Use of Crack Sealers/Healers for Protecting Concrete Decks with Focus on MMA Technology

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Summary

- Problem:
  - Hairline cracks that lead to the deterioration of concrete decks
- Solution:
  - Overview of Available Technologies
- MMA Technology
  - Gravity-Fed Sealer with Ultra-Low Viscosity
  - How it Works
  - Lab Test Results
  - Case Histories
  - Advantages

Steel Reinforced Concrete Bridge Deck Deterioration

Steel Reinforced Concrete (SRC) bridge deck deterioration frequently stems from the presence of cracks on the bridge deck.

Cracks are way to entry for water and chlorides.

Water causes damage by freeze-thaw, which induces superficial concrete spalls.

Chlorides causes steel bar corrosion, which is responsible for deep concrete spalls and loss of steel section, which can affect the structural integrity of the bridge

- FHWA AASHTO emphasis on crack sealing as deck protection for bridge preservation

Crack Healer / Sealer: Ideal Solution for Bridge Deck Preservation

- "Preservation" entails actions and strategies in order to:
  - Prevent, delay and reduce deterioration of the bridge elements;
  - Restore functions of existing bridge elements;
  - Extend useful life of bridges.
- Types of interventions in order to keep bridges functioning:
  - Maintenance $
  - Repair $$$
  - Rehabilitation $$$$$
  - Replacement $$$$$$$$

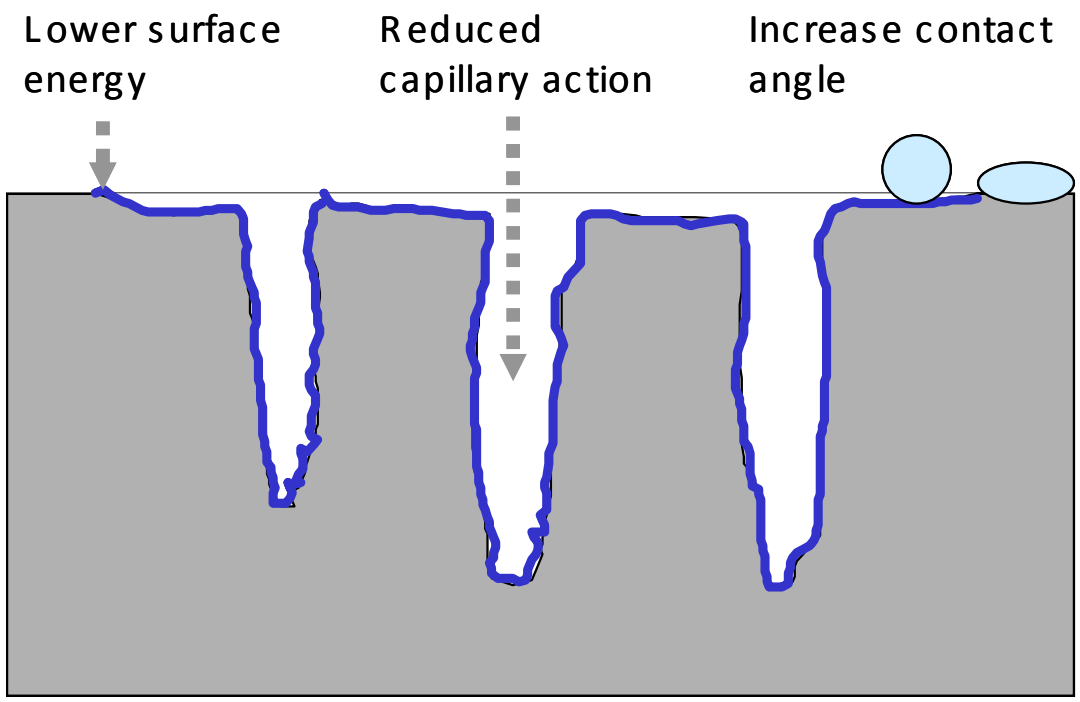
"**Keep Good Bridges Good**" is the essence of asset management principles promoted and supported by FHWA.

