Best Practices for Bridge Deck Overlay

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Roadmap to Presentation

- Objective of Presentation
- General information and paradigm shift in field practice
- Source of deterioration of bridge deck
- Protection system for bridge deck
- Best practices
- Conclusions

Objectives of Presentation

- Evaluate Deck Protection Alternatives
- Discuss Best Practices
- Access Best Alternatives

General information

- Corrosion damage is a multi-billion dollar problem
- A cost figure of 1% of GNP is related to the bridge deck corrosion, direct or indirect
- The worst bridge disaster, Silver Bridge over Ohio River in 1967, 46 fatality

Paradigm Shift

- Maintaining a State of Good Repair Using Cost Effective Investment Strategies
  - Bridge Preservation
  - Bridge Preventive Maintenance
- Definition:
  - Strategies that prevent, delay or reduce deterioration of bridges or bridge elements, restore the function of existing bridges, keep bridges in good condition and extend their life.

Cyclical PM Activities

Cyclical PM Activity Examples	Commonly Used Frequencies (Years)[4]
Wash/clean bridge decks or entire bridge	1 to 2
Install deck overlay on concrete decks such as: - Thin bonded polymer system overlays - Asphalt overlays with waterproof membrane - Rigid overlays such as silica fume and latex modified	 10 to 15 10 to 15 20 to 25
Seal concrete decks with waterproofing penetrating sealant	3 to 5
Zone coat steel beam/girder ends	10 to 15
Lubricate bearing devices	2 to 4

(4) - *Frequencies are based on FHWA's knowledge of typical State DOT practices*

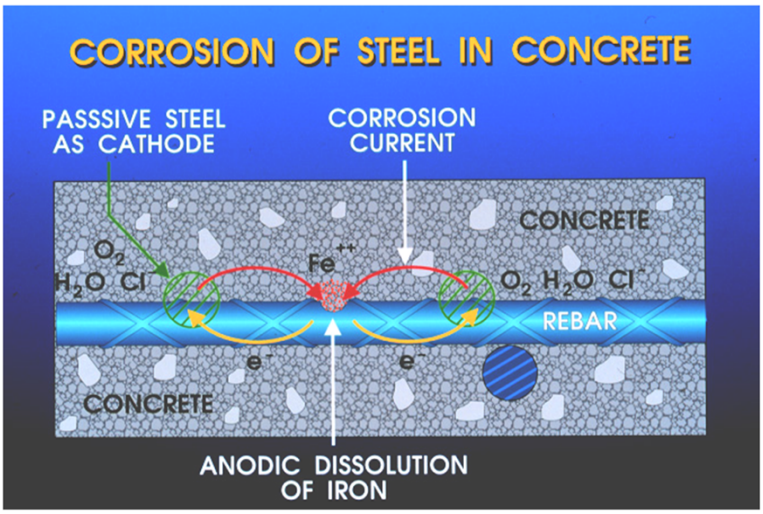
Preventive Maintenance

- PM activities that may extend the life of bridge decks
  - Seal or replace leaking joints.
  - Deck overlays - significantly increase the life of the deck by sealing of aging and weathering.
  - Cathodic Protection systems for bridge decks.
  - Electrochemical Chloride Extraction treatment
  - Concrete deck repairs in conjunction with installation of deck overlays

Cause of Deterioration

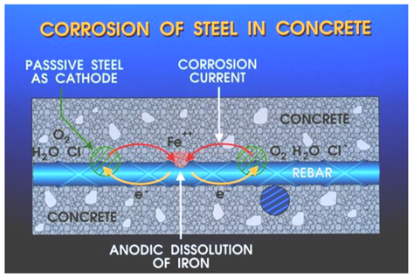
- Corrosion of the reinforcing bars and deterioration of the riding surface
- All are related to the co-existence of :
  - Water
  - Salt (chloride)
  - Oxygen

