



Preventative Maintenance for Concrete Bridge Decks

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Definition of PM

Preventive Maintenance (PM) -
Planned activities that are performed in advance of a need for repair or in advance of accumulated deterioration, so as to avoid such occurrences and reduce or arrest the rate of future deterioration. The activities may correct minor defects as a secondary benefit.

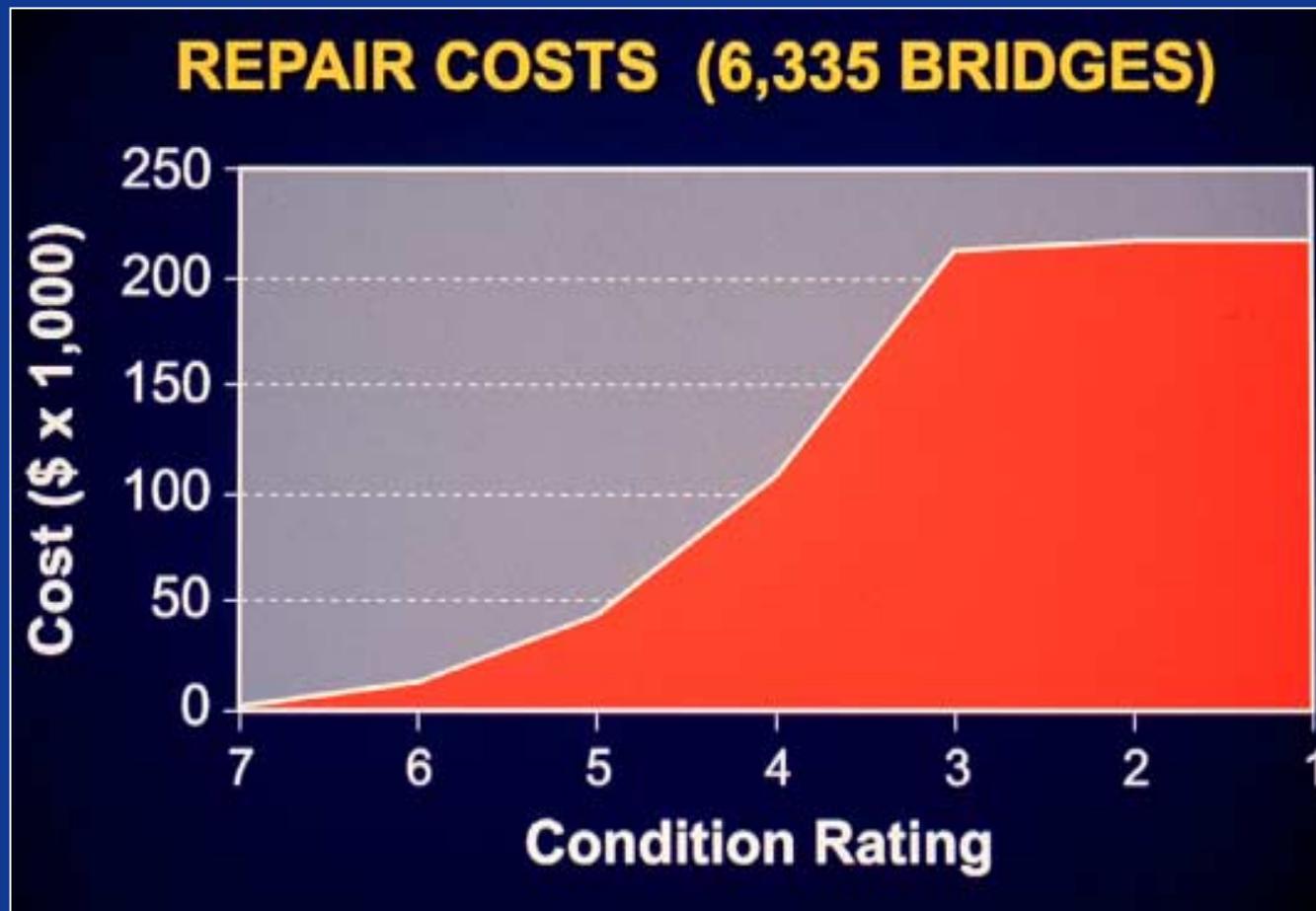
Preventive Maintenance Goals

- Extend the service lives of our infrastructure assets.
- Preserve our investment.

Bridge Inventory Condition

- VDOT maintains 11,703 NBI structures.
- 1,043 structures with $SR < 50$.
Replacement or rehabilitation.
- 3,663 structures with $50 < SR < 80$.
Rehabilitation.
- 6,997 structures with $SR > 80$.
Preventive maintenance.

