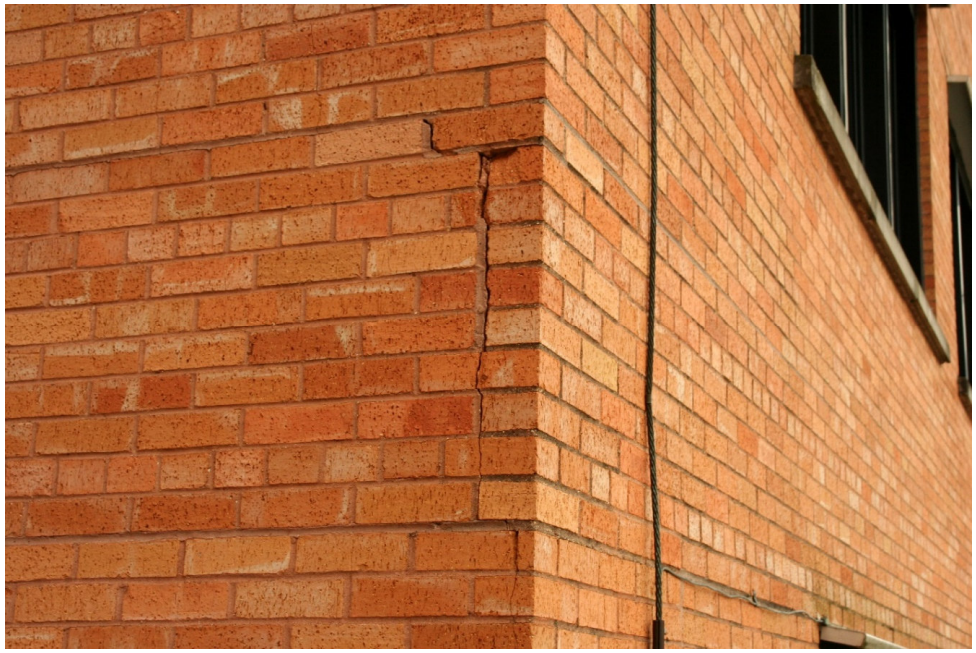
Thermal Expansion - Parapet

Bond Break
at Roof Line



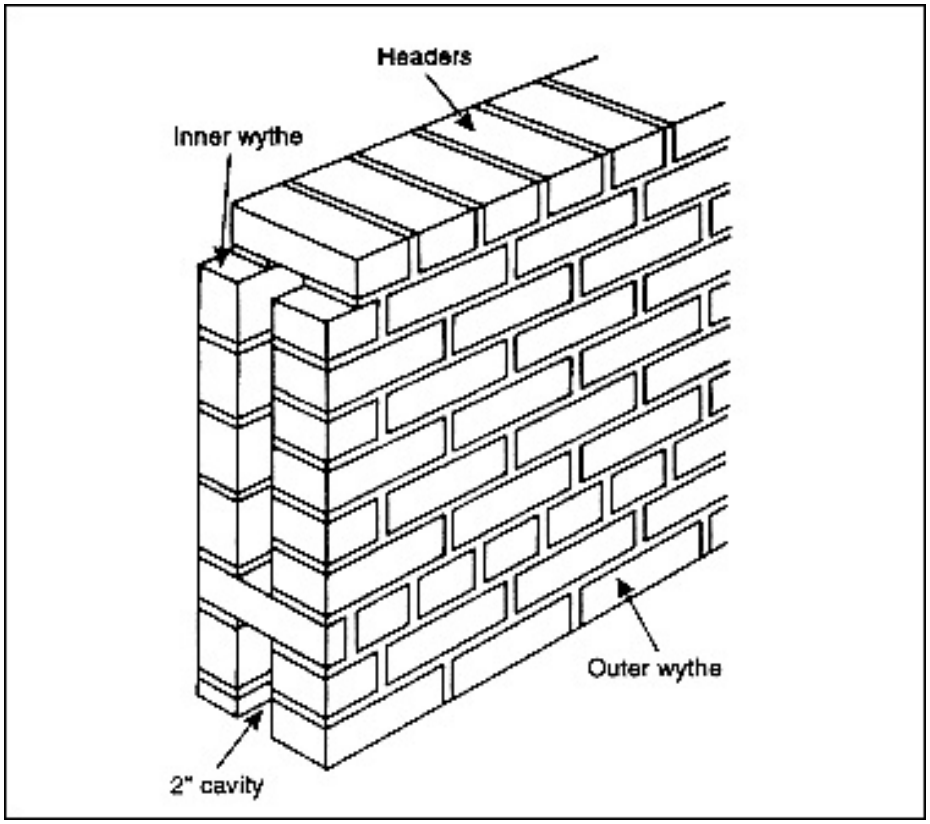
Movement of Materials – Thermal Expansion

