RAYMOND
SINCE 1992

Roofs, Walls, Windows, Maintenance & Asset Management

Presented by Ben West | 3/14/2024

BE106-1, 1 LU / HSW

CONTINUING EDUCATION AIA

www.raymond.global

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Course

This course reviews the importance of the design and maintenance of roof, wall, and window systems in buildings for building occupant health, safety, and welfare. This course covers the common defects to observe during maintenance and new construction inspections as well as best design practices to ensure long term occupant health and safety. Finally, building roof, wall, and window asset management is reviewed to underscore their role in reducing overall owner expenses and ensuring occupant well-being.

Learning Objectives

This course will meet the following learning objectives.

- Learning Objective 1: Learn to identify visual signs of water infiltration in existing roofs, walls, and window systems that suggest damage may be taking place (resulting in mold growth).
- Learning Objectives 2: Understand the function of barrier wall vs. rain screen wall technology and how each protects the health and well-being of building occupants.
- Learning Objectives 3: Review best practices for roof, wall, and window systems maintenance to ensure the safety and health of building occupants.
- Learning Objectives 4: Learn how Asset Management can extend the life cycle of building components and ensure occupant health safety and welfare.

Presentation Agenda

1. Roofs
    1. Common Defects
    2. Inspection Tips & What To Look For

2. Walls & Windows:
    1. Common Defects
    2. Inspection Tips & What To Look For

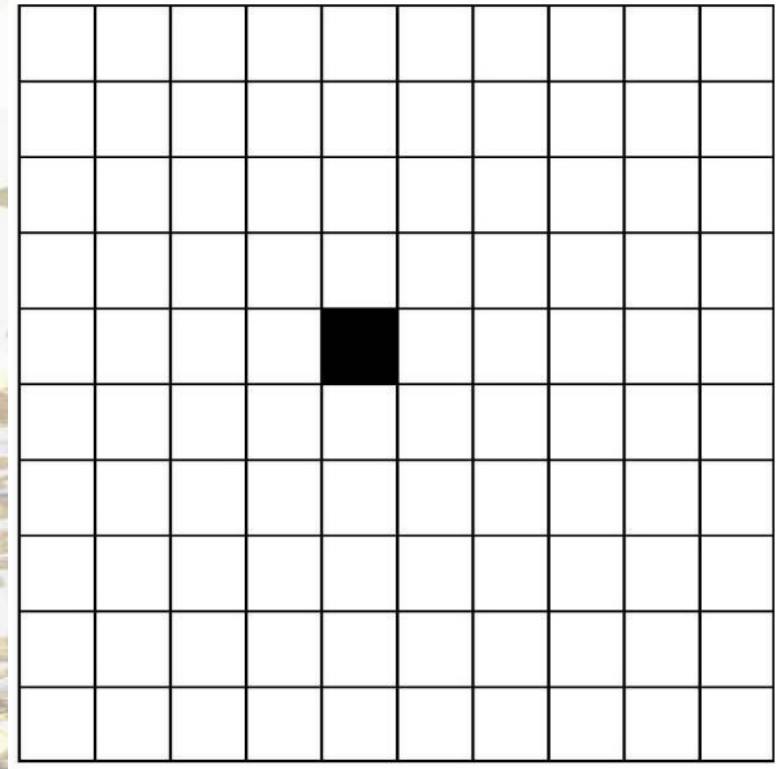
3. New Construction
    1. Roofs
    2. Walls / Windows

4. Asset Management

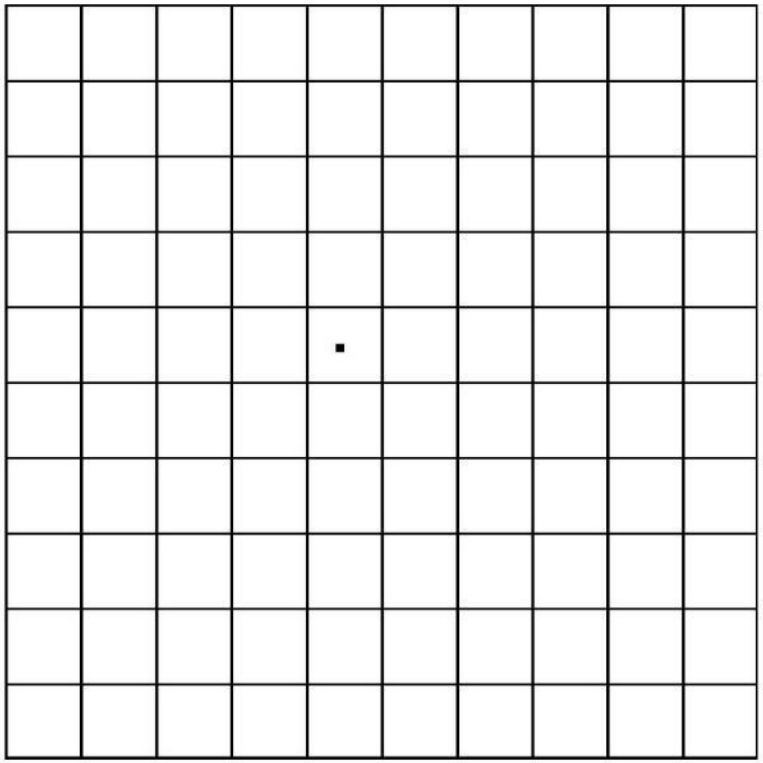
Is 99% Good Enough?

Your roof or wall should be better than gold!

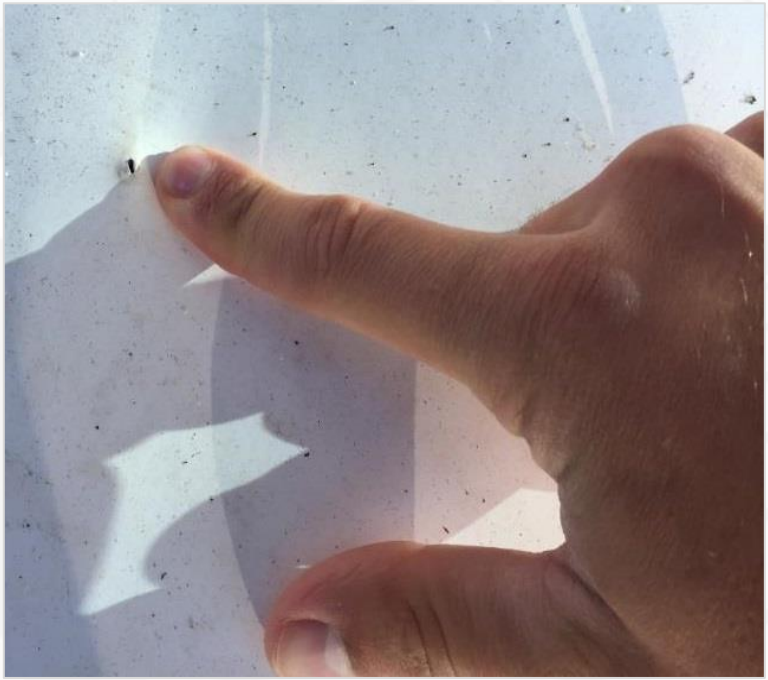
99.00% PERFECT
HOLE IS 1’ x 1’

