



## CONCRETE REPAIR (PART 2 – APPLICATION)

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WITH SIKA SINCE 1991

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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

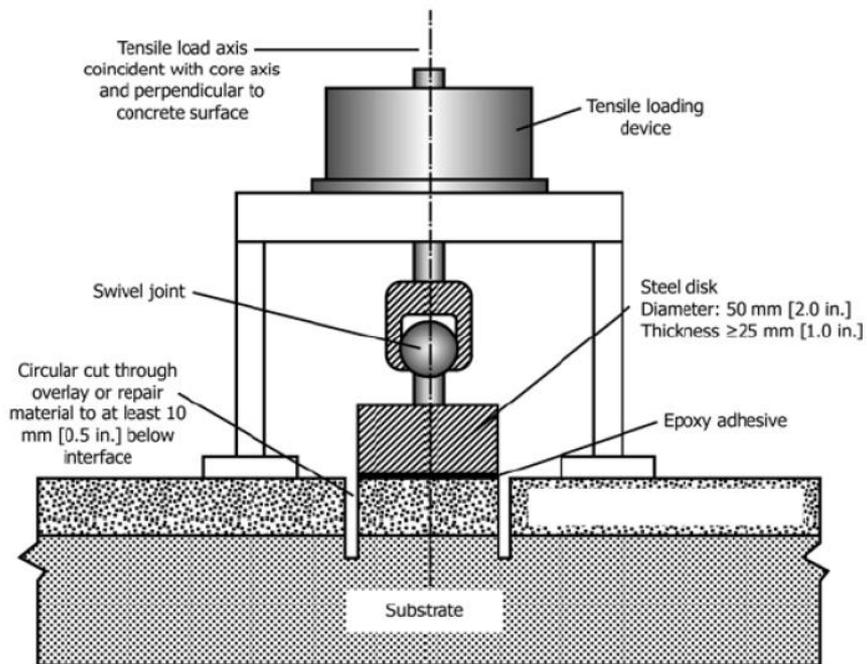
# CONCRETE REPAIR

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



# SURFACE PREPARATION

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



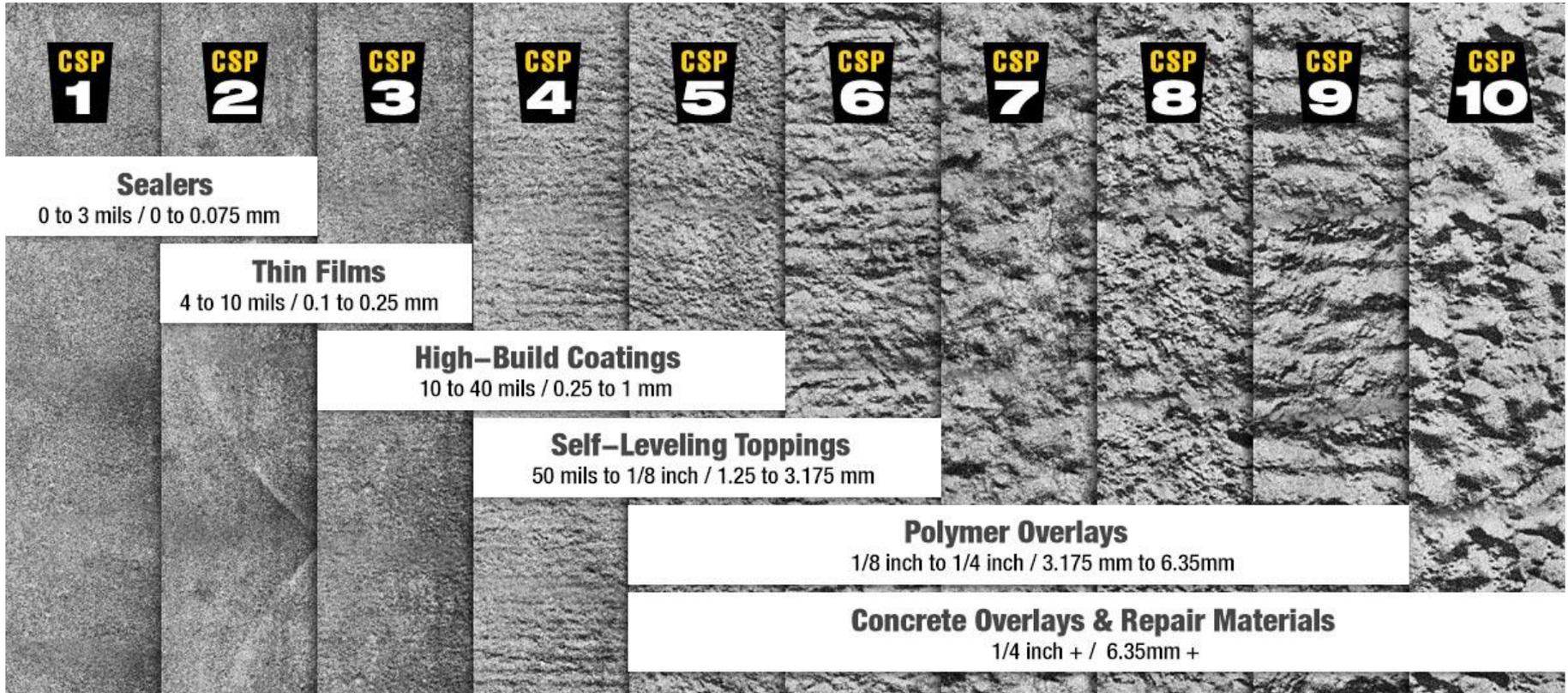
- A:



- B:



