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## Bridge Development Update

Rebecca Curtis, P.E.

Michigan Department of Transportation

Bridge Management Engineer

2017 Michigan Bridge Conference



# Bridge Development

**WE DID IT!**





# Bridge Development







# Bridge Development

**Reduce** the potential  
for unplanned **adverse events** to  
**impact bridges** in a way that causes  
**unacceptable performance**



# Bridge Development



Transportation Performance Management



Design QA/QC



Innovations



Load Rating



Requests for Action



Culvert Management



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Innovations



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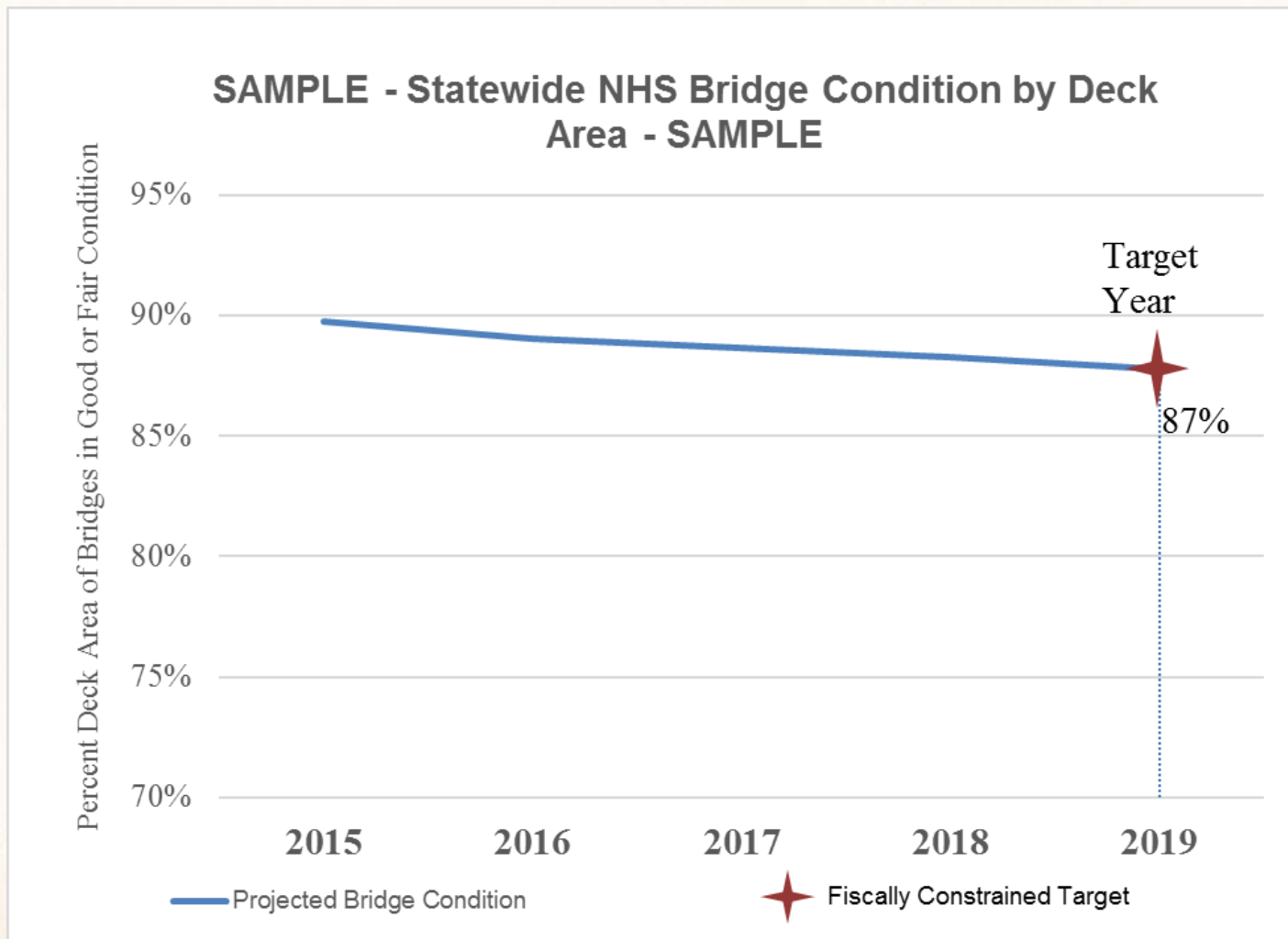