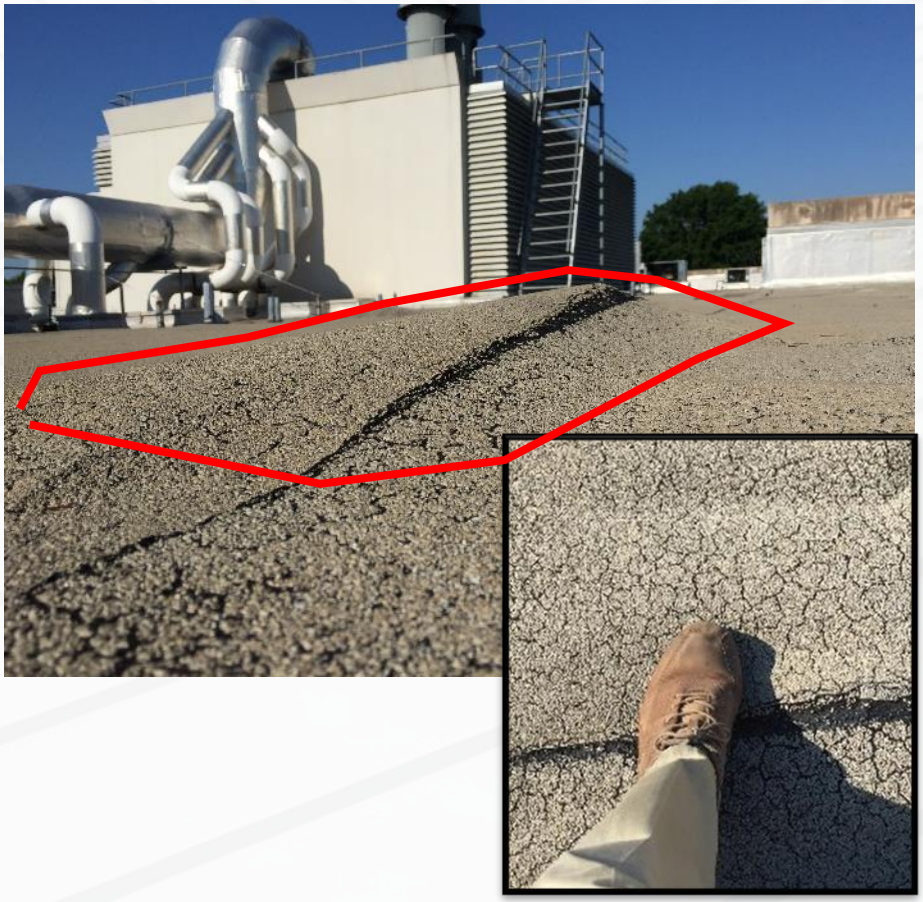


99.9935% PERFECT
HOLE IS 1 inch

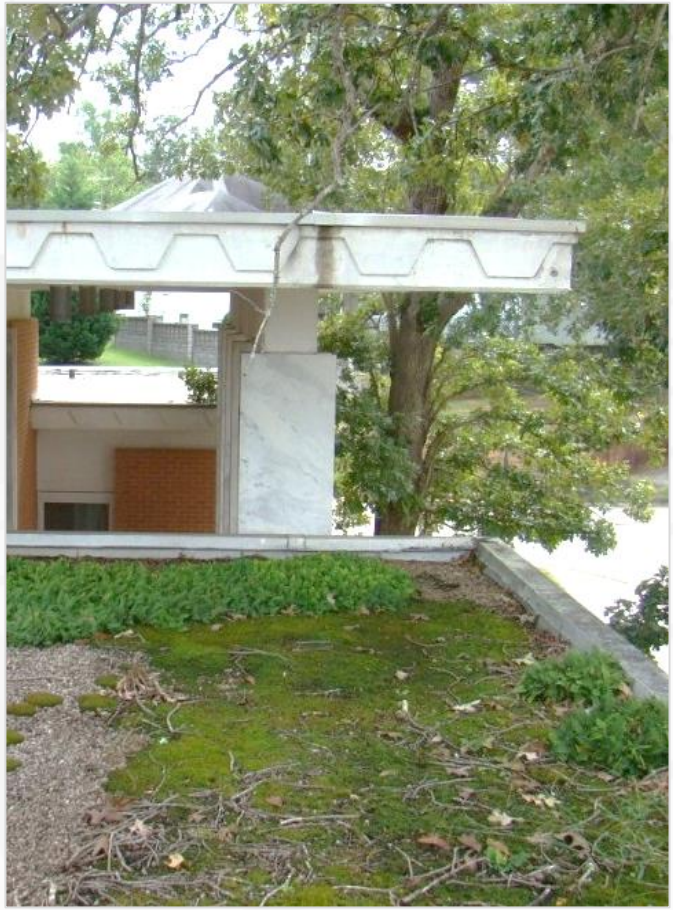


Membrane Punctures & Blisters





Vegetation



Animals

Wall Staining

Missing Shingles

Open Flashings

Membrane Shrinkage

Ice - Dams

Ponding – Poor Drainage

Old Roof

New Roof

Ponding – Clogged Drains

Defeat – due to poor drainage

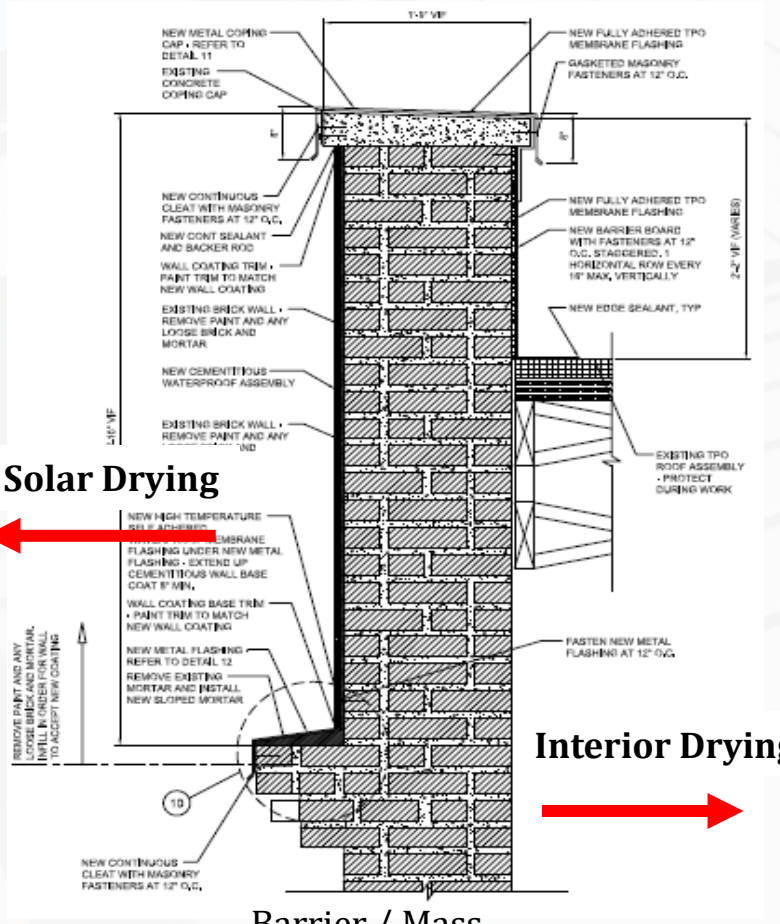
Defeat – due to poor drainage

Key Roof Inspection Observations

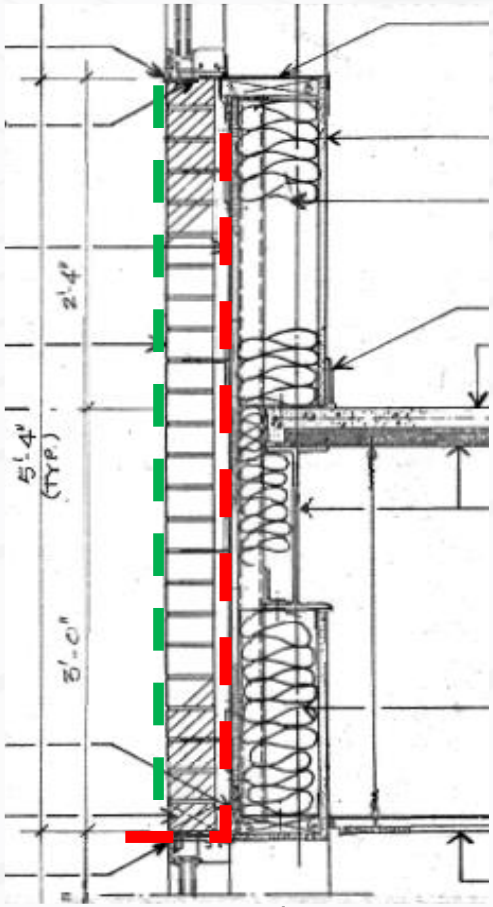
1. Drainage
    1. Ponding?? Slope to encourage drainage?
    2. Emergency Overflow (Secondary Drainage)
    3. Clean and clear drains
    4. Clear gutters and downspouts
2. Punctures / openings
    1. Eliminate Debris - Potential for punctures (servicing rooftop equipment).
    2. Minimize foot traffic – falls, potential punctures
    3. Fasteners backing out?
3. Membrane condition
    1. Secured to building?
    2. Blistered membrane – symptom of water entry and
    3. Loose / Open membrane seams – water entry
4. Flashing Condition:
    1. Metal or membrane
    2. Securement
5. Sheet Metal
    1. Loose / Unsecured perimeter metal and coping – wind blow off
    2. Deteriorating sheet metal - Rust