# 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



# PLANERS



# PLANERS



# PLANERS





# HIGH PRESSURE WATER

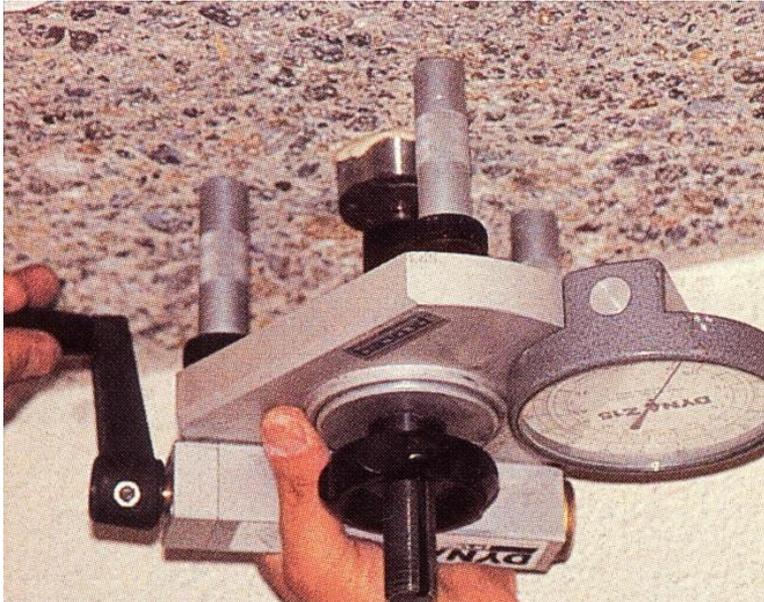


# ULTRA HIGH-PRESSURE WATER (HYDRODEMOLITION)



# VERIFYING SURFACE PREPARATION

- Direct pull testing can be performed according to ASTM 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
- ¼" plus diameter of largest aggregate in repair material (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



