NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Bridge Preservation Using Non-Destructive Testing on T1 Steel

July 24, 2025

12:00PM – 1:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING
RCEP
REGISTERED CONTINUING EDUCATION PROGRAM

Purpose Statement

This webinar will present case studies demonstrating how non-destructive evaluation (NDE) results can inform bridge preservation decision-making. Presenters will share examples of applying NDE to evaluate Grade 100 steel during long-term structural monitoring.

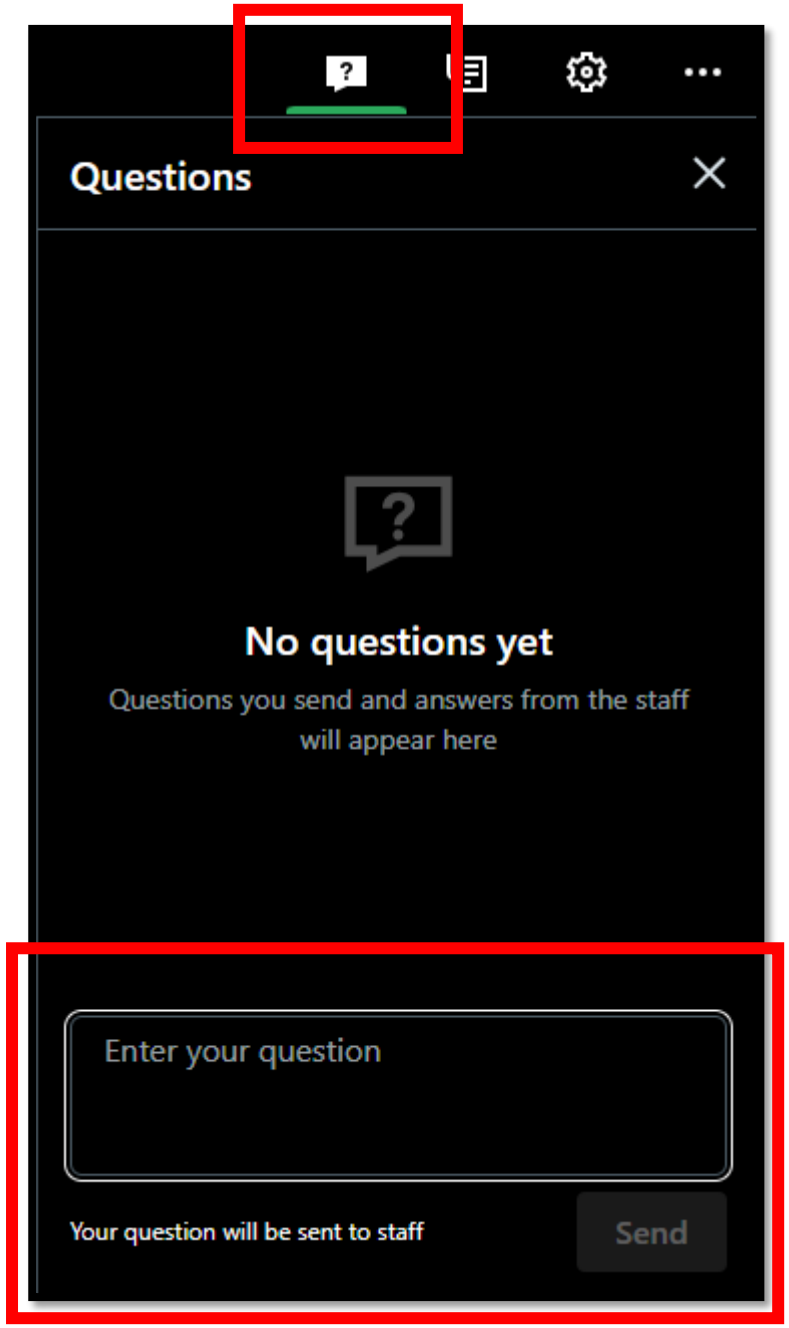
Learning Objectives

At the end of this webinar, you will be able to:

(1) Explain how NDE techniques are integrated into the bridge preservation decision-making process, with a focus on structures fabricated with Grade 100 steel

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters

Dr. Hoda Azari
Federal Highway Adminstration
hoda.azari@dot.gov

James Edmunds
KYTC
James.Edmunds@ky.gov

Jason Stith
Michael Baker
Jason.Stith@mbakerintl.com

Jen Laning
Gannett Fleming TranSystems
jclaning@transystems.com

NATIONAL ACADEMIES *Sciences Engineering Medicine*

Kentucky T-1 NDE and Remediation

TRB Webinar 2025

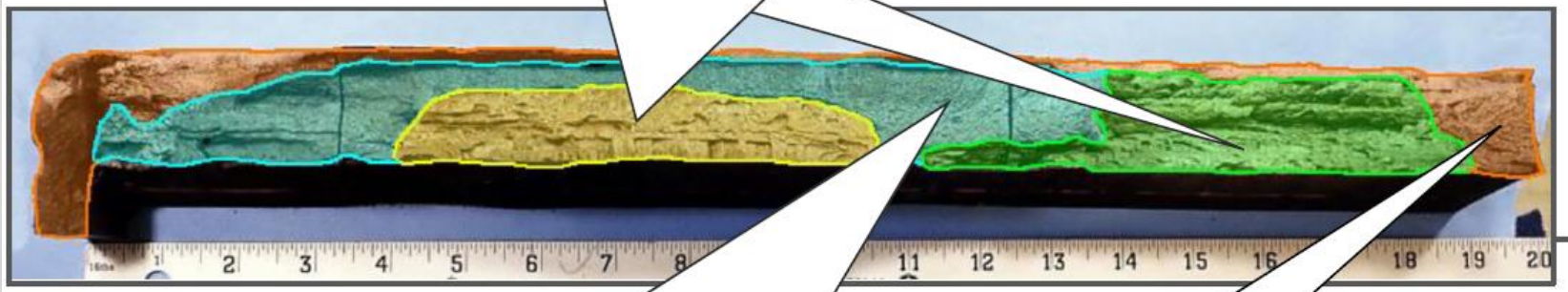
Presenter:
James Edmunds, PE

Hernando de Soto

Butt Welds and Hydrogen Cracking

Hernando de Soto Bridge – Fracture Surface

Yellow and green regions were surface breaking hydrogen cracks from fabrication. About 6.5” x 1” and 5” x 1.2”.

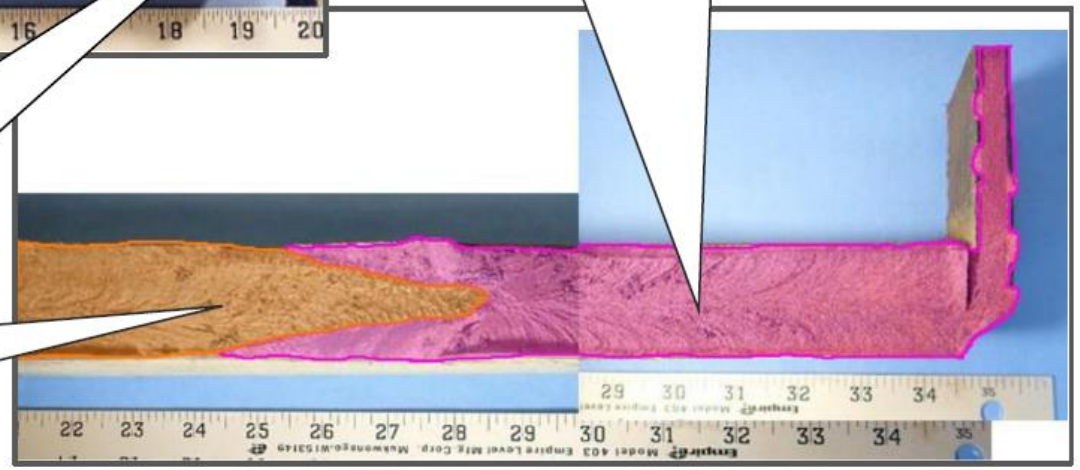


Source: Arkansas DOT

Blue region was 1st brittle extension sometime after fabrication. Broke surface on inside of box, not outside.

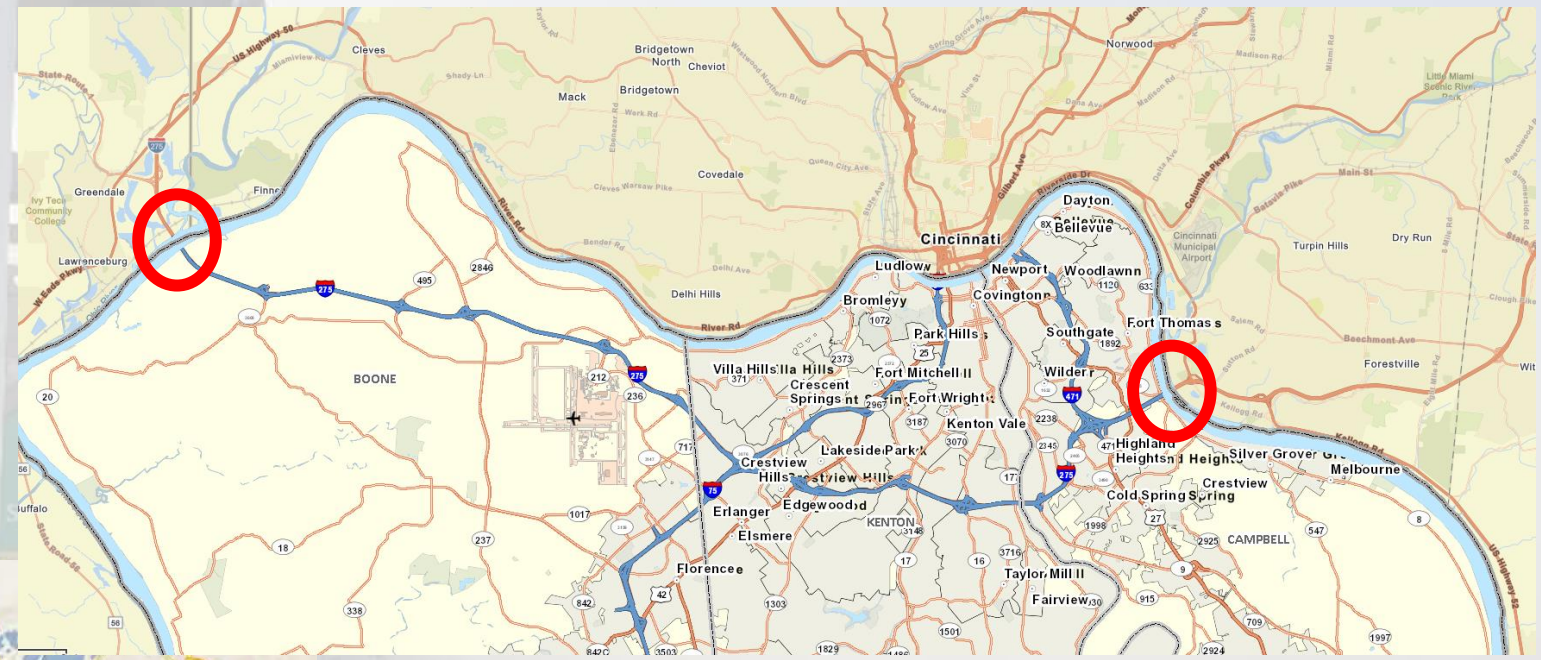
Orange region (both images) was 2nd brittle extension. Broke through outer box surface sometime before 2016.

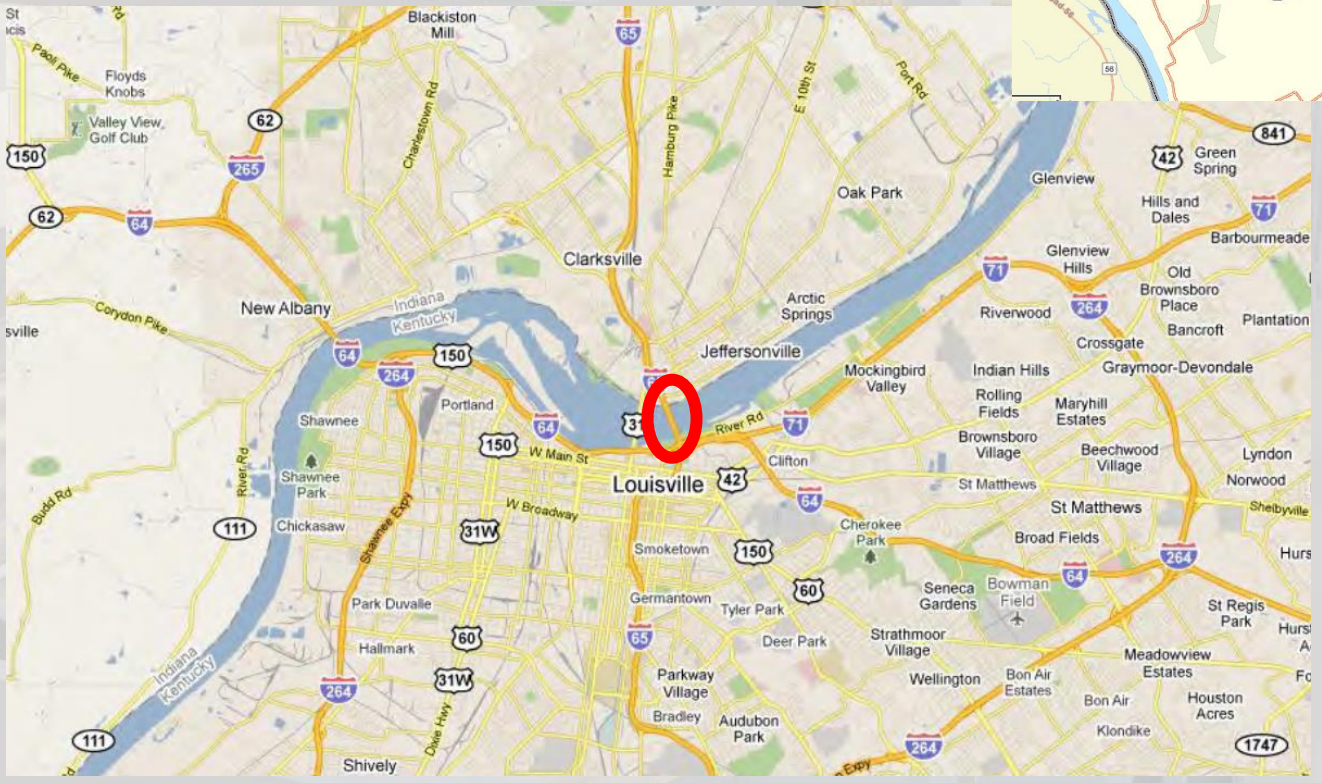
Pink region was 3rd brittle extension. Happened after 2019.

