

Data Collection and Analysis to Support Bridge Preservation

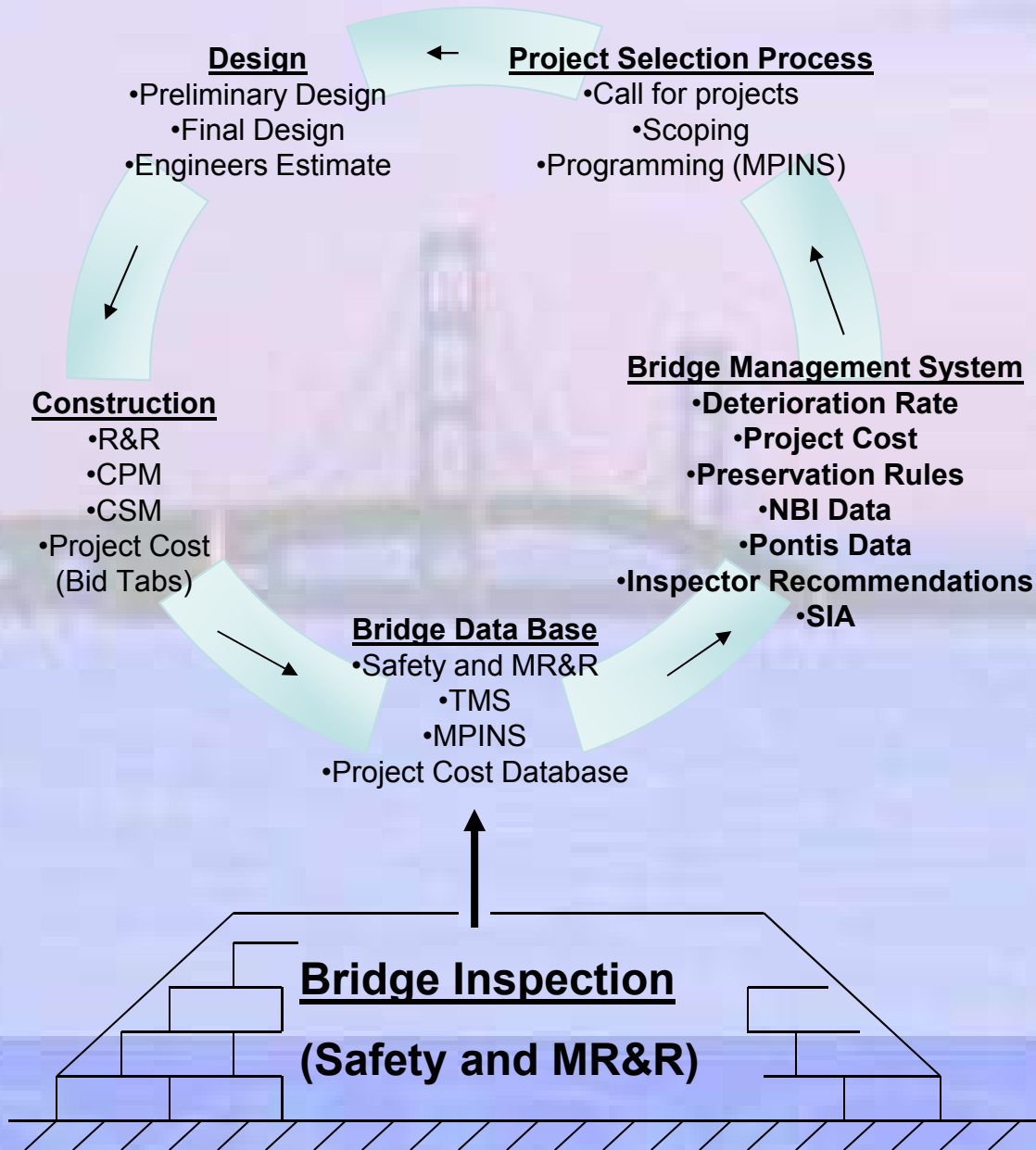
Dave Juntunen, P.E.

Michigan Department of Transportation
National Bridge Management, Inspection and Preservation

Conference (NBMIPC)

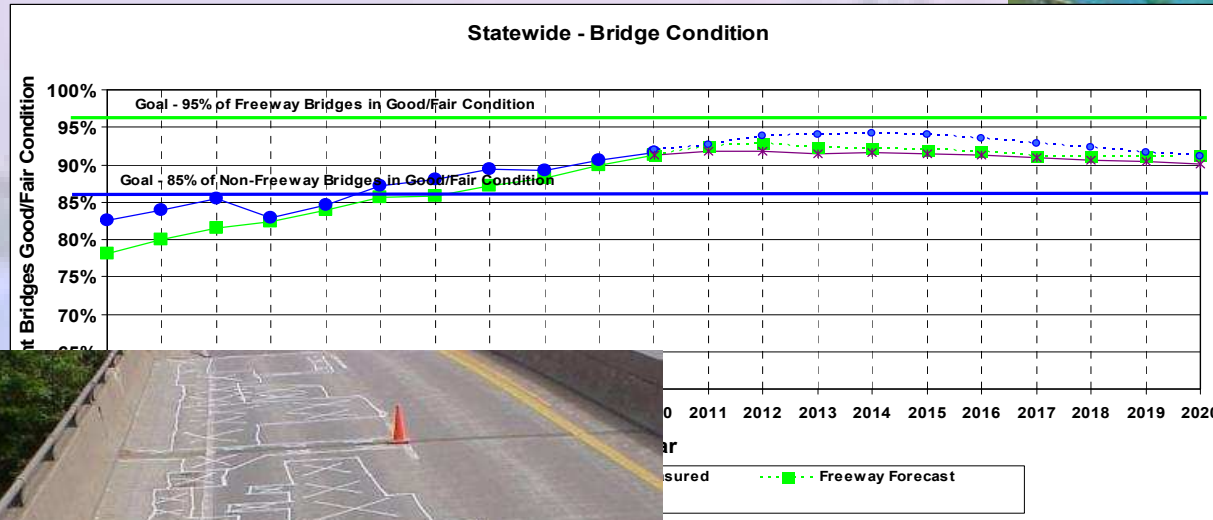
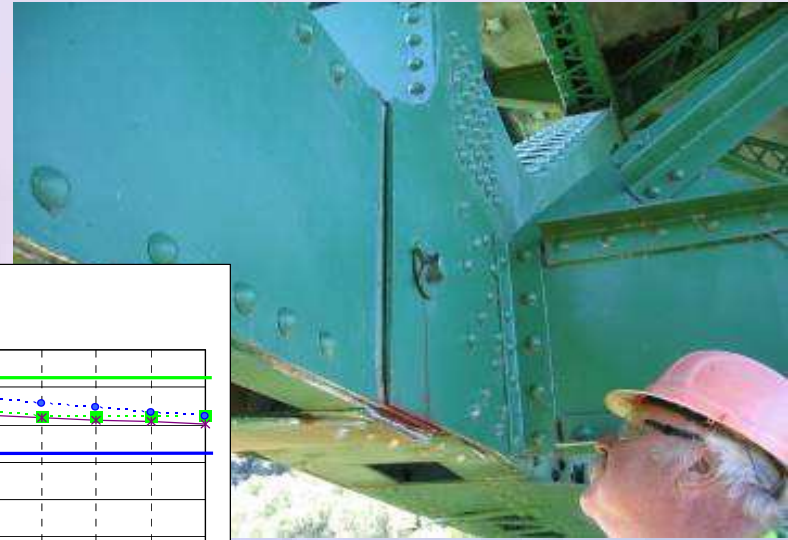
November 1, 2011





