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Field Guide to Concrete Repair Application Procedures

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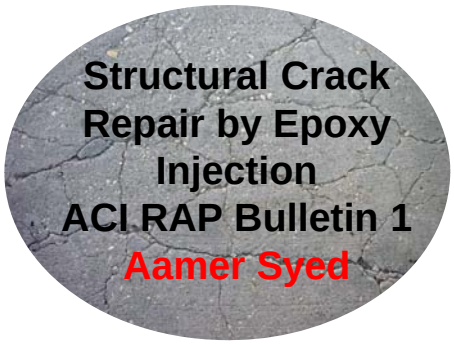


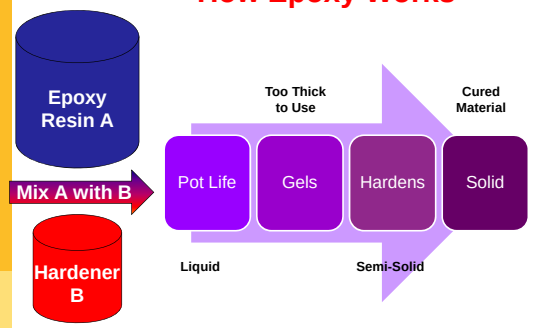
Purpose of Epoxy Injection

1. To restore structural integrity to concrete constructions
2. To resist the penetration of moisture in concrete elements

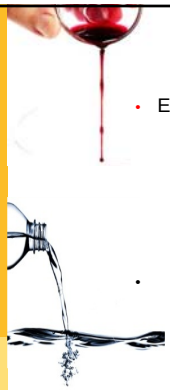

Vertical Cracks


Horizontal Cracks

How Epoxy Works



Properties



- Epoxies (Thermosetting Resins) have varying:
  - Modulus of Elasticity
  - Viscosity
    - Water = 1 centipoise
    - Syrup = 3000 centipoise
  - Coefficient of Thermal Expansion
- Exothermic Reaction
  - Produces Heat
  - Mixing time is critical
  - Manage the working time

When to Use Injection Method?

- Horizontal, Vertical & Overhead Cracks where conventional repair methods do not work
- Structural Crack Repair
- Static Cracks
- Moving cracks are not typically injected

Choosing the Right Epoxy

- Crack width <.02" - use an LV epoxy (500 cps or less)
- For wider cracks or one sided injection medium viscosity or gel can be used
- Other specs to consider:
  - Rigidity (MOE)
  - Working Life
  - Moisture Tolerance
  - Color
  - Compressive, Flexural, & Tensile Strengths

Table 1—ASTM C 881 requirements for epoxy resins that are used to bond hardened concrete to hardened concrete

	Type I[A]	Type IV[B]
Viscosity, centipoise		
Grade 1 (low-viscosity), maximum	2000	2000
Grade 2 (medium-viscosity), maximum	2000	2000
Maximum	10,000	10,000
Consistency, in.		
Grade 3 (non-sagging), maximum	1/4	1/4
Gel time, min.	30	30
Bond strength, minimum, psi		
2 days, moist cure[C]	1000	1000
14 days, moist cure	1500	1500
Absorption, 24 h maximum, %	1	1
Heat deflection temperature		
7 days minimum, °F	—	120
Linear coefficient of shrinkage		
On cure, maximum	0.005	0.005
Compressive yield strength		
7 days minimum, psi	8000	10,000
Compression modulus, minimum, psi	150,000	200,000
Tensile strength, 7 days minimum, psi	5000	7000
Elongation at break, minimum, %	1	1

[A] Type I: for use in non-load-bearing applications.
[B] Type IV: for use in load-bearing applications.
Source: ASTM C 881, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
[C] Moist-cured systems should be tested by assembling the sections to be bonded before immersing in water.

Equipment

For high or low pressure systems:

- Injection Ports
- Wire Brush or Grinder
- Air Guns
- Hand-Actuated Delivery System
- Spring Actuated Capsules
- Balloon-Actuated Capsules

Safety

- MSDS for all materials used
- Protective Clothing, Eyewear & Gloves
- Eye wash station / Ventilation
- Special Precautions for flammable/combustible material
- Necessary cleaning equipment
- Notify occupants of pending repairs

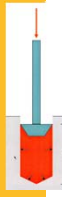
Preparation

- Clean surface ½" wide on each side of crack
- Wire brush recommended , grinders fill crack with unwanted dust
- Remove contaminants with "oil-free" compressed air or vacuums
- If concrete adjacent to crack is deteriorated, "V-Groove" the crack until sound concrete is reached.

Repair Procedure

1. Port Installation
2. Install the Cap Seal
3. Inject the Epoxy
4. Remove Ports & Cap Seal

Port Installation



- Two types of Ports
  - Surface Mounted – mainly used
  - Socket Mounted – used when crack is blocked
- **Spacing is typically 8”** – assume 4” travel of material in one direction
- Manifold system can be used for simultaneous injection

Install the Cap Seal

- Properly installed this contains the epoxy as it is injected under pressure into the crack
- If not done right leaks will occur
- Consistent application is a must: inconsistencies = failure point
- Capseal can be epoxies as well as polyester, wax or silicone caulk

Inject the Epoxy

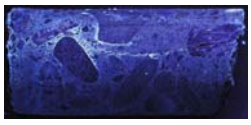
- Epoxy must be batched and mixed properly
- Start at widest point
- Vertical cracks are done from the bottom up
- Continue injection until refusal
- If hairline crack try increasing pressure and time (This must be managed to prevent blowout)
- When injection into port is complete cap immediately

Remove Ports and Cap Seal

- Can remove by heat, chipping or grinding
- Can be left if appearance is not of importance

Verification

- Penetration - Core samples
  - Fine Cracks – Epoxy glows under Black Light
  - Structural Compressive & Tensile
    - ASTM 42



- Non-Destructive
  - Impact Echo
  - Ultrasonic Pulse Velocity
  - Spectral Analysis of Surface Waves