Corrosion

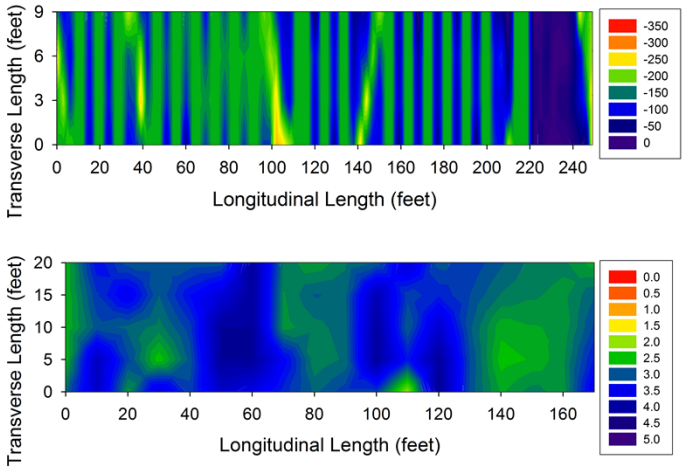

CORROSION OF STEEL IN CONCRETE
PASSSIVE STEEL AS CATHODE
CORROSION CURRENT
CONCRETE
O_2 H_2O Cl^-
Fe^{++}
O_2 H_2O Cl^-
REBAR
e^-
e^-
CONCRETE
ANODIC DISSOLUTION OF IRON

Principle of Deck Protection

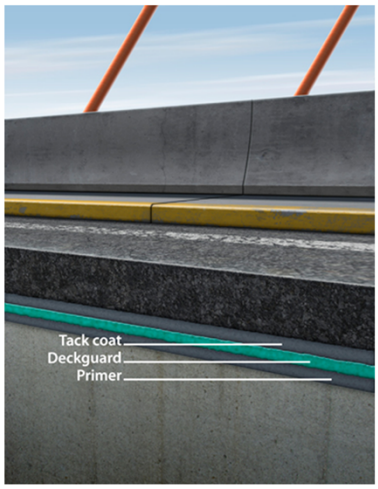
- Remove at least one component of the source of corrosion
- Not necessarily to remove all three components



