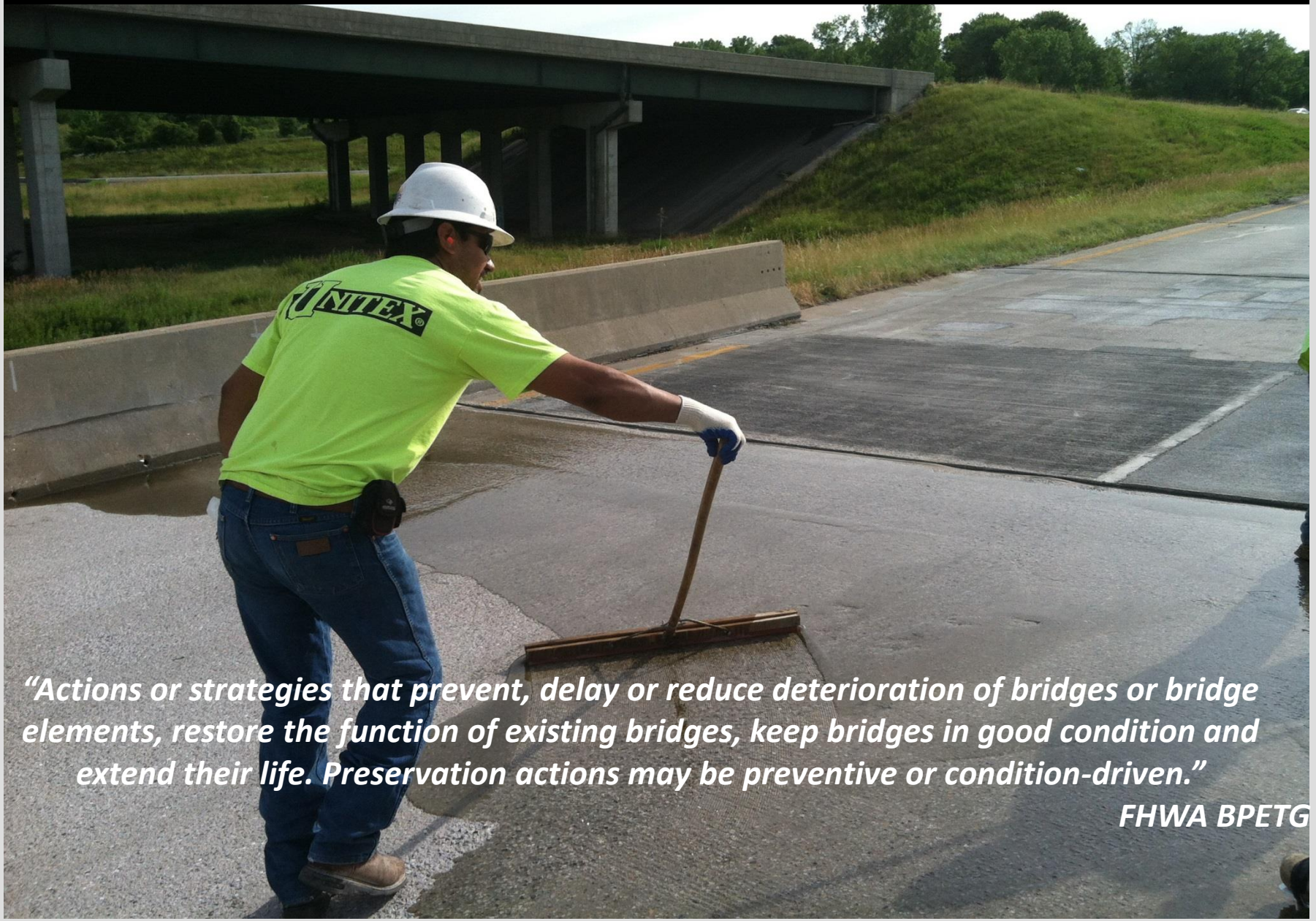
Bridge Preservation Programs

WESTERN BRIDGE PRESERVATION CONFERENCE

DAVID MINOR

UNITEX® BY DAYTON SUPERIOR®

BRIDGE PRESERVATION



"Actions or strategies that prevent, delay or reduce deterioration of bridges or bridge elements, restore the function of existing bridges, keep bridges in good condition and extend their life. Preservation actions may be preventive or condition-driven."

