Bridge Deck Overlays (MLPO vs PPC)

Nader Mavaddat, P.E.

Reminders

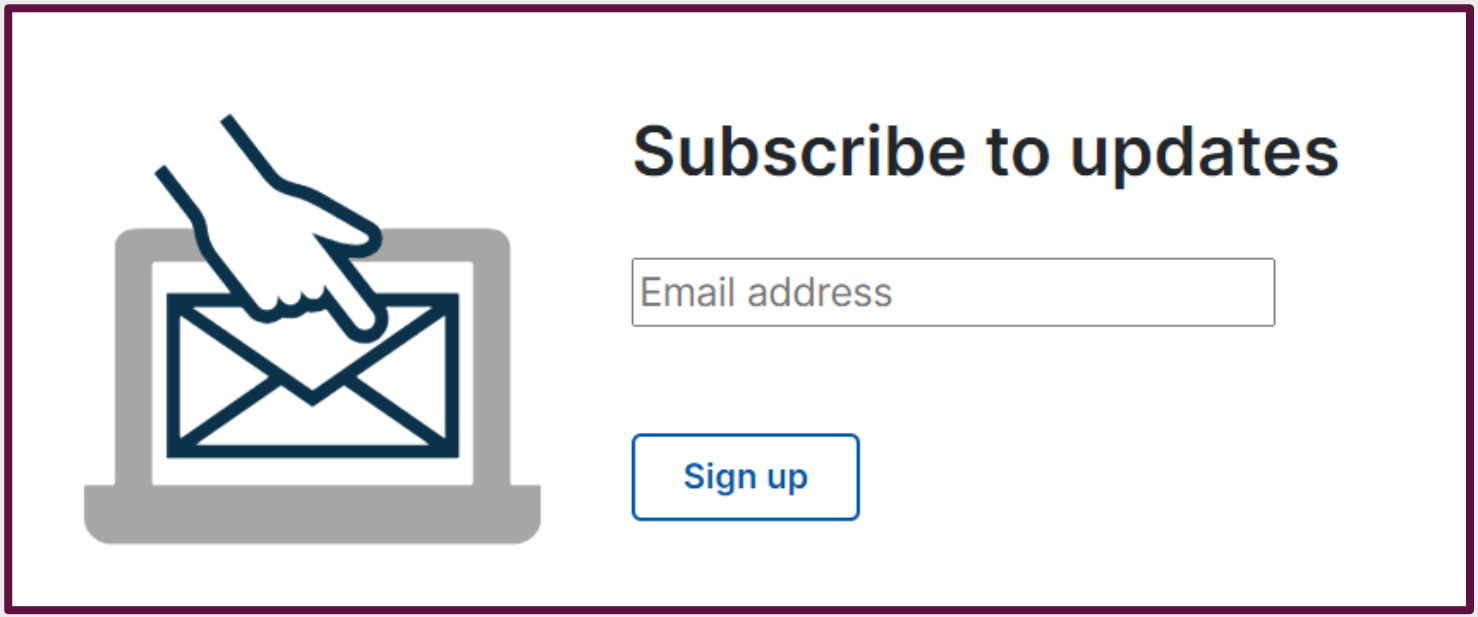
- Chat is turned off, please use the Q&A box
- Slides will be posted on the Bridge Website:

  https://www.txdot.gov/business/resources/highway/bridge/webinar-presentations/bridge-briefings.html

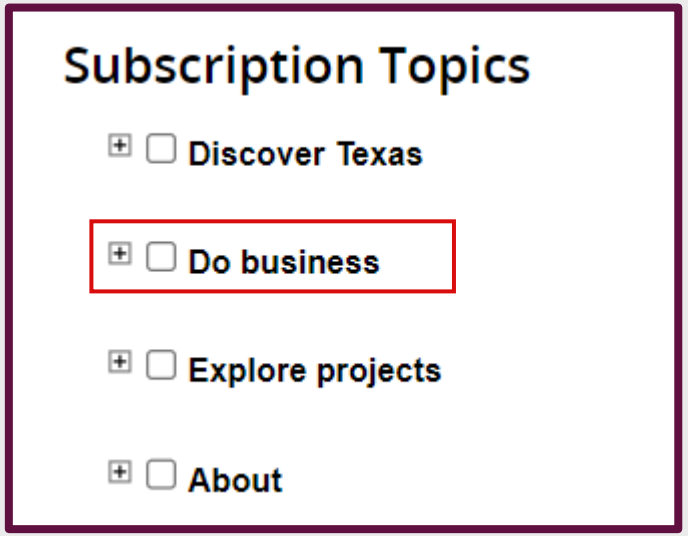
- Please submit additional questions to Nader.Mavaddat@txdot.gov

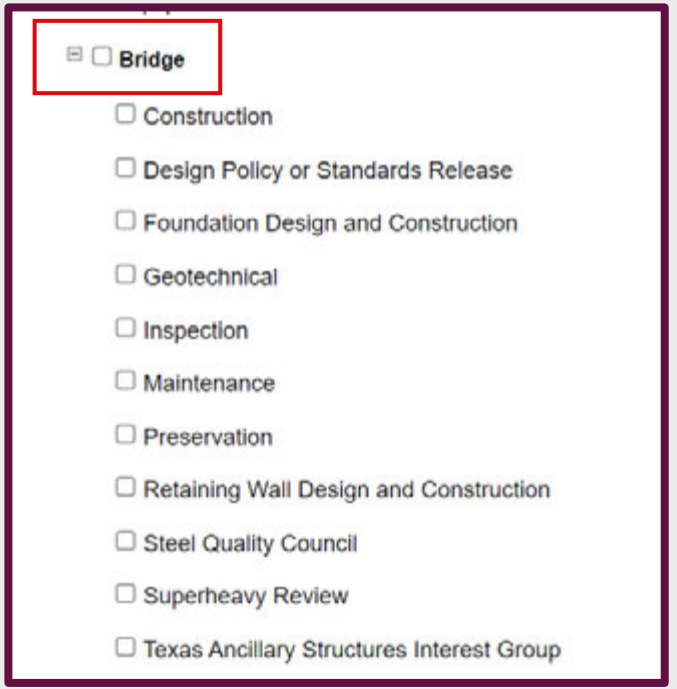
Don’t miss out on other updates!

https://www.txdot.gov/about/divisions/bridge-division.html



Don’t miss out on other updates!





PDH

- Please remember Bridge Division does not provide documentation for TX Board PDH approval. Each engineer should exercise personal judgement when counting webinar topics for their professional development hours. For more info on what qualifies for Continuing Education, please visit https://pels.texas.gov/CEPInfo.htm

2025 Roadway Design and Bridge Conference

- Registration is now open!

https://roadway-design-and-bridge-conference.webflow.io/

Bridge Deck Overlays (MLPO vs PPC)

Nader Mavaddat, P.E.

