High Molecular Weight Methacrylate Acrylic Resin for Sealing Bridge Deck Cracks and Surfaces

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A Tribute to Michael M. Sprinkel, PE

“A Forward-Thinking Engineer”

Early History

In the 1970's Methyl Methacrylate (MMA) resins with low viscosity of <25 cps were evaluated as an effective material for sealing cracks in horizontal concrete surfaces, primarily bridge decks.

Evaluation goals:

- Determine minimum crack width MMA could penetrate.
- What bond strength of the cured MMA to the crack walls could be anticipated?
- Would the MMA act to restore any of the initial concrete strength prior to crack formation?
- What method of application would achieve the best result?
- Where there any safety concerns with MMA for field applications?

First Application Methods

In the 1970's Brookhaven National Laboratory in Brookhaven New York worked on the development of a method for the polymer impregnation of concrete (PIC) to seal cracks and surface porosity in concrete bridge decks.

- Dry the concrete with kerosene heaters from below deck 300Fair temp 200F deck temp. Up to 6 days drying
- Allow the concrete deck to cool to 100F
- Apply a ½ inch layer of clean, dry sand to the concrete surface
- Apply the MMA resin to the sand surface
- Reapply heaters
- Apply heat to cure MMA resin

Application Results

- The MMA resin successfully penetrated the sand layer and sealed the concrete surface however crack penetration depth was approximately 0.50 in.

- The low viscosity of the MMA resin made it difficult to maintain a consistent application thickness due to resin flow caused by the surface cross slope.

- The MMA resin flash point of 50F raised concerns about a potential safety issue with the use of heaters to cure the MMA resin.
  Ultimately this application method was determined to be dangerous and total installation time was not practicle for field

Industry Resin Development

In the 1980's Rhome and Haas developed a new resin based on High Molecular Weight Methacrylate (HMWM).

Advantages of HMWM vs. MMA

- Both HMWM and MMA exhibited similar viscosities of 10 – 25 cps.
- HMWM could be cured using and initiator Cobalt Naphthenate and a promoter of Cumyl Hydroperoxide vs. heat curing.
- HMWM gel time could be extended with initiator and promoter ratios allowing for greater time for crack and pore penetration.
- HMWM flash point was >200F vs. MMA <50F, reducing safety concerns

Field and Laboratory Testing

In 1987 Michael Sprinkel, a Research Scientist at the Virginia Transportation Research Council, conducted research that included HMWM for concrete bridge deck crack sealing in cooperation with the U.S. Department of Transportation and the Federal Highway Administration

“Comparative Evaluation of Concrete Sealers and Multiple Layer Polymer Concrete Overlays” Sept. 1987 VTRC 88-R2

Michael was one of the first DOT engineers to see the potential of using HMWM to extend the life of a concrete bridge deck.

The goal of the evaluation was to determine the effectiveness of HMWM three years after initial application.

Evaluation Results

Sealers were classified into two categories:

- Hydrophobic sealers – exhibited water repelling

- Water blocking sealers (included HMWM) – seal concrete voids and cracks and block the intrusion of water and salt.

Evaluation Results

Laboratory:

- Specimens treated with HMWM were subjected to 100 thermal cycles with average permeability of 1,242 Coulombs with 1,000 – 2,000 considered low permeability.
- Tensile rupture strength of cracked specimens treated with HMWM was an average of 294 psi when tested in accordance with ACI 503R method.

Field:

- Friction of HMWM treated surfaces with sand surface broadcast was an average of 56 when tested in accordance with ASTM E501-76 method.