Culvert Management





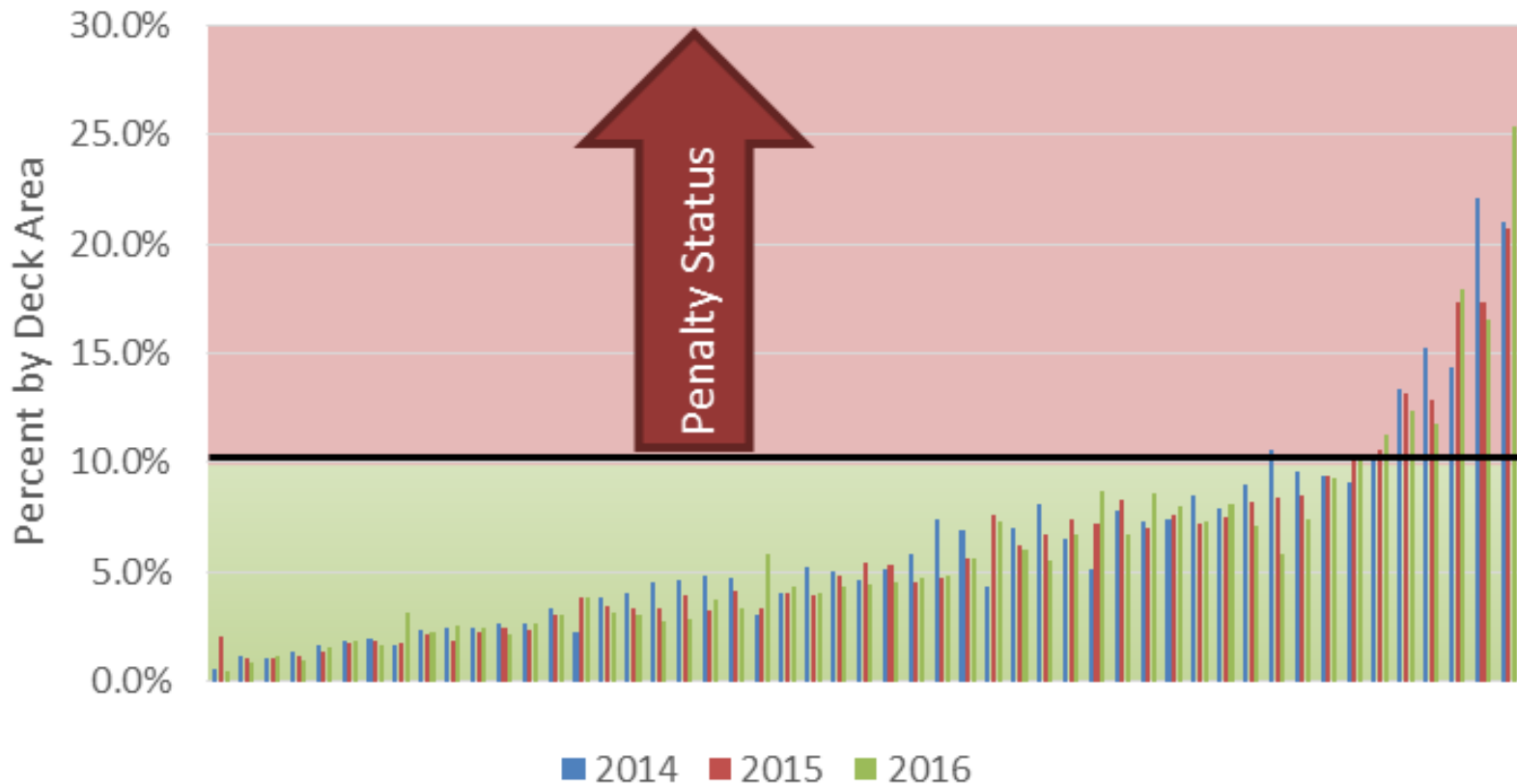
# TPM





# TPM

## National NHS Percent Structurally Deficient

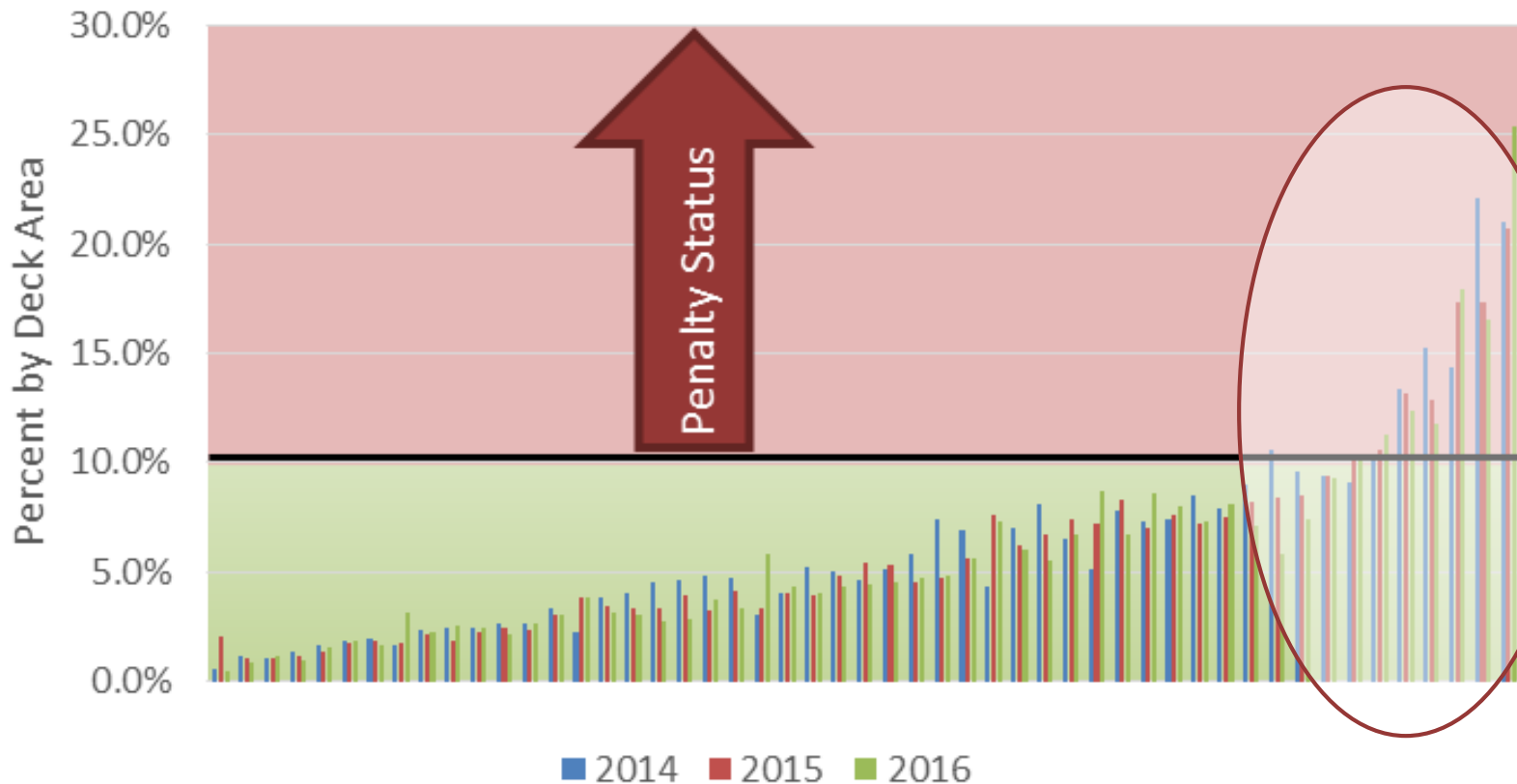






# TPM

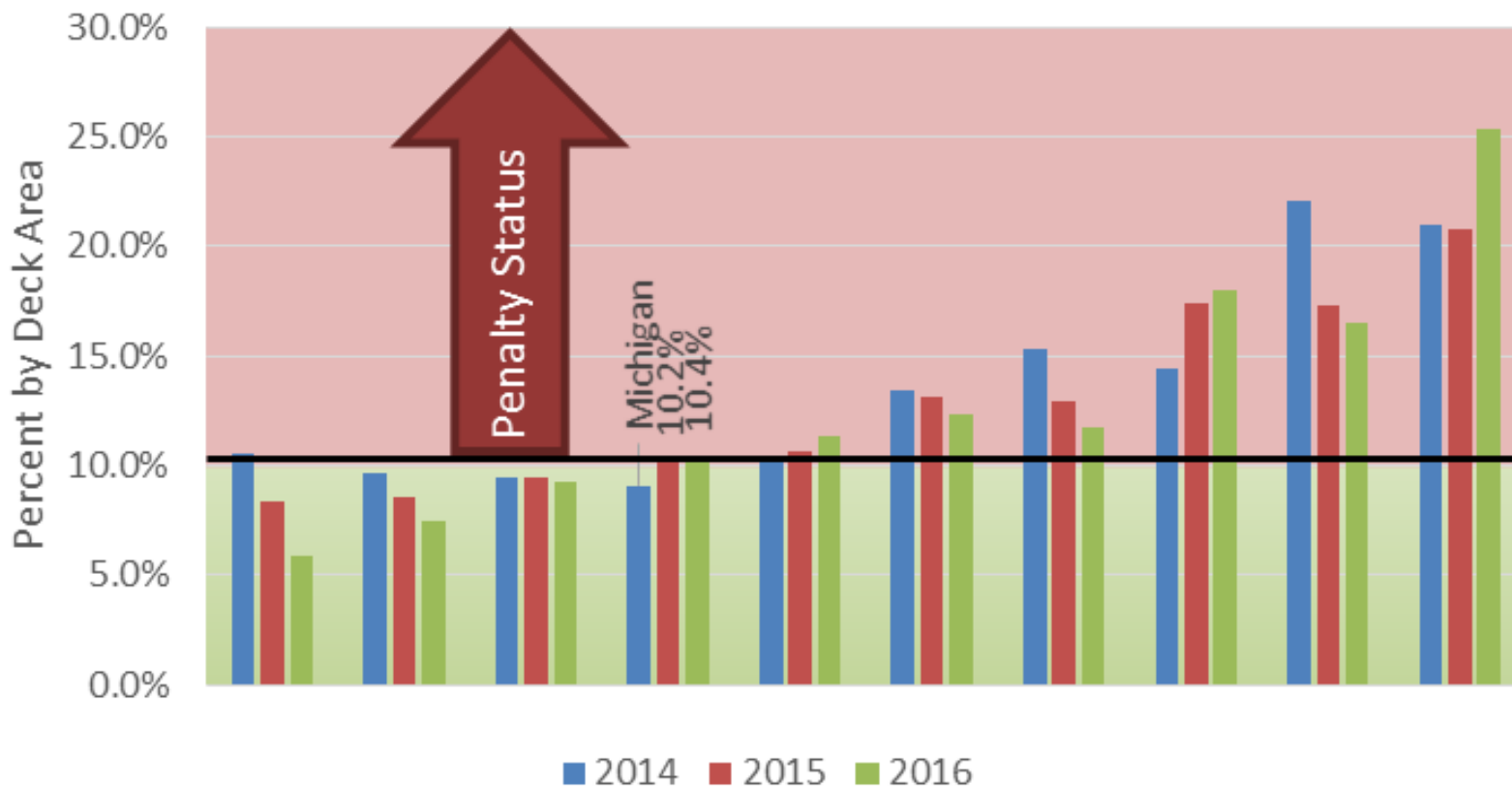
## National NHS Percent Structurally Deficient





# TPM

## National NHS Percent Structurally Deficient



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# Bridge Design QA/QC







# Bridge Design QA/QC

## MDOT Guidance for Bridge Design Quality Assurance & Quality Control

MICHIGAN DEPARTMENT OF TRANSPORTATION  
DRAFT Guidance  
Bridge Design Quality Assurance & Quality Control  
November 2015

CONTENTS

- I. Purpose.
- II. Overview.
- III. Definitions.
- IV. Implementing and Documenting Procedures.
- V. Role of FHWA.
- VI. References.

I. PURPOSE.

The purpose of this guidance is to document the Michigan Department of Transportation (MDOT) Bridge Design QC/QA procedures for design and plan preparation of trunk line highway bridge projects.

II. OVERVIEW.

- A. To ensure bridges are designed correctly, with no errors since the design calculations, drawings, and specifications are finalized, MDOT requires QC/QA procedures in accordance with this document.
- B. The MDOT Bridge Design QC/QA program consists of organizational procedures established to ensure a deliberate and systematic program that reduces the risk of introducing errors and omissions into bridge design final contract documents. The MDOT QC/QA program provides checks and balances within the organization to assure quality in final contract plans and specifications. The MDOT QC/QA program is implemented at different levels or phases of project activity, as defined in the [MDOT Bridge Design Manual](#), the [MDOT Road Design Manual](#), and the [MDOT Quality Assurance and Quality Control Process Guide for Project Managers](#) and as included in this document.