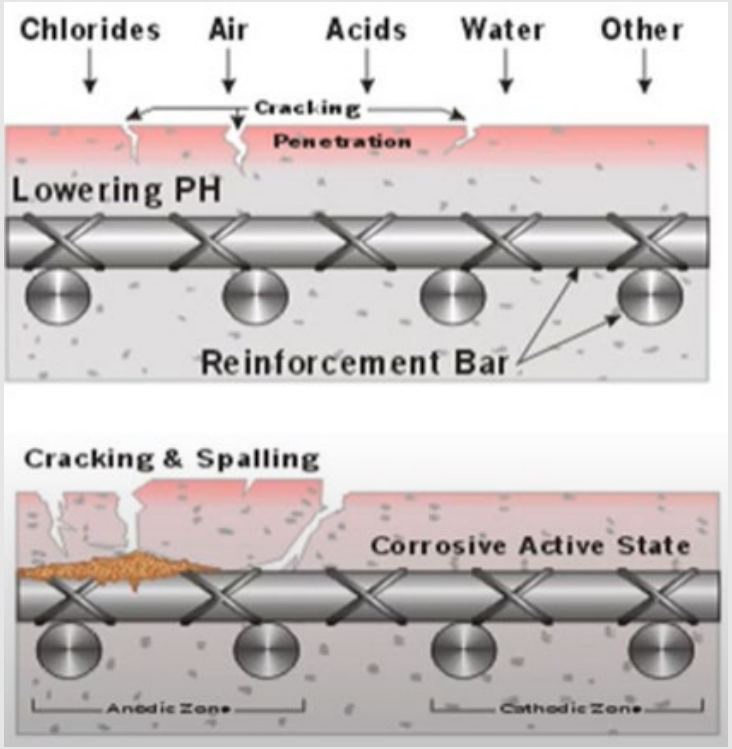
Importance of Bridge Deck Preservation

- The most structurally burdened element in a bridge is its deck
- Bridge deck is the element most exposed to the environment
- Receives constant pounding from heavy truck wheels
- In some regions treated with corrosive de-icing chemicals several months of the year

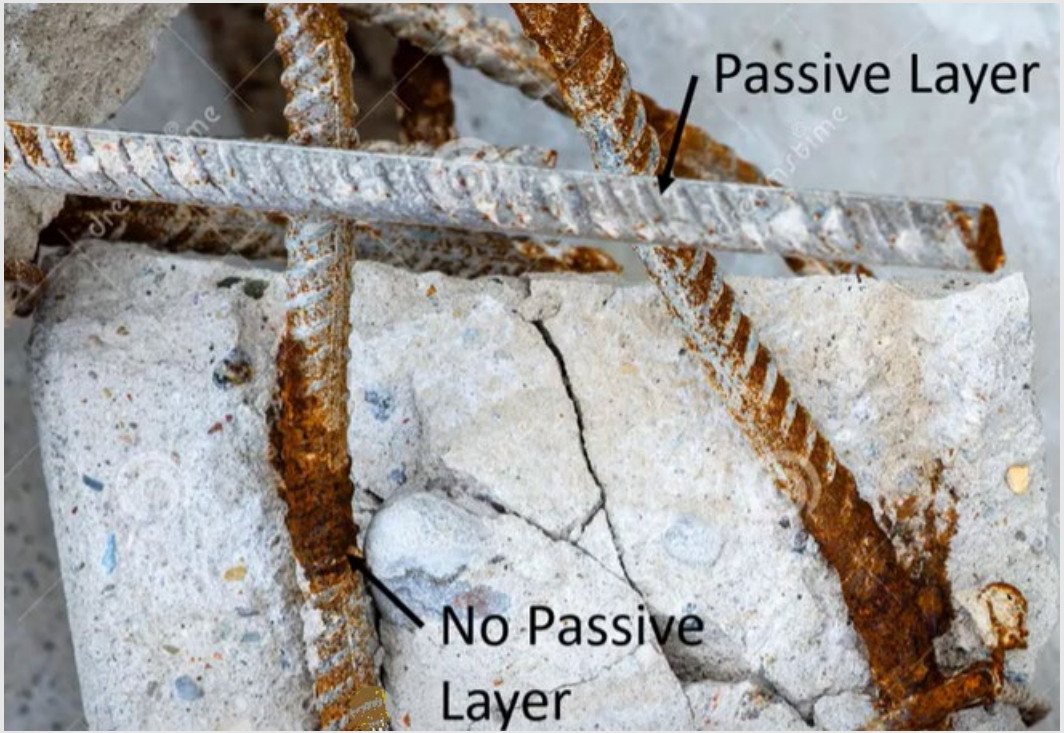
We are all aware that all bridge decks have cracks

Corrosion Initiation

- Cracks allow moisture and deleterious chemicals into the concrete
- As the concrete's PH decreases near the rebar, the passive protective layer coating (Iron hydroxide) is compromised
- The corrosion process begins leading to further cracking, spalling and freeze/thaw damage in colder environment



Corrosion Initiation



Why Overlays on Bridge Decks?

- **Protecting the Deck Surface**
  - Protective barrier to prevent water from penetrating the deck by sealing the cracks
  - Protect against chemicals such as de-icing agents that can be corrosive to the bridge deck surface and reinforcing
- **Improving Skid Resistance**
  - Provide a high friction surface that improves vehicle traction
  - Reduce the risk of skidding or hydroplaning
- **Enhancing Durability**
  - Some types of overlays can add structural value to the bridge
- **Reducing Maintenance Costs**
  - A cost-effective solution for extending the life of a bridge
  - Reduce the need for costly deck repairs

Common Bridge Deck Overlays Used in Texas

- Asphalt Concrete Pavement (ACP) overlay
- Concrete Overlay (CO)
- Latex Modified Concrete (LMC) Overlay
- Multi-Layer Polymer Overlay (MLPO)
- Polyester Polymer Concrete (PPC) Overlay

Multi-Layer Polymer Overlay (MLPO)

What is it?

- Polymer resin binder
- Polish-resistant aggregates are spread on the wet polymer
- Applied in two layers (3/8” total thickness)
- Applied in accordance with Item 439

What does it do?

- Seals extensive deck cracking
- Improve skid value
- Delay chloride penetration
- Low cost
- Rapid cure time
- 15-year service life with proper installation

Multi-Layer Polymer Overlay (MLPO)

Where to use it?

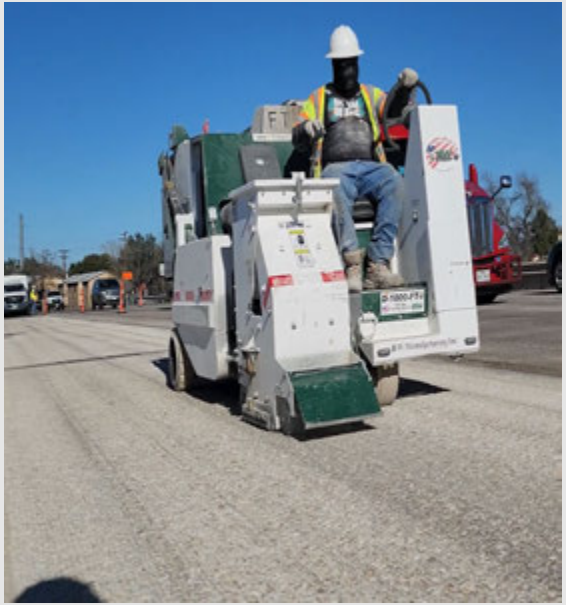
- Structurally sound bridge decks
- Bridge decks with small or moderate-sized cracks
- No severe deterioration, spalling, or major cracks
- Application on low ADT bridge decks
- Cannot apply MLPO in wet condition
- Does NOT provide structural value

