



## CONCRETE REPAIR (PART 2 – APPLICATION)

- Certificates provided via email
- All attendees will receive a copy and recording of the webinar, this may take up to a week

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BUILDING TRUST



# AGENDA – CONCRETE REPAIR (SPALL REPAIR)

- Surface preparation
- Establishing adhesion
- Application methods
  - Trowel
  - Pour
  - Form and pour
  - Form and pump
  - Resurfacing
  - Spray





# CONCRETE REPAIR



# CONCRETE REPAIR

- Choose method of application
- Select repair materials
  - Reinforcement coating
  - Bonding agent
  - Repair mortar/concrete
- Prepare substrate and reinforcement
- Install the repair materials



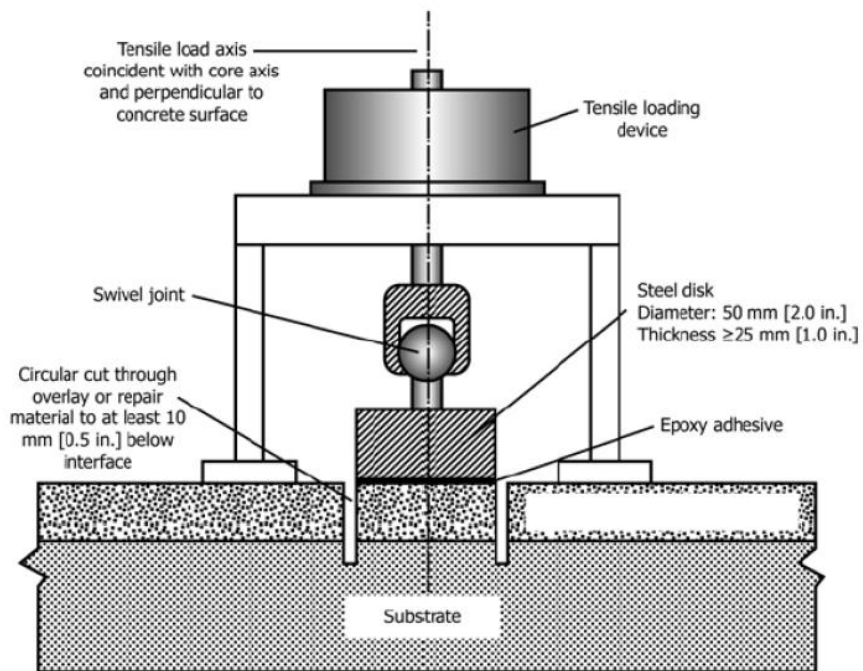


# SURFACE PREPARATION



# SURFACE PREPARATION

- Which surface will result in higher psi direct pull adhesion test, A or B?



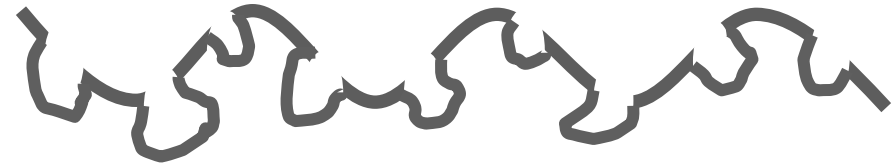
- A:



- B:

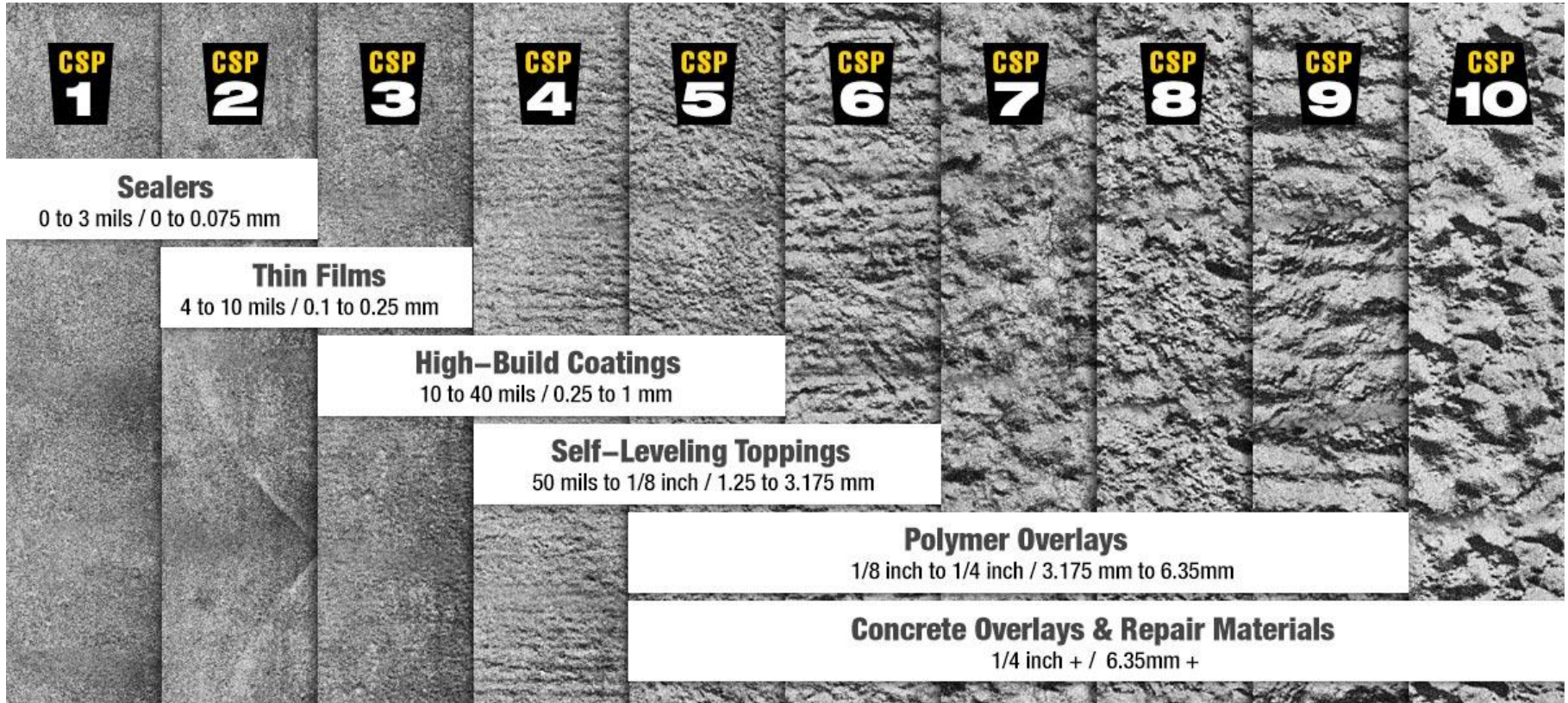


- C:





# SURFACE PREPARATION – ICRI CSP 1-10



# SURFACE PREPARATION

- Saw cut perimeter
- Rectangular shape
- Fractured-aggregate profile
- Clean and sound
- Saturated, surface dry





# SURFACE PREPARATION

- Saw cut perimeter
- Rectangular shape
- Fractured-aggregate profile
- Clean and sound
- Saturated, surface dry



