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Building Envelope Preventive Maintenance and Repair

Roofs, Solar, Curtain Walls, Exterior Cladding; and Budgeting Tips

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EDUCATION: B.S., Civil Engineering, Santa Clara University

REGISTRATION: P.E., Civil Engineering, States of California, Nevada and Hawaii

CERTIFICATION: Registered Roof Consultant (RRC), and
Registered Waterproofing Consultant (RWC), from the Roof Consultants Institute (RCI)

OVERVIEW:

- Experienced Instructor and Presenter – UC Berkeley Extension Certificate Program in Facilities Management, RCI, Solar Solutions, AIA's Continuing Education System and other professional organizations – over 200 programs and sessions.
- Over 23 years experience providing superior technical standards in all aspects of building technology.
- Principal consultant in forensic investigations of building assemblies, failure analysis, evaluation and design of building infrastructure and building envelope evaluation and design.
- Expert in all aspects of building envelope technology.
- Completed 1000's of projects in new construction, addition, rehabilitation, remodel and modernization projects, for public and private sector clients.
- Specialization in roofing; solar; curtain walls; building cladding including cement plaster (stucco), wood, GFRC and metal panels; water intrusion preventive maintenance and damage repair; window assemblies and storefronts; below grade waterproofing; and other complex building envelope and mechanical assemblies.

ABBAE HISTORY

- ABBAE is an Architectural Engineering Firm specializing in making buildings last longer.
- We enhance the value of the building asset for owners and operators.
- Specialty components include Roofing, Solar, Waterproofing, Curtain Walls, Stucco, Windows, Below Grade, Etc.
- Our 2000+ projects: 45% have been new Construction projects, and 55% Repair and Rehabilitation projects.
- Consultants to 100's of Facility Managers.

OBJECTIVES

- ✓ Provide a very general overview of proper design of the building envelope, so you can recognize problems.
- ✓ Help you understand what to look for, so that PM can be prioritized and done when needed.
- ✓ By providing some Preventive Maintenance examples, provide you knowledge to build on.
- ✓ Help you understand the operating issues associated with building envelope maintenance.
- ✓ Provide a basic understanding of what to look for
- ✓ Provide information to get you started in budgeting for Preventive Maintenance
- ✓ And how to watch out for hidden dangers…

Hidden Dangers Can Be Expensive

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Preventive Maintenance for Roofs

Best Preventive Maintenance

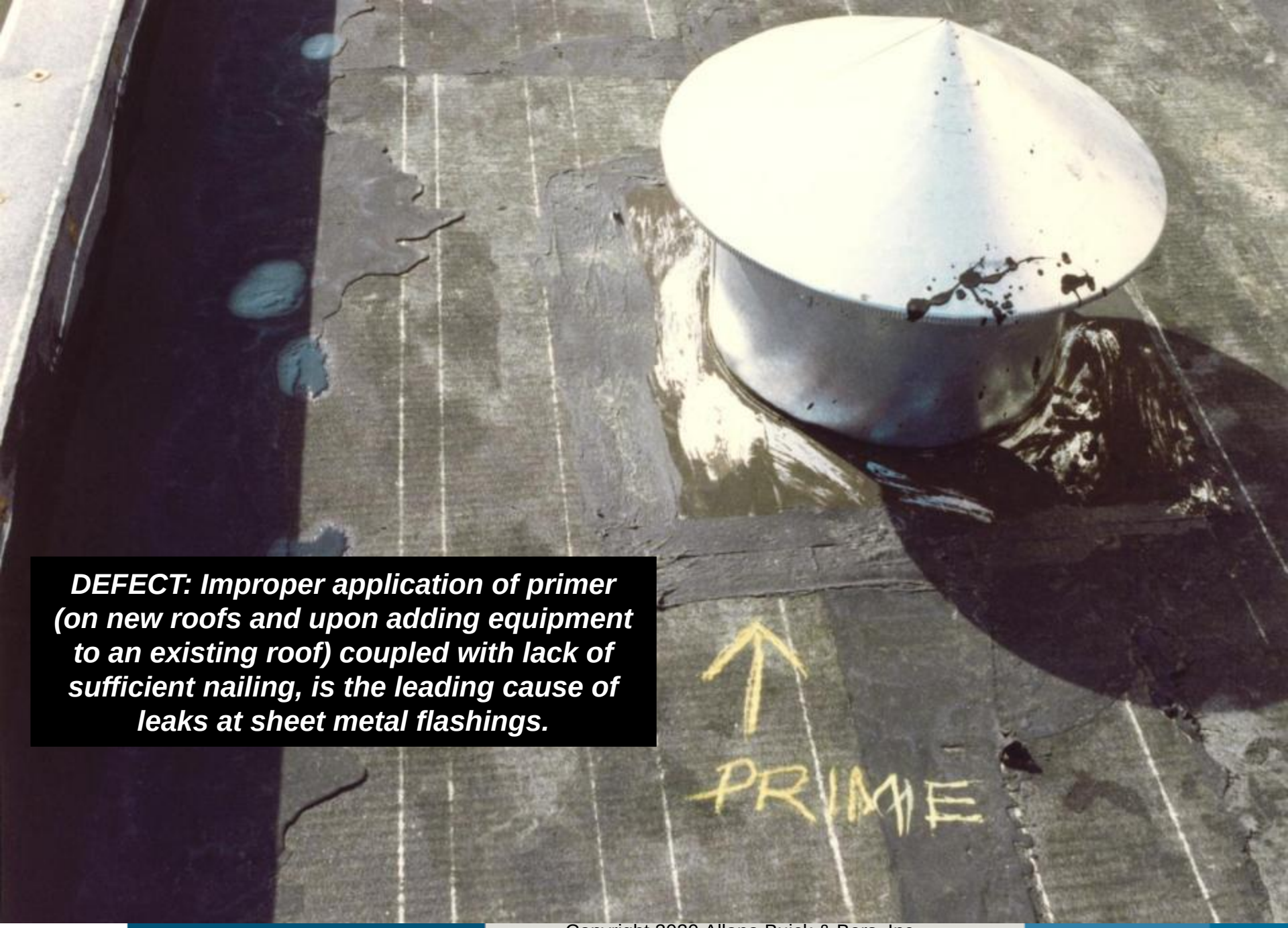
- **Best preventive maintenance?**
  - One that is not needed!
- **Design a Building that requires very little maintenance**
- **Poorly built or designed details are like “TIME BOMBS”**
- **Repairing roofs that “leak” within normal warranty is often due to “Construction or Design Defects”**
- **Owner Required Items:**
  - Regular Inspection of roofs and facades
  - Debris not allowed to accumulate on roof
  - Regular cleaning program – remove blowing trash, leaves, branches

How to Achieve 30+ Yr Low Maintenance Roofs?

- Good Design and Proper Installation!
- Good UV protection. Gravel surfacing, UV and heat resistive materials, Reflective Coatings
- Proper details such as drains, sleepers, base flashings, all designed to last 30+ years, not just the membrane
- Prevent contamination from chemicals
- Design for appropriate foot traffic
- Design for appropriate UV and heat exposure
- Design for ease of adding HVAC units or pipe penetrations if needed

Hot Applied Built Up Roof (BUR)

Appropriate delivery of hot asphalt and appropriate roofing over mechanical curbs.



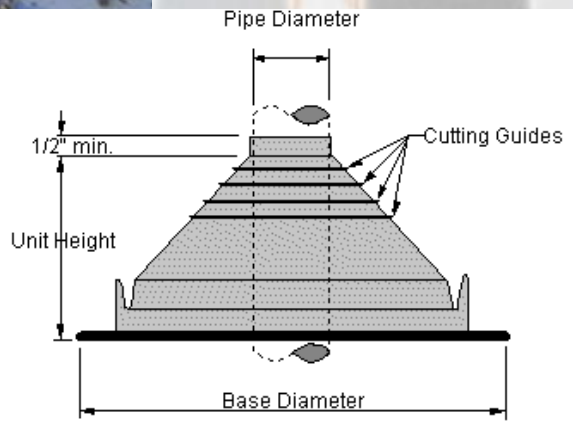
DEFECT: Improper application of primer (on new roofs and upon adding equipment to an existing roof) coupled with lack of sufficient nailing, is the leading cause of leaks at sheet metal flashings.

Roofs go through many additions, alterations and tenant improvements, usually resulting in premature leaks and loss of life expectancy.

Example of Poor Metal Roof Penetrations

New vent pipe was improperly added by tenant.

Proper installation.