# 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**

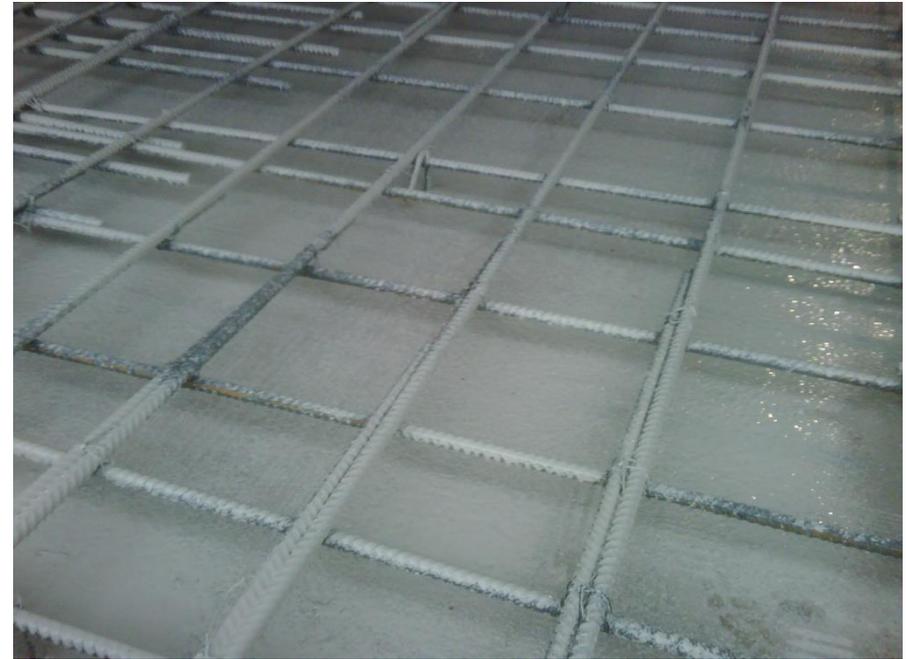




# BONDING AGENT AND REINFORCEMENT COATING

## Sikadur 32 Hi-Mod

- 100% epoxy
- Strongest adhesive
- Impermeable reinforcement coating

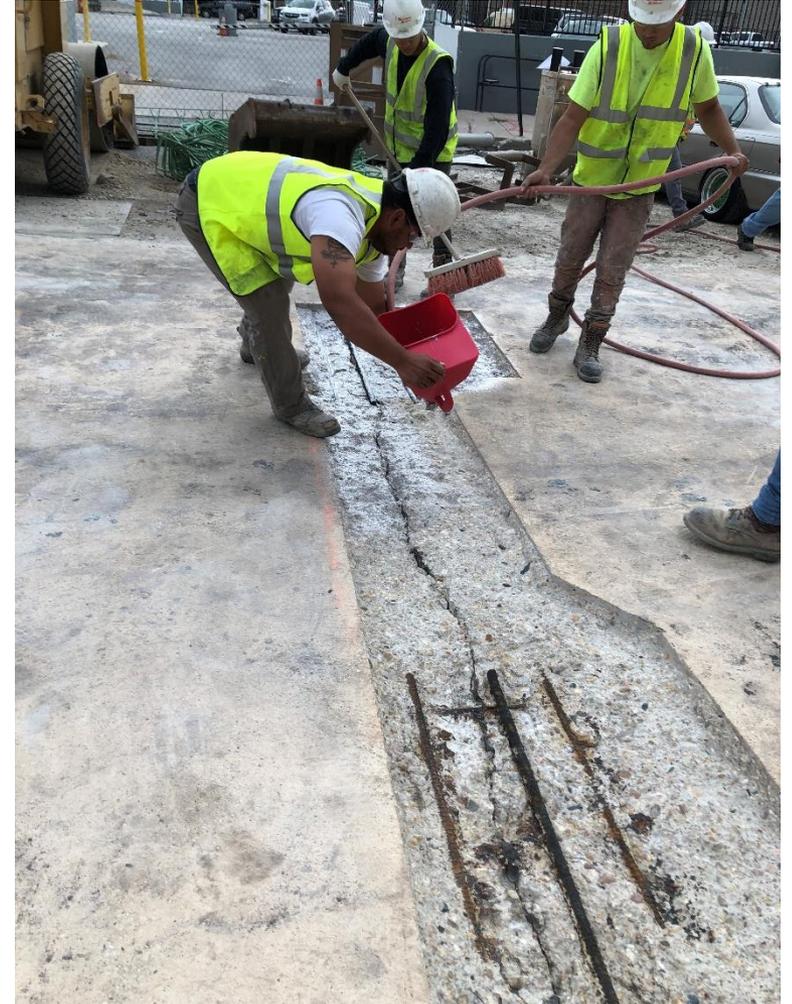


# BONDING AGENT AND REINFORCEMENT COATING



## 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



## 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

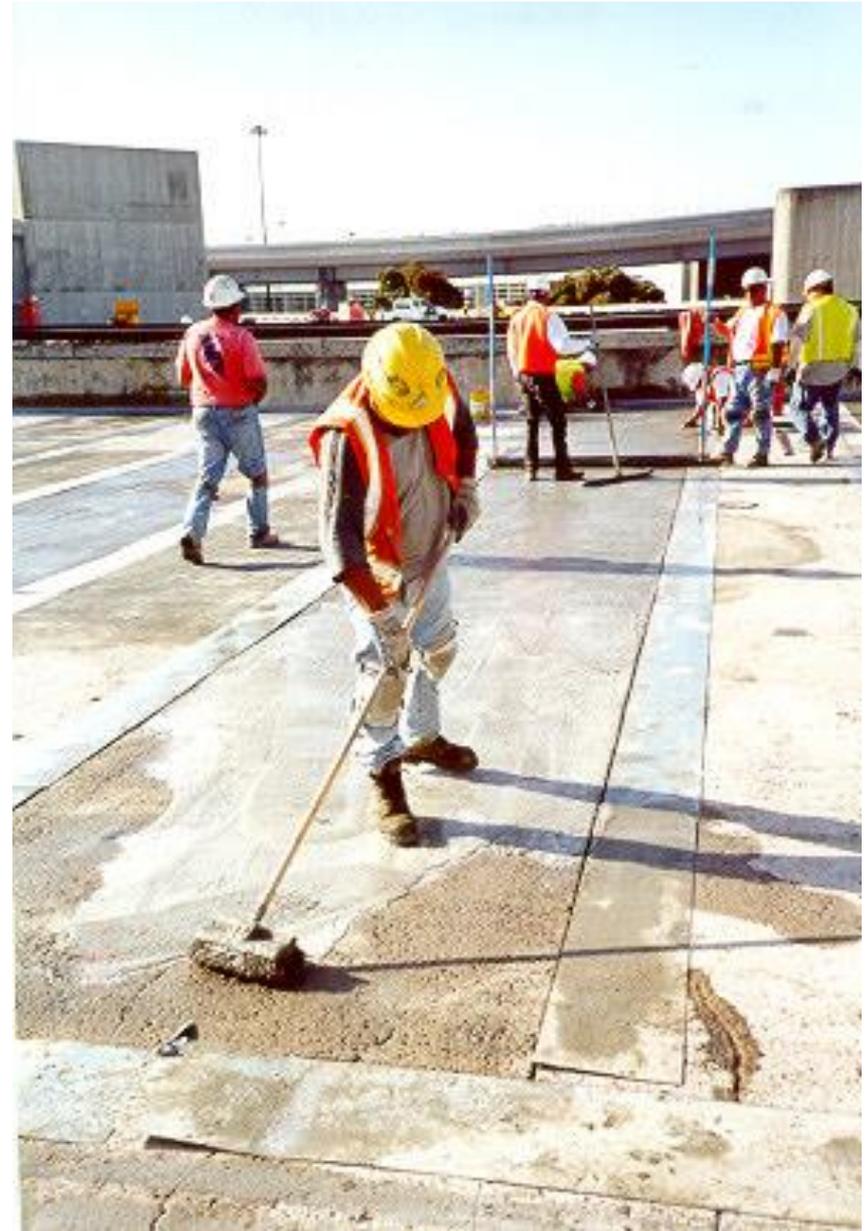
- 0-16 hours contact time\*
- Dry in about 1 hour
- 90-minute pot life\*
- Breathable
- Clean tools with water



# 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)



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# 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
Coating Mortar	SikaTop Seal 107	Sikagard FlexCoat	SikaTop 144
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