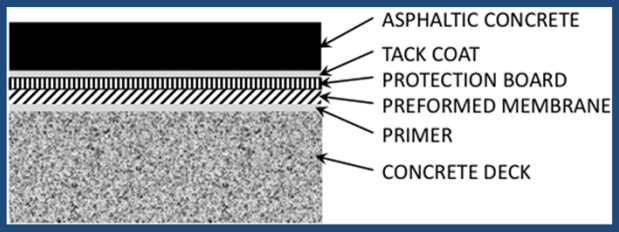
Good Protection Systems

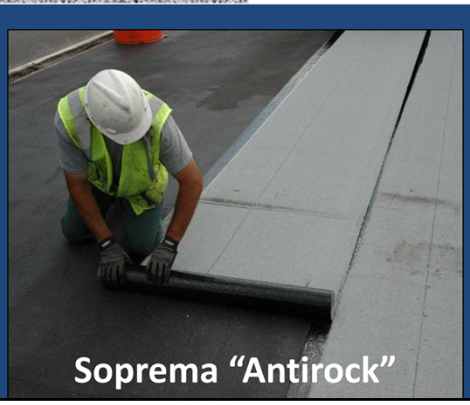


Waterproofing Membrane



Preformed System Components

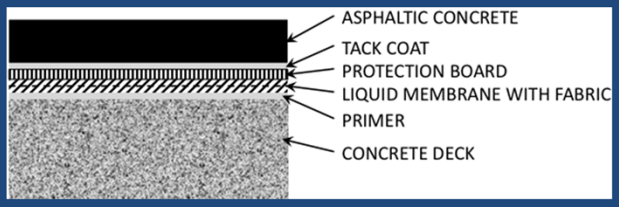




Preparation, primer, membrane, protection layer, tack coat, asphalt

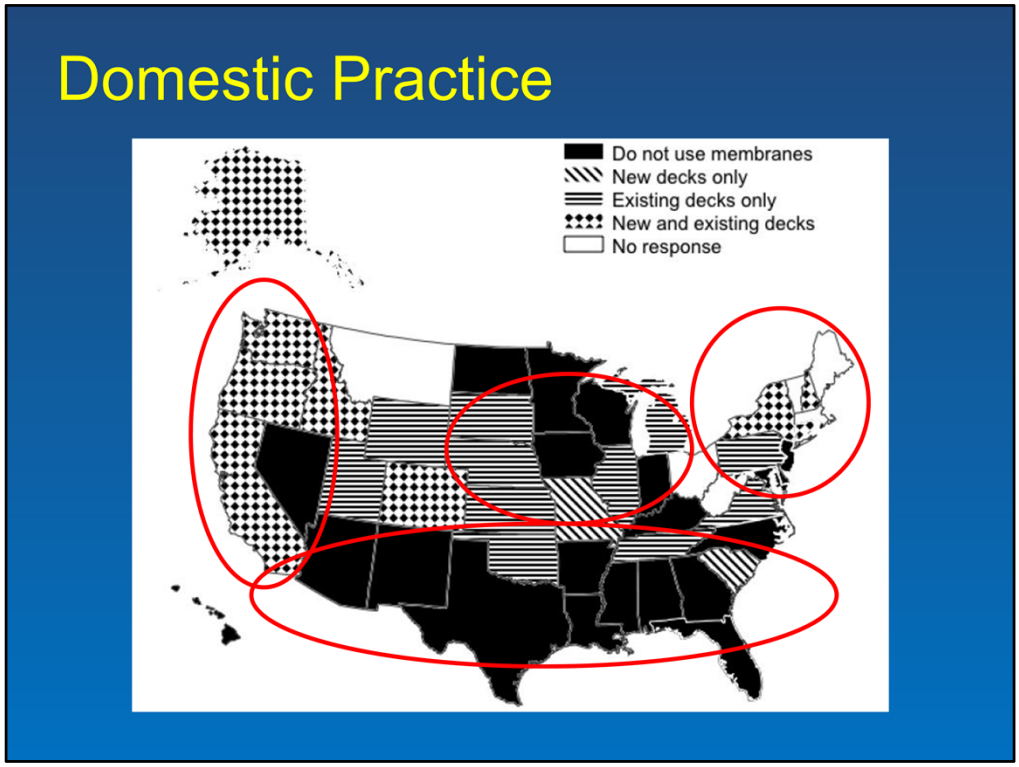
Preformed sheet vs. liquid applied

Liquid System Components



Preparation, primer, membrane, protection layer, tack coat, asphalt

Preformed sheet vs. liquid applied



In New England states and Canadian provinces it was first recognized that water and chlorides were being trapped under asphalt overlays. As a solution membranes were installed.

Maine, Massachusetts, Montana, Ohio, Rhode Island, Vermont and West Virginia all have specs for waterproofing membranes.
29 states (58%)

North East
Midwest
South
West

Some states that claim to “use” membranes only use them as last resort options (Kansas and Illinois)

States in the US have always been sharply divided over the merits of waterproofing membranes, and the ones that use membranes are divided over what systems are best.

International Practice

- United Kingdom
- Spain
- Germany
- Sweden
- Japan
- Canada
- Denmark
- Australia

Unique Features

Indiana Toll Road

Description	Milepost	Structure Number
Gary Sanitary Plant	11.6 to 12.0	8-3
Grand Calumet River West	12.3	8-5
Bridge Street	12.7	8-7
Grant Street	13.3	9-6
Buchanan Street	13.7	9-4
Grand Calumet River East	13.9	9-3
Broadway Street	14.5 to 15.2	9-1
Tennessee Street	15.4	10-7

