Roofing and Waterproofing Seminar
CSI Las Vegas

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Best Practice

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Karim P. Allana, PE, RRC, RWC

- **Education:** B.S., Civil Engineering, Santa Clara University
- **Registration:** P.E., Civil Engineering, California, Washington, Nevada, and Hawaii
- **Certification:** Registered Roof Consultant (RRC), Roof Consultants Institute, and Registered Waterproofing Consultant (RWC)
- **Overview:**
  - CEO and Senior Principal at Allana Buick & Bers.
  - Former Turner Construction Employee (Project Engineering and Superintendent)
  - Over 37 years experience providing superior technical standards in all aspects of building technology and energy efficiency.
  - 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 numerous new construction, addition, rehabilitation, remodel and modernization projects for public and private sector clients.
  - Specialization in siding, roofing, cement plaster, wood, water intrusion damage, window assemblies, storefronts, below grade waterproofing, energy efficiency, solar engineering and complex building envelope and mechanical assemblies.

ABBAE Firm Overview

- Allana Buick & Bers (ABBAE) is an Architectural Engineering firm specializing in Building Envelope Systems
- ABBAE is one of the 5 largest building envelope consultants in the country
- ABBAE has over 33 years of experience & over 12,500 projects
- ABBAE is also a leading Forensic Defect firm with hundreds of forensic projects (litigation)
- Locations – 16 offices across California, Nevada, North Carolina, Oklahoma, Oregon, Texas, Virginia, Washington, Colorado and Hawaii

Staff & In-House Expertise

- Licensed Professional Engineers – Civil, Structural, and Mechanical
- Registered Architects
- Building Enclosure Commissioning Process Providers (BECxPs)
- Registered Building Envelope Consultant (RBEC)
- Registered Roofing Consultants (RRCs)
- Registered Waterproofing Consultants (RWCs)
- Registered Exterior Wall Consultant (REWCs)
- Registered Roof Observers (RROs)
- Certified Exterior Insulation and Finish System (EIFS) inspectors
- Curtain Wall Specialists
- ICC Certified Building Inspectors
- Quality Assurance Monitors
- Water Testing Experts
- Leak Investigation and Diagnosis Experts
- Infrared Imaging and Nuclear Moisture Scanning Experts

ABBAE Building Expertise

- Building Envelope Systems
  - Roofing Systems
    - High-Slope/Low-Slope Roofs
    - Green/Garden Roofs
    - Drainage Systems
    - Pedestrian Plazas
  - Exterior Wall Systems
    - Wall Cladding/Siding/GFRC/pre-cast
    - EIFS/cement plaster/stucco
    - Sheet Metal Flashings
  - Windows and Glazing Systems
    - Punched Windows
    - Curtain Wall/Window Wall Systems
    - Sliding Glass Doors
    - Skylights

- Building Envelope Systems (cont'd)
  - Roofing & Waterproofing Systems
    - Deck/Balcony/Lanai Waterproofing
    - Podium Waterproofing
    - Pool/Spa Deck Waterproofing
    - Above-Grade/Below-Grade Waterproofing
    - All types of low and steep sloped roofing
  - Commissioning BECx
    - OPR/BOD/Commissioning Plan
- Mechanical/HVAC Systems
  - HVAC design
  - Plumbing systems
  - Commissioning and testing

ABBAE Core Services

- Consulting and third-party peer review services
- Engineer of record for building envelope systems
- Contract administration services
- Inspection services (usually direct with owner)
- Air and water performance testing
- Mock-up design, observation, and testing
- Building assessments and forensic investigations
- Litigation support and expert witness services
- Educational seminars with AIA credits

Seminar Objectives

- Fundamental Issues About Sustainability
- Making good Choices for Roofing and Waterproofing Systems
  - Case Study of Single Ply Roofing
  - Podium and planter waterproofing
  - Balconies, lanais, breezeway waterproofing
- Understanding the big picture
- Roofs can last over 30 years, but most don’t
- Understanding sustainability, life cycle costing, making design decisions
- Construction Defect Basics

Building Envelope Issues to Consider

- Warranties and Guarantees:
- Life expectancy:
- Reliability: Proven track record
- Sustainability: System's ability to handle foot traffic, hail, sun, rain , wind, root damage, heat, etc.
- Initial Cost:
- Maintenance Cost:

Written warranties, per RCI:

- Warranties can provide peace of mind

- They do not replace :
  - Sound design
  - Good materials
  - Quality workmanship
  - Proper maintenance

Express Warranty

- Words Warranty & Guarantee are generally interchangeable
- Term of warranty are generally stated
- An agreement usually requiring owners signature
- Warranty generally requires that application meets material manufacturer's *published* requirements
- Does not include consequential damage
- May not include overburden cost
- May be limited to materials only
- May depreciate in value over time

Contractor Responsibility for Defective Construction

- If a 20 year type roofing system needs “repairs” other than true maintenance for repairs.
- If 10 year sealant types need replacement or fail in less than their life expectancy.
- If windows leak in fewer than 10 years.
- If other materials that do not last their normally expected lives, and fail within the first 10 years

Who Pays for Damage From Leaks

- If damage occurs within the statue of limitation, contractor's insurance company is generally liable for costs to fix damage.
- "Completed Operations" portion of the insurance coverage kicks-in.
- Even if contractor goes out of business, insurance company may be on the hook.

Express Warranty

- An agreement usually requiring owners signature
- Words Warranty & Guarantee are generally interchangeable
- Some attorneys interpret warranties as a new contract, superseding statutes
- Warranty generally requires that application meets material manufacturer's *published* requirements
- Does not include consequential damage or may not include overburden cost
- May be limited to materials only and may depreciate in value over time

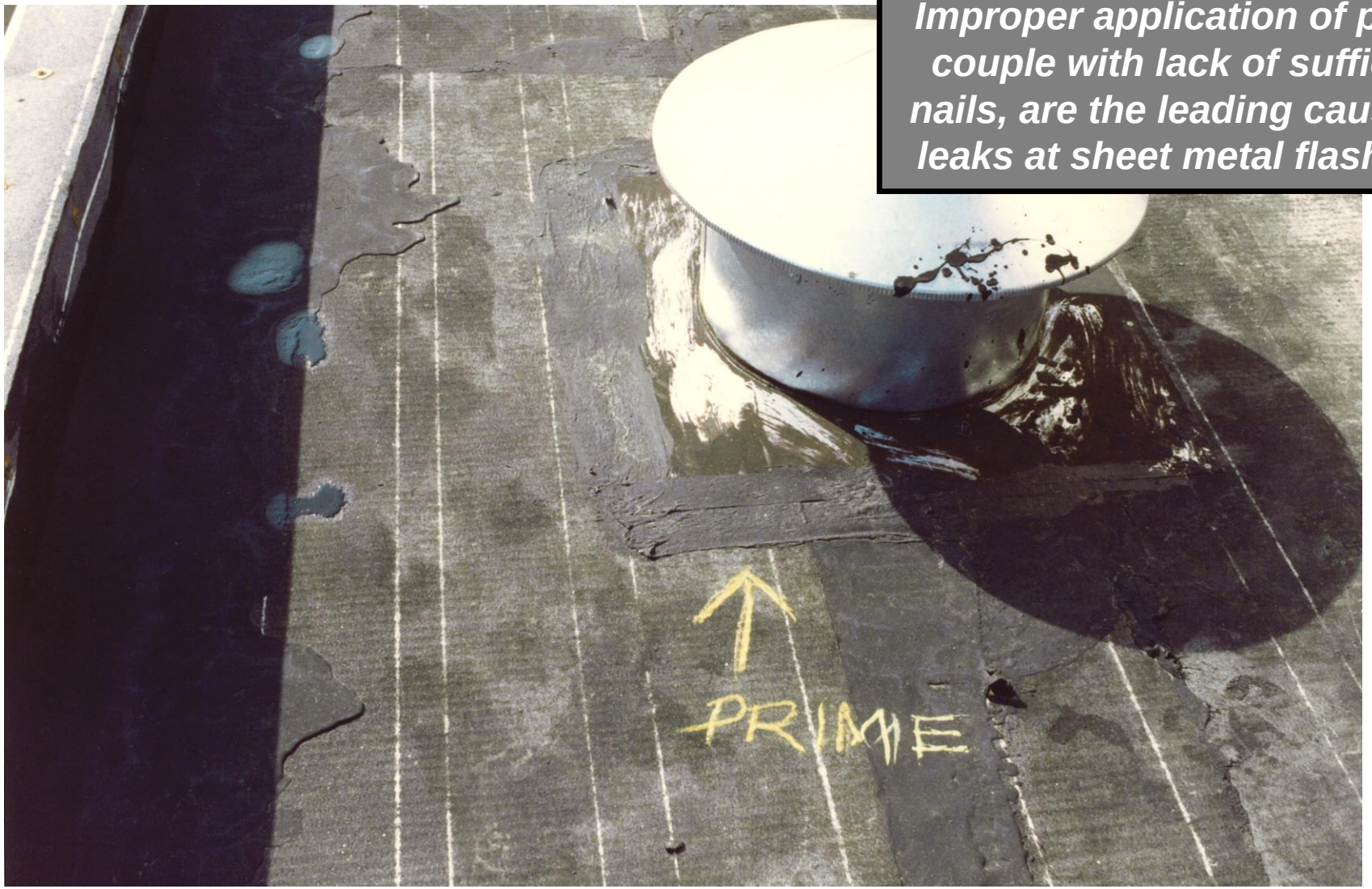
Implied Warranty

- Implied Warranty is not a written warranty
- Most States allow for a 10 year statue of limitation for defective construction (even re-roofing)
- Most States have a 4 year statue for contractual liability
- Most States have a 4 year statue for obvious or “patent” defects
- Most States have a 3 year Statue for hidden for “latent” defects, if the “latent” defect becomes “patent”