No Expansion Joints

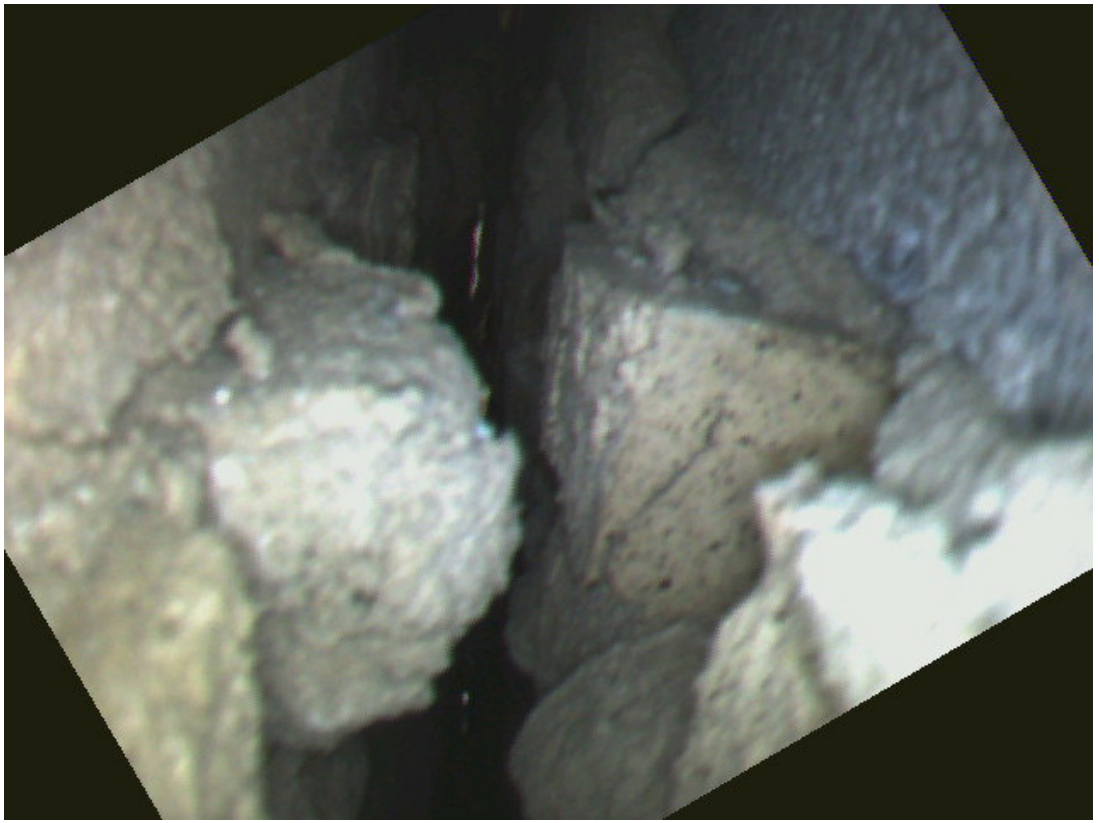


Creates Hinge at Corner

Movement of Materials – Thermal Expansion



Movement of Materials – Thermal



Moisture – Corrosion Expansion

Moisture – Moisture Expansion & Freeze Thaw

Movement of Materials – Elastic Deformation & Creep

Other – Impact Damage

Other - Lightning Strike

Watertight Integrity - Natural Aging

Sealants

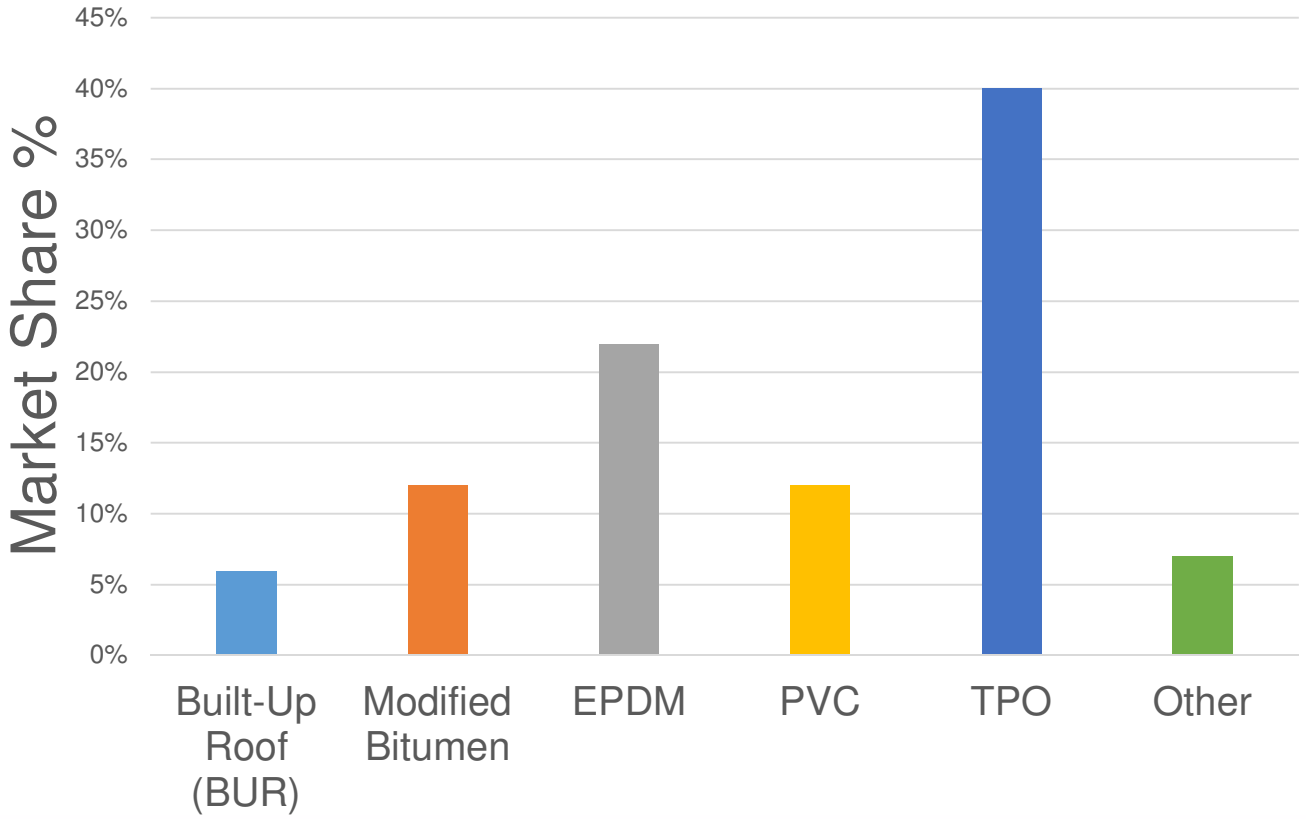
Roofing/Flashing

Watertight Integrity – Roof Drainage

Ponding > 48 Hours