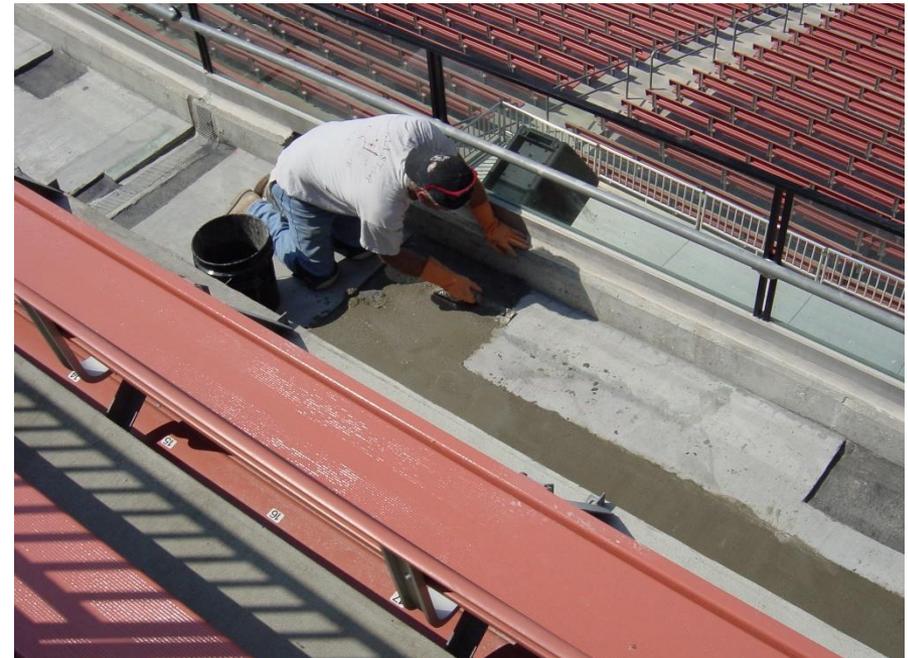
# POURABLE APPLICATIONS

- 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



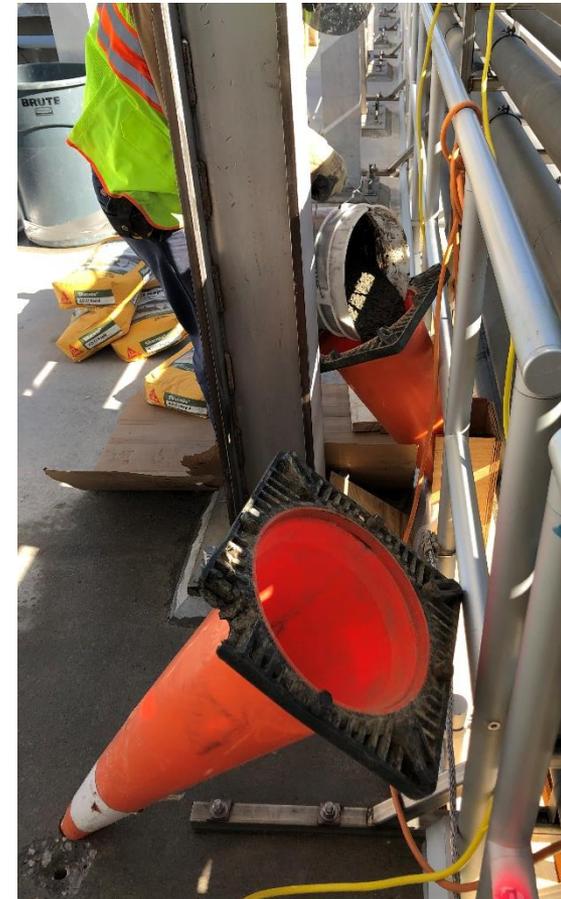
# FORM AND POUR

- 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



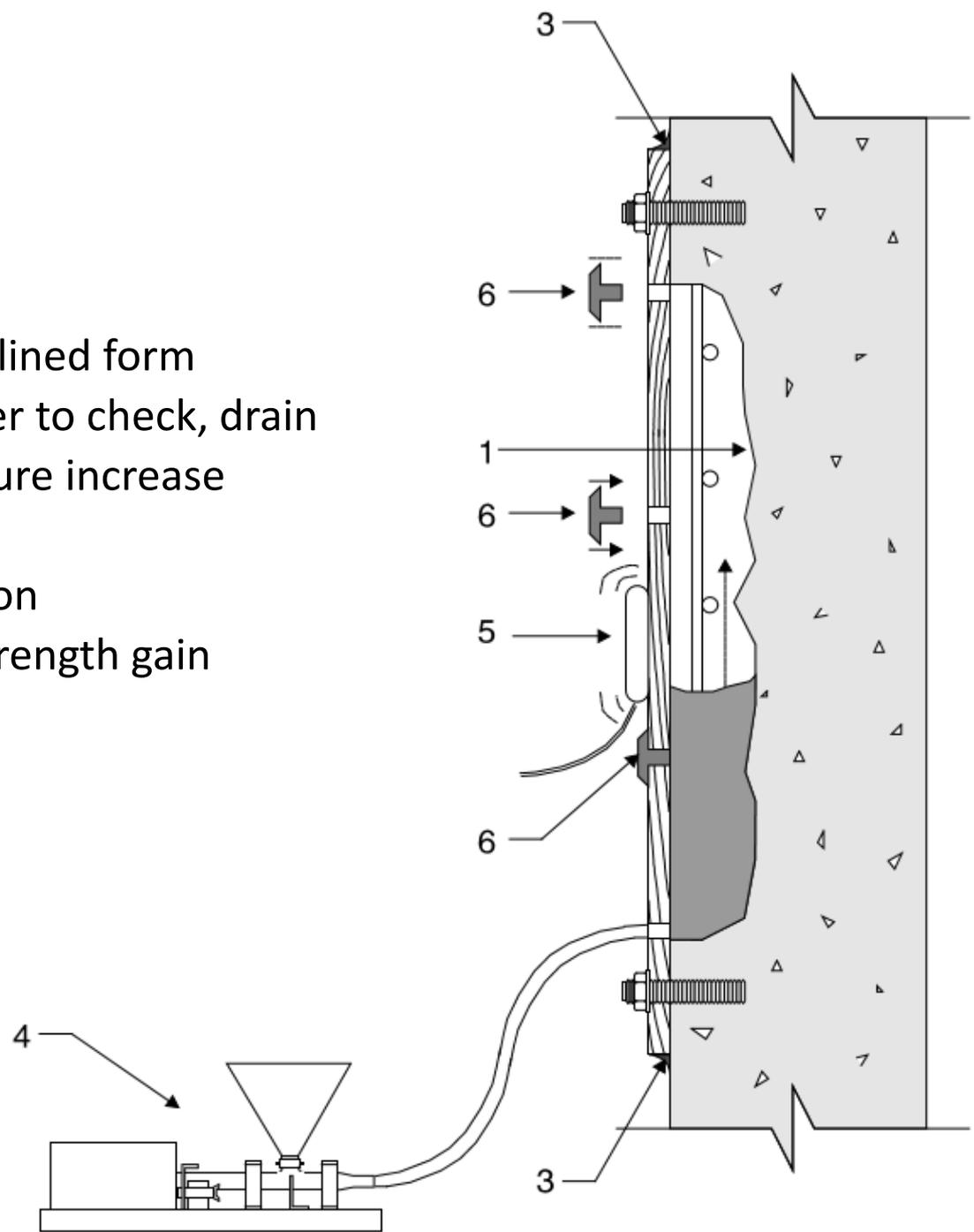
