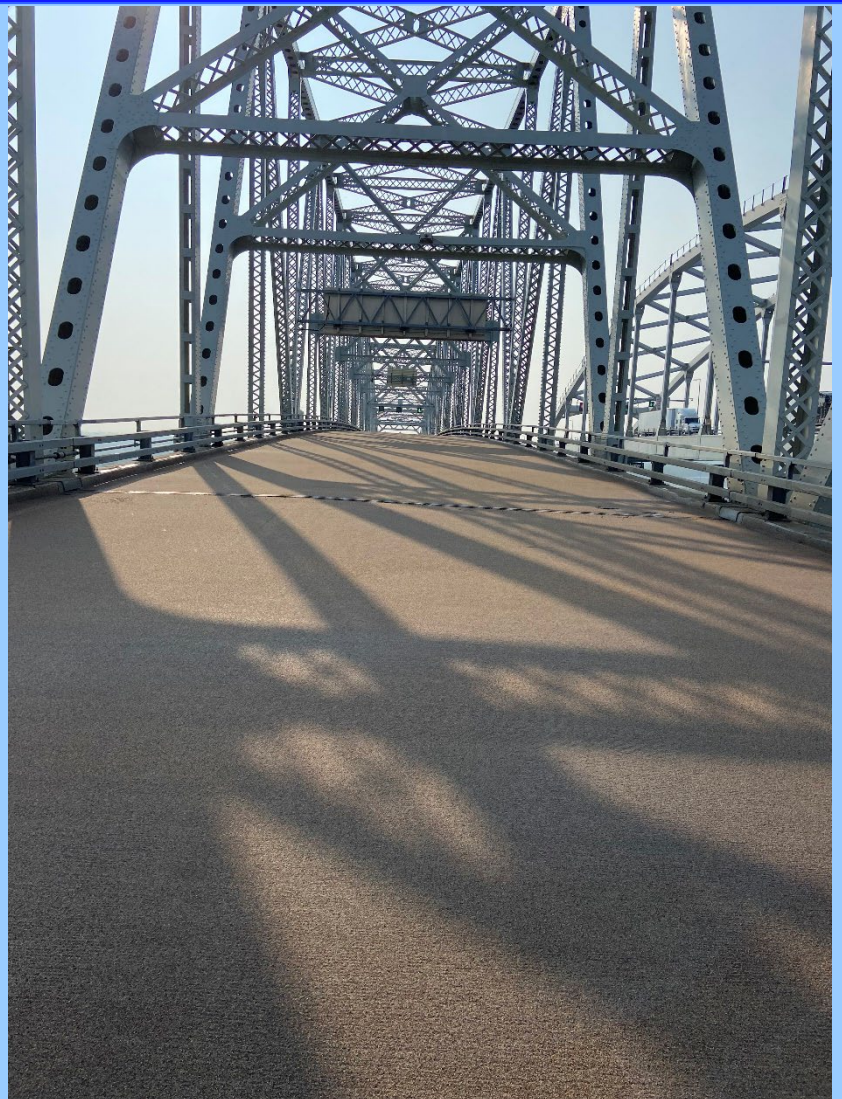
BUREAU of BRIDGES and STRUCTURES

SPANNING SAFETY CONNECTING EFFICIENTLY

Thin Epoxy Overlay / Healer Sealer/ Silane



Statewide Bridge Support Unit
Bridge Preservation
Bureau of Bridges and Structures

2024 Michigan Highway Maintenance Conference – Bridge Workshop

BUREAU of BRIDGES and STRUCTURES

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Agenda

- What are they (all preventative maintenance products)
- Silane
- Healer Sealer
- Thin Epoxy Overlay
- Summary

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BUREAU of BRIDGES and STRUCTURES

What are they

Silane – is a type of water-repelling sealer used to protect concrete surfaces.

- They act as a barrier against the ingress of moisture and water-borne salts into concrete
- It prevents deterioration caused by soluble salts in porous concrete.
- Can be used on horizontal and vertical surfaces
- Does not seal the crack so it must be applied prior to crack fillers
- Applying silane before crack fillers can enhance adhesion to the concrete.

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What are they

Healer Sealer – these are very low viscosity liquid-applied resins that penetrate by gravity into the hairline cracks and surface pores of concrete.

- Penetrates into the hairline cracks of the concrete by **Gravity.**
- Once inside the cracks, the healer sealer fills voids and adheres to the concrete matrix preventing further propagation of the cracks.
- Provides a protective barrier on the concrete surface and prevents harmful substances like chlorides from entering the concrete.
- Improves durability by maintaining the structural integrity of the concrete over time

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What are they

Thin Epoxy Overlay – "bridges" the cracks in a deck and acts as an integrally bonded layer on the bridge deck that prevents moisture from entering the cracks.

