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Horizontal Above Grade Waterproofing

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Horizontal Waterproofing Systems

- **Typical Configurations**
- **Life Expectancy of such systems**
- **Drainage, Protection, Insulation**
- **Forensic Learning**
  - Membrane issues
  - Configuration issues
  - Slope issues
  - Drainage issues
  - Flashing issues

Life Expectancies of Horizontal Waterproofing

- **Trafficable Waterproofing Systems:**
  - Polyurethane Deck Coatings (10 – 20 years with 4-5 year recoat)
  - Poly Methyl Methacrylate (PMMA 20-40 Years with 10-20 year recoat)
  - Acrylic Deck Coatings (5-10 years with 3-5 year recoat cycle)
  - Lath reinforced Polymer Modified Cement based systems (10 to 20 years with recoat every 3-5 years)

- **Concealed & Protected Systems:**

  (Overburden with concrete topping, pavers, planters, etc.)
  - Reinforced Hot Rubberized Asphalt (50+ years)
  - Modified Bitumen (50+ Years)
  - Single ply membranes (50+ years)

Why Protected Assemblies Are Built For Life?

- Can have very expensive and elaborate over- burden such as, planters, trees, play equipment, pools, gazebos, etc.
- Integrated with exterior façade (walls) and entrance doors, storefronts, curtain wall, etc.
- Protected from UV and heat
- Protected from foot traffic and vehicular traffic
- High Replacement Cost:
  - **While waterproofing membrane can cost less than $10/foot, total repair cost can exceed $150/SF!**
- Major disruption to occupied buildings
- Loss of use – Abatement of rent or lease

Life Expectancies, Protected Assemblies

Life of the building – Typically 50+ years

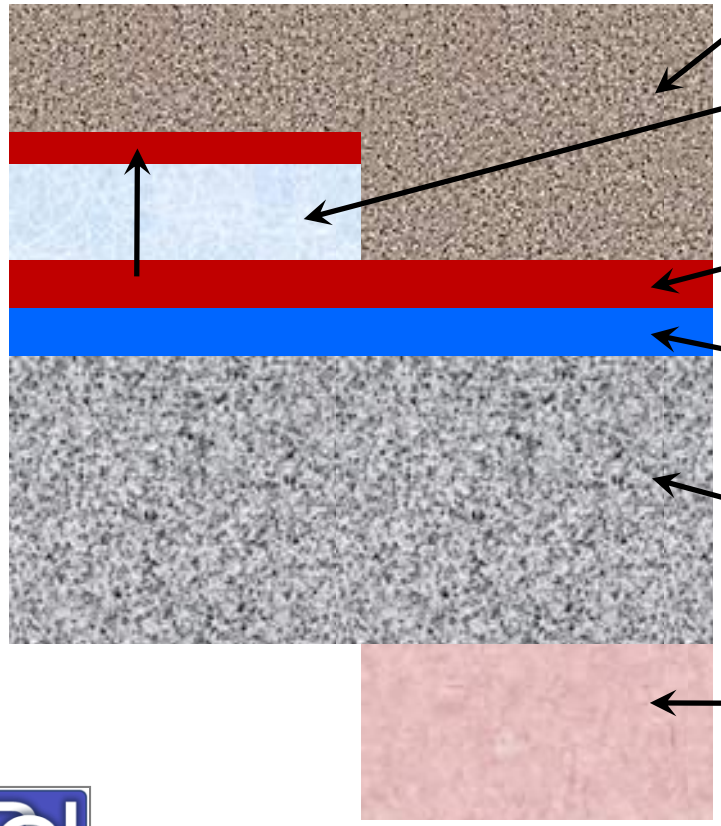
Post Tensioned Concrete Pool Decks

Complex Plaza Podium Decks

Why Protected Assemblies Are Built For Life?

These assemblies require extensive integration with permanent features

Split Slab



Concrete traffic surface

External insulation (optional)

Protection and drainage

Waterproofing membrane

Structural deck

Internal insulation (optional)

Complexities and Cost of Tie-in at Curtain Wall

Repairing Asphalt Paving Over Steel Podium

Elevated Exterior Surfaces on Wood Framing

These assemblies require extensive integration with permanent features

Wood Decks – w/Concrete Walkways Surfaces

Complexities of Repairing Wood Walkways

Key Elements of Assemblies Built for Life

- **Selection of appropriate waterproofing membrane**
  - Deal with standing water
  - Flashing and integration with doors and façade
  - Permeability of membrane (Friend or foe?)
- **Selection of Flashings:**
  - Stainless steel or copper, as opposed to Galvanized
  - If Galvanized, protect further with waterproofing
  - Composition base flashings
  - Neoprene
- **Proper drainage**
  - Surface drainage
  - Sub-surface drainage
- **Proper protection:**
  - Construction traffic damage
  - Trees and roots
  - Freeze/thaw
  - UV damage during construction

Structural Substrates

- Steel
- Concrete
- Wood

Concrete Structural Decks

- Readily capable of heavy deck loads
- Post tensioned best option as least likely to develop cracks
- Normal or lightweight structural types available (not LIC)
- Reduce cracking with W:C ratios of less than 0.4 and added top rebar
- Largest number of waterproofing options
- Obtain slope using structural concrete
- Typically the **best** substrate

Leaks Through Concrete Create Slower Damage

Steel Structural Decks

- Requires mechanical attachment of a rigid overlay or concrete to receive waterproofing
- Required capacity uses deep structural members
- Fewer waterproofing system options
- Not frequently seen in plaza deck construction …unless…concrete filled
- Generally require fireproofing from undersides
- Leaks more readily damage steel deck and framing

Steel Deck – Leaks Can Rust Steel More Readily

Wood Structural Decks

- Typical for elevated assemblies like elevated exterior walkways and rooftop recreational areas
- Elevated walking surfaces, stair landings and other common areas on Type V construction
- Restricted to lighter residential decks
- Fewer waterproofing system options
- Less forgiving than structural concrete
- Generally require sheet metal type flashings

Leaks Through Wood Can Cause Severe Damage

Forensic Learning

Study of Failures caused by:

- **Waterproofing membrane issues:**
  - Fluid applied membranes
  - Osmosis and Permeability issues
  - Swelling due to standing water
  - Membrane adhesion issues
- **Failures due to drainage issues:**
  - Topping slab/material slope issues
  - Sub-slab drainage issues with
    - Pavers
    - Topping slabs
    - Planters
  - Drains and Overflows
    - Clogged weep holes
    - Improper selection for membrane
- **Membrane integration issues with:**
  - Walls, edge metal (conform flashings) and doors
  - Planters

Drainage Issues

Waterproofing Drainage

- Is drainage required “under” the waterproofing membrane or only in topping material?
- Code classifies all such assemblies as “roofs”
- 2012 IBC: Section 1507
  - **All noted low slope roof systems must have minimum 2% slope (1/4”/foot)**

- Code classifies…plaza balconies and garden decks as roof assemblies

Waterproofing Drainage

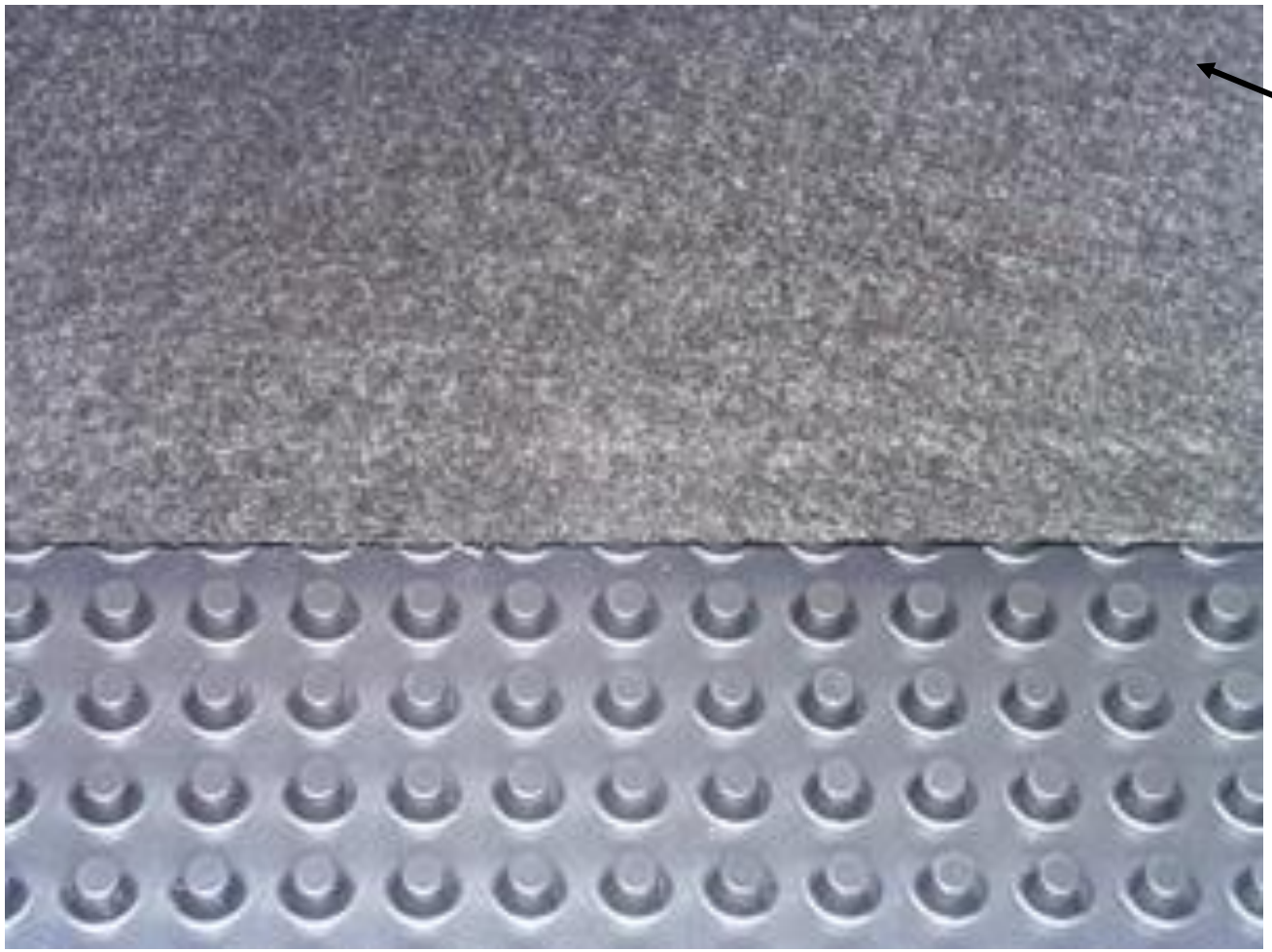
- **Slope best achieved in structural deck**
  - **Permanent feature of building**
  - **Roofer not responsible for adding slope**
- **Concrete deck easiest to achieve slope**
  - **Slope can be cast into deck surface**
  - **Easier to resolve slopes for complex area geometry**
- **Don’t forget drain location layout**