Repair Costs Increase without PM



Courtesy of Claude S. Napier, Jr., Division Bridge Engineer,
Virginia Division, Federal Highway Administration



Approved Deck PM List

1. Bridge cleaning (sweeping) and/or washing services.
2. Seal cracks and seal concrete for protection.
3. Seal, replace, reconstruct, or eliminate deck joints.
4. Deck overlays: epoxy and concrete.
5. Cathodic Protection (CP) Systems.
6. Electrochemical Chloride Extraction (ECE) Treatment.
7. Concrete deck repairs in conjunction with: deck overlays, installation of CP systems and ECE treatment.



PM Activity Timing & Costs

Activity	Frequency	Avg. Unit Cost
Deck Washing	Yearly	\$1.30/SY
Deck Sweeping	Yearly	\$0.40/SY
Scheduled Replacement of Pourable Joint Seal	6 Years	\$50/LF
Scheduled Replacement of Compression Joint Seal	10 Years	\$66/LF
Scheduled Installation of Thin Epoxy Overlay	15 Years	\$47/SY
Scheduled Installation of Concrete Overlay	30 Years	\$130/SY

Crack Sealers

1. Gravity Fill Polymers

- High molecular weight methacrylate
- Epoxy
- Urethane

2. Kevlar carbon fiber sheet

Gravity Fill Polymer Applications



Brooms are used for application of high molecular weight methacrylate monomer. Sufficient material must be applied to fill cracks

Gravity Fill Polymer Applications



Filling cracks with HMWM monomer. Broom excess monomer from grooves before it gels. Monomer left in grooves can reduce skid resistance.

Kevlar Carbon Fiber Sheet

- Shot blast surface along crack
- Mix and place epoxy along crack
- Roll Kevlar carbon fiber sheet, centered over crack, onto epoxy
- Press sheet into epoxy
- Broadcast aggregate into epoxy

Application of Kevlar Carbon Fiber Sheet



Concrete Sealers

- NCHRP Synthesis 209 Sealers for Portland Cement Concrete Highway Facilities
- 232 products identified in 1994
- Classes: **water repellent**, pore blocker
- Types: acrylic, linseed oil, epoxy, polyester, **silane, siloxane**, silicon, silicate, gum, stearate, urethane

Concrete Sealers



Spray application of sealer is not recommended. Sealer evaporates and gets on vehicles and other surfaces.

Concrete Sealers



Placing
sealer
with
brooms
works
well.

Joint Deterioration



Bridge deck showing deteriorated and leaking deck expansion joint material.

Beam Deterioration



Main bridge supporting members showing accelerated deterioration to the end portion of the main steel due to leaking expansion joints.

Pier Deterioration



Concrete bridge pier showing concrete deterioration (spalls / delamination) with exposed steel reinforcement due to leaking expansion joints.

Silicone Joint Seal



Joint Replacement



Joint and header replacement require major effort: removal of concrete and installation of rebar, header, concrete and joint.

Joint Elimination (over piers and abutments)

- Remove joint and concrete
- Form area
- Place 0.5-in neoprene pad over beams
- Place reinforcement
- Place concrete

Joint Elimination



Joint and concrete removed from deck and parapet for joint closure.

Joint Elimination



Formwork and reinforcement in place for joint closure concrete.

Joint Elimination



Cracks and joints in joint closure concrete have been sealed with gravity fill epoxy.

Joint Closure



Bottom
view of
joint
elimination
showing
0.5-in thick
neoprene
pad over
beam.

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Joint Elimination



Hydraulic cement concrete or epoxy overlays are often placed after the joint closure is complete.