Walls and Windows: Common Defects

General Exterior Wall Systems



Barrier / Mass



Rain Screen / Cavity

Barrier/Mass Exterior Wall

Typical Causes of Moisture:

- Cracks
- Mortar Joint Failure

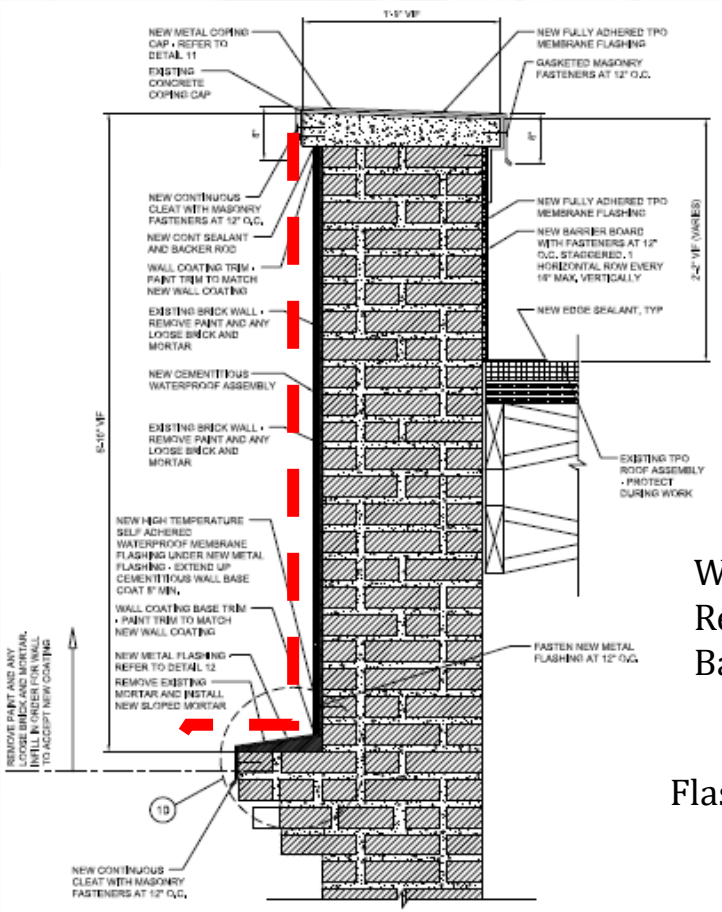
Barrier/Mass Exterior Wall

Visual Signs Of Moisture Issues:
-Efflorescence
-Cracks Adjacent to Embedded Steel

Barrier/Mass Exterior Wall

Repairs that stop the natural drying process

General Exterior Wall Systems



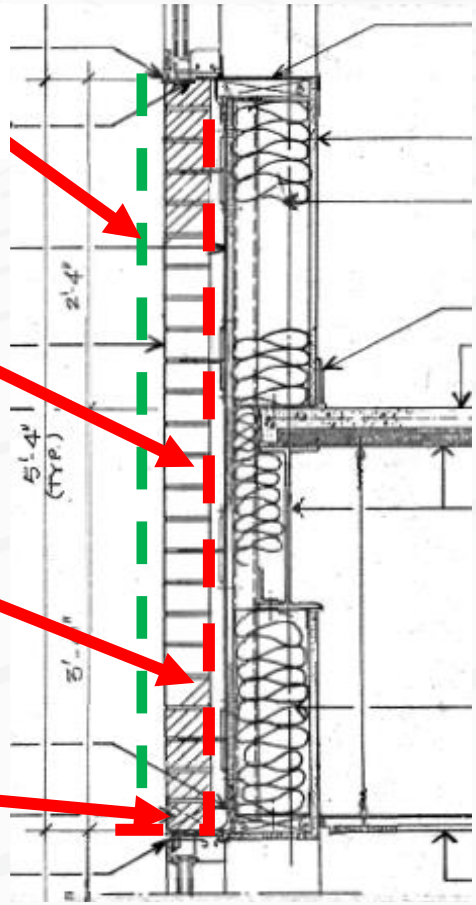
Barrier / Mass

Rainscreen (brick, metal)