# FORM AND POUR

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



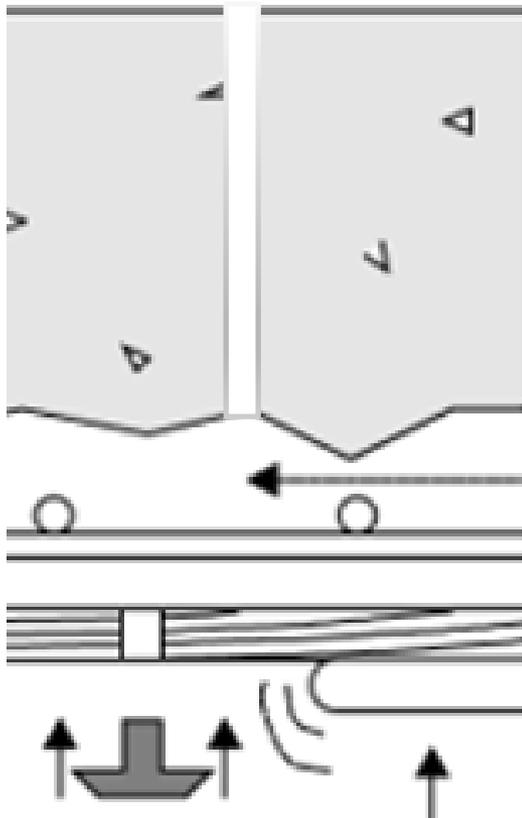
# FORM AND PUMP

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

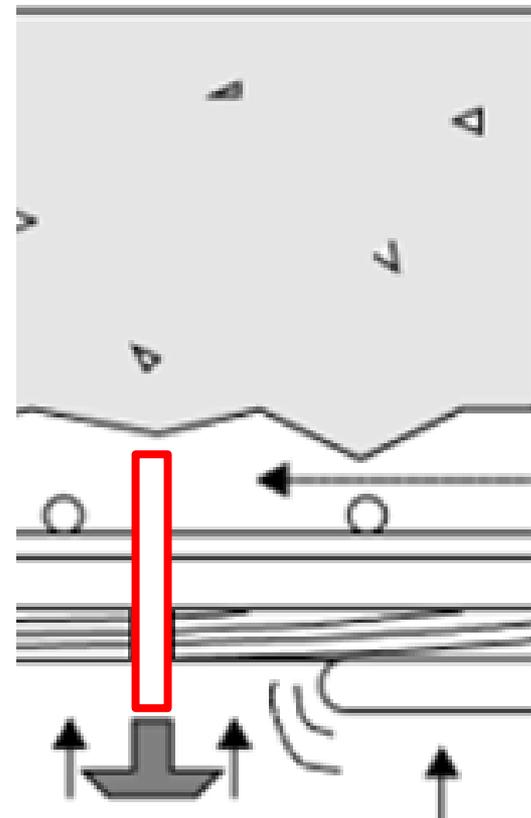


# VENTING OVERHEAD FORMS

- 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