Bridge Inspection Data

Safety



Performance Measures

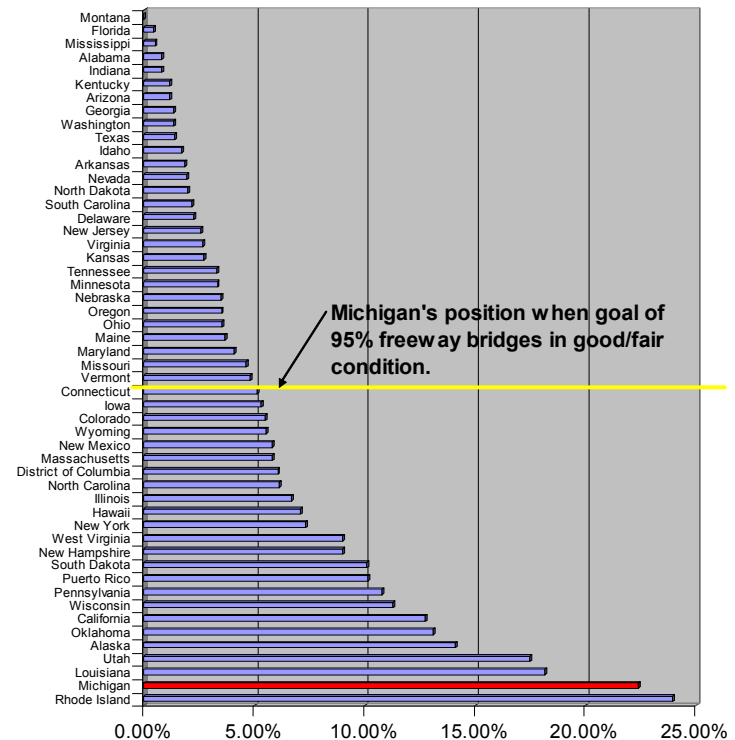
Need Indicators

Common Performance Measure

Structurally Deficient
(SD)
& Functionally Obsolete
(FO)
SD/FO Bridges

Better Roads.
For the Government/Contractor Project Team

National Ranking - Structurally Deficient Bridges.



Michigan's Bridge data

- National Bridge Inspection (NBI)
 - 0-9 rating scale
- Pontis (CoRe Elements)
- Inspector Recommendations
- Structural Inventory & Appraisal (SIA)

How well does this data work as need indicators and performance measures?

Inspection Data Collection

Bridge Operations

The Bridge Operations Unit

is responsible for the operational aspects of the Department's annual bridge program. The Unit provides support and liaison to the Department's seven Regions and Lansing Support Areas for all bridge operational issues.

> [More](#)



Michigan Bridge Inspection System

(MBIS) A tool allowing bridge owners and inspectors to create bridge inspection reports, including Bridge Safety Inspection Reports (BSIR), Pontis "CoRe Element" Reports, Fracture Critical Inspection Reports, Fatigue Sensitive Inspection Reports, Underwater Inspection Reports, Other Special Inspection, Scour Action Plans, and Work Recommendations.

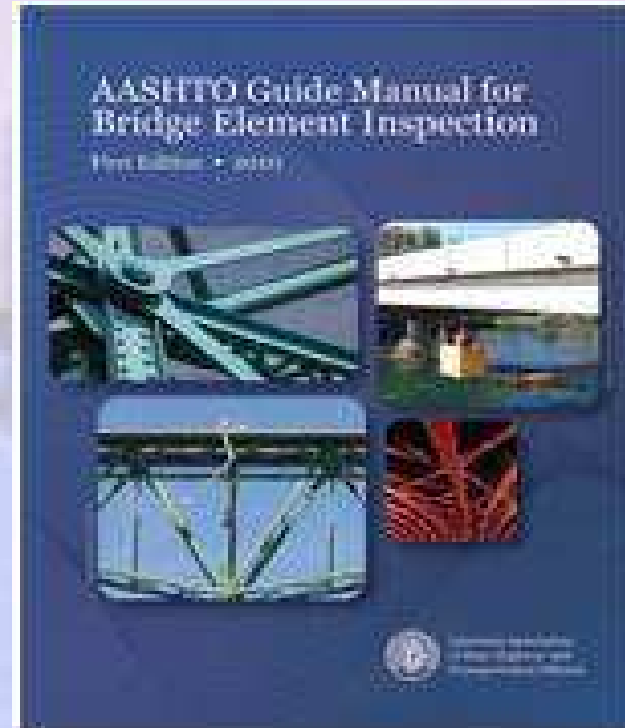


Michigan Bridge Reporting System

(MBRS) A tool allowing bridge owners and inspectors to retrieve bridge inspection information and standardized bridge reports, including network summaries, bridge condition reports, Federal Highway Bridge program (HBP) eligibility, Inspection Schedules, Scour Critical Structures, Load Rating Needs, Work Recommendations, and Ad-Hoc Reports.