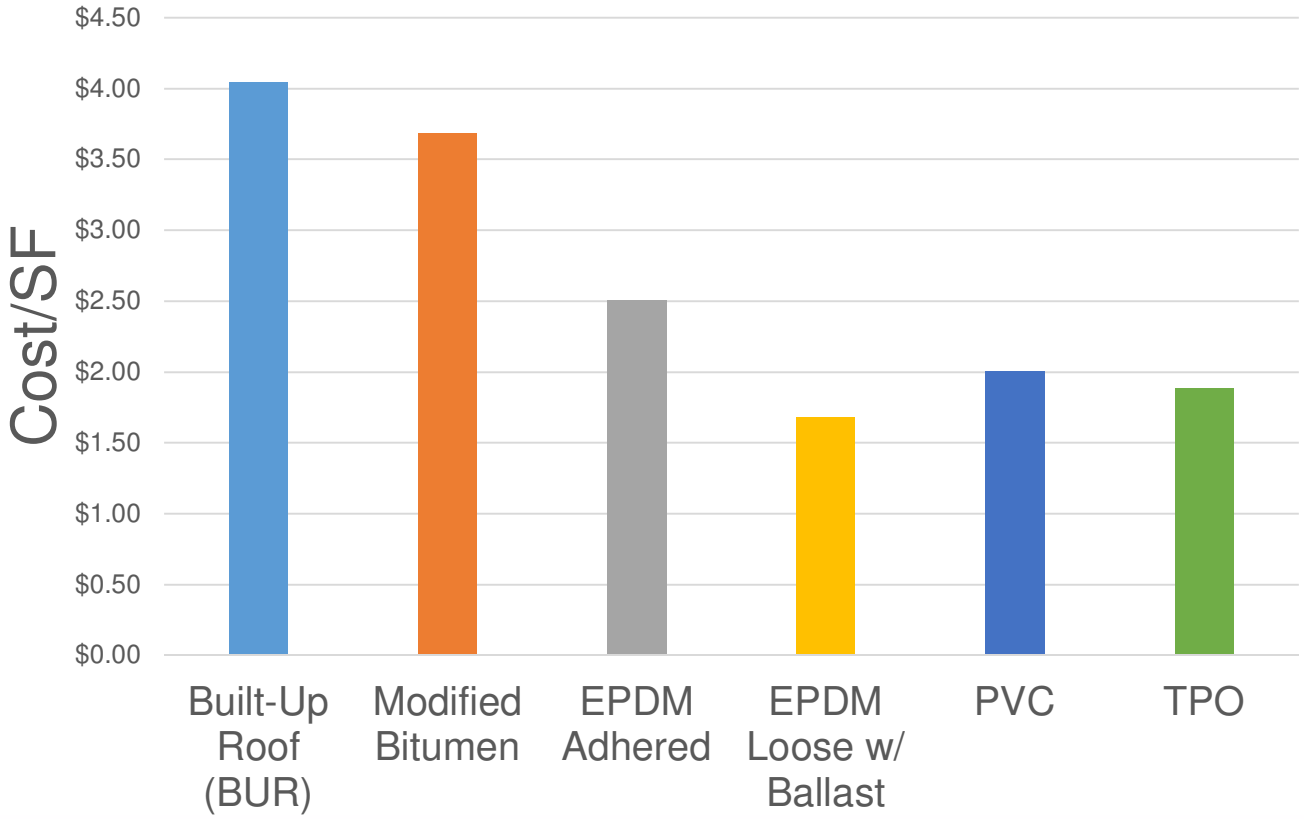
- **Ponding:** Most common factor in roofing failure
- **Water Shedding:** Can make for shortcomings in design, construction, durability, & maintenance.
- **Degradation:** Asphalt & Polymeric materials
- **Freezing:** Erodes surface aggerate
- **Voids:** Manufacturers warranty

Common Roof Materials – Market Share



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

Common Roof Materials – Cost Data



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

Built-Up Roofing (BUR)

