

Western Bridge Preservation Partnership
May 17-18, 2016
Salt Lake City, Utah



Bridge Deck Preservation Treatment Options

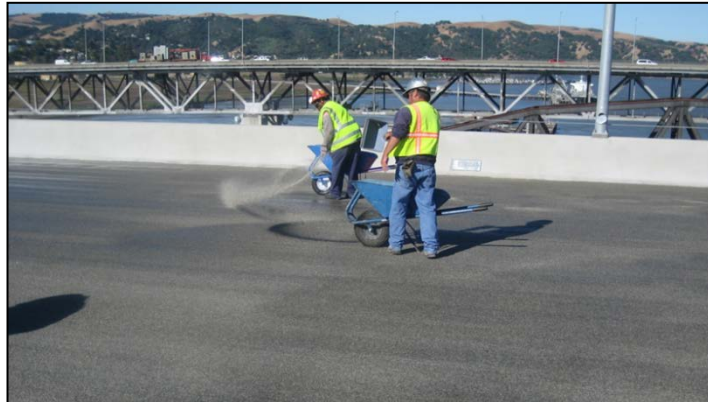
Gregg Freeman - Kwikbond Polymers

Rob Johnson - Transpo Industries

Clay Christiansen - Dayton Superior

Bridge Deck Preservation Treatment Options

Considerations for Success



- What is considered a sound substrate based on the chosen deck treatment system
- Surface preparation
- How to Mitigate Potential Failure Mechanisms
- Forensics/Repairs



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A Sound Substrate

What is a sound substrate?

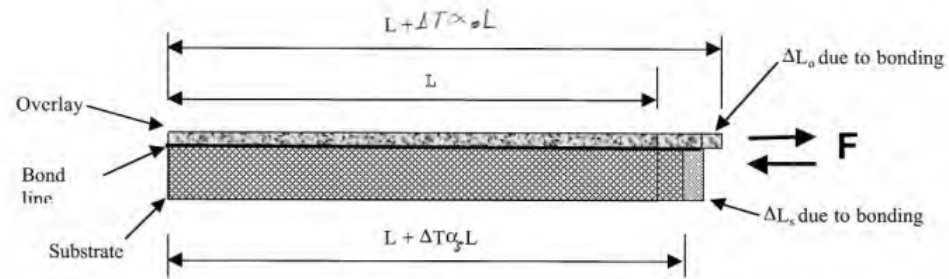


- All overlay systems will have a thermal relationship with the concrete substrate
- A sound substrate: tensile strength, map cracking, corrosion and spalling?
- A bridge deck with extensive map cracking and spalling would likely be better suited for a low viscosity crack sealing treatment
- Patching systems need to be compatible with the overlay



A Sound Substrate

What is a sound substrate?



So, the force at the bond line would be a function of the equation:

$$F = \Delta T (\alpha_o - \alpha_s) \left(\frac{1}{E_o A_o} + \frac{1}{E_s A_s} \right)^{-1}$$

Where:

F is the force developed

ΔT is change in temperature

α_o and α_s are the thermal coefficients for overlay and substrate

E_o and E_s are Young's Moduli for overlay and substrate

A_s and A_o are cross sectional areas for overlay and substrate

L is length before temperature change



Surface Preparation

All surface deck treatments

- Determine the correct surface profile required
- Shot-blasting
- Stripe removal
- Sand-blasting
- Taping & protection of joints/drains
- Air wash
- Concrete should be dry



Shot-blasting ICRI CSP Chips for Guidance



CSP Chips on prepared surface

- An ICRI CSP surface profile is sometimes specified for a polymer overlay
- Shot-blasting will remove surface contamination and can provide a good mechanical profile for bonding
- Various equipment, size of the shot and speed will control the surface profile

Bridge Deck Crack Treatment - Healer Sealer



Treating a bridge deck with a low-viscosity crack healer/sealer treatment is a cost effective way to minimize the intrusion of de-icing chemicals, moisture, freeze/thaw damage and other affects

Bridge decks beyond candidacy for less compatible overlay systems will benefit from this type of crack sealing treatment