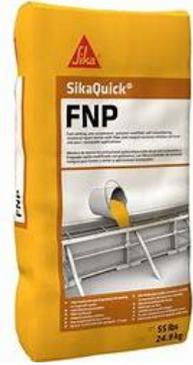


# FORM AND PUMP

- 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

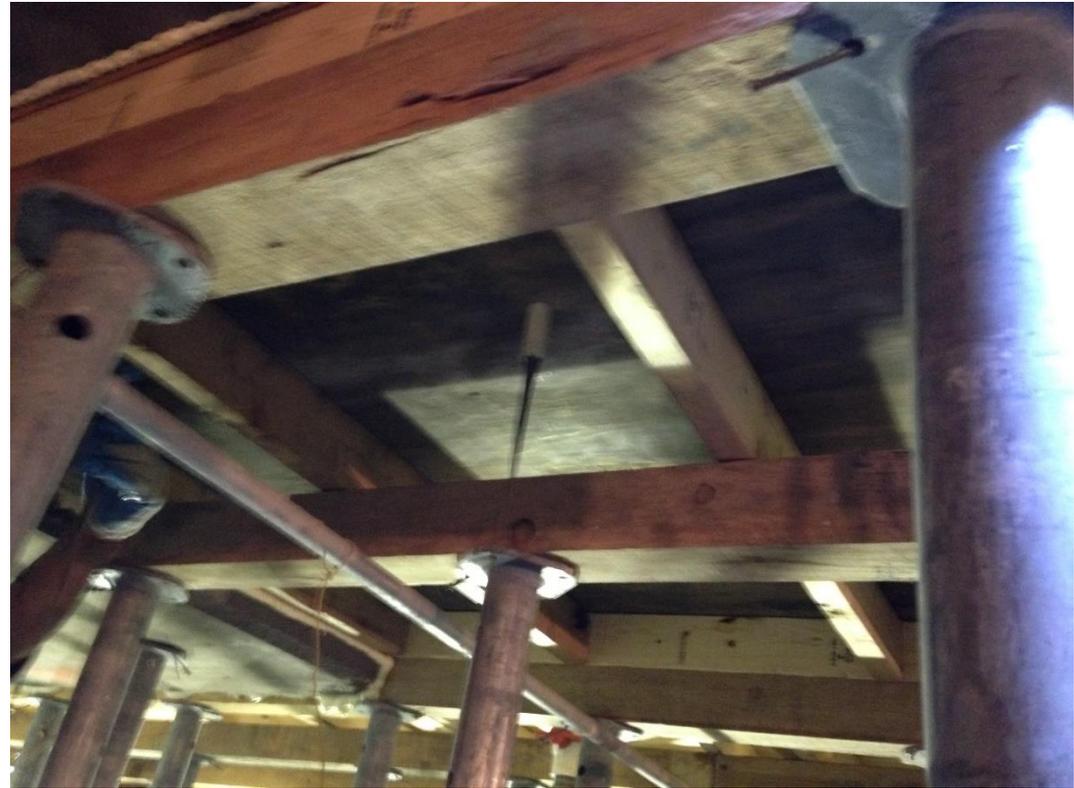
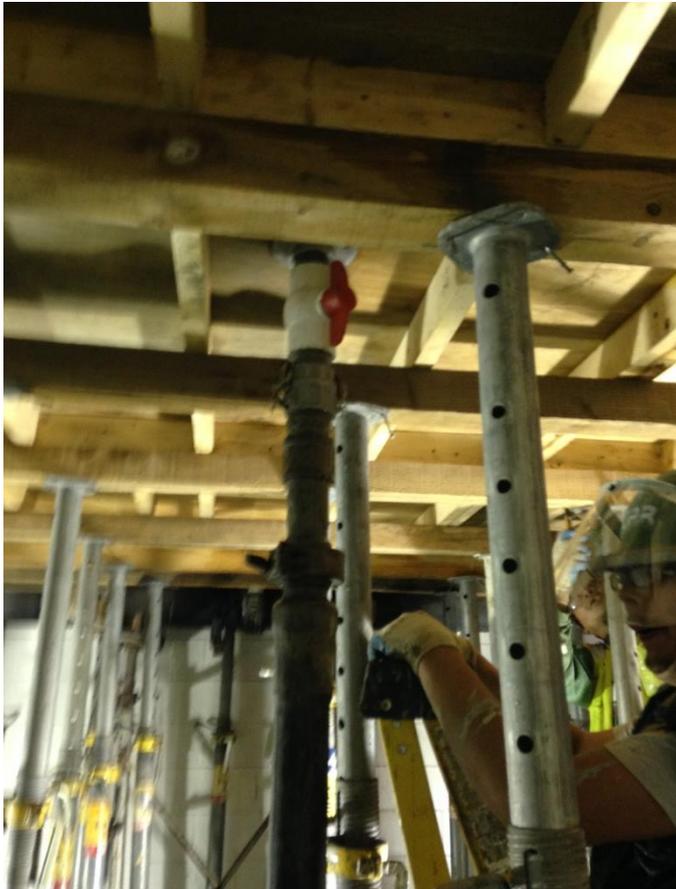
- Slick lines before starting
- Choose material for flow, working time, and line diameter and length