# CHIPPING/BUSH HAMMERS





# CHIPPING/BUSH HAMMERS



# SCABBLERS





# SCABBLERS



# SCABBLERS





# SCABBLERS





# PLANERS

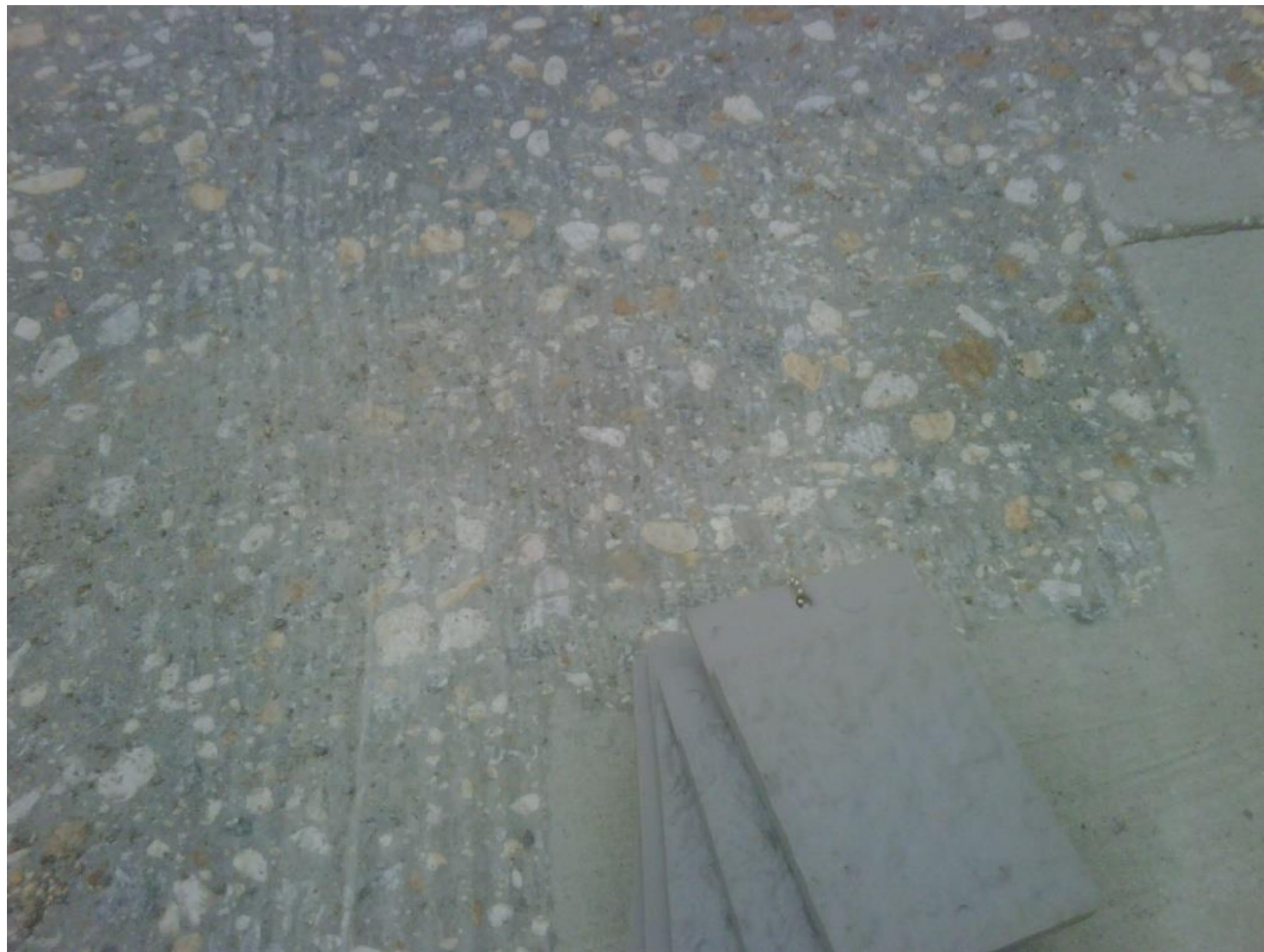




# PLANERS



# PLANERS

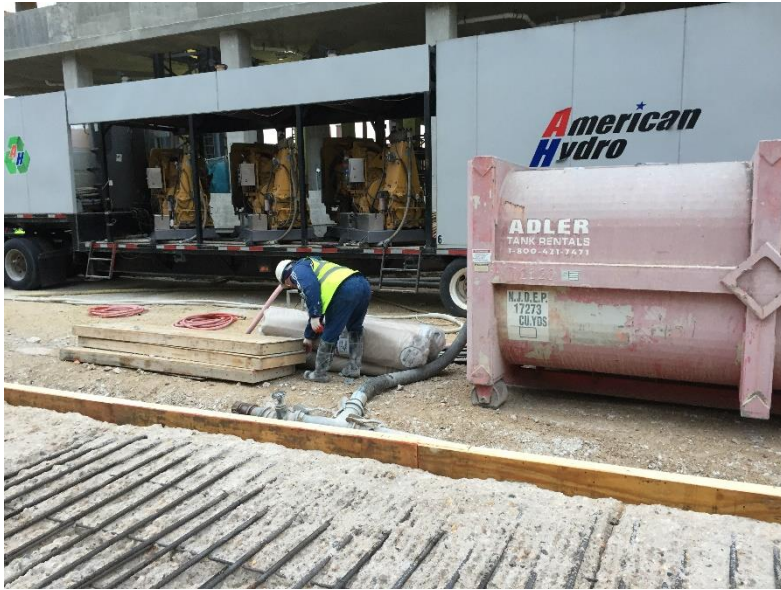




# HIGH PRESSURE WATER



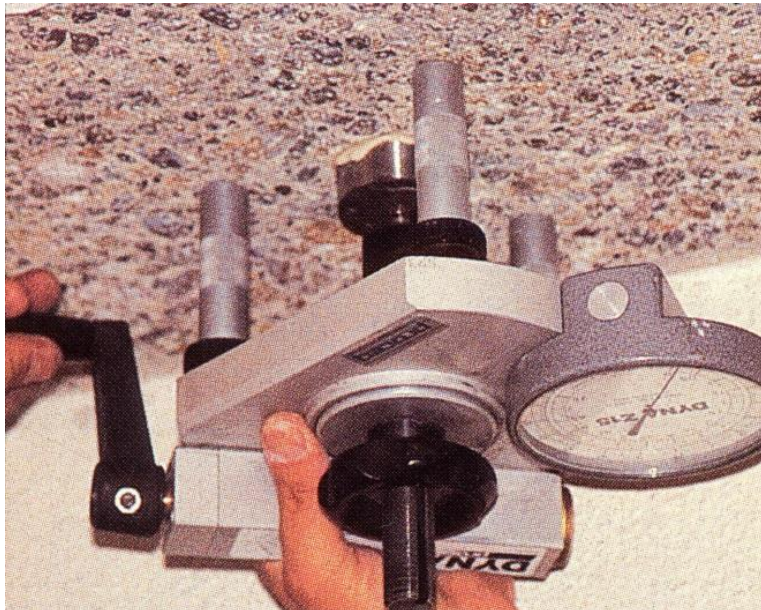
# ULTRA HIGH-PRESSURE WATER (HYDRODEMOLITION)