FHWA BPETG

IS PRESERVATION NEEDED?

IS PRESERVATION NEEDED?

OF COURSE BUT WHERE DO WE START?


BIGGEST
LOSER


BIGGEST
LOSER


BIGGEST
LOSER
BIGGEST
LOSER

PRESERVATION PLAN

- **Eat Healthy Diet**
- **Get Plenty of Rest**
- **Exercise Daily**
- **Limit Alcohol**
- **AVOID Sweets**

PRESERVATION PLAN

PROPER MAINTENANCE

- REGULAR INSPECTIONS
- SEALING DECK
- USE THIN OVERLAYS
- PATCHING
- PROPER DRAINAGE

OR IF YOU HAVE THE MONEY

- Hire Private Trainer
- Hire Private Chef
- Buy Nutrisystem
- Liposuction
- Tummy Tuck

Very <u>EXPENSIVE</u>

WANT TO AVOID

- **Large Contracts**
- **Costly Repairs**
- **Deck Replacements**
- **Bridge Closures**

PREVENTIVE MAINTENANCE

Preventive maintenance is defined as a planned strategy of cost-effective treatments applied at the proper time to preserve and extend the useful life of a bridge

EXPECTED SERVICE LIFE

There are over 600,000 highway bridges throughout the Nation with an average age of 46 years and over 160,000 of those bridges are considered deficient, either structurally deficient or functionally obsolete

THE FHWA HAS STATED THAT THEY ARE GOING TO RAISE THE EXPECTED DESIGN LIFE FOR BRIDGES FROM 75 YEARS TO 100 YEARS

Why Funding for Maintenance?

"Investment in maintenance pays dividends for years to come; on (maintaining) a bridge or culvert It is an approach that just makes sense." *a dollar we spend today can save as much as ten dollars for a full replacement.*

Vermont Governor Jim Douglas

Quoted in AGC/VT Build Board, January 2008

WHERE DO YOU START?

- **Bridge Deck Overlay when new?**
- **Apply a Healer/Sealer?**
- **When should we use a Silane Sealer?**
- **We can always just wait till it starts cracking and deteriorating then repair?**

WHERE DO YOU START?

- **Regular Inspections of all your structures**
- **Prioritization of Needs**

WHEN TO SEAL BRIDGE DECKS?

TYPES OF PRODUCTS TO SEAL BRIDGE DECKS

- Epoxy
- Epoxy Urethane
- High Molecular Weight Methacrylate (HMWM)
- Methyl Methacrylate (MMA)
- Silane
- Siloxane

If the maximum crack width is less than 0.002-inches, silane sealers are adequate to seal the deck.