MLPO Installation Process

- **Substrate rehabilitation**
  - Inspect the concrete surface and identify unsound areas
  - Chain drag
  - Hammer sound
- **Only remove bad concrete, all sound concrete stays in place**
  - Removal must be in accordance with CRM Chapter 3, Section 4
- **Repair the unsound substrate with repair material compatible with MLPO**

MLPO Installation Process

- Shot blast substrate surface
- Blow off the deck with a high-pressure air compressor (not leaf blower)



MLPO Installation Process

- Identify moisture in the deck
  - ASTM D4263 is a proper method. Using a plastic sheet (approximately 18” by 18”) left taped in place for at least 2 hr
- Mask existing joints and deck drains
- Tape all longitudinal overlay terminations to maintain a straight edge

MLPO Installation Process

- First layer of polymer resin application
  - Mix components with drill mixer

MLPO Installation Process

- First layer of polymer resin application
  - A timer must be used to make sure the materials are mixed for the manufacturer's recommended amount of time

MLPO Installation Process

- First layer of polymer resin application
  - To reduce the entrainment of air, a "Jiffy-style" mixer attachment is advised

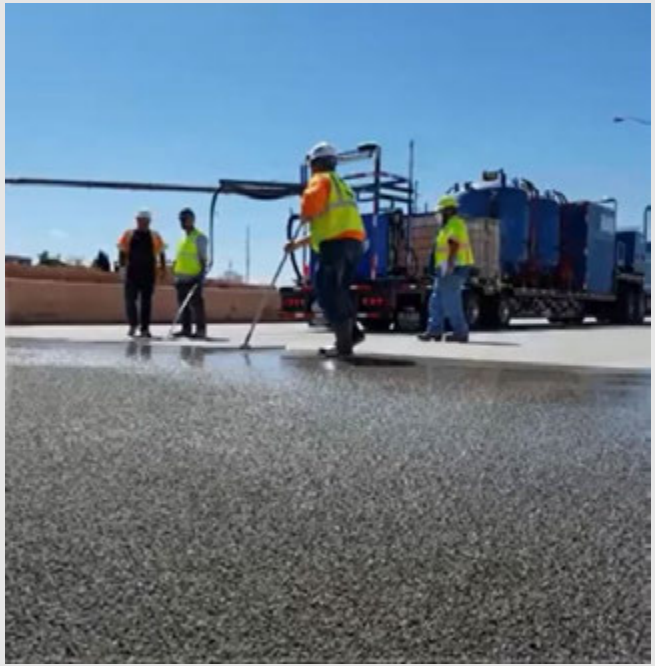
MLPO Installation Process

- First layer of polymer resin application
  - The mixing vessel must be perfectly round and/or have no sharp corners

NOT Acceptable

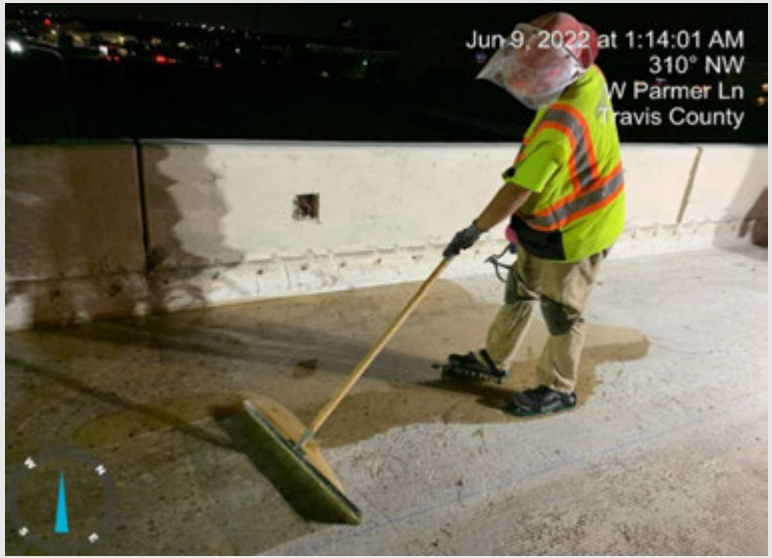
MLPO Installation Process

- First layer of polymer resin application
  - Squeegee the material at the appropriate coverage rate without overworking it



MLPO Installation Process

- First layer of polymer resin application
  - All staff must wear spiked shoes



MLPO Installation Process

- First layer of aggregate broadcasting
  - Spread evenly and as soon as possible during warm installation temperatures
  - Do not to let the resin binder begin gelling before spreading aggregates
  - Capillary wicking may occur if the aggregate is piled during placement

MLPO Installation Process

- Clean-up and removal of excess aggregate
    - Before the overlay gains strength, remove all masking tape
    - Make sure the course has gained sufficient strength. When prodded or pushed with a tool like a screwdriver, the embedded aggregate shouldn't move at all
    - Use mechanical sweeper/automated sweeping truck

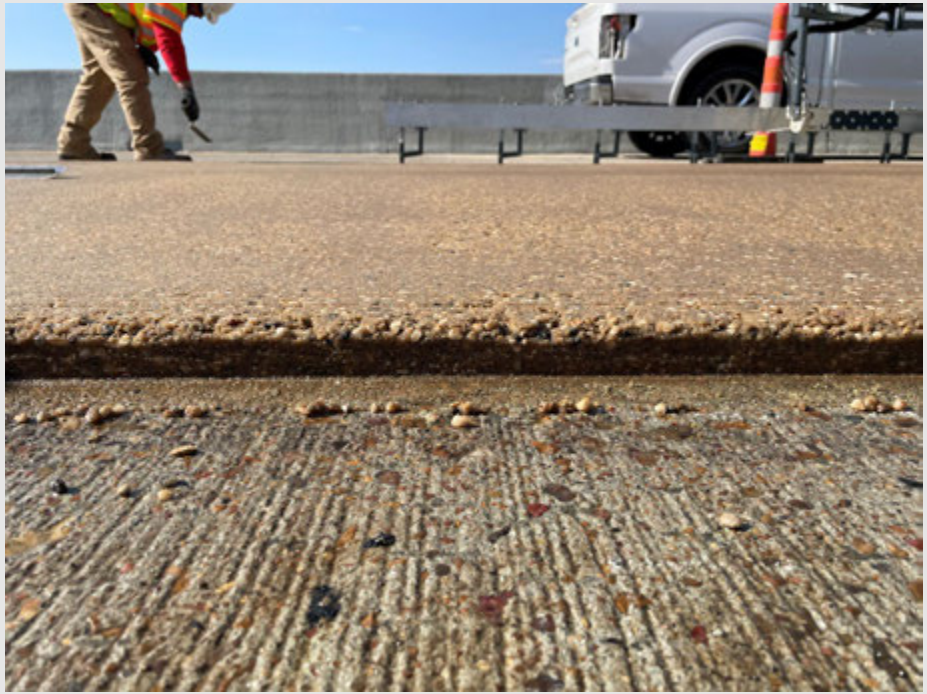
MLPO Installation Process

- Second layer
  - The second course will be repeated the same as the first course
  - Once more, cover joints and drains, mask/tape all longitudinal and transverse terminations
  - Remove as much loose aggregate as possible. Loose aggregate can act as an abrasive
  - Hold off opening the lane to traffic for about 2 hours after the system has hardened

Polyester Polymer Concrete (PPC)

What is it?