AASHTO Guide Manual for Bridge Element Inspection

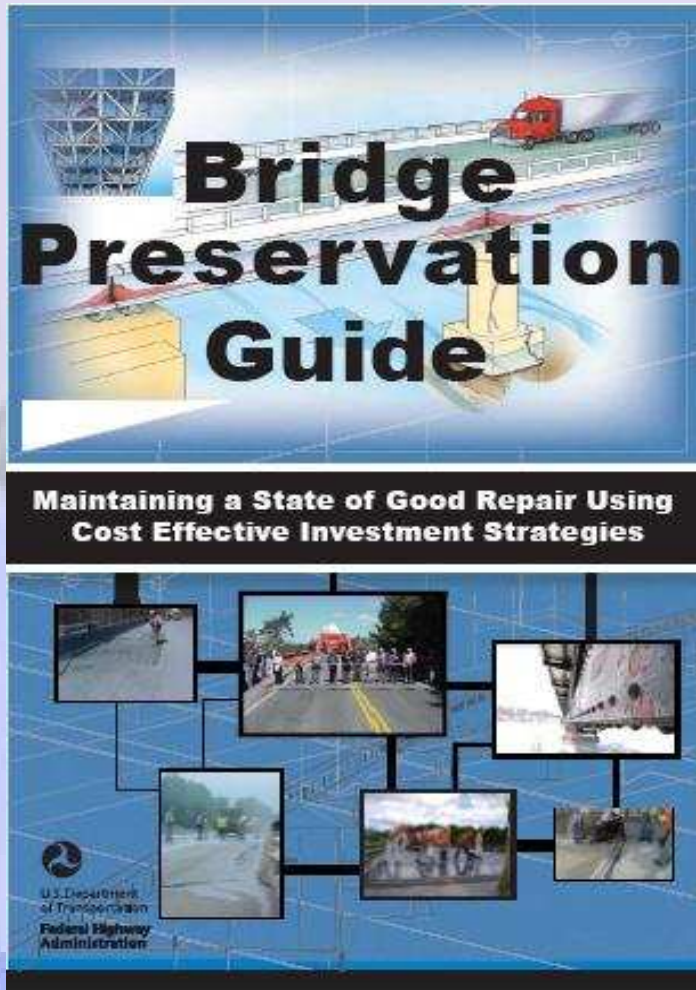
- Four condition states for all elements
 - Follow – Good, Fair, Poor, Severe convention
- Deck and slab units changed to square feet.
- Wearing surfaces and protective treatments separated from structural elements



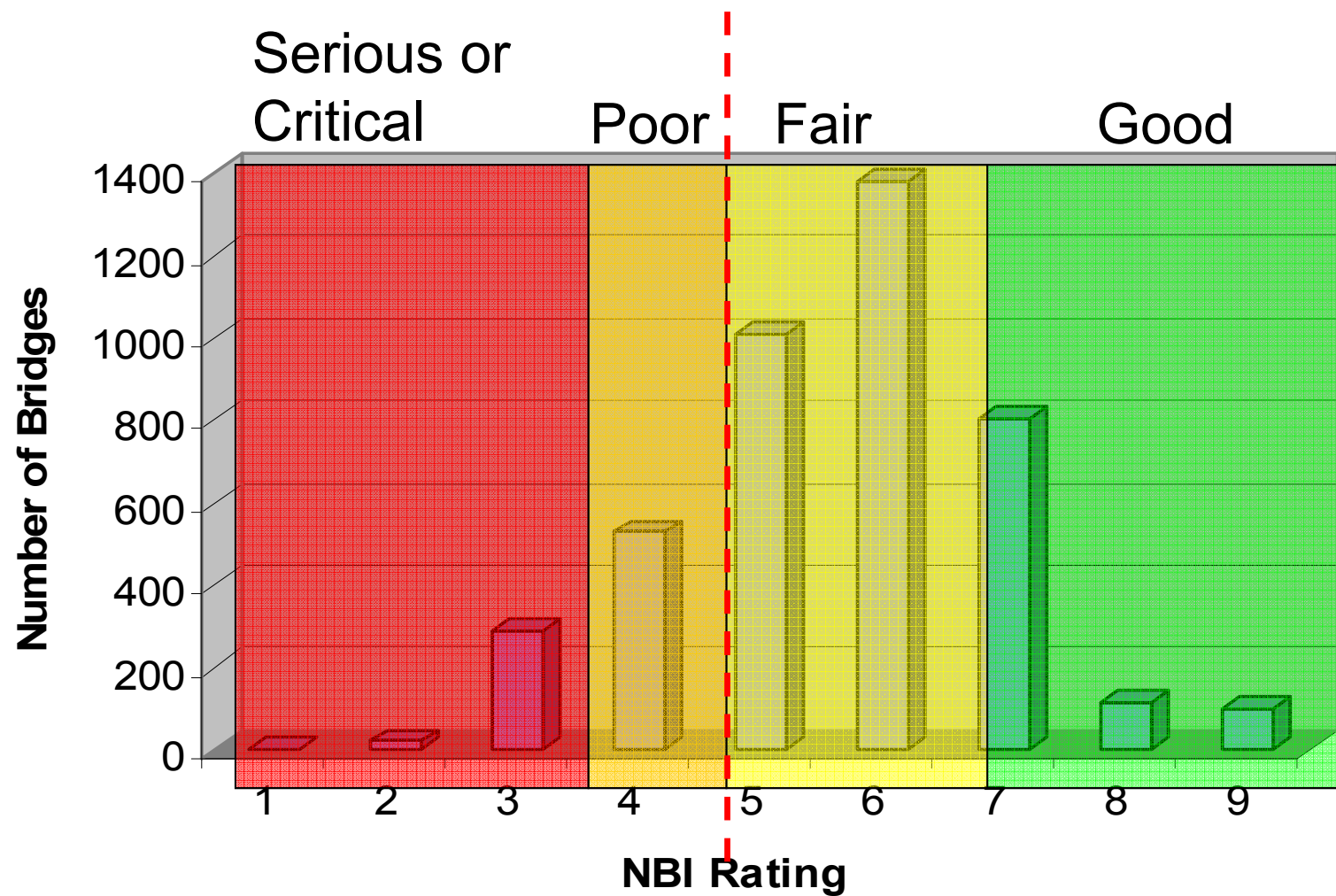
AASHTO Guide Manual for Bridge Element Inspection