- This has a higher viscosity but still penetrates slightly into the hairline cracks of the concrete by **Gravity**
- Concrete decks deteriorate due to wear, weathering, and traffic. This 3/16 inch thick decks restores the deck strength and skid resistance, improving safety for the users.
- Provides a protective barrier on the concrete surface and prevents harmful substances like chlorides from entering the concrete.
- By making the deck impermeable to air, chemicals, and contaminates, it enhances it overall durability by withstanding harsh environmental conditions.

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Silane

When to apply:

- You should apply it **29 days after the new deck has been poured.** Applying this early in the bridge life will enhance the durability and longevity of the new concrete deck.
- Never to late to start. Best for new bridges.

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SPANNING SAFETY CONNECTING EFFICIENTLY

Silane

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Pros:

- Penetrates the concrete surface and reacts with minerals of concrete, creating a hydrophobic (water repellant) layer. Prevents water and chemical (salt) intrusion.
- Easy to apply – minimal surface preparation
- Cost-effective protection
- Does not alter the skid resistance
- Dries quickly within an hour or 2.
- Silanes can last 6 to 10 years

Silanes

Cons:

- Can be affected by ultraviolet light, physical abrasion, weathering, & alkaline attack. Shorter lifespans.
- Should not be applied to bituminous or epoxy sealed surfaces.

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Silanes

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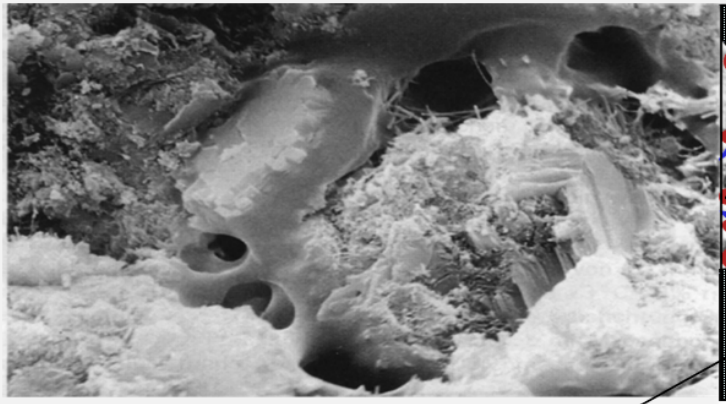
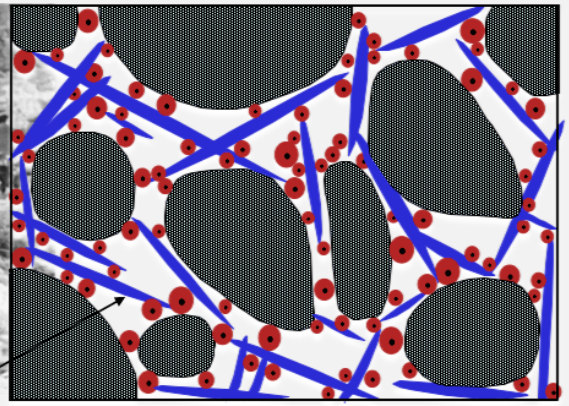
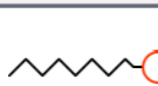
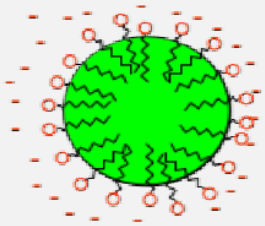
The process of hydrolysis and condensation of Alkoxy Silane and cement







Silane reacts with Silica in cement creating a covalent bond and a “hydrophobic tail”



The surface is changed from inorganic & porous to Hydrophobic with an organic interface

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Silane

How to apply it on the deck

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Silane

Finished product on the deck

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Alkali-Silica Reactivity (ASR) & Silane:

- ASR results in the expansion and cracking of the concrete due to the formation of a gel material at the interface between the aggregate particles and cement mortar. This leads to serious cracking, compromising structural integrity.
- Silane penetrant inhibits water permeation and absorption while allowing water vapor to permeate.
- It reduces the moisture state of the concrete which slows the development of ASR deterioration.