Drainage Layers

- **Placed above the waterproofing layer**
  - **Conducts water to sub-drain**
  - **In conjunction with surface slope, prevents standing water on waterproofing membrane**
  - **Reduces hydrostatic head in assembly**

- **Plastic cores with filter fabric covering**
  - **High compressive strength**
  - **Filter fabric prevents fines from clogging drain path**
  - **Carefully select to match loading and traffic**

Drainage Board With Filter Fabric



Filter fabric is often used to protect the weep holes in sub-slab drain weeps. Plastic cores can be cut away leaving filter fabric available for wrapping drain weep holes

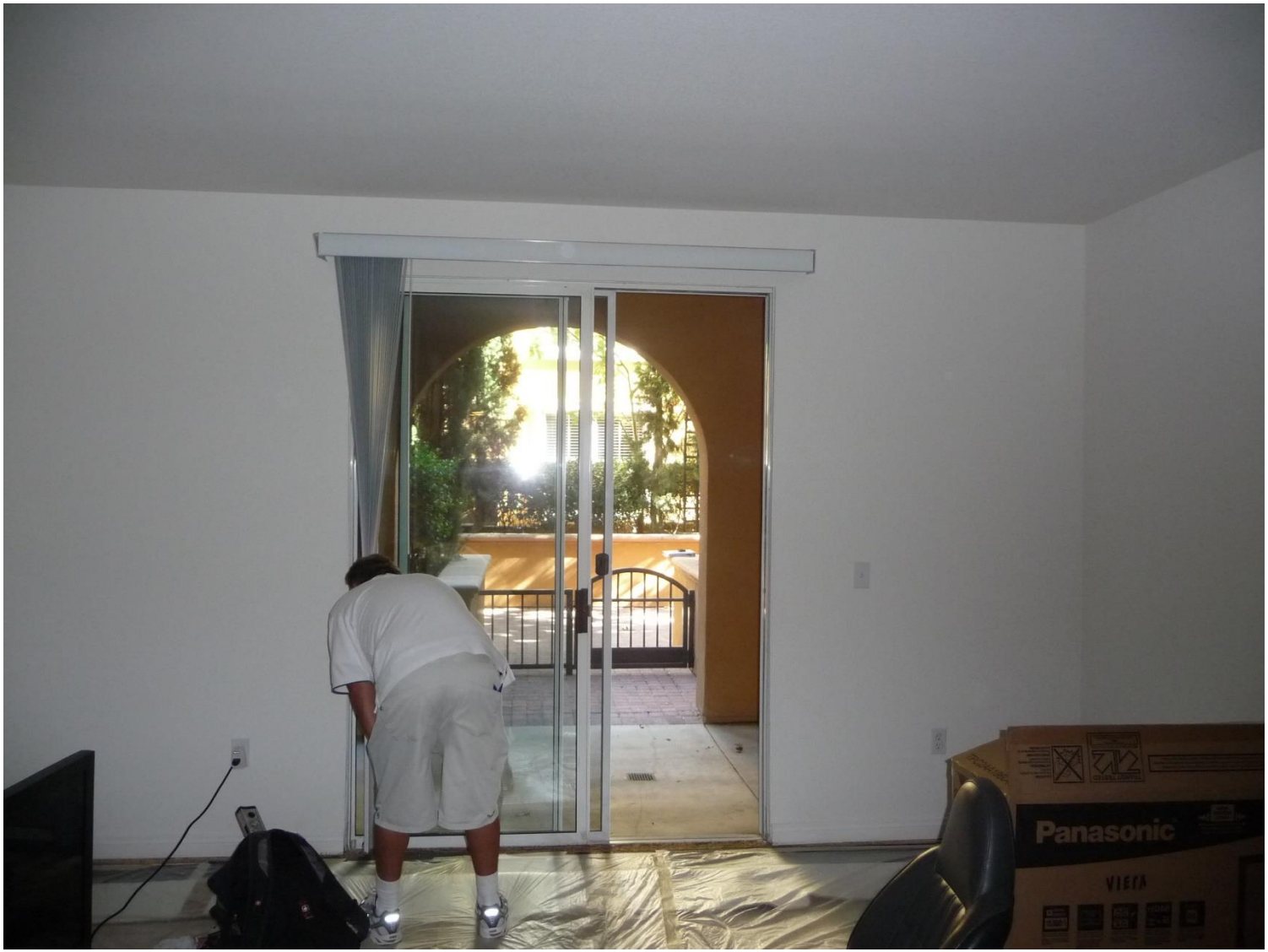
Drainage Issues
Case Study 1:
Importance of proper substrate slope

Case Study: Importance of Substrate Slope

Project Description

- Podium style Type V construction with 4 stories of wood framing over podium
- Post-tentioned concrete slab podium construction
- Sliding door well under an overhanging structure leaks

Case Study Drainage Issue



This sliding door was leaking deep under a recess

Case Study Podium Leaks

Existing Damage at carpet tack strip

Case Study: Importance of Substrate Slope

Investigation and Water Testing

- Water testing consisted of placing water on the topping slab approximately 20 feet away from the sliding door
- Water never placed against sliding glass door or building wall
- Water appeared at the face of the building wall and at the sliding glass door

Case Study Podium Leaks

Water test 20 feet away from sliding door

Case Study Podium Leaks Due To Drainage

Water never directly flowed to the door

Case Study Podium Leaks Due To Drainage

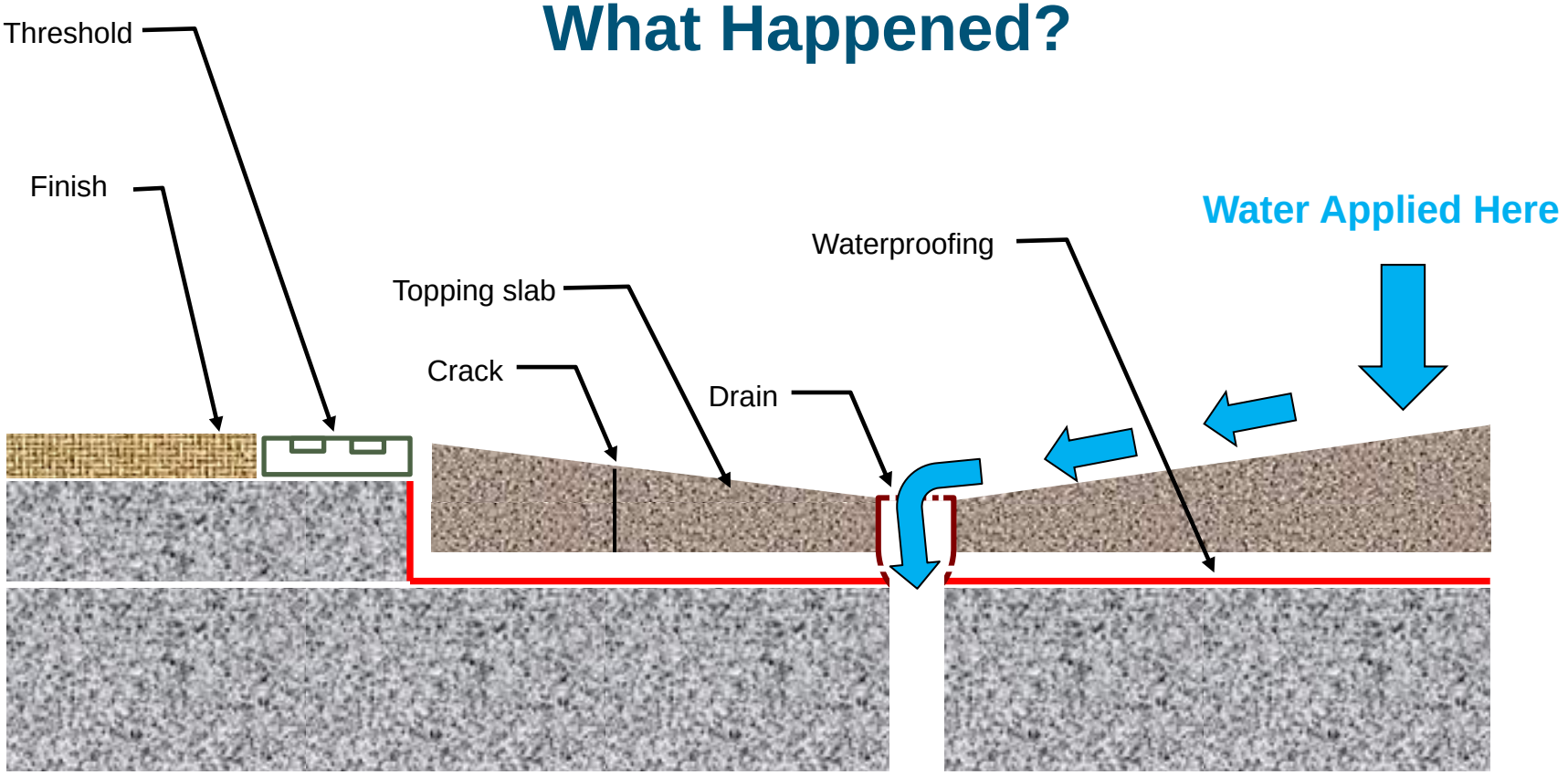
More and more water started to emerge from door jamb

Case Study Podium Leaks Due to Drainage Issue

Water started to emerge at the inside!!