How to Mitigate Potential Failure Mechanisms



How to minimize the chances of mixing the polymer resin binder off-ratio

- Use a "Jiffy" type mixer for hand mixing
- Pre-condition binder to proper temperature
- Mix in appropriate vessel and maintain pumping equipment
- Use a timer for mixing and stage components in an organized fashion



How to Mitigate Potential Failure Mechanisms



Polymer systems: Timing in the broadcasting of friction aggregates

- Cold joint in broadcast aggregates due to delay in production
- Delay in method of aggregate broadcasting
- Resin placing advances ahead of aggregate broadcasting, especially on a hot day
- Wet, or dirty aggregates

Friction

- Consider polish resistance of aggregates/overlay system relative to ADT

How to Mitigate Potential Failure Mechanisms



Minimize premature wear in the wheel path

- Mix material properly
- Return to traffic only when the system has reached proper strength
- Pre-condition materials to the proper temperature
- Install system at the proper temperature
- Consider the potential of a shorter life cycle if exposed to heavy studded tire and chain traffic



How to Mitigate Potential Failure Mechanisms



Pre-mixed Polymer Overlay System

- Sound substrate
- A full PC system from one source provides continuity
- Proper mix ratio between the polymer and aggregate is critical for workability, consolidation and minimizing the possibility of cracking
- Contractor experience with equipment and concrete placing is important
- Properly prepared, dry deck.



Forensics and Repairs



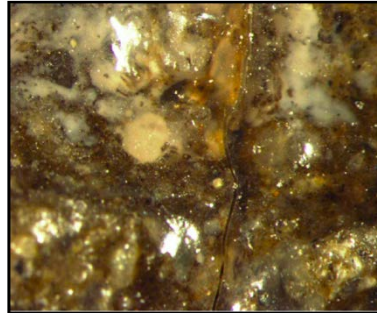
Improper mix ratio of the resin binder system



Thermal incompatibility, unsound substrate



Visible concrete curing compound



Reflective crack, possible material property consideration for moving cracks



Visible contaminants, first course mixed off ratio



Thermal compatibility, unsound substrate

Forensics and Repairs



Although repairs can be made, the final system will always have some level of variation in aesthetics and ride quality

Overview - Considerations for Success



- Sound, dry, properly prepared substrate
- Proper ambient conditions for the installation and storage of materials
- Good workmanship including proper equipment and skill level
- Assistance of a skilled manufacturers rep
- Thermal compatibility of overlay with substrate

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TREATMENTS APPLICATIONS

- Concrete Deck Spalling
- Expansion Joint Headers
- Concrete Crack and Surface Sealing
- Thin Waterproofing/Wearing Surface Overlays



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DESIRED TREATMENT RESULTS

CONCRETE DECK SPALLING

- Untreated spalls allow moisture to penetrate to steel reinforcement causing corrosion and additional deterioration.
- Spalls create a safety hazard for vehicles.
- Treatment should restore original riding surface.
- Material should exhibit high bond to existing concrete to eliminate the reoccurrence of spalls.



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DESIRED TREATMENT RESULTS CONCRETE DECK SPALLING

- Repairs should be waterproof to eliminate further steel corrosion
- Rapid cure in a wide application temperature range reduces inconvenience to vehicles and construction costs.
- Expected service life should be in excess of 10 years depending on overall condition of surrounding concrete.



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DESIRED TREATMENT RESULTS EXPANSION JOINT HEADERS

- Expansion joint materials rely on sound headers for proper bond and performance.
- Deteriorated headers lead to joints leaking which is a major cause of bridge beam corrosion.
- Treatment should restore ride quality and have a finished surface for proper bond of joint material.



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DESIRED TREATMENT RESULTS EXPANSION JOINT HEADERS

- High compressive, flexural strength are important properties of repair material in order to resist vehicle loads.
- Rapid cure in a wide application temperature range reduces inconvenience to vehicles and construction costs.
- Expected service life should be in excess of 10 years.



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DESIRED TREATMENT RESULTS CONCRETE DECK CRACKING

- Cracks in concrete decks are primary reason for moisture intrusion causing steel corrosion and freeze thaw damage.
- Deck cracks even small plastic shrinkage cracks that occur during concrete curing, if untreated, lead to premature deterioration.
- Material should have very low viscosity in order to achieve maximum penetration.