- Mix of Sand, Stone, and Polyester resin (No water or cement)
- High Molecular Weight Methacrylate (HMWM) Primer
- ¾” to 3” thickness (per specification)
- Work performed in accordance with Item 439



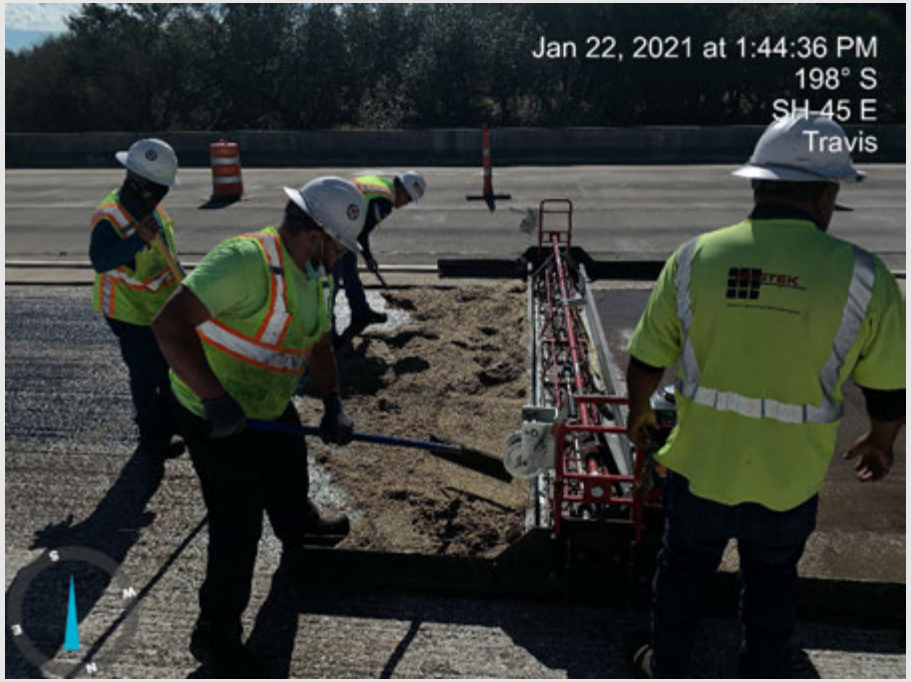
Properties

- 6,000 psi compressive strength
- 800 psi tensile strength
- 1,500 psi flexural strength (MOR)
- 1,500 ksi MOE
- 135 – 140 pcf unit weight

Polyester Polymer Concrete (PPC)

What does it do?

- Seals moderate to major cracks
- Impermeable to moisture/chlorides (brine or rock salt)
- High wear resistance and friction longevity
- Improve skid and ride quality
- Integrated chemical bond to substrate
- Rapid cure time (around 2 hours)
- 20 - 30 years service life with proper installation



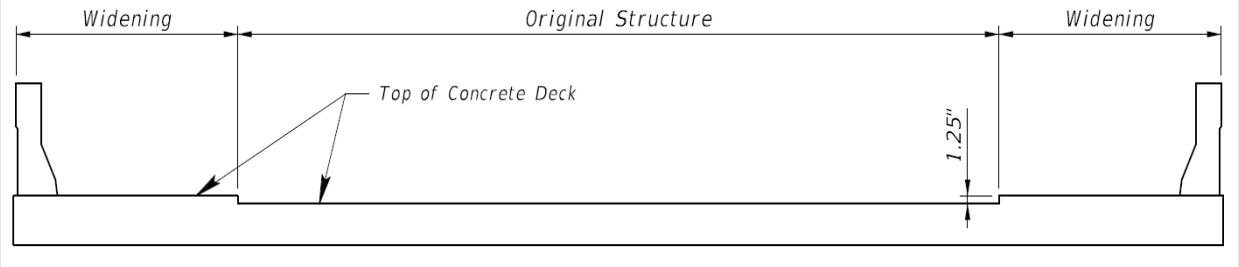
Polyester Polymer Concrete (PPC)

Where to use it?

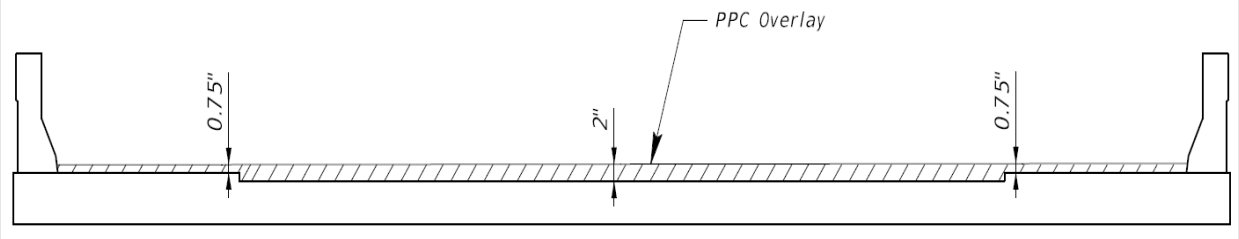
- Bridge decks with ride quality issues
- Bridge decks with moderate to major cracks
- Does NOT add structural value
- Dry condition (Moisture is the greatest enemy of PPC)
- Structurally sound bridge decks
- Unsound concrete can be rehabilitated using same PPC material as overlay
  - This would be for shallow partial depth repair areas
- Areas requiring rapid return to service
- More resistant to truck traffic than MLPO

Polyester Polymer Concrete (PPC)

Profile correction



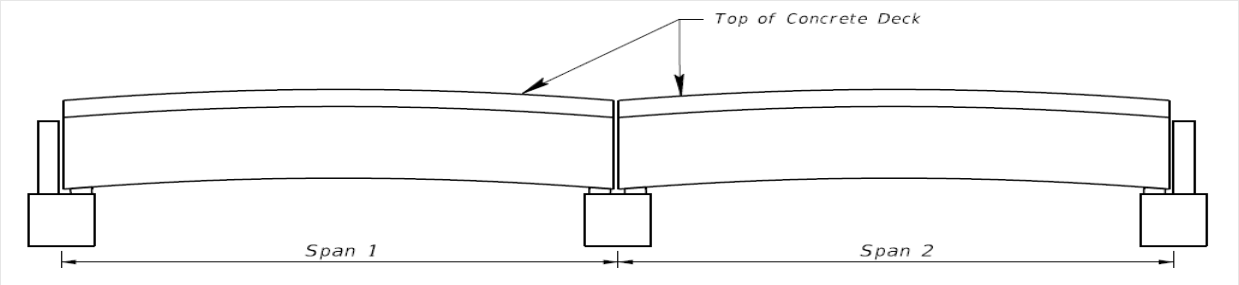
Uneven deck surface appears after milling off the ACP