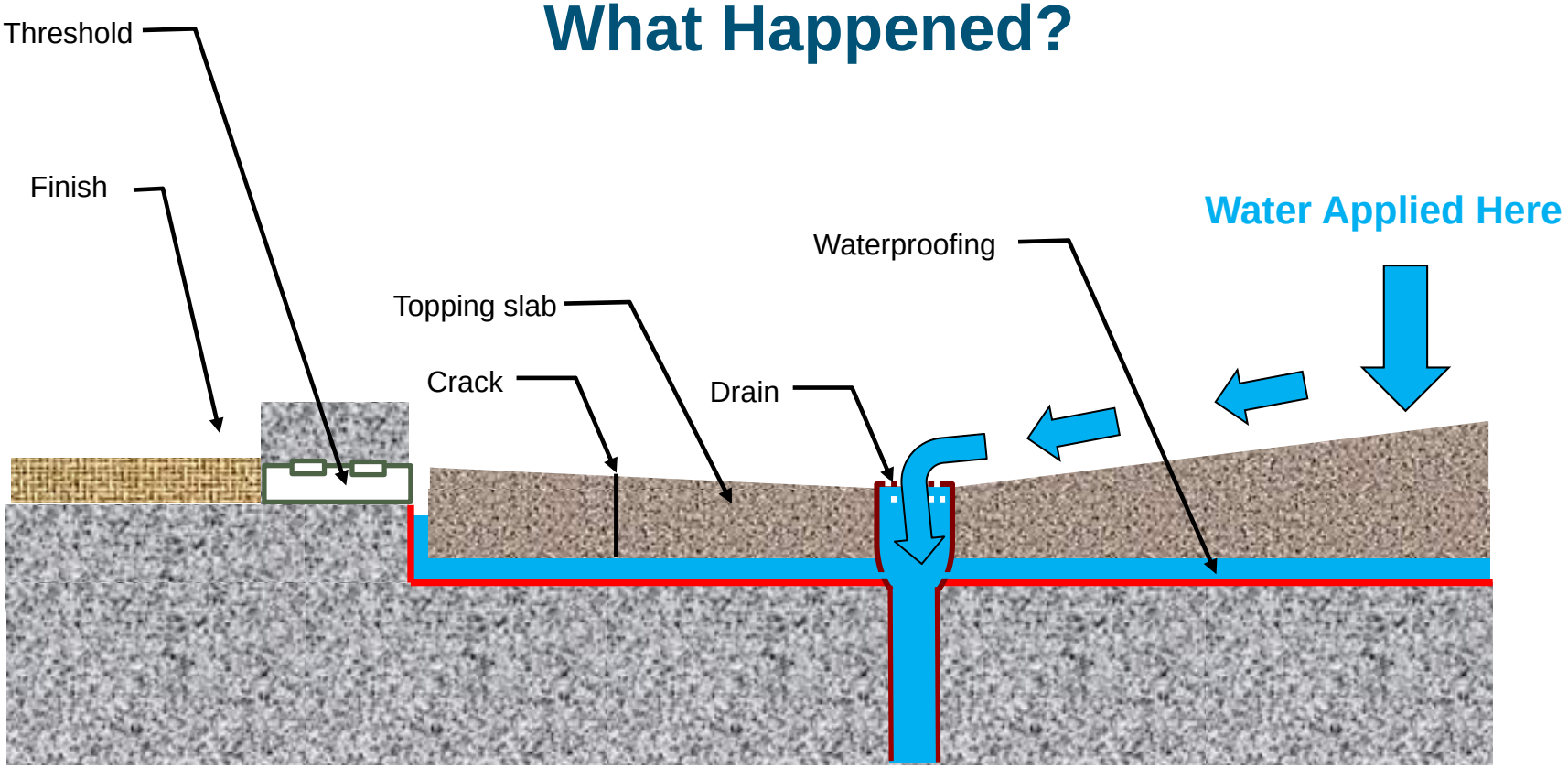
Case Study Podium Drainage Issue

What Happened?



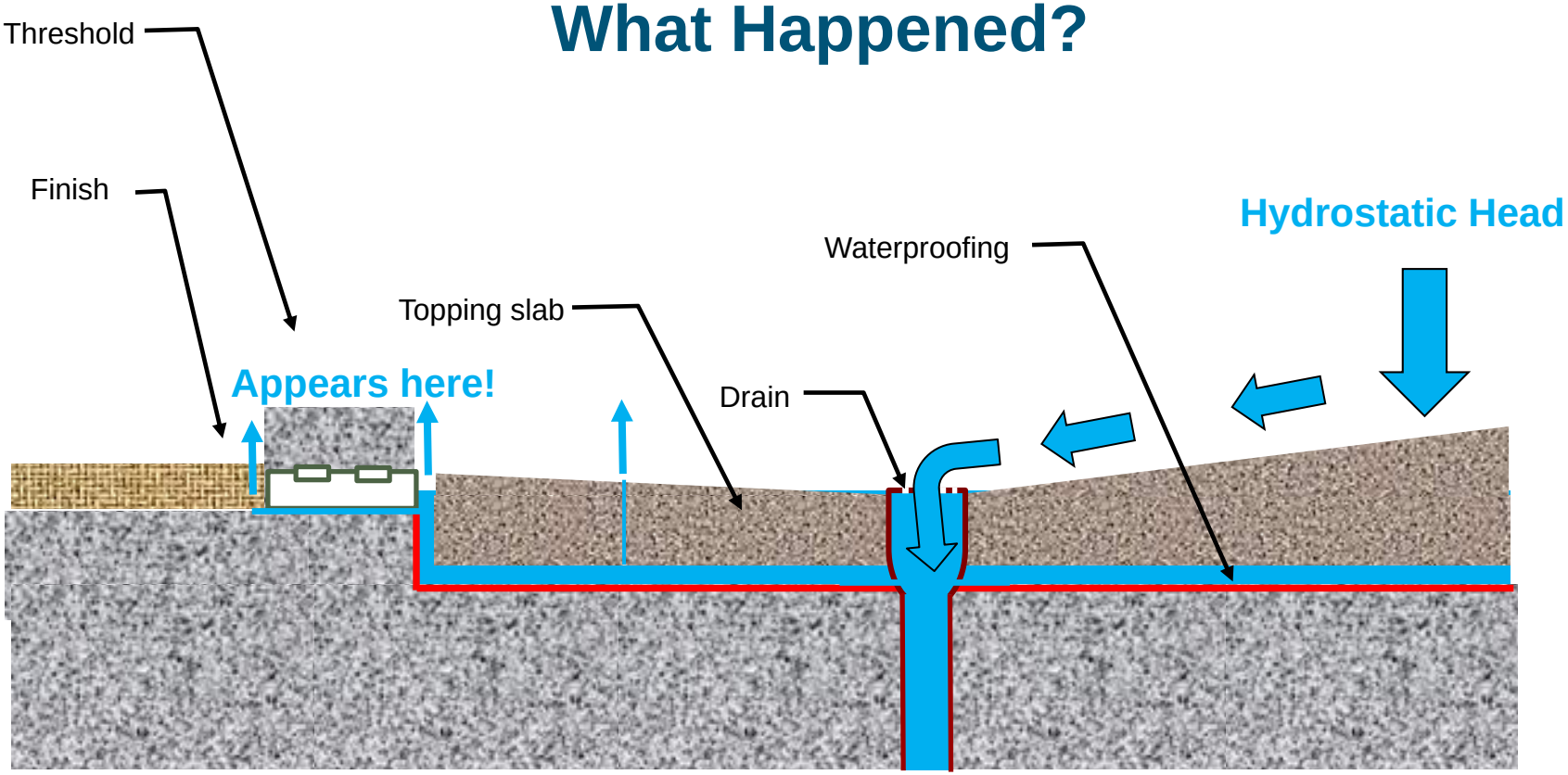
Case Study Leak Due To Slope and Drainage

What Happened?



Case Study Podium Leaks

What Happened?



Case Study Podium Leaks

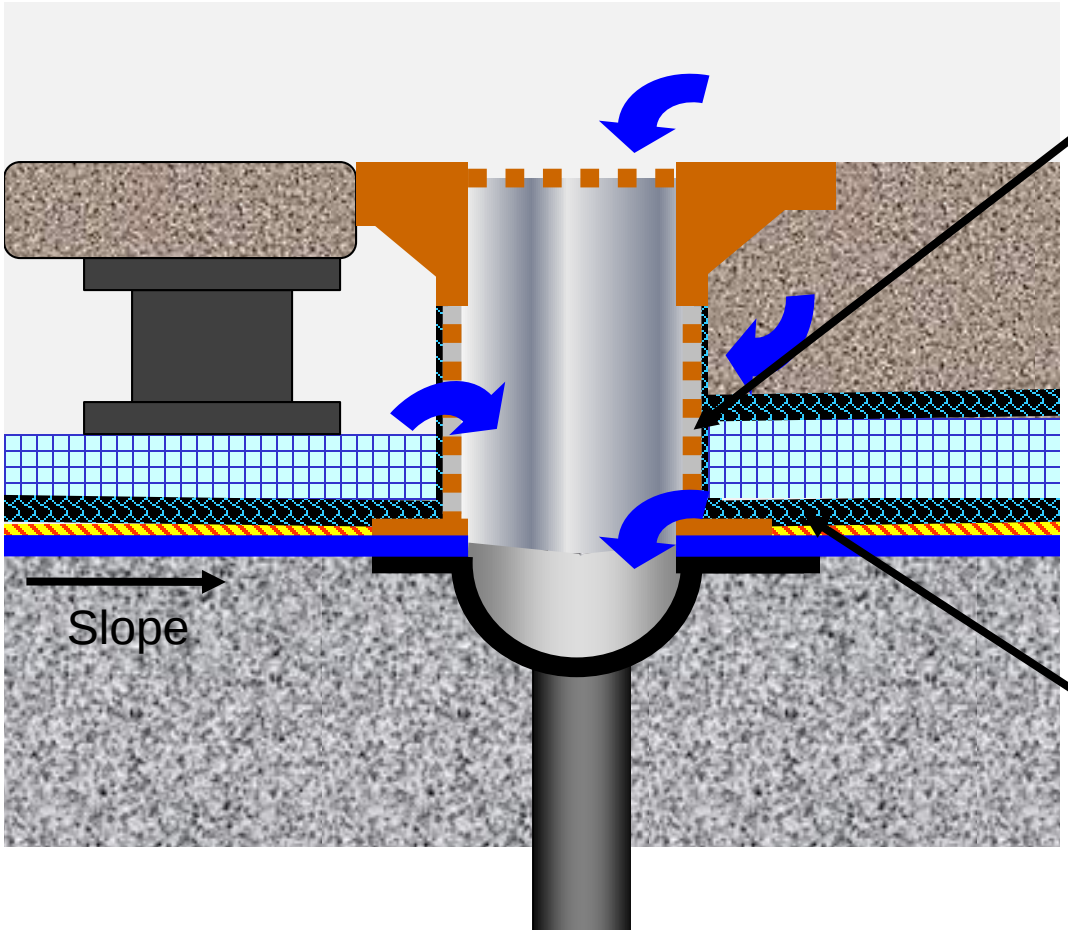
Always slope the structural slab!