Roofing

- Examples of Common Mistakes
  - Single Ply Case Study

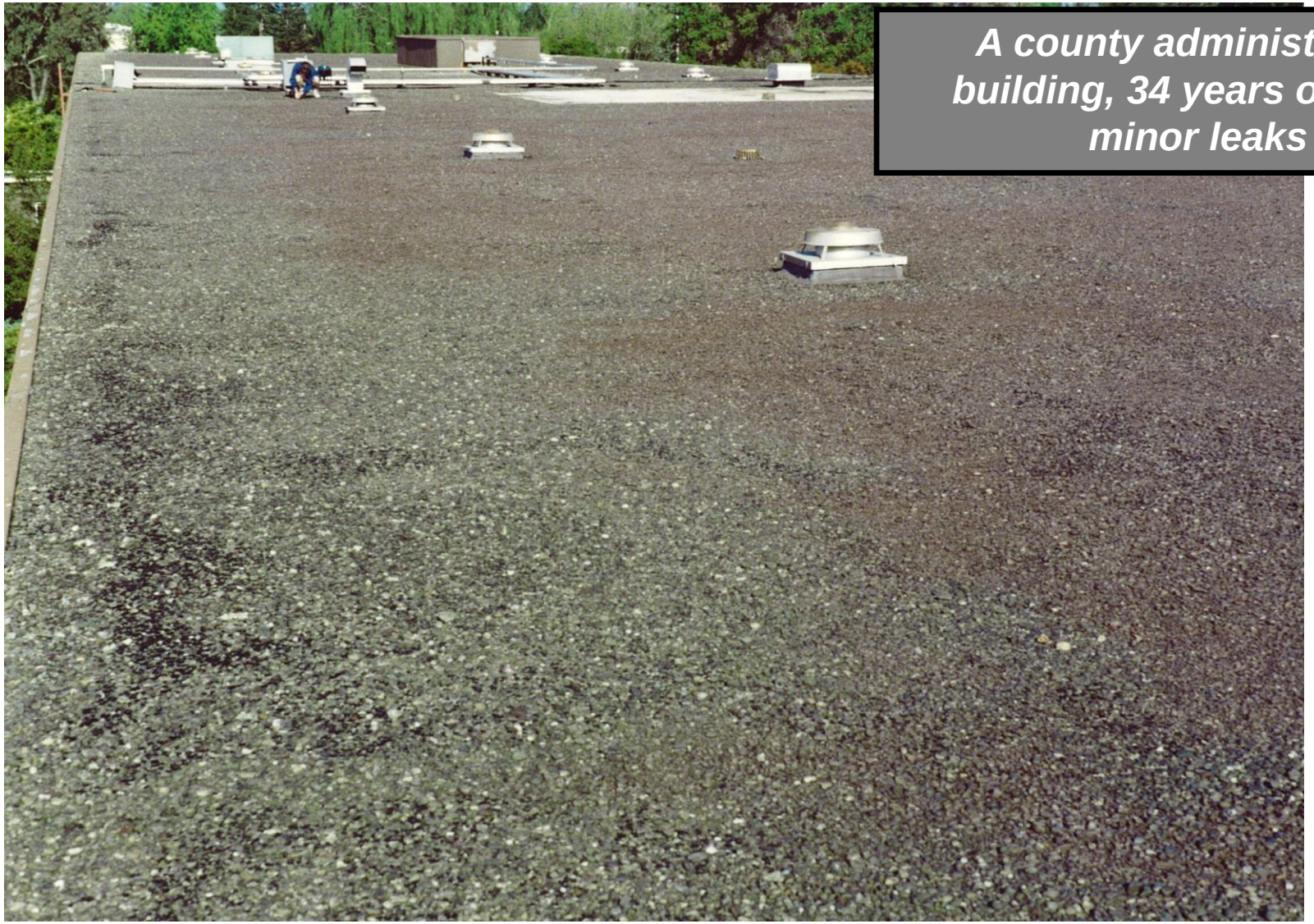
Lack of brooming and improper asphalt temperature causes voids and poor saturation of roof plies.



Improper application of primer couple with lack of sufficient nails, are the leading causes of leaks at sheet metal flashings.

Flashing at 34 year old roof is splitting, due to improper workmanship (fastening)

Same type of flashing, upon close examination of the edge flashing joint of a 32 year old roof shows no sign of splitting. Reason?



A county administrative building, 34 years old, two minor leaks

Roof Defects: *Whose Responsibility?*

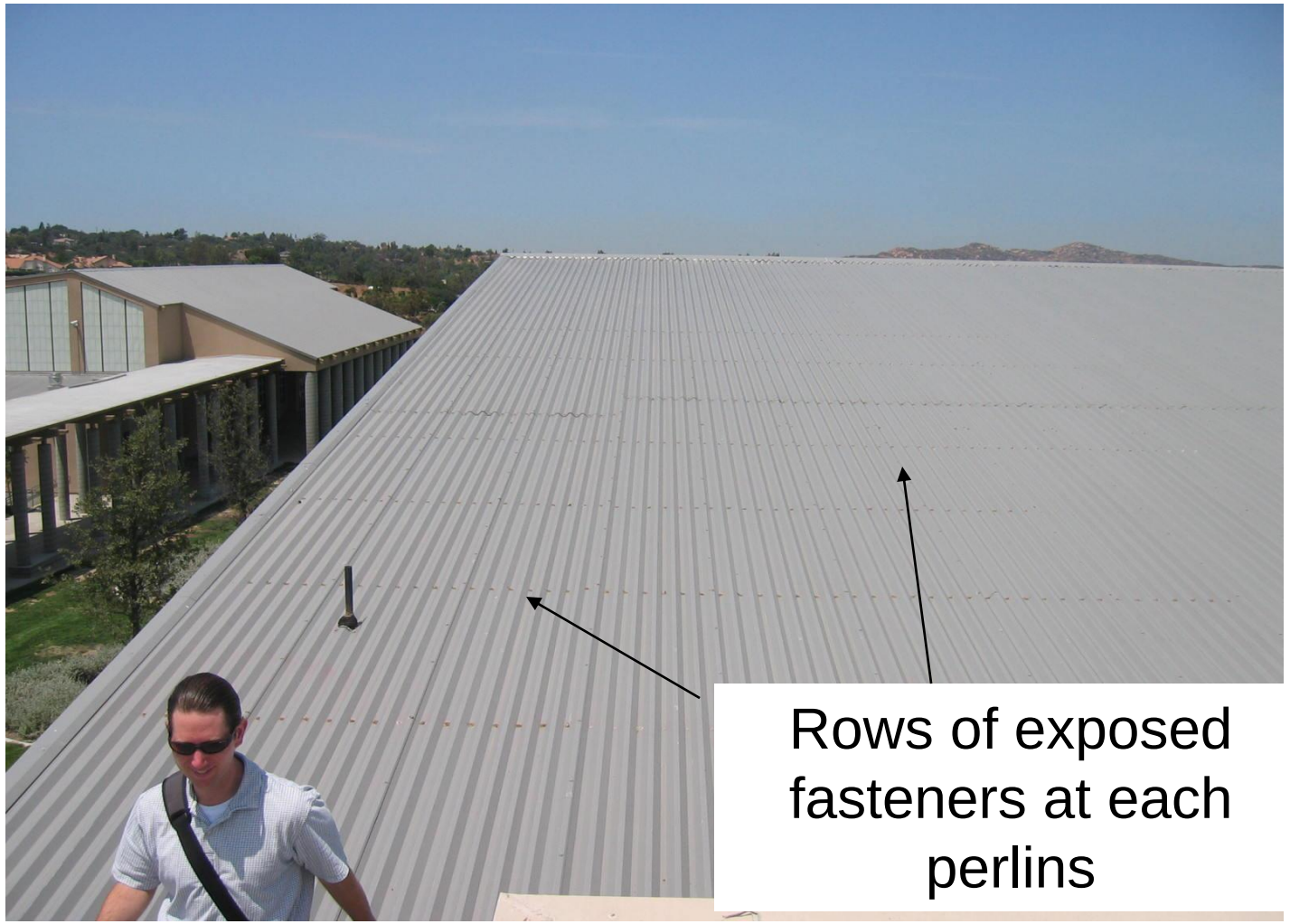
Crickets are undersized in some locations, or not provided at all. Need to be deeper and redesigned. Note deterioration.