Drainage Plane

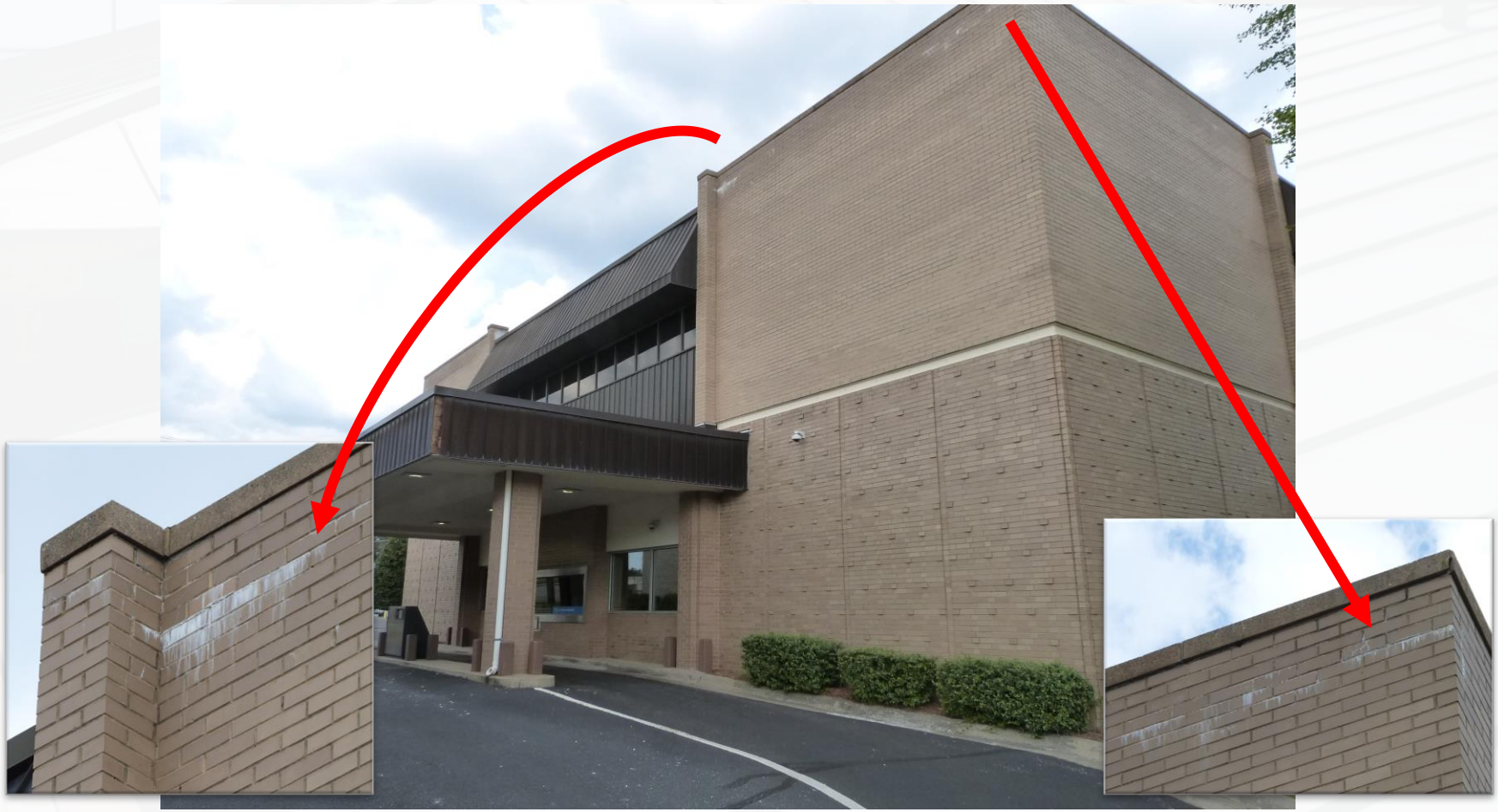
Weather Resistant Barrier

Flashing

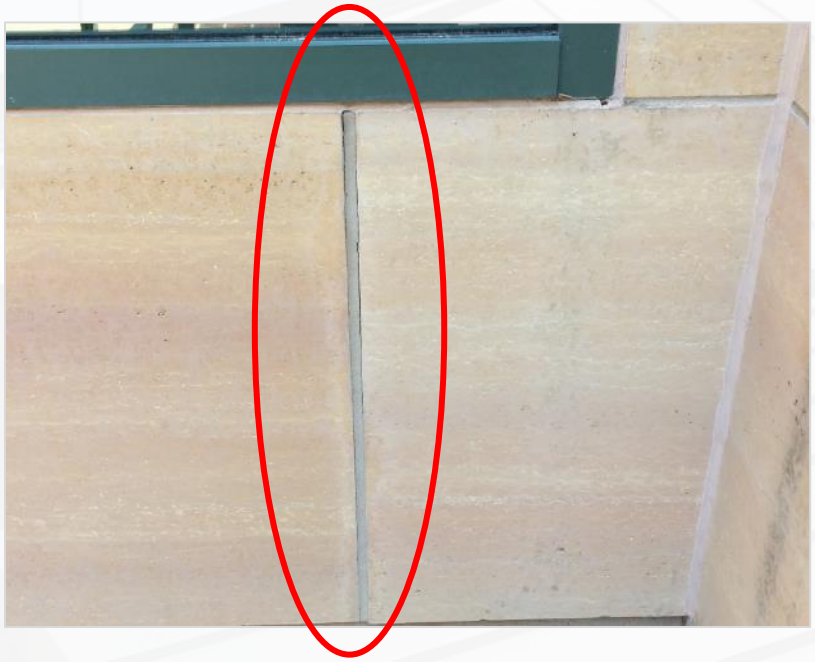


Rain Screen / Cavity

Efflorescence



Rainscreen Walls – Common Defects



Failed Mortar Joints

Rainscreen Walls – Common Defects

Failed Mortar and Sealant Joints

Rainscreen Walls – Common Defects

Failed Gaskets and Sealants

Rainscreen Walls – Common Defects

Interior Signs of Issues Within the Drainage Plane

Rainscreen Walls – Common Defects

Interior Signs of Issues Within the Drainage Plane

Walls and Windows – Common Defects

1. Mass Masonry Walls:
    - Failed mortar joints allowing excessive moisture into the wall than can be naturally dried out.
    - Improper repairs that stop the wall to naturally dry out or that trap water into the system such as the use of coatings and sealants.
    - Window Sealant and Gasket Failures

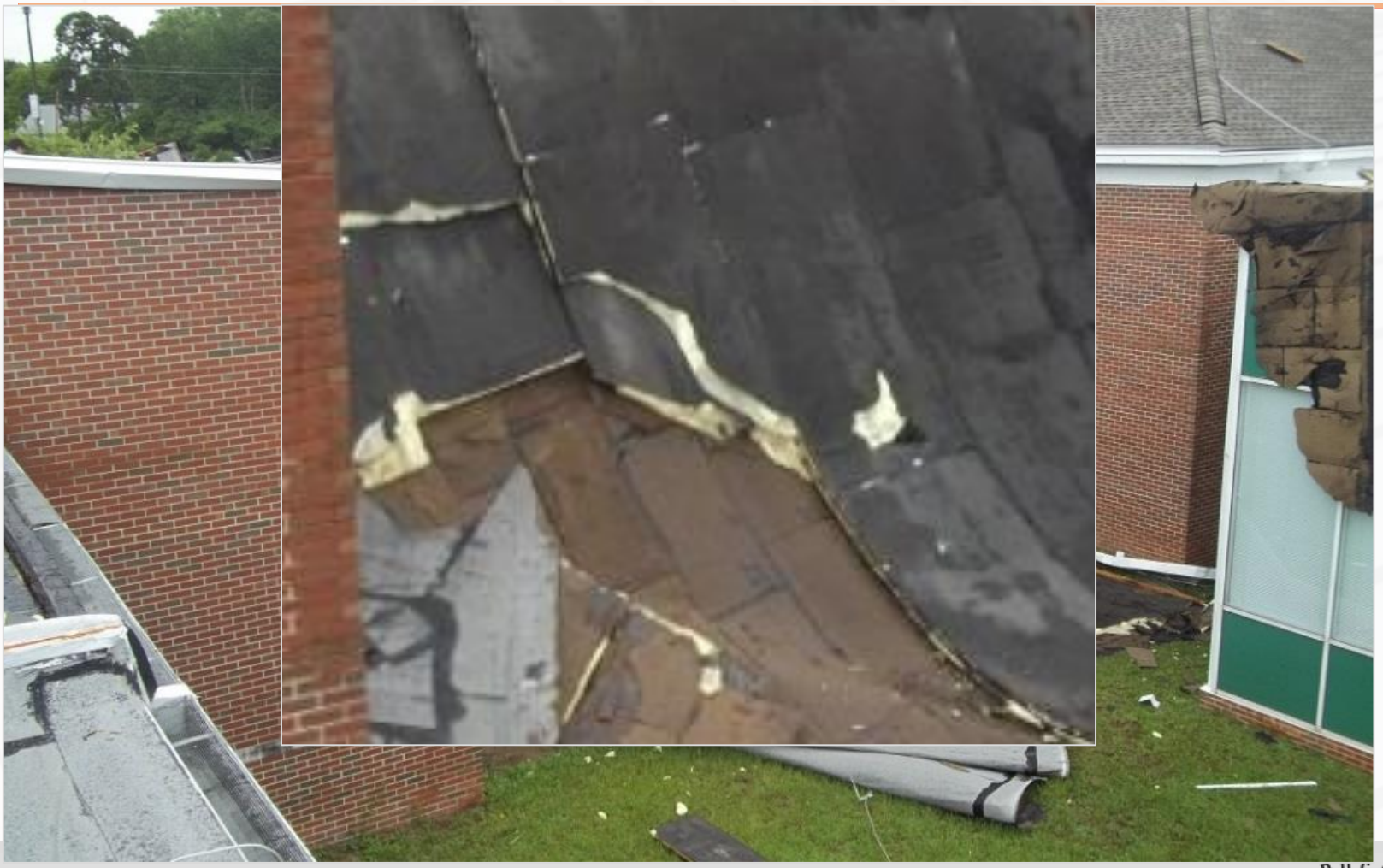
2. Cavity Walls:
    - Failed mortar and sealant joints that allow excessive moisture to get to the drainage plane.
    - Defects in the drainage plane:
        - Through wall flashing.
        - Defective Window Sill Plans.
        - More discussion of this during New Construction portion of this presentation.
    - Window Sealant and Gasket Failures.

New Construction

New / Replacement Roof Design Considerations

1. Building type and importance
    1. Membrane, cost, historic performance
    2. Redundancy?
    3. Architectural look of roof
2. Drainage
    1. Slope to encourage drainage
    2. Emergency Overflow (Secondary Drainage)
3. Securement
    1. Fasteners / Adhesive (solvent / water based = low VOC
    2. Perimeter
    3. Wind rating
4. Insulating R-value
    1. Code R=30 New, R=15 Existing (NC)
    2. Thickness of insulation = avoid low flashing heights on roof replacement
5. Maintenance
    1. Access to the roof
    2. Access below and around equipment

Roof Blow Off (Securement Failure)