Case Study: Importance of Substrate Slope

What Happened?

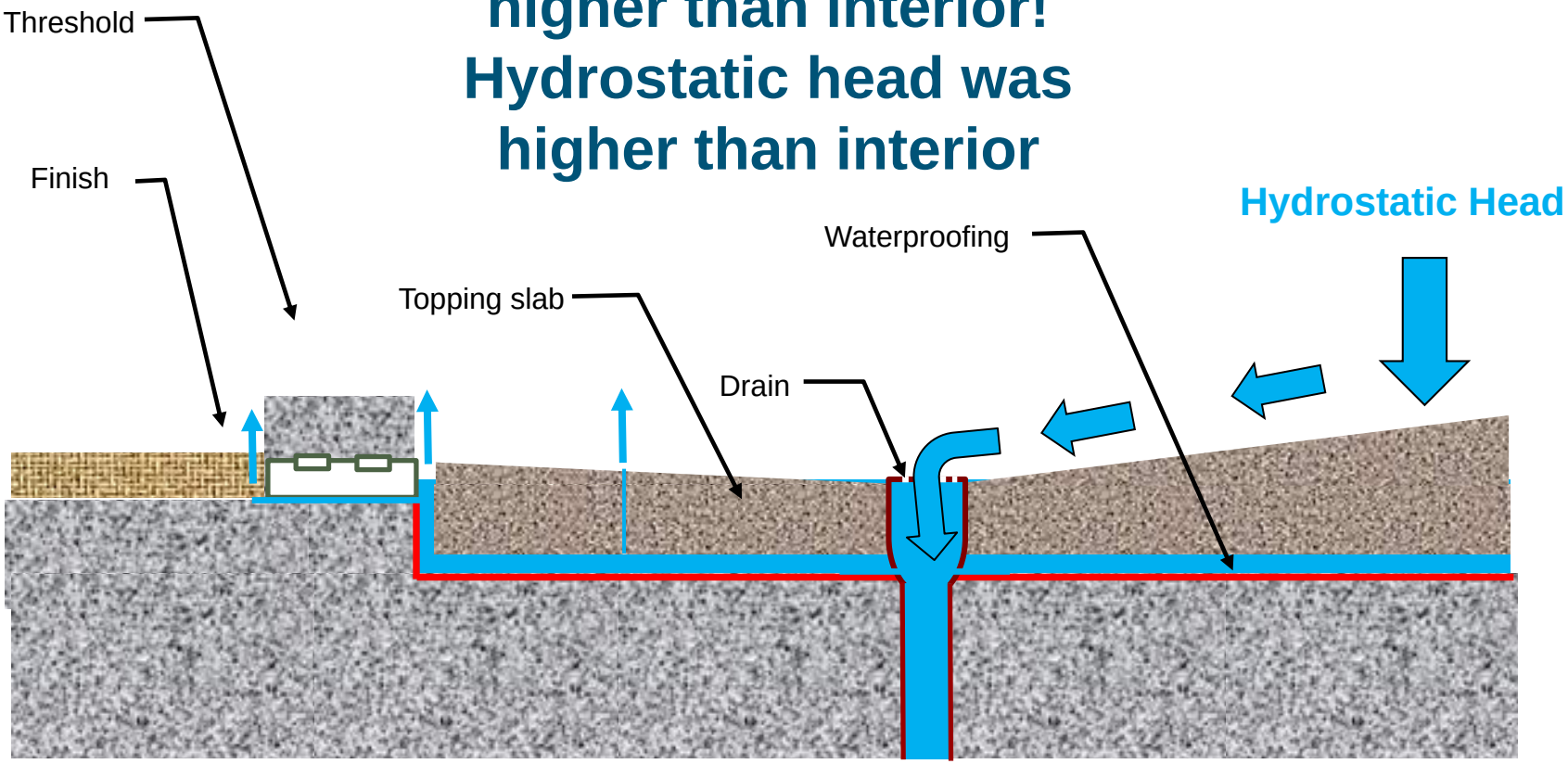
- Water entered drain but also saturated the topping slab, paver system and separation materials
- The drain weeps at the waterproofing membrane level are small and were partially plugged with concrete and waterproofing
- Water built a hydrostatic head equal to the surface of the topping slab
- Slopes in topping slab often cause height of topping slab to be higher than interior floor
- Water can collect and travel around cold joints and perimeter and leak at doors and sliders

Lessons Learned - Sub-Slab Drainage Is Critical



Lessons Learned – Hydrostatic Head

Topping slab was higher than interior! Hydrostatic head was higher than interior

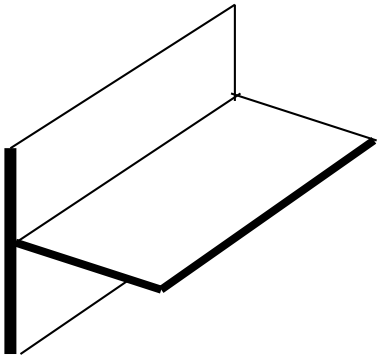


Failures Caused by Flashing Issues

- **Use of Conform Edge Flashings**
- **Rusting of submerged galvanized sheet metal flashings**
- **Door pan flashings, back legs and end dams**
- **Laps in metal flashings not sealed adequately**
- **Lack of soldering saddles, corners, scuppers**
- **Improper lapping, sealing and fastening of “L” flashings**
- **Lack of priming or prep for adhesion**
- **Incomplete or improper composition base flashings**
  - Missing reinforcement
  - Lack of membrane flashing extensions

Use of Concrete Form Edge Metal as Flashing

Extruded aluminum metal edge used as both a form for retaining concrete as well as a “flashing”



Con-form Edge Metal

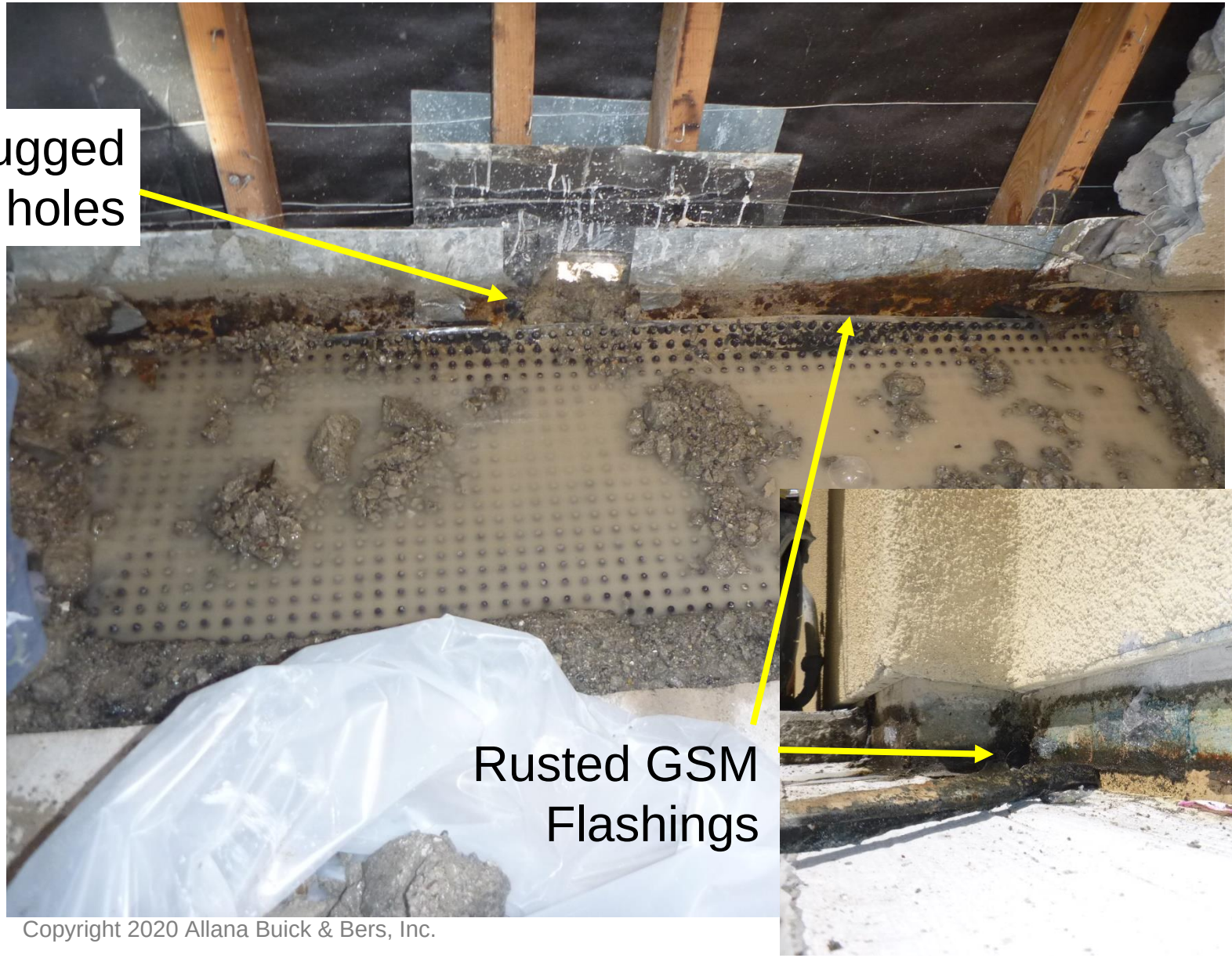
Use of Concrete Form Edge Metal as Flashing

Difficult to integrate Aluminum with GSM flashings other 3 sides. Corners can't be soldered, separation of dissimilar materials and proper integration.