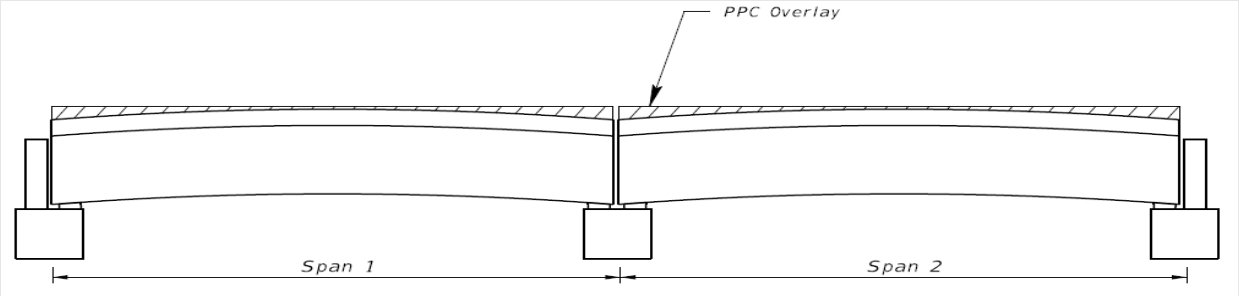
Fixing the issue by applying two different thicknesses of PPC

Polyester Polymer Concrete (PPC)

Ride quality improvement



Poor ride quality



Improving ride quality using PPC overlay

Polyester Polymer Concrete (PPC)

Trial Application

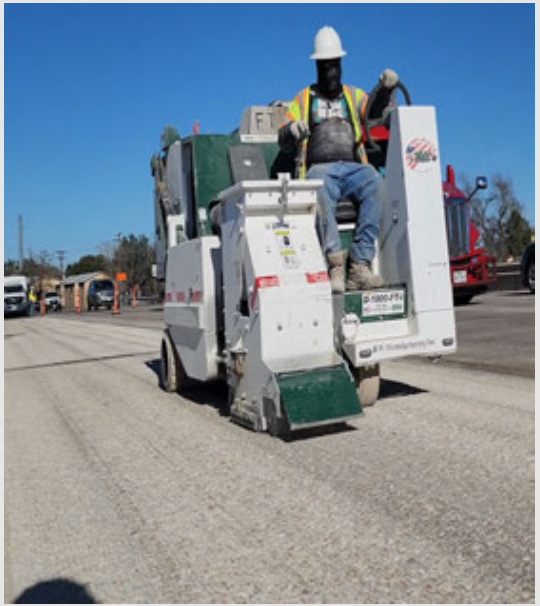
- Prior to overlay installation, one or more trial applications must be conducted on the prepared substrate
- The minimum bond strength on normal weight concrete substrates will be 250 psi with a concrete substrate failure area greater than 50% of the test area
- Do not proceed with overlay installation until the minimum bond strength is achieved
- Can be rejected after 3 failures

PPC Installation Process

- **Substrate rehabilitation**
  - Inspect the concrete surface and identify unsound areas
  - Chain drag
  - Hammer sound
- **Only remove/repair bad concrete, all sound concrete stays in place**
  - Same PPC material can be used in shallow repair locations
  - Removal must be in accordance with CRM Chapter 3, Section 4

PPC Installation Process

- Shot blast substrate surface
- Blow off the deck with a high-pressure air compressor (not leaf blower)

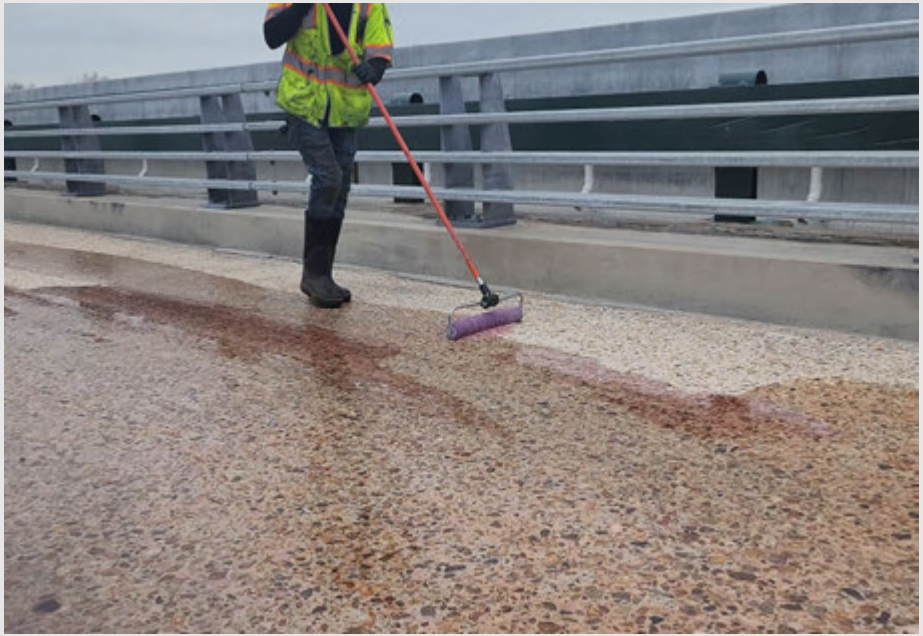


PPC Installation Process

- Identify moisture in the deck
  - ASTM D4263 is a proper method. Using a plastic sheet (approximately 18” by 18”) left taped in place for at least 2 hr
- Mask existing joints and deck drains
- Maintain a straight edge at longitudinal overlay terminations

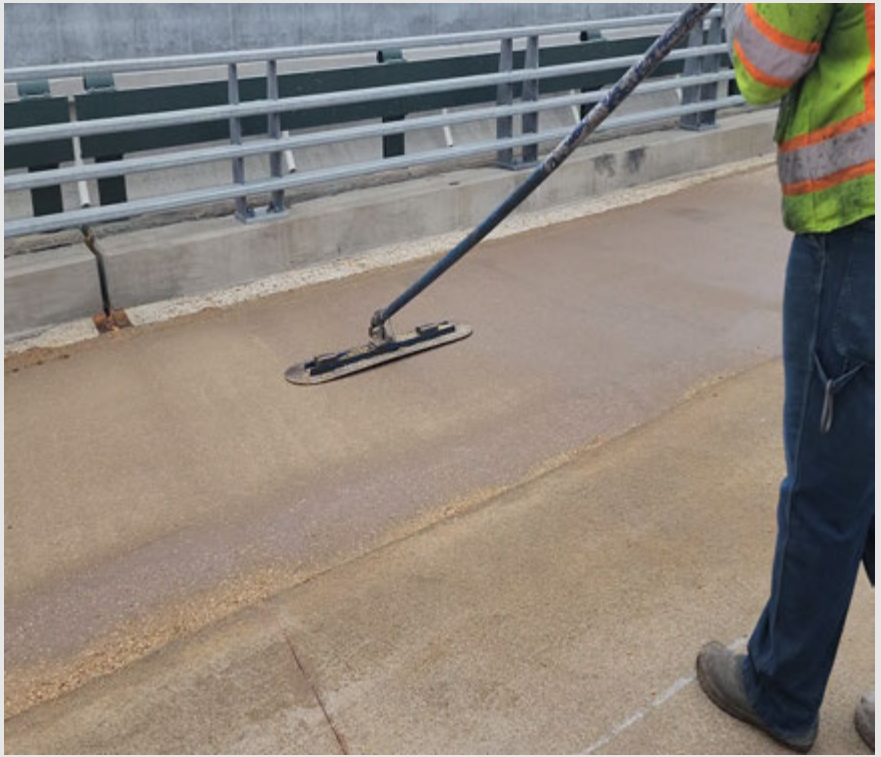
PPC Installation Process

- HMWM (High Molecular Weight Methacrylate) primer application
  - Fills the pores and cracks on concrete surface and saturates it, then will react with the overlay
  - Mix components with drill mixer
  - Push puddles with roller/broom/squeegee
  - Distribute to refusal, not excess
  - Place PPC between 15 min to 2 hours after primer application