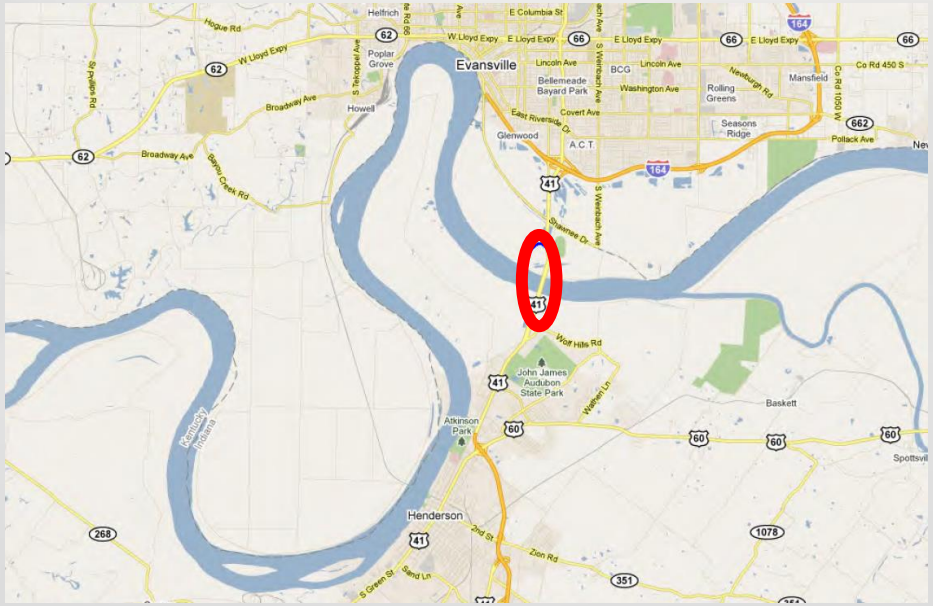


Source: Arkansas DOT

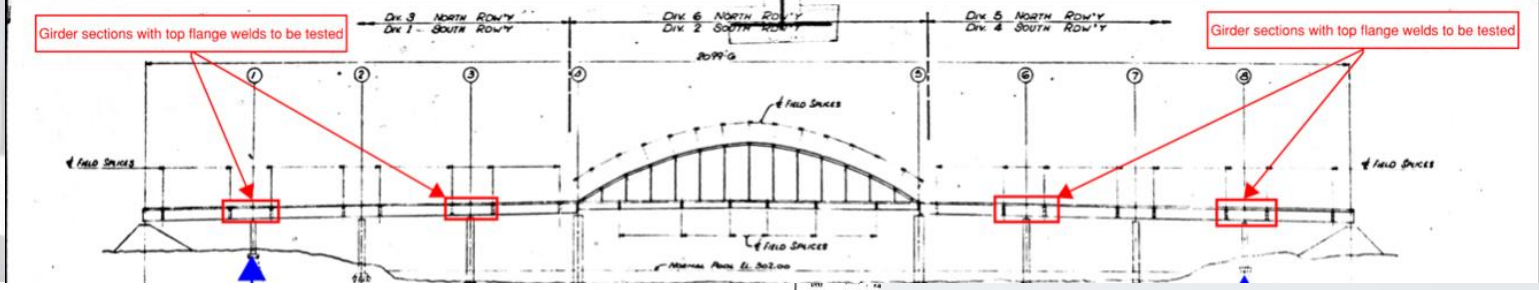
Kentucky's T-1 Inventory

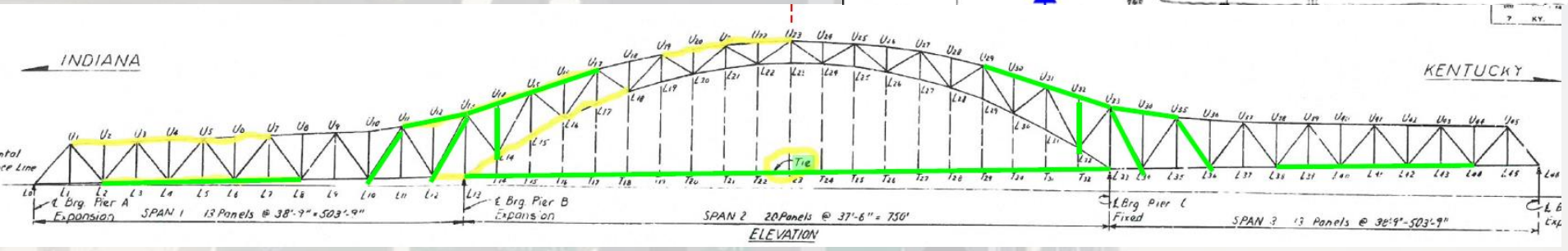


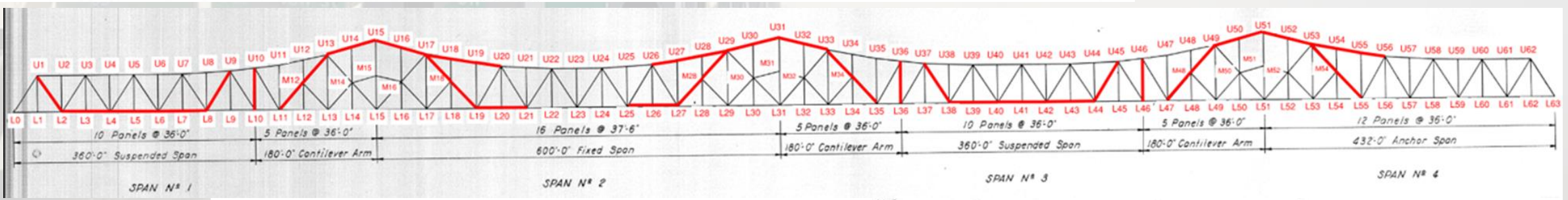


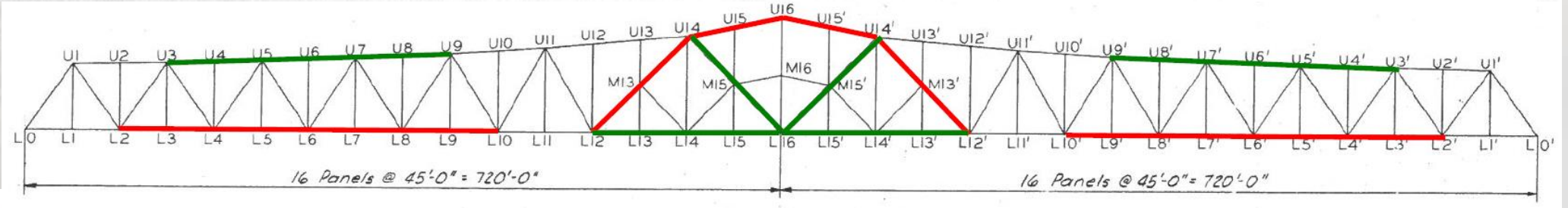


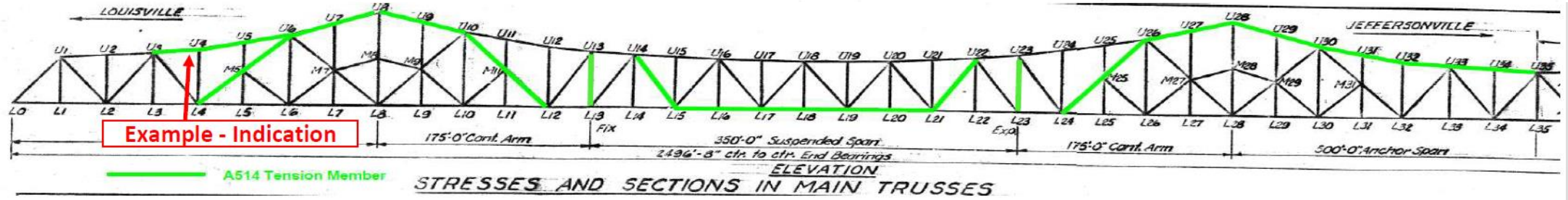
Risk


Girder sections with top flange welds to be tested
Girder sections with top flange welds to be tested


INDIANA
KENTUCKY
SPAN 1 13 Panels @ 38'-9" = 503'-9"
SPAN 2 20 Panels @ 37'-6" = 750'
SPAN 3 13 Panels @ 38'-9" = 503'-9"
ELEVATION


10 Panels @ 36'-0"
360'-0" Suspended Span
5 Panels @ 36'-0"
180'-0" Cantilever Arm
16 Panels @ 37'-6"
600'-0" Fixed Span
5 Panels @ 36'-0"
180'-0" Cantilever Arm
10 Panels @ 36'-0"
360'-0" Suspended Span
5 Panels @ 36'-0"
180'-0" Cantilever Arm
12 Panels @ 36'-0"
432'-0" Anchor Span
SPAN Nº 1
SPAN Nº 2
SPAN Nº 3
SPAN Nº 4


16 Panels @ 45'-0" = 720'-0"
16 Panels @ 45'-0" = 720'-0"


LOUISVILLE
JEFFERSONVILLE
Example - Indication
175'-0" Cont. Arm
Fix
350'-0" Suspended Span
2496'-8" ctr. to ctr. End Bearings
Exp.
175'-0" Cont. Arm
500'-0" Anchor Span
A514 Tension Member
ELEVATION
STRESSES AND SECTIONS IN MAIN TRUSSES

Research Report
KTC-11-10/SPR401-10-1F

Kentucky Bridges with High-Strength Quenched And Tempered Steel

Theodore Hopwood II
Associate Engineer III, Research

and

Jared Fairchild
Transportation Technician II

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

In cooperation with
Kentucky Transportation Cabinet
Commonwealth of Kentucky

June 2011

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **ACTION:** Non-Destructive Testing of Fracture Critical Members Fabricated from AASHTO M244 Grade 100 (ASTM A514/A517) Steel

Date: December 13, 2021

From: Hari Kalla
Associate Administrator, Office of Infrastructure

HARI KALLA Digitally signed by HARI KALLA Date: 2021.12.13 11:01:42 -05'00'

In Reply Refer To: HIBS

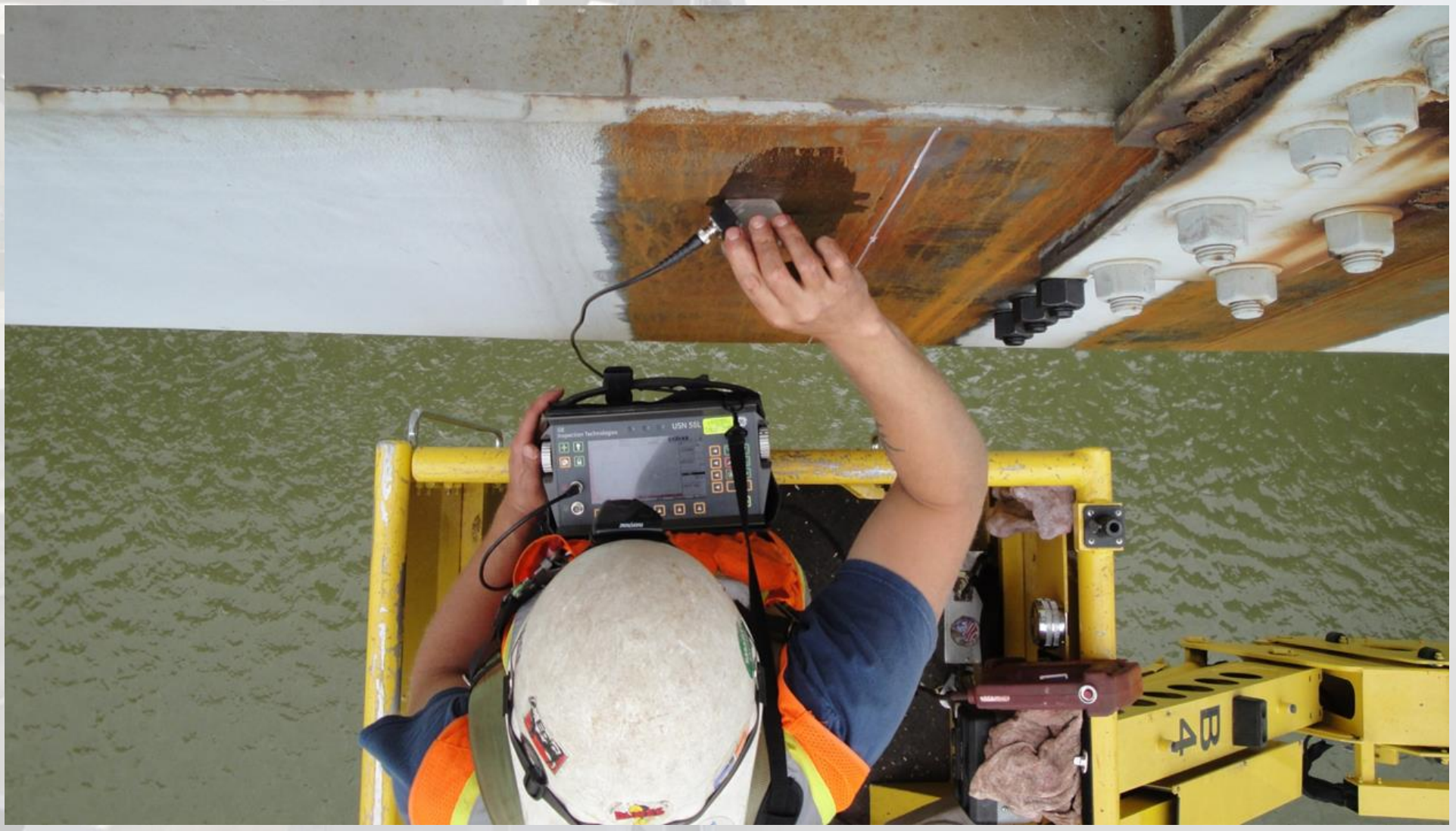
To: Division Administrators
Directors of Field Services

The purpose of this memorandum is to provide direction regarding the in-service inspection, inventory, and testing of butt welds in fracture critical members fabricated from AASHTO M244 Grade 100 (ASTM A514/A517) steel, more commonly known as “T-1” steel.

Choice of NDT

- High volume with access challenges
- Availability of Technician workforce
- Seek and remove all rejectable indications

NDT - Traditional UT



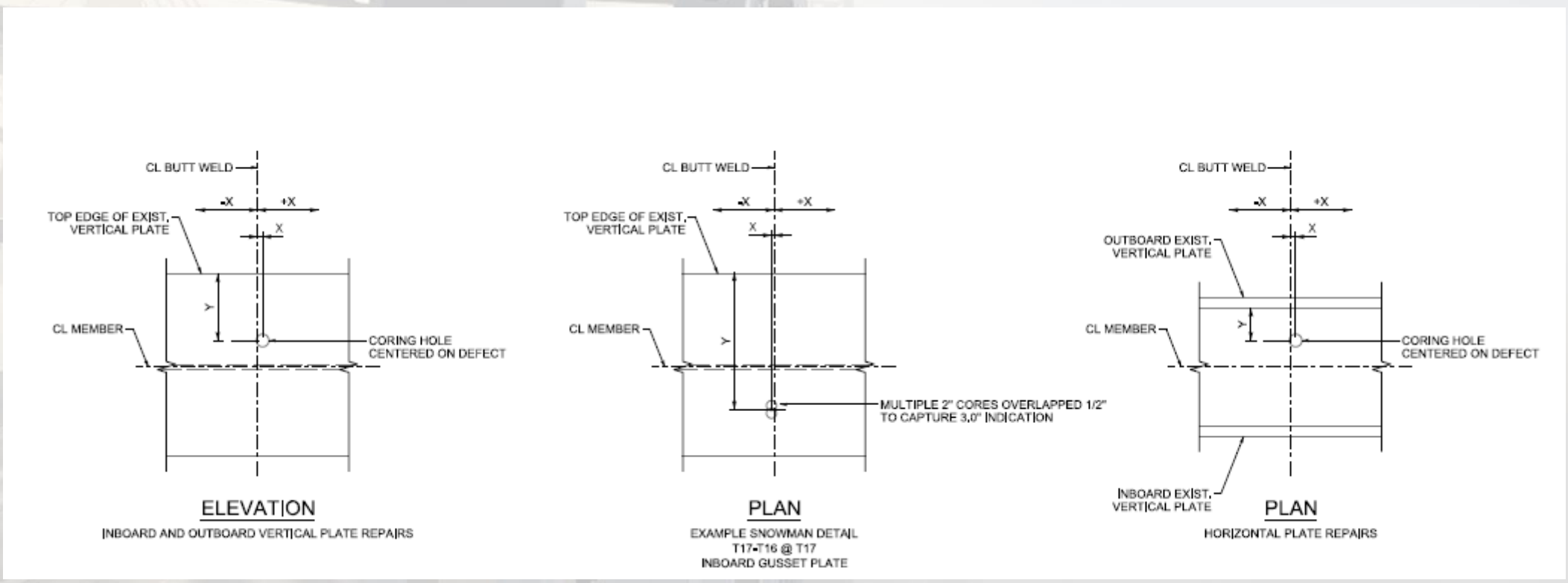
Kentucky’s Strategy

- Inspection
- Design
- Remediation Contracts per each bridge

Kentucky's Findings

Bridge Name	T-1 Butt Welds	Rejectable Indications
I-65 (JFK Bridge)	696	44
I-24 WB & EB	32	1
I-275 WB & EB (Combs Hehl)	343	20
I-275 (Carroll Cropper)	600	101
US 41 SB (Henderson)	547	51