- C. The rigor and level of resources allocated to QC/QA applications on a given bridge are tempered by the size, complexity, and degree of redundancy in the structural system involved, and by the degree of standardization of the design. For major projects involving unusual, complex, and innovative features, a peer review may be desirable to raise the level of confidence in the quality of design and construction.

III. DEFINITIONS.

- A. Quality Control (QC). Procedures followed within a unit or working group to check the accuracy of the calculations, drawings, and specifications for the purpose of detecting and correcting design omissions and errors to accomplish the overarching goal of producing complete and error free final plans and specifications. QC occurs continuously throughout the course of a project.

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# Innovations

## Strategic Areas Of Focus

Leadership | System Focus | Safety | Partners | Workforce  
Customer-Centered | Innovative & Efficient



## Wildly Important Goal (WIG)

MDOT will build upon our innovative culture by measuring, promoting and celebrating innovations

**Measure:** Highlight 5 to 10 MDOT innovations that can yield measurable results and/or can be effectively communicated to the public.

### Innovative Thinking

Any idea or action that results in added value.



## Sub-WIGs: Region/Bureau/Office (R/B/O)

### Positive Culture:

Shared values and behaviors that:

- Promote an atmosphere of trust
- Provide a sense of purpose
- Seek continuous improvement
- Encourage and support creativity
- Freedom to challenge the status quo

Specific and actionable innovation initiatives that help achieve the WIG.

(Truly Important Goals (TIGs), used in some R/B/Os, are an even finer level of specificity)