PPC Installation Process

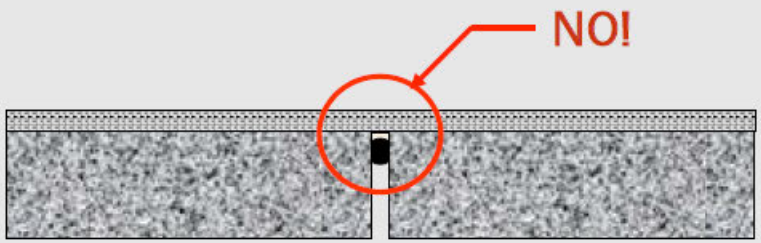
- Place PPC overlay

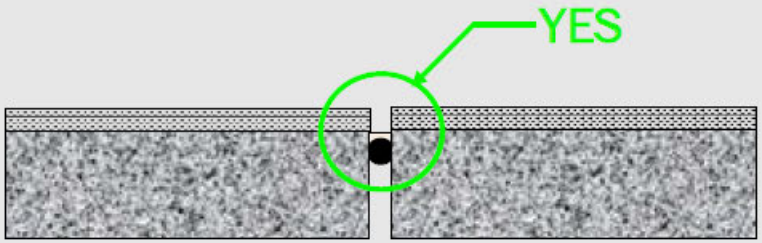


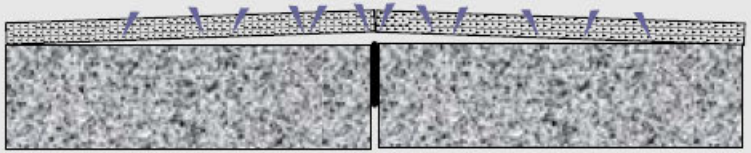
PPC Installation Process

- **Abrasive top sand**
  - Broadcast evenly
  - Slight excess, no streaks/heaps

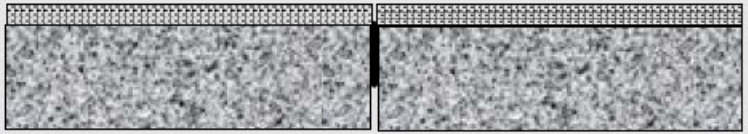
Expansion Joints







Overlay cracks and pulls away from the deck.



Overlay moves along with the deck.

PPC Installation Process

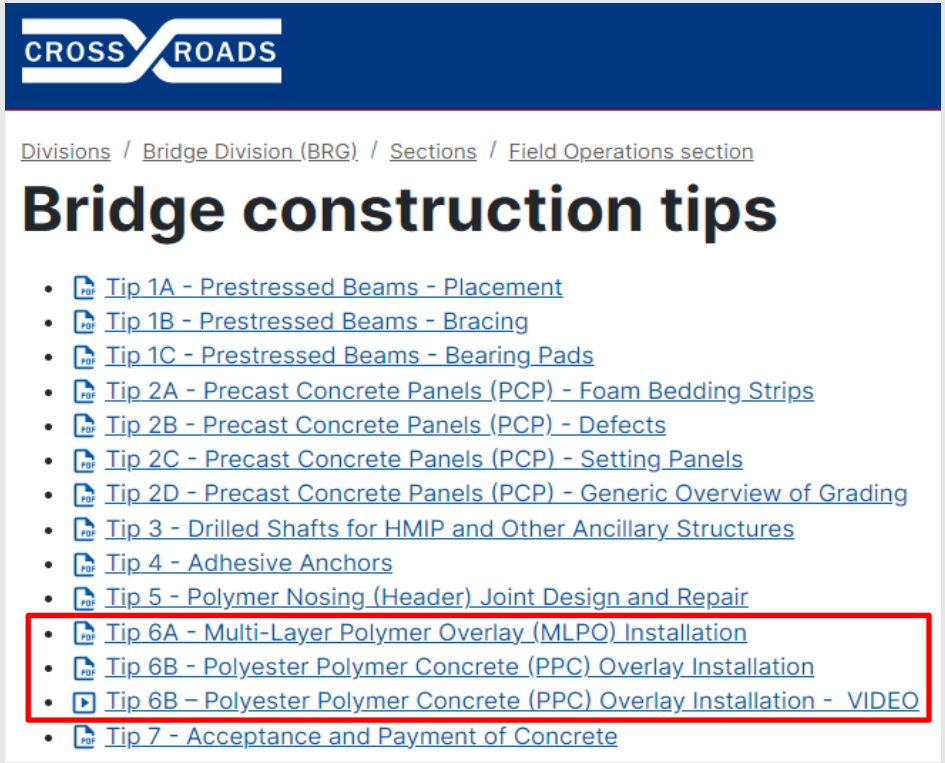
- Use Manual Rebound Hammer to check if the overlay is at 3,000 psi
- Open to traffic in about 2 hours

Bridge Construction Tips

Bridge construction tips for MLPO and PPC overlays covers the installation means and methods including:

- What to Inspect When Installing
- Handling and storing of materials
- Surface preparation
- Mixing
- Placing
- Aggregate broadcasting
- Curing
- Texturing

Note: Internal guidance available for TxDOT employees



Link: https://crossroads/divisions/brg/sections/field-operations-section/bridge-construction-tips.html

“Bridge Deck Overlay Notes” Working Drawing

Working drawings are found in Bridge Standards page:

- Primarily used by the designers
- DGN files are available to be modified
- Non-standard sheets, need to be signed and sealed