Insulation Height & Membrane Interfaces

Old Roof

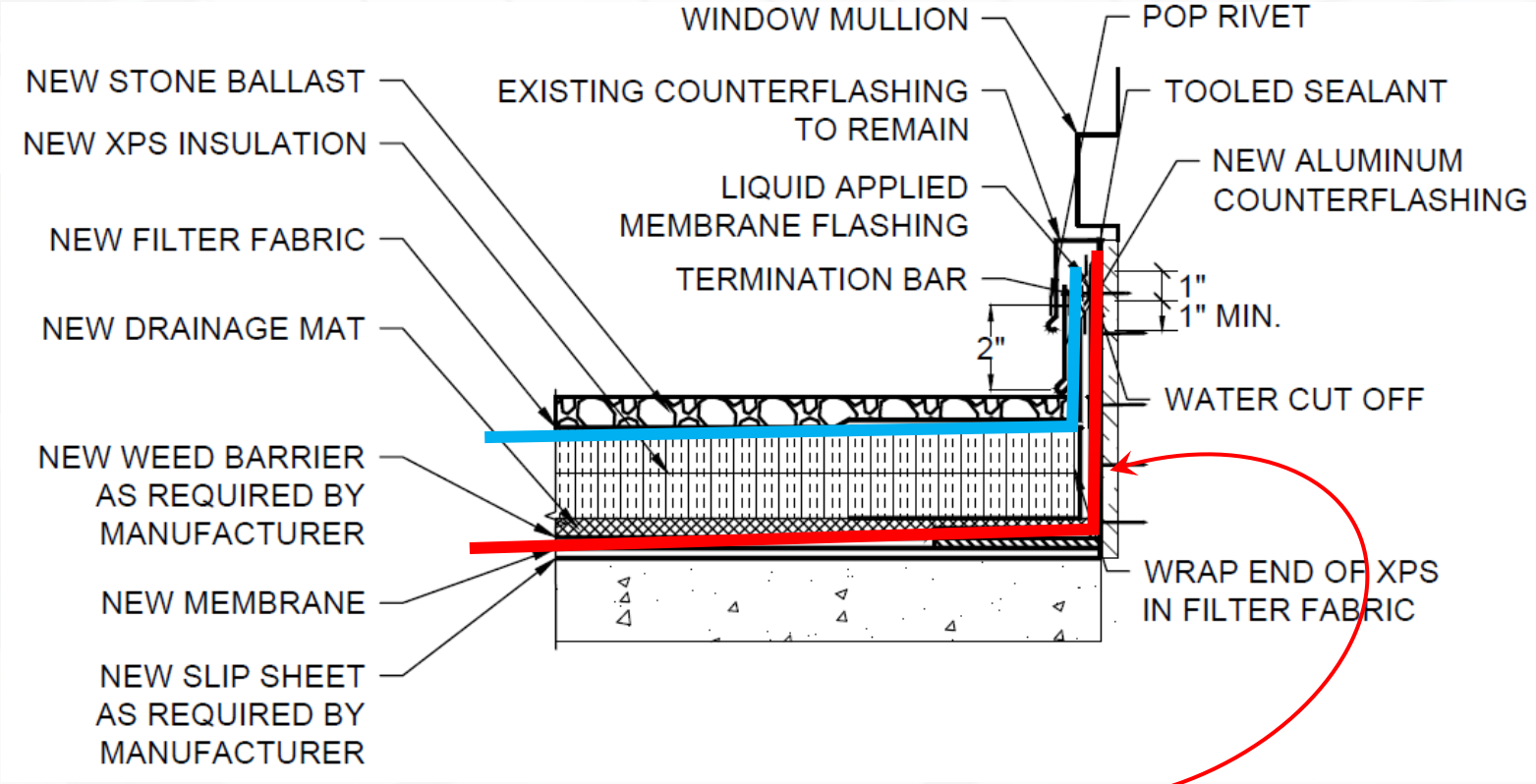
2” Flashing @
Window Interface

Insulation Height & Membrane Interfaces

2” Flashing @ Window Interface
(Old Roof)

New Roof 8” Flashing

Insulation Height & Membrane Interfaces



New Roof - 8" Flashing

Maintenance Access

Low Slope Roof Membrane Comparisons

Membrane		Thickness per ply	Pros or Cons		Attachment " * " = Typical	Relative System Cost ($ / sq.ft.)	Relative Quality Lifespan (Years)
Single Ply	Multi-ply						
EPDM		45-90 mils	Long track record. Wide rolls - 50ft. (faster install). Black – White w/additive Glued seams.	Shrinks over time. Owner repairs possible. Warranties available	Ballasted * Fasteners * Adhesive *	**Low – Medium**	**Low** 10 – 30 yrs
TPO		60-90 mils	Newer matrl. - short track record 12 ft. Roll widths. Welded seams.	White – limited other colors Can heat age - brittle, repairs? Contractor repairs only. Warranties available	Ballasted Fasteners * Glue Adhesive *	**Lowest**	**Low** 10 – 20 yrs
PVC		36-90 mils	Newer matrl. - long track record 12 ft. Roll widths Welded seams. White – limited other colors	Resists chemical/grease exp. Resists standing water. Contractor repairs only. Warranties available	Fasteners * Glue Adhesive * Self Adhesive Hot Asphalt	**Medium – High**	**Medium – High** 15 – 30 yrs
Modified Asphalt	2-ply	100- 200 mils (System total 200-400 mils)	Long track record 3 ft. Roll widths Welded seams, monolithic White – very limited other colors	Most puncture resistant Redundancy of 2 plys Owner repairs possible. Warranties available	Torch * Cold Asphalt * Hot Asphalt * Self Adhesive	**High**	**High** 20 – 25 yrs
Asphalt Built-Up	Multi Ply	100 mils	Long track record. 3 ft roll widths. Odor with application. Gravel surfaced typically.	Monolithic. Very workmanship dependent. Owner Repairs possible.	Cold Adhesive Hot Asphalt *	**High**	**Medium – High** 20 – 30 yrs

Steep Slope Roof Material Comparisons

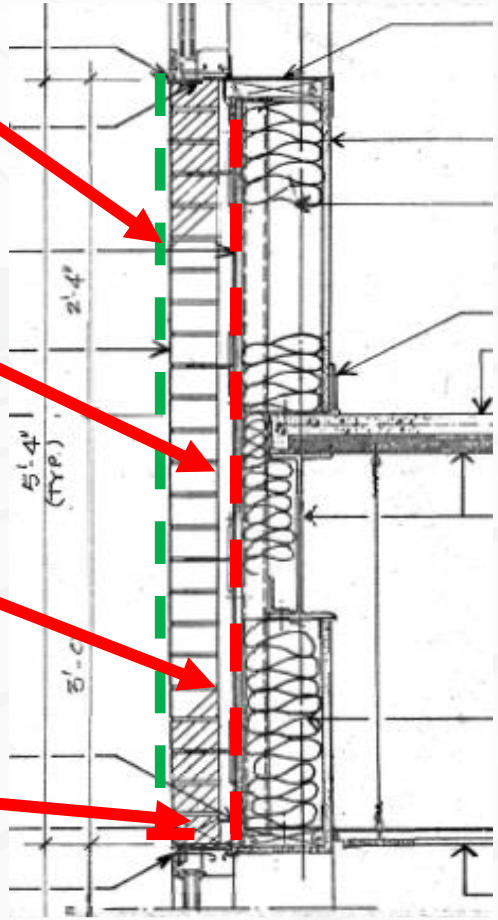
Material	Pros or Cons		Minimum Slope	Relative System Cost ($ / sq.ft.)	Relative Quality Lifespan (Years)
Asphalt Shingles	Easy to mis-install fasteners Susceptible to wind / hail damage Manufacturing defects	Attention to underlayment Warranty available Owner repairs possible.	4 / 12 2 / 12 possible	**Low**	**Low** 30 yrs
Wood Shakes/ Shingles	Architectural look Susceptible to wind / hail / damage Susceptible to fungus / mold damage	Susceptible to sun damage Attention to underlayment Contractor repairs only	4 / 12	**Med-High**	**Low** 20 - 30yrs
Slate	Architect look /pattern but limited colors Heavy weight (structural roof design) Mineral / freeze/thaw sensitive	Not waterproof – needs underlayment Copper or stainless steel flashings Salvage & re-use possible Contractor repairs only.	4 / 12	**High**	**High** 75 – 100 yrs
Tile (Ceramic)	Architectural look / Many colors Heavy weight (structural roof design) Freeze/thaw sensitive Not waterproof – needs underlayment	Copper or stainless steel flashings Salvage & re-use possible Contractor repairs only. Warranties available (color / breakage).	4 / 12	**High**	**High** 50 – 100 yrs
Metal (Coated) **Standing Seam** **Steel** **Aluminum**	Architectural look / Many colors Snap or mechanical seams Semi-Monolithic Thermal expansion/contraction	Avoid metal debris Contractor repairs only. Warranties available (color / water).	2 / 12	**Medium**	**Medium** 40 – 50 yrs
Metal (Natural) **Zink** **Lead** **Copper**	Architectural look Soldered / welded seams Monolithic	Thermal expansion/contraction Needs flush fasteners Contractor repairs only.	¼ " / 12	**High**	**High** 75 – 100 yrs