# Innovations



M-25 over Mill Creek – Bay Region







# Innovations



US-12 over Swan Creek – Southwest Region



# Bridge Development



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# Load Rating

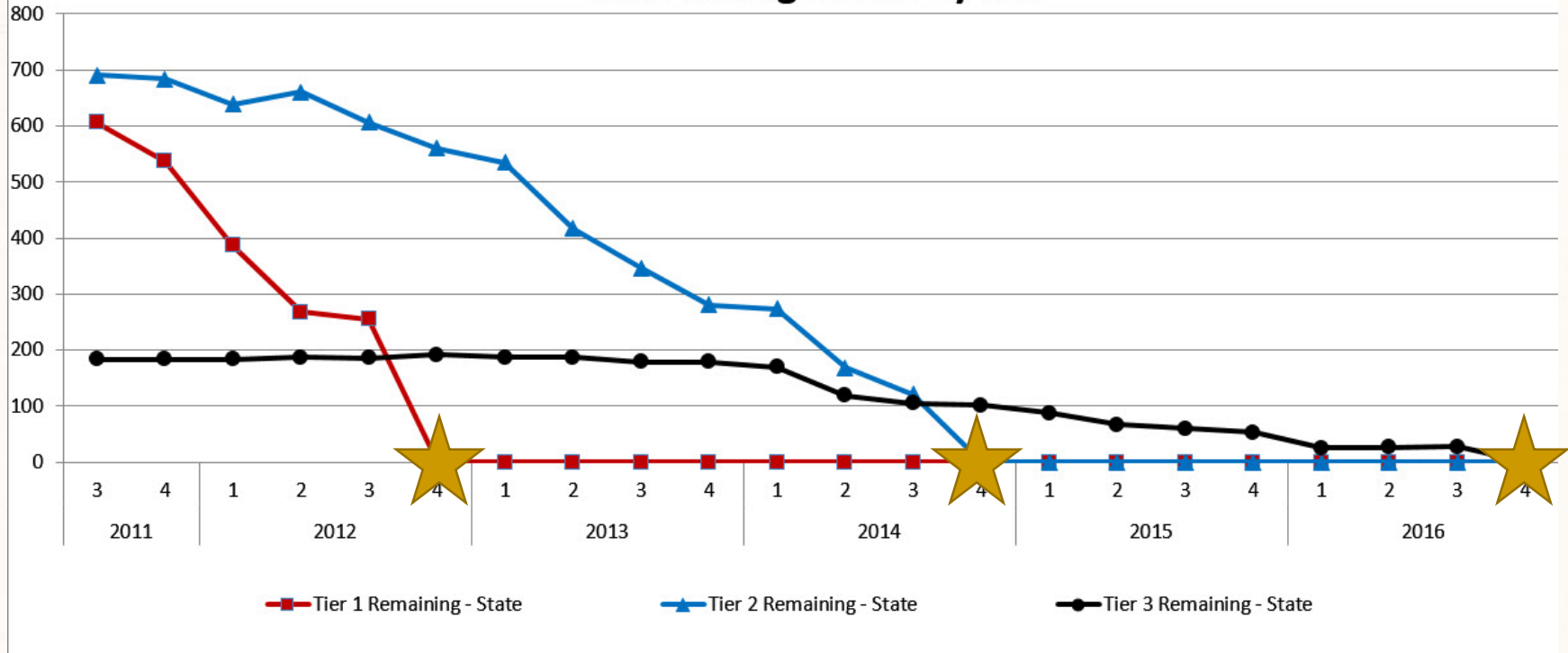
**WE DID IT!**





# Load Rating - PCA

## Load Rating Status by Tier







# Load Rating

Signs are intended to prevent stresses above the design load on the bridge. The Michigan Traffic Control Devices Manual shows signs that can be used in combination shown on those signs and text. Figure 1a, shows a common bridge load

Updated version of the sign. It has been updated to accommodate multiple trailers more than one based implementation. The updated versions of the signs are in use today. Both are used for one-unit, two-unit and three-



(b)

For all typical configurations of vehicles, as it is not possible to present every vehicle configuration. It is important to note that the weight limit on each silhouette is a gross weight only. Actual axle



Figure 2



Figure 3

The signs shown above are frequently used in situations where severe load restrictions apply. The gross vehicle weight (Figure 2) or axle weight (Figure 3) for any vehicle is limited regardless of the number of axles or axle configuration.



Figure 4

The sign shown in Figure 4 can be used to combine the load posting information from both Figure 2 and Figure 3.

For all load posting signs, the gross vehicle weight and/or axle weight cannot exceed the limit shown on the posted sign, regardless of how much of the total weight of the vehicle is on the bridge.

Bridges  
Process



42

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W





# Load Rating







# Load Rating



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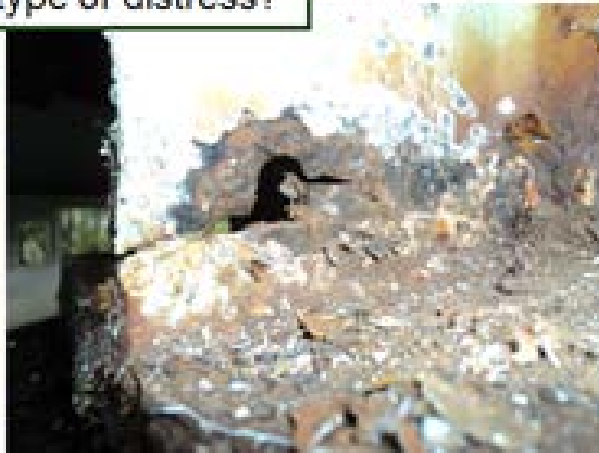




# Requests for Action

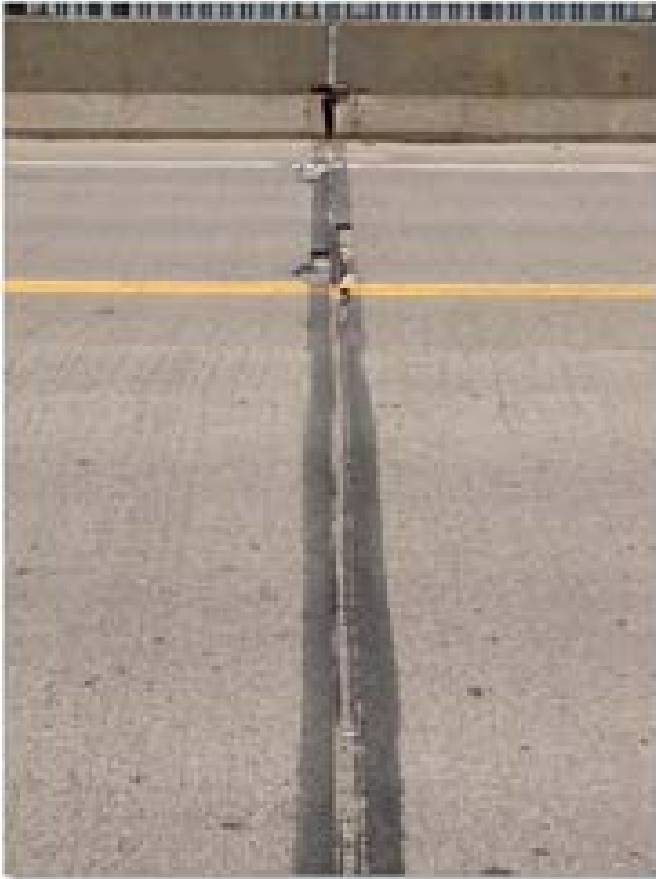


What causes this type of distress?





# Requests for Action



# Bridge Development



Transportation Performance Management



Design QA/QC



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Culvert Management



# Culvert Management







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Thank You!