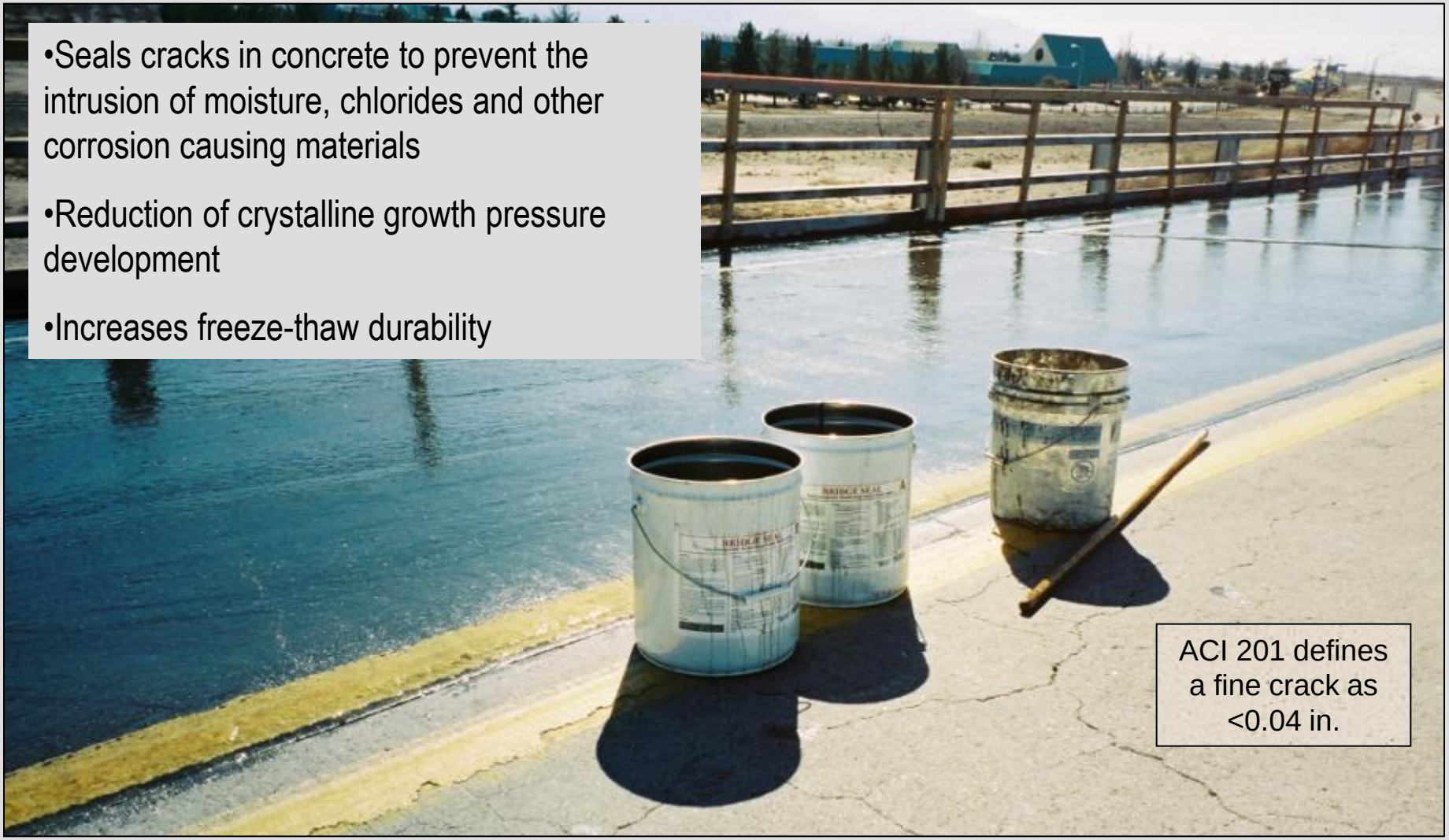
The research results indicate that penetrating sealants may be an effective means of protecting concrete bridge decks if a minimum penetration of 0.25 inches is achieved.

Most often cracks on a bridge deck typically range in width from 0.001-0.125 in.