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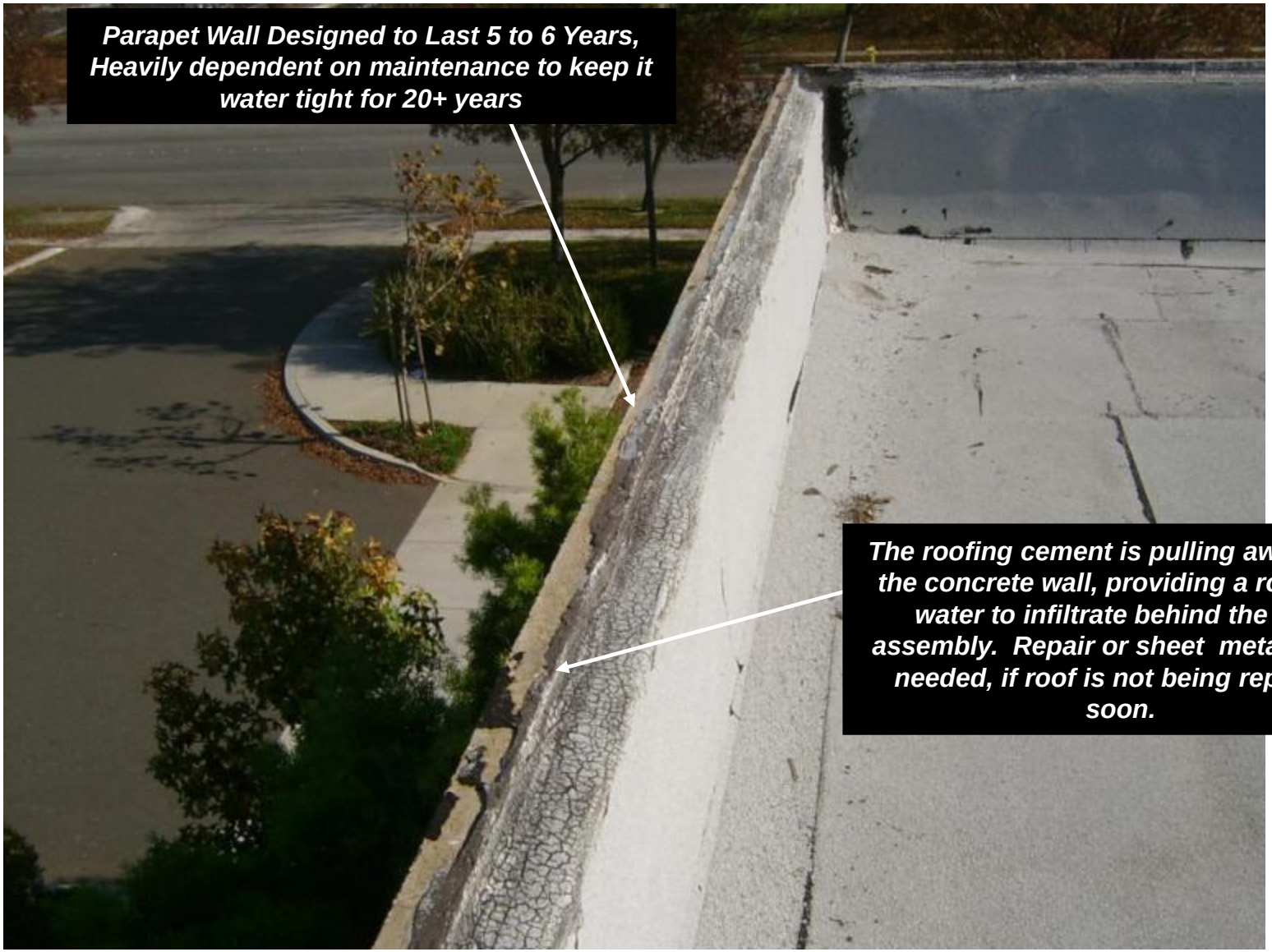
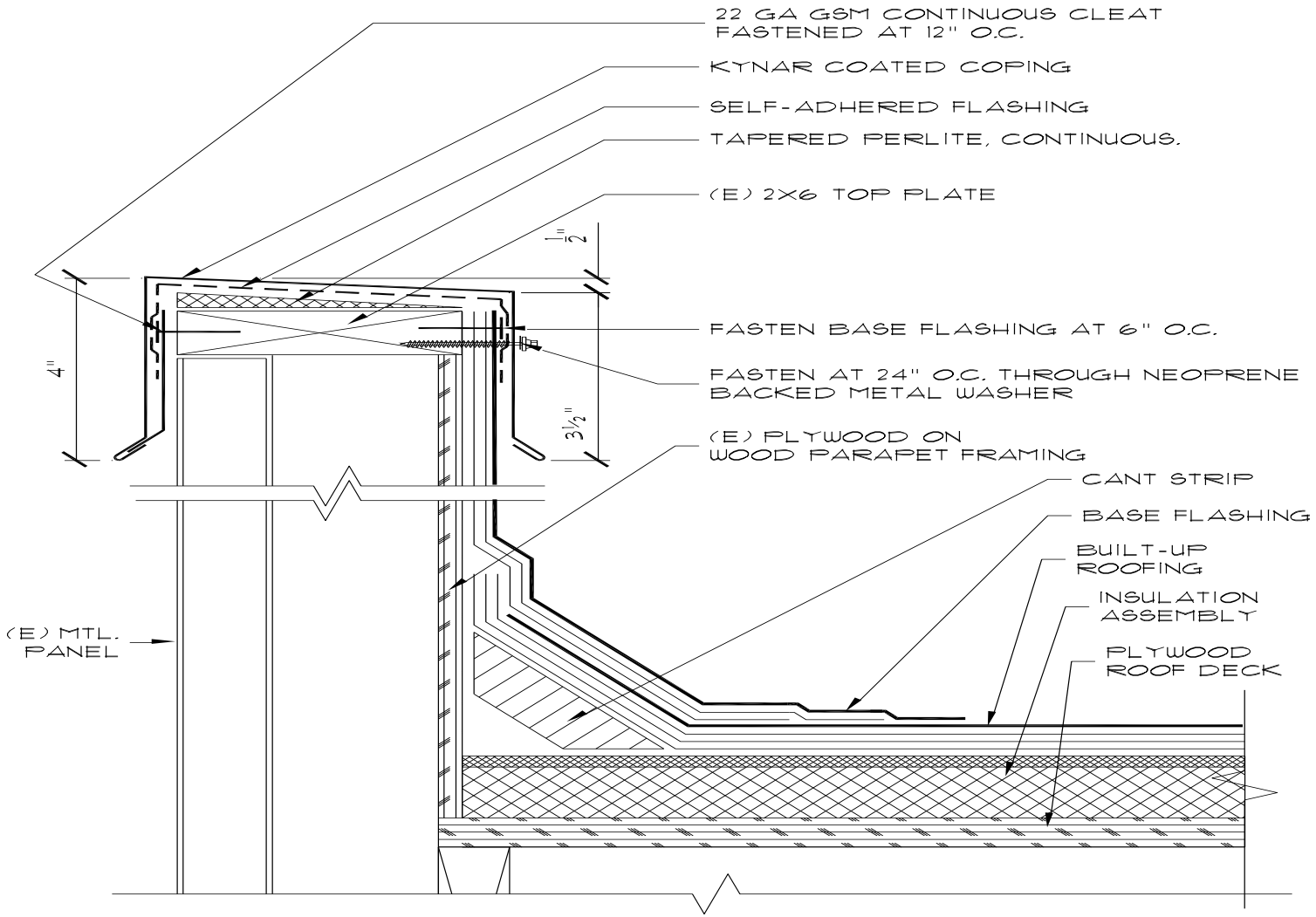
This Parapet Wall Could Use a Cap.