A very expensive roof at a major west coast university, failing after only five years. Installation by large company

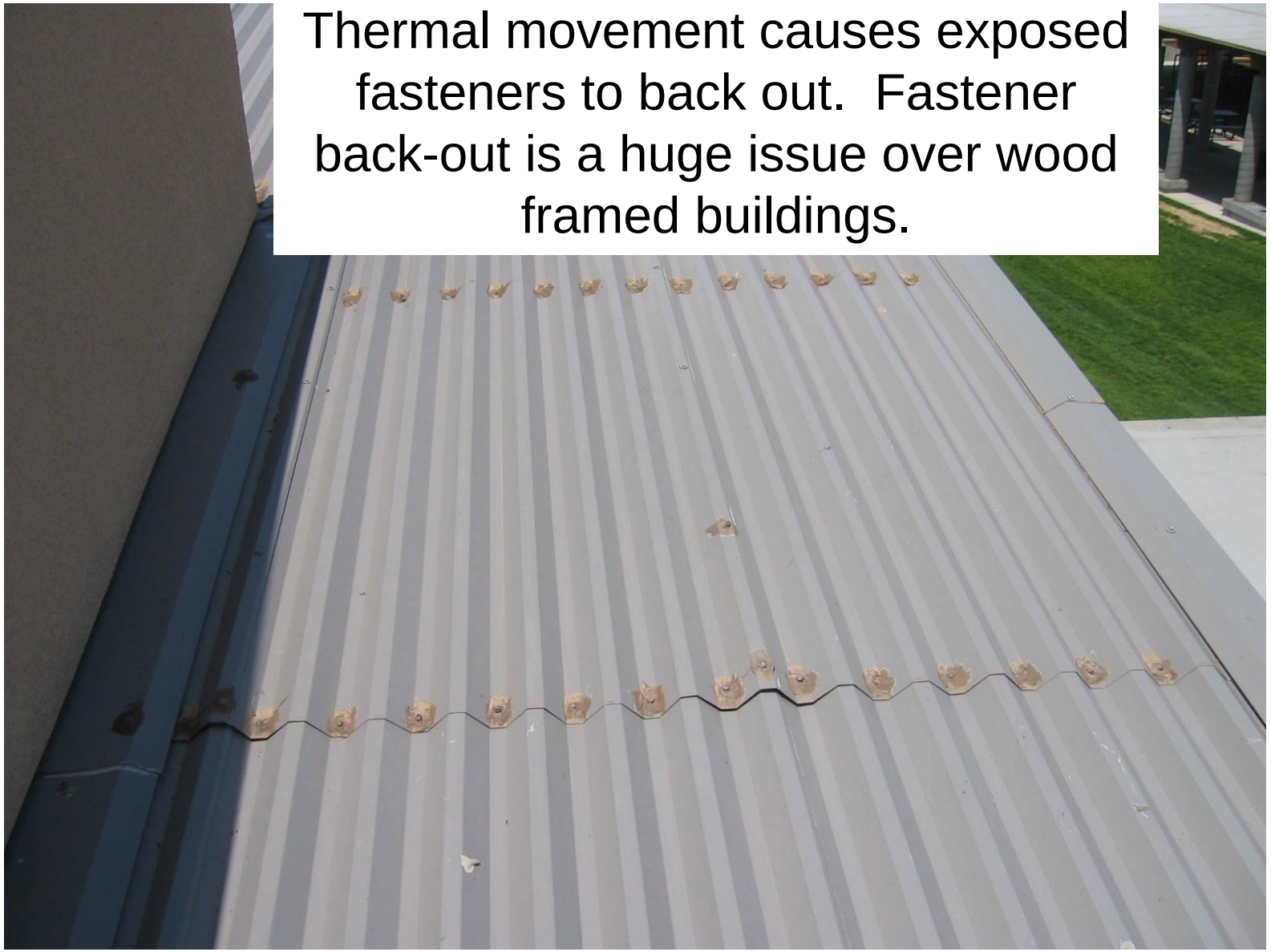
Inappropriate fasteners, poorly secured insulation boards, resulted in cupping of boards and ridging.

Agricultural/Industrial Metal Roofing

- Roof is not perfectly water tight!
- Does not accommodate thermal movement



Thermal movement causes exposed fasteners to back out. Fastener back-out is a huge issue over wood framed buildings.

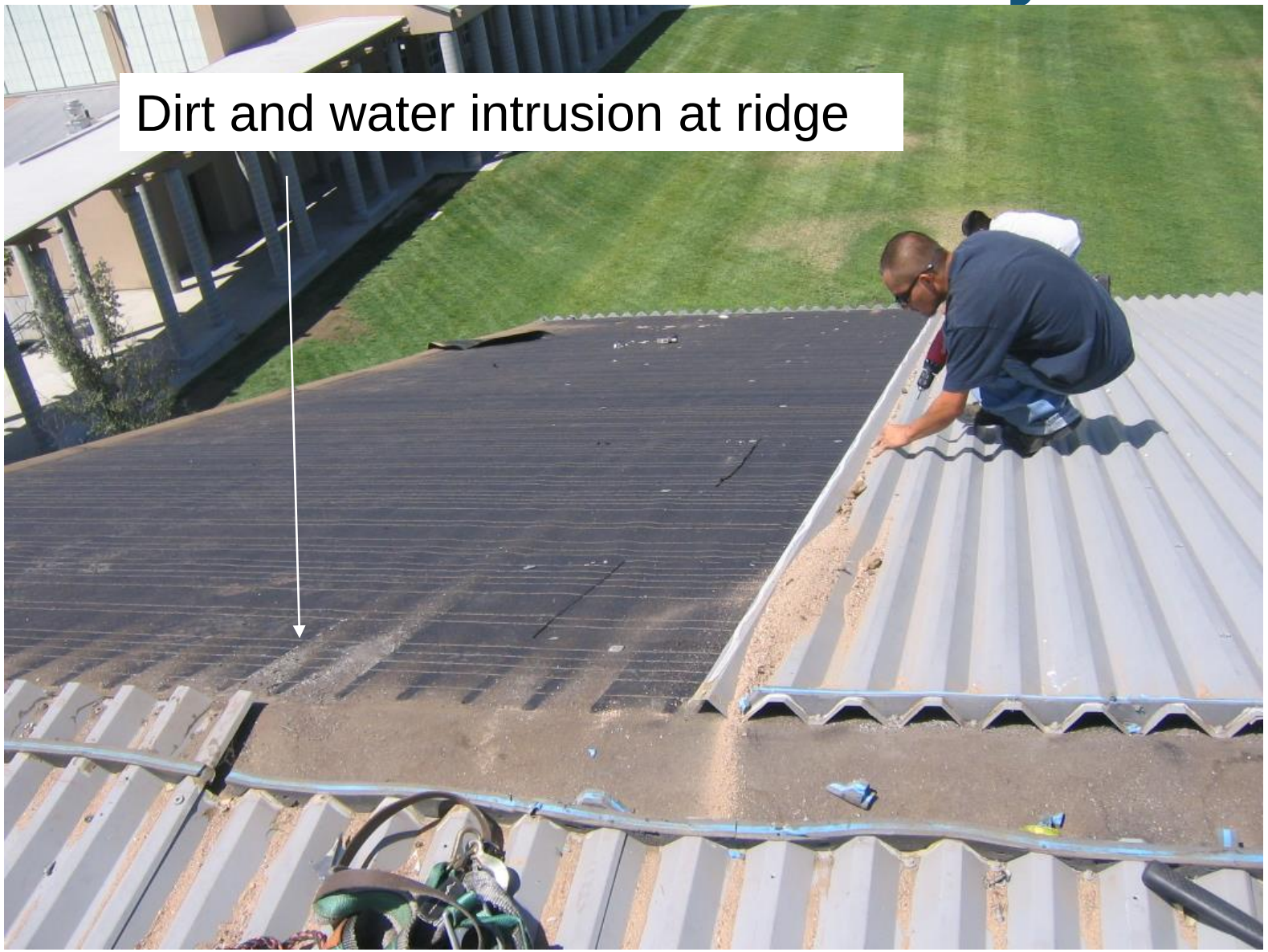


Water Test for Exposed Fastener Leakage

Fastener Leaks

LEAKING RIDGE CAP

Traditional Felt Underlayment



Roofing

- Roof Common Defects
- Case Studies
- Examples of Good Design
- Roofing Design Philosophy

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OVERVIEW

- Roofs can, and should, last 30 years or more – *but many do not even come close!*
- Today's presentation – analyze premature failures, either due to construction or design defect
- Provide lessons learned from forensic evaluation of roof performance
- Provide lessons learned about single ply roofs and their sustainability