HMWM Product Development

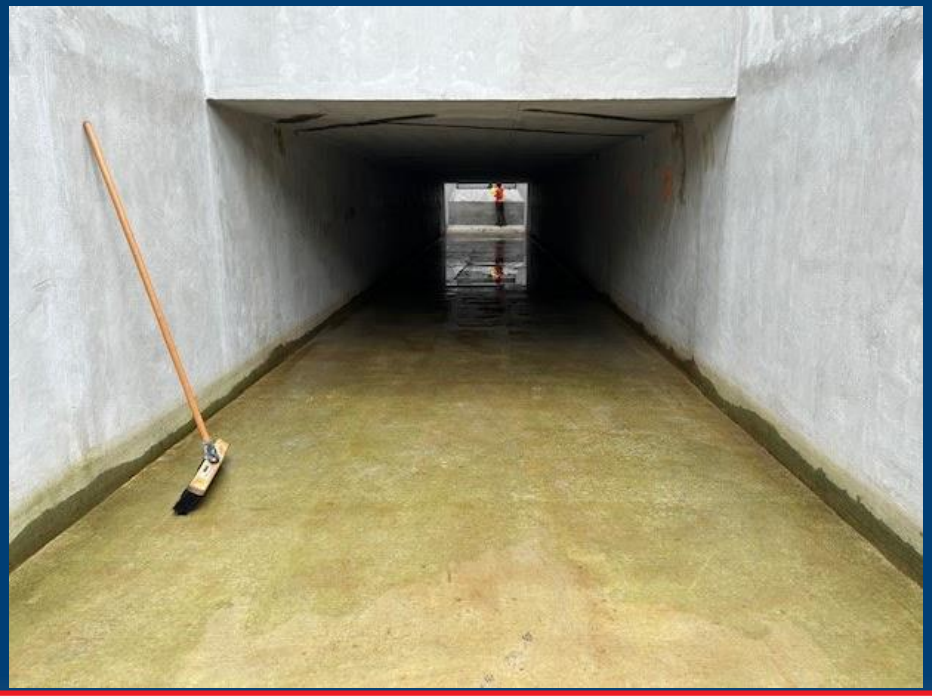
Various HMWM resin manufacturers have developed several versions of material to meet various application requirements.

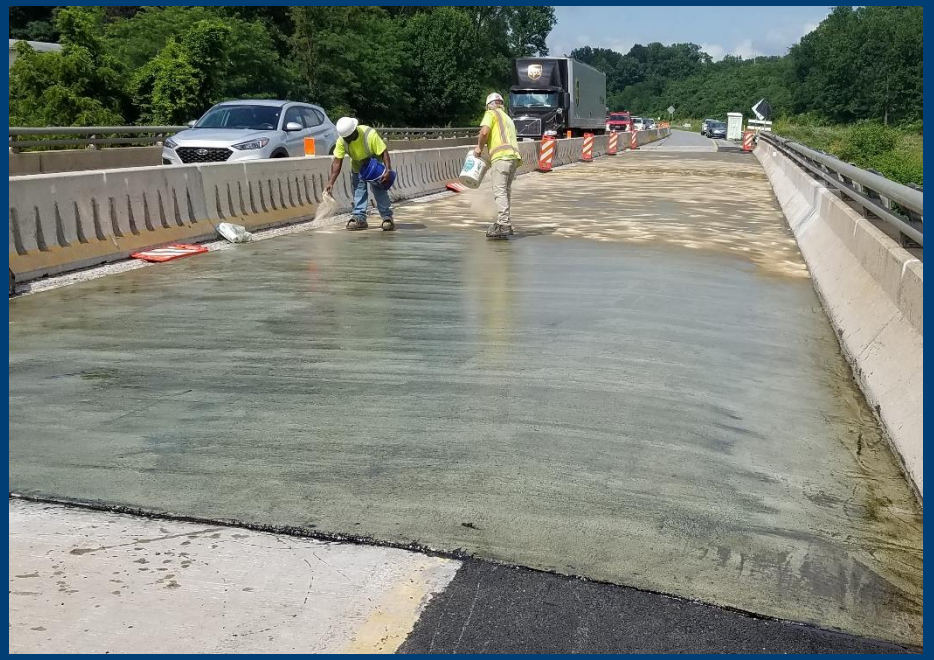
- Standard HMWM with 1-10% elongation
- Flexible HMWM with up to 30% elongation
- HMWM for low pressure crack injection
- HMWM with thixotropic properties for vertical and overhead applications

HMWM Flexibility

- Standard HMWM formulas have a tensile elongation of 1-10%. Designed to treat dormant cracks, slabs on grade, structures with short/stiff spans.