# Michigan Bridge Conference

## Bridge Field Services

*March 21, 2017*

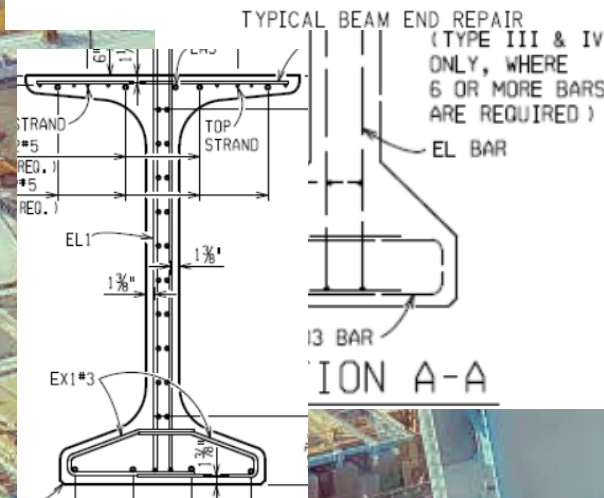
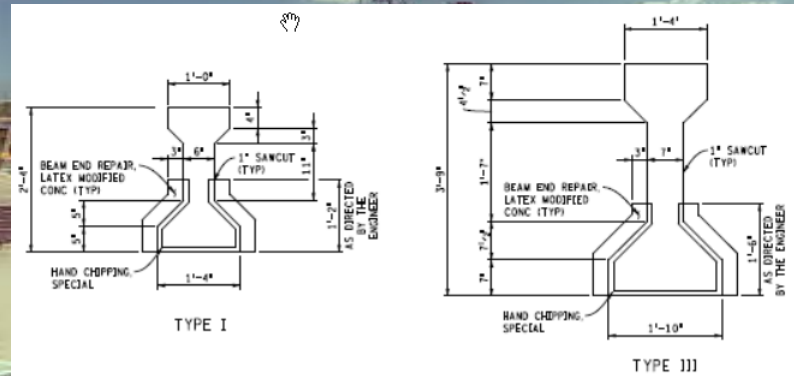
*Corey Rogers, P.E.  
Engineer of BFS*





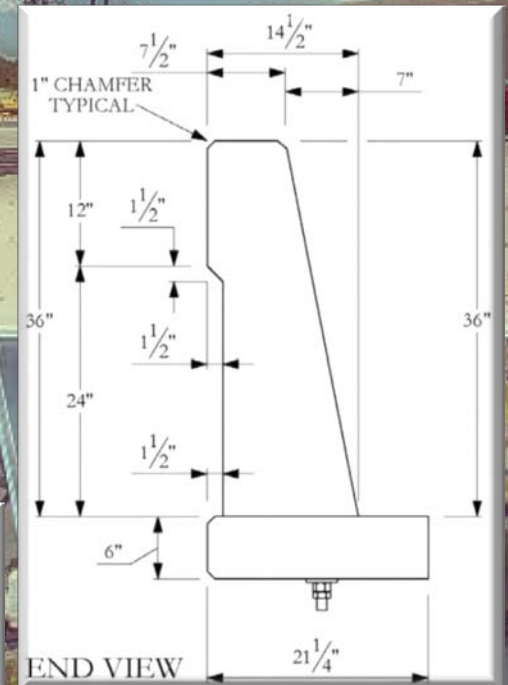
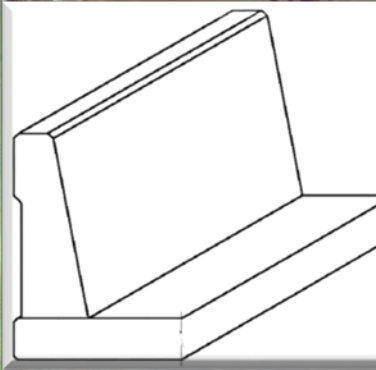
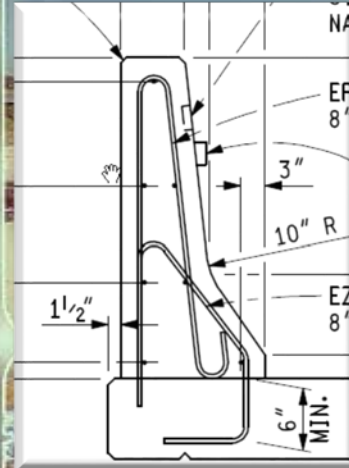
## Beam End Reinforcement

- Early signs of PCI beam end deterioration due to black bar and insufficient cover
- Black strands meant black bar
- Preference is for epoxy coated or stainless steel when applicable.



## MASH Railing Update

- Manual for Assessing Safety Hardware (MASH)
- Update to NCHRP 350
- Effects all Test Levels (TL) 1-4, TL-5 is the same
- May result in design changes to MDOT bridge railings in 2019
- Pooled Fund with TTI
- Bridge Committee working with Barrier Advisory Committee





# Bridge Demolition

- **Bridge Demolition DOT Survey**
  - Examined demolitions, accidental incidents, and unintentional collapses
  - Common reasons for incidents and collapses
    - Removal of span or component of continuous span bridge caused other spans to fail
    - Crane or demolition equipment overloading bridge
    - Demolition plans were not followed in the field
  - Very few post incident reports are created making in depth evaluation difficult
- Deck Removal SP created for the Rouge River project
- MDOT is currently developing a special provision for bridge demolition



# Bridge Inspection Audit



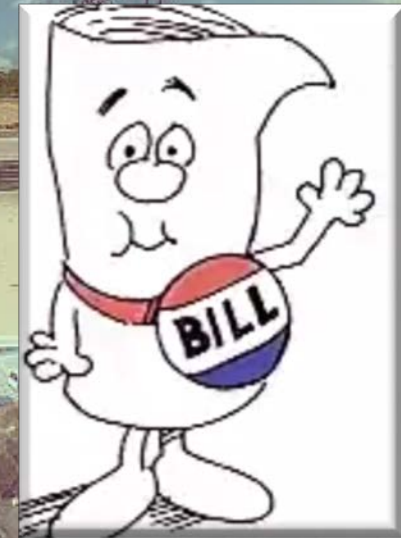
- The scour POA and false decking processes are fairly new and being evaluated for effectiveness. MDOT is partnering with OCA to close out audit findings.

- Extended Frequencies
  - Federal compliance may allow for extended inspection frequencies for bridges in rare situations
  - State law required 2 year inspections, recently changed to comply with FHWA
- Scour Plan of Action
  - Scour POAs forms have been created through Scour Committee and integrated into MiBRIDGE
- False Decking
  - Created fields in MiBRIDGE to document false decking





# Moveable Bridge Bill



- Recent changes to Act 51 to create a \$5 million Moveable Bridge Fund (MBF) to fund operations or publically owned moveable bridge.
- 24 publically owned moveable bridges
- MDOT created guidance document to address the multitude of operational payment methods.