# VERIFYING SURFACE PREPARATION

- Direct pull testing can be performed according to ASTM C1583 or D7234
- This does not provide an interpretation of the results, but 250 psi or higher would generally be an accepted value
- Tensile strength of concrete typically ranges 5-10% of compressive strength





# VERIFYING SURFACE PREPARATION

- Test can be direct to substrate or over repair material
- Failure mode must also be observed
  - Substrate - desired
  - Bond line
  - Repair material
  - Dollie adhesive





# REINFORCEMENT PREPARATION

- Chip/remove concrete completely around visible rebars
- Greater of  $\frac{1}{4}$ " plus diameter of largest aggregate in repair material or  $\frac{3}{4}$ " (book)
- Enough to get fingers behind bar (field)



# REINFORCEMENT PREPARATION

- Remove all corrosion such as by abrasive blasting or wire wheel grinding
- Prime or repair soon afterwards





# REINFORCEMENT PREPARATION

- Typically, if 25% or more cross-sectional area is gone, splice or replace with new bar
- Engineer's decision (ACI 318)





# ESTABLISHING ADHESION

Appropriate  
repair  
material



Established  
adhesion



Proper  
surface  
preparation





# ESTABLISHING ADHESION

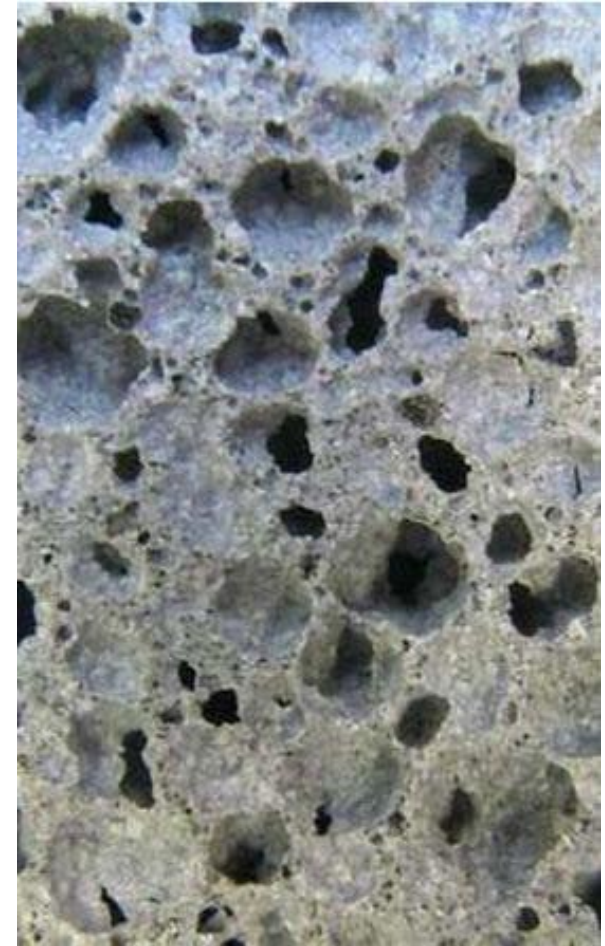
## Adhesive Strength

1. Epoxy
2. Epoxy-cement
3. Latex-cement
4. Cement

## Pore Filling

1. Liquid
2. Slurry – scrub
3. Gel – scrub harder

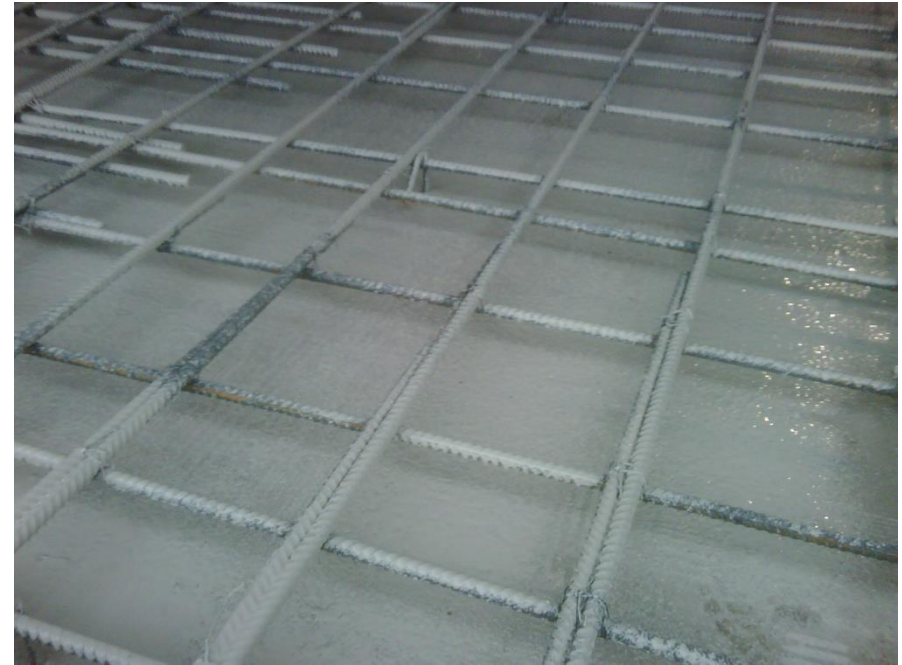
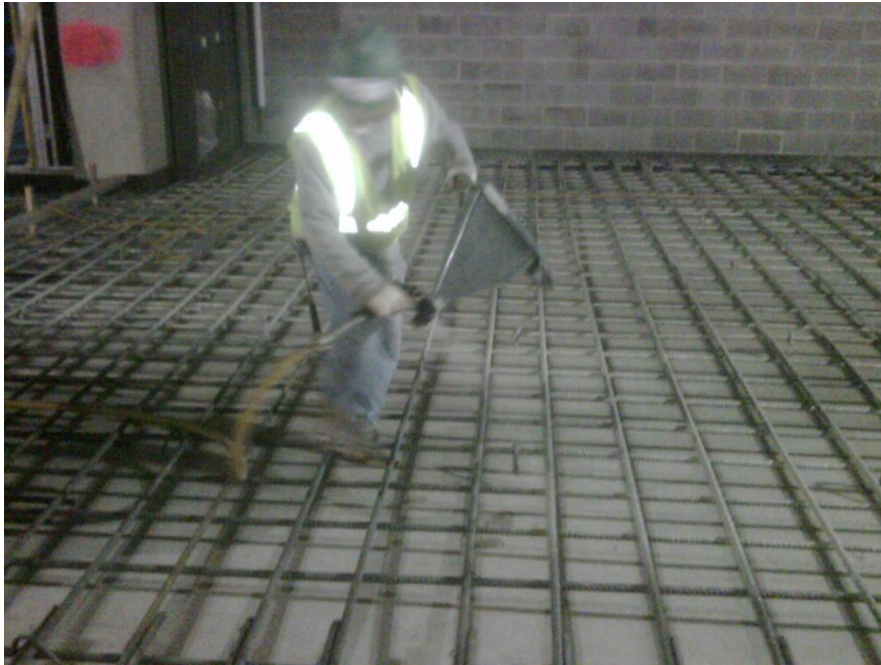
**Just pouring a low slump mix or troweling a gel mortar on top of a well-prepared substrate may result in weak bond**