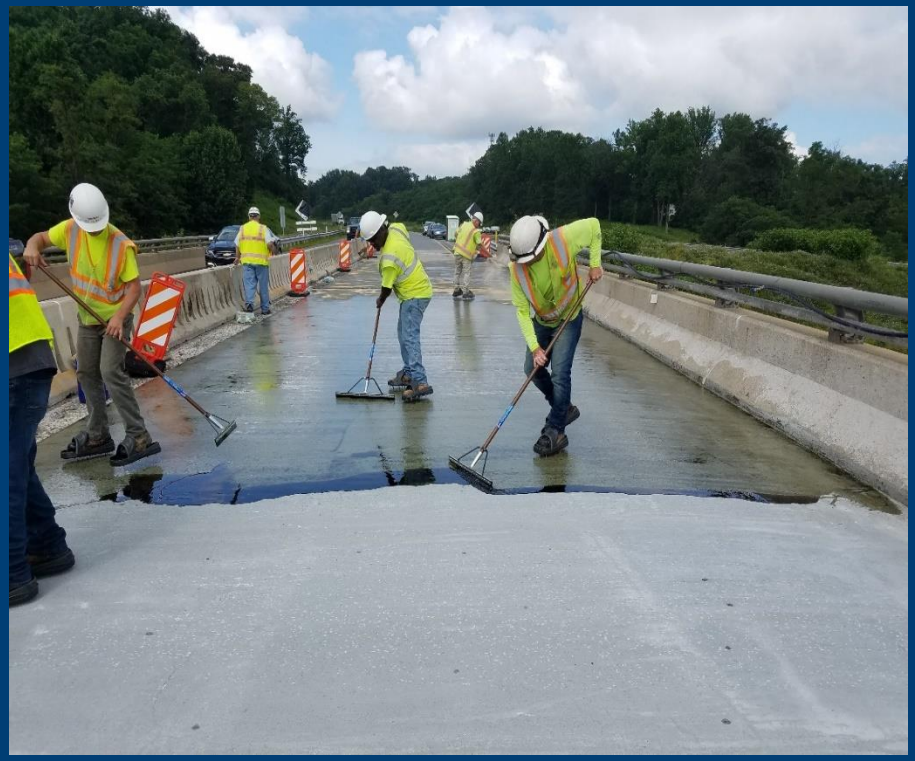
- Formulas with tensile elongations of up to 30% were developed for active cracking and structures experiencing movement.