Roof Coating Material Comparisons

Material	Pros or Cons		Compatible substrate (Always Mock-up Test Substrate)	Relative System Cost ($ / sq.ft.)	Relative Quality Lifespan (Years)
Urethane	Various levels of quality Fabric / scrim & coating only Various colors Water soluble	Long-term dependent on substrate Warranties available	EPDM TPO PVC Metal Modified Asphalt	**Low**	**Low** 5 – 10 yrs
Silicone	Better quality Fabric / scrim & coating only Limited colors Restricted only silicone future	Can be slippery Water resistant / waterproof Long-term dependent on substrate Warranties available	Metal Modified Asphalt	**Low – Medium**	**Medium** 10 – 15 yrs
Epoxy **(PMMA)**	Higher quality Fabric / scrim Limited colors Can be slippery High resistant to foot/vehicle traffic	Ridged Waterproof Resists chemical / grease exposure. Long-term dependent on substrate Warranties available Flashing w/ metal/PVC/mod. asphalt	TPO PVC Metal Modified Asphalt	**High**	**High** 10 – 30 yrs

New Construction: Walls/Windows

Typical New Construction Wall System



Rain Screen / Cavity

New Construction: Walls and Windows

Evidence of Sealed Weep , Why?

Breach in Drainage Plane

New Construction: Walls and Windows

Improper Through Wall Flashing Installation – Water Cannot Escape From Drainage Plane

Incomplete Through Wall Flashing

New Construction: Walls and Windows

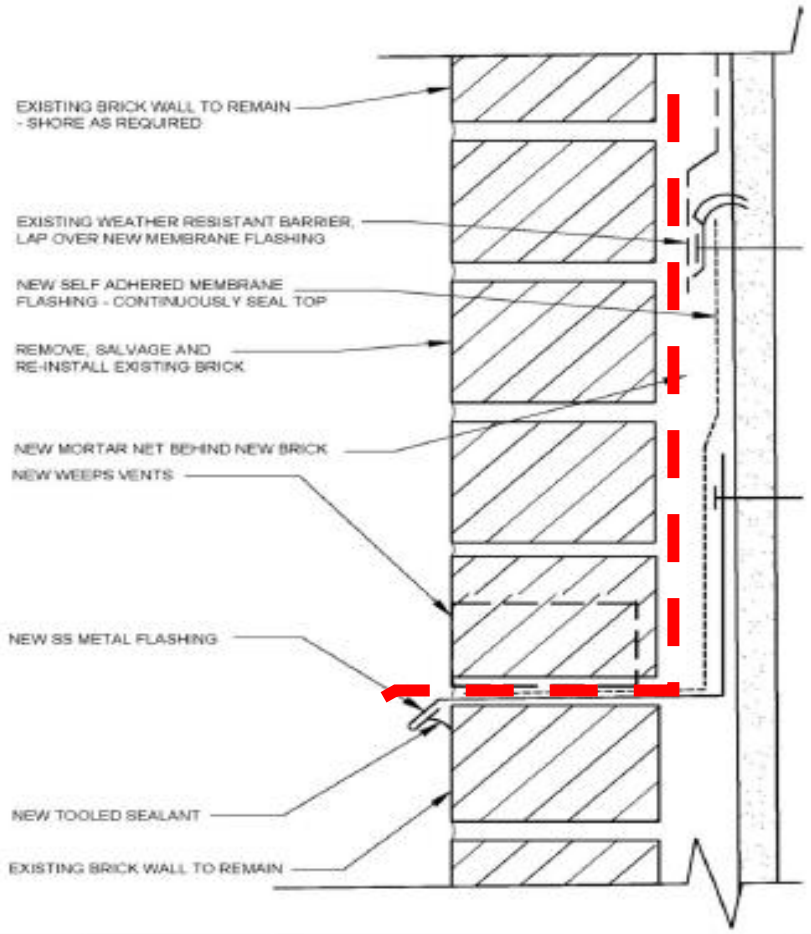
Open Seam

Open Termination
at Window Head

Incomplete Through Wall Flashing and
Breaches Within the Drainage Plane

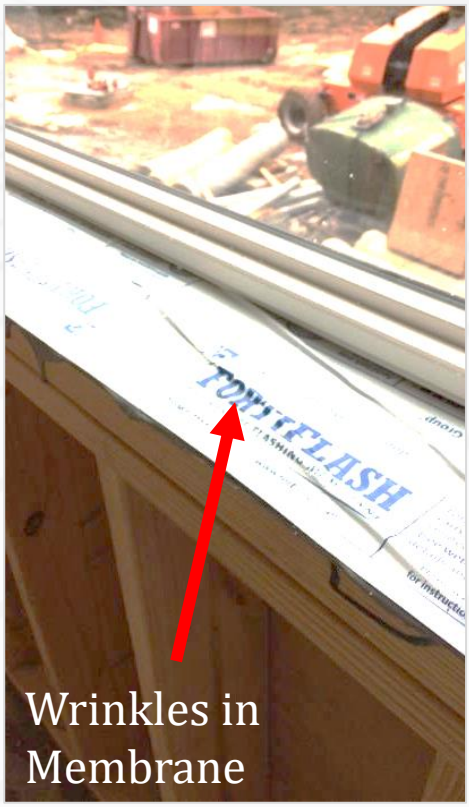
Hole in Drainage Cavity
To Inside of the Building

New Construction: Walls and Windows



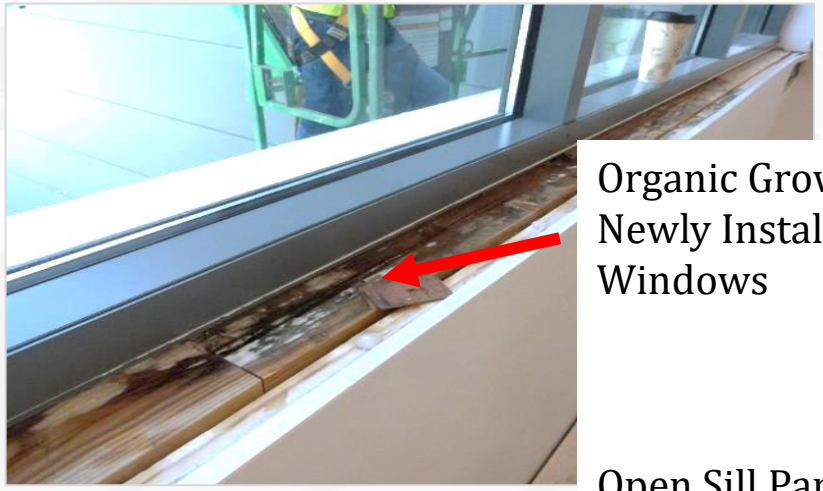
Through Wall Flashing Basics:
-Extend Through wall
-Seal all terminations and seams

New Construction: Walls and Windows



Window Flashing – Poor Installation

New Construction: Walls and Windows



Organic Growth at Newly Installed Windows

Open Sill Pan Flashing with no membrane beneath

Water Testing Revealed Immediate Water Infiltration

New Construction: Walls and Windows

New Construction: Walls and Windows

Curtain Walls:
Installers must strictly adhere to manufacturers installation recommendations. Failure to install sealant, flashings in correct locations and allow for correct tolerances will lead to expensive future repairs