# BONDING AGENT AND REINFORCEMENT COATING

## Sikadur 32 Hi-Mod

- 100% epoxy
- Strongest adhesive
- Impermeable reinforcement coating



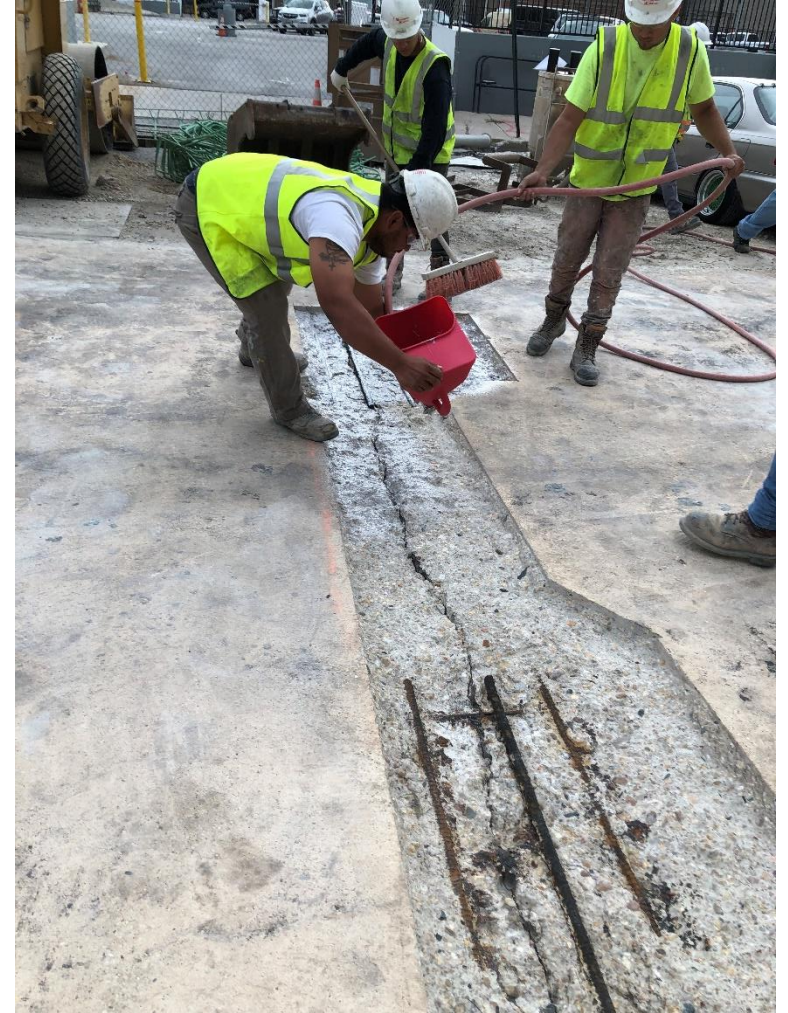


# BONDING AGENT AND REINFORCEMENT COATING



## Sikadur 32 Hi-Mod

- Brush, broom, roll, or spray apply
- Self wetting of pores
- Apply to dry or damp substrate

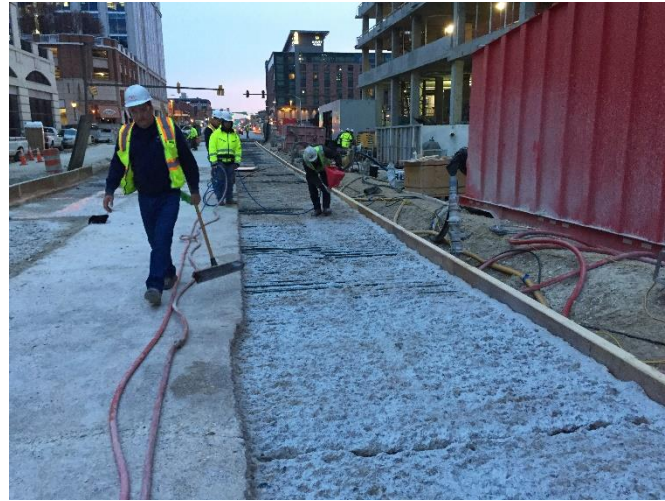




# BONDING AGENT AND REINFORCEMENT COATING

## Sikadur 32 Hi-Mod

- 0-4 hour contact time\*
- Must be wet or tacky
- Adheres to saw cut perimeter





# BONDING AGENT AND REINFORCEMENT COATING



# BONDING AGENT AND REINFORCEMENT COATING



## Sika Armatec 110 EpoCem

- Epoxy-cement chemistry
- Strong adhesive
- Triples the time to corrosion initiation
- 40% reduction in corrosion rate





# BONDING AGENT AND REINFORCEMENT COATING

## Sika Armatec 110 EpoCem

- Brush, broom, glove, spray apply
- Slurry consistency
- Scrub into pores
- Apply to SSD substrate



# BONDING AGENT AND REINFORCEMENT COATING



## Sika Armatec 110 EpoCem

- 0-16 hours contact time\*
- Dry in about 1 hour
- 90-minute pot life\*
- Breathable
- Clean tools with water





# BONDING AGENT

## Scrub Coat

- Scrub repair material into substrate
- Good strength
- Do not wet down
- Apply to SSD substrate
- 0-15 minutes contact time typical





# REINFORCEMENT COATING

## Sika Armatex 10 ZR

- 1-component, zinc-rich polyurethane
- Apply by brush, glove, or spray
- Allow about 1.5 hours to dry
- 1 quart covers 600 lf of #4 bar





# APPLICATION METHODS

## Trowel apply

- Smaller areas
- Shallower repairs

## Pour/Form and pour

- Larger volumes
- Easy to pour and enter formwork

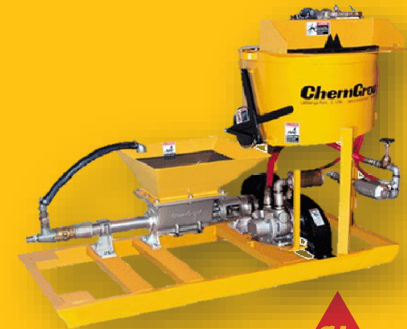
## Form and pump

- More difficult access to formwork
- Need to move material from source through line to formwork
- Overhead repairs

## Spray apply (wet/dry, high/low pressure)

- Large volume of vertical or overhead
- Often large area but not so deep

(All methods effective when performed properly)



# MIXING

- Clean and rinse mixing container
- Add most of liquid (water/polymer)
- Mix while adding powder
- Add rest of liquid
- Mix thoroughly until it looks right
- Aggregates to be added should be SSD
- Allow time for activation of plasticizers