Remediation



Record of Coring

UPSTREAM TRUSS REPAIRS

			NON-DESTRUCTIVE TESTING				REMEDIATION PLAN		REMEDIATION					
MEMBER	LOCATION	PLATE	INDICATION LENGTH (IN.)	X* (IN)	Y (IN)	DATE TESTED	REPAIR TYPE	CORE DIAMETER (IN)	INDICATION LENGTH (IN.)	X* (IN)	Y (IN)	DATE + REMEDIATED	NDT TECHNICIAN INITIALS +	REMARKS
U35-U34	U35	OB-FLANGE	1.80	-0.60	12.25	4/4/2023	I	2						
U35-U34	U34	OB-FLANGE	1.00	0.00	22.25	4/4/2023	I	2						
			2.50	0.00	3.00	4/4/2023	I***	2						SNOWMAN RETROFIT
U34-U33	U34	IB-FLANGE	2.00	-0.50	22.38	4/3/2023	I	2						
L34-U33	U33	IB-FLANGE	1.00	-1.00	2.50	4/11/2023	I	2						
U33-U32	U33	IB-FLANGE	0.50	-0.25	11.50	4/3/2023	I	2						
U33-U32	U32	IB-FLANGE	1.00	0.00	12.25	4/3/2023	I	2						
U32-U31	U31	OB-FLANGE	1.00	0.00	12.20	4/2/2023	I	2						
U31-U30	U31	OB-FLANGE	1.30	0.00	10.75	4/2/2023	I	2						
U30-U29	U29	IB-FLANGE	1.00	-0.25	12.50	4/2/2023	I	2						
U17-U16	U17	IB-FLANGE	6.50	-0.31	4.00	4/6/2023	II**	N/A						
U16-U15	U15	IB-FLANGE	1.00	+0.13	5.25	4/6/2023	I	2						
			1.63	0.00	12.25	4/6/2023	I	2						
U15-U14	U15	IB-FLANGE	2.38	0.50	11.75	4/6/2023	II**	N/A						
			1.00	-0.25	3.00	4/6/2023								
			1.00	-0.25	5.50	4/6/2023								
			1.00	-0.25	10.75	4/6/2023								
		OB-FLANGE	1.75	+0.5	12.00	4/6/2023	I	2						
U15-U14	U14	IB-FLANGE	1.00	+0.25	12.50	4/6/2023	I	2						
			0.50	+4.5	11.75	4/6/2023	I	2						
		OB-FLANGE	2.75	-1.50	11.50	4/6/2023	I	2						
U14-U13	U14	IB-FLANGE	2.50	-0.25	11.75	4/6/2023	I	2						
			1.00	+1.38	12.25	4/6/2023	I	2						
		OB-FLANGE	3.38	-1.00	11.50	4/6/2023	II**	N/A						
			1.75	-1.75	11.60	4/6/2023								
U14-U13	U13	IB-FLANGE	1.75	-2.00	12.00	4/6/2023	I	2						
		OB-FLANGE	1.75	-1.25	13.00	4/6/2023	I***	2						SNOWMAN RETROFIT
			1.75	-2.00	12.00	4/6/2023								
U13-U12	U13	IB-FLANGE	1.00	-0.75	11.40	4/6/2023	I	2						
		OB-FLANGE	0.75	-2.00	12.13	4/6/2023	I***	2						SNOWMAN RETROFIT
			1.25	-0.50	12.13	4/6/2023								
U13-L12	U13	OB-FLANGE	0.75	0.00	12.25	4/6/2023	I	2						
			1.50	1.00	5.50	4/6/2023	I	2						
U13-U12	U12	OB-FLANGE	1.00	-1.25	12.00	4/6/2023	I	2						
U12-U11	U12	IB-FLANGE	1.00	-1.25	12.75	4/6/2023	I	2						
			1.00	-1.50	12.25	4/6/2023	I	2						
		OB-FLANGE	1.00	-1.25	12.00	4/6/2023	I	2						
U12-U11	U11	IB-FLANGE	1.00	-0.25	11.75	4/6/2023	I	2						
			1.00	0.00	12.75	4/5/2023	I	2						
L33-T32	T32	IB-FLANGE	12.00	0.00	13.00	4/13/2023	II**	N/A						
		OB-FLANGE	5.75	0.00	13.00	4/13/2023	II**	N/A						
T28-T27	T27	MID	0.75	0.00	9.00	4/2/2023	I	2						
T28-T27	T27	OB-FLANGE	3.00	-0.13	0.75	4/2/2023	I***	2						SNOWMAN RETROFIT
T22-T21	T22	OB-FLANGE	7.00	0.00	4.00	4/3/2023	II**	N/A						
T17-T16	T17	IB-FLANGE	3.00	-0.38	21.25	4/5/2023	I***	2						SNOWMAN RETROFIT
L44-L43	L44	TOP-COVER	1.38	+0.13	0.88	4/7/2023	I	2						
L44-L43	L43	TOP-COVER	1.50	+5.25	16.50	4/7/2023	I	2						
		IB-MAIN	2.00	+1.25	20.00	4/7/2023	I	2						
L43-L42	L43	IB-MAIN	3.00	+4.00	2.50	4/12/2023	I***	2						SNOWMAN RETROFIT
		OB-MAIN	15.00	-4.50	7.50	4/12/2023	II**	N/A						
L43-L42	L42	BOT-COVER	2.13	+1.00	0.00	4/12/2023	I***	2						SNOWMAN RETROFIT
		IB-MAIN	3.50	-4.25	0.75	4/12/2023	I***	2						SNOWMAN RETROFIT
L42-L41	L42	TOP-COVER	2.25	+0.75	1.00	4/12/2023	I***	2						SNOWMAN RETROFIT
		IB-MAIN	1.13	0.00	8.13	4/12/2023	II**	N/A						
			3.75	0.00	14.00	4/12/2023								
L42-L41	L41	TOP-COVER	1.75	0.75	19.25	4/12/2023	I	2						
L41-L40	L40	TOP-COVER	1.50	-5.75	18.75	4/12/2023	I	2						
L40-L39	L40	OB-MAIN	24.00	+1.00	2.00	4/12/2023	II**	N/A						
L40-L39	L39	TOP-COVER	1.50	0.00	19.75	4/12/2023	I	2						
		IB-MAIN	2.00	+0.75	19.75	4/12/2023	I	2						
		OB-MAIN	8.75	+5.25	0.00	4/12/2023	II**	N/A						
L39-L38	L39	OB-MAIN	18.00	+0.75	8.00	4/12/2023	II**	N/A						
L39-L38	L38	TOP-COVER	3.75	0.00	20.00	4/12/2023	I***	2						3 CORE SNOWMAN RETROFIT
		OB-MAIN	19.75	+0.13	6.50	4/12/2023	II**	N/A						
L33-T32	L33	IB-FLANGE	2.50	0.00	13.00	4/13/2023	I***	2						SNOWMAN RETROFIT
T14-L13	L13	IB-FLANGE	1.50	-1.00	12.50	4/13/2023	I	2						
L6-L5	L5	OB-MAIN	1.50	-0.38	15.75	4/13/2023	I	2						
L5-L4	L5	TOP-COVER	1.25	-6.00	3.50	4/13/2023	I	2						
			4.25	-6.00	15.00	4/13/2023	I***	2						3 CORE SNOWMAN RETROFIT

Record of Coring

UPSTREAM TRUSS REPAIRS

			NON-DESTRUCTIVE TESTING				REMEDIATION PLAN		REMEDIATION					
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U35-U34	U34	OB-FLANGE	1.00	0.00	22.25	4/4/2023	I	2						
			2.50	0.00	3.00	4/4/2023	I***	2						SNOWMAN RETROFIT
U34-U33	U34	IB-FLANGE	2.00	-0.50	22.38	4/3/2023	I	2						
L34-U33	U33	IB-FLANGE	1.00	-1.00	2.50	4/11/2023	I	2						
U33-U32	U33	IB-FLANGE	0.50	-0.25	11.50	4/3/2023	I	2						
U33-U32	U32	IB-FLANGE	1.00	0.00	12.25	4/3/2023	I	2						
U32-U31	U31	OB-FLANGE	1.00	0.00	12.20	4/2/2023	I	2						
U31-U30	U31	OB-FLANGE	1.30	0.00	10.75	4/2/2023	I	2						
U30-U29	U29	IB-FLANGE	1.00	-0.25	12.50	4/2/2023	I	2						
U17-U16	U17	IB-FLANGE	6.50	-0.31	4.00	4/6/2023	II**	N/A						
														SNOWMAN RETROFIT
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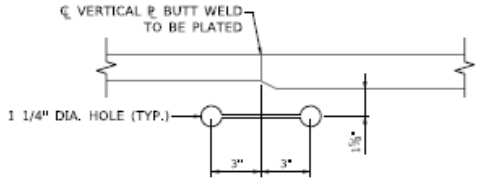
														3 CORE SNOWMAN RETROFIT
														SNOWMAN RETROFIT
T14-L13	L13	IB-FLANGE	1.50	-1.00	12.50	4/13/2023	I	2						
L6-L5	L5	OB-MAIN	1.50	-0.38	15.75	4/13/2023	I	2						
L5-L4	L5	TOP-COVER	1.25	-6.00	3.50	4/13/2023	I	2						
			4.25	-6.00	15.00	4/13/2023	I***	2						3 CORE SNOWMAN RETROFIT

REMEDIATION

INDICATION LENGTH (IN.)	X* (IN)	Y (IN)	DATE + REMEDIATED	NDT TECHNICIAN INITIALS +	REMARKS
					SNOWMAN RETROFIT

Remediation

GENERAL NOTES



DOG-BONE RETROFIT DETAIL

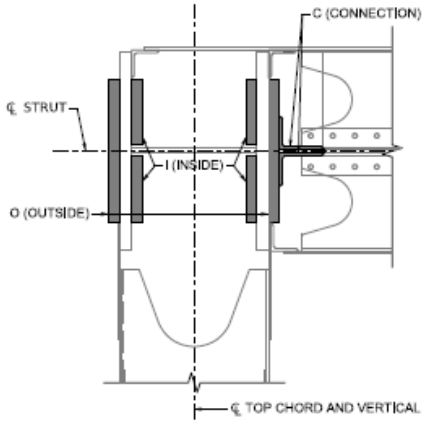
INSTALL AT EACH BUTT WELD AT EACH LOCATION AS SPECIFIED IN THE PLANS

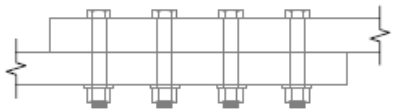
DOG-BONE RETROFIT PROCEDURE:
1. DRILL 1 1/4" DIA. HOLE IN HORIZONTAL PLATE.
2. WITH A CUTTING WHEEL OR PORTABLE PLASMA USE HOLES AS A START/STOP POINT FOR CUTTING SLOT PARALLEL TO VERTICAL PLATE.

PLATE MARKING CONVENTION

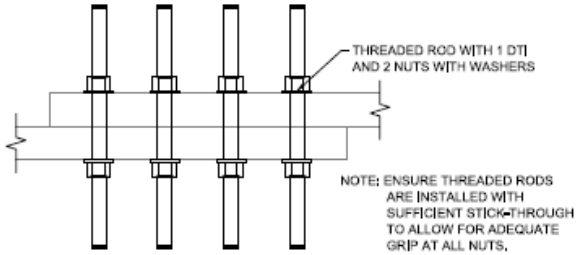
PLATE MARK	JOINT LOCATION	OUTSIDE/INSIDE	PLATE NUMBER
T22-O-1	T22	O	1
U14-I-2	U14	I	2
T32-C-1	T32	C	1

*REFER TO BELOW SKETCH DEFINING OUTSIDE, INSIDE, AND CONNECTION PLATE MARKS

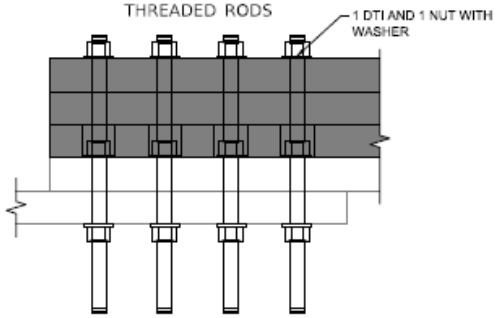




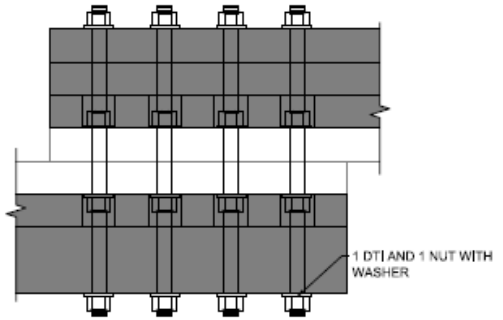
EXISTING CONDITION



REPLACE EXISTING BOLTS WITH THREADED RODS



INSTALL CHEESE PLATE AND OUTSIDE PLATES ON ONE SIDE



INSTALL CHEESE PLATE AND OUTSIDE PLATES ON REMAINING SIDE

THREADED ROD INSTALLATION SEQUENCE

TRB Webinar 2025

NDE and Remediation Plans for T-1 Steel Members

Jason Stith, Ph.D., P.E., S.E.

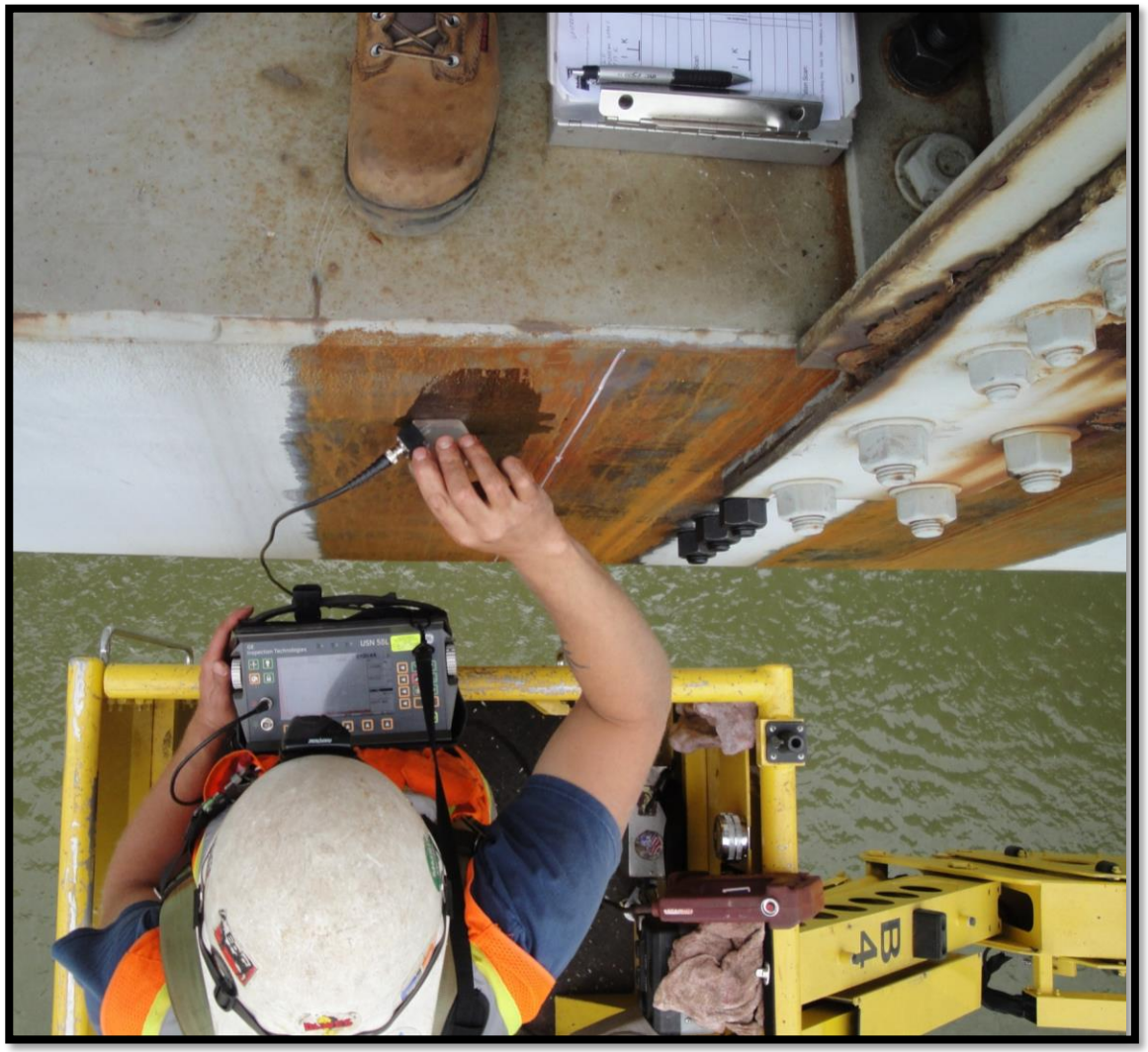
July 17th, 2025

Michael Baker INTERNATIONAL | *We Make a Difference*

Presenter

Jason Stith, Ph.D., P.E., S.E.