Blistering

Slippage

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

Modified Bitumen

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

EPDM

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

PVC

Photo by RCI

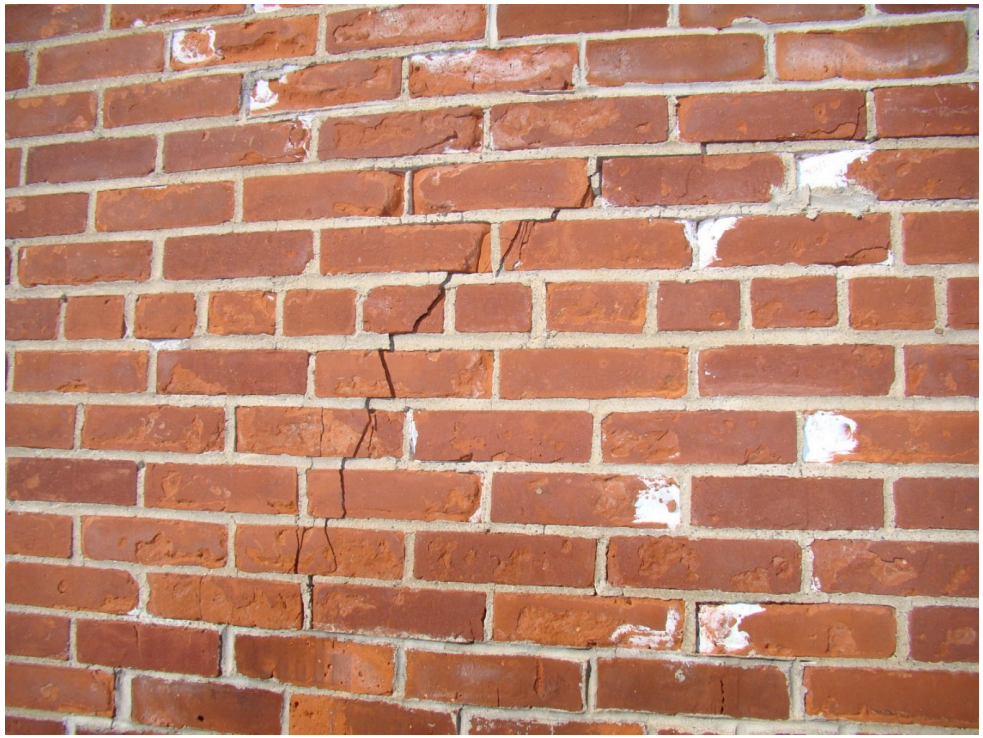
- **Embrittlement**
- **Puncture**

TPO

Image by RCI

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

Watertight Integrity - Wall



Cracks

Failed Sealant

Façade/Envelope Inspection Procedure

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

General Inspection – Binoculars & Camera

General Inspection - Drones

Detailed Inspection

Boom Lift

Rope Access

Bore Scope – Brick Veneer

Crack Gauges

Dynamic

Static

Water Tightness - Probing

Sealants

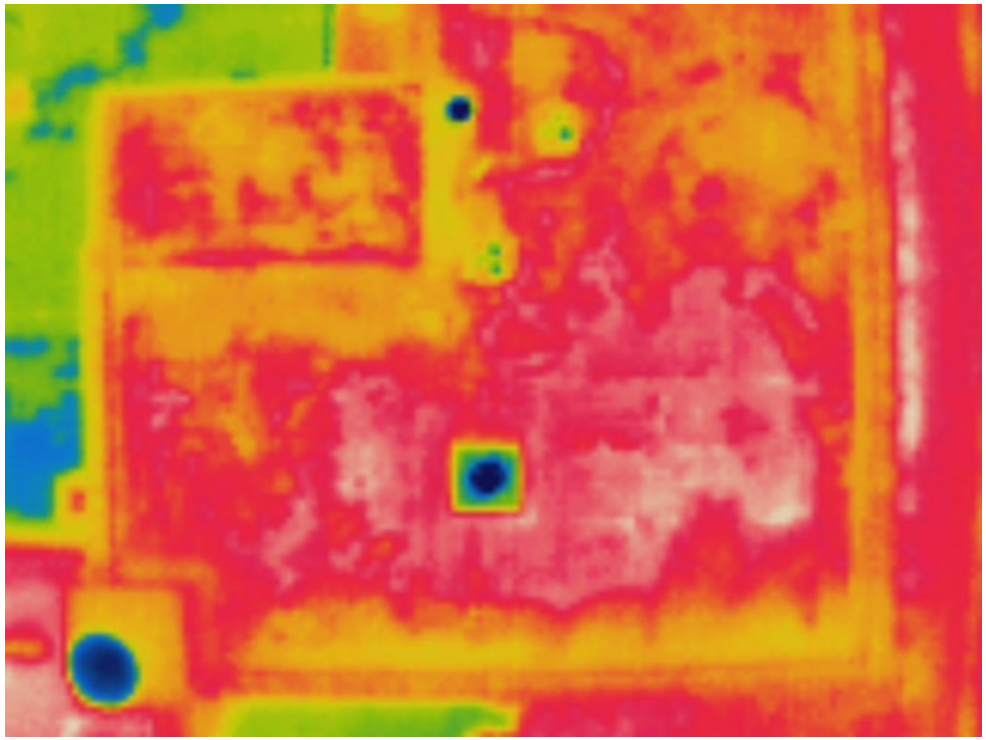
Roof Seams

Watertight Integrity - Finding a Leak

- **Easiest when someone finds it for you.**

Water Tightness – Thermal Imaging

Red-Green-Blue (RGB)



Infrared (IR)