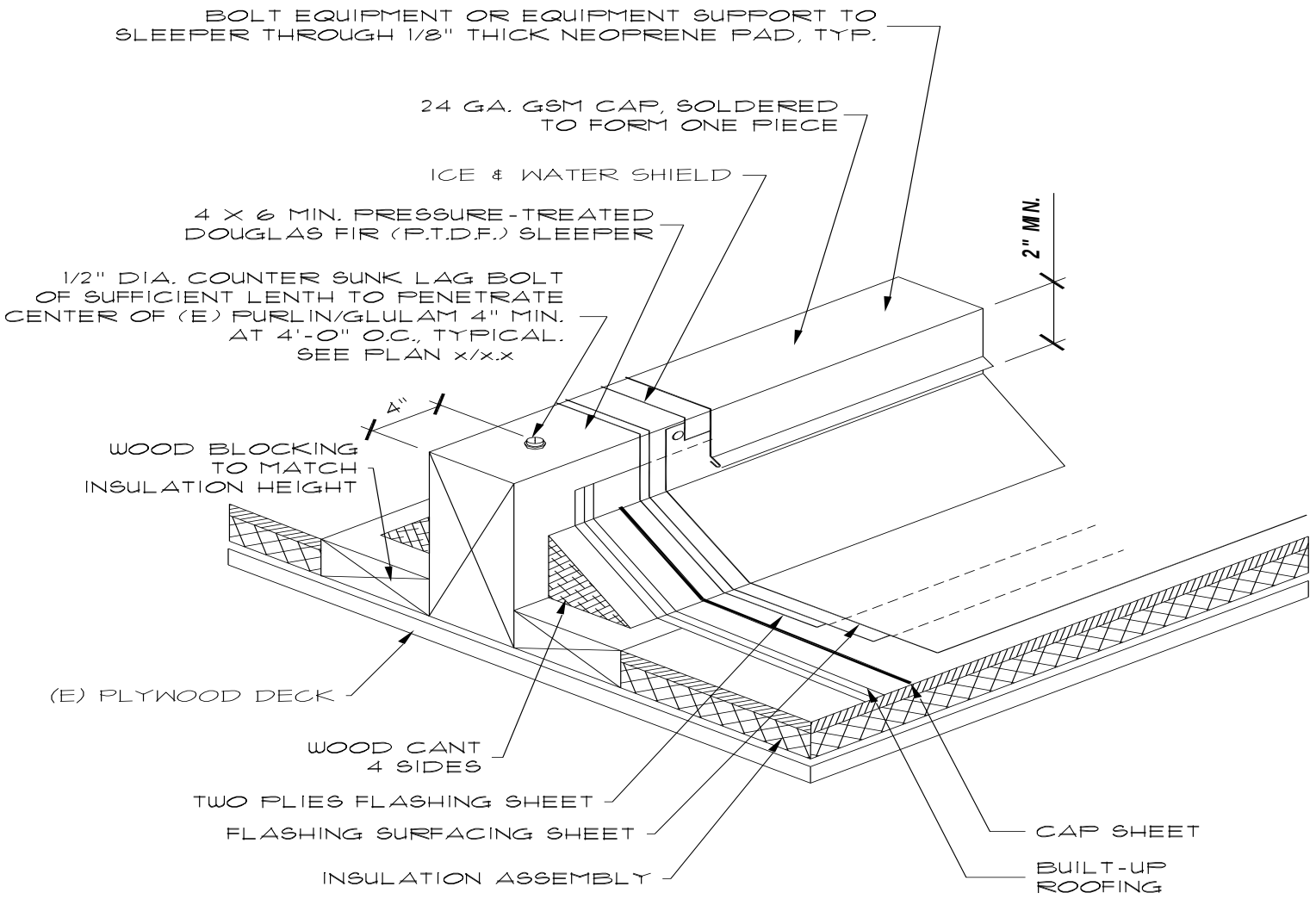


Low Maintenance Parapet Wall Design

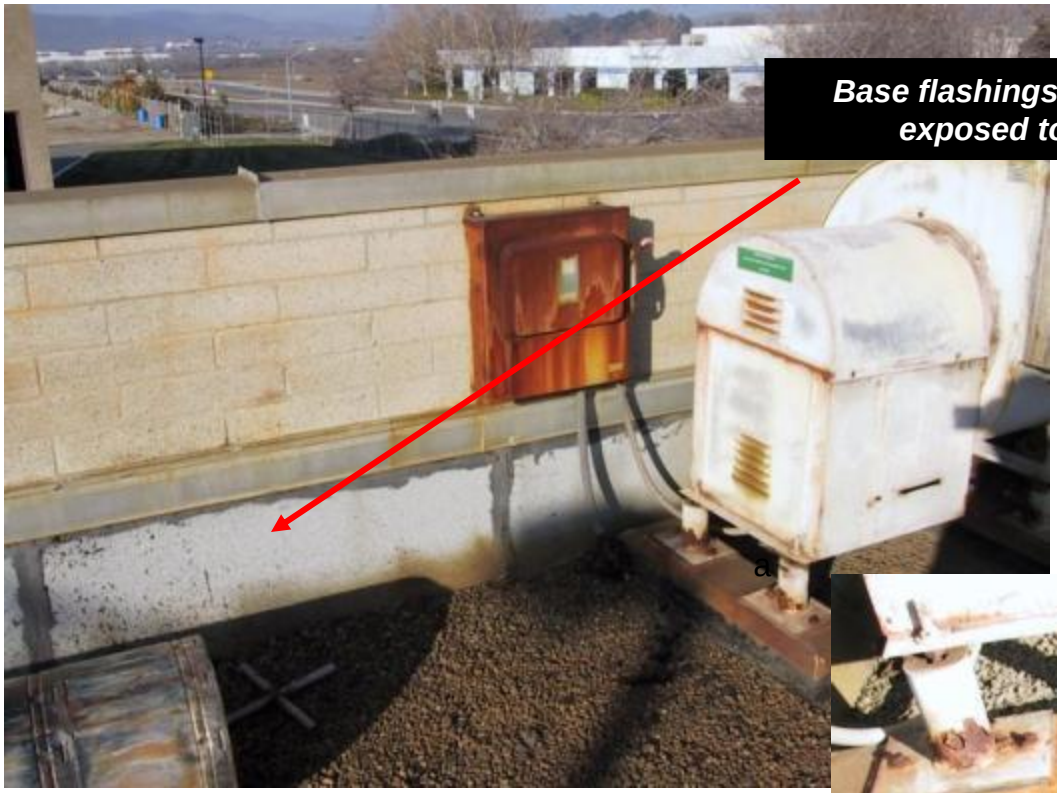


Poor Sleeper Construction

More Sustainable Sleeper Detail



Base Flashing Repairs OR Maintenance?



Base flashings (Horizontal to vertical junction) are exposed to more UV and physical abuse.

Ponding Water Leads to Deterioration

Proper Material Selection

Proper Maintenance Cycle

Maintenance or Repair?

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Single Ply PVC Roofing

Excessive Wear and Abuse

Design Issue – Result in Ongoing Maintenance Headache

Improper Tenant Improvement Work

Electrical conduit added and pipe jack added, both set in mastic that is incompatible with PVC.

Gutter Defect Requires More Maintenance

Slope in gutter was omitted, resulted in weed growth, which restricted flow of water and caused leaks and increased need for maintenance

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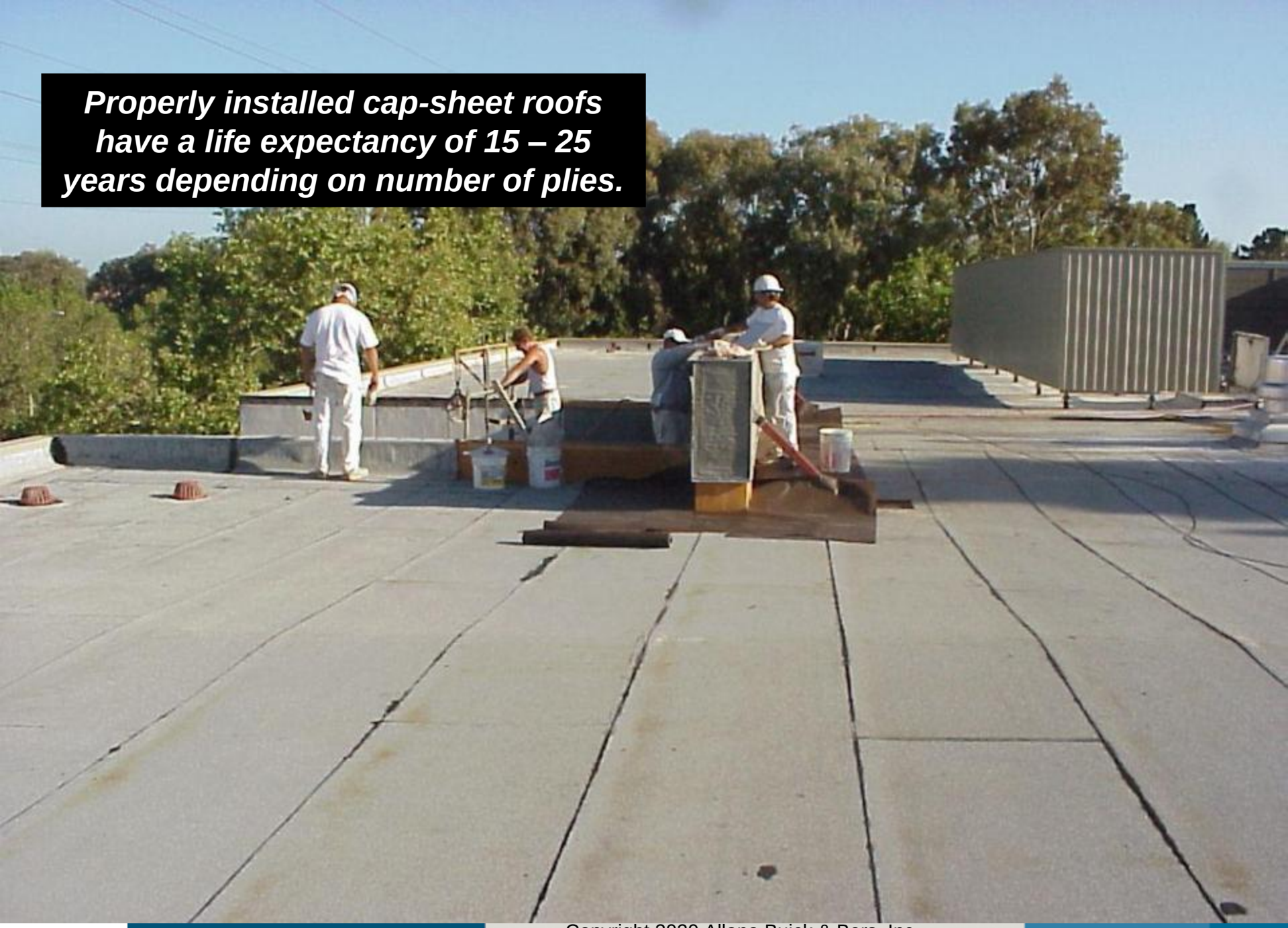
Preventative Maintenance Roof Coatings

Extending the life of roofs and meeting Energy Star Compliance with White Acrylic Coatings



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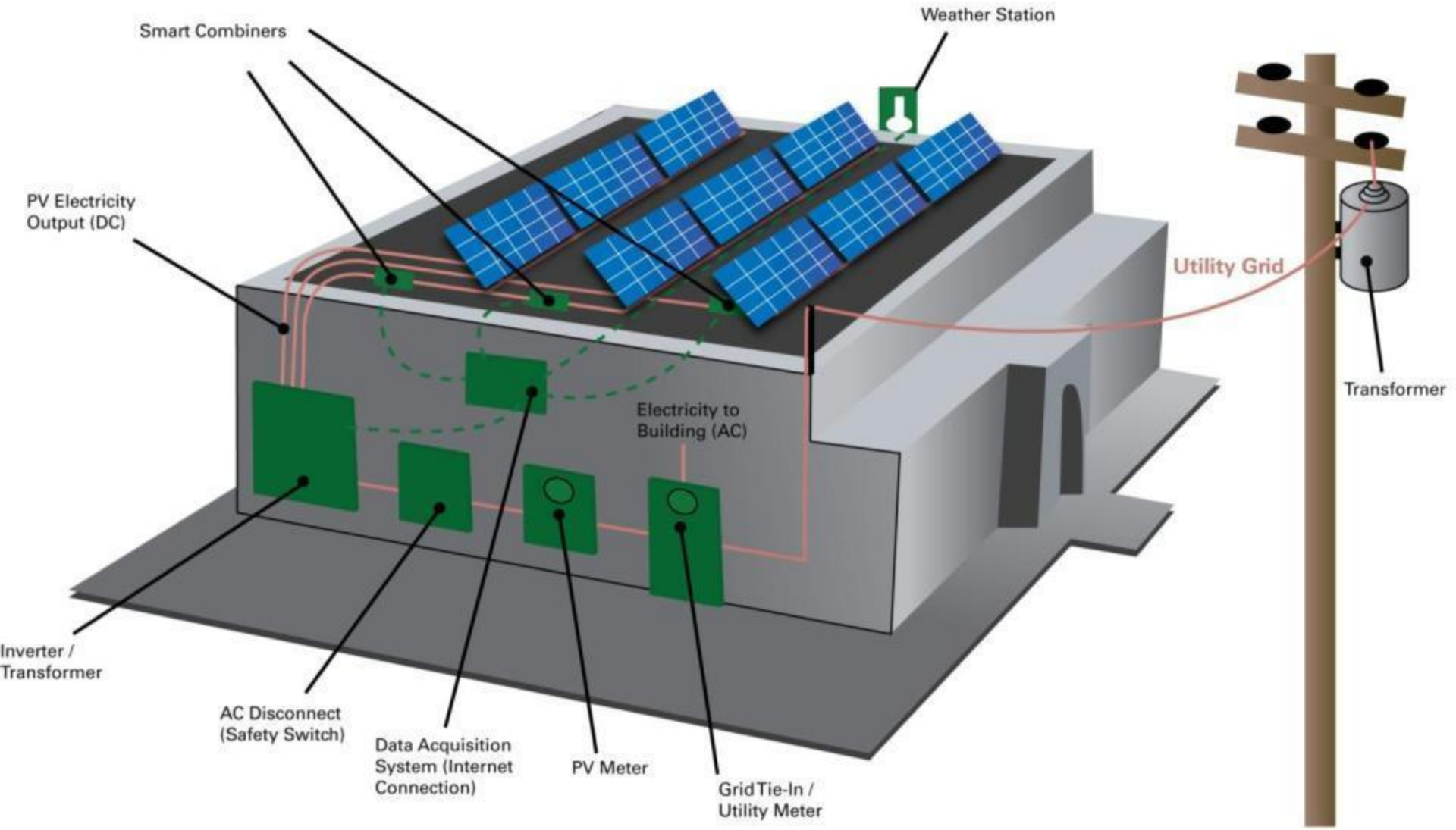
Solar PV Installations On Existing Roofs