# Ultra-High Performance Concrete (UHPC)

- Increased compressive, flexural, and tensile strength while lowering permeability
- Allows for reduced closure pours and closure times which facilitates ABC projects
- MDOT & U of M are working to develop a non-proprietary version
- 1<sup>st</sup> UHPC project for MDOT was US-23 in Cheboygan, MI





# Spray Applied Membranes

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

I  
SPECIAL PROVISION  
FOR  
SPRAY APPLIED WATERPROOFING MEMBRANE

BRG:JLS

1 of 2

APPR:TES:JAB:07-13-16

b. **Materials.** Use materials from one of the following suppliers or approved equal:

1. Stirling Lloyd, Eliminator, 860-666-5008
2. Bridge Preservation, Bridge Deck Membrane, 913-912-3305
3. D.S.Brown, Deckguard Spray Membrane, 419-257-3561
4. Wasser Coatings, Polyflex Bridge Deck System, 216-536-6777

- I-696 Plaza and 2 other standard structures in 2016
- Unit price was around \$65-70 /syd
- Each product has its own systems for handling expansion joints and bonding to substrate and potential overlays
- Significant improvement over preformed membranes





# Asbestos Identification (LAP)


- Local Agencies are responsible for asbestos investigation and identification on their projects

- Bridge Deck Concrete Testing
- EPA Requirement
- Test prior to project letting if possible.



The background of the slide is a collage of four images. The top-left image shows a close-up of a concrete structure with some rebar. The top-right image shows a large concrete bridge or overpass structure. The bottom-left image shows a construction site with scaffolding and rebar. The bottom-right image shows a construction site with a large concrete structure and a crane.

# Structural Concrete Fabrication Update

- Non-Conformance Reports (NCR)
  - Spalls, honeycombing, missing or misplaced inserts, etc.
- 2015: 258 NCR's  2016: 138 NCR's (62 from one fabricator)
- Collaborative approach with industry
  - Pre-fabrication meeting on every job
  - Annual workshops – MDOT, Industry, Consultants, National Experts
  - Pre-approved & standard repair procedures
  - Quarterly meetings with fabricators



# Structural Concrete Fabrication Update

- Transparency in Rejections
- Clearly Define QPL Process and Required Certs
- Buy America – What is required?
- Stepped-up QC by Fabricators
- Defined RFI's and How they should be used
- Concrete Slumps
- Steel Attachments to Concrete Beams

# Structural Concrete Fabrication Update

12SP-708C-01

MICHIGAN  
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION  
FOR  
QUALITY CONTROL AND ACCEPTANCE OF STRUCTURAL PRECAST  
CONCRETE

OFS:MJF

1 of 10

APPR:JFS:POJ:07-20-16  
FHWA:APPR:08-12-16

a. **Description.** The Contractor must administer quality control (QC) and the Department will administer quality assurance (QA) procedures that will be used for acceptance of and payment for all Portland cement concrete (PCC) used to fabricate structural precast (prestressed and non-prestressed) concrete elements. This special provision applies to the following structural precast concrete elements that are required to be accepted based on "Fabrication Inspection" per MDOT's Materials Quality Assurance Procedures (MQAP) manual or per project specifications:

- Bridge beams;
- Culverts (10 foot span lengths and greater measured parallel to the roadway centerline);
- Prefabricated bridge elements and systems;
- Mechanically stabilized earth wall;
- Spun concrete poles;
- Sound walls; and
- Other elements as specified in project specifications.

Except as explicitly modified by this special provision, all materials, test methods, and PCC mixture requirements of the standard specifications and the contract apply.

Do not place PCC until the Engineer's daily startup testing verifies that the fresh PCC properties have been met, in accordance with subsection d.2 of this special provision.

Provide the Engineer with 7 calendar days notification prior to the start of fabrication, unless a longer notification period is specified in the contract. Additionally, provide the Engineer with notification of any changes to the fabrication process.

- QC and Acceptance of Precast Concrete
- Pulled and modified from Materials QC spec
- Ability to focus and implement change specifically toward structural precast.



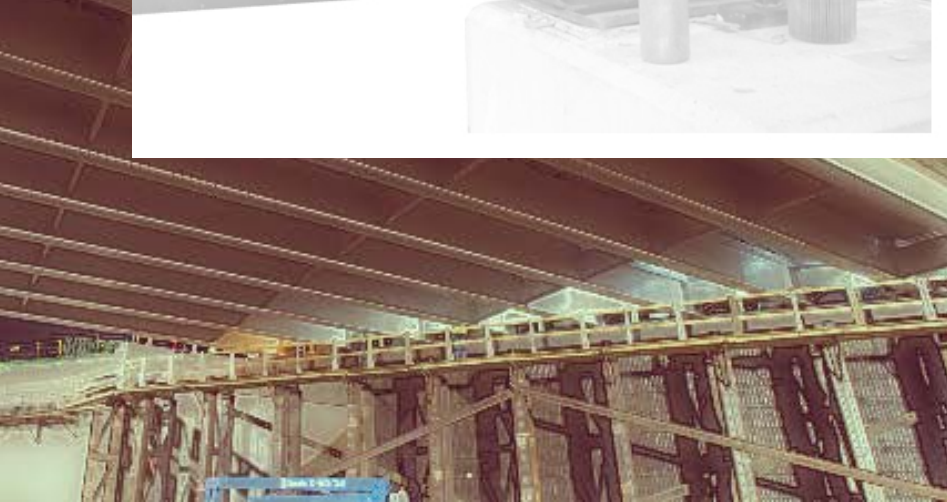
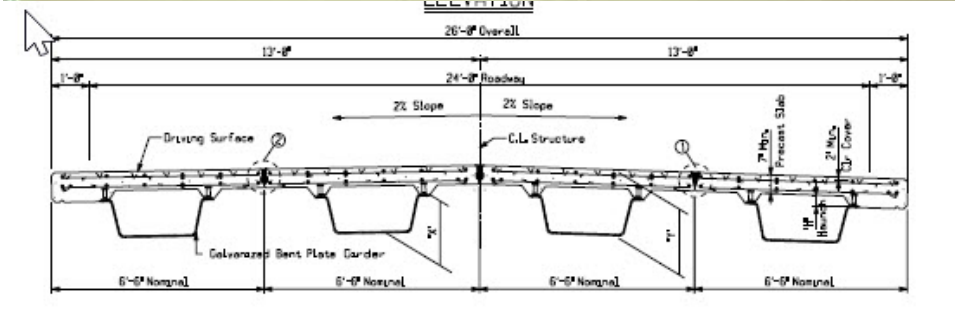
# Structural Steel Fabrication Update

- DOT-QS: Third party quality system audit
  - Supplements AISC certification requirement
- M85 Bascule Bridge
  - Fabrication inspection cost = \$1.5 million...and cost
  - Previous similar projects = \$500,000
- Pilot project in 2017/2018
- Prequalification for complex jobs
  - Screens out unqualified fabricators
  - Third party conducts audits before and during fabrication
  - Frees up MDOT resources