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DESIRED TREATMENT RESULTS CONCRETE DECK CRACKING

- Cured material should have good bond strength to concrete and flexibility to resist freeze thaw stresses.
- Material should eliminate the ability for water intrusion.
- Expected service life should be 10-15 years with inspection and reapplication on new deck cracking.



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DESIRED TREATMENT RESULTS

THIN WATER PROOF/WEARING SURFACE

OVERLAYS

- Exposed concrete decks are susceptible to deterioration due to moisture intrusion resulting in steel reinforcing corrosion and spalling
- Deterioration begins at the completion of construction and the rate of deterioration will depend on the concrete quality, depth of reinforcing steel cover, exposure to moisture and salt.



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DESIRED TREATMENT RESULTS THIN WATER PROOF/WEARING SURFACE OVERLAYS

- Thin waterproof/wearing surface overlays can be used on new and existing decks to reduce or eliminate the effects of moisture and salt intrusion.
- Materials should have high bond strength, flexibility and wear resistant surface aggregate to assure long term performance.
- Expected service life should be in excess of 10-15 years.



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TREATMENT SELECTION CRITERION NEW DECK CONSTRUCTION

- If concrete surface exhibits cracking, sealer application should be done prior to opening to traffic.
- Thin waterproofing/wearing surface overlay application can increase deck design life by 10-15 years.



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TREATMENT SELECTION CRITERION EXISTING DECK

- Spalls should be repaired before extensive steel corrosion occurs.
- Cracks and concrete porosity can be eliminated with the application of sealer materials, which is a low cost high benefit treatment option.
- Thin waterproofing/wearing surface overlays when applied on decks in fair to good condition are more expensive. The cost benefit ratio of extending the time required for extensive deck rehabilitation make them cost effective.



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The Goal

Through systematic long term management systems, states can produce stable conditions for the entire inventory of bridges for the lowest life-cycle cost. The goal is to find the right preservation balance between fixing immediate problems, conducting preventative maintenance, and periodically replacing a reasonable number of old bridges to keep the health of its bridge population stable.

AASHTO 2008



Preservation Methods and Materials

Considerations

- Condition of the Bridge
- Objective
- Budget
- Short term and long term considerations
- Average Daily Traffic
- Construction Duration and Closures



Deterioration of Concrete



Three Main Causes of Cracks in Bridge Decks

- Degree of Restraint
- Concrete's Effective Modulus of Elasticity
- Concrete Volume Change

We need to become experts at understanding Cracks in order to proscribe the remedy.



Sealers

- ▶ Water Repellants and Pore Blockers
- ▶ Silane is most common sealer used on bridge decks

Success Factors of Sealants

- Type of material
- Viscosity
- Width of crack
- Type of crack
- Temperature
- Moisture content of concrete