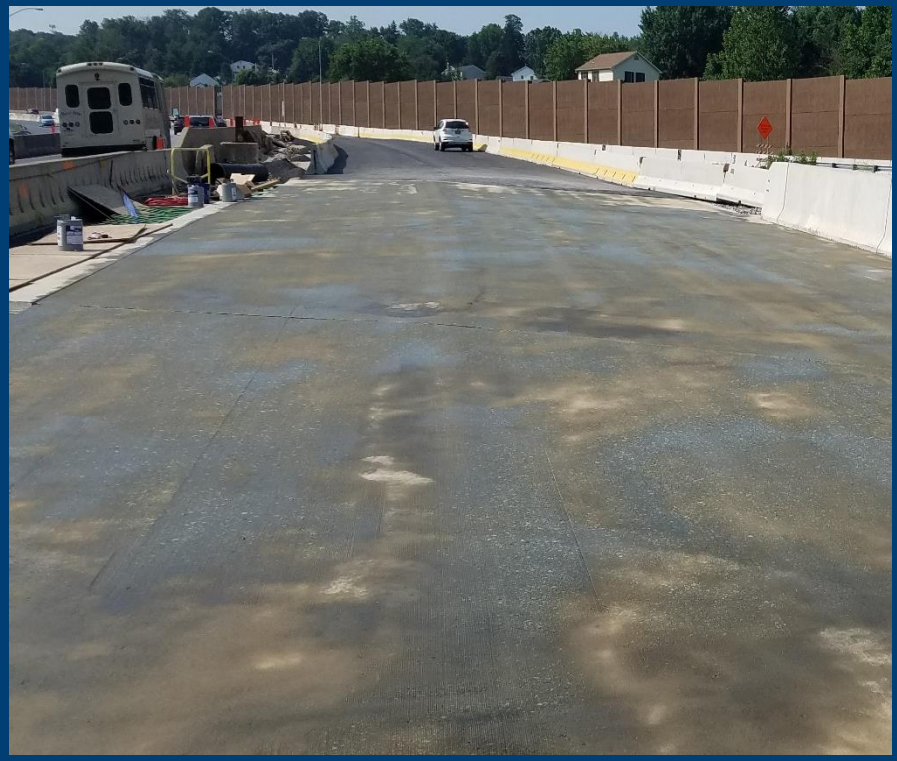




Gravity-Fed Application

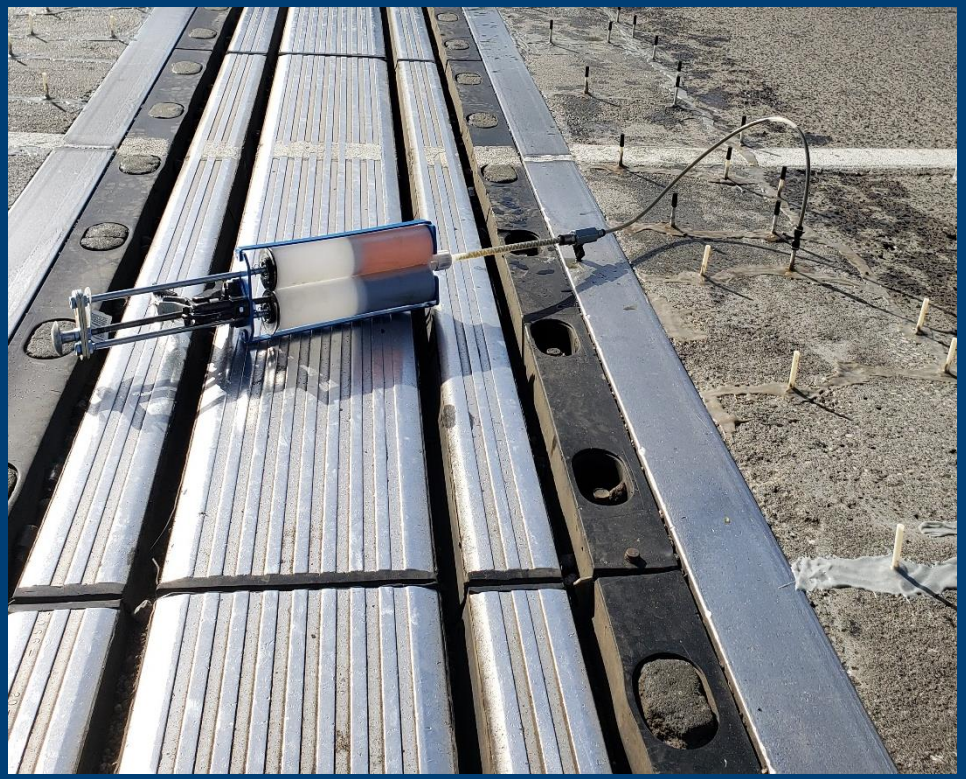
Applied by means of flood coating substrate, followed by aggregate broadcast