Lack of Soldering Saddles, Corners & Scuppers

Improper Lapping & Sealing Flashings

Rusting of Submerged GSM Flashings



Door Pan Flashings, Back Legs & End Dams Crushed

Membrane, Adhesion Failure to Stainless

Lack of priming or prepping

Failures Caused by Flashing Issues

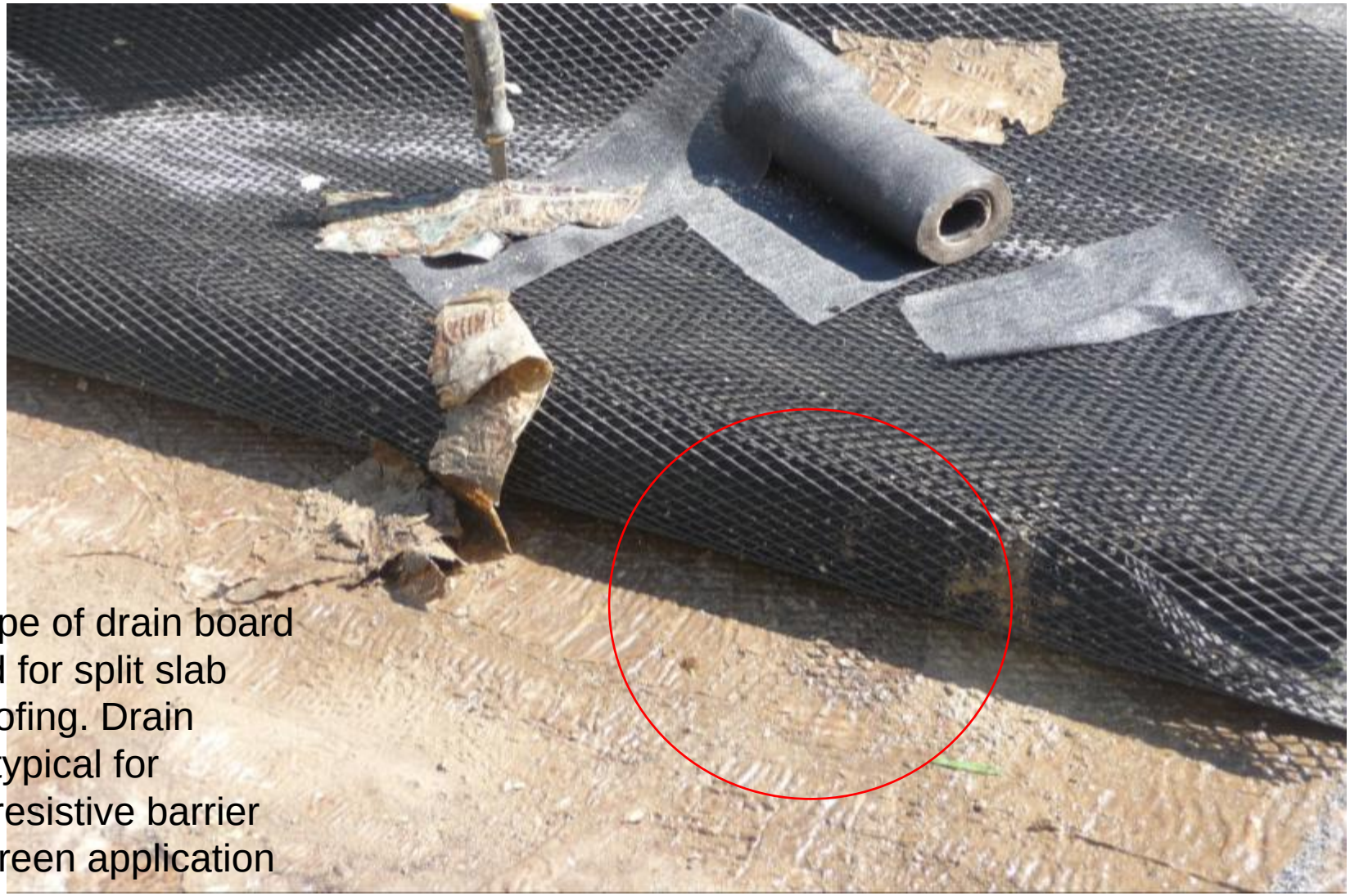
- **Incomplete or improper composition base flashings**
  - Lack of membrane flashing extensions

Case Study 2:

Importance of proper protection layer selection

Protection Layer Case Study

Protection Layer Case Study



Wrong type of drain board was used for split slab waterproofing. Drain board is typical for weather resistive barrier in rain screen application

Protection Layer Case Study

Common Plaza Waterproofing Systems

Typical Waterproofing Membranes

- **Fluid Applied Systems**
  - Hot Applied
  - Cold Applied
- **Sheet Membrane Systems**
  - Thermoset (Rubber)
  - Thermoplastic (Plastic)
  - Reinforced SBS modified asphalt sheets
  - SBS Modified self adhering (Peel and Stick)

Fluid Applied Membranes

- **Hot Systems**
  - **Rubberized Asphalt (HRA)**
    - **For split slab & protected systems**
    - **Typically reinforced with polyester**
    - **More that 30 years of experience**
    - **Must be protected from exposure**
    - **Installation is reasonably forgiving**

HRA Being Applied With Pouring Cans

HRA Expansion Joints Over Cold Joints

HRA Challenges

4 HRA Issues

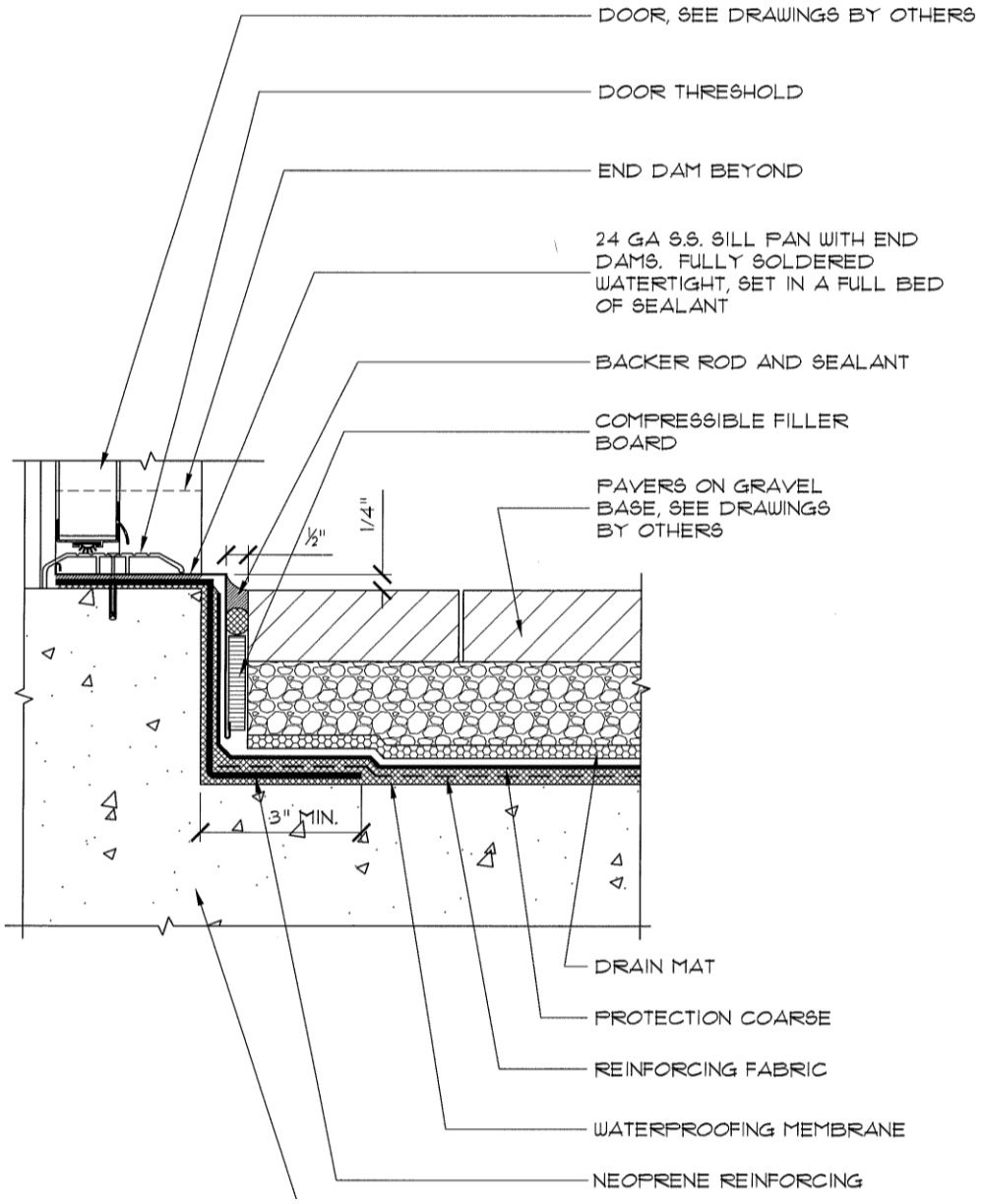
- Adhesion Issues
- Flashing build-up
- Rebar waterproofing
- Planter construction
- Substrate acceptance