Water Tightness - Verification

Impedance Meter

Pin-Type Meter

Water Tightness - Verification

Roofing Core

Sample

Reporting

- **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**

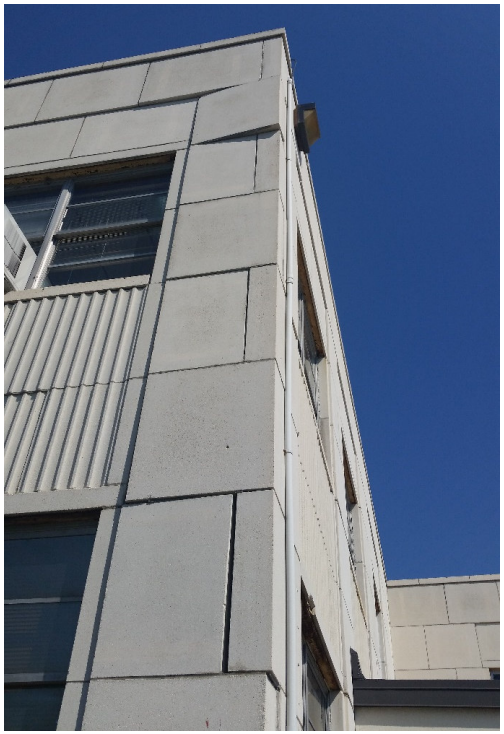
- **Classification of Deficiencies**
  - Level F: Structurally Unstable
  - Level D: Will Become Structurally Unstable
  - Level B: Acceptable Condition

