Polymer Materials for Bridge Deck Rehabilitation and Preservation

Bridge Deck Overlay Questionnaire

Does your state use thin polymer deck overlays?

Maryland:	--
Delaware:	No
New Jersey:	Yes
Pennsylvania:	Yes
Connecticut:	No
Rhode Island:	No
Massachusetts:	--
Vermont:	--
New Hampshire:	No
Maine:	No

Bridge Deck Overlay Questionnaire

Are thin polymer bridge deck overlays used commonly throughout the state?

Maryland:	--
Delaware:	No
New Jersey:	No
Pennsylvania:	Yes
New York:	No
Connecticut:	No
Rhode Island:	No
Massachusetts:	--
Vermont:	--
New Hampshire:	No
Maine:	No

Bridge Deck Overlay Questionnaire

Do you have an approved product list of polymer overlay manufacturers?

Maryland:	--
Delaware:	No
New Jersey:	No
Pennsylvania:	Yes
New York:	Yes
Connecticut:	No
Rhode Island:	No
Massachusetts:	--
Vermont:	--
New Hampshire:	No
Maine:	No

Bridge Deck Overlay Questionnaire

What is the process used to determine if a thin polymer bridge deck overlay should be installed as a preservation treatment?

Maryland:	--
Delaware:	N/A
New Jersey:	Currently used as experimental
Pennsylvania:	Age, deck condition, evaluation (sounding, GPR, chloride content)
New York:	Deck condition (less than 15% deterioration)
Connecticut:	Physical inspection of existing HMA overlay condition
Rhode Island:	N/A
Massachusetts:	--
Vermont:	--
New Hampshire:	
Maine:	N/A

Bridge Deck Overlay Questionnaire

What products are you currently using?

Maryland:	--
Delaware:	N/A
New Jersey:	Sterling Lloyd (MMA), Transpo (MMA), Kwik Bond (Polyester)
Pennsylvania:	BASF (LMC), Dow (LMC)
New York:	Euclid Chemical (Flexolith), Unitex (Pro-poxy Type III DOT), C.S. Behler (SSI RE-DECK), BASF (EP-35), Kwik Bond (PPC 1121)
Connecticut:	N/A
Rhode Island:	N/A
Massachusetts:	--
Vermont:	--
New Hampshire:	N/A
Maine:	N/A

Bridge Deck Overlay Questionnaire

What is your current impression of the effectiveness of thin polymer bridge deck overlays?

Maryland:	--
Delaware:	N/A
New Jersey:	Satisfactory, only in use for 1 year
Pennsylvania:	Perform well at 1-11/2 inch based on deck condition
New York:	Satisfactory (proof of waterproofing)
Connecticut:	Process has just started
Rhode Island:	N/A
Massachusetts:	--
Vermont:	--
New Hampshire:	N/A
Maine:	N/A

Bridge Deck Overlay Questionnaire

Do you have a standard process for trying new thin polymer overlay materials?

Maryland:	--
Delaware:	No
New Jersey:	No
Pennsylvania:	Yes. Process on DOT website for vendors to reference
New York:	Yes. Trials done through design or maintenance. Must perform well for 2 winters before approval.
Connecticut:	Review by new products committee
Rhode Island:	DOT has a process for approving new products but polymer overlays have not been considered to date.
Massachusetts:	--
Vermont:	--
New Hampshire:	No
Maine:	N/A

States Using Polymer Concrete Overlays

Polymer Resins

* Epoxy
* Modified Epoxies
* Methyl Methacrylates
* High Molecular Weight Methacrylates
* Polyester

Typical Applications

* Spall repairs
* Joint headers
* Bearing pads
* Wearing surface overlays
* Skid resistance
* Crack and surface sealing

Selecting the Proper Material

* Compressive strength
* Flexural modulus
* Elongation
* Viscosity
* Temperature limitations
* Cure time
* Required mixing and installation equipment

Epoxy

Epoxies have been in use in the United States for over 40 years as concrete bridge deck overlays. Over this time there have been many changes to the basic epoxy resins primarily due to problems caused by high modulus materials, UV sensitivity, leaching and environmental issues.

Epoxies resins with low modulus of elasticity (13 ksi max) and high tensile elongation of (30 to 70%) should be used for polymer overlays.

The compressive strength of the polymer overlay system (resin and aggregate) should be between 1 to 5 ksi.