# REPAIR MATERIAL SELECTION

Application	Premium Performance	High/Speed Performance	Quality Performance
Vertical/Overhead Trowel Mortar	SikaTop 123 PLUS SikaRepair 224	SikaQuick VOH	SikaRepair 223
Pour/Pump Concrete	Sikacrete 211 SCC Plus Sikacrete 360 SCC	Sikacrete 421 CI Rapid	Sikacrete 100 CI Sikacrete 211
Pour/Pump Mortar (3/8" gravel can be added)	SikaTop 122 PLUS SikaTop 111 PLUS Sikadur 43 Patch-Pak	SikaQuick 2500 SikaQuick 1000 SikaQuick FNP	SikaRepair 222 SikaGrout 328
Leveling Mortar	SikaTop 121 PLUS SikaTop 122 PLUS Sikadur 22 Lo-Mod	SikaQuick Smooth Finish SikaQuick Resurfacer SikaQuick EZ Patch	SikaRepair SHB SikaRepair 222
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Spray Apply Mortar	Sikacem 133, 226 CI SikaRepair 224	Sigunit L72 AF	Sikacem 103 Sikacem 103F
Grout	SikaGrout 328, 350 SikaGrout 528 SF Sikadur 42 GP/PT/LE	SikaGrout 428 SikaSet Plug	SikaGrout 212
Underlayment	SikaLevel 325	SikaLevel 325	SikaLevel 125

# TROWEL APPLIED VERTICAL/OVERHEAD REPAIRS

- Bonding agent or scrub coat
- Force repair material into place for good compaction
- Provide mechanical locking between lifts
- Finish as desired without excess water
- Finishing agent allows trowel to slide and prevent crusting
- Cure





# TROWEL APPLIED VERTICAL/OVERHEAD REPAIRS

- Work material against perimeter
- Apply following lift as soon as first lift is set to hold



# TROWEL APPLIED VERTICAL/OVERHEAD REPAIRS

- Can hang lift up to point before it starts to sag





# TROWEL APPLIED VERTICAL/OVERHEAD REPAIRS

- Same process for overhead
- Slower due to worker fatigue
- Overhead lift hangs about ½" less than vertical lift



# TROWEL APPLIED VERTICAL/OVERHEAD REPAIRS

- Much better results with premium performance, low shrinkage mortars





# TROWEL APPLIED VERTICAL/OVERHEAD REPAIRS

- Can be applied to large surface areas
- No cracking, very durable
- Overcoat SikaTop 123 PLUS in 3 days\*
- Overcoat SikaQuick VOH in 6 hours\*



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# POURABLE APPLICATIONS

- Deeper applications (>1") to contain larger aggregates (3/8")
- Better to mix multiple units, and even use multiple mixers for large applications





# POURABLE APPLICATIONS

- Harsh environment, low cover
- Quick traffic time, quick overcoat time
- Quality and economical





# POURABLE APPLICATIONS

- Screed
- Finish
- Cure



# FINISHING AID

- Use instead of finishing water
- Slickens better
- Reduces moisture loss and crusting
- Repair materials often stickier and set faster
- Very economical
- Remove before coating or sealing





# CURING

- Start curing as soon as possible after applying finish
- Objective is to keep moisture in the repair material
- Burlap needs to remain wet
- Soakers and misters can be used
- Polyethylene needs to lay flat
- Burlene needs to lay flat





# CURING

- Keep curing until at least 75% of design strength is reached
- Hard to keep burlap in contact with vertical surfaces
- Forms can prevent moisture loss





# CURING

- Curing compounds meeting ASTM C309 are effective
- Use water-based curing compounds with materials containing polymers
- Curing compounds need to be removed before applying coatings and sealants



# POURABLE APPLICATIONS

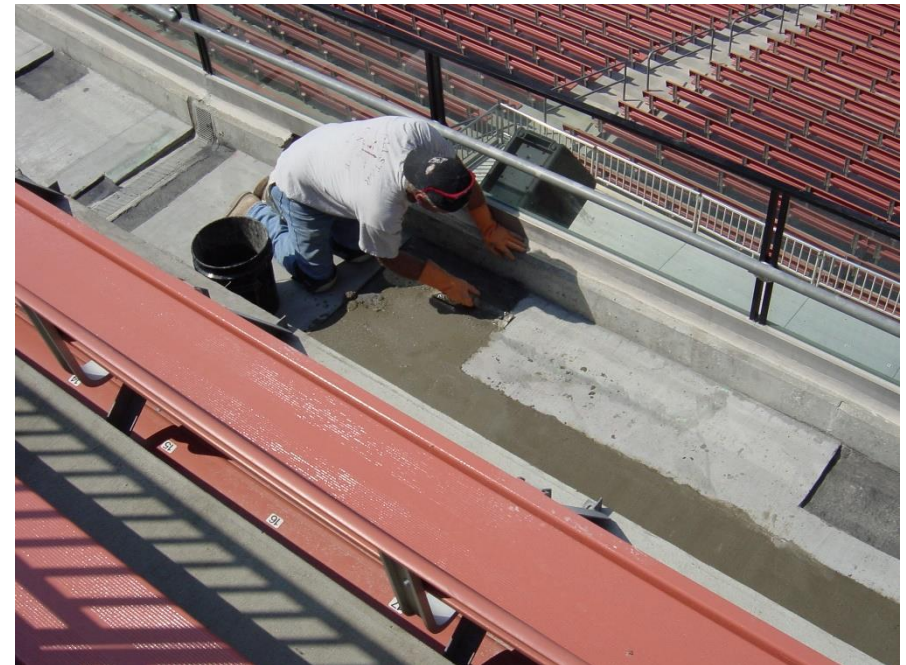
- Premium performance
- Harsh exposure
- Low cover





# POURABLE APPLICATIONS

- Premium performance
- Harsh environment
- Low cover





# POURABLE APPLICATIONS

- Premium performance
- Harsh environment
- Low cover





# POURABLE APPLICATIONS

- Vehicle traffic in 1 hour, overcoat in 4 hours
- Vehicle traffic in 2 hours, overcoat in 6 hours
- Vehicle traffic in 6 hours, overcoat in 6 hours





# FORM AND POUR

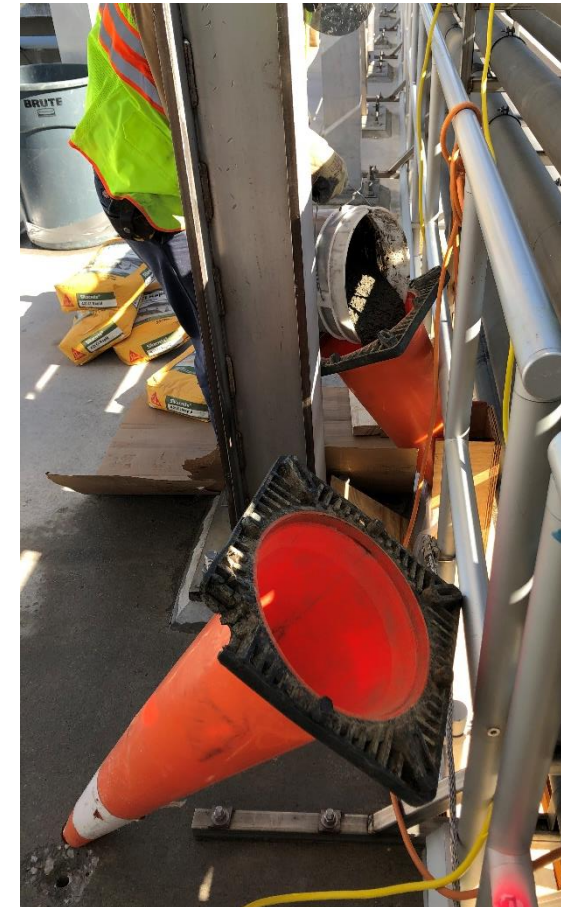
- High volume productivity
- Monolithic single application