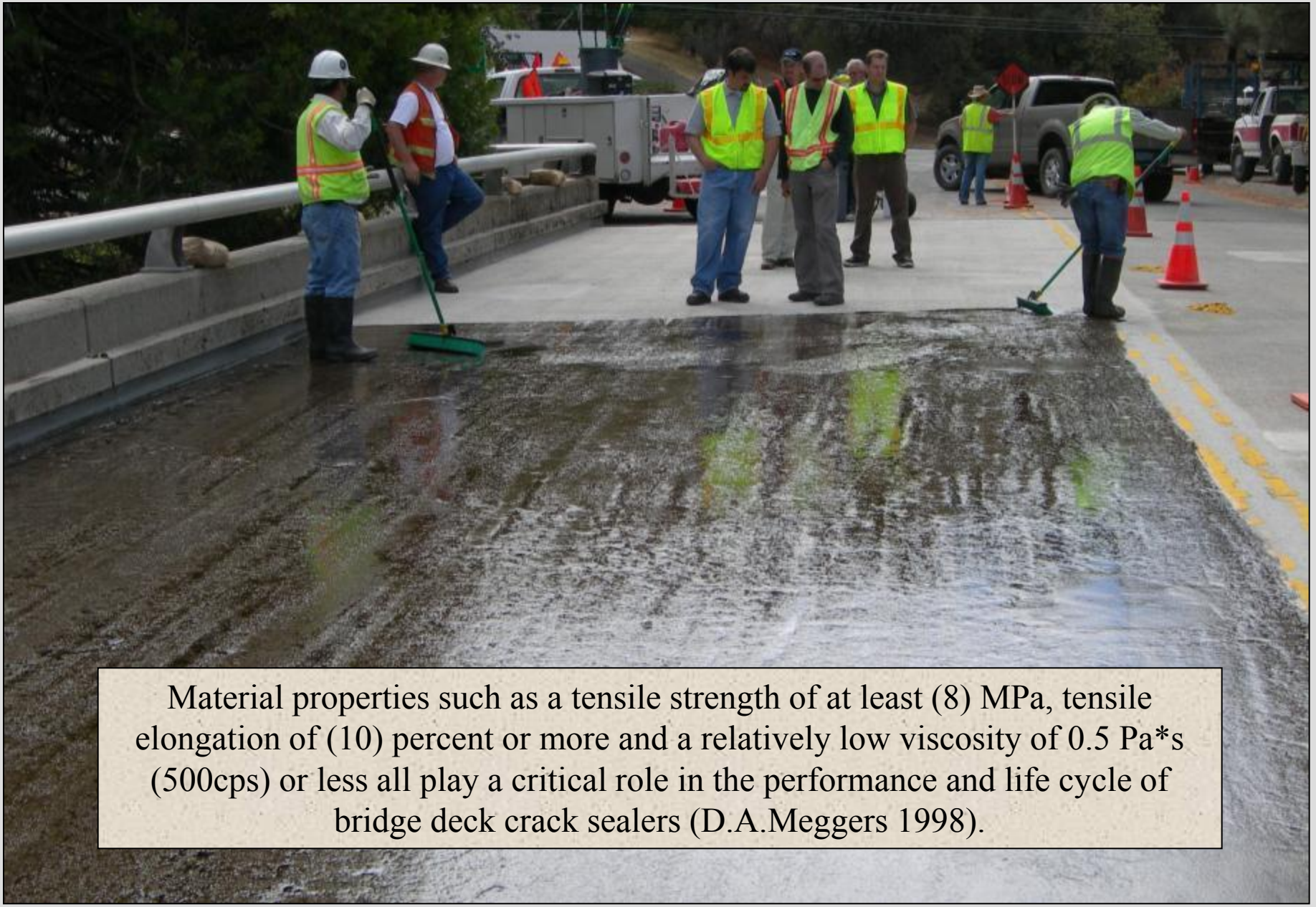
40% Silanes that incorporate alkyl groups rather than methoxy or ethoxy groups are more effective according to a South Dakota DOT Study.

Healing & Sealing of Cracks in Concrete Decks

Water, penetrating through these cracks, is the most important substance that is involved in virtually every form of concrete deterioration-freezing-thawing damage, reinforcement corrosion, alkali-aggregate reactions, dissolution, sulfate attack and carbonation (Cody, 1994).



American Concrete Institute ACI recommended tolerable crack width for structures exposed to deicing chemicals is 0.007 in. - (ACI) 204 as a trigger for planned maintenance activities.