- National Bridge Elements
 - Primary Load Carrying Members,
 - refinement of the deck, superstructure, substructures and culvert condition ratings
 - Also bearings and bridge rails
 - National Performance Measures
- Bridge Management Elements
 - Define secondary elements and protective systems to support advanced bridge management.
 - Flexibility allowed so states can develop need indicators to meet their BMS needs

What is Preservation?



Bridge Condition Ratings



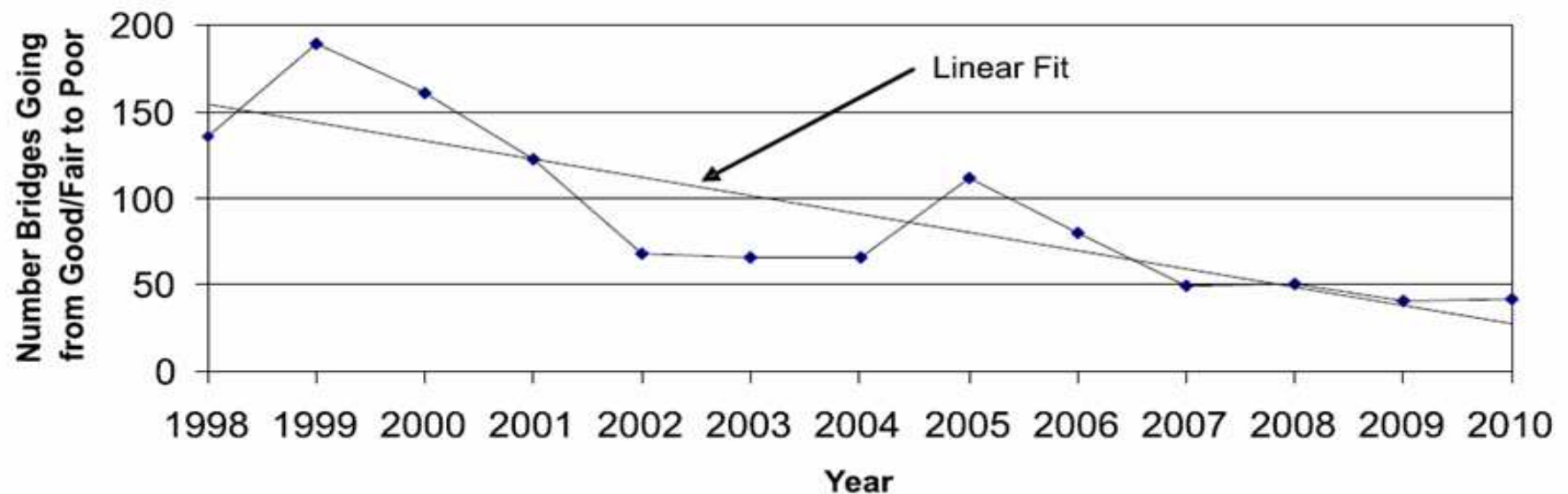
Definition: Bridge Preservation

- **Bridge Preservation**

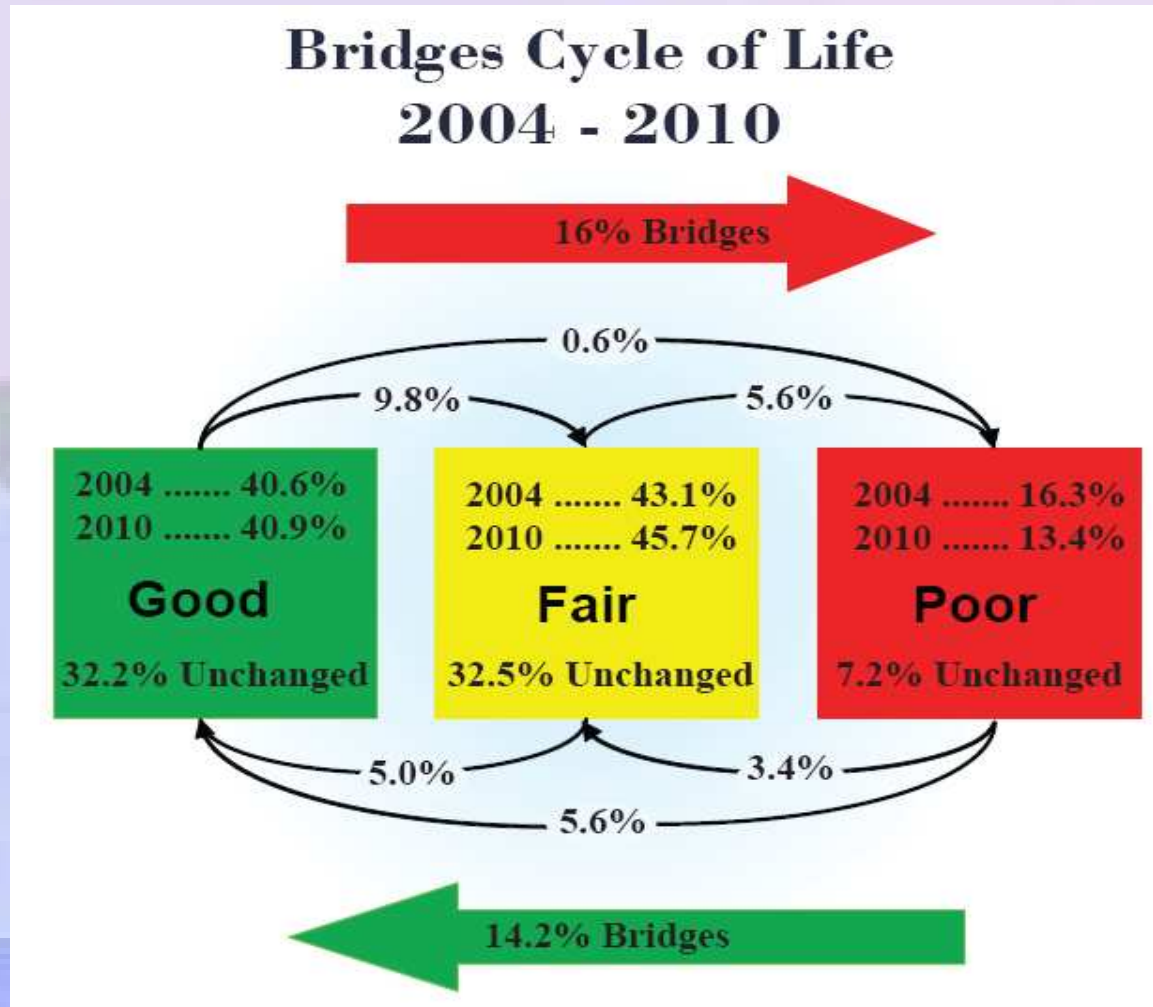
- **Actions or strategies that prevent, delay or reduce deterioration of bridges or bridge elements, restore the function of existing bridges, keep bridges in good condition and extend their useful life. Preservation actions may be preventive or condition-driven.**