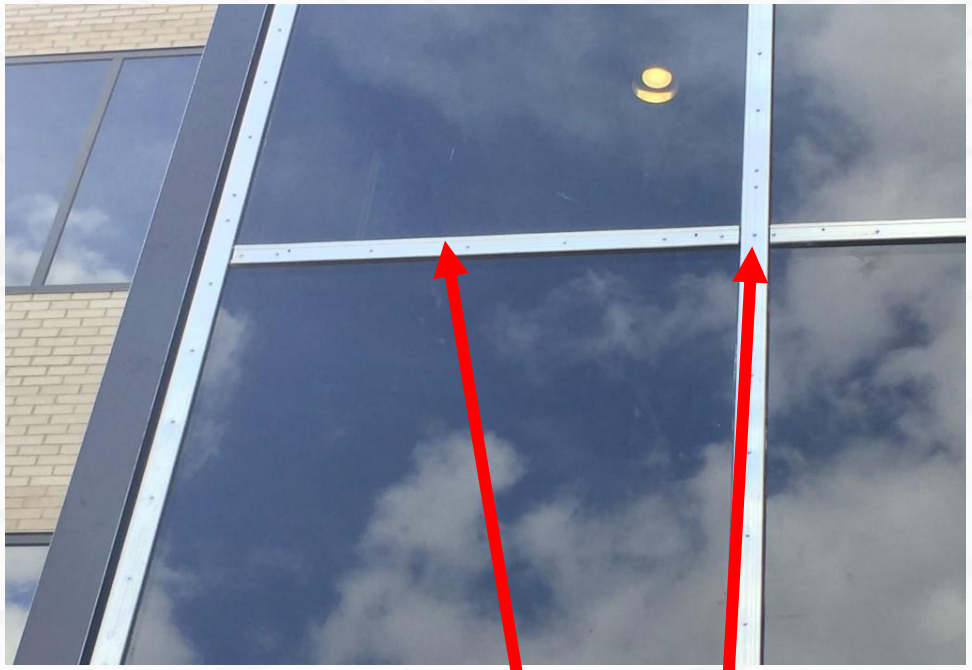
New Construction: Walls and Windows

Proper joint sizing between wall and curtain wall frame

Pre-glazing – seal metal-to-metal joints. Failure to install sealant in correct locations will lead to expensive future repairs

New Construction: Walls and Windows

Temporary glazing retainer clip ready to receive new glass

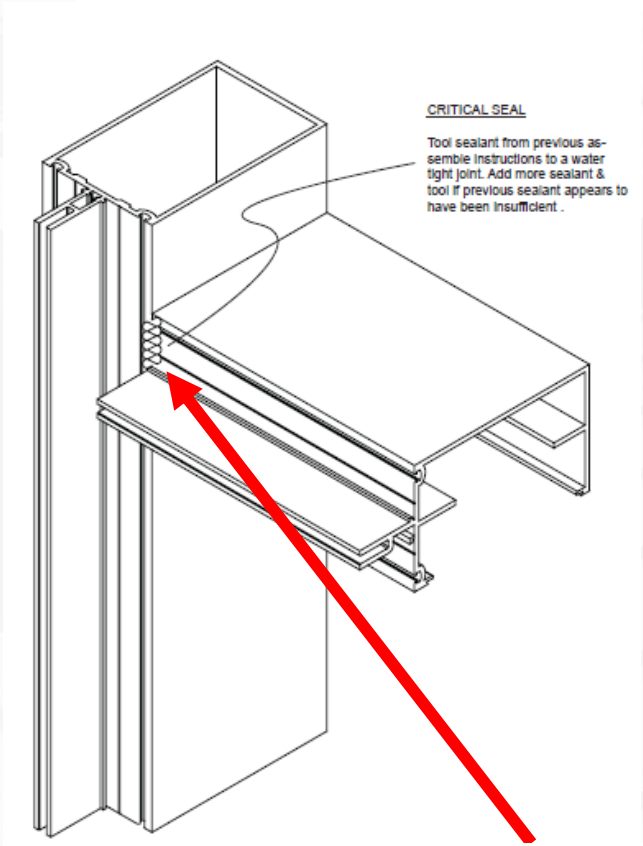


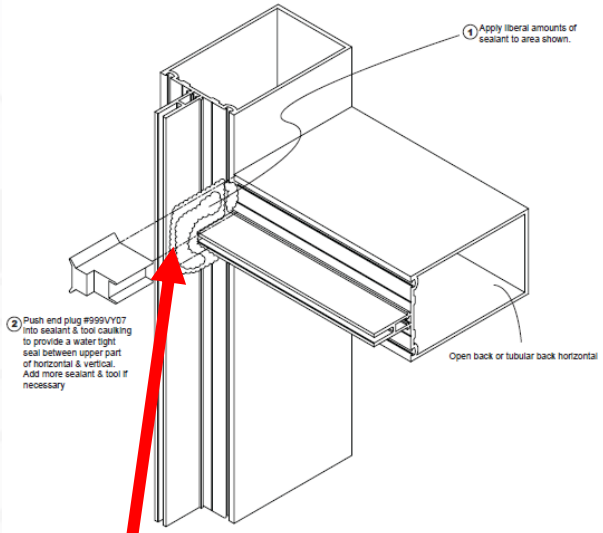
New pressure plates installed

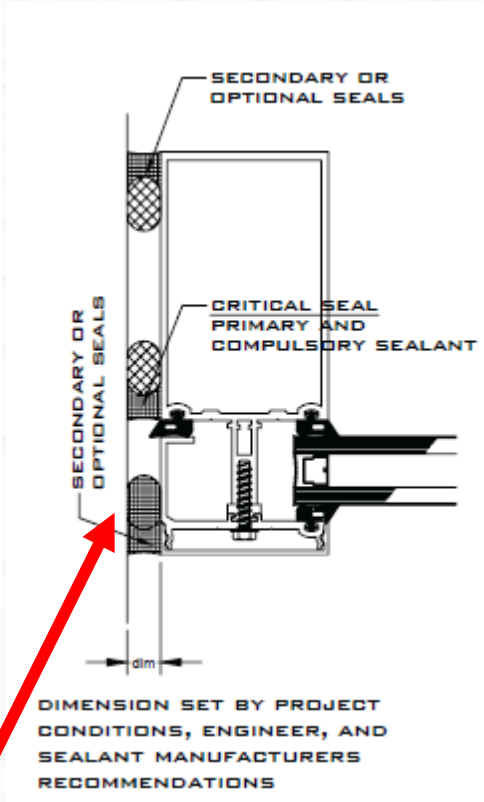
Seal joint at plates

New Construction: Walls and Windows

Curtain Wall: Proper Application of Critical Seals







At horizontal to vertical framing

At perimeter of system

New Construction: Walls and Windows

1. Through wall flashing and window sill pans - Designed to be continuous and easily pass water through the cavity.
2. Rainscreens – Failures = no leaks! - When failures happen at the rainscreen (mortar joints, sealant joints, cracks, etc.) should be expected and should not result in leaks.
3. Mock-Ups – Use & install for all through wall flashings and windows sills prior to work beginning.
4. QA/QC Testing - Recommend testing during construction and prior to installation of interior finishes. The drainage cavity can be expensive to access after construction has been completed.

Asset Management

What is Asset Management, Why does it matter?

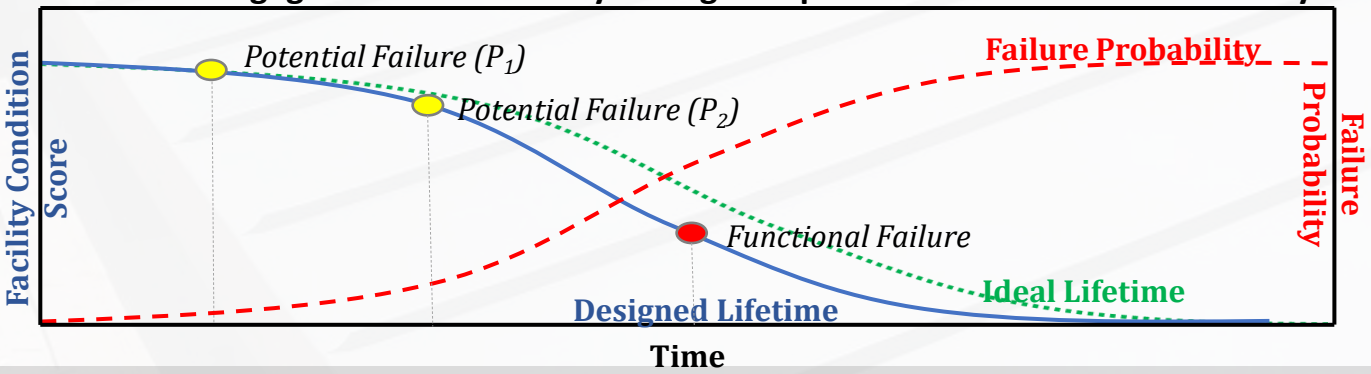
Definition

The servicing by personnel for the purpose of maintaining ***equipment and facilities*** in satisfactory condition by providing for ***systematic inspection, detection, and correction*** of incipient Failures either before they occur or before they developinto major defects.