How Solar PV Works



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Improper Mounting and Racking

Roof Mount - Attached to Structure

What is wrong with these pictures

Attached to Structure

Angled Attached to Structure

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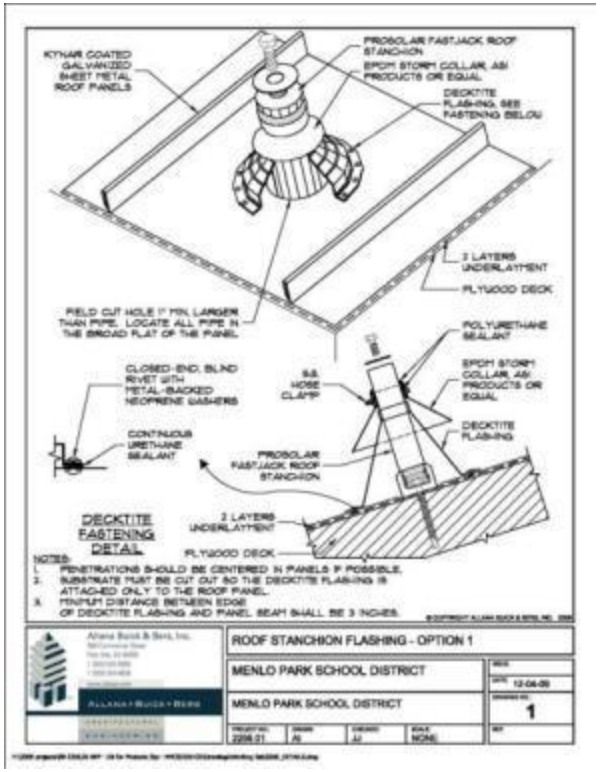
PV Installations on Existing Metal Roofs

- **Our philosophy of design:**
  - Sustainable means removing uncertainty about performance and longevity
- **We consider all factors:**
  - Structural
  - Roof Condition and Assessment
  - Site Condition and Entitlement Process
- **We design systems that will stand the test of time**
- **Design flashings that don't void roof warranty**



Proper Mounting and Racking

Roof Mount - Attached to Structure

Can The Existing Roof Handle Solar?

- **Constructability**
  - Structural Engineering Considerations
    - Load, Seismic, Wind
  - Roofing considerations
    - Age and condition
    - Integration
    - Warranty
    - Waterproofing
    - Drainage
    - Maintenance access
    - Installation damage controls
    - Chemical compatibility

Site Assessment and Site Control

- **Physical Constraints**
  - Available area on your roof?
  - How much mechanical equipment is on roof?
  - Access clearances required for maintenance of mechanical equipment?
  - Does local fire code affect clearances?
  - Conduit runs possible from solar to electrical tie in?
  - Space on ground for a mounting system?
  - Over a parking lot or parking structure?
  - Trench from this area to electrical tie-in point possible?
  - Space for inverter? Outside? Inside?
  - Inverter(s) require closed in structure?
  - Type of structure? Space required?
  - Security issues?

Solar Roof or Garden Roof?

Is This a Good System For Your Roof?

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Importance of Maintenance

Excessive dirt build-up on PV modules creates "Hot Spots".
Can cause cell series wiring to prematurely fail
and VOID the manufacturer's warranties

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Mounting and Racking

Roof Mount Non-penetrating - Ballasted

Thermal movement can damage the roof

Importance of Solar Maintenance

- **Warranties - which may not be honored if no proof of proper maintenance is documented**
- **Inverters, Panels, Combiner Boxes can fail prematurely due to excessive heat build-up**
- **Photovoltaic systems are designed to last 30-40 years**
  - Chaffing wires or faulty mounting hardware can be detected early with a regular maintenance program.
- **Simple problems may reduce the life expectancy of the PV system**
- **Without proper inspection and cleaning, production guarantees may be violated**
- **According to the National Renewable Energy Laboratory, soiled modules can show a deficiency of 25%**

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Curtain Wall Maintenance.

The 3 Basic Glazing Systems

- **Curtainwall - Prefab units attached to the edge of slab, then weather-sealed in place or factory sealed to a certain extent.**

- **Storefront-Typically floor to ceiling, includes entrance doors and vestibules. Field installed from floor, frames first then glass placed in the frame, then stop is snapped in place.**

- **Windows-Individual units fixed or operable, set in a wall.**

Store Front Systems

- Glass is supported by blocks
- Gaskets act as spacers and hold glass in frame
- Designed to leak due to gaskets not always tight to glass
- Designed to move ¼” per 20 feet
- Requires review and maintenance

Curtain Wall

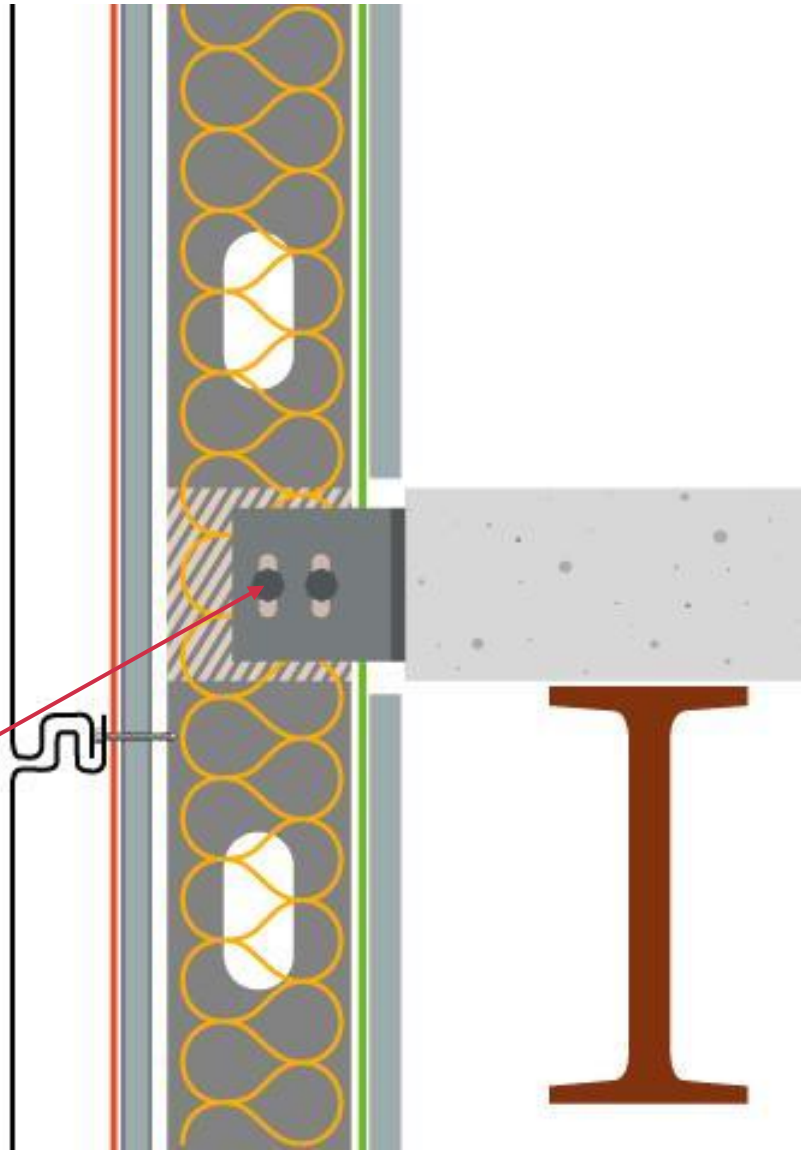
- Building Façade which does not carry any dead load from the building other then its own dead load
- Loads from curtain wall are transferred to building at edge of floor slab
- Designed to resist air and water infiltration
- Resist wind and seismic pressure acting upon it.
- Curtain walls frame commonly in-filled with glass, but can be in-filled with stone veneer, metal panels, vents

Metal Studs Curtain Wall

Solutions:

- Include the installation of the metal studs in the architectural wall installers scope of work

- Studs outboard of the floor slab, with slip connectors, eliminate the deflection problem



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Curtain Wall Materials

- Glass
- Metal
- GFRC
- Pre-cast concrete
- EIFS (not common)
- Masonry (also not common)

System Vulnerabilities

Leak observed on the 2nd floor after the first spray test at the GFRC panel

Leak observed on the 1st floor after the third spray test at the (inviso vert.)