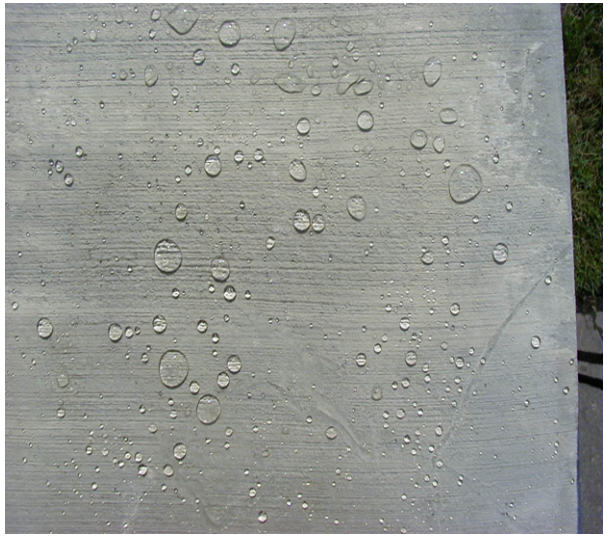
Crack Sealer / Healers: maintenance application with the value of repair job. In line with asset management principles.

Crack Treatments to Prevent Bridge Deck Deterioration

- Water Repellents
  - Flooding of the surface
- Low Viscosity Epoxy
  - Gravity fed
    - Sealing individual cracks
    - Flooding the surface
  - Pressure injection
- Methacrylate
  - Flooding on the surface

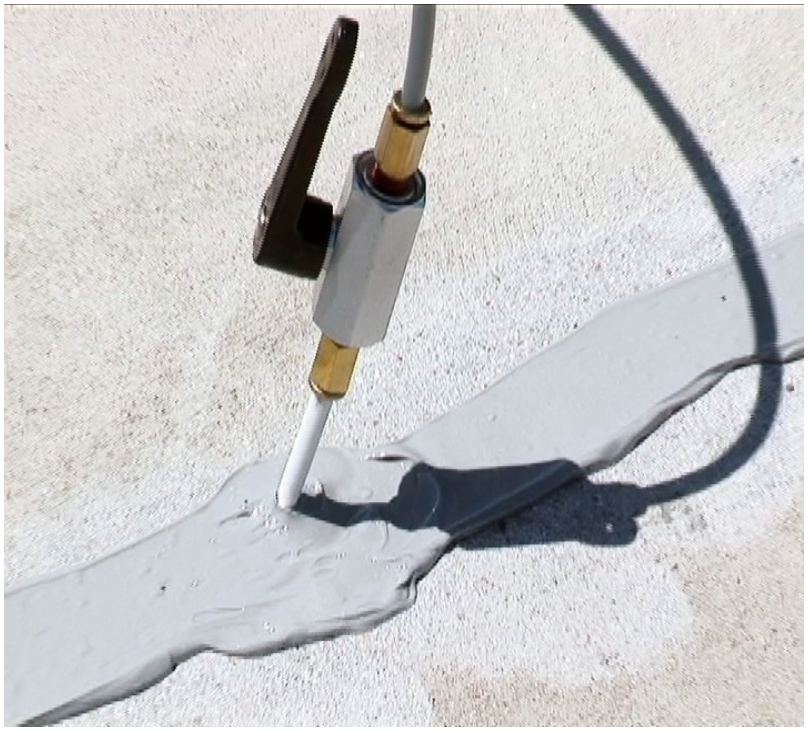
Water Repellents:
Make Concrete Surface Hydrophobic