HRA Challenges

Flashing Build Up

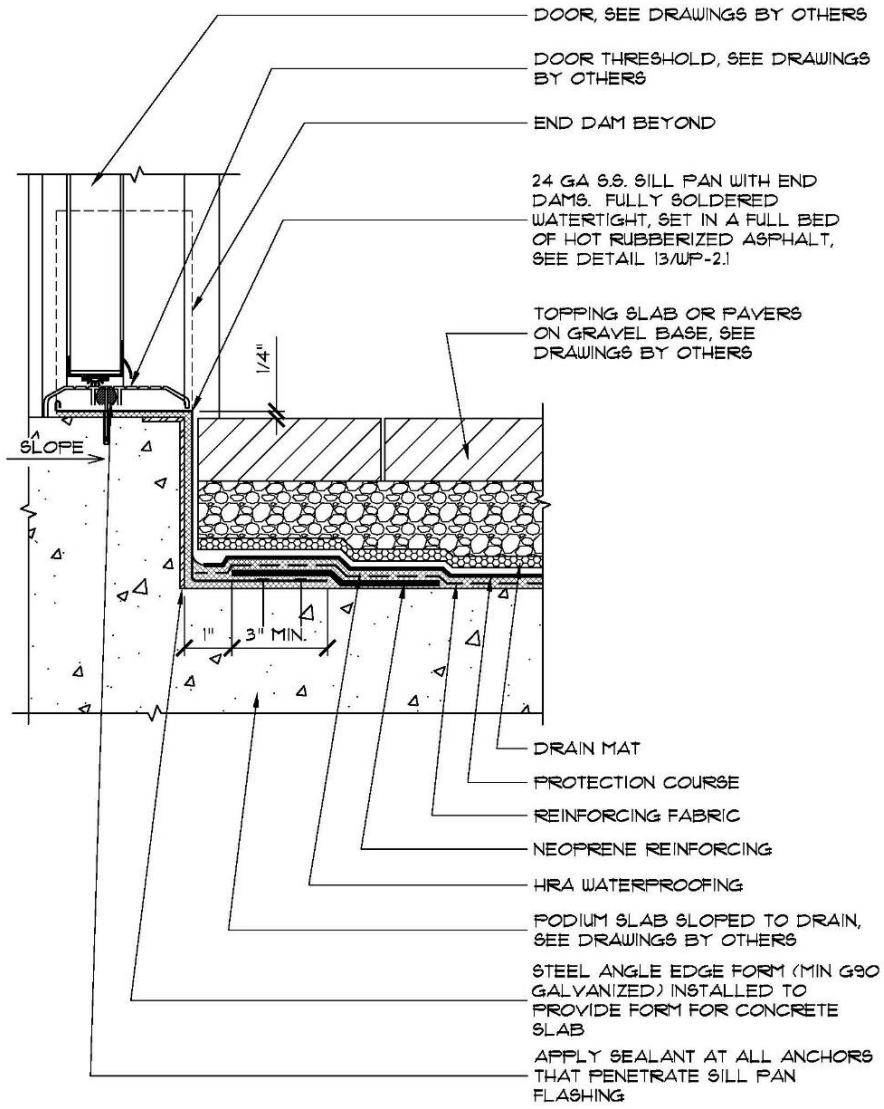
- Field HRA is 215 mils (nearly ¼”) thick
- Embedded neoprene 60 mils
- Protection flashings 110-180 mils
- With laps of membranes…you are getting close to ¾” thick!

HRA Challenge: Flashing Build Up



HRA Challenge: Flashing Build Up

HRA Flashing Build Up - Solution



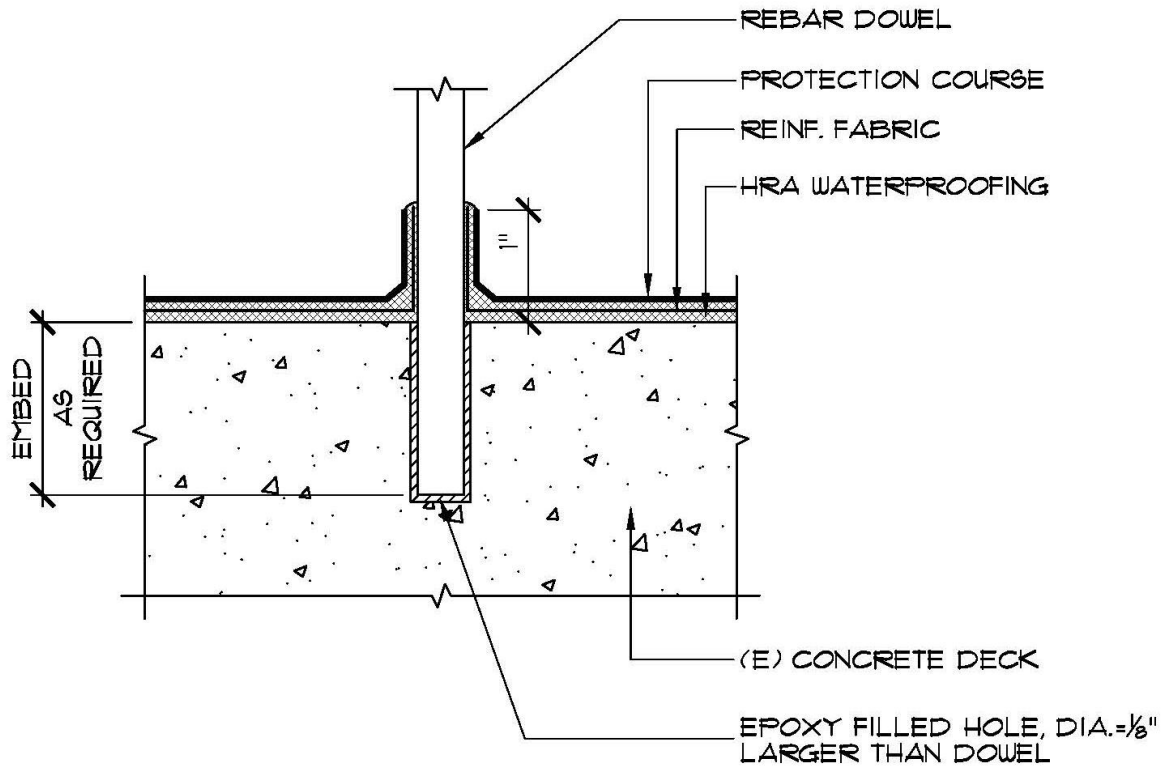
Composition Flashing Build Up - Solution

HRA Challenges: Penetration Flashing

Rebar Flashing

- Requires proper detailing
- Requires more elbow greese
- Needs reinforcement
- Substrate must be cleaned – remove rust
- Cannot be left exposed

HRA Challenges: Penetration Flashing



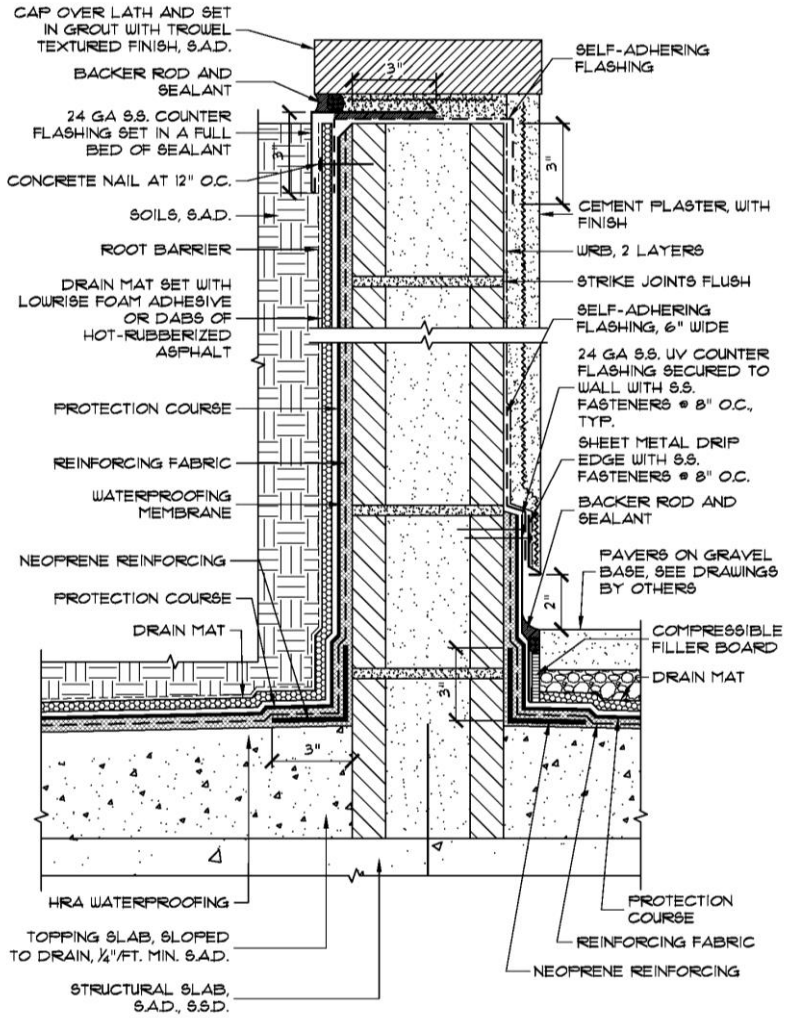
NOTES:
1. EPOXY IS SIMPSON SET-XP (ICC ESR-2508) OR APPROVED EQUAL. SPECIAL INSPECTION (VISUAL, PERIODIC) IS REQUIRED.
2. DRAIN MAT AND OVERBURDEN NOT SHOWN FOR CLARITY.