System Failures

Leak observed on the 1st floor after the third spray test at the

Curtainwall

A curtainwall is mechanically anchored to a building's primary structural frame and is constructed of various component types

It carries only its own dead and live weights, not that of the building

Mounting Brackets

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Sealants and Gaskets on Curtain Walls and Store Fronts

Types of Sealants and Application

Types of Sealants

1. Low, Medium and High Modulus Silicones
2. Perimeter sealants need to be Low Modulus
3. Structural sealants need to be High Modulus
4. Internal sealants need to be Low Modulus or Non Hardening

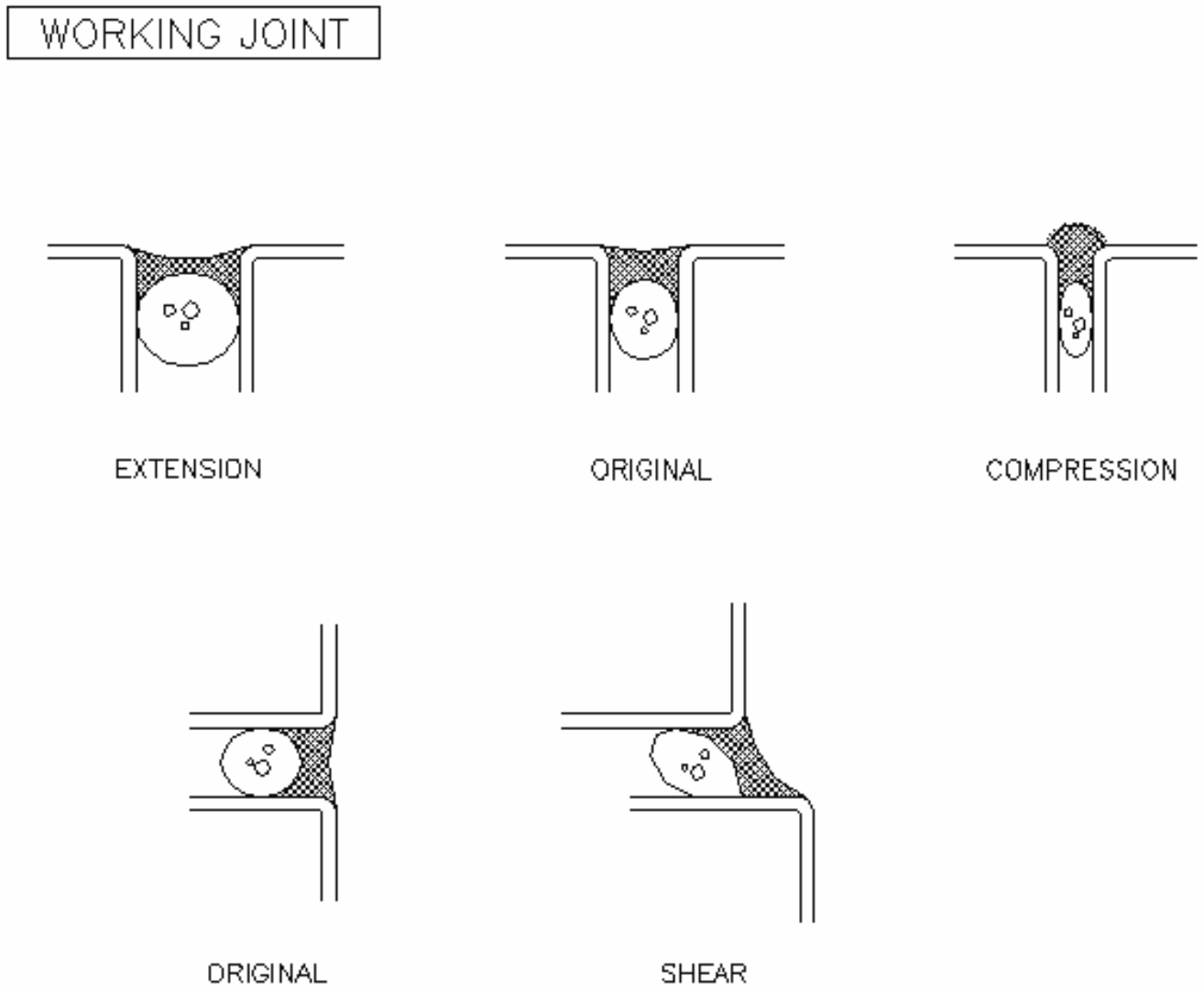
Sealant Application

1. Proper Cleaning
2. Priming if necessary, testing required
3. Proper tooling and cure times
4. Constant quality control throughout installation

Backer Rod Types

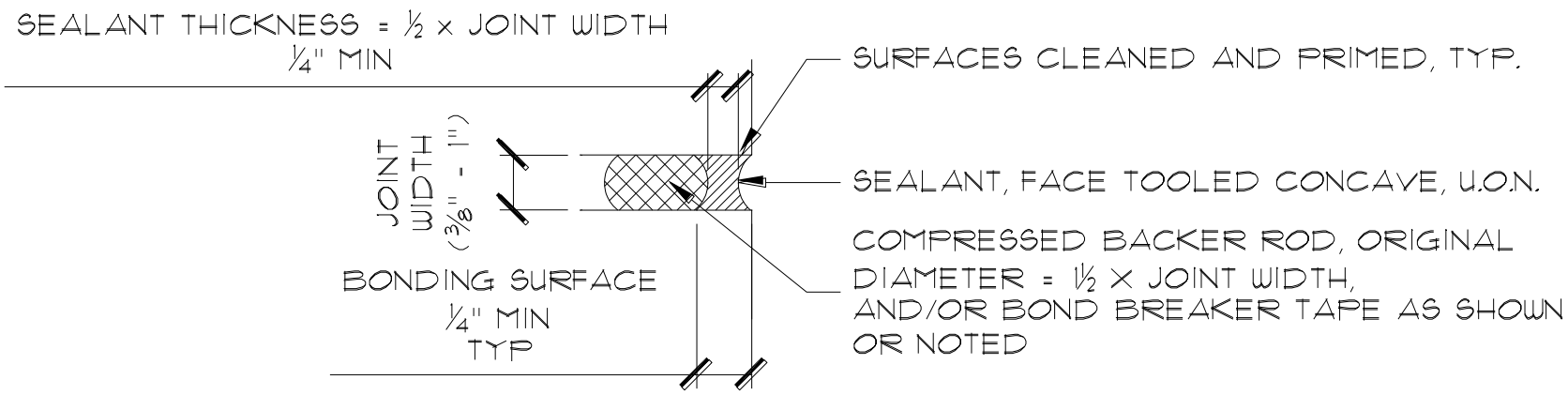
1. Closed Cell
2. Open Cell

Sealant Joint Movement Over Time and Temperature

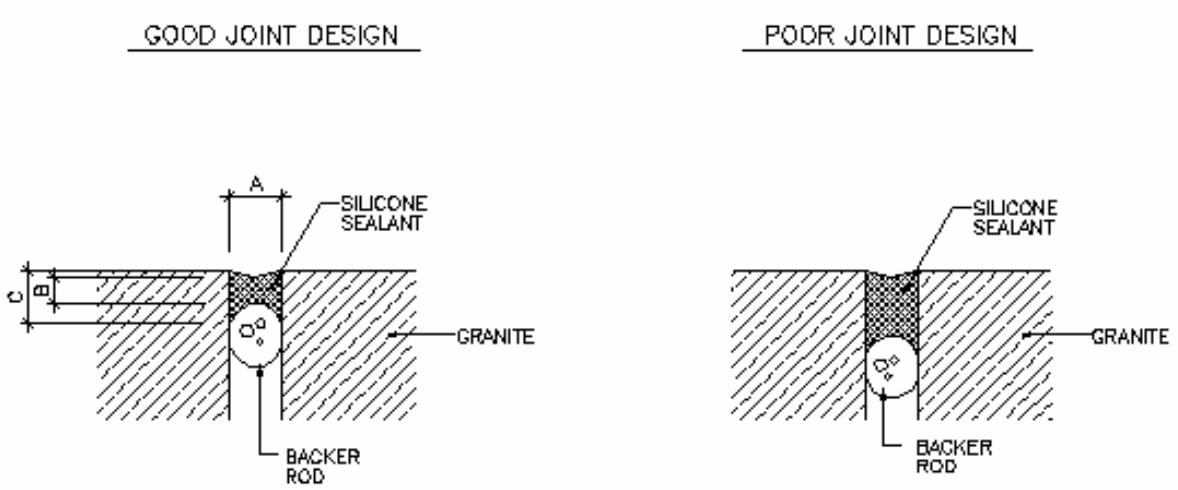


Source: Dow Technical Manual

Typical Backer Rod and Sealant Joint



Depth to Width Ratio 2:1



Source: Dow Technical Manual

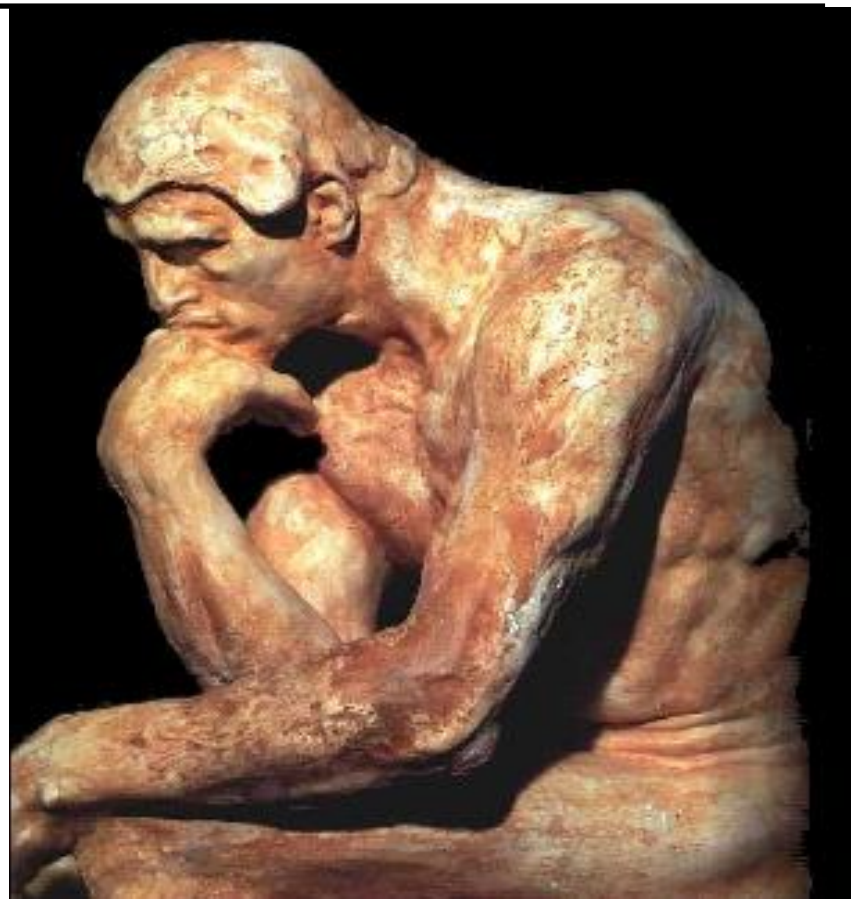
1. Dimension A must be at least 1/4" (6 mm).
2. Dimension B must be at least 1/8" (3 mm).
3. Dimension C must be at least 1/4" (6 mm).
4. Ratio of A:B should be 2:1 minimum.
5. Joint surface tooled.
6. Dimension B suggested Maximum = 1/2" (12.7 mm).
7. Dimension A Maximum = 4" (100 mm). Joints wider than 2" (50 mm) may slump slightly; therefore double application of the sealant may be required.