Case Study: 18 Year Old PVC Single Ply Roof

Case Overview

- Large department store in Northern California
- Eighteen years old
- No repairs, no leaks, no problem?
- Purpose of the investigation: Determine longevity of single ply
- We were with a team of other skeptical consultants

Forensic Methodology

- Visual inspection to observe performance of system for sustainability
- Limited destructive testing
- Laboratory testing of samples to compare between original membrane and aged membrane

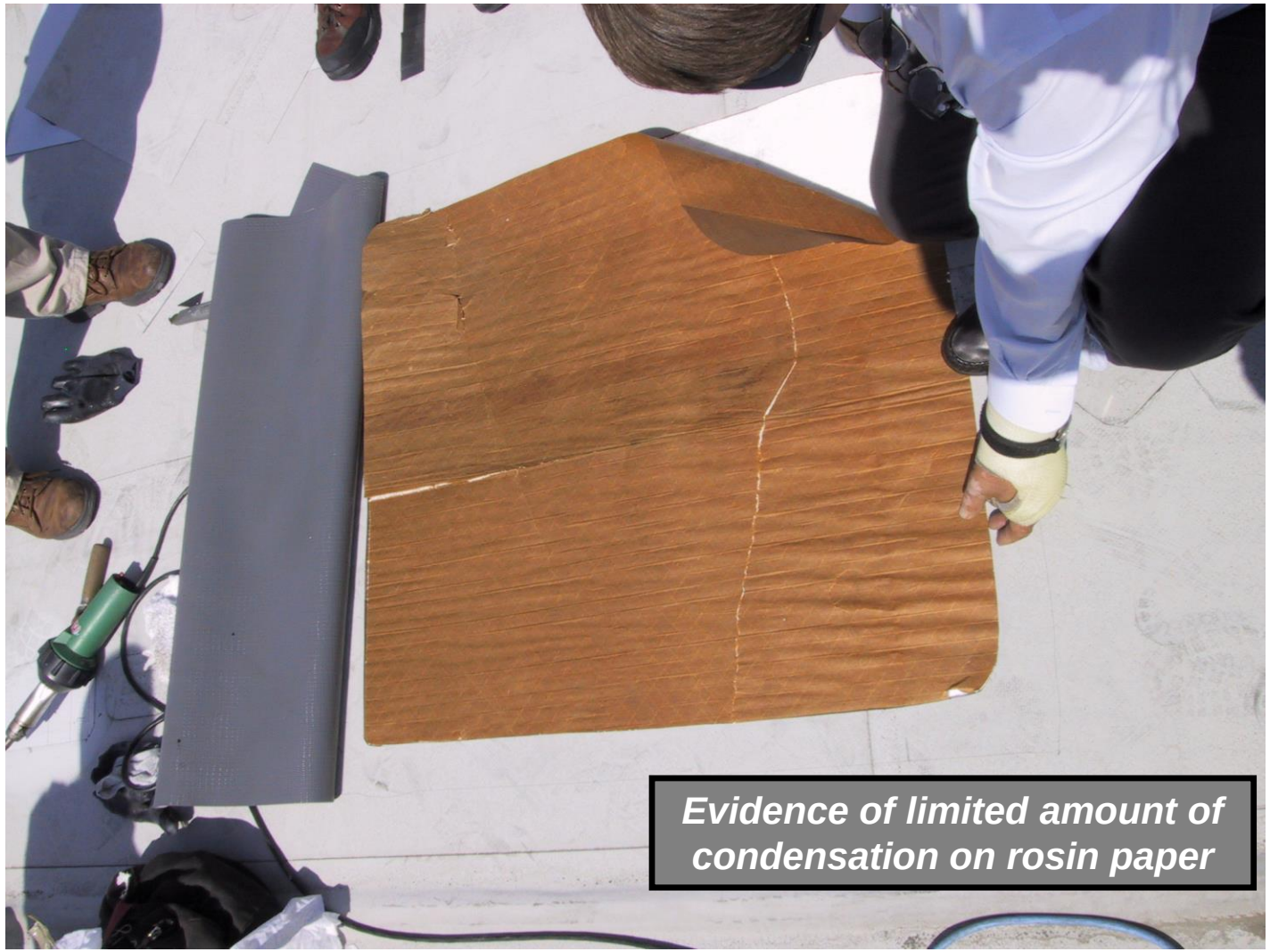
Sustainability Checklist

- Roof system's ability to handle foot traffic and impact damage
- Membrane's ability to handle ponding water and condensate
- Membrane's ability to be patched and repaired
- Membrane's physical properties, tensile strength, thickness, bend test, etc.

Sustainability Checklist Continued….

- Was roof system sustainable for type of use (retail store)?
- Was original design of the roof system adequate for its intended use?
- Was original application (construction) installed per manufacturer’s requirements?