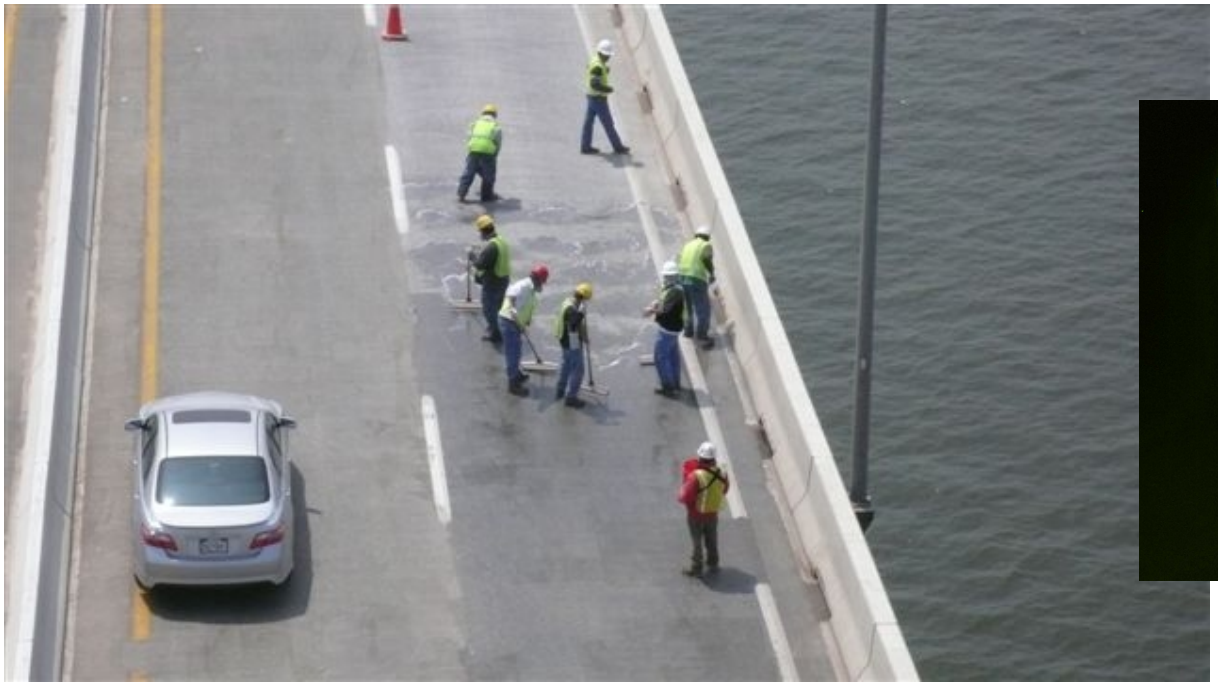
Silane water repellents lower the surface energy, increase contact angle, repel water, promote beading and reduce capillary action in pores. They prevent entry of water into concrete surface including cracks.

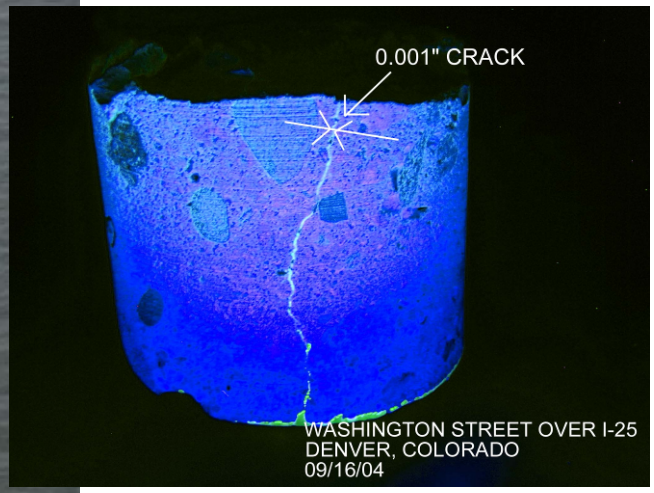
Epoxy:
Fields of Application



- Gravity Feed
  - V-notch and Fill
  - Ultra Low Viscosity
- Pressure Injection
  - Cracks 0.002 to 0.25 in. (2 to 250 mils) in Width
  - Ultra Low Viscosity or Gel
- ASTM C 881, Type I or IV
- Non-moving Cracks

Methacrylate (MMA): Uniquely Seals Capillary Cracks





MMA penetrates cracks by gravity down to 0.001 in. (1 mil). Application can be conducted quickly and safely while the bridge remains open to traffic.