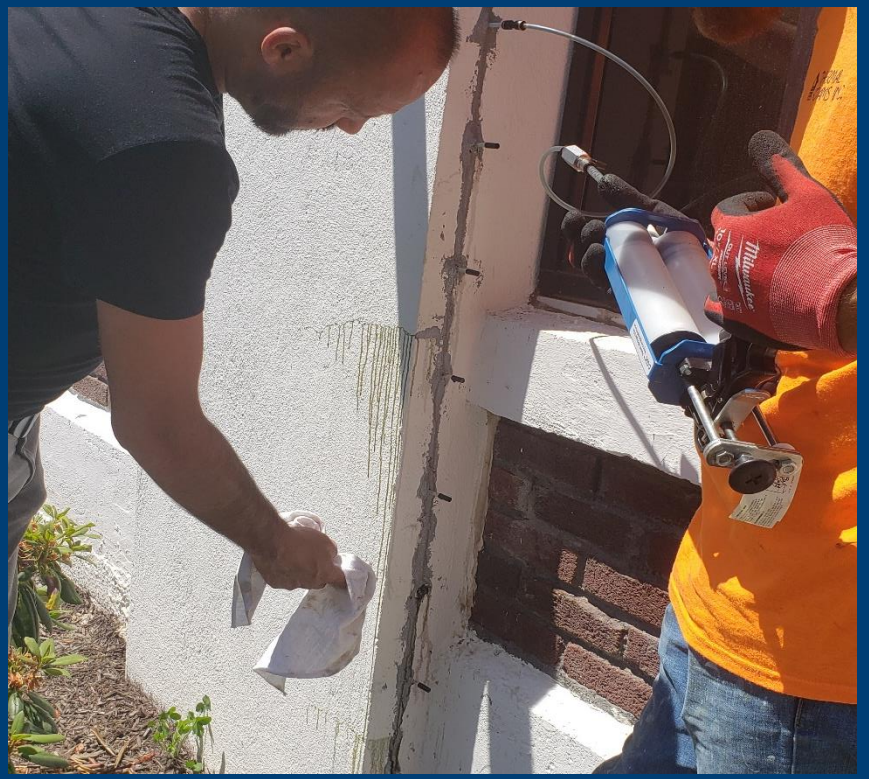




Low-Pressure Injection Application

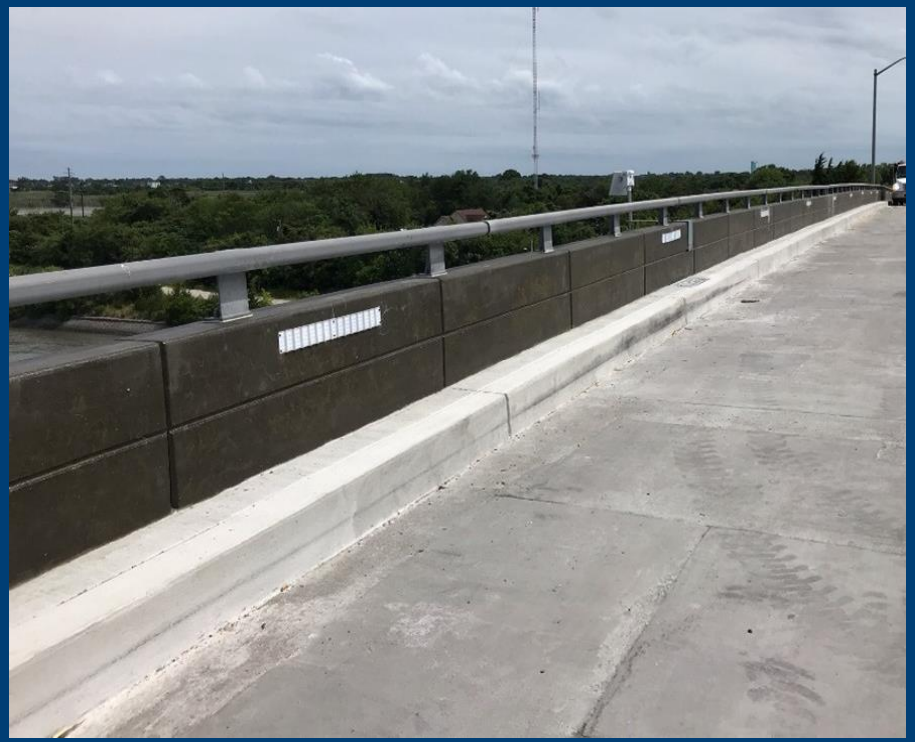
Material dispensed manually, through a network of surface-mount ports