HRA Challenges: Planter Construction

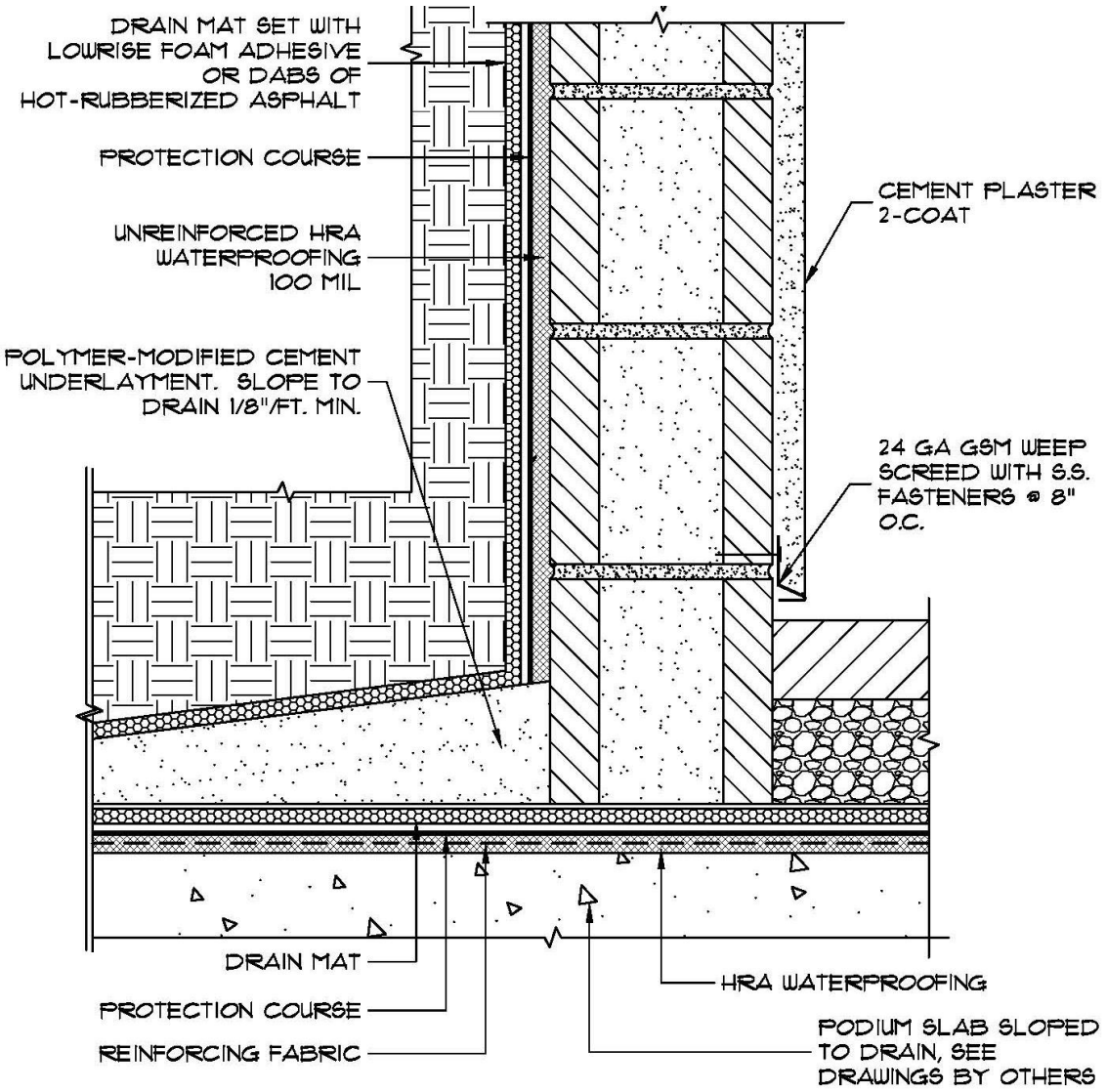
Planter Construction

- Under the planter? Or stop at planter?
- UV Protection
- Protection from roots
- Dampproofing for exposed wall
- Drainage considerations

HRA Challenges: Planter WP Discontinuous



HRA Challenges: Planter WR Continuous (Better)



HRA Challenges: Planter Construction

HRA Modes of Adhesion Failure

Adhesion Testing

- Cohesive failure in concrete substrate
- HRA Adhesive failure
- Emulsification of water based primer
- Curing of water based primers
- Testing standards
  - No ASTM Test
  - No industry agreement
  - What do you do?

Typical Adhesion Testing With Reinforcing

HRA Adhesion Failure (HRA Adhesion)

HRA Adhesion Failure (HRA Adhesion)

HRA Adhesion Test Failure (Concrete Cohesion)

Concrete Cohesion Failure Mode

- The podium slab was poured in mid November
- It may have been raining when they finished pouring
- The temperatures recorded during this period was about freezing
- The surface of the concrete was very soft

Cold Fluid Applied Systems

Cold Systems

- **Urethane**
  - Split slab, protected membrane or exposed
  - Either reinforced or non-reinforced
  - Cure times typically more than 24 hours
  - Caution … *permeable membranes (>.1us perms dry cup method) installed over concrete substrates can blister*

Cold Modified Polyurethane Membranes

Cold, modified polyurethane systems

- **Osmosis and Permeable Membranes**
  - Concrete has calcium salts
  - Interior moisture is readily present in concrete
  - Permeable membranes with >0.1 US perms
  - Establishes an osmotic cell where fresh water passes through the membrane and collects under the membrane resulting in blisters
- **Membrane Swelling due to standing water**