Slab too thick for top venting

# FORM AND PUMP

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



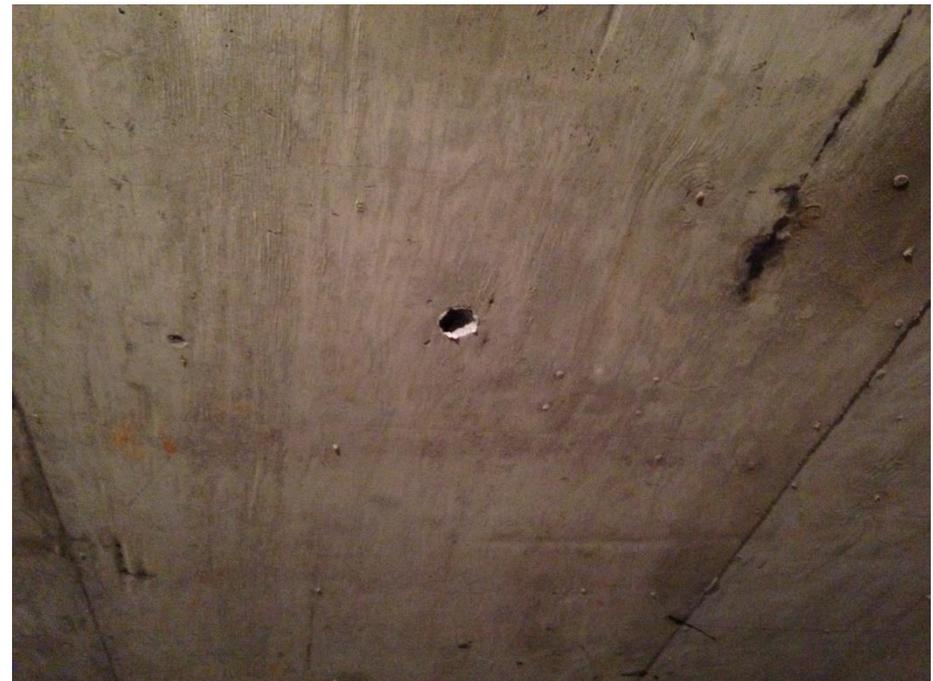
# FORM AND PUMP

- 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



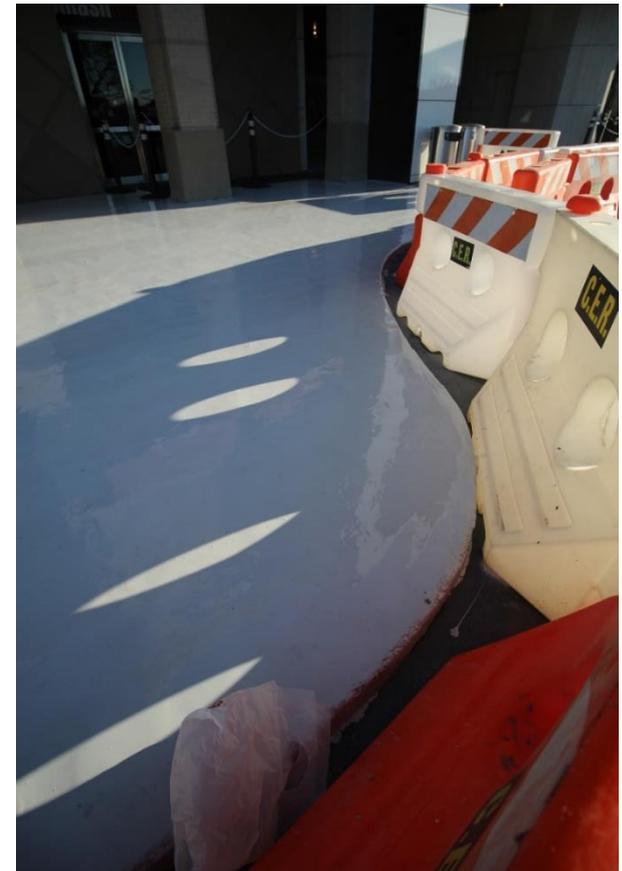
# RESURFACING

- 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



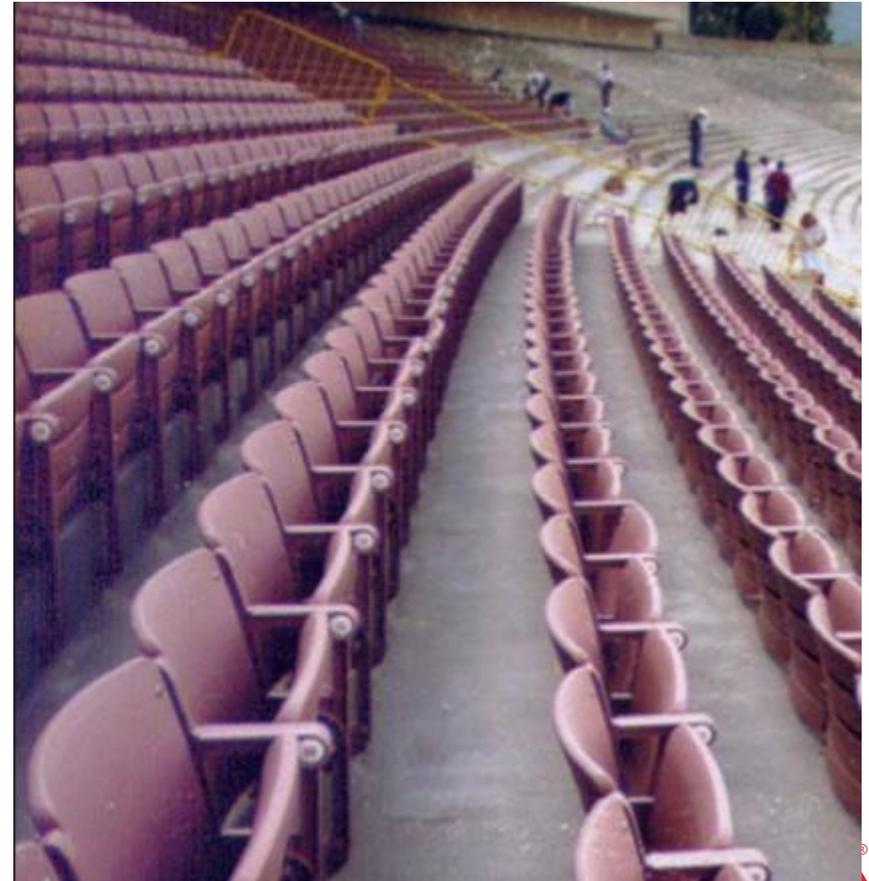
# RESURFACING

- 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



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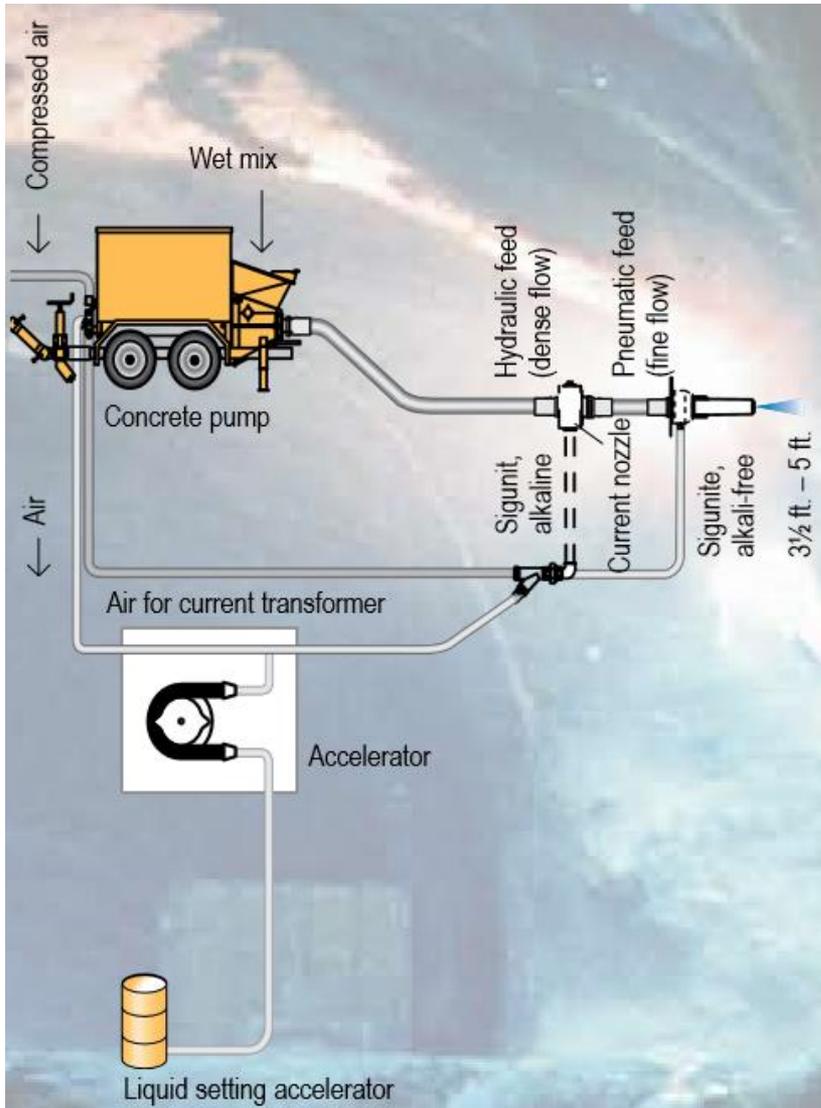
# SPRAY APPLY