# Folded Steel Plate Girders



# Steel Bridge Paint Matrix

## STEEL BRIDGE GIRDER COATINGS REPAIR MATRIX

ELEMENT No. 515, STEEL PROTECTIVE COATING					RECOMMENDED REPAIR	POTENTIAL RESULT TO CS (NBI)	ANTICIPATED FIX LIFE
Defect	Condition State-CS (National Bridge Inspection-NBI)						
	1 (9-7)	2 (6-5)	3 (4-3)	4 (2-0)			
Chalking (3410)	Chalking is primarily an aesthetic deficiency which may have little to no indication of overall coating system performance, or correlation with remaining service life. See other defects for determining recommended repairs.						
Peeling/ Bubbling/Cracking (3420)	< 5%				Spot Painting <sup>A</sup>	CS 1 (9-7) <sup>C</sup>	Note D
	5% to 15% <sup>B</sup>				Partial Painting	CS 1 (9-7) <sup>C</sup>	30 years <sup>C</sup>
	> 15%				Full Painting	CS 1 (9-7)	35-40 years <sup>E</sup>
Oxide Film Degradation, Color/Texture Adherence <sup>F</sup> (3430)	100%				None	-	-
	0% to 15%				Partial Painting <sup>G</sup>	CS 1 (9-7) <sup>C</sup>	30 years <sup>C</sup>
	> 15%				Full Painting	CS 1 (9-7)	35-40 years <sup>E</sup>
Effectiveness (3440)	< 5%				Spot Painting <sup>A</sup>	CS 1 (9-7) <sup>C</sup>	Note D
	5% to 15% <sup>B</sup>				Partial Painting	CS 1 (9-7) <sup>C</sup>	30 years <sup>C</sup>
	> 15%				Full Painting	CS 1 (9-7)	35-40 years <sup>E</sup>
Damage (7000)	Damage due to vehicle or vessel impact should be evaluated for spot painting or partial painting on a case by case basis. The frequency of damage on some structures should be considered when deciding on the proper repair.						
<b>STRUCTURAL STEEL ELEMENTS (No. 113, 120, 141, 152, 161, 162, 201, 231, 824, 825)</b>							
Corrosion <sup>H</sup> (1000)	< 5%				Spot Painting <sup>A</sup>	CS 1 (9-7) <sup>C</sup>	Note D
	5% to 15% <sup>B</sup>				Partial Painting	CS 1 (9-7) <sup>C</sup>	30 years <sup>C</sup>
	> 15%				Full Painting	CS 1 (9-7)	35-40 years <sup>E</sup>

NOTES: A) Spot painting is not to be used on bridges with red lead paint.

B) When defects are concentrated at beam ends and pin and hanger locations, partial painting may be more appropriate even if CS2-4 is <5% or >15%.

C) Applies only to the areas where repair was done.

D) For the area repaired, assume new service life the same as the current service life of unrepaired coating.

E) Additional spot and partial painting may be necessary during this time.

F) For use with unpainted weathering steel only.

G) Partial painting is typically done at beam ends. If CS3 and CS4 is not at beam ends consider Full Painting.

H) For CS3-CS4, or in the case of steel cracks, buckling, or section loss in excess of 25%, girders should be evaluated for structural steel repairs through detailed inspection or scoping prior to any coating.





## Innovative Paint Systems

- **Two-Coat Polyaspartic**
  - Zinc Rich Primer,
  - Polyaspartic top coat - replaces epoxy intermediate and urethane top coat
  - Possible alternative = polysiloxane
  - Potential 25-30% reduction in material cost and time
  - Pilot Project – West Rd./I-75
- **HRCSA – High Ratio Calcium Sulfate Acrylic**
  - International Bridge
  - Powerwashing, sealer, one coat
  - Minimal waste, minimal containment
  - MDOT crews
- **Metallizing**
  - Cadillac of corrosion protection
  - Pricy, but could save additional time



## Pack Rust Removal



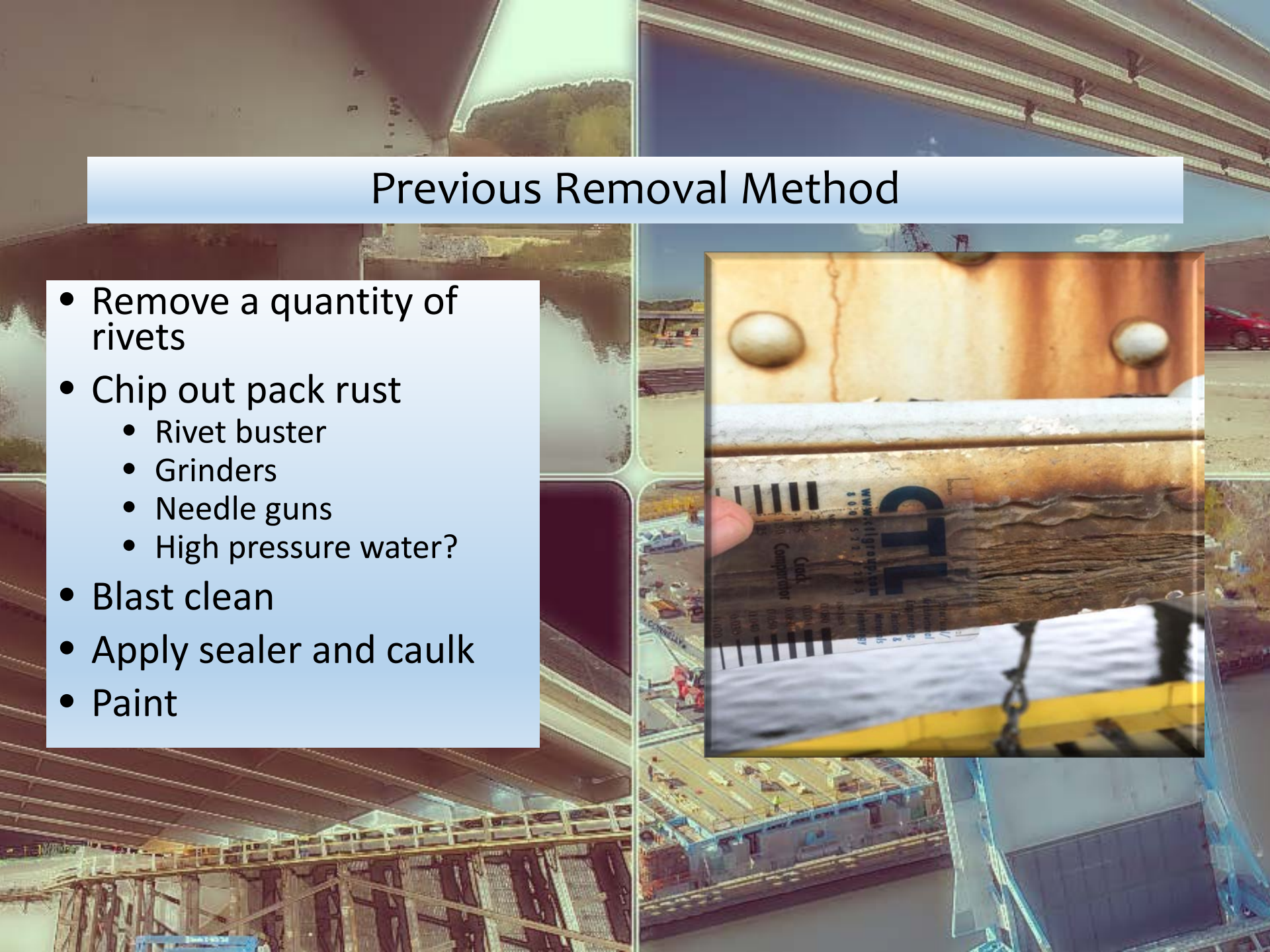
- JN 109761, M14 over the Huron River, Ann Arbor
- Fracture critical, riveted steel plate girders
- Approx. 350 lft of pack rust
  - Approx. 175 ft<sup>2</sup>