Level F Deficiency

Loose Mullion Covers

Concrete Spalls

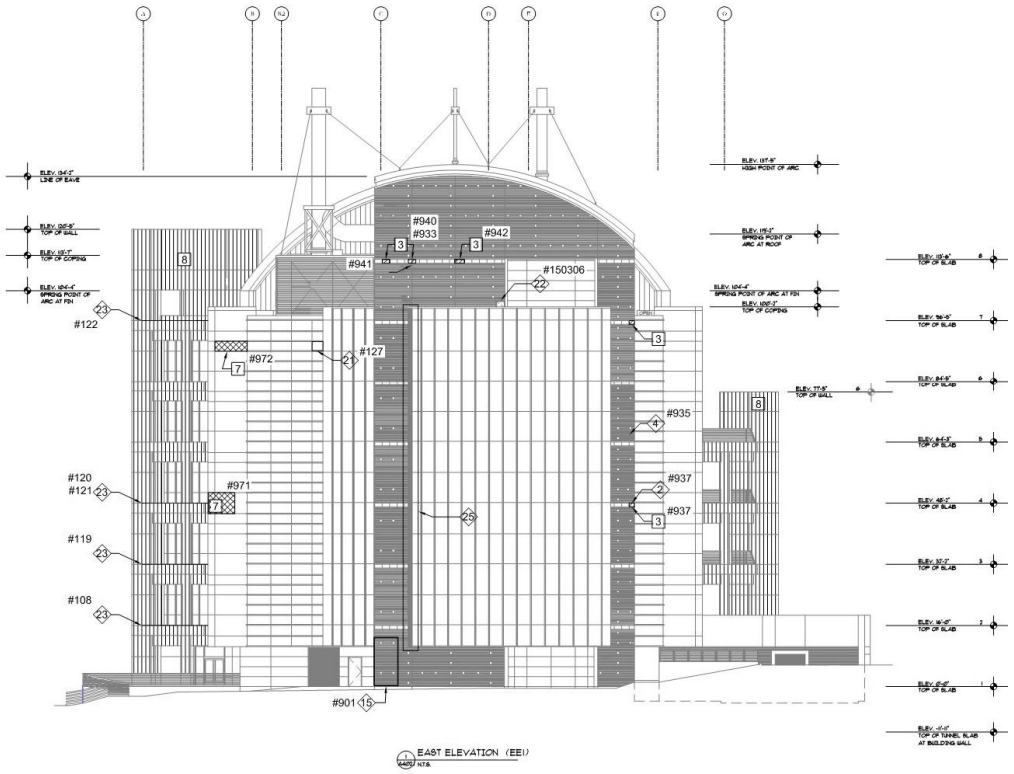
Level D & B Deficiency

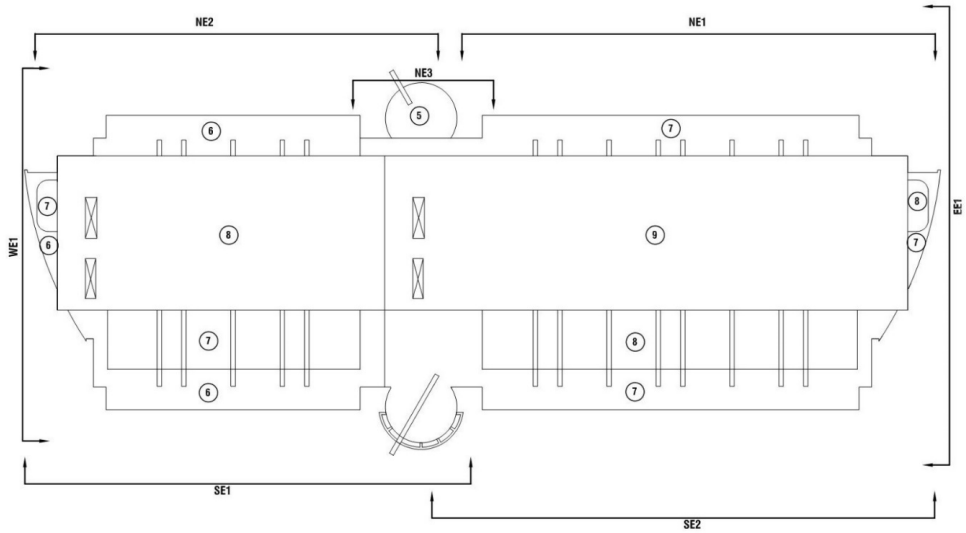


Level D: Loose Stone Panels

Level B: Failed Sealant

Elevation & Plan Views - Annotated





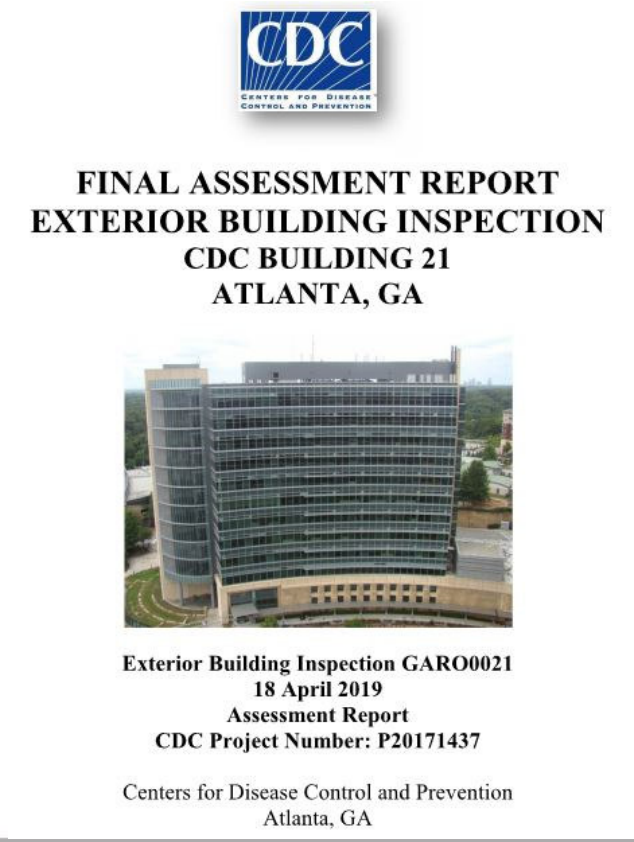
KEYNOTES

(X) = ROOF HEIGHT IN STORIES

DEFICIENCY ELEVATION PLAN

CDC BUILDING 17 FACADE INSPECTION
ATLANTA, GA DATE: 05 SEPTEMBER 2016

Final Report



FINAL ASSESSMENT REPORT
EXTERIOR BUILDING INSPECTION
CDC BUILDING 21
ATLANTA, GA

Exterior Building Inspection GARO0021
18 April 2019
Assessment Report
CDC Project Number: P20171437

Centers for Disease Control and Prevention
Atlanta, GA

- Permanent Document
- Findings
- Repair Recommendations
- Estimated Costs
- Additional Investigation Suggested

Learning Objectives

- **Façade Inspection**
  - Why
  - Behavior
  - Inspection Process
  - Reporting

Questions?

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