Inspection and Testing



Inspection Process Overview – Field Coring

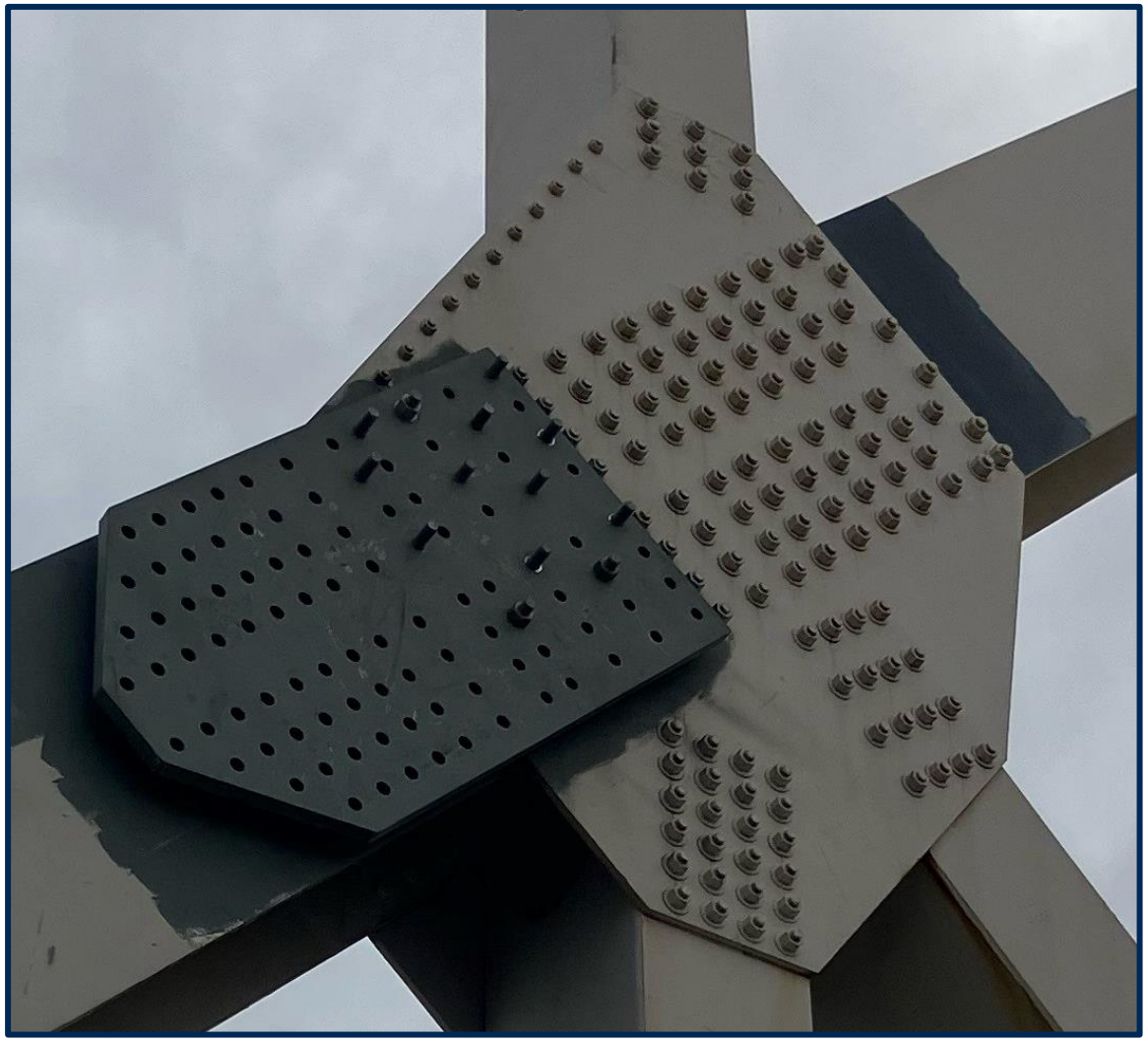
- Start with Desktop Member and Weld ID
- Field Identification of Welds
- Non-destructive testing
  - Magnetic (Particle) Testing (MT or PT)
  - Ultrasonic Testing (UT)
- Field Coring – Set by inspection criteria

- **REPAIR DESIGN!**

Inspection Process Overview – Test Results

Bridge Name	Bridge ID	Bridge Type	T-1 Butt Welds	Rejectable Indications	Inspection Dates	Year Constructed
I-65 SB over Ohio River (JFK Bridge)	056B00214L	Multi-Span Cantilevered Truss	676	44 (7%)	11/7/2022 - 12/13/2022	1963
US 41 SB over Ohio River (Henderson)	051B00007L	Multi-Span Cantilevered Truss	546	50 (9%)	9/25/2023 – 11/6/2023	1965
I-24 WB & EB over Kentucky River	079B000L&R	Continuous Two-Girder System	32	1 (3%)	7/17/2023 - 7/28/2023	1974
I-275 WB & EB over Ohio River (Carroll Cropper)	008B00052N	Continuous Tied Arch Truss	524	102 (19%)	3/14/2023 – 4/7/2023	1977
I-275 WB & EB over Ohio River (Combs Hehl)	019B00040L&R	Multi-Span Cantilevered Truss	372	20 (5%)	4/11/2023 – 6/9/2023	1979

Repair Design



Repair Design – Project-Specific Design Criteria

- What do you design for?
  - Member Capacity?
  - Demands?: LRFD, LFD, ASD
  - Load Rating?: LRFR, LFR, ASR,
    - What trucks?: HL-93, H-20, Legal, EV, Permit
- Axial vs. Flexural Member

Tension Capacity

- **Yield on Gross Section**

$$P_r = \phi_y P_{ny} = \phi_y F_y A_g \qquad \text{(EQ. 6.8.2.1-1)}$$

$$P_r = 0.95\ (\mathbf{100\ ksi})\ A_g = \mathbf{95\ ksi \times A_g}$$

- **Fracture on Net Section**

$$P_r = \phi_u P_{nu} = \phi_u F_u A_n R_p U \qquad \text{(EQ. 6.8.2.1-2)}$$

$$P_r = 0.8\ (\mathbf{115\ ksi})\ A_n R_p U = \mathbf{92\ ksi \times A_n}\ R_p U$$

=> Any hole reduces the capacity

Bolted Splice

- AASHTO 6.13.6.1.1 – Tension Members
  - Average of Demand and Capacity or,
  - 75% of Capacity

- AASHTO 6.13.6.1.3 – Flexural Members
  - Capacity of Flange
  - Web Shear Capacity

Bolted Splice

- AASHTO 6.13.6.1.1 – Tension Members
  - Average of Demand and Capacity or,
  - 75% of Capacity

- Capacity - (EQ. 6.8.2.1-1 or 2)
- Demand – LRFD Strength I

Bolted Splice

- AASHTO 6.13.6.1.3 – Flexural Members
  - Capacity of Flange
  - Web Shear Capacity

- Design for load rating > 1.0
- All legal loads at operating level
  - $(1.25DC + 1.5DW + 1.35(LL+IM)) < 0.85*\phi R_n$

Design Criteria

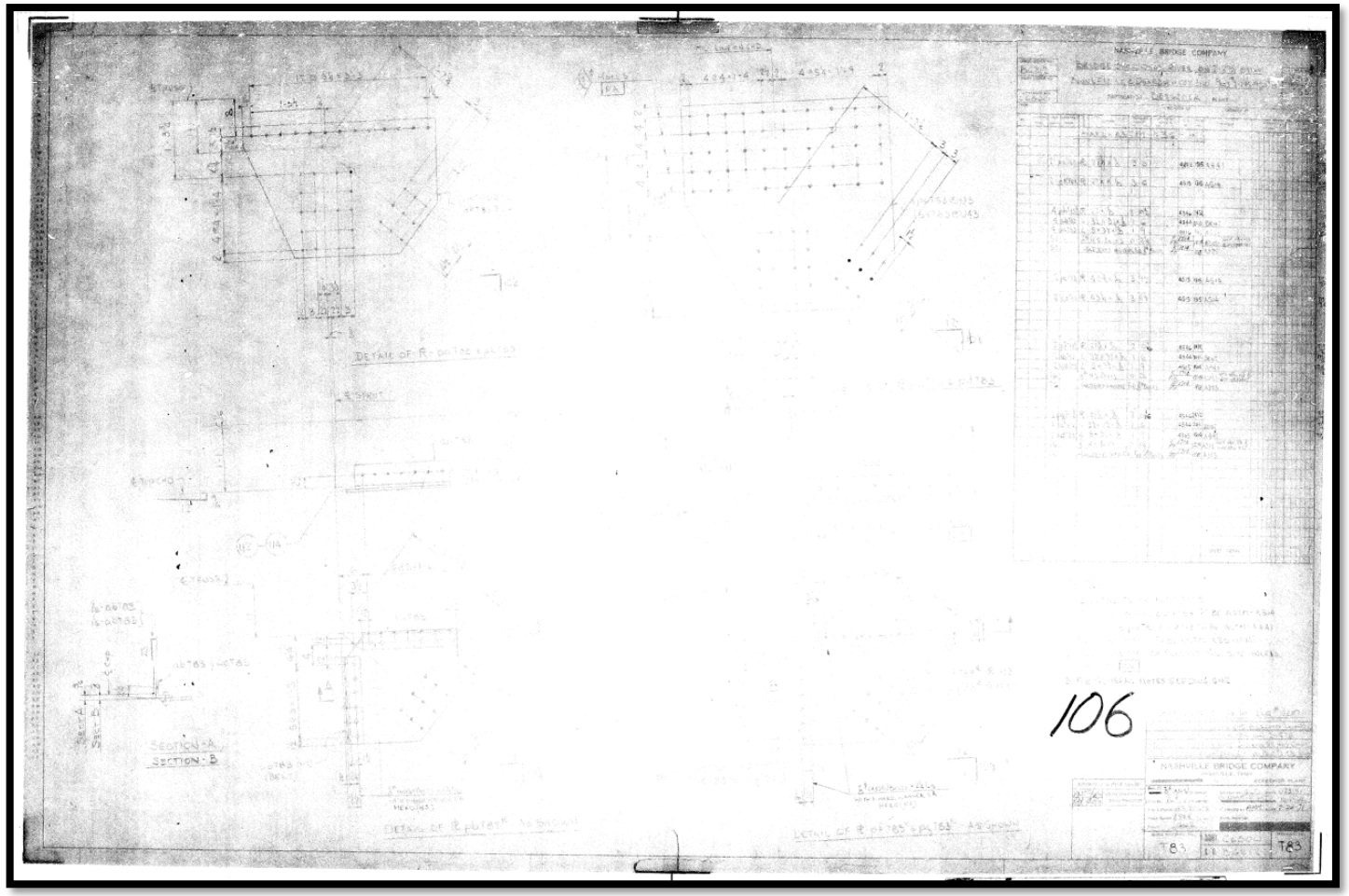
- What do you design for?
  - Member Capacity: Can not get 100% of original capacity
  - Demands: **LRFD**, LFD, ASD
  - Load Rating: **LRFR**, LFR, ASR,
    - What trucks: HL-93, H-20, **Legal, EV**, Permit
- Axial vs. Flexural Member

FS ≈ 2.0

0.9 DL + (LL+IM)
1.8DL+2.0(LL+IM)
1.25DL+1.75(LL+IM)

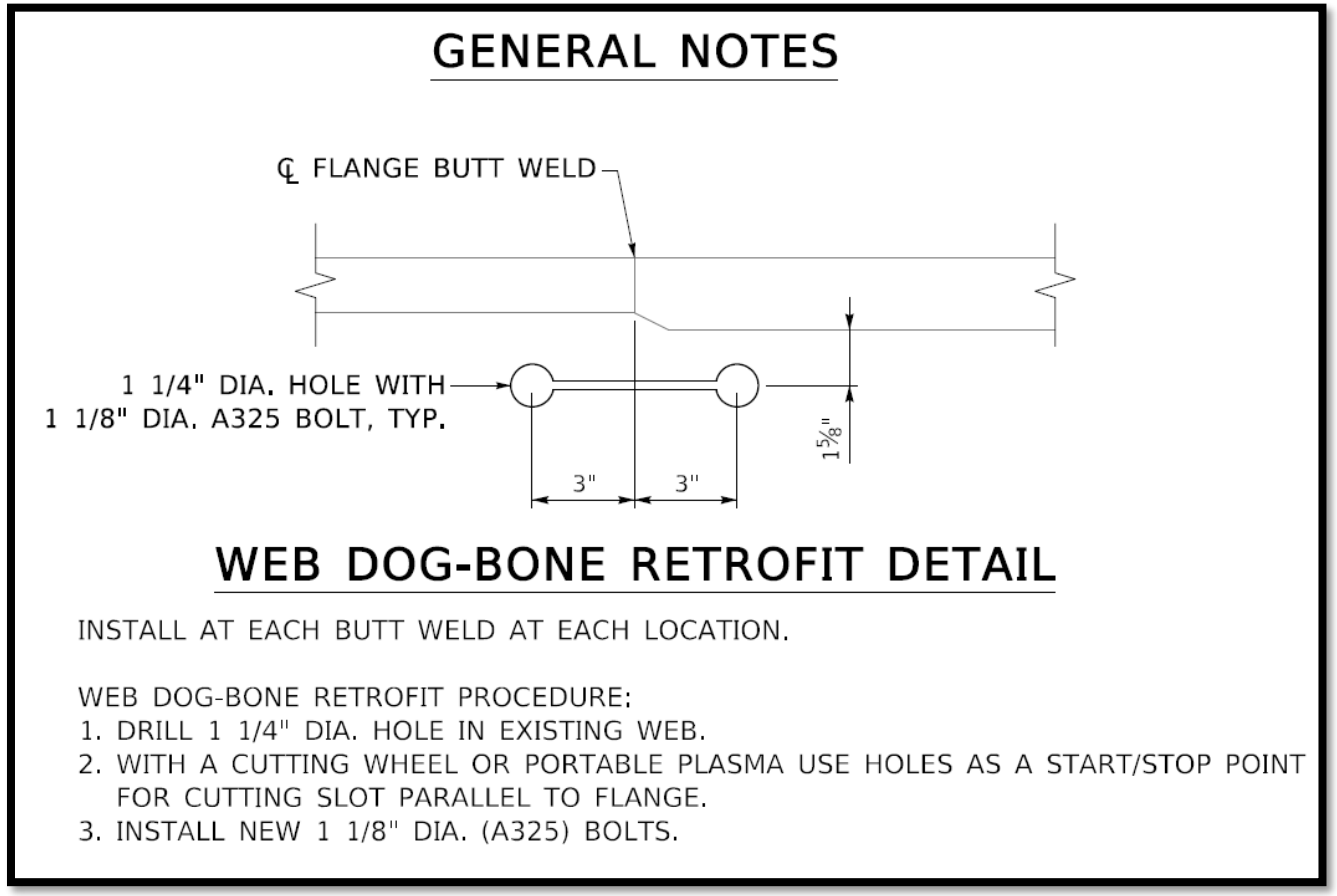
Start with Document Review

- Some shop drawings were very clear, and others were none existent
- Field verification by the contractor was critical to project success