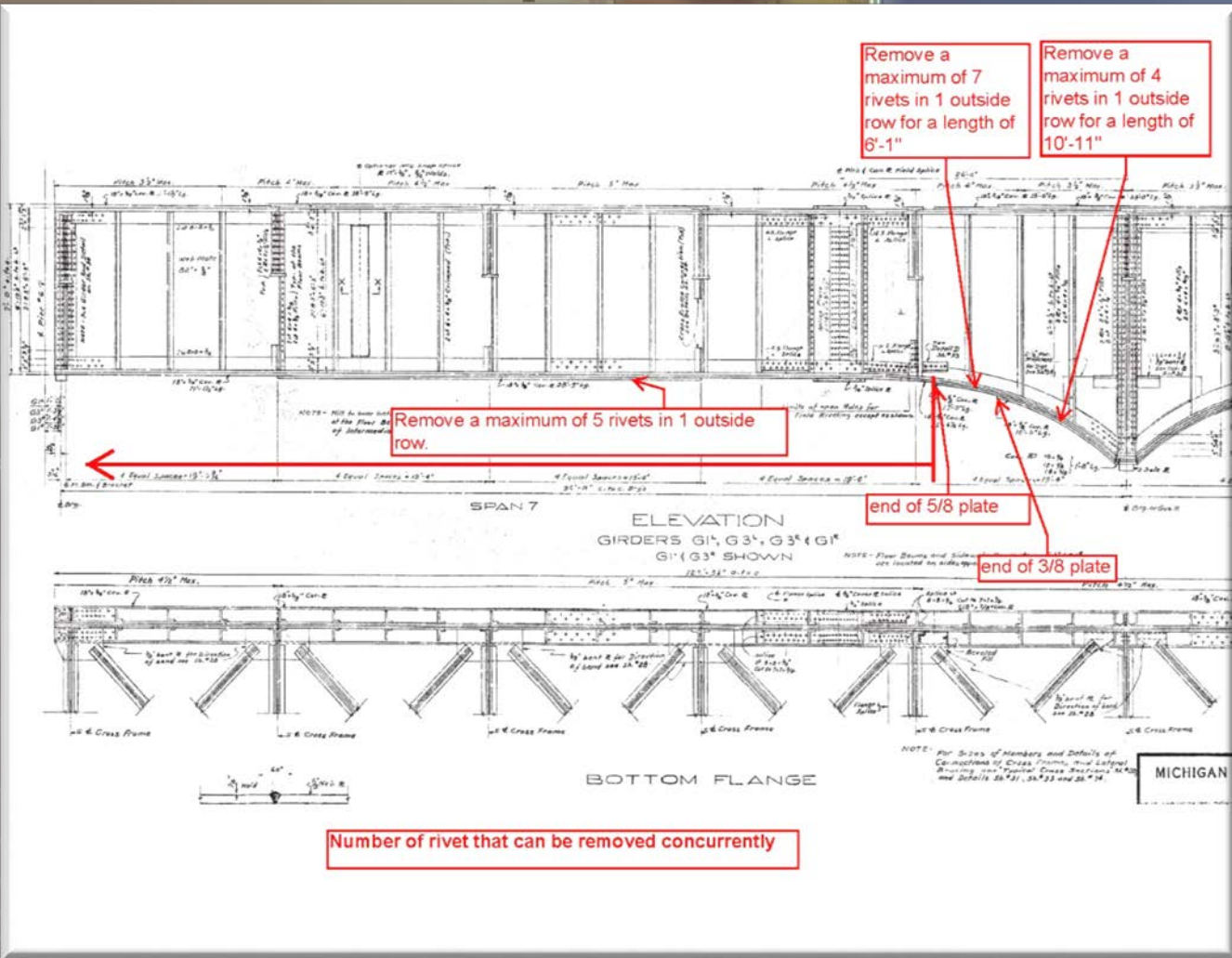
## Previous Removal Method

- Remove a quantity of rivets
- Chip out pack rust
  - Rivet buster
  - Grinders
  - Needle guns
  - High pressure water?
- Blast clean
- Apply sealer and caulk
- Paint



## Original plan

- Remove only a few rivets at a time
- Clean out pack rust
- Re-bolt
- Months (years?)



Number of rivet that can be removed concurrently



## Alternate Method

- Heat up to 800 deg. F
- Rivet hammer
- Blast clean
- Heat straighten and clamp as necessary







The background of the slide is a collage of four images related to bridge construction and maintenance. The top-left image shows a close-up of a bridge's underside with a bright green highlight on a specific area. The top-right image shows a long bridge with multiple lanes and support structures under a clear blue sky. The middle-left image shows a close-up of a bridge's steel structure with some white material, possibly a repair or coating. The middle-right image shows a construction site with a large crane and a building in the background. The bottom-left image shows a bridge under construction with extensive scaffolding and support beams. The bottom-right image shows a close-up of a bridge's steel structure with blue protective material.

## Pack Rust Removal Guidelines

- At what thickness should pack rust be removed?
- Guidelines for replacing rivets with bolts
- Tension zones vs. compression zones
- Structure redundancy
- Possible upcoming research



# Bridge Maintenance

- Preventative Maintenance is Critical.
- Training Opportunities Through MDOT.
- Shot Blasters – MDOT recently purchased 6 machines
- Joints, Floodcoats, Deck Injections, Painting, etc.





# Laser Paint Removal