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8-2017

Mitigation and Evaluation of Alkali-Silica Reaction (ASR) and Freezing and Thawing in Concrete Transportation Structures

Richard Albert Deschenes Jr.
University of Arkansas, Fayetteville

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6.3. CONTRIBUTIONS

- Mitigating ASR through surface treatment with silane reduces the moisture state of concrete over time, thereby limiting expansion due to ASR. The rate of deterioration in this study ranged from 0.01 and 0.12%/yr. for the minimally to severely deteriorated barrier wall sections evaluated. Additionally, several surface treatment methods were evaluated in addition to silane, to determine the most economical and practical treatment.
- Silane was applied to a concrete pavement and strain, internal-RH, and DRI monitored for three-years. This is the longest running field-evaluation of silane applied to concrete pavement. The results were inconsistent, but indicate silane may slow expansion and deterioration in concrete pavement relative to untreated controls.

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Silane

ELSEVIER

Construction and Building Materials
Volume 116, 30 July 2016, Pages 121-127

Determining the effective service life of silane treatments in concrete bridge decks

Mehdi Khanzadeh Moradllo, Bryan Sudbrink, M. Tyler Ley

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https://doi.org/10.1016/j.conbuildmat.2016.04.132 Get rights and content

Highlights

- The effectiveness of silane is investigated in 60 bridge decks with service life of 6–20years.
- The silane layer starts to decrease after 12years of service.
- The average silane thickness is reduced by 75% in 17–20year old bridges.
- Abrasion was not a significant silane deterioration mechanism in investigated structures.
- Silane deterioration starts in the bulk of the concrete and progresses towards the surface.

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Healer Sealer

When to apply:

- Any deck that is 29 days old or **older. Applying this early in the bridge life will enhance the durability and longevity of the existing concrete deck.**
- Any deck surface where you see cracks.
- Any deck with a deck bottom rating of good.
- Any deck with a surface condition that would warrant deck patching and rated a 5 or greater.

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BUREAU of BRIDGES and STRUCTURES

Healer Sealer

Pros:

- Rapid cure and requires one layer
- Excellent absorption into the concrete cracks and pores.
- Acts as a barrier against contaminates.
- Crack healing and improves durability.
- Well applied healer sealers can last 5 to 10 years

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Healer Sealer

Cons:

- Reliant on deck preparation
- Effectiveness depends on its ability to penetrate into the concrete so dense concrete or non-porous concrete may limit penetration.
- Salts and acids can degrade the healer sealer over time. Regular maintenance is essential
- Provide immediate protection but their long term performance depends on factors like traffic load, freeze thaw cycles, and UV exposure.

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Healer Sealer

- **Surface preparation is the most important step**
- Spalls repaired at all locations.
- Mastic on the deck needs to be removed.
- All oils, dirt, curing compounds, other contaminants must be removed
- Shotblasting at a slow pace for CSP 3 can be achieved with one pass. Cleans and rounds the edges of the cracks making easier for epoxy to penetrate.
- Tinning and paint lines do not have to be removed.

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Healer Sealer

- International Concrete Repair Institute Guideline No. 03732 defines the profiles:
  - CSP 1 – Acid Etched
  - CSP 2 – Grinding
  - CSP 3 – Light Shotblast (Healer Sealer)
  - CSP 4 – Light Scarification
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  - CSP 8 – Scabbed
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Healer Sealer

Deck preparation

- We need to sweep the deck or blow it off with dry compressed air prior to shotblasting.

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Healer Sealer

Final Cleaning

- Remove shot with magnetic sweeper
- Clean with dry compressed air
- Tape expansion joints
- Tape deck drains

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BUREAU of BRIDGES and STRUCTURES

SPANNING SAFETY CONNECTING EFFICIENTLY

Healer Sealer

One of our Healer Sealer Rigs

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Placing the epoxy material

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Placing the Epoxy Material

- PLEASE DO NOT APPLY LIKE THIS?

(This is Brushing it on versus moving the flood)

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Placing the Aggregate Material

- Broadcast across the deck.
- No visible wet spots

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Healer Sealer

Finished Product

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Thin Epoxy Overlay

- Any deck 1 year or **older**
- Any deck with a deck bottom rating of good.
- Any deck with a surface condition that would warrant deck patching and rated a 6 or greater.
- Any deck you want a higher Skid Number
  - Typical Skid Number on Michigan Bridge Tined Bridge Deck is 40
  - Typical Skid Number on Michigan Bridge Deck with Thin Overlay is 65

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Thin Epoxy Overlay

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Pros

- Protects the deck from chlorides and deicers
- Provides aesthetic wearing surface
- Increases skid resistance
- Prevents icing of the bridge
- Improves ride quality
- Can last 10 to 20 years or more
- Cost effective way to extend the service life, enhance safety, and maintenance costs