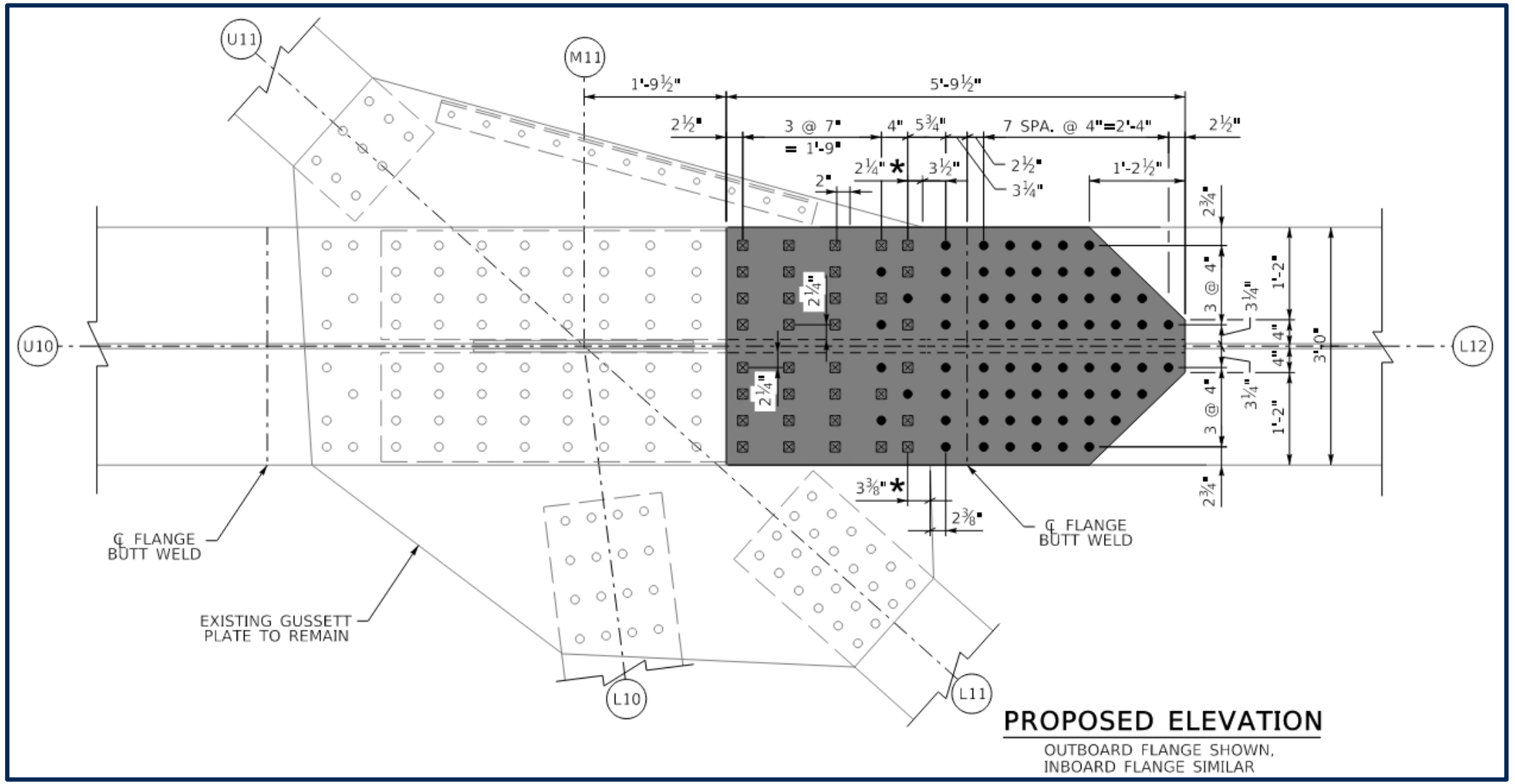


Repair Design – Effective Isolation

- Dog-Bone Detail
  - Typically used at faulting CJP Weld
  - Creates saw joint between plates
  - Arrests “unzipping” behavior
  - Cut longitudinally, minimally effects net section – still consider!

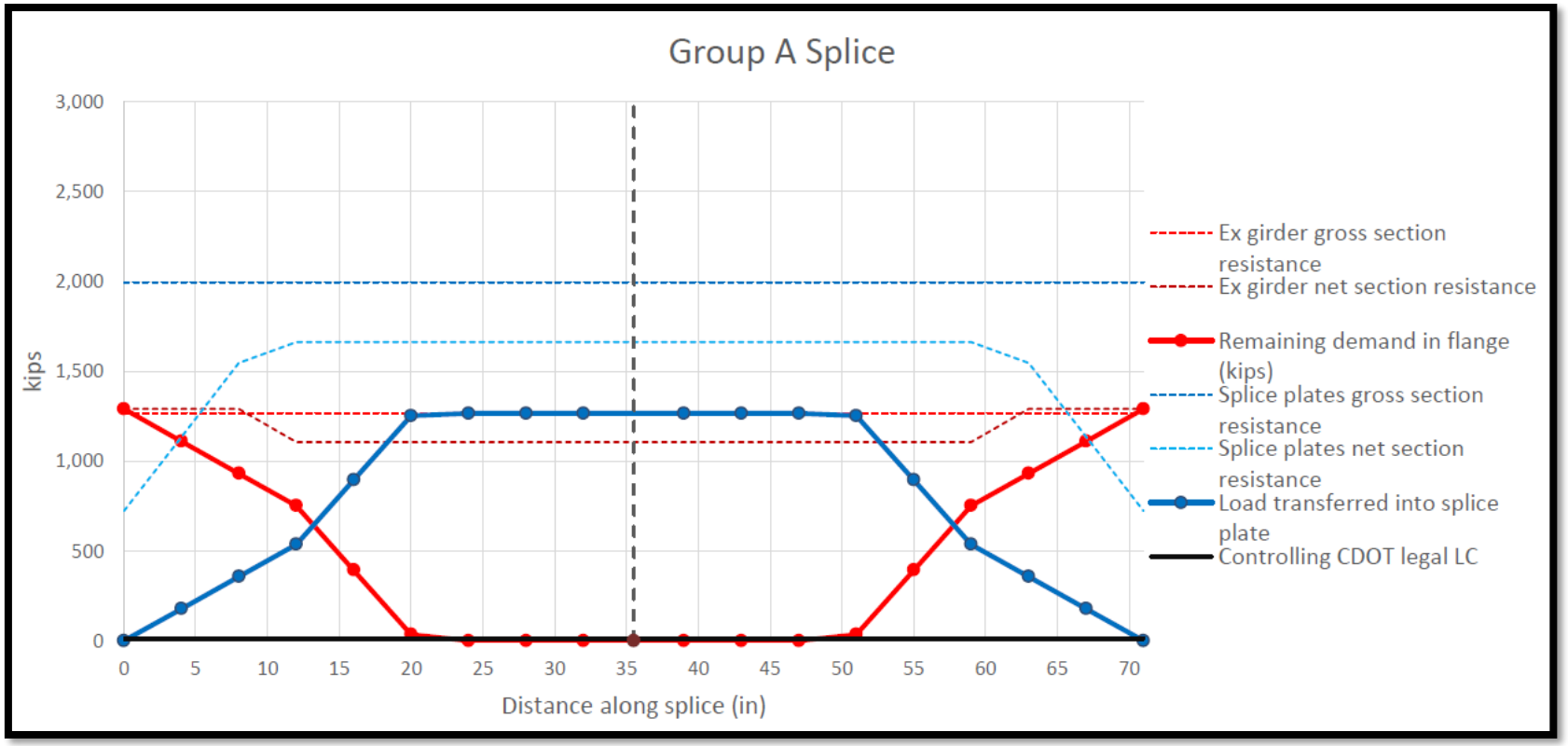


Splice Repair Design – Overview



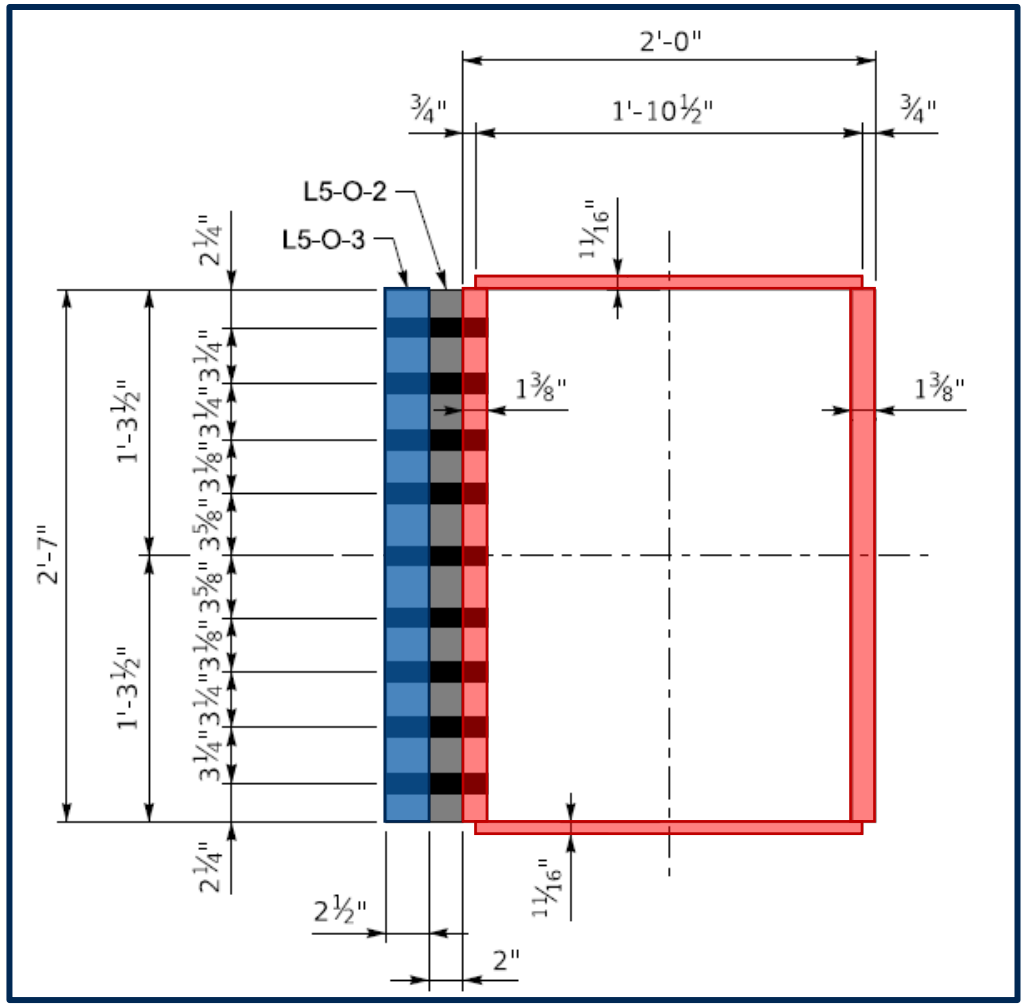
Repair Design – Flow of Forces

- ***NEW!*** Splice Plates
- Bolt Groups
- Existing Section



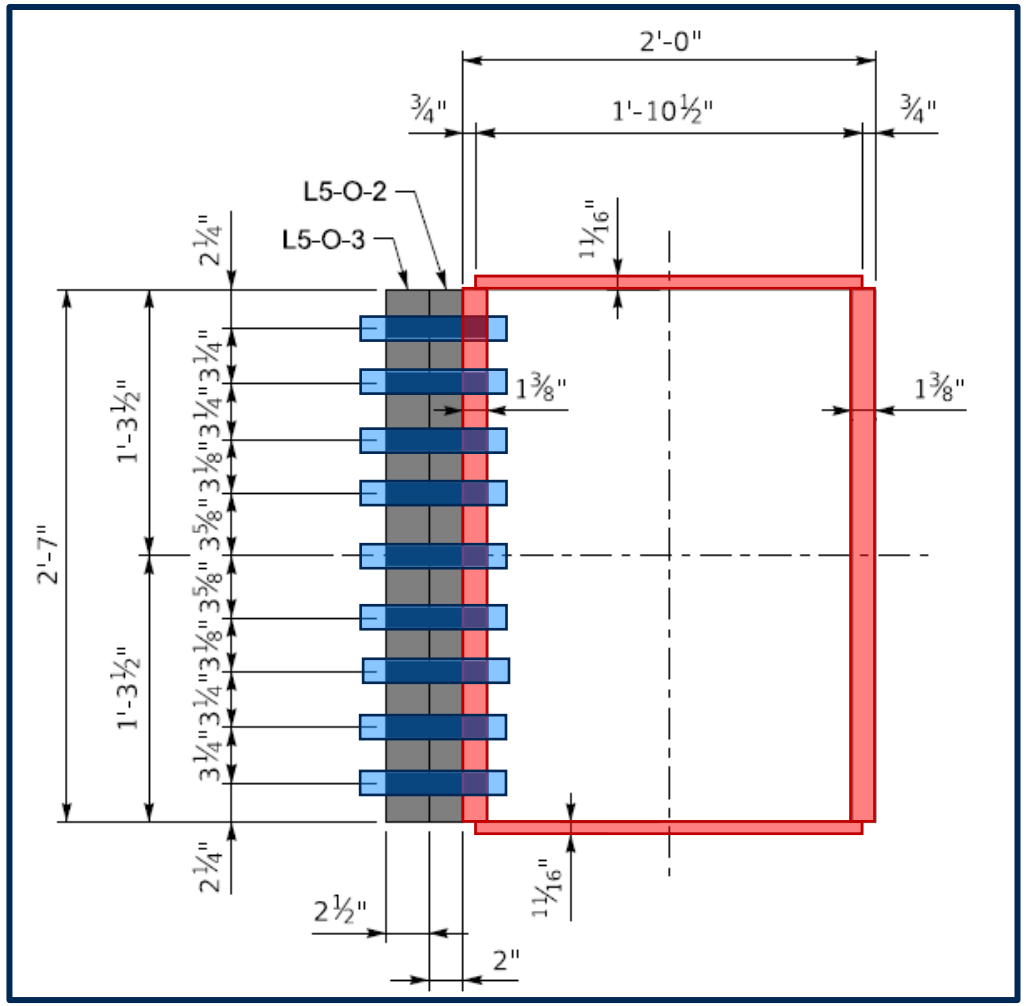
Splice Repair Design – Overview

- Gross Yielding Resistance
- Net Fracture Resistance
- Block Shear Resistance



Splice Repair Design – Bolt Resistance

- Bolt Shear Resistance
- Bolt Slip Resistance
- Bolt Bearing Resistance
- Bolt Layout, Spacing, Sealing



Repair Design – Demand Considerations

- AASHTO 6.13.1 – Maximum Demand
  - Tension Members (Truss) – Maximum of:
    - Average of:
      - Factored Load Effects
      - Factored Resistance
    - 75% of Factored Resistance (Gross Yielding)

6.13—CONNECTIONS AND SPLICES

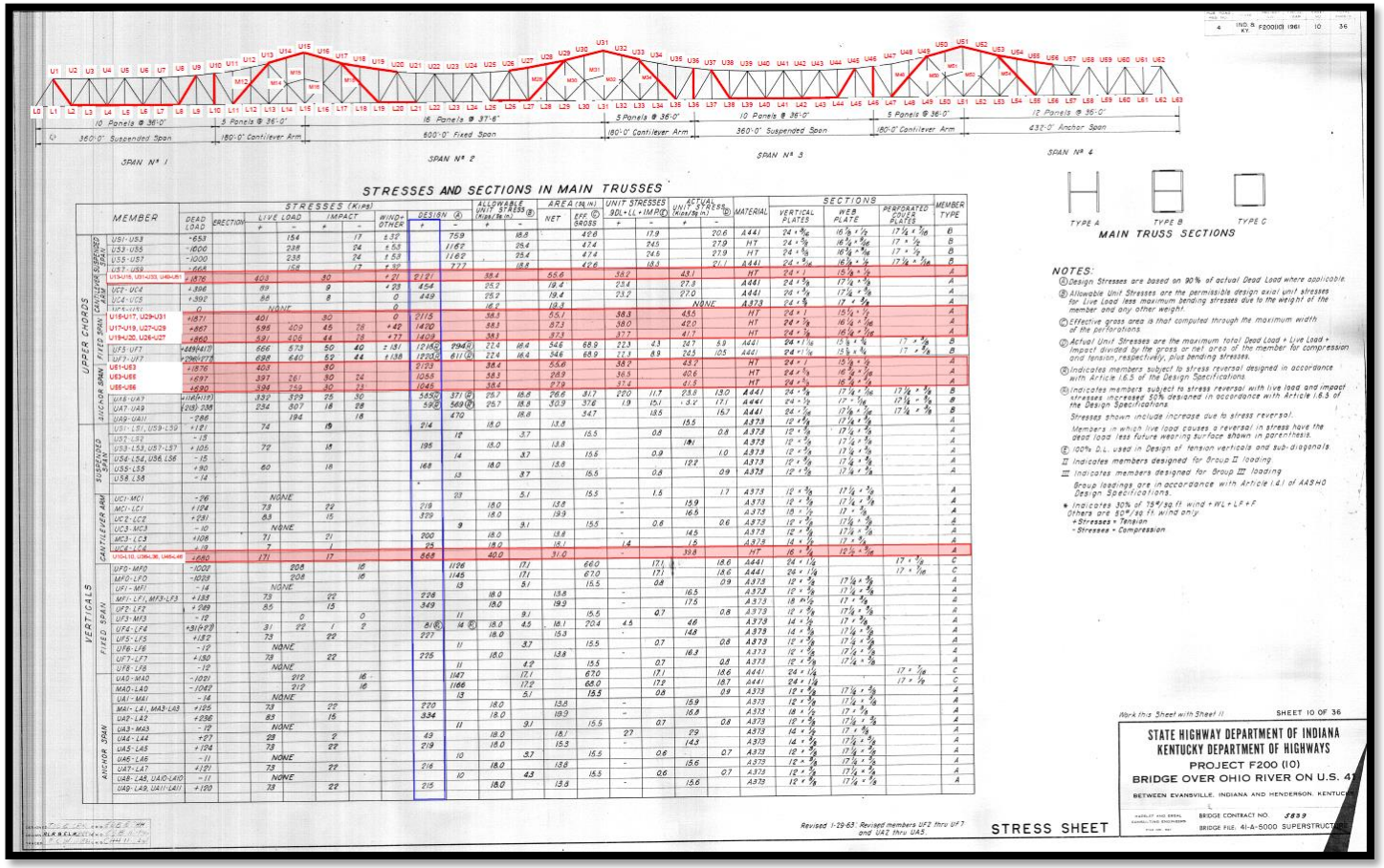
6.13.1—General

Except as specified herein, connections and splices for primary members subject only to axial tension or compression shall be designed at the strength limit state for not less than the larger of:

- the average of the factored axial force effect at the point of splice or connection and the factored axial resistance of the member or element at the same point, or
- 75 percent of the factored axial resistance of the member or element.