WORKING DRAWINGS

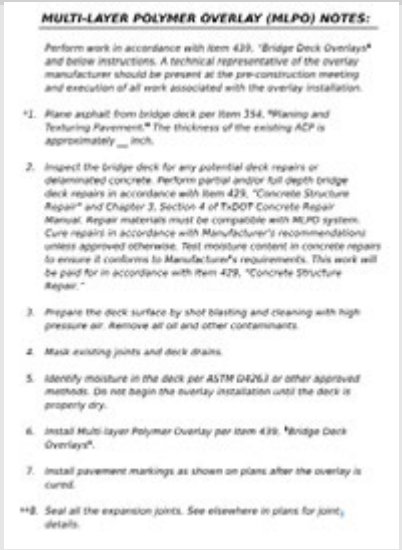
Rev Date	Std Name	Description	File Name
02-24		Index Sheet of Working Drawings	WD-Table-24.dgn
		Bridge Decks	
Rev Date	**Std Name**	**Description**	**File Name**
02-24		Full Depth Deck Repair	WD-FDDR-24.dgn
02-24		Partial Depth Deck Repair	WD-PDDR-24.dgn
02-24		Bridge Deck Overlay Notes	WD-BDON-24.dgn
02-24		Waterproof Details	WD-WPD-24.dgn
		Bridge Joints	
Rev Date	**Std Name**	**Description**	**File Name**
02-24		Cleaning and Sealing Existing Bridge Joints	WD-CSBJ-24.dgn
02-24		Cleaning and Sealing Existing Bridge Joints (Strip Seal)	WD-CSBJ(SS)-24.dgn
02-24		Cleaning and Sealing Bridge Joints (Pan Girders)	WD-CSBJ(PG)-24.dgn
02-24		Precompressed Foam Expansion Joint Seal	WD-PFEJ-24.dgn
02-24		Joint Repair and Replacement Details (For Bridges With Asphalt Overlay)	WD-JRR(ACP)-24.dgn
02-24		Joint Repair and Replacement Details (For Bridges Without Asphalt Overlay)	WD-JRR-24.dgn
		Beams and Bearing Pads	
Rev Date	**Std Name**	**Description**	**File Name**
02-24		Elastomeric Bearing Replacement (Concrete)	WD-EBR(C)-24.dgn
02-24		Elastomeric Bearing Replacement (Steel)	WD-EBR(S)-24.dgn
02-24		Prestressed Concrete Beam Repair	WD-PCBR-24.dgn
02-24		Bridge Protective Beam Wrap	WD-BPBW-24.dgn
02-24		Steel Beam Repair	WD-SBR-24.dgn
02-24		Zone Painting Details	WD-ZPD-24.dgn
		Substructure and Culverts	
Rev Date	**Std Name**	**Description**	**File Name**
02-24		Pile Encasement	WD-PED-24.dgn
02-24		Bent Cap Repair Details	WD-BCRD-24.dgn
02-24		Box Culvert Slip Lining Details	WD-BCSL-24.dgn

Link: https://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridge-e.htm#WORKINGDRAWINGS

“Bridge Deck Overlay Notes” Working Drawing

Bridge Deck Overlay Notes cover overlay installation sequence for different overlay types including:

- Multi-Layer Polymer Overlay (MLPO)
- Polyester Polymer Concrete (PPC) Overlay
- Latex-Modified Concrete (LMC) Overlay
- Concrete Overlay (CO)



MULTI-LAYER POLYMER OVERLAY (MLPO) NOTES:

Perform work in accordance with Item 439, "Bridge Deck Overlays" and below instructions. A technical representative of the overlay manufacturer should be present at the pre-construction meeting and execution of all work associated with the overlay installation.

*1. Plane asphalt from bridge deck per Item 354, "Planing and Texturing Pavement." The thickness of the existing ACP is approximately __ inch.

2. Inspect the bridge deck for any potential deck repairs or delaminated concrete. Perform partial and/or full depth bridge deck repairs in accordance with Item 429, "Concrete Structure Repair" and Chapter 3, Section 4 of TxDOT Concrete Repair Manual. Repair materials must be compatible with MLPO system. Cure repairs in accordance with Manufacturer's recommendations unless approved otherwise. Test moisture content in concrete repairs to ensure it conforms to Manufacturer's requirements. This work will be paid for in accordance with Item 429, "Concrete Structure Repair."

3. Prepare the deck surface by shot blasting and cleaning with high pressure air. Remove all oil and other contaminants.

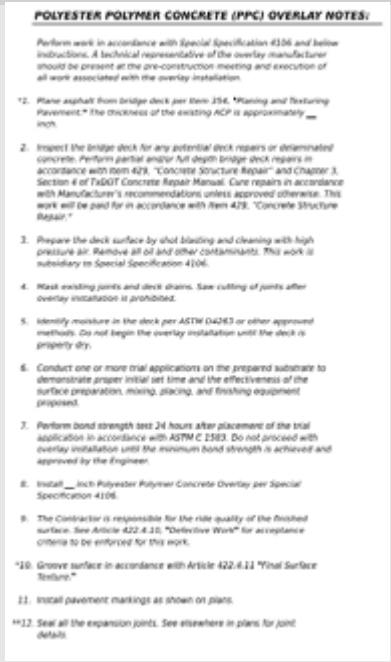
4. Mask existing joints and deck drains.

5. Identify moisture in the deck per ASTM D4263 or other approved methods. Do not begin the overlay installation until the deck is properly dry.

6. Install Multi-layer Polymer Overlay per Item 439, "Bridge Deck Overlays".

7. Install pavement markings as shown on plans after the overlay is cured.

**8. Seal all the expansion joints. See elsewhere in plans for joint details.



POLYESTER POLYMER CONCRETE (PPC) OVERLAY NOTES:

Perform work in accordance with Special Specification 4106 and below instructions. A technical representative of the overlay manufacturer should be present at the pre-construction meeting and execution of all work associated with the overlay installation.

*12. Plane asphalt from bridge deck per Item 354, "Planing and Texturing Pavement." The thickness of the existing ACP is approximately __ inch.

2. Inspect the bridge deck for any potential deck repairs or delaminated concrete. Perform partial and/or full depth bridge deck repairs in accordance with Item 429, "Concrete Structure Repair" and Chapter 3, Section 4 of TxDOT Concrete Repair Manual. Cure repairs in accordance with Manufacturer's recommendations unless approved otherwise. This work will be paid for in accordance with Item 429, "Concrete Structure Repair."

3. Prepare the deck surface by shot blasting and cleaning with high pressure air. Remove all oil and other contaminants. This work is subsidiary to Special Specification 4106.

4. Mask existing joints and deck drains. Saw cutting of joints after overlay installation is prohibited.

5. Identify moisture in the deck per ASTM D4263 or other approved methods. Do not begin the overlay installation until the deck is properly dry.

6. Conduct one or more trial applications on the prepared substrate to demonstrate proper initial set time and the effectiveness of the surface preparation, mixing, placing, and finishing equipment proposed.

7. Perform bond strength test 24 hours after placement of the trial application in accordance with ASTM C 1583. Do not proceed with overlay installation until the minimum bond strength is achieved and approved by the Engineer.

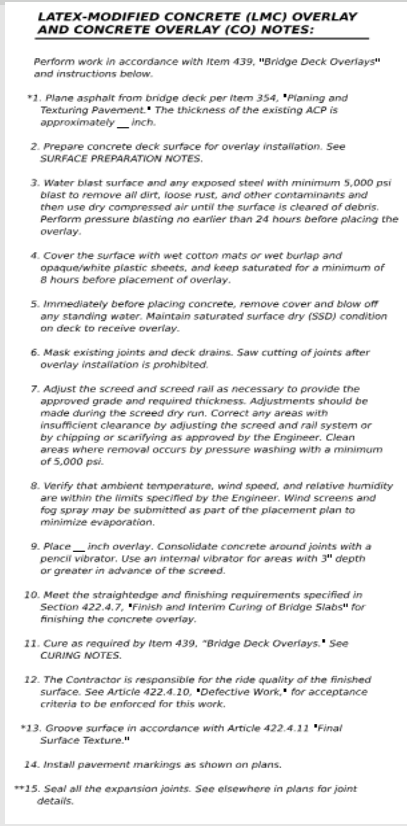
8. Install __ inch Polyester Polymer Concrete Overlay per Special Specification 4106.