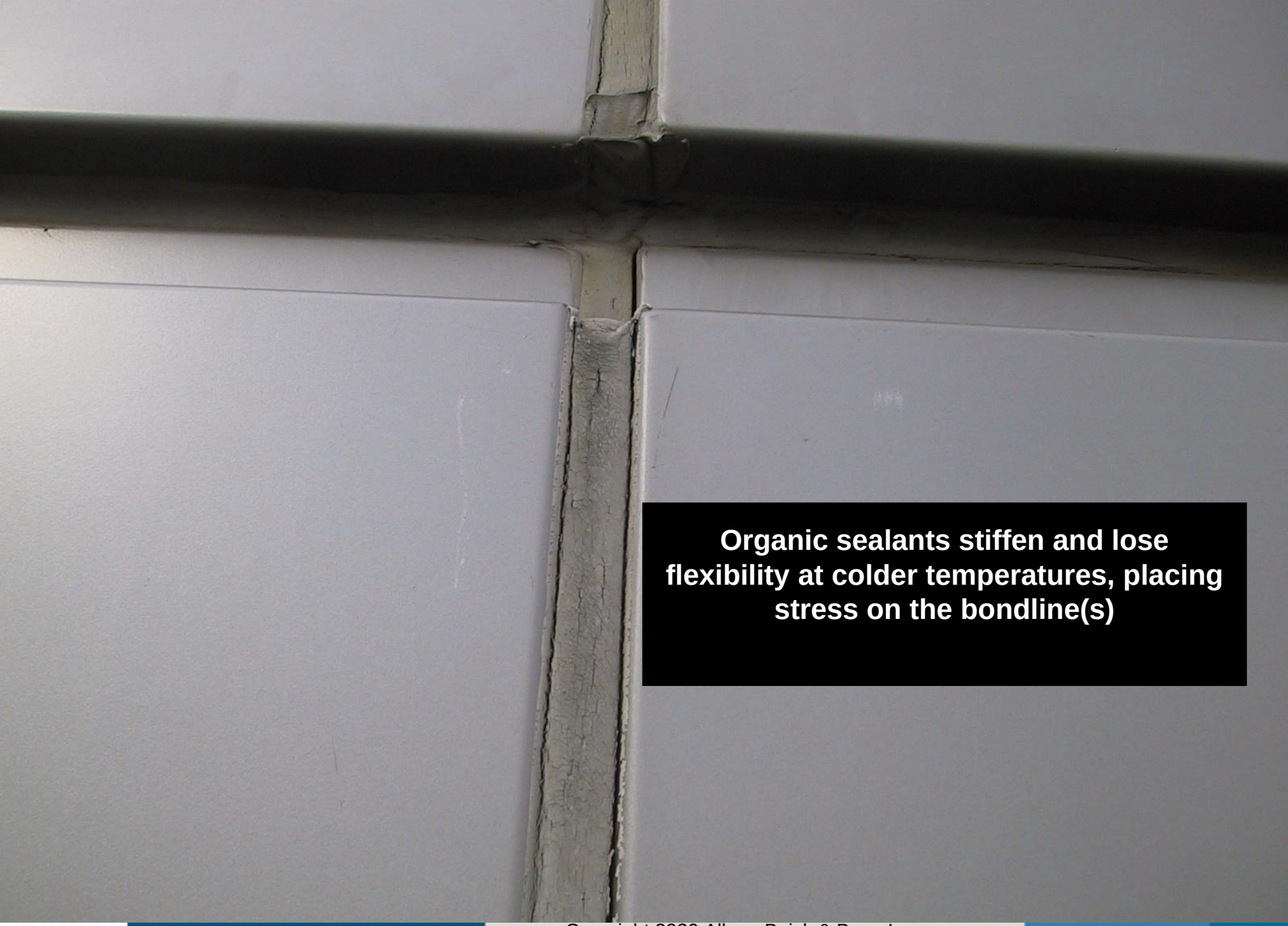
Metal Surface Preparation for Maintenance

- **Anodized aluminum - typically EXCELLENT for sealant adhesion.**
  - **Anodized finish often varies between anodizer manufacturer**
  - **Anodized finishes typically do not require a primer**
  - **Clear Anodized can sometimes be difficult - may require primer**
  - **Surface prep is most always IPA wipe**
- **Painted aluminum - widely variable, dozens of paint manufacturers.**
  - **Painted finishes - good chance primer not required**
  - **Surface prep is almost always IPA wipe**
- **Lead, Copper, Stainless & Galvanized - use Neutral cure sealants.**
- **Unpainted steel will corrode causing adhesive release of sealant.**

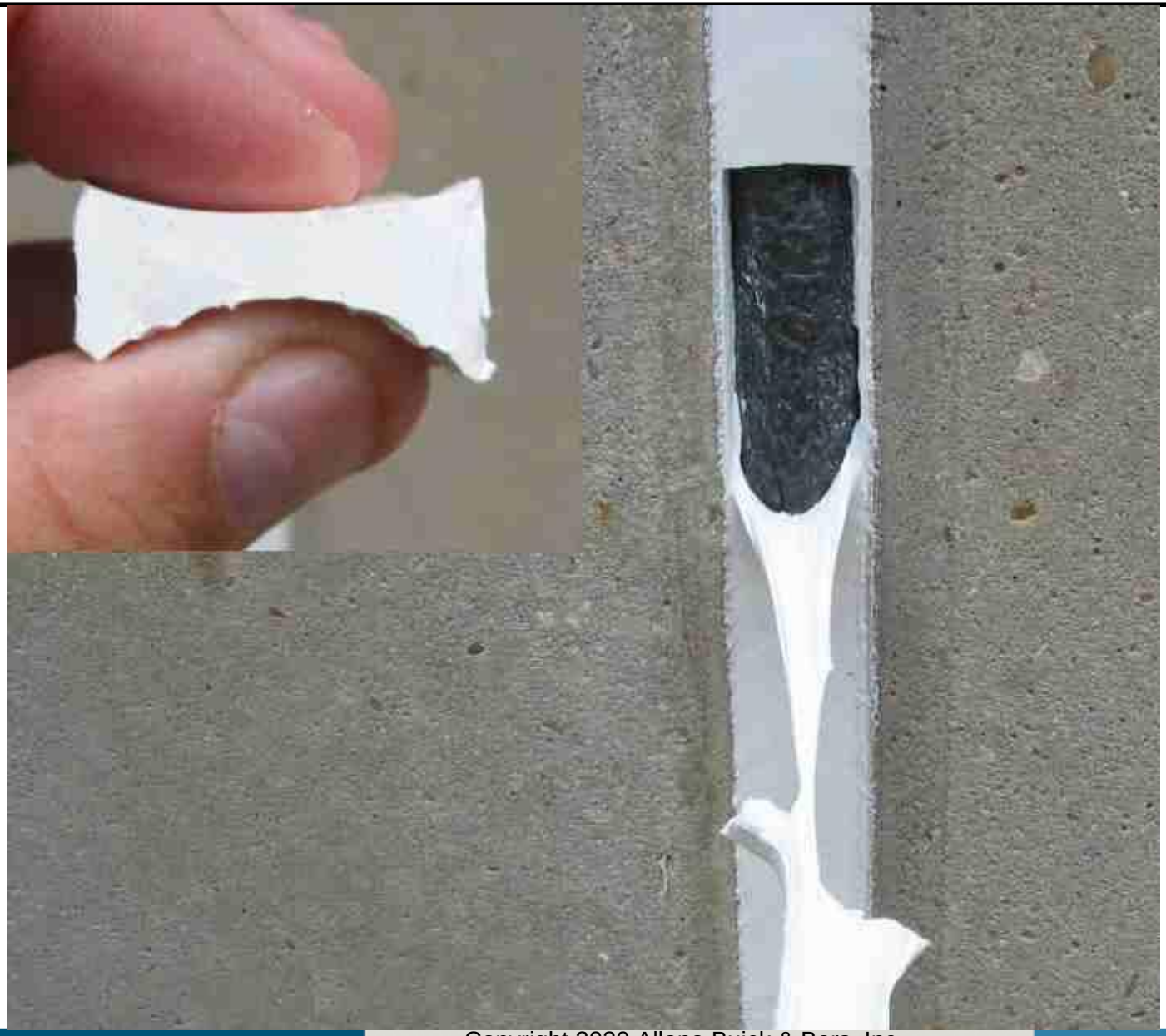
Why Use Silicone?