# FORM AND POUR

- Flowable, fluid, or SCC consistency
- Vibrate to consolidate, prevent honeycombs and bug-holes





# FORM AND POUR

- Use head pressure
- Overfill & close, or bird-mouth & patch





# FORM AND POUR

- Harsh environment, low cover
- Quick strength and overcoat time
- Quality and economical
- Unlimited shaping/molding



# FORM AND POUR

- Very low shrinkage
- Can use expansive materials
- Forms provide curing





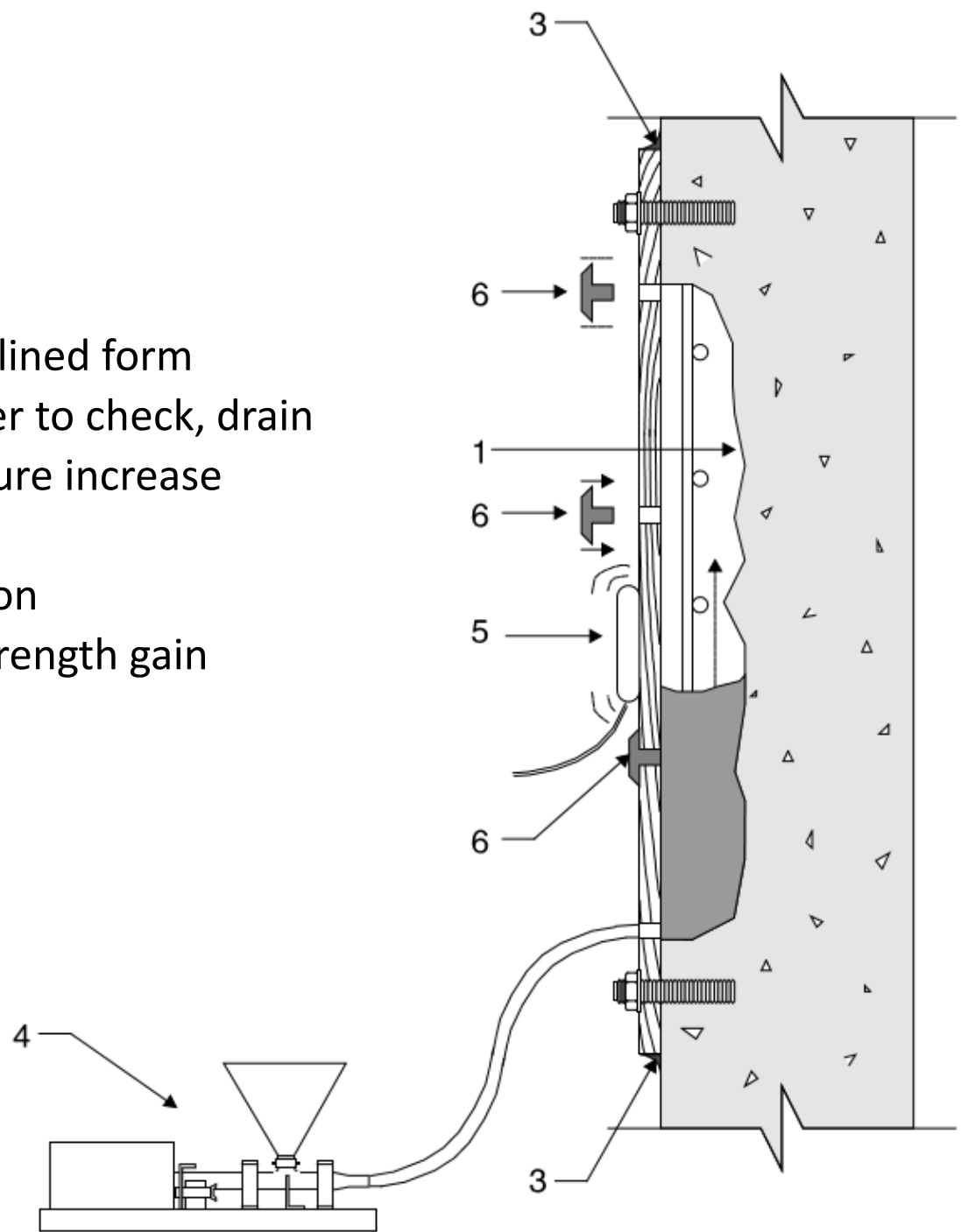
# FORM AND POUR

- Excellent flow and consolidation
- Consistency, pressure, & vibration delivers adhesion
- Outstanding durability



# FORM AND PUMP

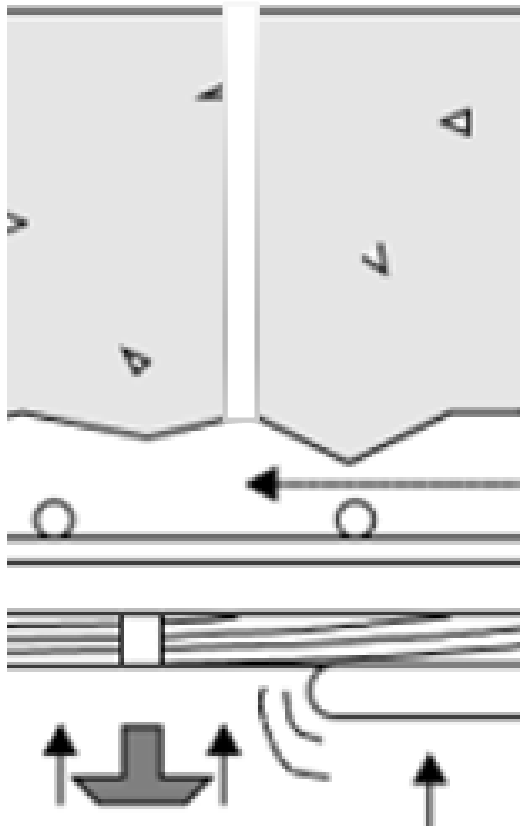
1. Bonding agent or SSD
2. Use release agent or plastic lined form
3. Seal perimeter, fill with water to check, drain
4. Pump full until 3-5 psi pressure increase
5. Vibrate while pumping
6. Cap vents upon fill verification
7. Strip forms after required strength gain
8. Dry pack anchor holes





# VENTING OVERHEAD FORMS

- Vent through to top
- Thinner slabs
- No top side concerns



- Vent tube to be withdrawn
- Thicker slabs
- Top side concerns



# PUMPS

- Hand lever grout pumps (no large aggregate)
- Power grout pumps (no large aggregate)
- Concrete pumps





# FORM AND PUMP

- Self-consolidating concrete
- Initial spread 27-33"
- 60-minute application time
- Need concrete pump



- Self-consolidating mortar
- 1/8" – 3" as mortar
- 60-minute application time
- Can use grout pump



# FORM AND PUMP

- Large volume productivity
- Monolithic single application
- Unlimited shaping/molding
- Mix batches