- 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

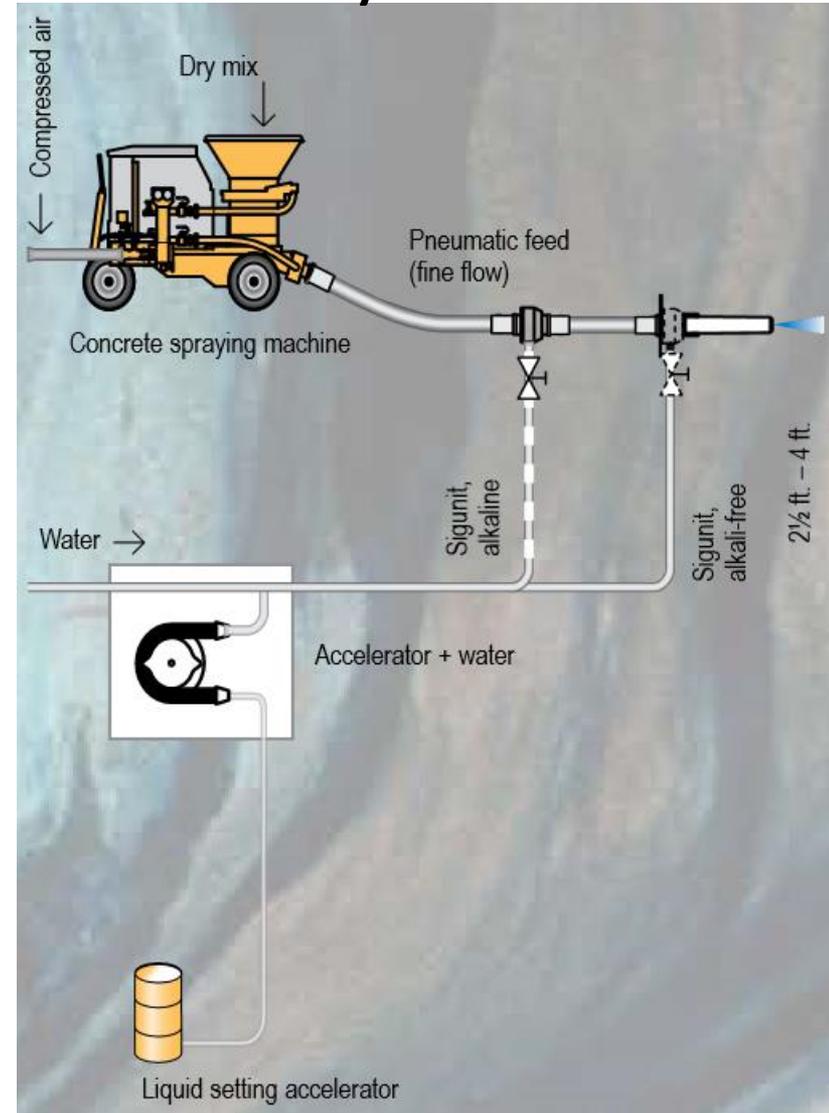


# SPRAY APPLY

## Wet Process



## Dry 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

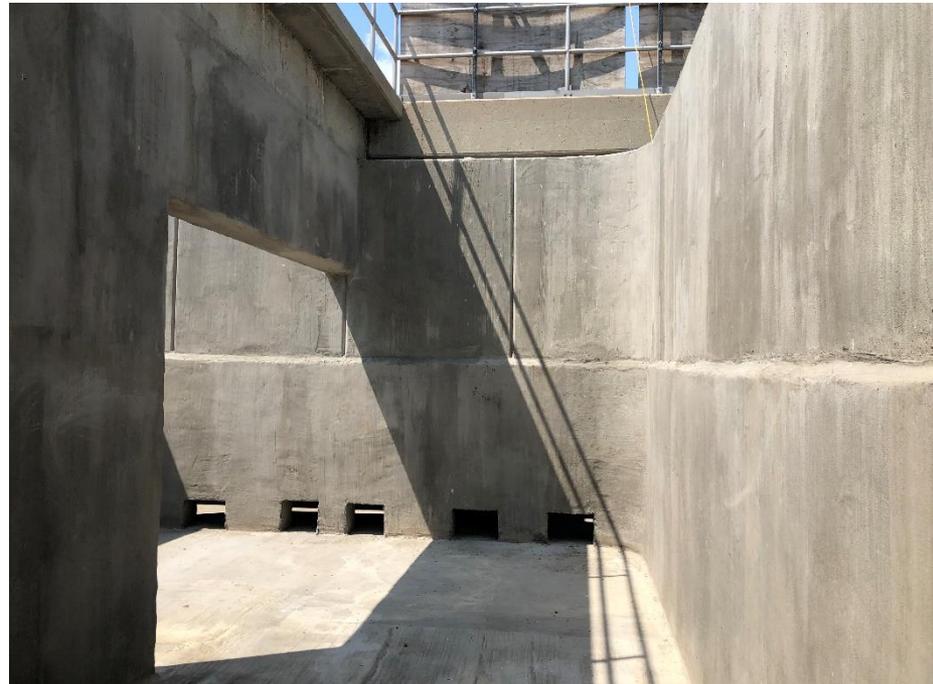
- Bonding agent or scrub coat
- Continue spraying and finish



# SPRAY APPLY

## Low Pressure Spray

- Durable repairs performed efficiently





Baltimore Design School – 2014 ICRI  
Sustainability Award Winner

**THANK YOU FOR YOUR ATTENTION!**

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