9. The Contractor is responsible for the ride quality of the finished surface. See Article 422.4.10, "Defective Work" for acceptance criteria to be enforced for this work.

*10. Groove surface in accordance with Article 422.4.11 "Final Surface Texture."

11. Install pavement markings as shown on plans.

**12. Seal all the expansion joints. See elsewhere in plans for joint details.



LATEX-MODIFIED CONCRETE (LMC) OVERLAY AND CONCRETE OVERLAY (CO) NOTES:

Perform work in accordance with Item 439, "Bridge Deck Overlays" and instructions below.

*1. Plane asphalt from bridge deck per Item 354, "Planing and Texturing Pavement." The thickness of the existing ACP is approximately __ inch.

2. Prepare concrete deck surface for overlay installation. See SURFACE PREPARATION NOTES.

3. Water blast surface and any exposed steel with minimum 5,000 psi blast to remove all dirt, loose rust, and other contaminants and then use dry compressed air until the surface is cleared of debris. Perform pressure blasting no earlier than 24 hours before placing the overlay.

4. Cover the surface with wet cotton mats or wet burlap and opaque/white plastic sheets, and keep saturated for a minimum of 8 hours before placement of overlay.

5. Immediately before placing concrete, remove cover and blow off any standing water. Maintain saturated surface dry (SSD) condition on deck to receive overlay.

6. Mask existing joints and deck drains. Saw cutting of joints after overlay installation is prohibited.

7. Adjust the screed and screed rail as necessary to provide the approved grade and required thickness. Adjustments should be made during the screed dry run. Correct any areas with insufficient clearance by adjusting the screed and rail system or by chipping or scarifying as approved by the Engineer. Clean areas where removal occurs by pressure washing with a minimum of 5,000 psi.

8. Verify that ambient temperature, wind speed, and relative humidity are within the limits specified by the Engineer. Wind screens and fog spray may be submitted as part of the placement plan to minimize evaporation.

9. Place __ inch overlay. Consolidate concrete around joints with a pencil vibrator. Use an internal vibrator for areas with 3" depth or greater in advance of the screed.

10. Meet the straightedge and finishing requirements specified in Section 422.4.7, "Finish and Interim Curing of Bridge Slabs" for finishing the concrete overlay.

11. Cure as required by Item 439, "Bridge Deck Overlays." See CURING NOTES.

12. The Contractor is responsible for the ride quality of the finished surface. See Article 422.4.10, "Defective Work," for acceptance criteria to be enforced for this work.

*13. Groove surface in accordance with Article 422.4.11 "Final Surface Texture."

14. Install pavement markings as shown on plans.

**15. Seal all the expansion joints. See elsewhere in plans for joint details.

“Bridge Deck Overlay Notes” Working Drawing

Please carefully read “NOTE TO DESIGNER” box before using any Working Drawing sheets.

NOTE TO DESIGNER:

These sheets are to be used as a guide for preparing plans for bridge deck overlays. They include installation procedures for several different overlay types. Details with appropriate notes from this guide should be prepared for the specific application. These sheets cannot be used without modification and in all cases notes not required must be removed. This note and the phrase "Not to be used as a standard" must be removed and the sheet must be signed and sealed by a Professional Engineer.

CONCRETE OVERLAY (CO) AND LATEX-MODIFIED CONCRETE (LMC) OVERLAY:

Application:
These products can provide structural value with or without added reinforcing steel or steel fibers. CO and LMC can restore integrity of the bridge deck, improve ride, skid values and provide additional cover to reinforcing steel which will delay chloride penetration. These materials can be installed in thicknesses ranging from minimum 1-¾" for LMC and 1-½" for CO to maximum 3" for both. CO and LMC can spall along longitudinal construction joints within wheel paths and at acute corners. Care should be taken when developing details to clearly indicate that a longitudinal phase/construction joint does not occur along a wheel path. Details should also incorporate a breakback to avoid acute corners at skews over 15 degrees.

Anticipated Service Life:
CO and LMC can provide 20+ years of service with proper installation.

POLYESTER POLYMER CONCRETE (PPC) OVERLAY:

Application:
This product does not add structural value but can provide additional wearing surface and improve skid, improve ride, seal cracks, and delay chloride penetration. This material can be installed in thicknesses ranging from minimum ¾" to maximum 3". Special Specification 4106 is a one-time use special specification and its use will need to be requested on a project by project basis.

Anticipated Service Life:
PPC overlays have an estimated 20 - 30 year service life with proper installation.

MULTI-LAYER POLYMER OVERLAY (MLPO):

Application:
This product does not provide a structural benefit. However, it can seal extensive deck cracking, improve skid values and delay chloride penetration. The thickness of this material is approximately ⅜".

Anticipated Service Life:
MLPO is estimated to have a 15 year service life with proper installation.

Questions?

Nader Mavaddat, P.E.

TxDOT Bridge Division

Construction & Maintenance Section

Nader.Mavaddat@txdot.gov

Questions?

- Can an MLPO be installed in phases? if so, how long between each phase is acceptable?
  - Yes, both of these overlay systems can be installed in phases. As soon as the first phase can take traffic (both layers are fully cured), the second phase can begin.
- Has TxDOT had any success in using PPC overlay to replace existing asphalt overlays on pan girders? Specifically trying to address leaking through the longitudinal cracks in the crowns of the pan girders? Will the cracks just reflect through the PPC and continue to leak?
  - We have used PPC on several pan girder bridges for this reason, though the overlay system may not have been in service long enough to evaluate the success. We expect it to work, and the lower MOE should allow the PPC to be flexible enough for the cracks not to propagate through.
- Does TxDOT requires a load rating when adding the additional load of the PPC overlay?
  - Yes. Just like adding additional ACP or changing the loading on the bridge in anyway, a load rating should be performed. Even if the thickness of PPC is less than the existing ACP, the load rating should be modified to show that it may have improved.

Questions?

- What is the recommendation for using different PPC overlay thickness? 3/4" vs 1" vs 3" etc.
  - 3/4" is sufficient to serve the function of a PPC overlay. Anything additional is usually to maintain grade.
- You mentioned PPC is limited to 3/4" min and 3" max thickness. What do you recommend for an application that requires thicker than 3"? Could this be used beyond 3" or do you recommend something else?
  - Per TxDOT Specifications, 3" is the maximum thickness that can be used for PPC application.
- If PPC can be used as patching material but is not considered a structural material do we not want to expose the rebar of the areas to be patched or what would be best practice?
  - Depending on the depth of the unsound concrete, we might need to remove more concrete and reach the rebar mat, in this case it is recommended to use concrete material for repair. For shallow spall depth (around 1"), the PPC material can be used.
- What would be the recommended concrete milling depth for a PPC overlay?
  - For a PPC overlay you typically should not have to do any milling.