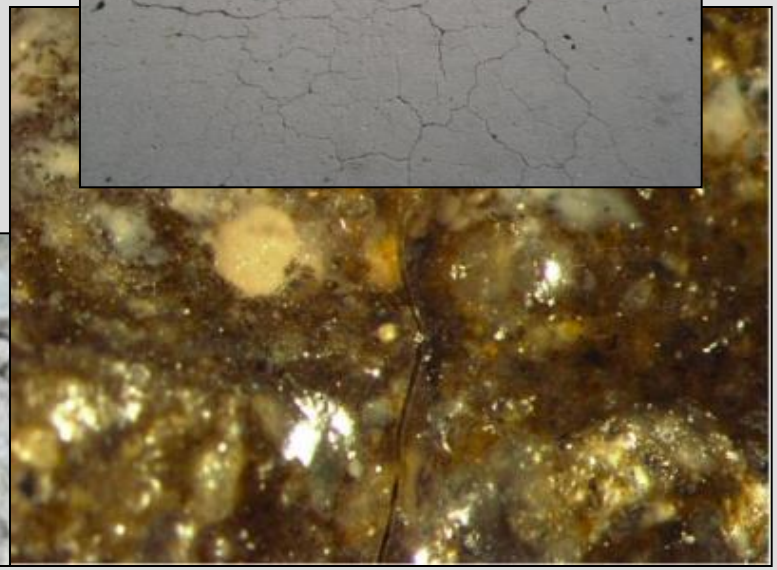


Material properties such as a tensile strength of at least (8) MPa, tensile elongation of (10) percent or more and a relatively low viscosity of 0.5 Pa*s (500cps) or less all play a critical role in the performance and life cycle of bridge deck crack sealers (D.A.Meggers 1998).