Thin Epoxy Overlay

Cons

- Time consuming compared to Silane and Healer Sealer.
- Reliant on deck preparation
- Susceptible to snowplow damage if your deck is higher than your approach slab.
- It is weather dependent

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Thin Epoxy Overlay

Temperature and Weather Dependent

- Minimum recommended air and surface temperatures are 50°F and rising
- If precipitation is expected floodcoating should be delayed

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Thin Epoxy Overlay

- Surface preparation is **everything** for the long term performance of the Epoxy Polymer Overlay. All soft, weak surface mortar, laitance or carbonation must be removed to allow the epoxy compound to **bond to the aggregate** within the concrete matrix.
- **Moisture test is recommended.**

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Thin Epoxy Overlay

- **Surface preparation is the most important step**
- Spalls repaired at all locations.
- All oils, dirt, curing compounds, weak surface mortar (delaminations) and other contaminants must be removed
- Shotblaster VELOCITY and number of passes determine the Concrete Surface Profile (CSP)

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Thin Epoxy Overlay

- **Surface preparation is the most important step**
- Deck tining must be removed
- Layer of aggregate exposed
- Paint striping is a bond breaker (must be removed)
- If unsound areas (delaminations) are discovered delay application
- Vehicles are not allowed on the prepared surface.

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Thin Epoxy Overlay

Surface Preparation

- Scarify the paint lines

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Thin Epoxy Overlay

Surface Preparation

- Inadequate Surface Profile

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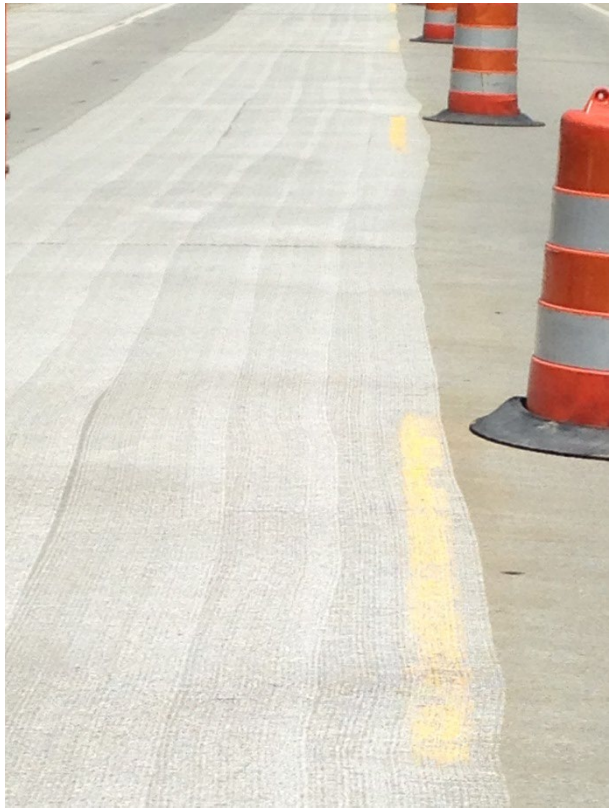
Thin Epoxy Overlay

Surface Preparation

- Remove paint striping before epoxy application



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Surface Preparation

- Remove paint striping before epoxy application

Thin Epoxy Overlay

Surface Preparation

- Remove paint striping before epoxy application

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Surface Preparation

- Epoxy is difficult to remove from strip seal gland so tape joints and drains well.

Thin Epoxy Overlay

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Surface Preparation

- Exposed aggregate

Thin Epoxy Overlay

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Placing the Epoxy Material

- Squeegee material as tight as possible (especially for thin epoxy overlay)
- Always use epoxy spikes while squeegeeing
- You should replace the squeegee when it gets worn down.
- Be sure to seal 1-2 inches up the sidewall
- Use notched squeegees

Thin Epoxy Overlay

Finished product

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BUREAU of BRIDGES
SPANNING SAFETY
CONNECTING EFFICIENTLY
and STRUCTURES

Thin Epoxy Overlay

Not a good candidate!

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BUREAU of BRIDGES and STRUCTURES

SPANNING SAFETY CONNECTING EFFICIENTLY

Summary

- All three of these are acceptable preventative maintenance activities. This will prolong the life of the bridge.
- Silane should be used prior to a Healer Sealer or a Thin Epoxy overlay as it will help enhance the bond strength as well as give it the protection it needs.
- These products should be used early in the bridge life to get the best results.

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BUREAU of BRIDGES and STRUCTURES

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Questions?????

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