Performance Measure for Preservation Monitor Bridges Dropping to Poor (Structurally Deficient)

DETERIORATION RATE STATEWIDE TRUNKLINE BRIDGES



Performance Measure for Preservation Bridge Cycle of Life



Performance Measures For Preservation

Counting number of bridge projects per year and what type of projects.

- MDOT 2005 Construction Program
 - Replacement
 - 59 Projects
 - Rehabilitation
 - 133 Projects
 - Preventive Maint.
 - 206 Projects



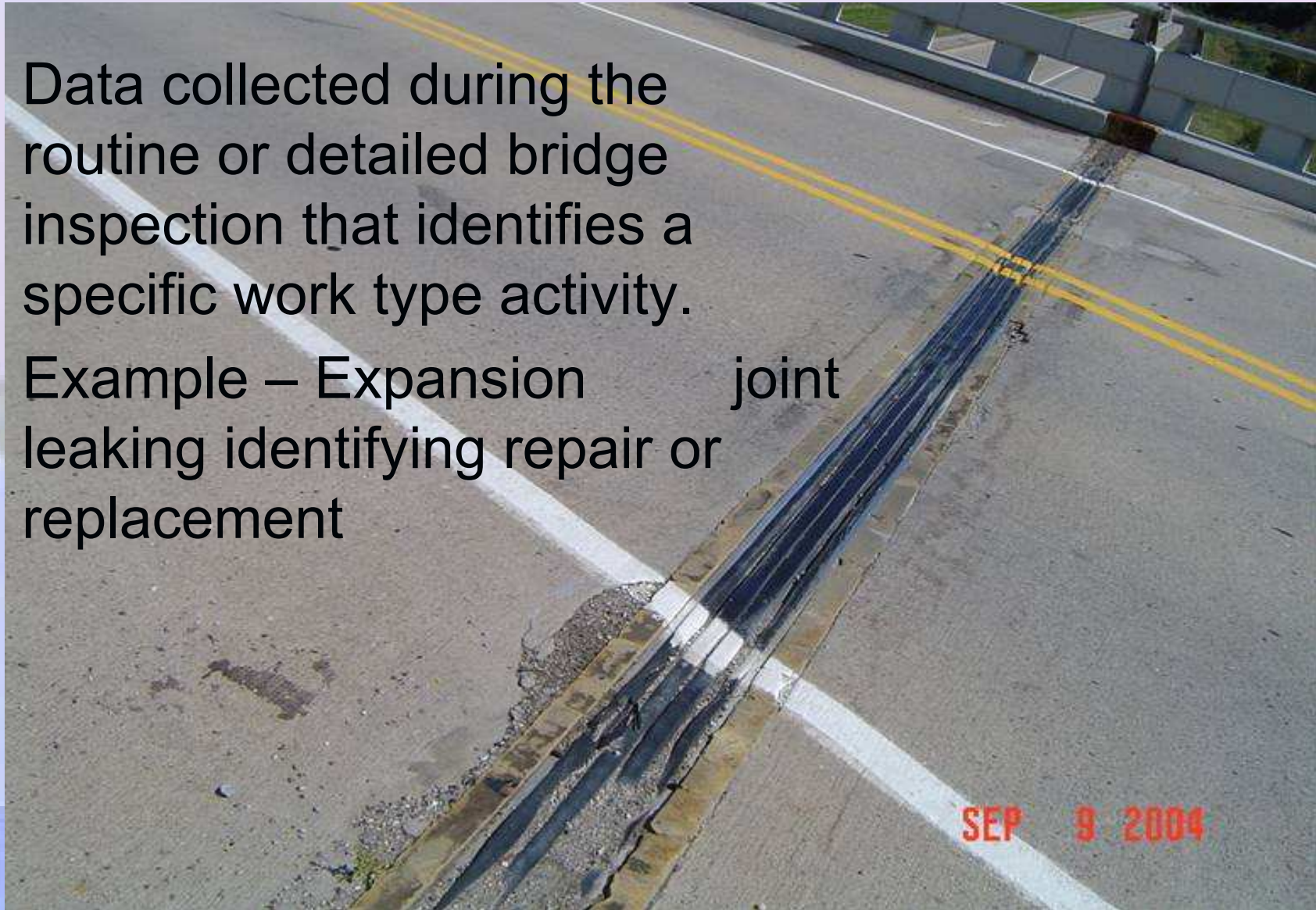
Preventive Maintenance Projects

- Joint Replacements
- Pin & Hanger Replacements
- Complete Painting
- Zone Painting
- Epoxy Overlays
- Deck Patching
- (many more)...