Test Cut Analysis

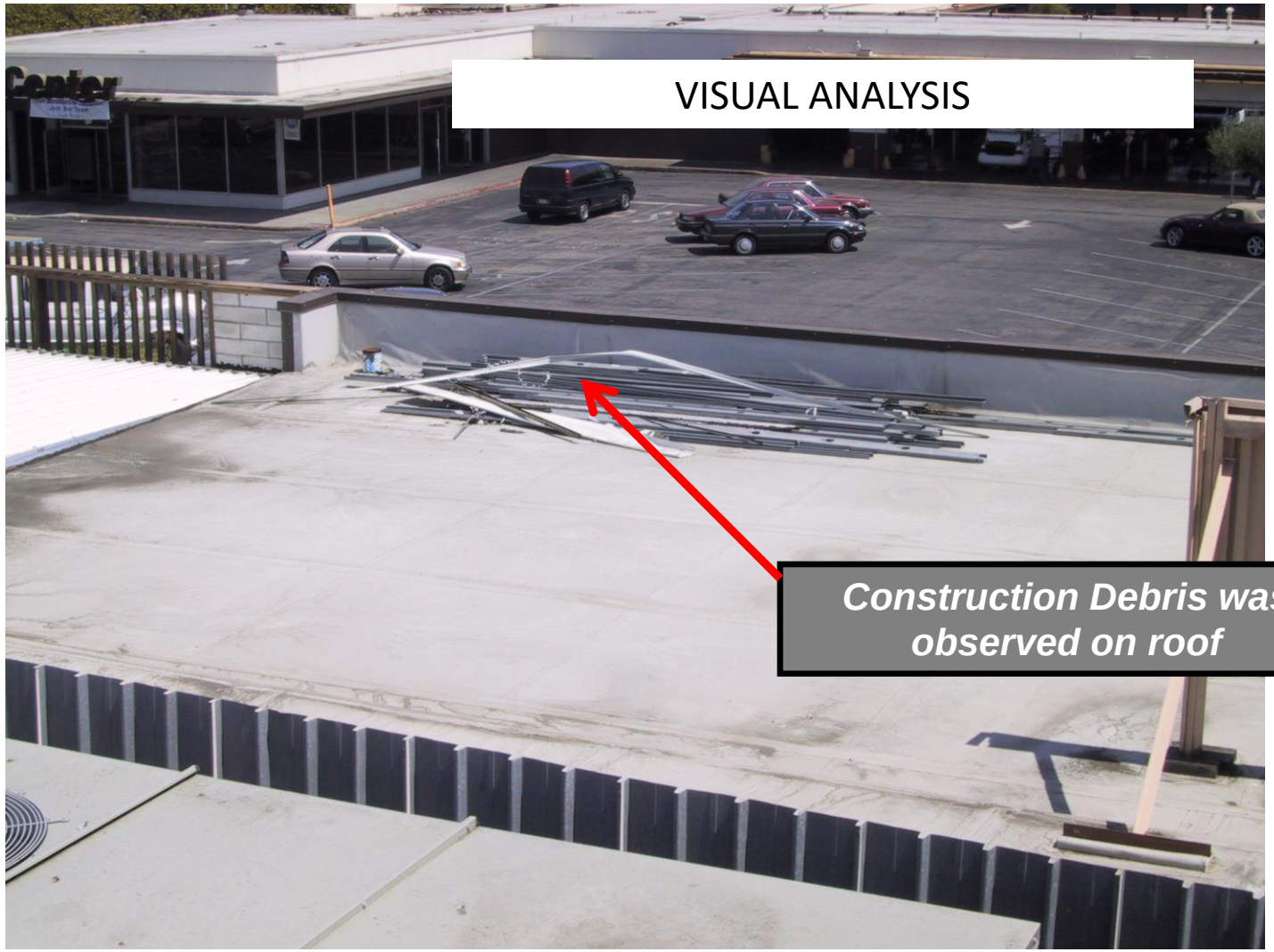


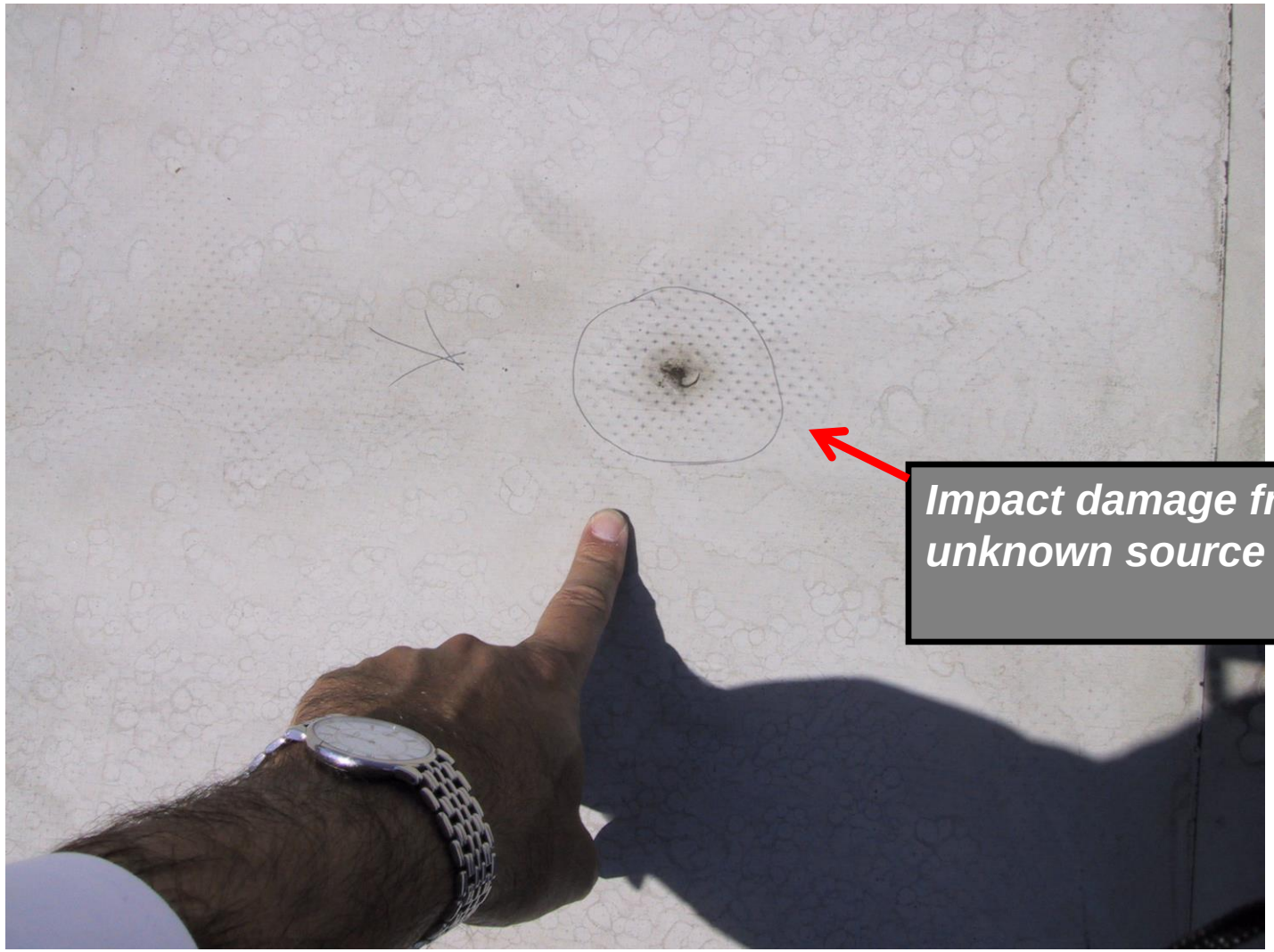
Mechanical bar fastener in excellent condition

Laboratory Test of this 18 year old single ply

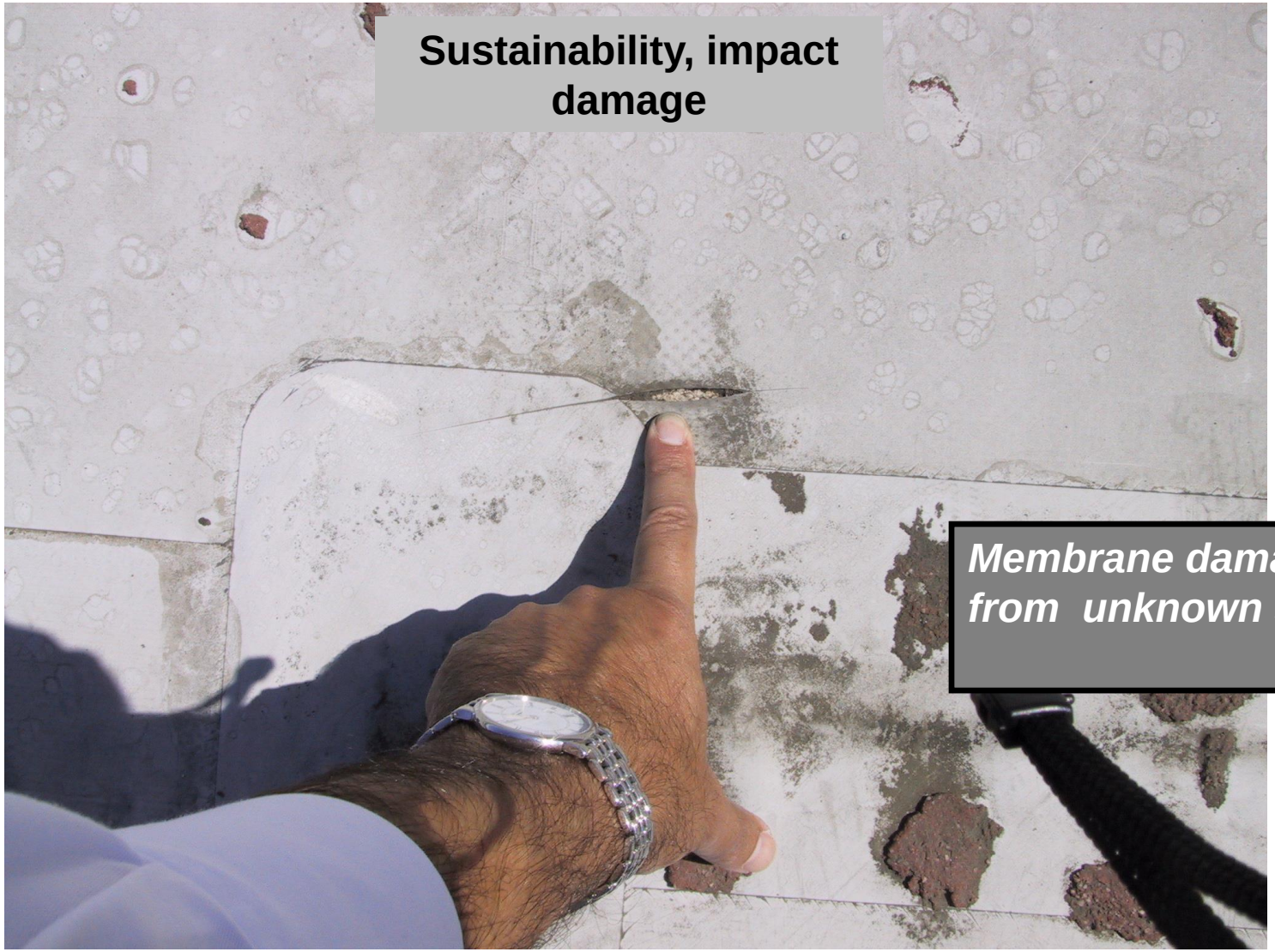
- Samples tested for thickness, tensile strength, elongation, dimensional change, seam strength.
- 95%+ samples met original membrane test results