Repair Design – Demand Considerations

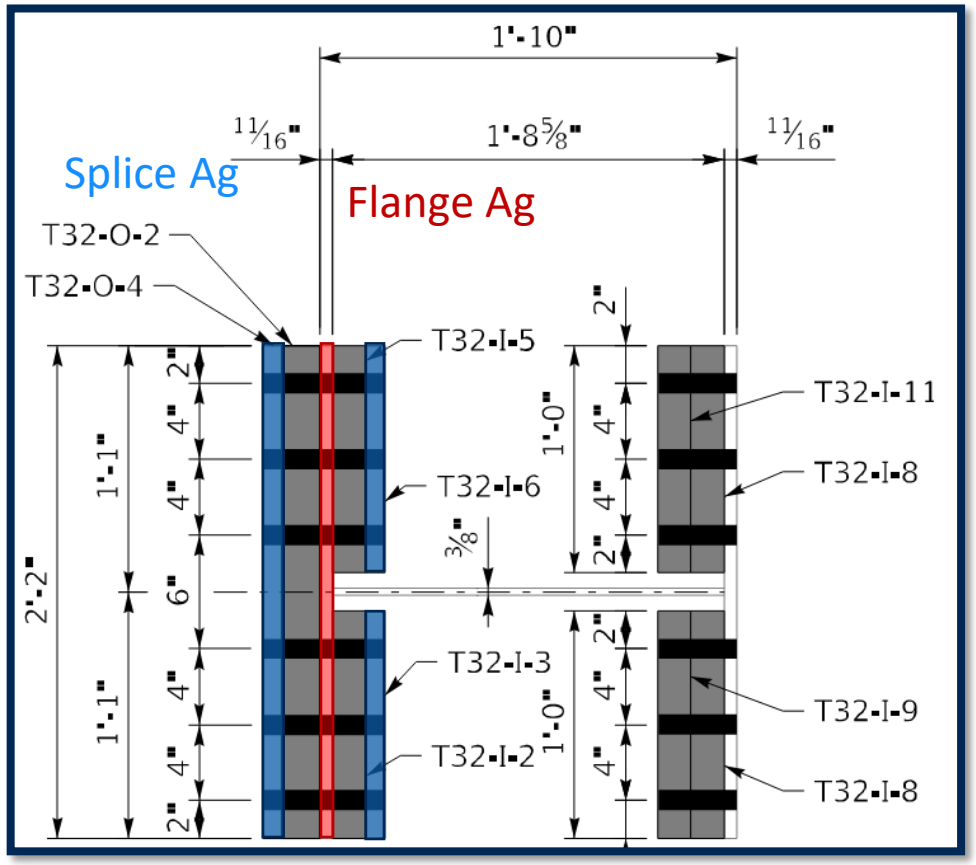
- Design Loads
  - Design Truck
    - HS-20?
    - HS-20-44?
    - H-20?
    - H-10?
  - Original LL Assumptions
  - Retrofits?
- Original Design Drawings



Splice Repair Design – Overview

Splice Repair Design – Gross Yield/Net Fracture

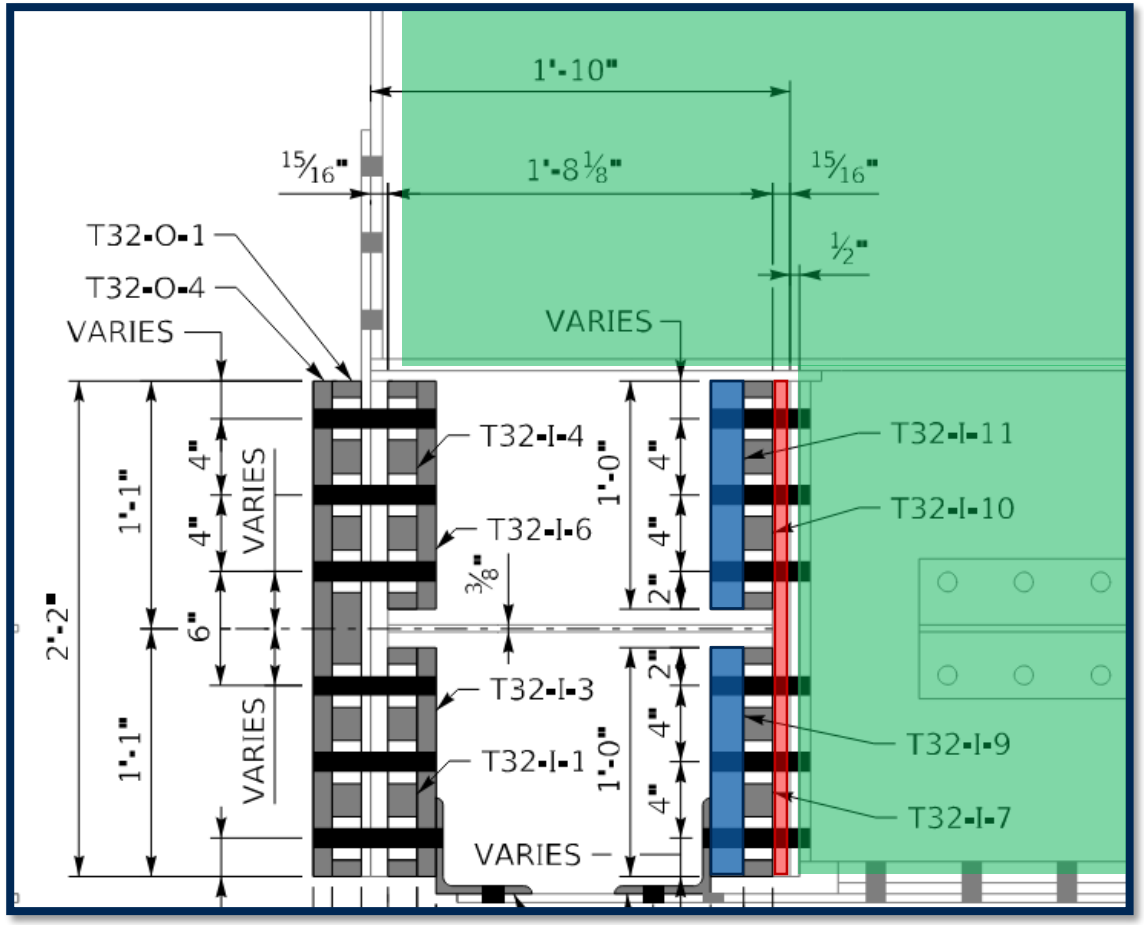
- Plate Size – Relative to Gr. 100
  - Good practice to match existing
  - Consider grade closely
- 1-Sided vs. 2-Sided Plating
  - Available plate thicknesses



Splice Repair Design – Gross Yield/Net Fracture

- Plate Size – Relative to Gr. 100
  - Good practice to match existing
  - Consider grade closely
- 1-Sided vs. 2-Sided Plating
  - Available plate thicknesses
  - Detailing conflicts
    - Lateral bracing members
    - Floorbeams
    - Diaphragms

Floorbeam

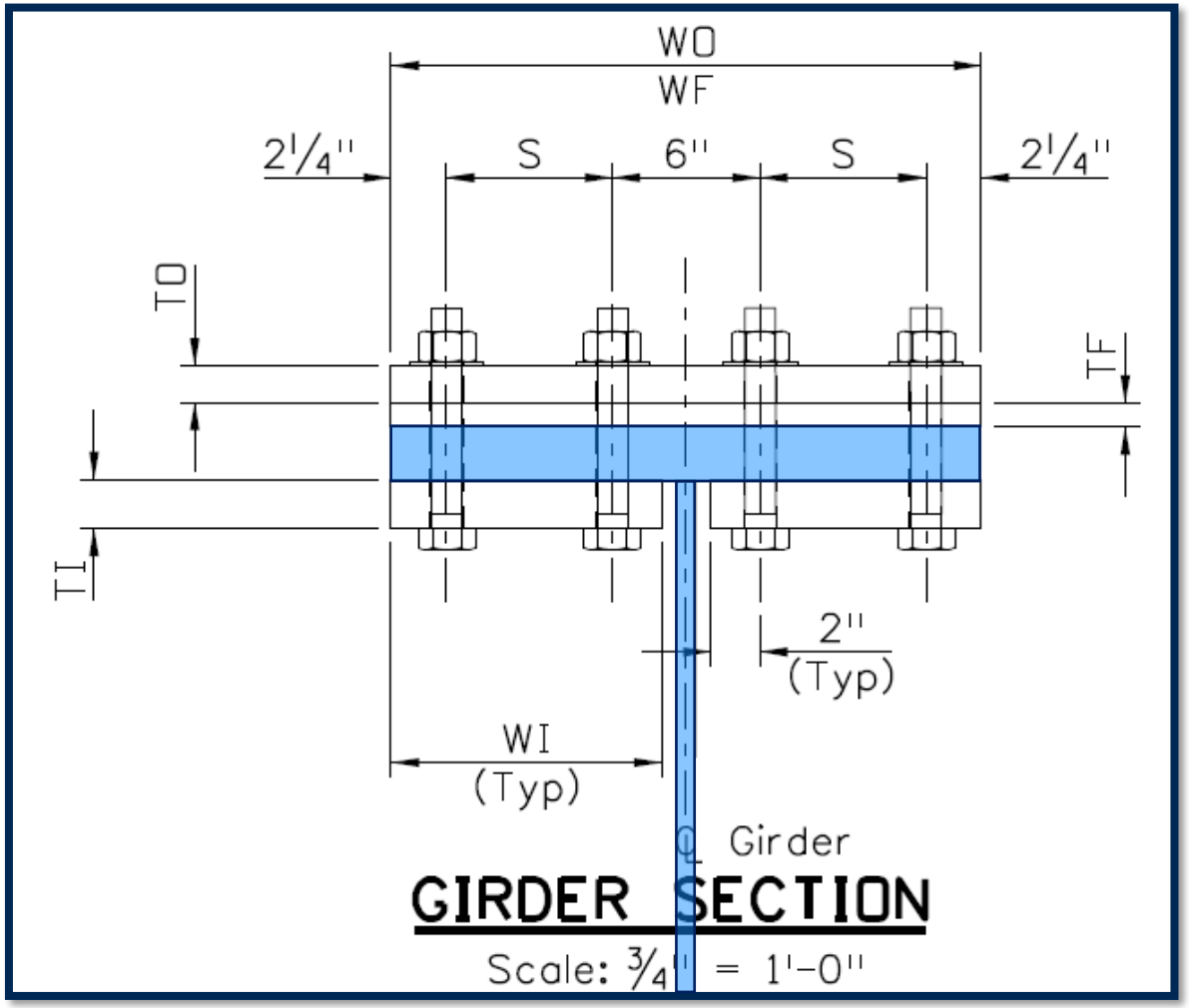


Splice Flange

Splice Repair Design – Existing Section Resistance

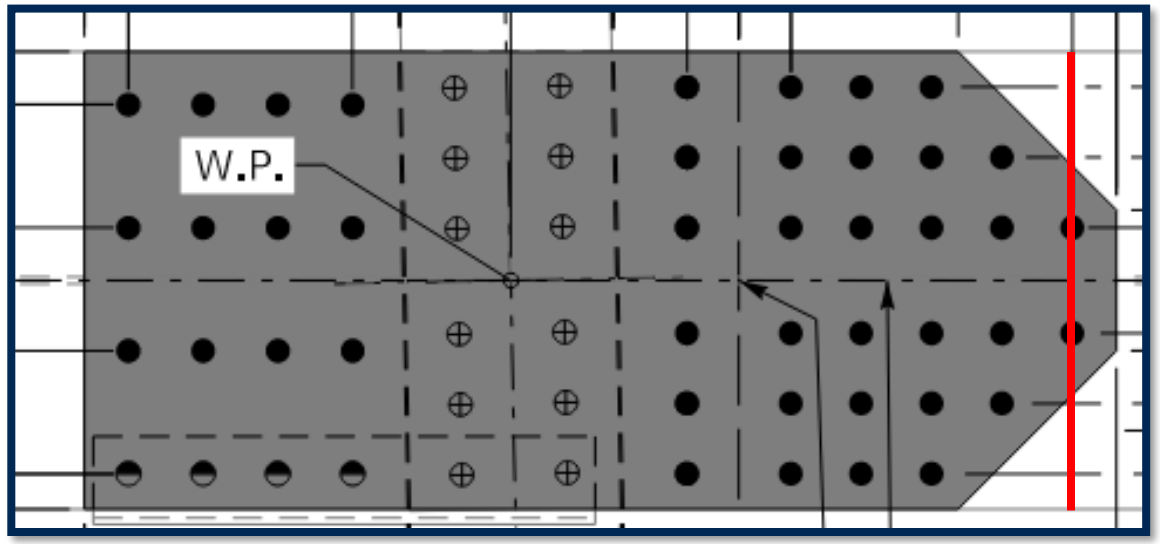
- Net Section Resistance
- ~~Block Shear Resistance~~

Options are limited.



Splice Repair Design – Existing Section Resistance

- Philosophical Considerations
  - Unavoidable loss of strength
  - Drilling holes in tension member/flange
  - *"Hippocratic Oath"*
- Practical Considerations
  - Holes are drilled before splice is fully developed
  - Construction loads may control
  - Determine minimum net section
  - Determine all potential net sections



Project Status Summary

- Over 2000 welds tested starting in Oct. 2022
- All field testing was completed. Nov. 2023
- Reports by FHWA March 2024 deadline
- 1St Repair project let in April 2024
- Last bridge repair let in Jan. 2025
- Scheduled for project completion March 2026

Michael Baker INTERNATIONAL

We Make a Difference

Thank You!

Questions?