Summary: Silane, Epoxy and Methacrylate

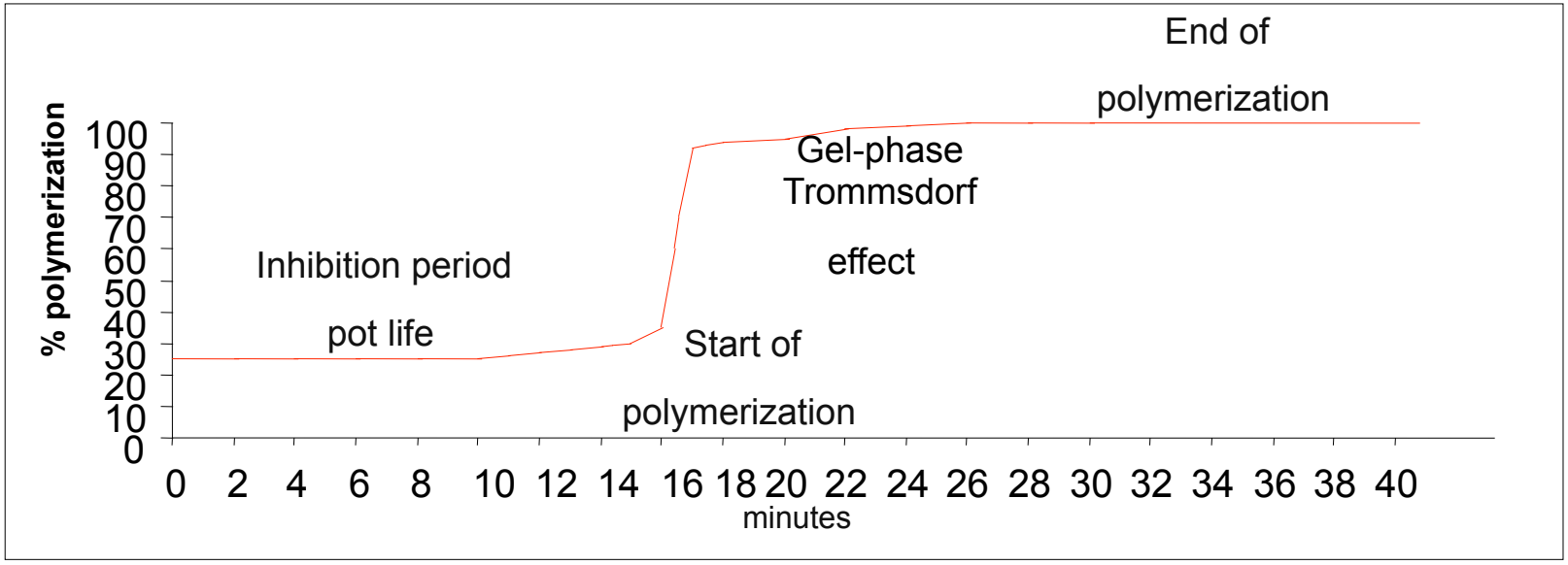
	Silane Water Repellent	Epoxy	Methacrylate
Fine Crack < 5 mils	Penetrates, makes concrete hydrophobic	Pressure injection: Fills and seals	penetrates & fills
Larger Cracks 5 - 40 mils	not applicable	Gravity fed: Seals and generally fills	deep penetration, completely fills crack
Set time	Open to traffic when dry - 2 to 4 hours	20 min working, 10+ hours for true set	15 minutes, open to traffic in 1 hour
Daily production	100,000 sq.ft (spray bar)	Slow, both gravity fed and pressure injection	30,000 sf depending +/-
Effective crack filler	not a crack filler	Depending on the application	all cracks
Effective water repellant	yes	yes surface protection, until worn off for flood applications	Yes but relies on filling the crack to keep water out
Cost/ Sq.ft. est.	Very fast, low labor cost can be applied with basic training.	Lowest material cost, highest labor and time cost, esp. pressure injection.	Highest material, very fast, low labor cost.

Methacrylate (MMA): Deep Penetration in One Hour Cure

Rapid curing reactive methacrylate resin MMA is formulated to fill and seal cracks by gravity over concrete substrates

Fully cures in less than 1 hour (see gel-phase effect)

Cures from 14 to 104 F (-10 to 40 C) ambient temperature



Common Uses of Methacrylate Technology

Industrial/Commercial Floors

Coatings/Protective Sealers

Dental Bonding Materials

Artificial Joint Replacements

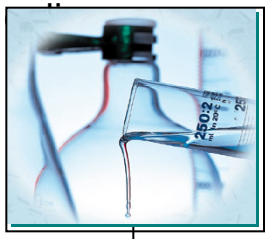
Contact Lenses

Acrylic Auto/Boat Parts

Helicopter Blades

Methacrylate Technology Development

First world-class MMA plant goes

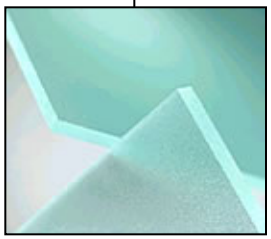


Polymer concretes

Waterproofing membranes

Rapid curing crack sealers

1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000



Plexiglass (PMMA) invented by Otto Röhm

Reactive resins developed for road marking, industrial flooring

Thin polymer overlays
Injection gels
Structural adhesives

MMA:
Easy and Fast Application

Mixing

Spreading

Sand Broadcasting

Final

MMA Powder Hardner:

- Surface Preparation
  - Concrete should be clean, free of contaminants, dry, and fully cured.
  - Inspect the underside of the deck for signs of leakage due to full depth crack
  - Expose aggregate and remove loose materials using a dust-free mobile shotblaster.
- Mixing
  - Add Powder Hardener to Resin and mix until dissolved (approx. 1 minute).