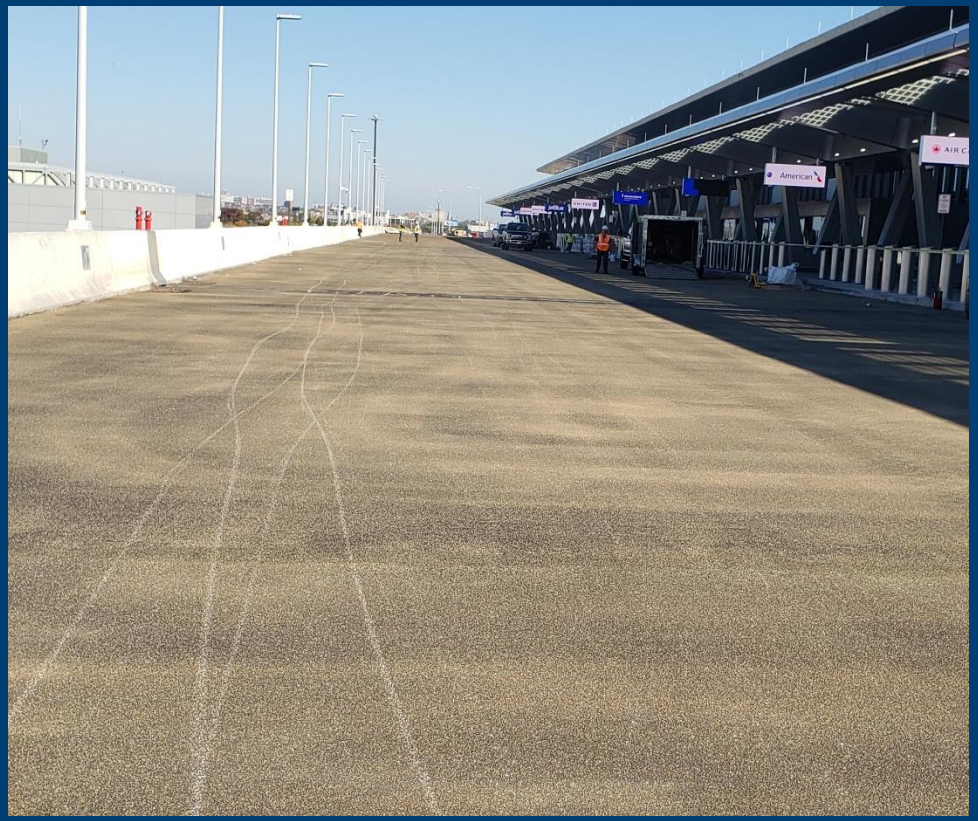
Vertical and Overhead Application

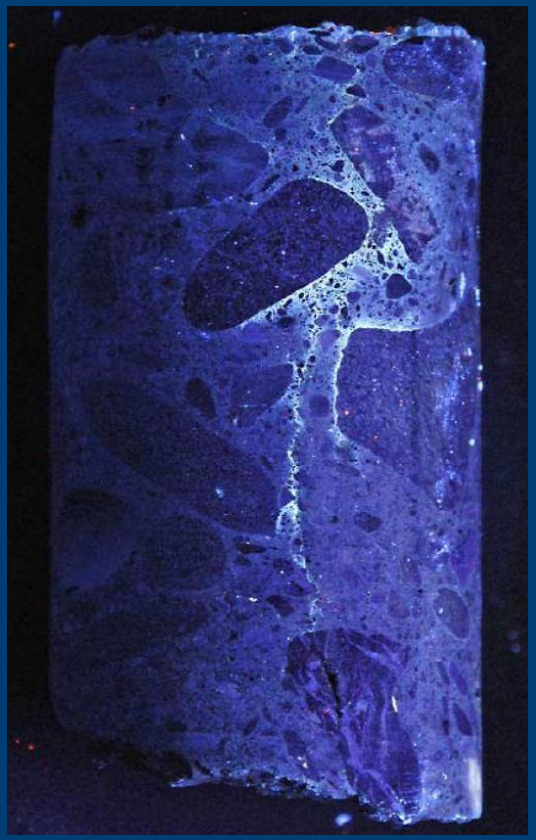
Thixotropic formulas are “painted” on using rollers and brushes