- ✓ Unmatched UV Resistance
- ✓ High Strength
- ✓ Outstanding Flexibility
- ✓ Wide Thermal Performance Range **(Thermal Stability)**
- ✓ Wide Application range
- ✓ Excellent Adhesion
- ✓ Custom-Tailored Formulations





Sealant Pull Test



Sealant Adhesion Testing

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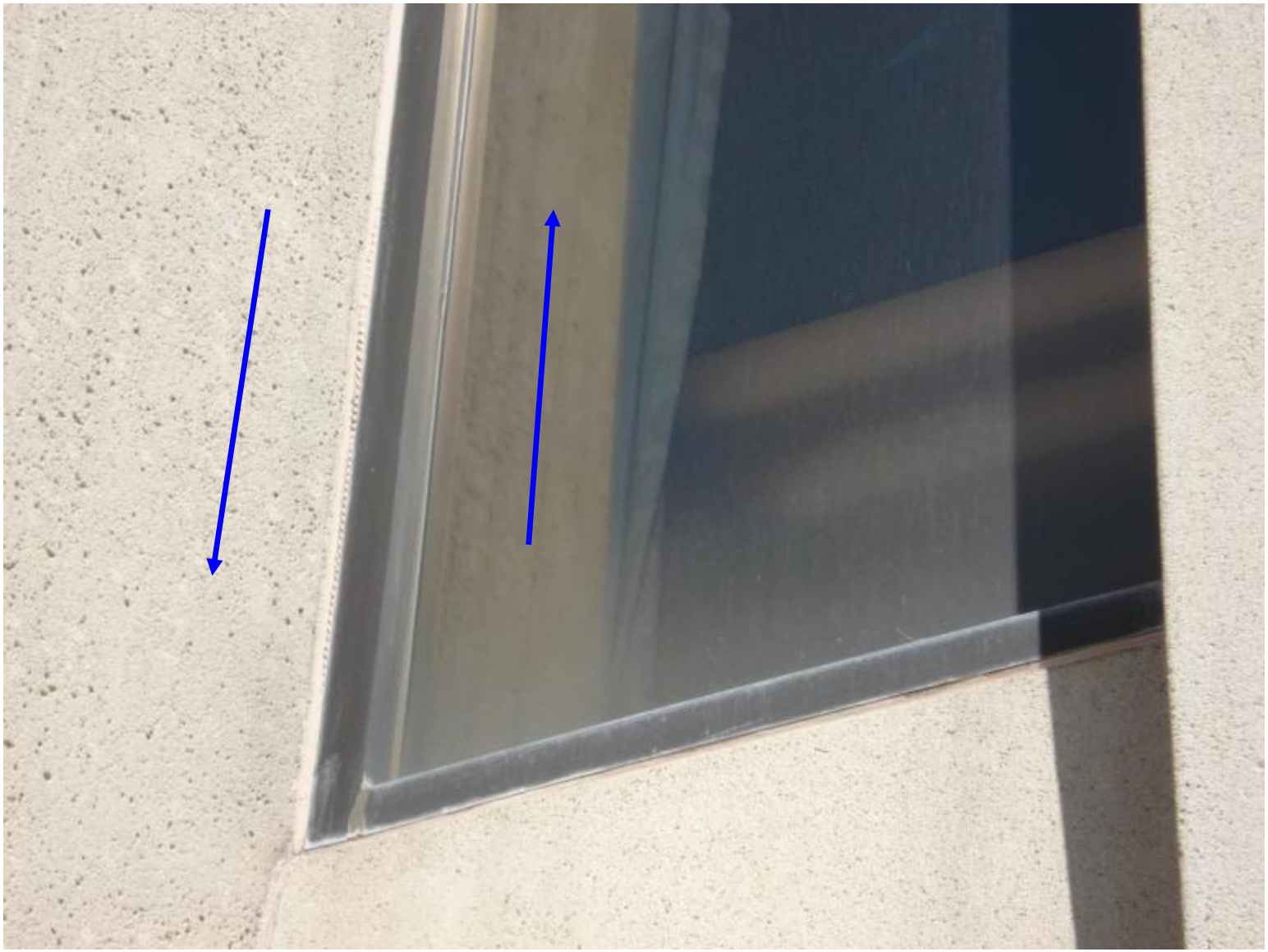
Project Example
Kaiser Sealant Repair

Kaiser - Sealants on Precast and Curtain Wall

Sealant Between Curtain Wall and Pre-Cast

Sealant Between Pre-cast and Mullion



Gasket Shrinkage/Failure

Budget Tips for Typical PM Tasks – Sealants

- ✓ **Wet seal window gaskets, including the following steps**
  - Properly prepare the area
  - Clean and wash windows
  - Remove metal caps
  - Remove loose gaskets
  - Cut remaining gaskets
  - Apply wet seal and replace caps
  - $4.50 - $7.50 per lineal foot
- ✓ **Replace sealants between GFRC and other panel types, including the following steps:**
  - Remove existing sealants and backer rods
  - Perform adhesion test and if necessary, grind the bonding area
  - Replace backer rod and sealants, properly tooling the sealants
  - $5 to $10 per lineal foot, depending on prep time

Leak Testing Curtain Wall

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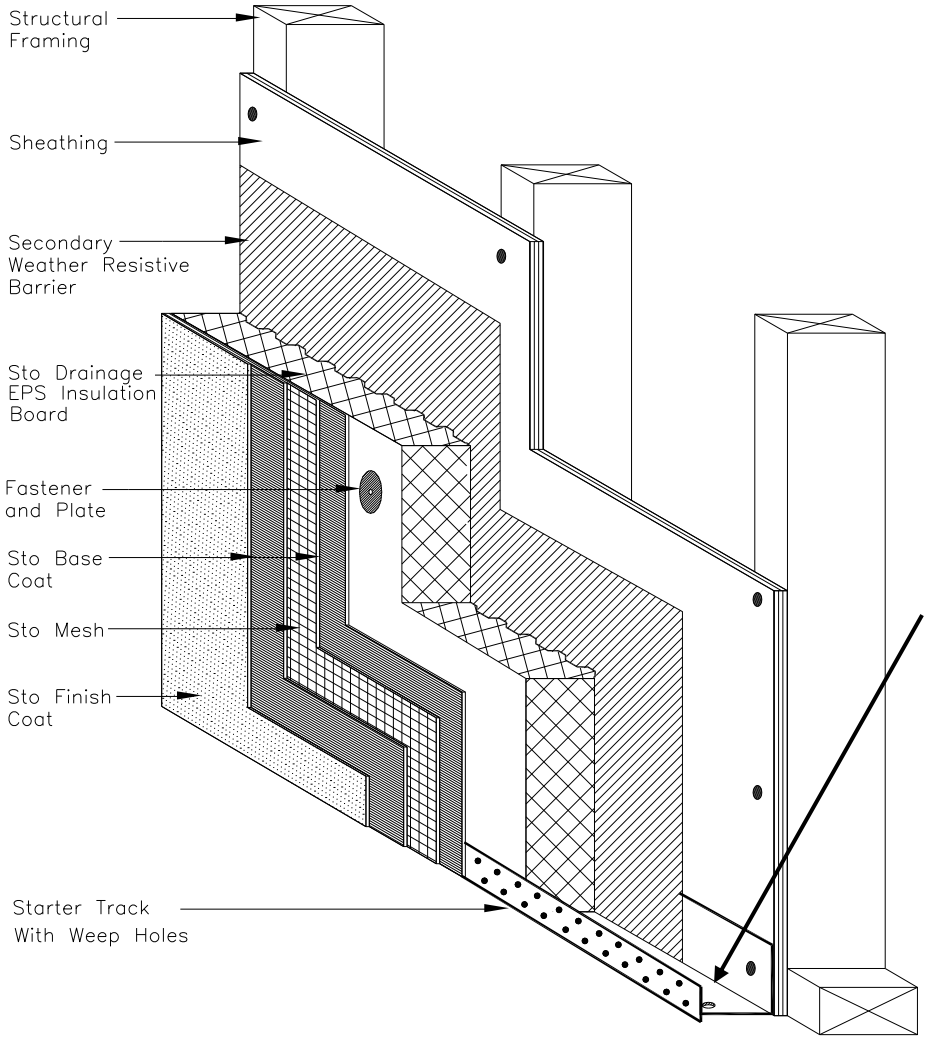
Stucco and EIFS

EIFS Wall Systems May Have Drainage + Weep



Unless system is tested as a “Barrier System” it must have weather resistive barrier and weep mechanism

EIFS Preventive Maintenance - Investigation

EIFS exterior on building at large Silicon Valley Campus. Occupant of office had reported major leaks.

ABB was hired to determine causes and if possible prescribe major preventive maintenance repairs rather than very expensive replacement of entire skin of all 13 buildings (several $$$$ million).