What is a need indicator?

- Data collected during the routine or detailed bridge inspection that identifies a specific work type activity.
- Example – Expansion joint leaking identifying repair or replacement



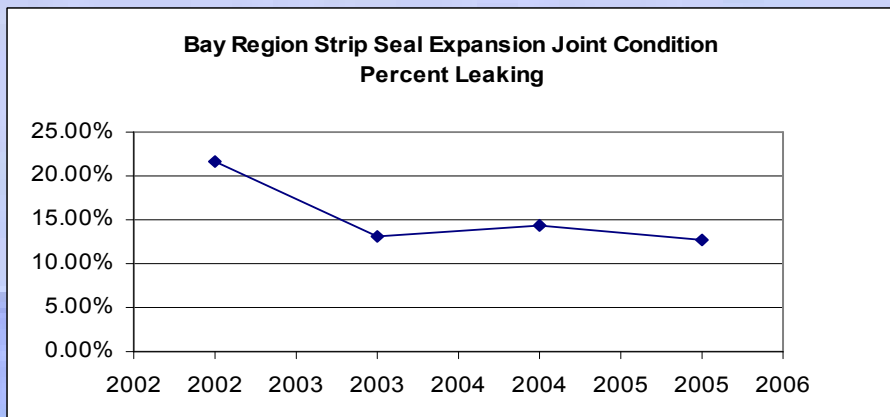
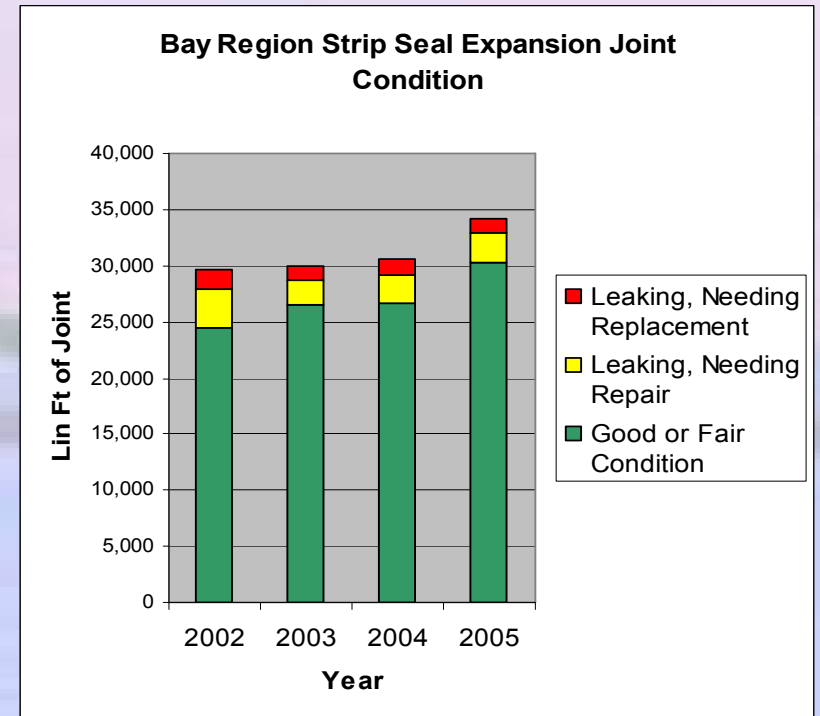
Scope (Detailed Inspections) May Be Need to determine right “fix”

- The routine (visual) bridge inspection may not be enough to determine actual bridge project needs.
- Chain drag bridge deck
- Sound concrete surfaces
- Measure section loss of corroded beams
- Compare costs of different fixes (sometimes using life cycle cost analysis)



Performance Measures and Need Indicators for Preventive Maintenance

- Expansion joints leaking
 - Measured using Pontis data.
 - MDOT categorizes seven different types of joints



Track Deterioration (Know how long things last)