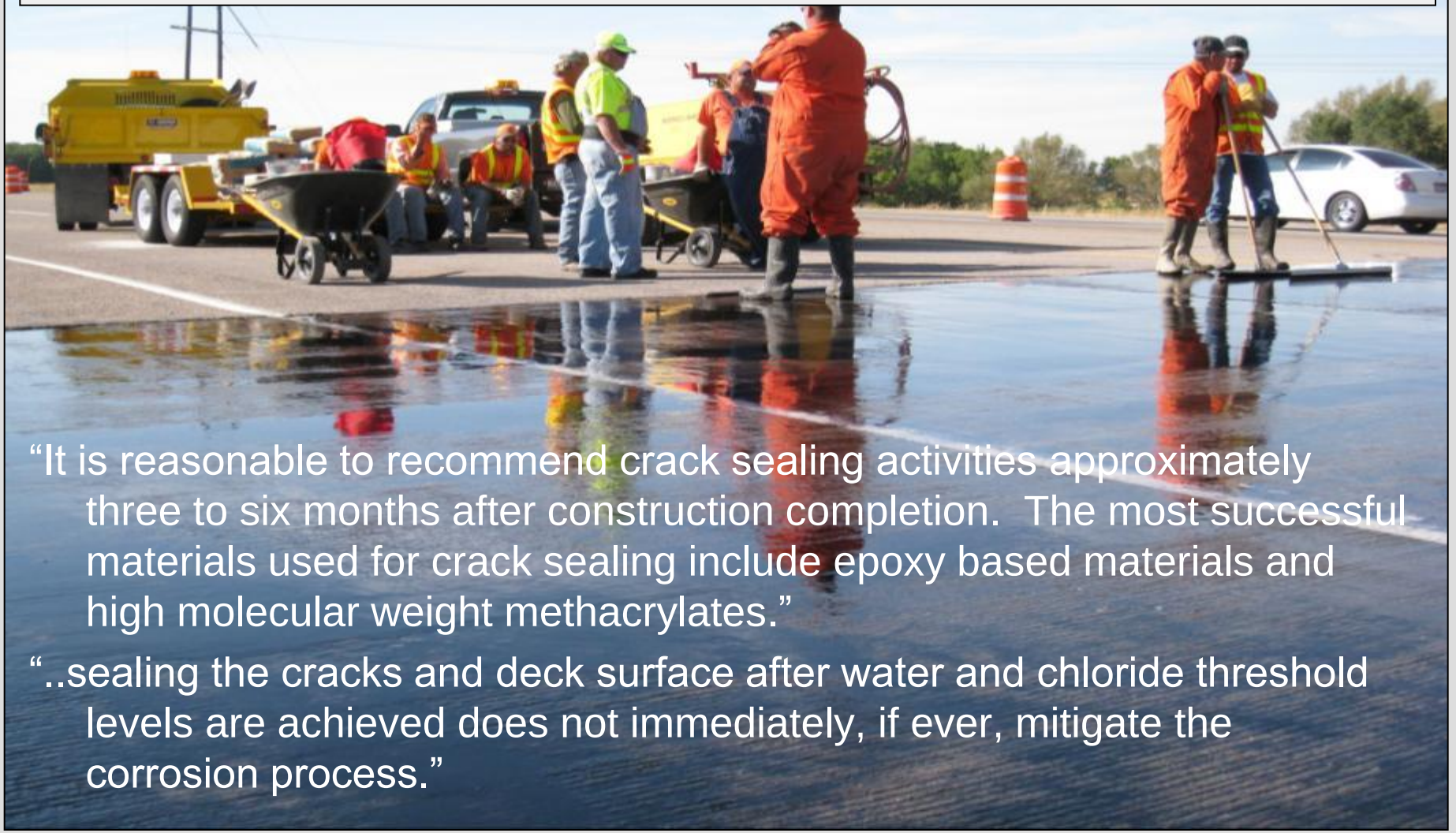
Internal Stresses

- Once the initial stresses are relieved through cracking, a relaxation of internal forces occurs.

- If surface cracks are filled with a rigid, high strength material, thermal and dynamic forces could be dispersed at the weakened horizontal interface between the top mat of reinforcing steel and the concrete or re-crack internally.



SD2001-04-D
Alternative Sealants For Bridge Decks
South Dakota DOT, FHWA

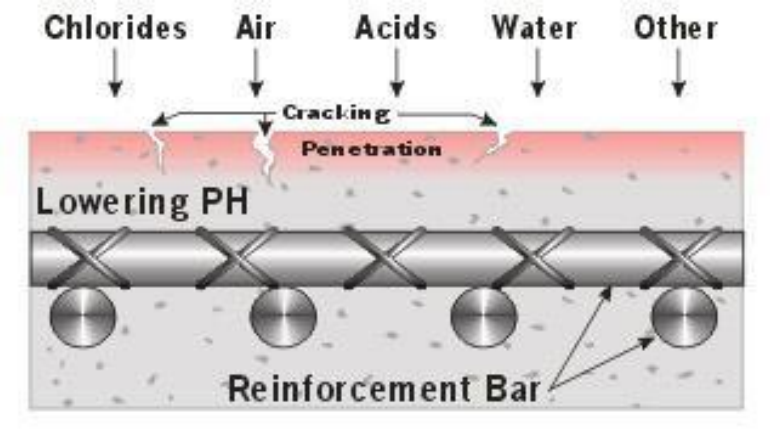


"It is reasonable to recommend crack sealing activities approximately three to six months after construction completion. The most successful materials used for crack sealing include epoxy based materials and high molecular weight methacrylates."