Modified Polyurethane Membranes, Osmosis

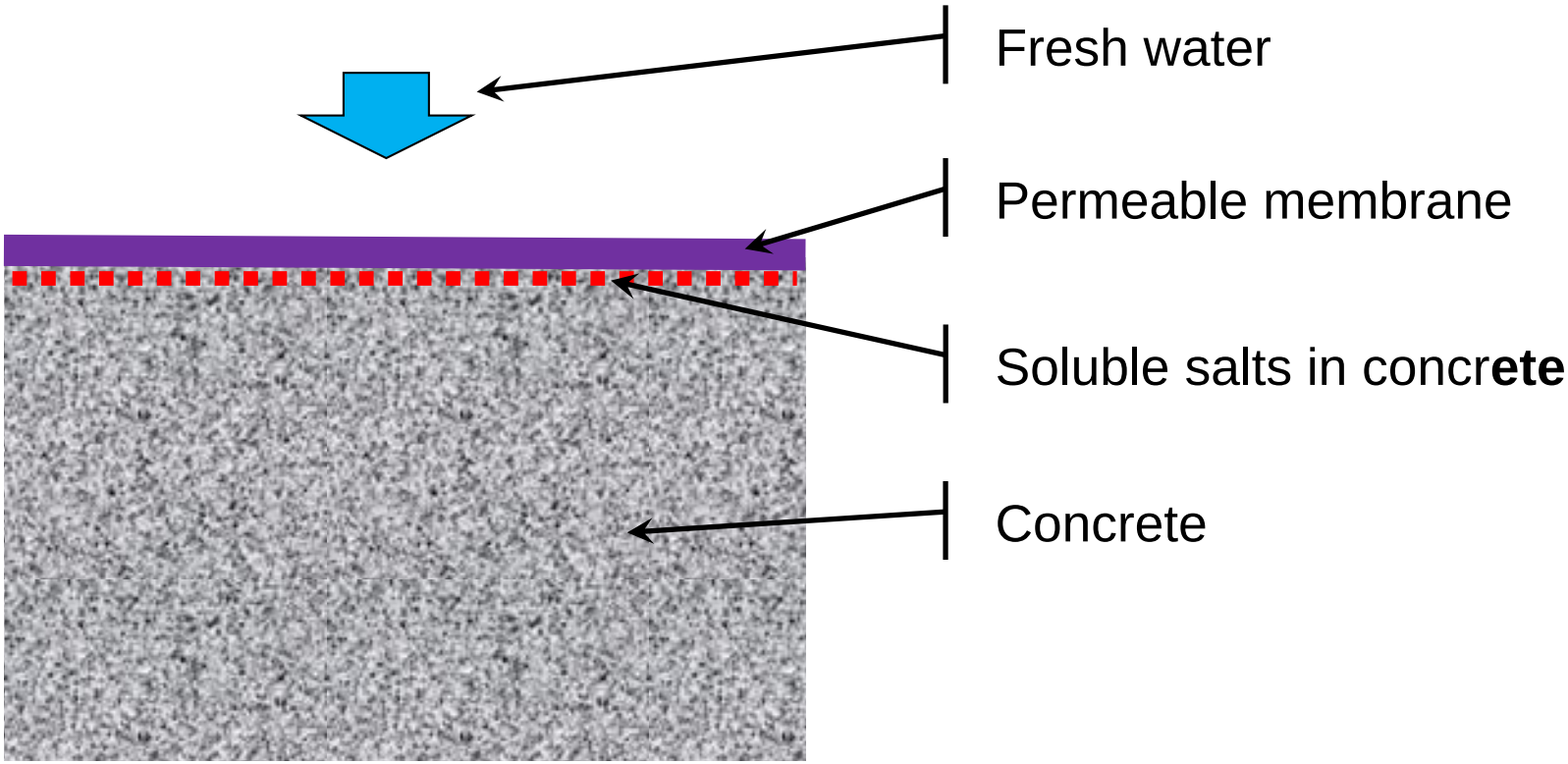
Cold Systems

- **Osmosis and Permeable Membranes**

Semi-Permeable Membranes, Osmosis

Cold Systems

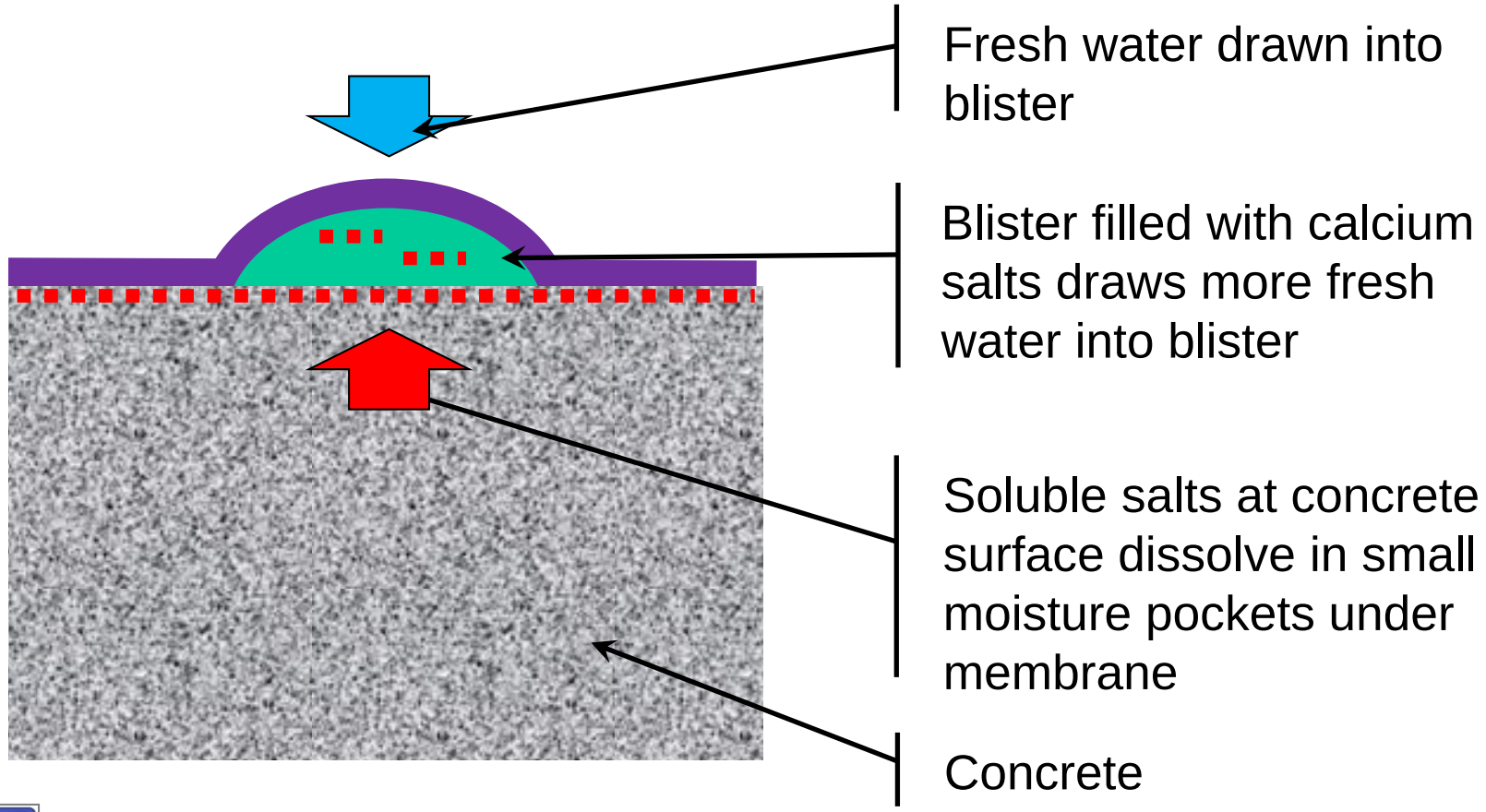
- **Osmosis and Permeable Membranes**



Semi-Permeable Membranes, Osmosis

Cold Systems

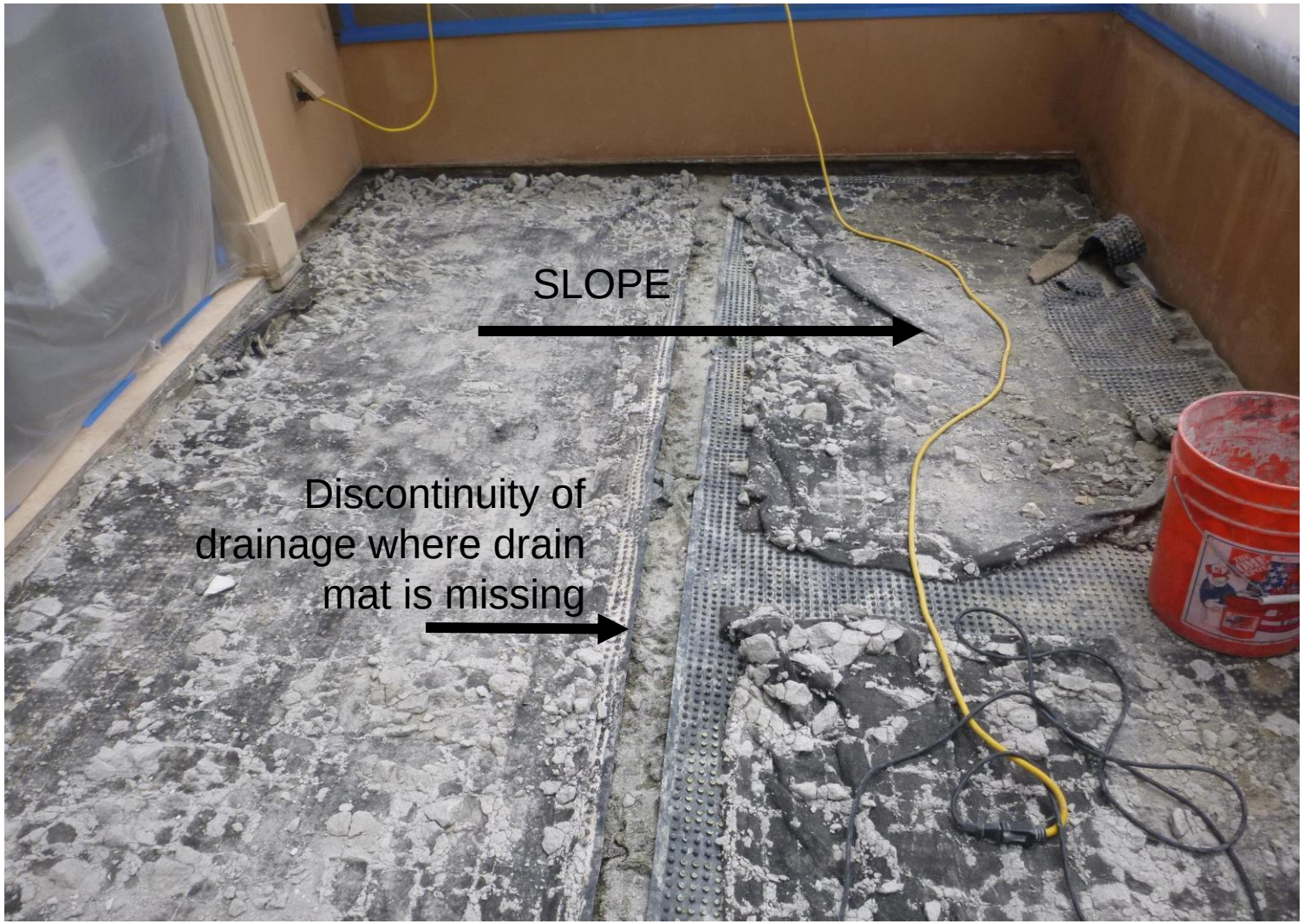
- **Osmosis and Permeable Membranes**



Membrane Permeability Rusting GSM

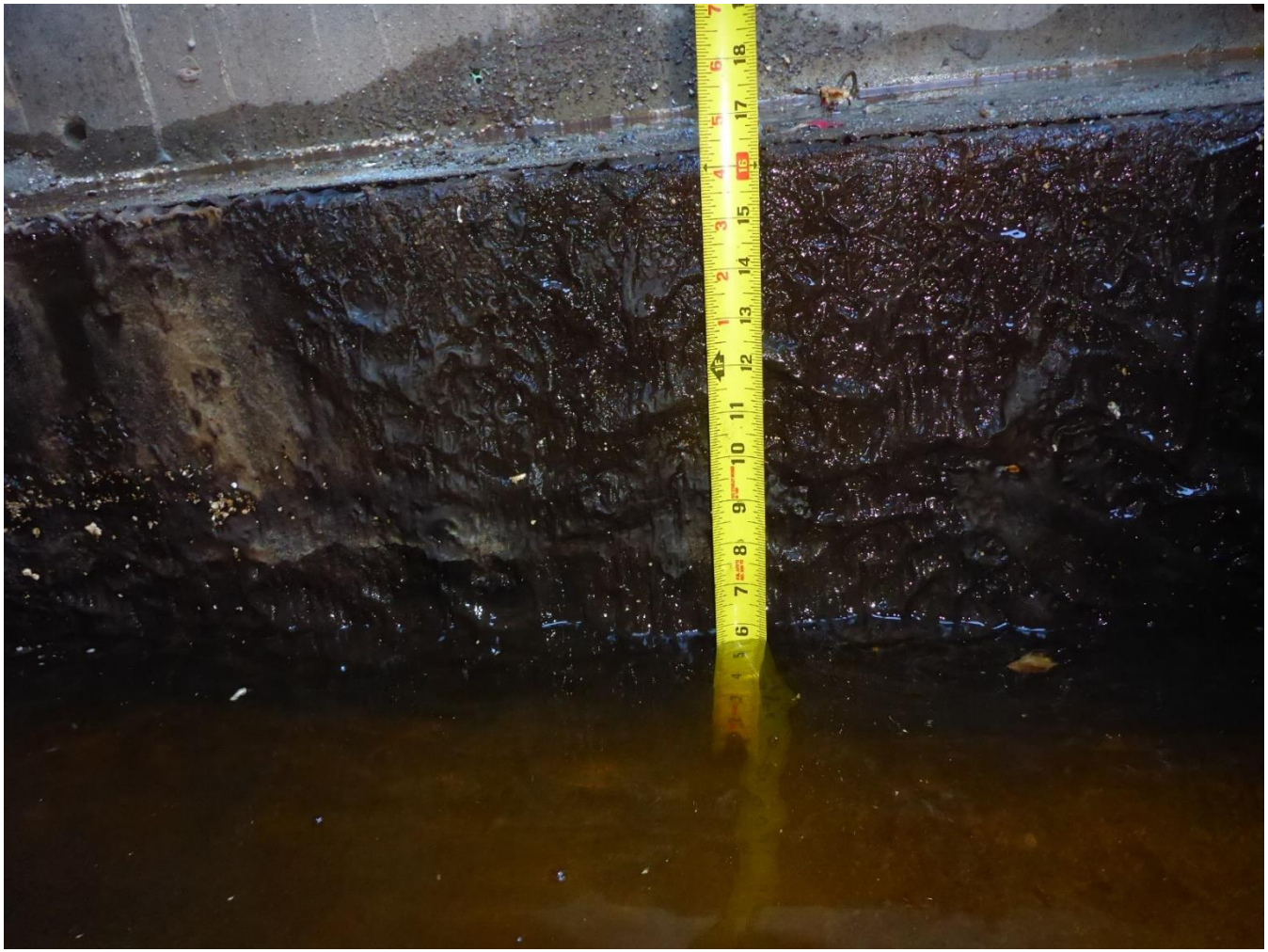
Permeability Issue, Rusting GSM Flashings

Modified Polyurethane Membranes, Swelling



Membrane Swelling Due To Ponding

Membrane Swelling Vertical Condition



Stair riser, on a vertical condition, lack of drainage and standing water resulted in swelling

Membrane Selection For Permeability

- Difference between ASTM C-836-00 Method A and B
- Wet cup versus dry cup method. Most manufacturers publish testing per dry cup method
- Semi-permeable membranes with dry cup of <0.03 can have a wet cup permeability significantly higher
- Best to use a membrane with “no” permeability like asphalt, HRA, modified bitumen, PVC and similar roofing membranes
- Avoid semi-permeable membranes where long term exposure to standing water is possible

Questions and Answers

Thank You!