Epoxy Coated Rebar Deck time to poor = 70+ years

Black Rebar Deck time to Poor = 35 years

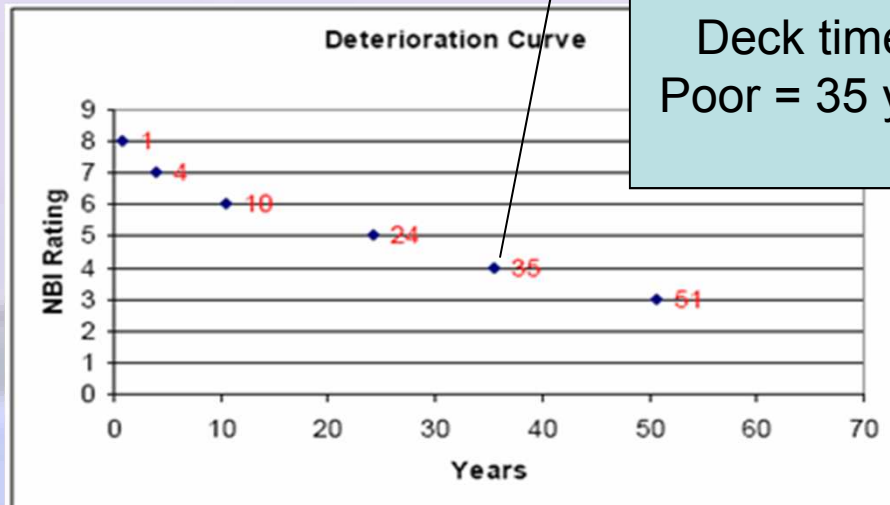


Figure 2-2: Black Rebar Bridge Deck Deterioration Curve

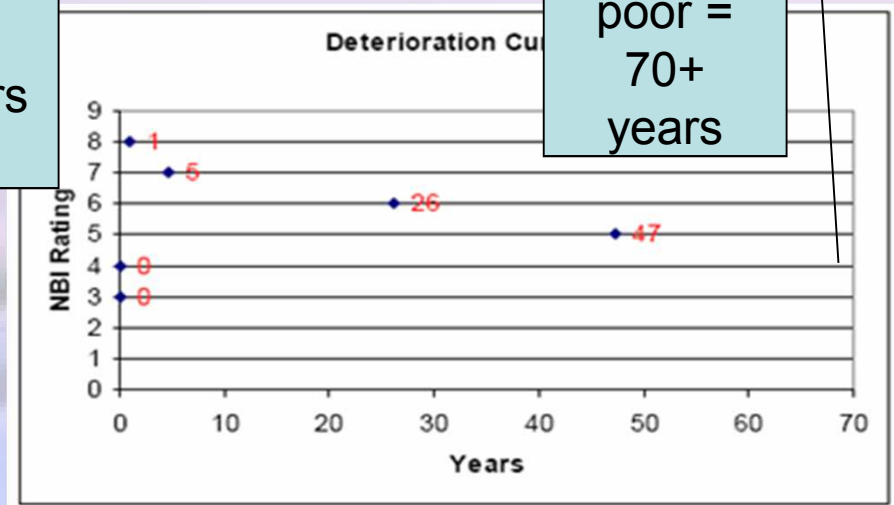


Figure 2-3: ECR Bridge Deck Deterioration Curve

Example - Compare Deck Surface Condition Ratings

$$n = \frac{\log(0.5)}{\log(T)}$$

where; T = Transition Probability
n = average # of years to reach next condition state.

Develop Guides for Projects Given Condition (Know your need indicators)

- Separate matrix provided for decks with epoxy coated rebar

BRIDGE DECK PRESERVATION MATRIX – DECKS WITH EPOXY COATED REBAR (ECR)

| DECK CONDITION STATE | | | | REPAIR OPTIONS | POTENTIAL RESULT TO DECK BSIR | | ANTICIPATED FIX LIFE |
|----------------------|--------------------|----------------|--------------------|---|-------------------------------|--------------------------|----------------------|
| Top Surface | | Bottom Surface | | | Top Surface BSIR #58a | Bottom Surface BSIR #58b | |
| BSIR #58a | Deficiencies % (a) | BSIR #58b | Deficiencies % (b) | | | | |
| ≥ 5 | N/A | N/A | N/A | Hold (c) Seal Cracks/Healer Sealer (d) | No Change | No Change | 1 to 4 years |
| | ≤ 5% | > 5 | ≤ 2% | Epoxy Overlay | 8, 9 | No Change | 10 to 15 years |
| | ≤ 10% | ≥ 4(k) | ≤ 25%(k) | Deck Patch (e) | Up by 1 pt. | No Change | 3 to 10 years |
| 4(k) or 5 | 10% to 25%(k) | 4(k) | 10% to 25%(k) | Shallow Concrete Overlay (h, i) | 8, 9 | No Change | 20 to 25 years |
| | | | | HMA Overlay with waterproofing membrane (f, h, i) | 8, 9 | No Change | 8 to 10 years |
| | | 2 or 3(k) | > 25%(k) | HMA Cap (g, h, i) | 8, 9 | No Change | 2 to 4 years |
| ≤ 3(k) | >25%(k) | 4(k) or 5 | 2% to 25%(k) | Shallow Concrete Overlay (h, i) | 8, 9 | No Change | 10 years |
| | | | | HMA Overlay with waterproofing membrane (f, h, i) | 8, 9 | No Change | 5 to 7 years |
| | | 2 or 3(k) | >25%(k) | HMA Cap (g, h, i) | 8, 9 | No Change | 1 to 3 years |
| | | | | Replacement with Epoxy Coated Rebar (ECR) Deck | 9 | 9 | 60+ years |

- (a) Percent of deck surface area that is spalled, delaminated, or patched with temporary patch material.
 (b) Percent of deck underside area that is spalled, delaminated or map cracked.
 (c) The "Hold" option implies that there is on-going maintenance of filling potholes with cold patch and sealing of incipient spalls.
 (d) Seal cracks when cracks are easily visible and minimal map cracking. Apply healer sealer when crack density is too great to seal individually by hand. Sustains the current condition longer.
 (e) Crack sealing can also be used to seal the perimeter of deck patches.
 (f) Hot Mix Asphalt overlay with waterproofing membrane. Deck patching required prior to placement of waterproofing membrane.
 (g) Hot Mix Asphalt cap without waterproofing membrane for ride quality improvement. Deck should be scheduled for replacement in the 5 year plan.
 (h) If bridge crosses over traveled lanes and the deck contains slag aggregate, do deck replacement.
 (i) When deck bottom surface is rated poor (or worse) and may have loose or delaminated concrete over traveled lanes, an in-depth inspection should be scheduled. Any loose or delaminated concrete should be scaled off and false decking should be placed over traveled lanes where there is potential for additional concrete to become loose.
 (k) Contact C&T's Bridge Operations section if a deck with epoxy coated rebar in poor condition is identified.