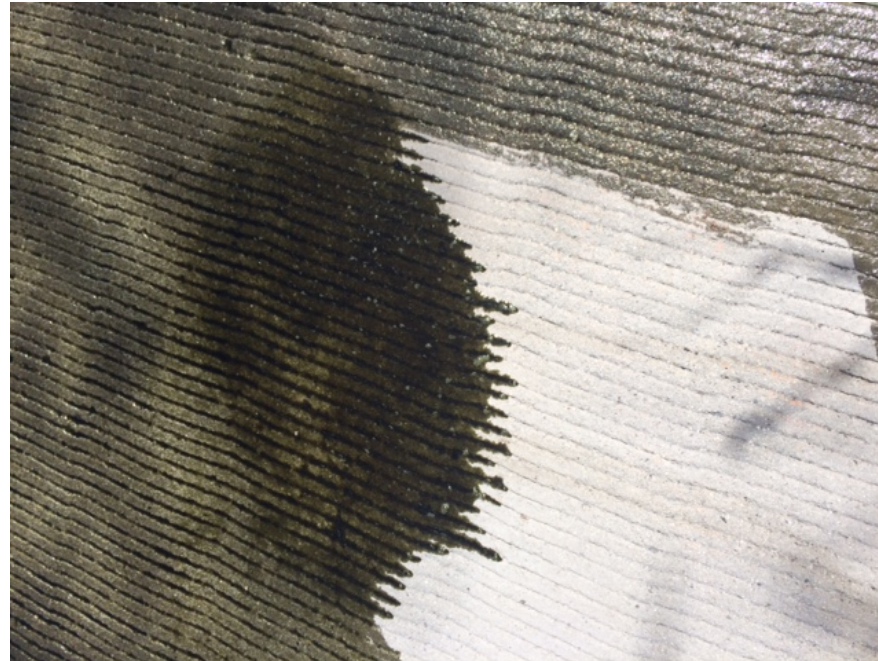
Healer/Sealers

- High Molecular Weight Methacrylate (HMWM)
- Methyl Methacrylate (MMA)
- Epoxy



High Molecular Weight Methacrylate (HMWMM)

- ▶ Low Viscosity <20 cps
- ▶ Furthest penetration in smaller cracks .02 MM
- ▶ Rapid Cure Times
- ▶ Rigid material that can restore close to original design strength lost from crack propagation
- ▶ Life expectancy of 5 yrs



Epoxy

- ▶ Low Viscosity between 50-200 cps
- ▶ Higher Elongation
- ▶ Longer open time for gravity penetration
- ▶ Wide range of formulations for desired crack treatment
- ▶ Simple installation
- ▶ Life expectancy of 5 yrs



Thin-Bonded Polymer Overlays

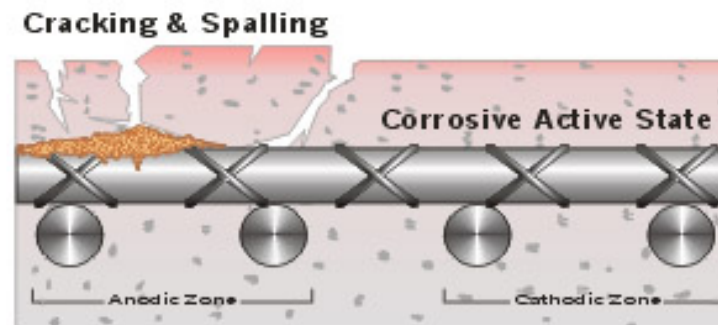
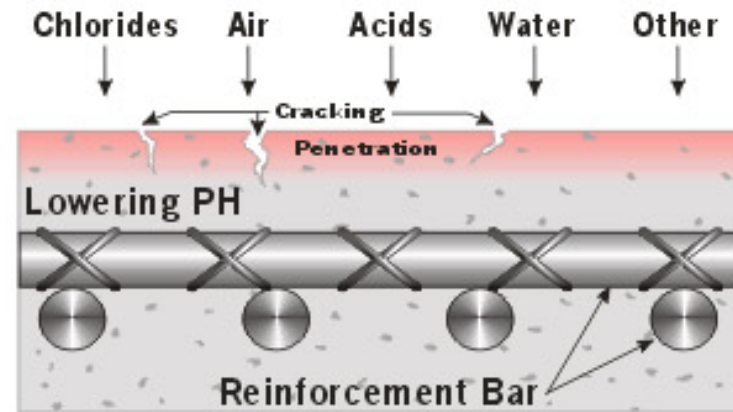
- ▶ Multi- Layer Wearing Course
- ▶ Low Viscosity Low Modulus
- ▶ Moisture / Vapor Barrier
- ▶ Durable 15-30 Yr Life Expectancy
- ▶ Cost Effective
- ▶ Quick Return to Traffic
- ▶ Enhanced Friction Values
- ▶ Used by Majority of State DOT's





SHRP-S-344 (Strategic Highway Research Program)

- ▶ New bridge decks with a 1.75in avg. cover could 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 no protection treatment is used
 - 25 years when an epoxy sealer is maintained
 - 77 years when a polymer overlay is maintained



Polyester Polymer Concrete Overlays

- ▶ Primarily for Bridge Rehabilitation
- ▶ Longest Expected Life of all Materials
- ▶ Variable Thickness
- ▶ Rapid Cure Times
- ▶ Typically Requires Hydro Demo
- ▶ HMWM Primer