HMWM Penetration

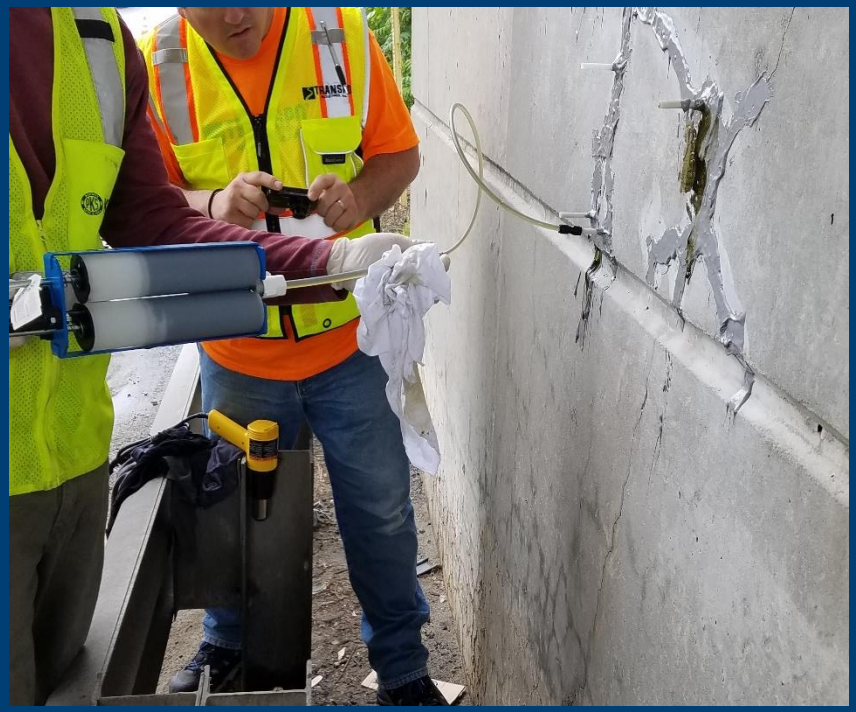
Gravity-fed applications able to penetrate full-depth cracking, in horizontal concrete surfaces