GFT

Bridge Preservation using Non-Destructive Testing on T1 Steel

Jennifer Laning, PE

Ingenuity That Shapes Lives™

Commodore Barry Bridge

Owner:

DELAWARE RIVER PORT AUTHORITY

Reports to FHWA through NJ DOT

Cantilever truss

Delaware River

Carries five lanes

ADT:
~35,000

Total length:
13,912′

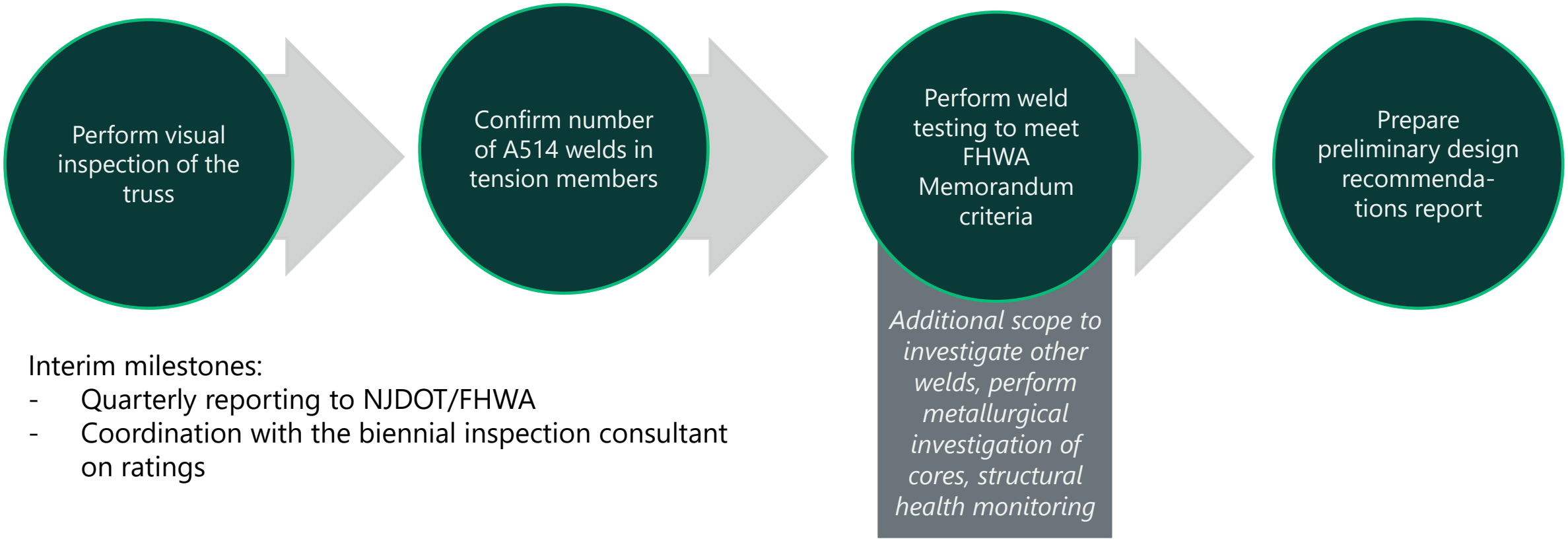
Construction started:
April 14, 1969

Opened to Traffic:
February 1, 1974

Type of connection:
Weld (shop) and bolt (field)

Commodore Barry Bridge

Through Truss A514 Weld Investigation Scope:



Interim milestones:

- Quarterly reporting to NJDOT/FHWA
- Coordination with the biennial inspection consultant on ratings

Team Experience

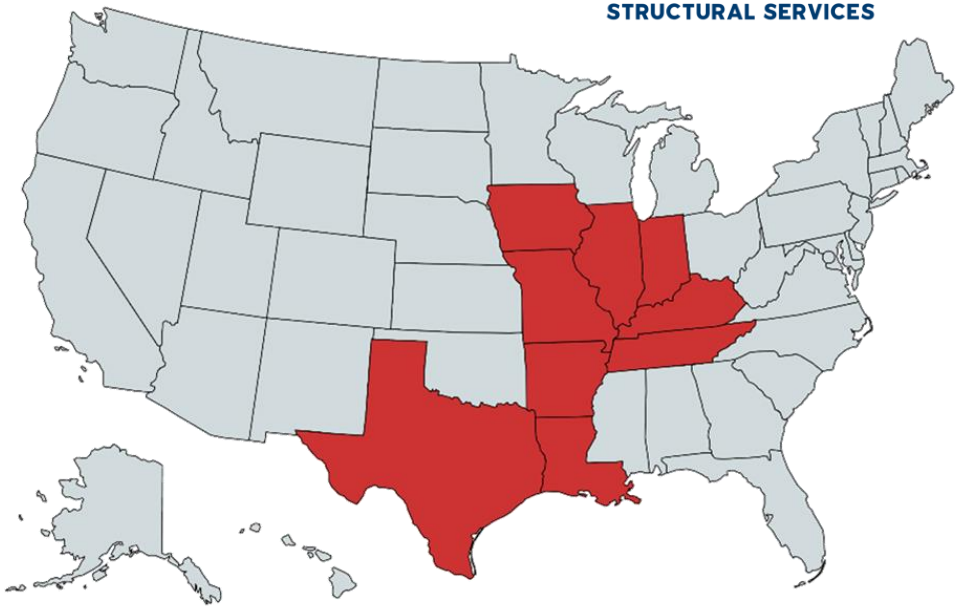
Recognized experts with experience on similar high-profile projects

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

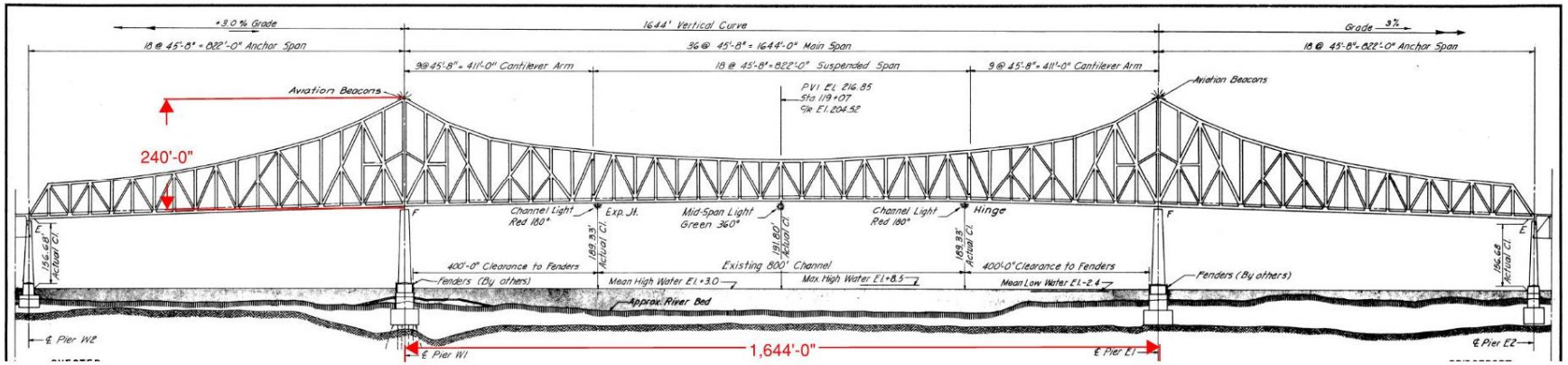
Wiss, Janney, Elstner Associates, Inc.

RUSSO STRUCTURAL SERVICES

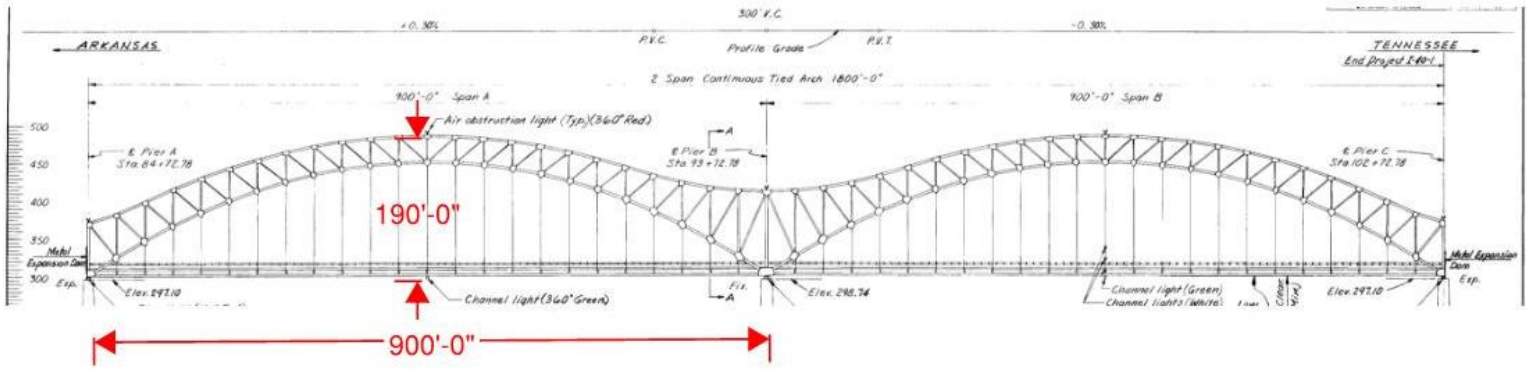
- Implemented weld testing programs on T-1 steel
- Designed retrofits to remediate welded members
- Performed forensic analyses



Project Scale



Commodore Barry Bridge Total Truss length = 3,288 lf



Hernando de Soto Bridge Total Truss length = 1,800 lf

Fact:
CBB is nearly 2x the length and 50’ higher than the Hernando de Soto Bridge

NDT Methods & Inspection Procedures

- Eddy current – weld location
- Shear wave ultrasonic testing – weld defect characterization and defect location prior to core removal
- Magnetic particle testing – confirmation of defect removal
- Metallurgical evaluation of cores

Critical Path Items

- Inspector training and qualifications
- QA/QC during testing
- Coating removal
- Tracking of testing and resolution of defects

Significant decision points in proposal:

- Coating removal - Ultrasonic testing through existing coating is achievable but highly dependent on the required amplitude correction factor to achieve the desired confidence level.
- Use of UT vs. PAUT

Weld Inspection – Challenges

- Testing work performed from August 2023 through March 2024

Lane closure schedules/ coordinating with operations maintenance needs	Weather (wind, snow, ice, cold temperatures) and events/ holidays	Steel cleaning progress	Equipment limitations and availability	Tester comfort level with some access methods

Goal: Complete testing by March 31, 2024 to meet the FHWA Deadline!

Visual Inspection of North and South Trusses

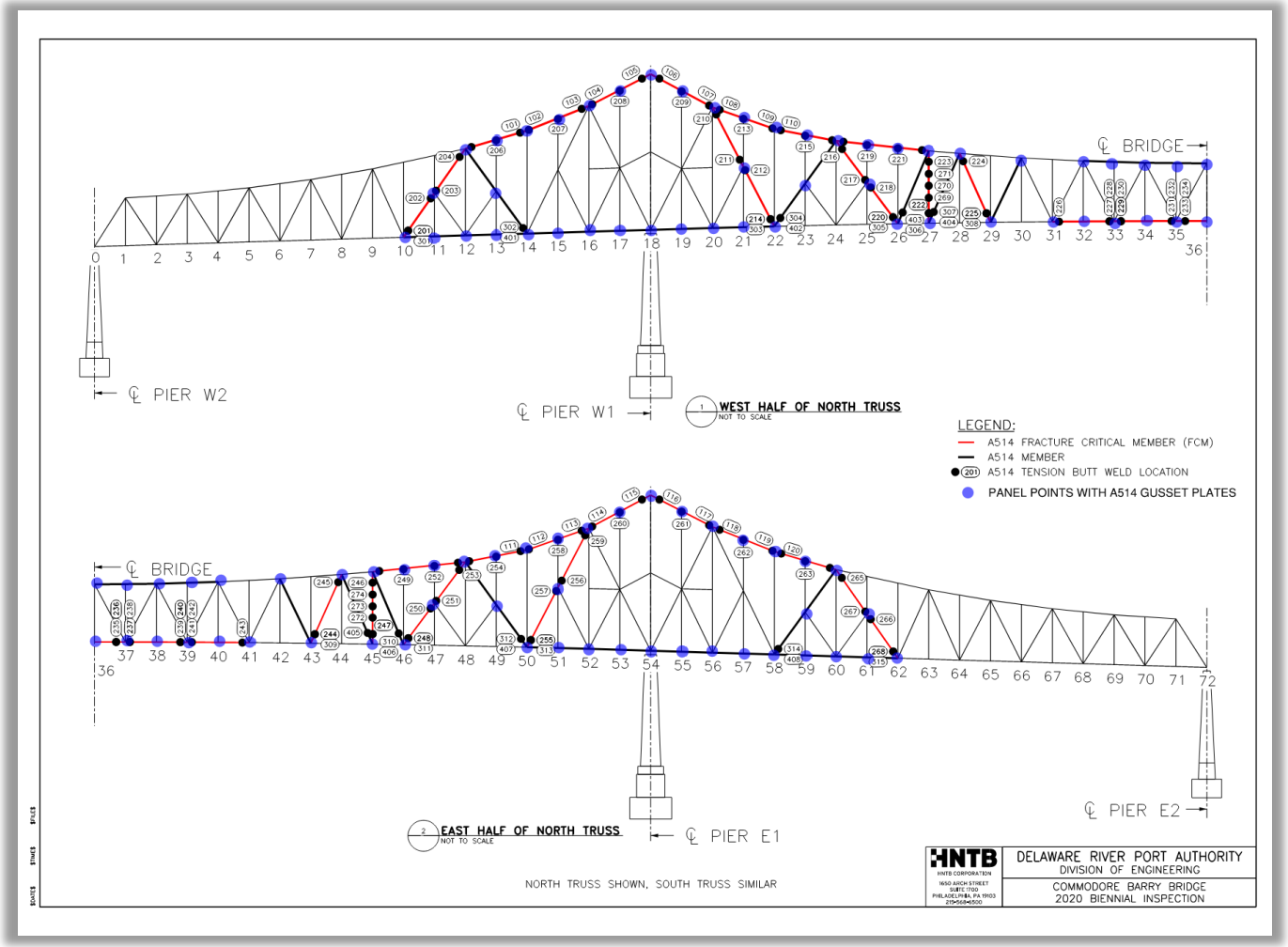
- **Started** in: June 2023
- ***Primary*** goals:
    1. Confirm and mark weld locations using eddy current
    2. Visual inspection to confirm no cracks or distress
    3. Collect inspection imagery with UAS
- ***Secondary*** goal:
    1. Set the stage for the testing and coring

Visual Inspection of North and South Trusses

Access methods:

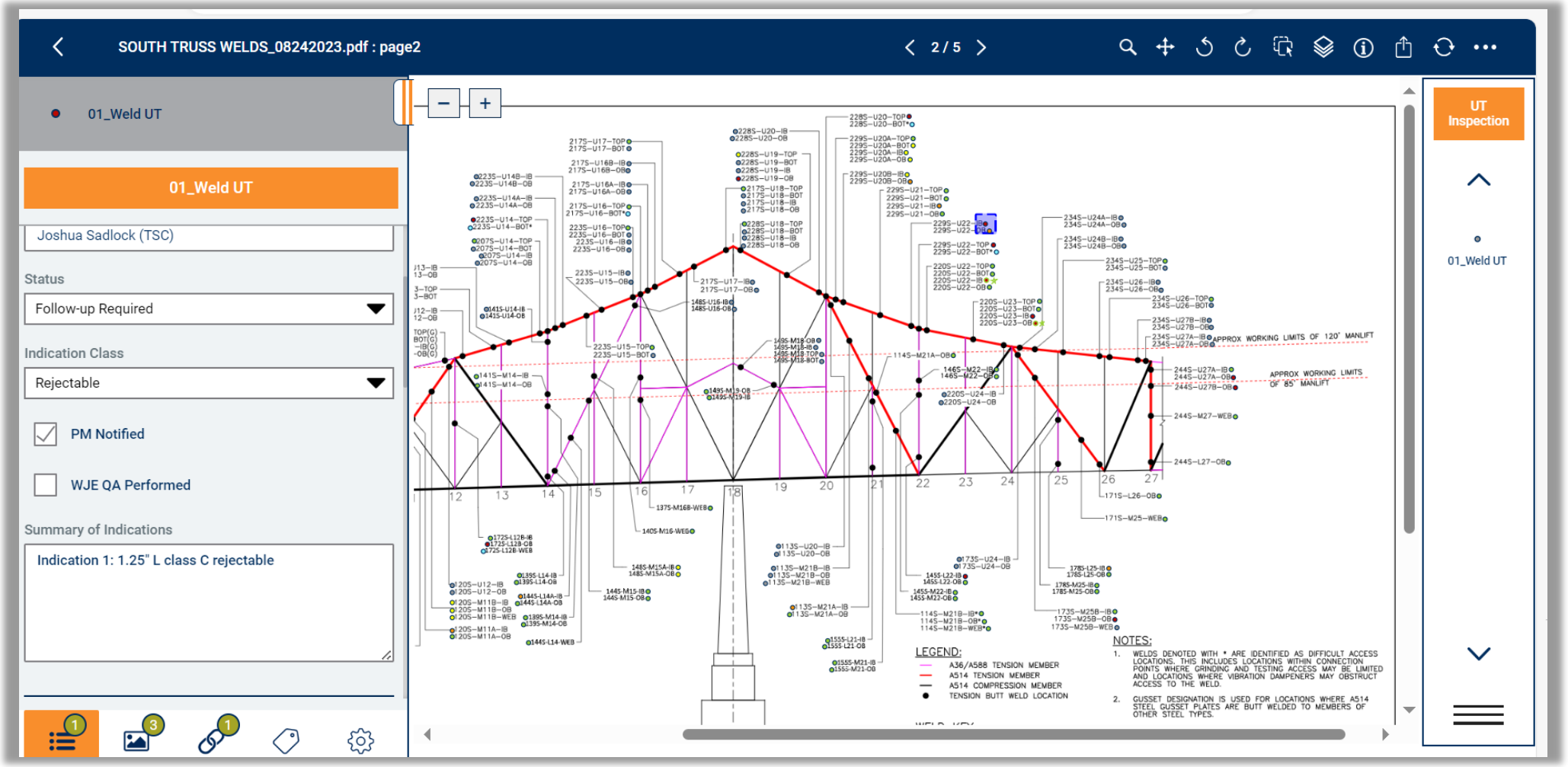
- Rope access
- Walking top chord
- Underbridge vehicle
- Manlifts/bucket truck