Reference: http://www.thefreedictionary.com/Preventative+Maintenance

Why It Matters:

- Each Building has a design lifespan.
- The problem is proper care assumed.
- **Time and negligence are the enemy. Cost goes up with failure before end of lifecycle.**



Raymond Engineering has a track record of successfully completing Assessment programs.

Agency	No. of Buildings	Total Square Footage
Harnett County Schools, NC	6	312,000 + sf
Gwinnet County Public Schools, SC	13	634,618 sf
Greenville County Schools, SC	108	3,633,000 sf
Durham Water Management, NC	71	350,000 + sf
City of Rocky Mount, NC	20	150,000 + sf
NC Based National Property Mgmt Co.	50	650,000 sf
University of North Carolina – Chapel Hill	10	200,000 sf
Army Reserve	**477**	**6,812,200 sf**
Walmart	350	6,000,000 sf

What an Asset Management Program looks like.

Asset Management is a planned/deliberate process that consists of the following actions.

- Inventory of Assets
- Perform Observed Assessment of the Condition/Defects
- Analyze and Produce Maintenance and Repair Action Plans
- Produce Financial Forecasts on immediate and short/long term investments

Condition Index - A comparative ranking of the condition of each asset within a facility

CI = Total Deferred Maintenance/Current Replacement Value

Facility Condition Index – Compares the relative condition of a group of facilities

FCI = Total Deferred Maintenance/Current Replacement Value

- Manage, Track and Maintain – *it is a continual process through the life cycle.*

Excel/Adobe Based Asset Management

								Annual Budgets				
NO.	NAME / LOCATION	Roof type	Roof Condition Score	Repair Estimate	New Roof Estimate	Estimated Service Life	Condition	Year 1 2017	Year 2 2018	Year 3 2019	Year 4 2020	Year 5 2021
50	PRIMARY SLUDGE P S 3 & 4	Built-up, Aggregate Surface	72	$1,500.00	$18,000.00	10+	Fair		$1,622.40			
19	CONTROL/ BUILDING AREA B	Modified Bitumen, Granulated	71	$8,000.00	$191,500.00	10+	Fair		$8,652.80			
21	ENGINE GENERATOR BUILDING	Built-up, Aggregate Surface	71	$3,000.00	$96,750.00	5 to 10	Fair	$3,120.00				$117,711.17
17	BOOSTER PUMP BUILDING	EPDM Ballasted	70	$1,500.00	$26,750.00	5 to 10	Fair	$1,560.00				$32,545.47
47	ANAEROBIC DIGESTERS 1 & 2	EPDM Ballasted	70	$6,000.00	$54,250.00	5 to 10	Fair	$6,240.00				$66,003.42
22	SLUDGE THICKENING BUILDING	EPDM Ballasted	69	$9,000.00	$103,500.00	5 to 10	Fair	$9,360.00				$125,923.58
8	ELECTRICAL BUILDING	PVC	68	$10,000.00	$97,750.00	5 to 10	Fair	$10,400.00			$114,353.67	
51	INFLUENT BUILDING	Built-up, Aggregate Surface	68	$3,000.00	$20,750.00	5 to 10	Fair	$3,120.00			$24,274.57	
13	AMMONIA FEED/HYPOCHLORITE	EPDM	67	$15,000.00	$135,500.00	5 to 10	Fair	$15,600.00			$158,515.83	
46	CONTROL BUILDING Area A	EPDM Ballasted	61	$21,000.00	$136,500.00	5 to 10	Fair	$21,840.00			$159,685.69	
46	CONTROL BUILDING Area B	Built-up, Aggregate Surface	59	$60,000.00	$359,500.00	<5	Poor			$404,388.61		
55	SCUM CONCENTRATOR BUILDING	EPDM Ballasted	57	$7,500.00	$31,500.00	<5	Poor			$35,433.22		
40	EFFLUENT FILTER BUILDING	EPDM Ballasted	55	$24,000.00	$133,750.00	<5	Poor			$150,450.56		
67	PUMP STATION BUILDING	EPDM Ballasted	53	$15,000.00	$94,250.00	<5	Poor		$101,940.80			
58	THICKENER BUILDING	EPDM Ballasted	50	$16,500.00	$94,250.00	<5	Poor		$101,940.80			
11	CHEMICAL BUILDING #2	Built-up, Aggregate Surface	49	$0.00	$208,000.00	Replace now	Poor		$224,972.80			
59	VEHICLE MAINT. BUILDING	EPDM Ballasted	46	$45,000.00	$272,750.00	Replace now	Poor	$283,660.00				
30	BIO-SOLIDS BUILDING	EPDM Ballasted	41	$0.00	$220,100.00	Replace now	Poor	$228,904.00				
68	PARKWOOD	Exposed Concrete	40	$0.00	$9,000.00	Replace now	Poor	$9,360.00				
66	BLOWER/OFFICE BUILDING	Exposed Concrete	39	$0.00	$40,750.00	Replace now	Poor	$42,380.00				

Software Based Asset Management

Financial Plan - Total (5 Years)					
Facility	**2017**	**2018**	**2019**	**2020**	**2021**
General Mills Covington Administration Building	$1,235	$1,005	$1,120	$1,120	$1,120
General Mills Covington East Plant	$1,325	$1,325	$99,675	$41,130	$1,325
General Mills Covington Fabrication Shop	$250	$250	$250	$250	$250
General Mills Covington General Contractor's Building	$50	$50	$50	$50	$50
General Mills Covington Guard House	$150	$150	$9,800	$150	$150
General Mills Covington PH House	$150	$150	$150	$150	$150
General Mills Covington Storeroom	$300	$300	$300	$300	$300
General Mills Covington Utility Building	$212,460	$150	$150	$150	$150
General Mills Covington Wastewater Treatment Plant	$250	$250	$250	$250	$250
General Mills Covington West	$258,795	$500,461	$403,166	$1,410,908	$707,258
	$474,965	**$504,091**	**$514,911**	**$1,454,458**	**$711,003**

Web Based Enterprise Asset Management System

Digital Data Collection | Data Repository | Cloud Based | GIS Interface | Reporting

New Systems Assist with:

- Remaining Service Life
- Condition Indices
- Efficient Data Collection
- Standardized Reporting
- Repository for As-builts, Construction documents, Warranties, Specifications, etc.
- Exportable Data
- Forecasting & Planning

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The Financial Case Study (Roofing Assets)

Asset Management Case Study Scenario

Construction: New Building

Anticipated Lifetime: 50 Years

Original Roof Cost[1]: $1,000,000

Inflation Rate[2]: 2%

Special Features: None

Roof Designed Lifetime: 20 Years

[1]Includes roof design and construction only

[2]May be higher based on the economic state

15 Year Performance – 3 Roofs Required

- Maintenance Plan: $1,000 / year [Total: $15,000 / roof]
- Remaining Roof Lifetime: 5 years

20 Year Performance – 2 Roofs Required

- Maintenance Plan: $1,000 / year (1st 10 years), $3,000 / year (2nd 10 years) [Total: $40,000 / roof]
- Remaining Roof Lifetime: 10 years

25 Year Performance

- Maintenance Plan: $1,000 / year (1st 10 years), $3,000 / year (2nd 10 years), $5,000 / year (last 5 years) [Total: $90,000 / roof]
- Remaining Roof Lifetime: N/A

Roof Life Cycle	Construction Costs (Building Lifetime)	Maintenance Costs (Building Lifetime)	Total
15 Years	$6,595,084	$50,000	$6,645,084
20 Years	$4,693,987	$90,000	$4,783,987
25 Years	$2,640,606	$180,000	$2,820,606

Presentation Take Aways

1. Roofs
    1. Common Defects
    2. Inspection Tips & What To Look For
2. Walls & Windows:
    1. Common Defects
    2. Inspection Tips & What To Look For
3. New Construction
    1. Roofs
    2. Walls / Windows
4. Asset Management

This concludes The American Institute of Architects Continuing Education Systems Course

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