Modified Epoxies

Modified epoxies are those materials that incorporate other chemicals in the base epoxy resin to enhance its physical properties. They were first used in the United States for bridge deck overlays approximately 20 years ago. They have similar modulus of elasticity, tensile elongation and compressive strength, as the standard epoxy resins.

The advantages to Epoxy Urethane and Polysulfide Epoxies are that they maintain their modulus of elasticity and tensile elongation over a wider range of ambient temperatures and are resistant to the detrimental effects of UV rays.

Methyl Methacrylates

Methyl Methacrylates have been used in the United States for over 30 years as concrete bridge deck overlays. Original systems had very high compressive strength, high modulus of elasticity and virtually zero elongation. Their rapid cure did not allow broadcast aggregate to be used and surface tyning was not possible. The advantage of the methyl methacrylate systems was their ability to be installed at low temperatures (14°F) and they cured in approximately 1 hour.

Currently available Methyl methacrylate overlays have low modulus of elasticity(44 ksi), high tensile elongation (150%) and compressive strength of (2.5 ksi). They have also been changed so that wearing aggregate can be broadcast onto the surface before they cure.

High Molecular Weight Methacrylate

High Molecular Weight Methacrylates (HMWM) have been used in the United States for over 20 years as concrete crack and surface porosity sealers. These materials are available in low elongation (5%) and high elongation (30%) formulations. HMWM is very effective at sealing cracks in horizontal concrete surfaces and can seal cracks with widths as small as ½ mm.

Cured HMWM can restore concrete up to 75 to 90% of its original strength. Once HMWM is cured in cracks it permanently seals them from intrusion of moisture unlike some sealers that must be reapplied to maintain performance.

HMWM should not be considered a wearing surface, any material remaining on the surface will be quickly be worn away by vehicles.

Polyester

Polyesters have been in use in the United States for over 25 years as concrete bridge deck overlays. This overlay system was developed by Caltrans and has been primarily used in California and Nevada with several installations in New York. These overlays are designed to be installed at approx 1in. thick and use vibrating screeds to finish. HMWM is required as a primer for all polyester overlays.

Caltrans is the largest user of polyester concrete overlays and their specifications list typical physical properties, elongation (35% min), tensile strength (2.5 ksi) and compressive strength (5 ksi).

Safety and Environmental Issues

Safety

- 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

Spall Repairs
Joint Headers
Bearing Pads

* Epoxies
* Methyl Methacrylates
  - Wide range of application thicknesses
  - Mixing requirements
  - Ease of placement and finishing
  - Temperature limitations
  - Curing time

Wearing Surface Overlays

* Epoxies
* Modified Epoxies
* Methyl Methacrylates
* Polyesters
    - Application method (multi-layer/slurry)
    - Mixing requirements (special machine)
    - Ease of placement and finishing (vibratory screed)
    - Temperature limitations
    - Curing time

Crack and Surface Sealing

* Epoxies
* High Molecular Weight Methacrylate
* Methyl Methacrylate
  - Application method
  - Temperature limitations
  - Curing time
  - Penetration depth in cracks

Common Failure Causes

* Existing concrete strength is too low for good polymer bond
* Concrete is contaminated with chemicals used for concrete curing or surface sealing
* Improper surface preparation
* Poor application procedure used
* Loss of broadcast aggregate
* Excessive broadcast aggregate wear
* UV sensitivity which can cause some polymers to become brittle over time
* Modulus of polymer too high to withstand thermal cycle stresses

Application Temp and Curing Time

Polymer Resin	Temp limit	Curing time @70°F
Epoxy	50°-100°F	4 hours
Modified Epoxy	50°-100°F	4 hours
Methyl Methacrylates	14°-100°F	1 hour
High Molecular Weight Methacrylate	50°-100°F	5 hours
Polyester	50°-100°F	4 hours

Application Procedure

Epoxy	Modified Epoxy	Methyl Methacrylate	Polyester
resin coat	primer coat	primer coat	primer coat
agg broadcast	slurry layer	slurry layer	mortar layer
resin coat	agg broadcast	agg broadcast	agg broadcast
agg broadcast	or	seal coat	
	resin coat		
	agg broadcast		
	resin coat		
	agg broadcast		

Proper Polymer Material Selection

- What existing problem needs to be corrected
- Expected life of polymer for proposed installation
- Different polymers systems (meet minimum project requirements)
- Physical properties on polymer compatible with existing structure
- Application method appropriate for specific project
- Application temperatures requirements
- Curing time
- Installation equipment requirements
- Safety and environmental issues
- Future maintenance issues
- Life cycle cost

Thank You

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