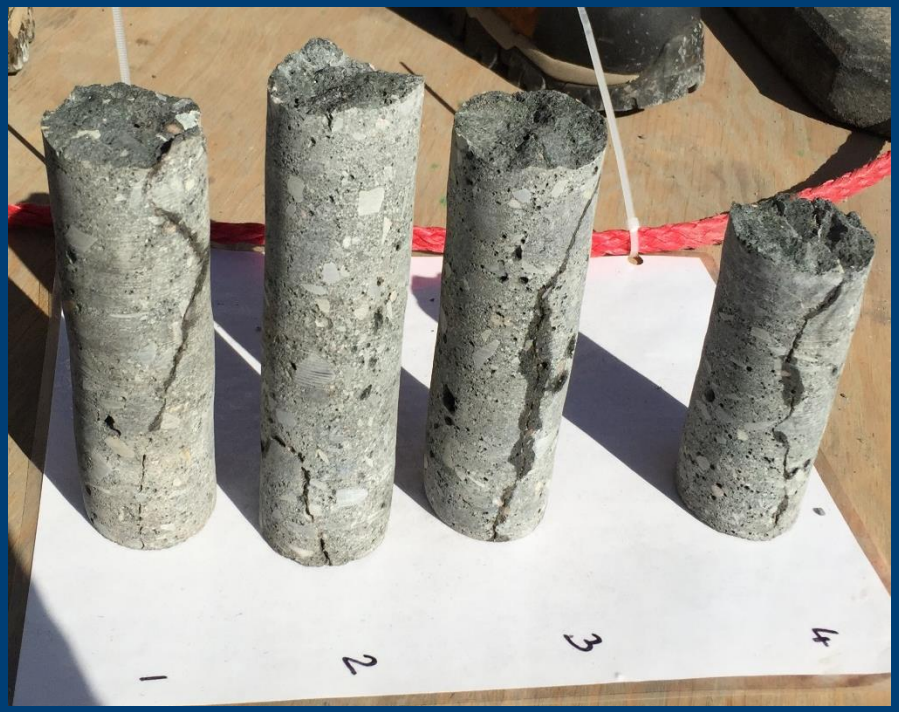




HMWM Penetration Continued

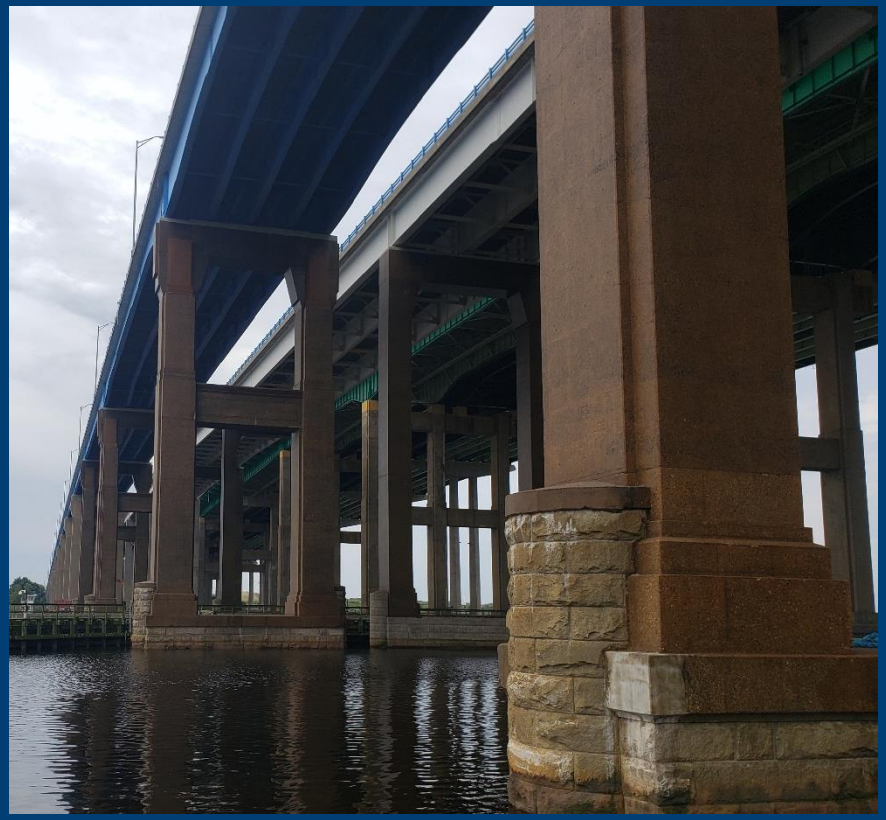
Low-pressure injection applications able to penetrate full-depth cracking, on any plane





HMWM Penetration Continued

Thixotropic formulas able to partially penetrate cracking (1-2”) in vertical surfaces



Conclusions

Originally developed for sealing cracks in concrete bridge decks to extend the service life of deteriorating bridges however, manufacturers have developed various formulations enabling applications on horizontal, vertical, and overhead surfaces.

HMWM effectively sealing cracks and surface porosity prohibits the intrusion of moisture and contaminates has let to widespread use of the chemistry by DOT's, consultants as well public and private concrete structure owners.

Thank you

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www.concrete.org