Joint Elimination

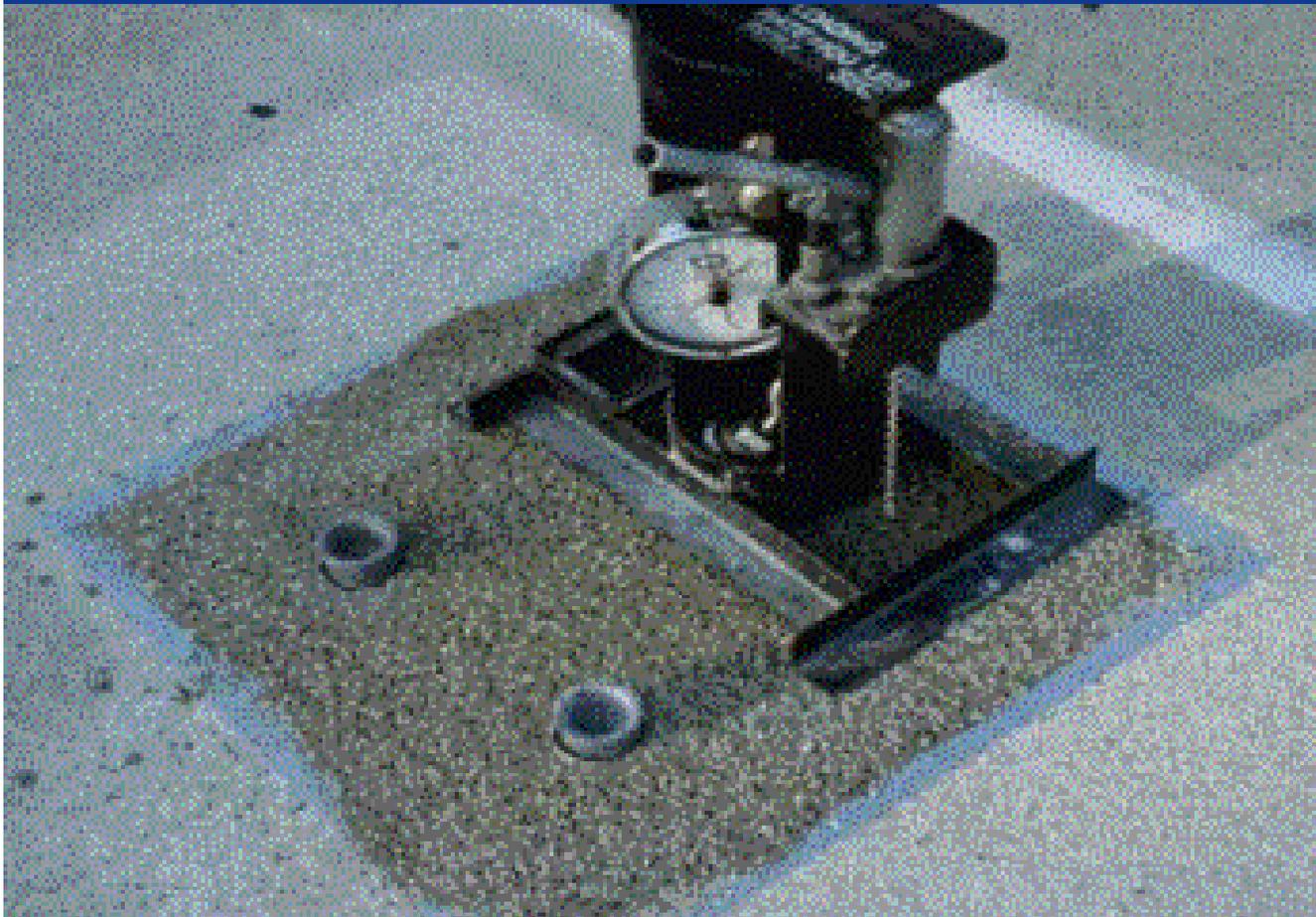


Reflective
cracks in
concrete
overlay
over joint
closure.

Deck Overlays: Epoxy

- 2 layers of epoxy and broadcasted aggregate placed on a dry, shot blasted surface.
- Test patches done to verify materials, surface preparation, and mixing and placing of materials are acceptable.

Deck Overlays: Epoxy



Overlay Tensile Adhesion Test: Load cell is hooked to cap, the core is loaded, the cored overlay fails, red needle on load cell indicates failure load. Three results are averaged.

Deck Overlays: Epoxy



Surface preparation: dry, shot blasted surface. Shot blast equipment: 9-in (left) and 6-ft (right).

Deck Overlays: Epoxy



2 layers
of epoxy
and
broadca
sted
aggrega
te, 0.25-
in thick.

Hydraulic Cement Concrete Overlays

- LATEX MODIFIED (LMC)
- SILICA FUME (SF)
- OTHER

Concrete Overlays

1. High bond strength: often a problem
2. Few cracks: often a problem
3. Low permeability: easily obtained
4. Good skid resistance, ride quality, and surface appearance: typically not a problem

Concrete Overlays

- Clean surface by shot blasting and other approved cleaning practices to remove asphalt, oils, dirt, rubber, curing compounds, paint, carbonation, laitance, weak surface mortar, and other detrimental materials that may interfere with the bonding or curing of the overlay.
- Water soak and cover with polyethylene within 24 hours of final pass of shot blaster.
- Maintain in wet and covered condition until overlay is placed.

Concrete Overlays

Polyethylene covers prepared deck surface until mobile mixer discharges latex-modified concrete.



Concrete Overlays



Overlay mortar is broomed over surface, screed consolidates and strikes-off overlay.

Concrete Overlays



Mobile mixer discharges LMC-VE (3 hr. to traffic) overlay concrete. Fogging (right) increases relative humidity.

Concrete Overlays



Wet burlap is placed on overlay as soon as practical to prevent plastic shrinkage cracking.

Concrete Overlays



Curing: wet burlap and polyethylene are applied as soon as practical. Keep burlap wet for 2 days (LMC) and 3 days (SF).

Conclusions

Preventive Maintenance:

- extends the life of our decks.
- needs to be proactive rather than reactive.
- needs to be an integral part of our deck preservation program.
- protects our investment.



Thank you.

Questions?