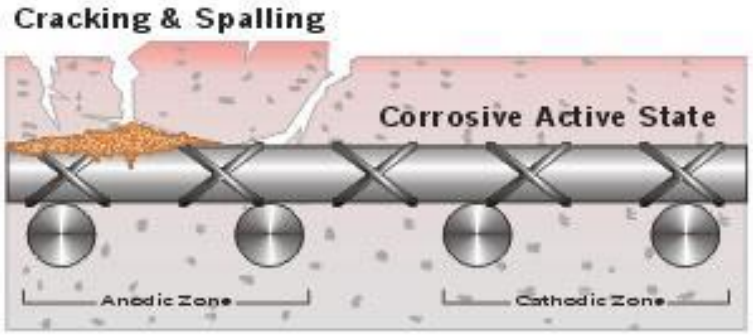
"..sealing the cracks and deck surface after water and chloride threshold levels are achieved does not immediately, if ever, mitigate the corrosion process."

SHRP-S-344
(Strategic Highway Research Program)

New bridge decks with a 1.75in avg. cover should show signs of chloride-induced corrosion (chloride ion content equals 1lb/yd³ [0.63 kg/m³]) as follows when the average chloride application rate is moderate:

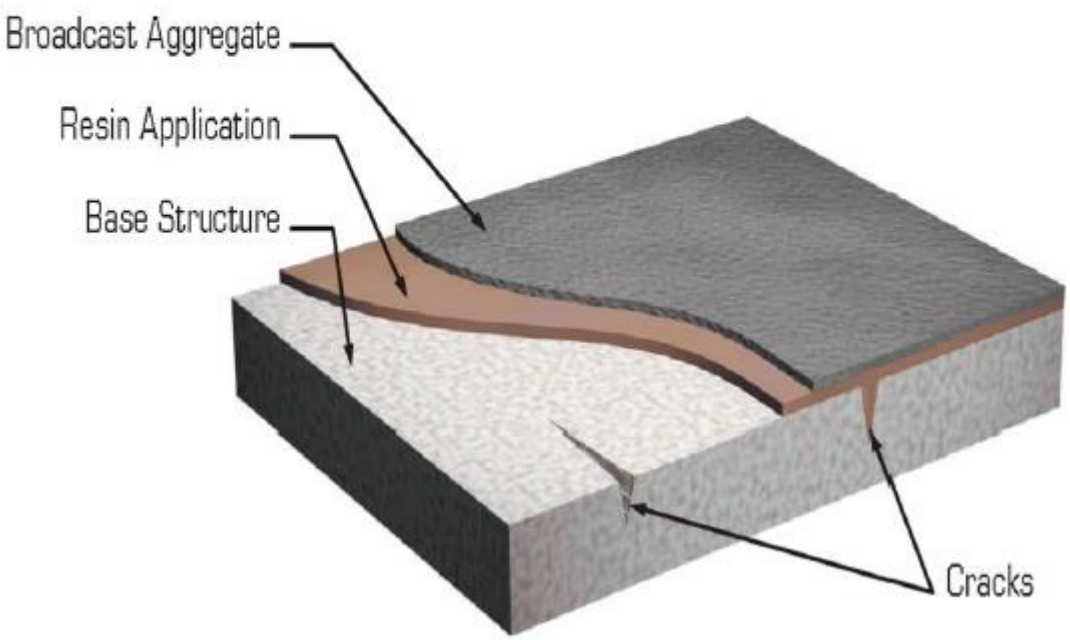


- **13 Years – When Not Protected**
- **25 Years – Epoxy Sealer Used**
- **77 Years – Polymer Overlay Used**



WHAT IS A POLYMER OVERLAY?

- ✓ Preservation → Seal
- ✓ Safety → Friction



POLYMER OVERLAY BINDER RESINS

- **Epoxies**
- **Epoxy Urethane / Modified Epoxies**
- **Methyl Methacrylates** (MMA'S)
- **Polyester**

KEY POLYMER BINDER PROPERTIES

- Compressive Strength
- Flexural Modulus
- Elongation
- Viscosity
- Temperature Limitations
- Cure Time
- Required Mixing and Installation Equipment
- Safety & Environmental Factors

SELECTION OF AGGREGATES

- Looking for aggregates with high polished stone value
- Calcined Bauxite has highest values, but is expensive