Pontis Reports

- Possible projects with estimate of cost (unlimited budget)
- Future Poor Bridges (predicts what year a bridge will become poor (2012 – 2031))

| Facility | Feature Int | Future Predicted Conditions | | | |
|------------------|----------------------|-----------------------------|------|-------|-------|
| | | Year To Turn Poor | Deck | Super | Subst |
| M-50 | TUPPER RIVER | 2012 | 0 | 6 | 6 |
| M-66 | GRAND RIVER | 2030 | 4 | 5 | 5 |
| HASTINGS RD | I-96 | 2030 | 4 | 6 | 5 |
| NASH HWY | I-96 | 2012 | 4 | 6 | 6 |
| MORRISON LAKE RD | I-96 | 2012 | 3 | 5 | 6 |
| JORDAN LAKE RD | I-96 | 2018 | 4 | 5 | 6 |
| I-96 EB | GRAND RIVER & MARKET | 2012 | 4 | 4 | 6 |
| I-96 WB | GRAND RIVER & MARKET | 2020 | 4 | 6 | 6 |
| I-96 EB | CSX RR (ABN) | 2020 | 4 | 5 | 5 |
| I-96 WB | CSX RR (ABN) | 2020 | 4 | 5 | 5 |
| M-66 NB | I-96 | 2012 | 4 | 6 | 6 |
| M-66 SB | I-96 | 2028 | 4 | 6 | 5 |
| SUNFIELD RD | I-96 | 2030 | 4 | 6 | 5 |
| I-96 EB | PORTLAND RD | 2012 | 4 | 6 | 6 |
| I-96 WB | PORTLAND RD | 2020 | 4 | 6 | 6 |

| Facility | Feature | Action | Element | Item Cost | Proj Cost | Proj Type |
|----------|--------------------|------------|----------------------|-----------|-----------|-----------|
| M-32 | BEAN CREEK | Paint | Pnted Stl Girder /Bm | 42,641 | 42,641 | CPM |
| US-23 | THUNDER BAY RIVER | Rehab Elem | Misc Bridge Railing | 6,865 | 7,189 | CPM |
| | | Rehab Elem | Sidewalk | 324 | | |
| US-23 | LONG LAKE CREEK | Repl Elem | Reinf Conc Girder/Bm | 10,104 | 12,290 | Replace |
| | | Min Repair | Reinf Conc Girder/Bm | 1,379 | | |
| | | Rehab Elem | Reinf Conc Culvert | 807 | | |
| M-68 | PIGEON RIVER | Paint | Pnted Stl Girder /Bm | 47,366 | 47,366 | CPM |
| US-23 | LITTLE BLACK RIVER | Rehab Elem | Misc Bridge Railing | 6,862 | 6,862 | CPM |
| I-75 NB | D&M RR (ABN) | Epoxy Ovly | Conc Dk Thn Epoxy Ov | 39,123 | 42,290 | CPM |
| | | Rehab Elem | Fixed Bearing | 3,167 | | |

Need Indicators for Preventive Maintenance

- Paint condition
 - Measured using Michigan Specific NBI rating and Pontis data.
 - Full painting
 - Zone painting
 - Spot painting



Full Painting Candidates when greater than 15% paint failure.

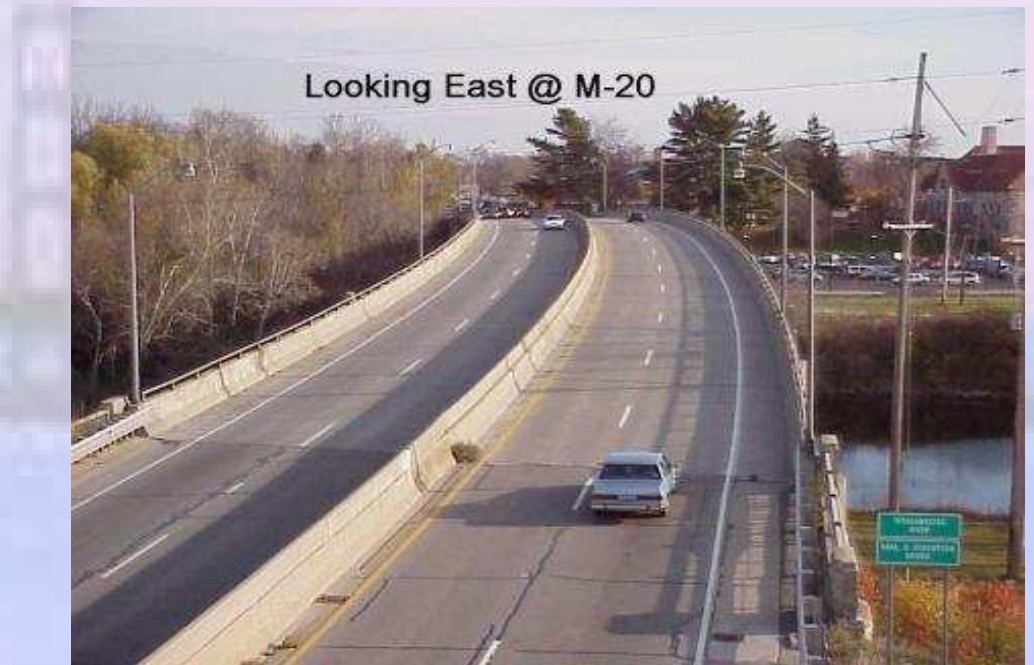
Develop Paint Preservation Guidance

- Lead based and zinc based paint systems handled differently
 - Only do spot and zone painting on Zinc based paint systems
- Take into account effectiveness of paint contractors and full containment requirements.
- Have had limited effectiveness because of reduced surface preparation.



Bridge Decks

- Number one overarching need Indicator
 - The condition of bridge decks most often drive bridge projects.



Need Indicators are Deck Top and Bottom Surface Condition

- Top Surface
 - 2 to 5% - deck patch, epoxy overlay
 - 5% to 15% - deck patch
 - > 15% - rigid overlays, HMA overlays
- Bottom Surface
 - < 10% - deep overlay
 - 10% to 30% shallow overlay
 - > 30% replace deck.



For more information see MDOT Bridge Deck Preservation Matrix

Need Indicator for Crack Sealing and Epoxy Overlays

Pontis Smart Flag – Deck Cracking



Epoxy Overlay



Crack Sealing



Differentiate spalls from delaminations



We often have bridge decks having rigid overlays (concrete, latex modified, or silica-fume) having very small percentage of spalls (< 2%) but having large percentage of delaminations (30% plus).

Question – How long will it take delaminated area to spall?

Review Your Bridge Management Data (Bridge Management Elements) with Your Practitioners



Thank You

- Our work is not done
- We must continue to develop and enhance our performance measures and need indicators for preventive maintenance