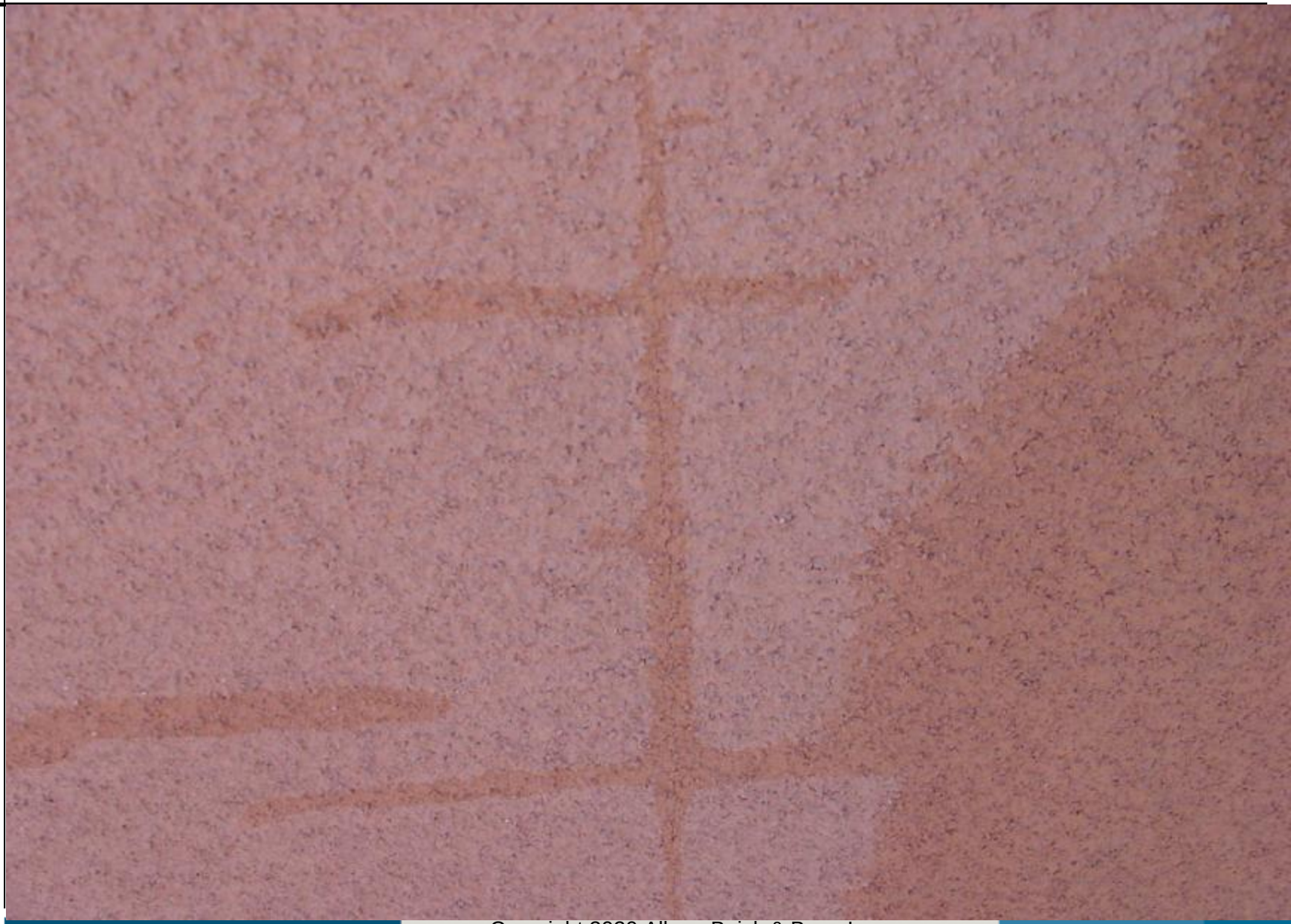
Client Had Made Attempts at Repairs

Cracks Smaller Than Hairline, in Field of EIFS

Removal of ceiling tile showed more evidence.

Water Testing of Other Building Envelope Components

Water Testing Results



Water Testing Showed The Extent of The Problem

Result of Investigation

- Significant number of cracks were found in the EIFS, creating leaks. (Defective Construction)
- The original construction created recessed gaps between the window frame and the EIFS. These leaked.
- The windows leaked.
- The base of the walls leaked.
- The owner was faced with complete replacement of the EIFS on 12 buildings, or major preventive maintenance.
- They chose elastomeric paint, filling the recessed gaps around the windows with sealant, and sealing leaks in the windows.

Preventive Maintenance of Stucco and EIFS

- Hairline cracks can be repaired with elastomeric coating and filler, but only if the cracks are narrow (< 1/32 inch). (Cracks are due to defective construction)
- Sealants are required where the stucco transitions to other building components, such as windows. Replace every 10 o 20 years
- Remove landscaping near wall and redirect irrigation spray
- The majority of stucco/EIFS problems involve water and moisture intrusion and the failure to manage water

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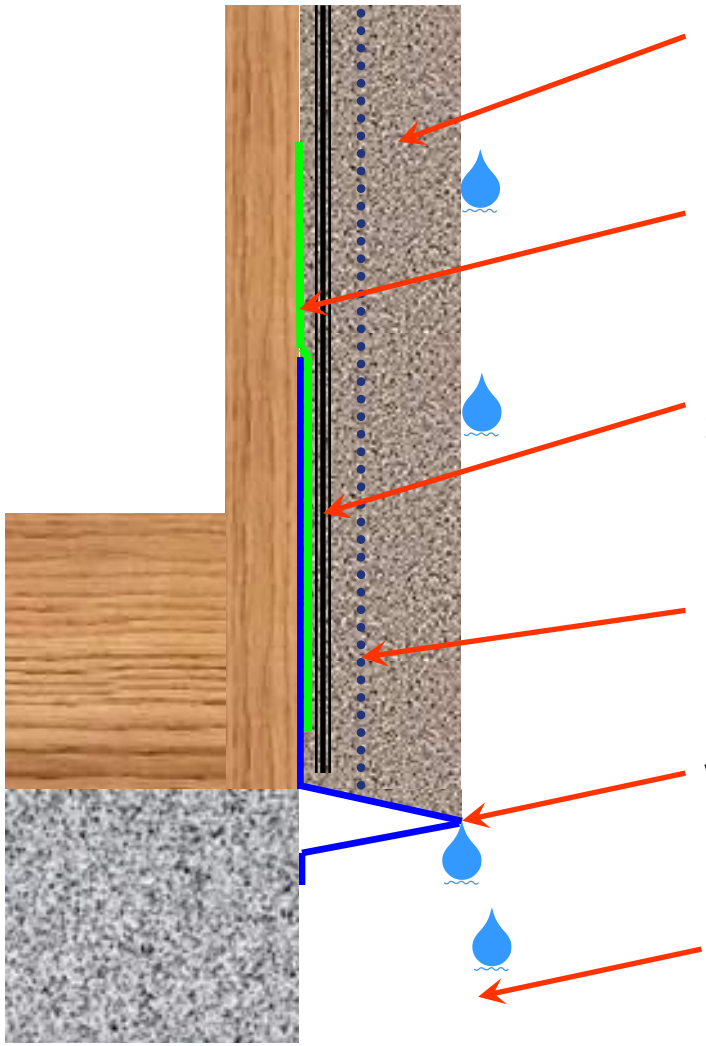
STUCCO

Typical Stucco System in Section



Cement Plaster (Stucco)

Flexible flashing

2 Layers Grade D paper

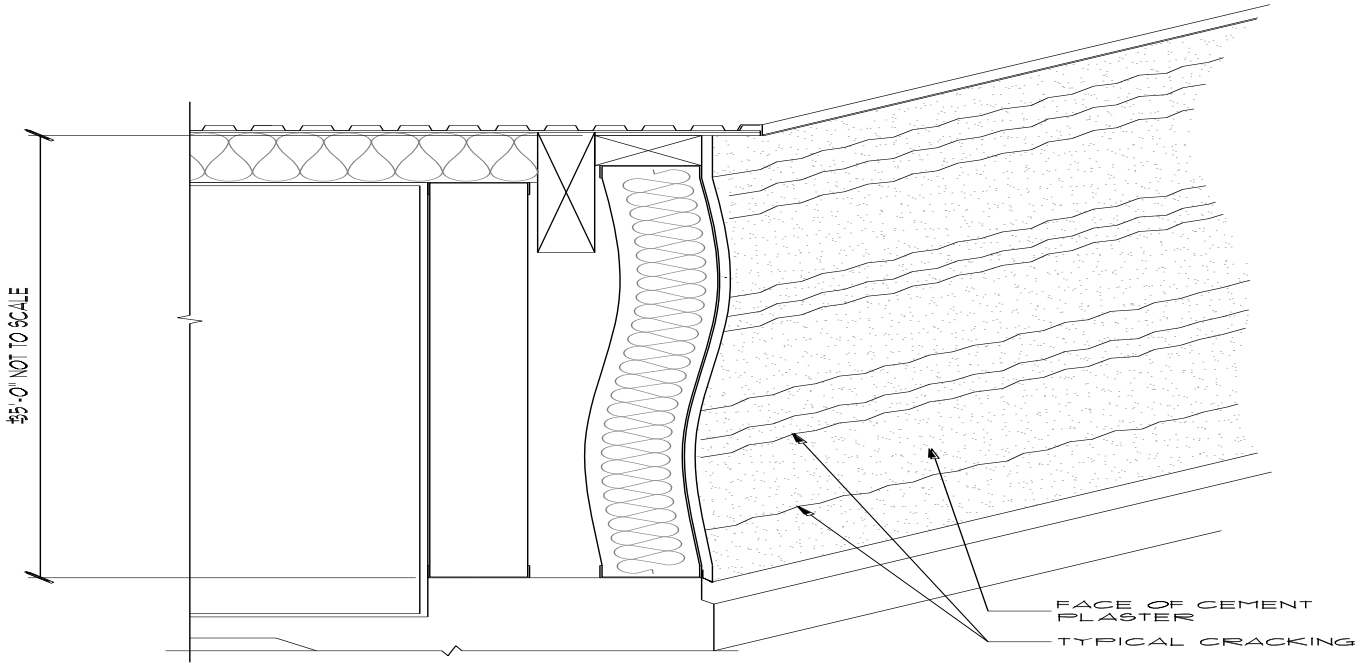
Lath

Weep provision

Area below weep is clear (at least six inches below weeps)

High Incidence of Stucco Cracks in Metal Stud Building

Impact of Night to Day Variation



STUCCO CRACK
CONDITION - ISOMETRIC

Stucco Cracks – School Gymnasium

Budget Tips for Typical PM Tasks - Painting

Painting

- Power wash
- Route cracks larger than ¼” and fill all cracks with proper sealant (looks ugly)
- Mask all areas
- Cover landscaping and fixtures where necessary
- One Coat Prime
- Apply finish coat, four (4) to six (6) mil thickness
- $2.50 to $4.50 per square foot not including sealant repairs

• Elastomeric Paints

- Same steps as above plus
- Rout and sealing of cracks is mandatory
- Sealant around all windows and penetrations are mandatory
- $6.00 to $12.50 per square foot not including sealant repairs

Budget Tip - Know The Normal Life Expectancies…

- Sealants: 10 to 25 years
- Roofs: 10 to 40 years
- Gutters: 10 to 30 years
- Below grade waterproofing: Life of the building if designed and installed properly
- Windows: Life of the building, unless energy savings are desired, then replace as desired
- Window gaskets: 10 to 20 years
- Stucco: Life of the building if designed, installed and maintained properly
- Painting: 5 to 7 years
- Wood siding: 20 to 40 years
- Sidewalks and pavement – 10 to 30 years
- Landscaping – 10 to 20 years
- Trees – Depends on the species
- HVAC, Other Mechanical, Electrical and Plumbing – varies widely

Thank You!

Questions?