VISUAL ANALYSIS





Sustainability, impact damage



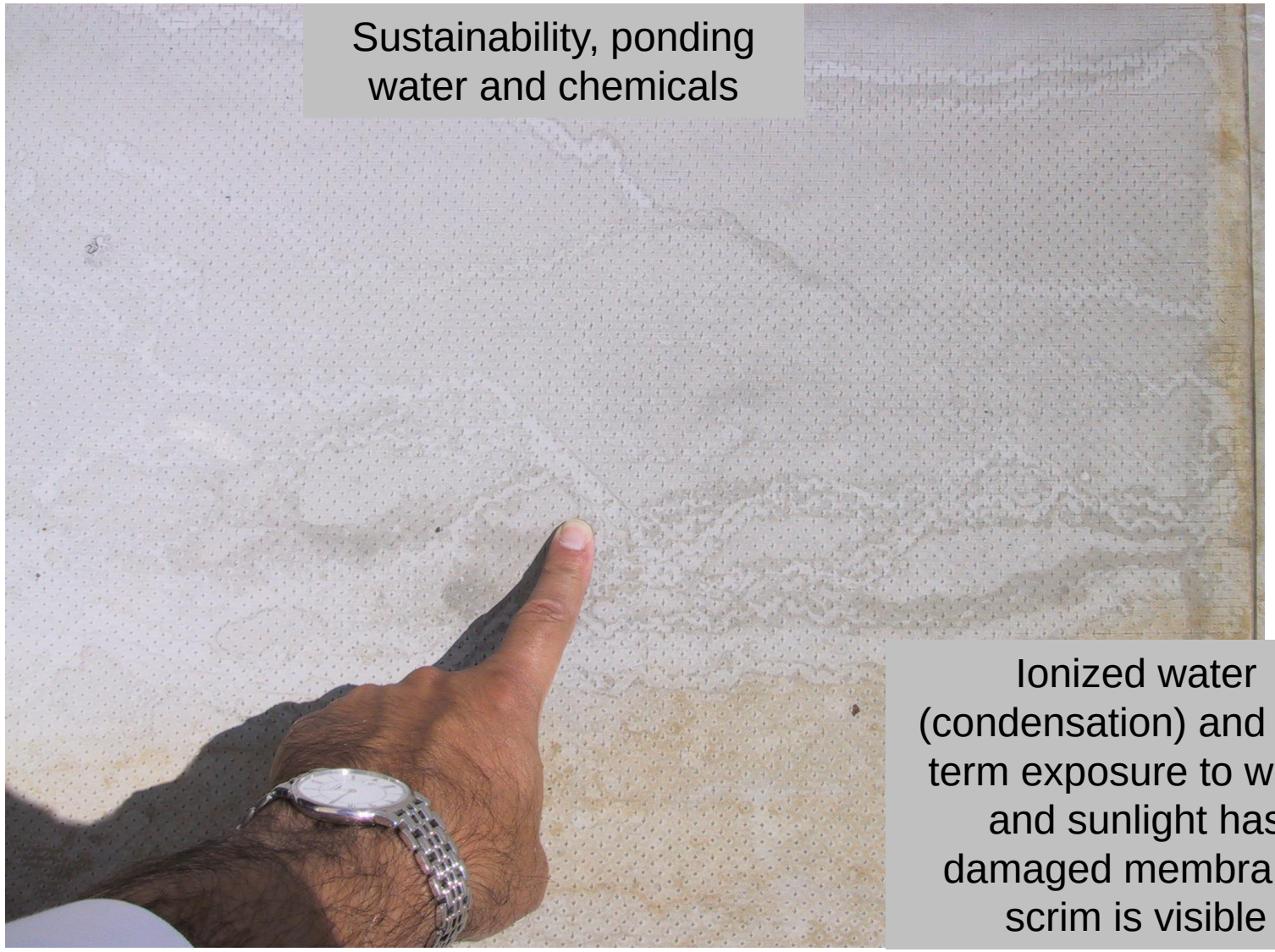
Membrane damage from unknown source

Tenant Improvement Work

New electrical pipe added, pipe jack set in mastic (not properly flashed with single ply) and wood block set in mastic (incompatible with PVC)

Cooling tower and condensate water leaking over roof

Sustainability, ponding water and chemicals



Ionized water (condensation) and long term exposure to water and sunlight has damaged membrane, scrim is visible

Sustainability Score

- MEMBRANE MATERIAL
  - Field areas of membrane performance good/excellent 20+ years
  - Easy to patch
- TRAFFIC AND IMPACT DAMAGE
  - Susceptible from impact damage
  - Damage easy to identify and repair

Sustainability Score

- 3.DESIGN
  - Original poor design of pipe supports caused damage
  - Poor design of roof drainage caused ponding water and damage
  - Poor design of condensation control mechanism caused damage

Sustainability Score

- MAINTENANCE
  - Lack of frequent inspection
  - Lack of proper roof protection during remodel construction
  - Lack of proper maintenance of HVAC equipment damaged the roof
  - New pipe penetrations not properly flashed (use of asphalt mastic)

Lessons Learned (Single Ply)

- Sustainability depends on many factors
- Membrane's ability to handle normal exposure to sun, rain and elements.
- In 20+ years, expect the roof to go through many different challenges
- When designing a roof, consider, building may undergo remodel, HVAC replacement, new electrical addition, etc.
- Impact of original design defects
- Owner's lack of frequent inspections, timely repairs, and use of proper patching techniques.

Balcony, Breezeway and Landing Waterproofing

Breezeway Split Slab

Pinnacle Crow Canyon

Walkway to wall, transition lacks proper flashing

Walkways and Plazas

Walkways and Plazas

- “L Flashing was improperly used in BUR Assembly
- Flashing was not primed, lack of adhesion
- Flashing was not soldered or sealed properly

Typical Garden Style Multi-family

- Exterior walls consist of Western 1 coat stucco over 2 layers of building paper

Landings

Typical landings and breezeways have concrete topping slab (wearing surface) and do not require any maintenance. Note: leak damage is not patent.

Project

Landings and breezeways are plywood, W.R. Grace, Procor waterproofing and concrete topping.
Damage from leaks is not obvious

Leaks at Stringer, Waterproofing, Sheet Metal Stucco

Leaks from multiple Sources

Edge Metal Joins Leak

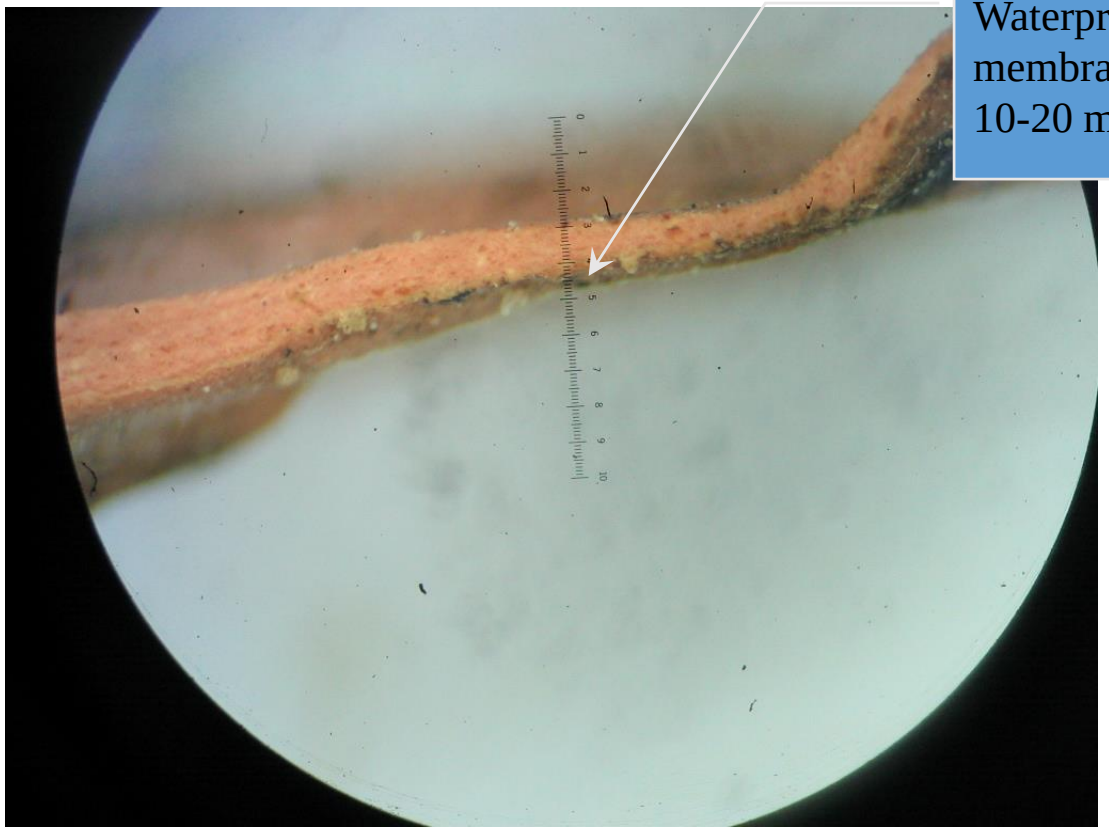
Concrete Edge Form/Waterproofing Flashing