# FORM AND PUMP

- Load the screened hopper
- Match pump and material





# FORM AND PUMP

- Slick lines before starting
- Choose material for flow, working time, and line diameter and length

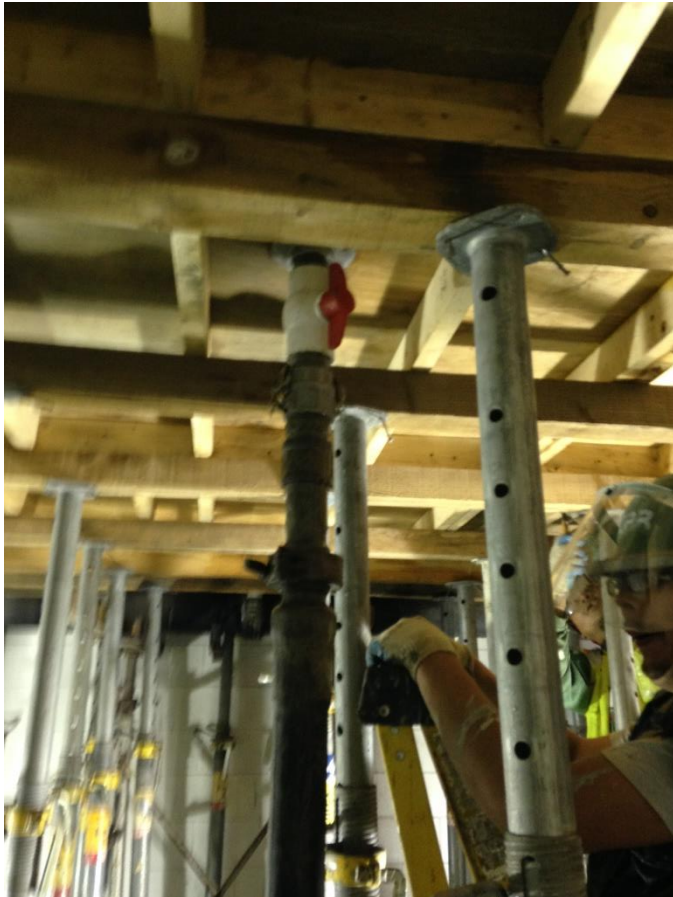


Slab too thick for top venting



# FORM AND PUMP

- Pump full checking vent tubes
- Slowly withdraw vent tube & plug





# FORM AND PUMP

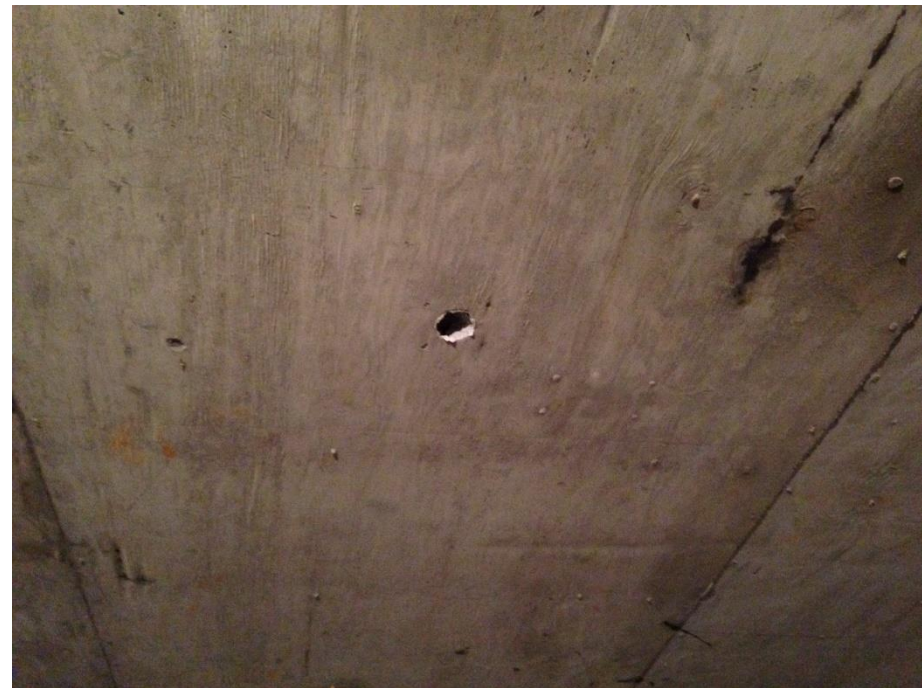
- Pump for 3-5 psi pressure increase
- Be ready to seal form leaks
- Close ports





# FORM AND PUMP

- Harsh environment, low cover
- Quick curing and overcoat time
- Quality and economical





# FORM AND PUMP

- Excellent flow and consolidation
- Consistency, pressure, & vibration delivers adhesion
- Outstanding durability





# FORM AND PUMP

- Versatile for many types of challenging conditions



# FORM AND PUMP

- Effective repair of columns, beams, and slabs





# REPAIR MATERIAL SELECTION

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# RESURFACING

- Fill bug-holes
- Improve appearance
- Featheredge to ½"
- Coat the following day





# RESURFACING

- Optional finishes
- Protective



# RESURFACING

- Apply by trowel or squeegee
- Choose vehicular or pedestrian traffic





# RESURFACING

- Variety of aggregates for color and slip resistance
- Very durable and protective





# RESURFACING

- Localized and large areas





# RESURFACING

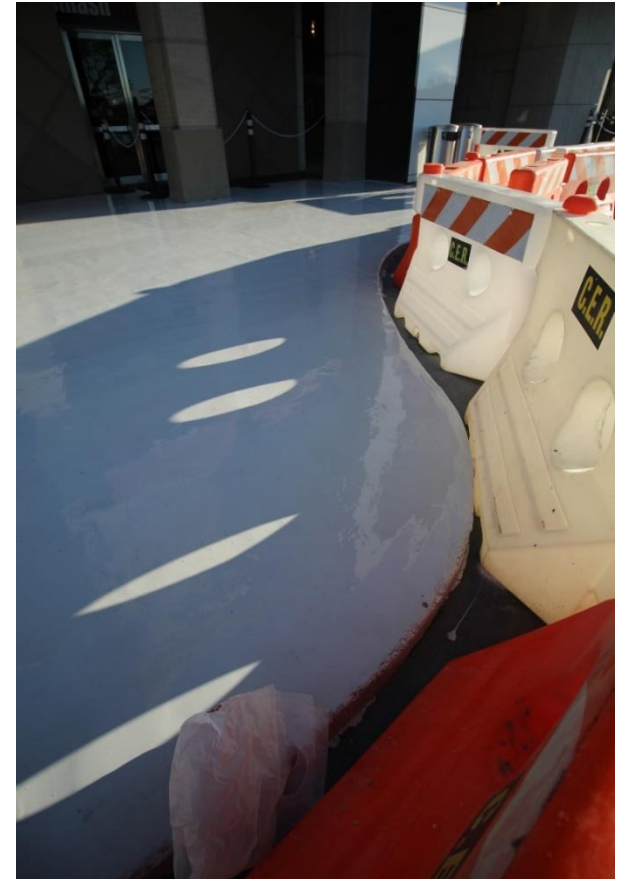
- Minimal to heavy resurfacing
- Options for sloping and building crickets