SELECTION OF AGGREGATES

- Hardness (>6 Mohs)
- Durability
- Consistent Gradation (#8 Critical Sieve)
- Angular
- Clean (Washed)

Resistance to Polish
Resistance to Degradation

WHEN TO USE POLYMER OVERLAYS

- Overall Bridge Condition
  - >6 (min condition index 6-7)
  - “Right Bridge”/”Right Time” (when?...scoped,let,install?)
  - Good concrete strength (pull off test)
  - Some repairs ok (spall, patching, cracking)
  - Recent survey (chain, rod, GPR, thermal imaging)
- Tining
  - Depth
    - Shot blasting & plane
    - Tining can affect polymer yields and quality
- Roughness and Ride Quality – “Right Treatment”

COSTS OF EPOXY APPLICATION

- $1.60 - $2.25/ sq ft (materials only*)
- $3.30 - $5.00/ sq ft (contractor installed)
- 3/8-inch (nominal thickness)
- 0.075 gallons/sf (epoxy)
  - 1st Course (40 sf/gallon)
  - 2nd Course (20 sf/gallon)

  } ~10-ozs of epoxy per SF!
- 3-lbs aggregate/sf
- 10 Yrs – 15 yrs (>30,000 ADT)

* Epoxy & Aggregate - excludes shot blasting & traffic control

DATA SUPPLIED BY NATIONAL BRIDGE PRESERVATION PARTNERSHIP CONFERENCE

FHWA

http://www.fhwa.dot.gov/BRIDGE/segmental/protect.htm

"The epoxy overlay is a deck protection system that has been successfully used for 27 years on conventionally reinforced concrete bridge decks. The epoxy overlay has been shown to prevent the infusion of the chloride ions and can be expected to provide a skid resistance wearing and protected system for decks for 15 to 30 years depending on traffic volume"

"The thin epoxy overlay is not prone to cracking and delamination like the hydraulic cement concrete overlay"

"The average cost is $36 per square yard including grinding and shot blasting. It costs approximately 65 percent of an asphalt overlay on a membrane. However, on a life cycle basis, the cost can be 32 percent of that of the membrane when the epoxy overlay lasts for 30 years"

References

Ozyildirim, Celik, "Permeability Specifications for High-Performance Concrete Decks" Transportation Research Record 1610, Transportation Research Board, Washington D. C. 1998.

Pyc, Wioleta A., Weyers, Richard E., Weyers, Ryan N., Mokarem, David W., Zemajtis, Jerzy, Sprinkel, Michael M., Dillard, John G., "Field Performance of Epoxy Coated Reinforcing Steel in Virginia Bridge Decks", VTRC 00-R16, Virginia Transportation Research Council, Charlottesville, Virginia, 2000.

Repair Spalls & Delaminations

WHAT ABOUT MAG PHOS PATCHES?

3.4.1 Do not place polymer overlay on hydraulic cement concrete less than 28 days of age unless specified otherwise. Do not place polymer overlay on magnesium phosphate cement concrete.

FROM
American Concrete Institute - ACI
SPECIFICATION FOR POLYMER OVERLAY FOR BRIDGE AND PARKING GARAGE DECKS

SAFETY & ENVIRONMENTAL ISSUES

Safety, Storage & Handling

- Do not store materials in extremely high temperatures
- Have copies of manufacturers MSDS on job site
- Review proper mixing procedures
- Supply recommended personal protective equipment

Environmental

- Read MSDS for any VOC and hazardous chemicals
- Prevent spills or discharge thru joints or drains
- Proper disposal of unused resins and powders
- Proper disposal of empty drums and containers

DATA SUPPLIED BY NATIONAL BRIDGE PRESERVATION PARTNERSHIP CONFERENCE


CORROSIVE
8
2735


EXIT 48
City of
Rogue River

Bridging the Present with the Future !

www.daytonsuperior.com