Use Separate Waterproofing Metal Edge

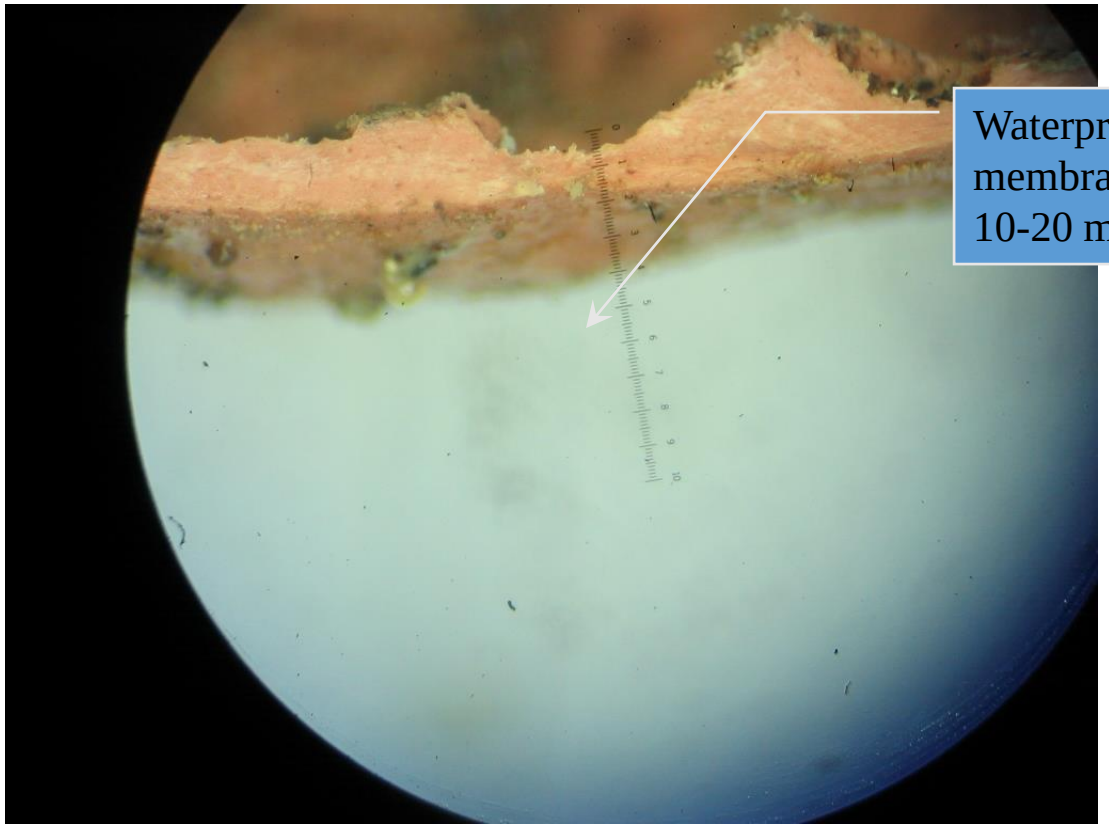
Balcony Scupper Rusting in 3 Years

Breezeway-Unit 325 (Membrane too thin)

Common Defect: Membrane Too Thin

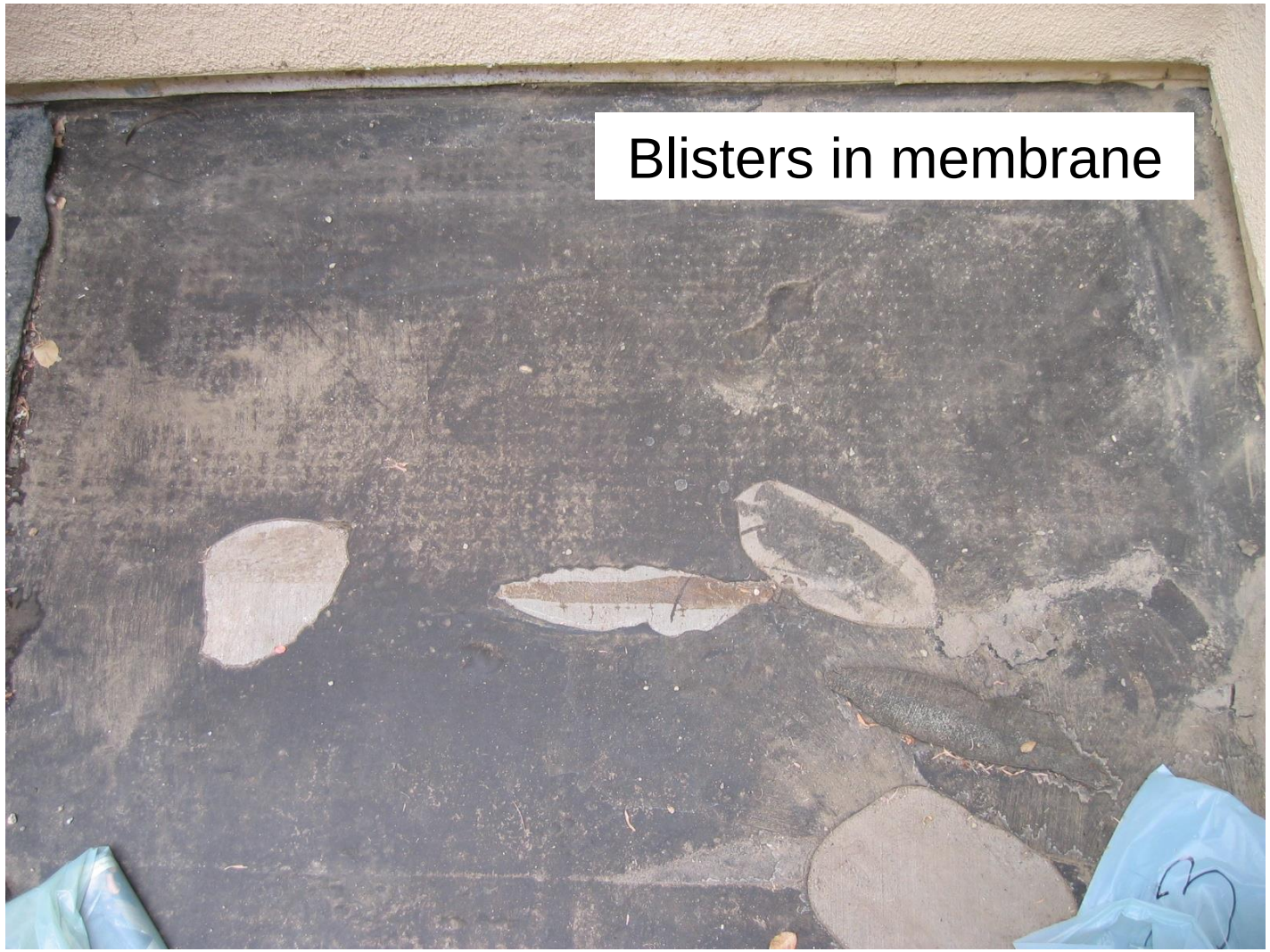


Irregular Thickness of Waterproofing Membrane



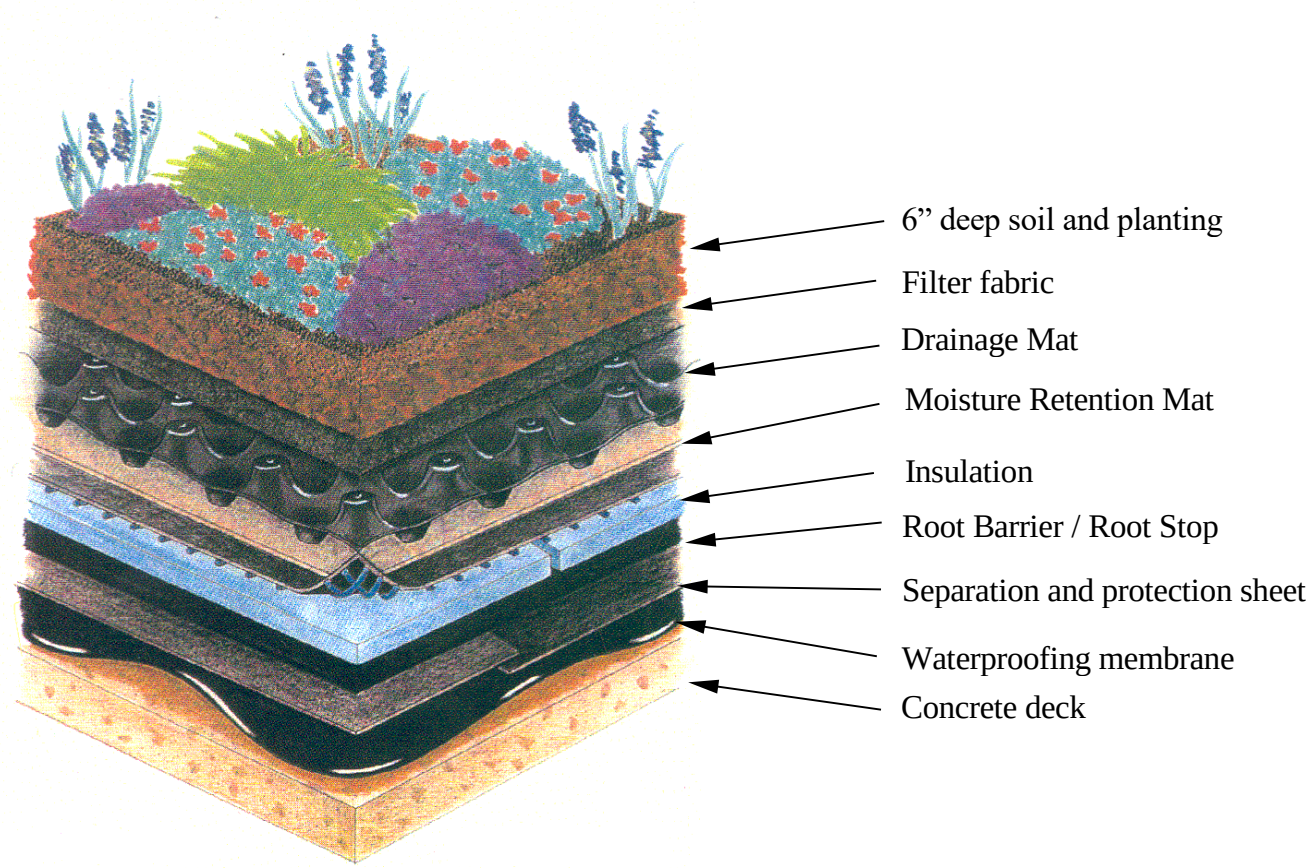
Podium, Pavers, and Planter Waterproofing