Toll road Installations

Images courtesy of Jim Wallen, Soprema

Toll Road Installations

Images courtesy of Jim Wallen, Soprema

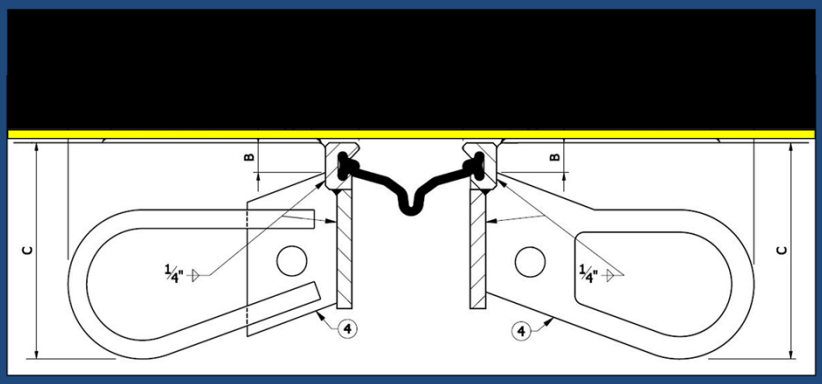
Japanese Robot System

Overlay Thickness

$$\frac{\text{INDOT Allowable Weight of W. S.}}{\text{Weight of Bituminous W. S.}} = \frac{35\ \text{lb/ft}^2}{140\ \text{lb/ft}^3} = 3\ \text{in. (75mm)}$$

- UK – 120 mm (4.7 in.)
- Denmark – 100 mm (4.0 in.)
- Maine DOT – 3 in.
- Conn DOT – minimum 3 in.

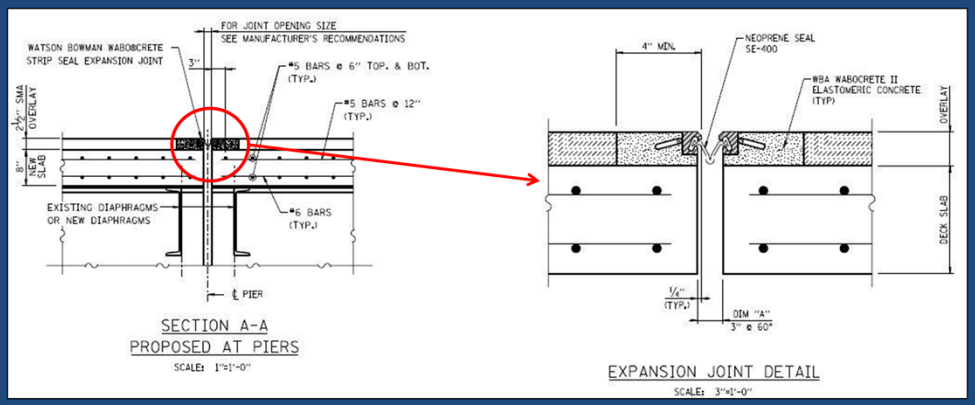
Joints



INDOT Strip Seal Joint

Toll Road Specs

Expansion Joint

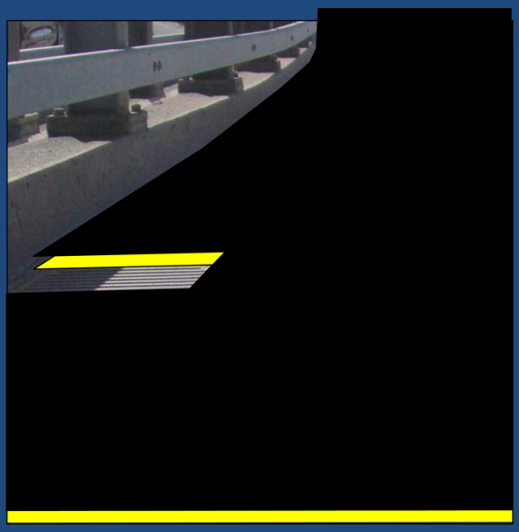


Toll Road Installations

Soprema “Antirock” w/ 2½ in. SMA Overlay

Images courtesy of Jim Wallen, Soprema

Drainage



After 2 years of service, all of the bridge decks received a 9 (excellent condition) and the wearing surface received either a 7 (good condition) or 8 (very good condition)