# RESURFACING

- Restore appearance
- Selections for featheredging





# RESURFACING

- Options requiring less preparation (CSP-3)
- Eliminate tripping hazards



# RESURFACING

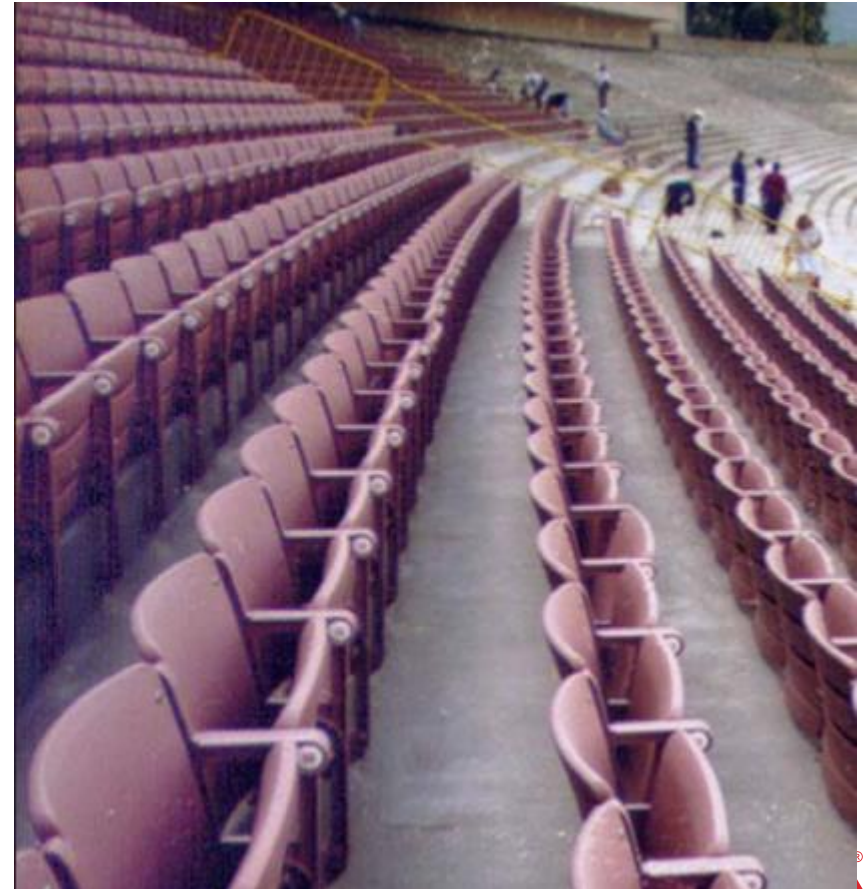
- Finishing choices
- Fast curing options for traffic or coatings





# RESURFACING

- The Rose Bowl (2008)
- 1 million sf of SikaTop 122 PLUS
- 2018 Winner of ICRI Longevity Award



# REPAIR MATERIAL SELECTION

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# SPRAY APPLY

- Spray apply the repair material
- Also referred to as machine applied, shotcrete, and gunitite
- Gunitite infers wet process, high volume, high pressure, and large aggregate
- Shotcrete can be done as wet or dry process with high pressure
- Low pressure spraying is wet process







# SPRAY APPLY

## Wet Process Shotcrete

- Mixer
- Pump mixed material through line



# SPRAY APPLY

## Wet Process Shotcrete

- Slow setting material
- May use retarder and accelerator
- Can hang several inches thick at a time





# SPRAY APPLY

## Wet Process Shotcrete

- Larger volume applications
- Continuous areas



# SPRAY APPLY

## Dry Process Shotcrete

- Larger repair areas
- Mobile and long line capable
- Simple start and stop





# SPRAY APPLY

## Dry Process Shotcrete

- Mixing at nozzle
- Excellent hanging





# SPRAY APPLY

## Dry Process Shotcrete

- Can minimize dust and rebound





# SPRAY APPLY

## Dry Process Shotcrete

- Naturally controlled water-cement ratio to hang yet limit dust
- Paste forced into pores as aggregates initially rebound



# SPRAY APPLY

## Dry Process Shotcrete

- Plenty of finishing time
- Quality repair





# SPRAY APPLY

## Low Pressure Spray

- Much faster than troweling onto surface
- Gets mixed material onto surface quickly saving time and labor



# SPRAY APPLY

## Low Pressure Spray

- Economical equipment





# SPRAY APPLY

## Low Pressure Spray

- Bonding agent or scrub coat
- Continue spraying and finish

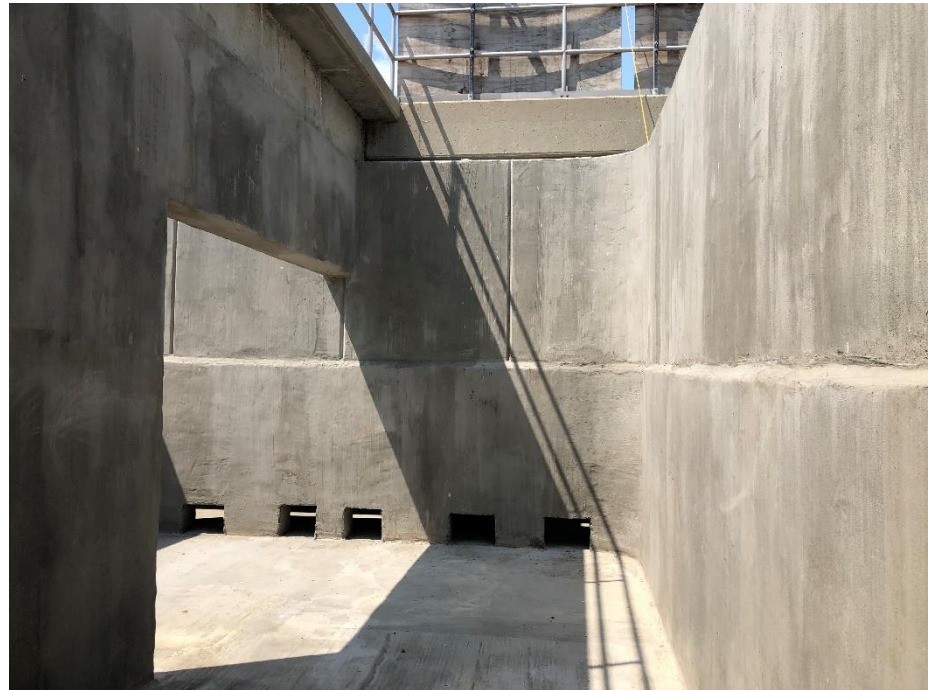




# SPRAY APPLY

## Low Pressure Spray

- Durable repairs performed efficiently





# AVAILABLE RELATED PRESENTATIONS

- ✓ Concrete Repair (Part 1 – Material Selection)
- ✓ Concrete Repair (Part 2 – Preparation & Installation)
- Crack Repair
- Concrete Protection



Baltimore Design School – 2014 ICRI  
Sustainability Award Winner

**THANK YOU FOR YOUR ATTENTION!**

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BUILDING TRUST