Podium with Pavers



Walkways and Plazas

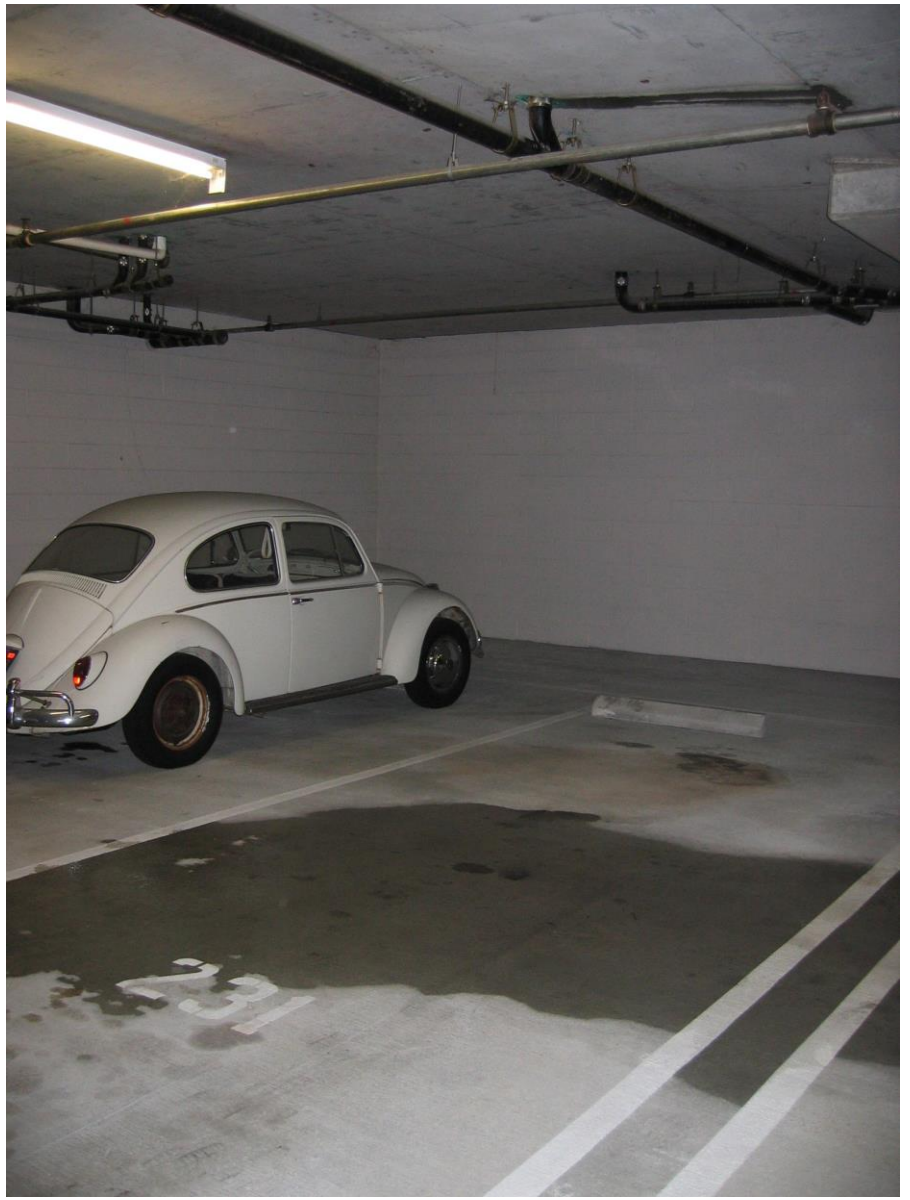
PLANTER OR GARDEN ROOF: Typical Pieces



Typical cross section of Green Roof

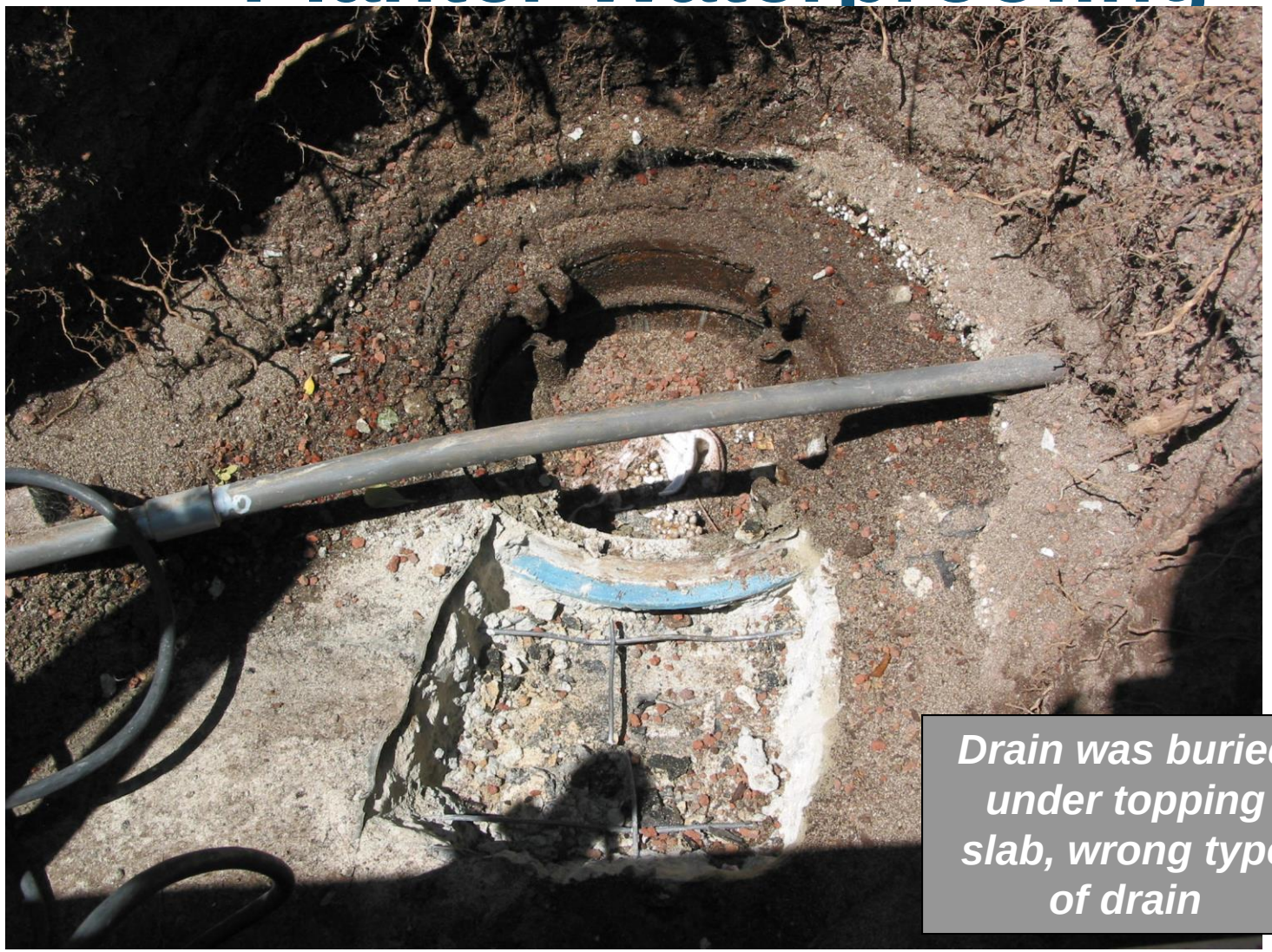
Post Tensioned Concrete Podium over Parking

Typical Podium and Planter Leaks



Podium Waterproofing

Planter Waterproofing



Water Filled Blister

Planter Waterproofing

Planter Waterproofing

Water Filled Blisters Due to osmotic action

THANK YOU!