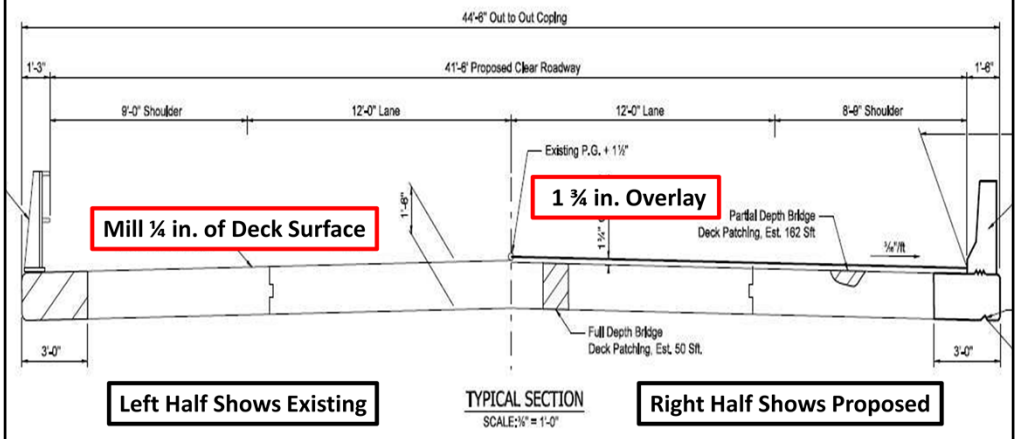
Membrane System Merits

- Largest potential
- Flexible
- Waterproofing maintained during resurfacing
- Proven successful in many parts of world

Many failures have been observed in the Midwest
Most demanding installation procedure
Installations can require long lane closures
Substantially increases dead load
Proper drainage of the asphalt overlay is difficult to achieve
Difficult to inspect
Difficult to replace
Expensive option

Concrete Overlay

Concrete Overlays



Latex-modified concrete overlays are placed at a thickness of 1-¾ in. after ¼ in. of the concrete deck is removed by milling or hydrodemolition.

Types of Concrete Overlays

- Standard
  - Latex-modified
  - Silica fume
  - Low-slump
- Experimental
  - Fibrous
  - High-reactivity metakaolin
  - Early-strength

Latex-modified concrete overlays are placed at a thickness of 1-¾ in. after ¼ in. of the concrete deck is removed by milling or hydrodemolition.

Concrete Overlay Merits

Early-age cracking compromises the overlay
Long installation time due to curing procedures
Substantially increases dead load
Requires the use of mobile mixers
Expensive option

Epoxy Overlay

- Mostly proprietary systems
- Open to traffic after one or two days
- Good friction during wet weather
- Sensitive to temperature and construction practice

Two Part Epoxy

Aggregate - Oklahoma Flint Rock

Application Truck

Epoxy Application

Epoxy Test Batch

- Gel Time
- Monitor
  - Temperature
  - Time to set

Details - Drain Covers

Volume Monitoring

US231 Installation

Transpo “E-Bond”

SR26 Installation

POLY-CARB “Flexogrid”

Finished Application

Thin Polymer Overlay Merits

- Easily installed
- Short installation time
- Thin application
- Proven successful in Indiana

New Bridge Decks

Options for preventative maintenance

- Membrane system
- Thin polymer overlay

Existing Bridge Decks

Critical bridges and bridges w/ patching

- Latex-modified concrete overlay

Quick

- T

Exten

- M

Field Performance

- Better field coordination/communication
- Better preparation of the substrate concrete
- Follow the specifications, manufacturer recommendation, and materials data sheet
- Temperature dependent materials
- Quality of construction/workmanship

Conclusions

- Each bridge deck protection system has advantages and disadvantages
- Selection of bridge deck candidate is very important to achieve good performance
- Workmanship during construction influences the performance the most
- The protection systems have been proven effective in the field

QUESTIONS?