  Application
  - MMA Resin is applied as a flood coat in a gravity-fed process by broom or nap solvent grade roller (1/2 “ to 3/4 “).
  - Mixed batch should be immediately poured into the substrate and worked into cracks. Working time is 10 - 15 minutes once the batch has been applied to the substrate.
  - Do not allow the mixed batch to remain in the mixing vessel. Randomly broadcast dry aggregate into the wet uncured resin.
- Pre-Treat Wide Cracks
  - Cracks over 1/8 “ should be treated individually prior to deck application. Fill with dry 30 mesh silica sand. Pour the resin into the cracks and distribute with a paint brush.

MMA Crack Sealer:
Same Application, Core Comparison

MMA Crack Sealer cores

Epoxy resin cores: Lesser penetration and adhesion

MMA Crack Sealer : Full Depth (6”) from 0.005 to 0.04”Opening

0.04 in
40 mils

0.02 in.
20 mils

0.01 in.
10 mils

0.005 in.
5 mils

MMA Crack Sealer :
Wakota Bridge Application

Owner: Minnesota Department of Transportation

Contractor: Lunda Construction Company

Project size: 180,000 square feet Year: 2006

Wakota Bridge: Cracks

- Close to bridge opening, transverse cracks were discovered in the concrete overlay.
- The majority of the cracks were hairline cracks, barely detectable except after rain events.
- Low viscosity epoxy was tested in parallel with MMA.
- The small size of the cracks (down to 1 mil) made it difficult, costly, and time consuming to attempt to fill cracks by low viscosity epoxy. Furthermore the result was not reliable.

Wakota Bridge: Mixing

- MMA Crack Sealer was supplied in the project in 49 gallons drums.
- The drums were laid on dollies and fitted with valves for easy mixing and ease of movement on the deck.
- The material was mixed in five gallon batches using a BPO Hardener in amounts appropriate for the daily temperatures.

Wakota Bridge: Application

- White pigmented curing compound was removed by sandblasting. Sandblasting removes contaminants that might inhibit penetration while also exposing additional cracks that were not previously visible.
- MMA Crack Sealer was poured out on concrete and workers moved the material along the deck using solvent resistant rollers on extension polls. The material was applied at a rate of approximately 100 square feet per gallon.

Wakota Bridge: Sacrificial Layer

- The very low viscosity of MMA Crack Sealer (5-15 cps) allowed the material to penetrate even the smallest cracks while not altering the surface profile.
- Cores shows crack penetration of a minimum of one-inch up to full depth.
- Silica sand was broadcast into wet MMA Crack Sealer to provide slip resistance. This sacrificial layer will wear off over time with abrasion.
- The 180,000 square feet bridge deck surface application took approximately five days (not including surface preparation time)

MMA Crack Sealer : Benefits

- Easiness of application
  - Limited equipment use and cost. No blending
  - Chart for using the Powder Hardener – No guess
- High productivity
  - With 6 people crew (1 mixing, 1 dumping, 1 spreading, 3 applying):

    up to 50,000 sq.ft/day

    average 30,000 sq.ft/day
- Efficiency
  - Rapidly re-open to traffic
- Safety
  - Shorter lane closures
- Extend working season
  - Low temperature application

A Few US References

Year	Project Name	Location
2002	**Commodore Barry Bridge**	**NJ -** Connecting NJ with PA
2006	**Route 3**	**MA -** North of Boston
2006	**Wakota Bridge**	**MN -** Saint Paul
2006	**Triboro Bridge**	**NY -** connecting Manhattan-Bronx and Queens
2006	**Verrazano Narrows Bridge**	**NY -** Staten Island
2007	**Nordel Overpass**	**BC -** Delta
2008	**Francis Scott Key Bridge**	**MD -** Baltimore
2008	**I5 Salem**	**OR**
2008	**I5 Sutherlin**	**OR**
2008	**Little Smoky Bridge**	**AB - Canada -** Near Peace River
2008	**Spring Bank Overpass**	**AB - Canada -** Near Calgary
2008	**I-35W**	**MN -** Minneapolis

Thank You !