Bridge Elevation – Weld Tracking and Locations



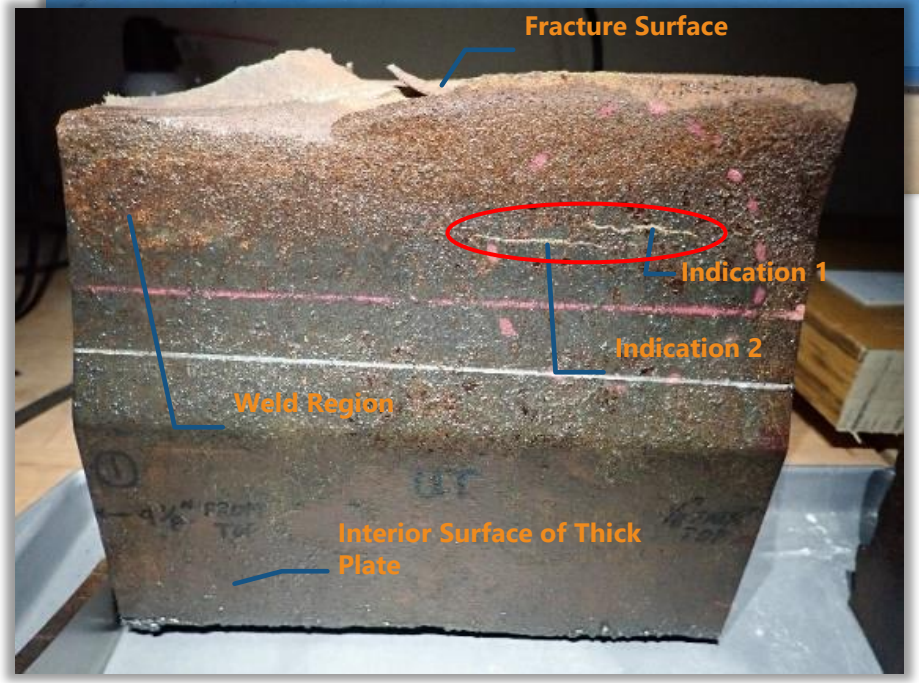
- Details of A514 weld locations in tension members in suspended span and back spans
- This information input into PlannotateTM for testing data collection
- Team leaders with the testing technicians used cell-enabled iPads to enter data on the bridge

Plannotate™ for Collecting Testing Data



Inspector Screening and Qualifications

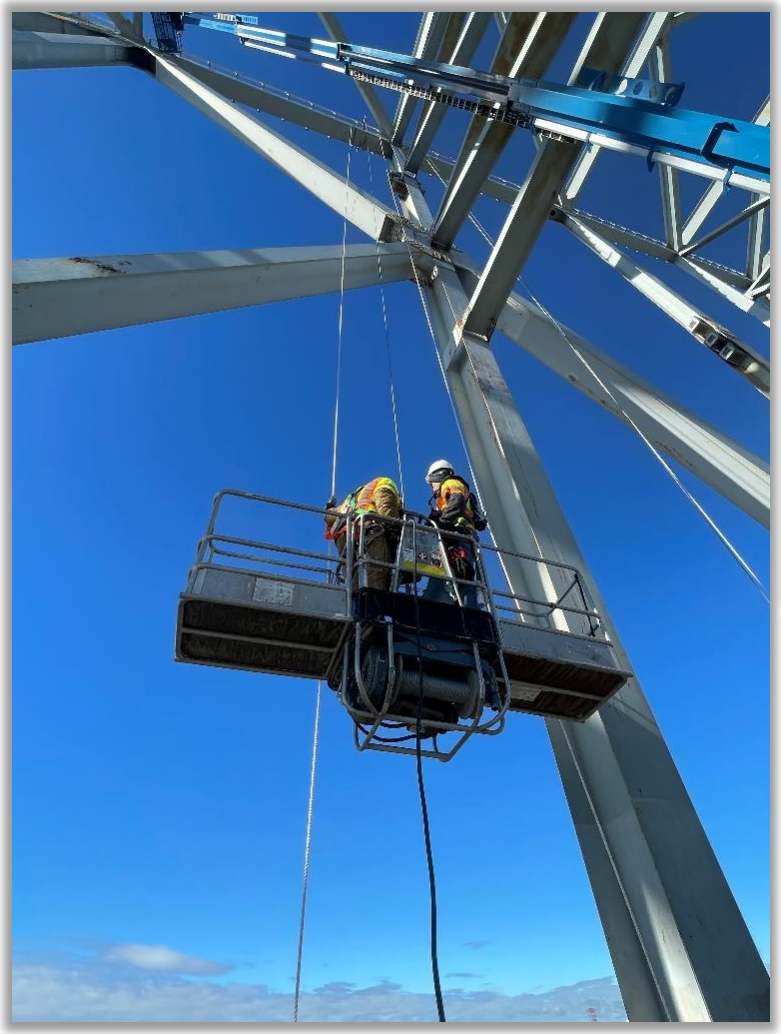
- Qualifications testing in July and August 2023
- **Inspectors:**
  - Qualified to AWS D1.5 and by performance testing prior to field testing on the in-service structure
  - Qualified on I-40 CJP butt weld test block with existing hydrogen cracks or other test blocks with similar defects
- **Quality Assurance:**
  - On-site QA one day every two weeks to independently review test procedures and re-test welds

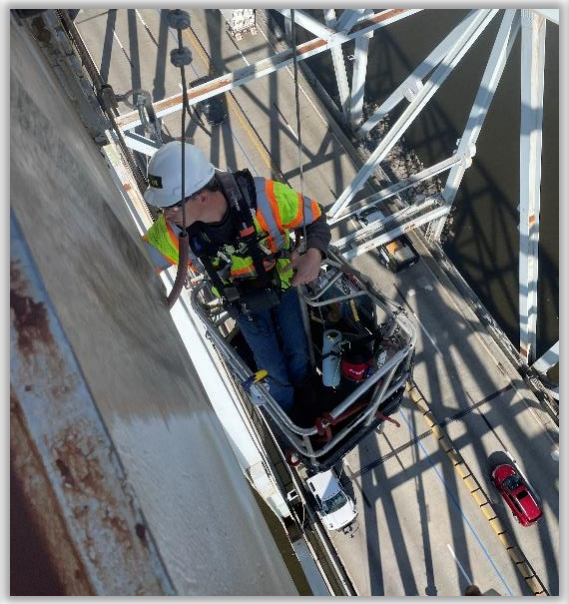


Weld Inspection – Access Methods

- Contractor started cleaning steel at weld locations in July and continued throughout testing
- Started testing in August 2023
- Access methods:
  - Maintenance walkways at deck
  - Walking top chord
  - Underbridge vehicle
  - Manlifts/bucket truck
  - Spider baskets
  - Rope access

Weld Inspection – Access Methods





Coring Work

- Scope required at least 10 core samples
  - Obtained 5 by end of 2023
  - Started coring operations in February 2024 for welds with single indications and ended in March 2024, completing 50 cores
- Core analysis by WJE

Status of A514 Weld Testing

- Previously tested **143** A514 welds under the biennial testing program
- TranSystems' testing stats for **594** welds*:

North Truss		
Status	Count	% of Total
Inspected	270	96.8%
Rejectable	46	17.0%
Inaccessible	9	
Total A514 Welds	279	

South Truss		
Status	Count	% of Total
Inspected	306	97.1
Rejectable	67	21.8%
Inaccessible	9	
Total A514 Welds	315	**As of 3/31/24*

- Total A514 welds in tension members on the bridge: **725**
- Total welds with Class A rejectable indications: **113 (15.5%)**

Note: retested 12 welds from the 143 previously tested welds
Note: inaccessible welds will be monitored in future inspections

Testing Conclusions

- Many indications were found that would not pass today's AWS inspection standards
  - Not all were crack-like indications
  - Suggests that similar rejectable indications exist in many non-T-1 welds.
- **Plan of Critical Action**
  - Remediation to be complete by September 2025
- **Emergency remediation contract underway in May 2024**
  - Coring and plating solutions
- **Preliminary Design Report:**
  - Document practices and procedures for the testing program and our recommended solutions
  - Draft report submitted in December 2024 but will be finalized when remediation contract is complete

Indication Remediation/Repairs

Emergency remediation contract:

- Coring remediation locations (1.5” and 3” cores typical, 54 locations)
- Intermediate repairs (multiple cores, cores with slots, 13 locations)
- Plating repair locations (42 total)
- Structural analysis performed to evaluate member capacity with reduced section
- All indications re-confirmed with UT prior to coring
- Note that coring locations have potential to convert to intermediate repairs or plating if post-core magnetic particle testing is not NSI.

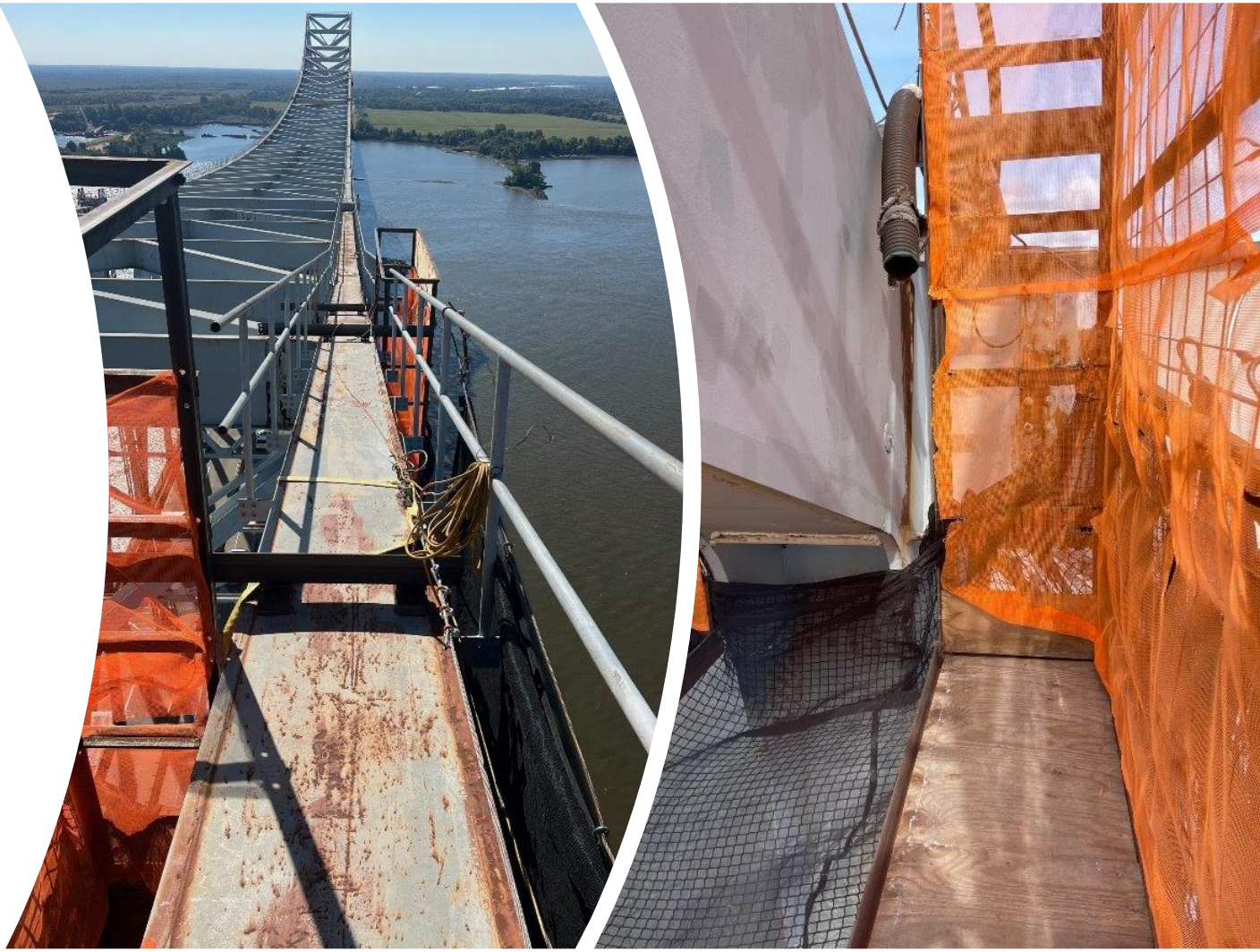
Repair Contract Key Considerations

- Access for the coring operations; technician to relocate the crack with UT, driller to work and MT the cored surface
- Long term wide load restrictions/lane closures in place for crane to install platforms and lift steel repair plates
- Challenges to get people/equipment at height for extended periods
- Access/work within box members
- Weather issues, including removal of closures
- Provide a horizontal safety line across the top chord for independent worker tie-off

Repair Contract Access Methods

Access methods:

- Underbridge vehicle, manlifts, spider baskets for:
  - Shop drawing field verification
  - Plate installation on verticals, diagonals and bottom chord
  - Coring repairs
- Suspended work platforms for plate installation on top chord

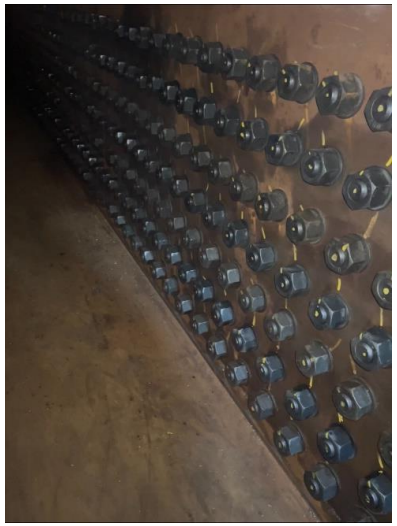


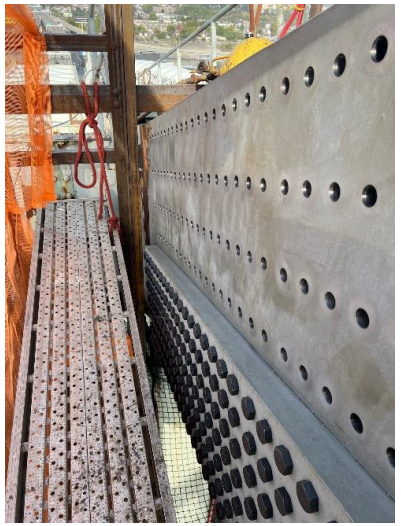
Typical Coring Remediation

- Coring remediation locations (1.5” and 3” cores typical, 54 locations)

Typical Plate Repairs

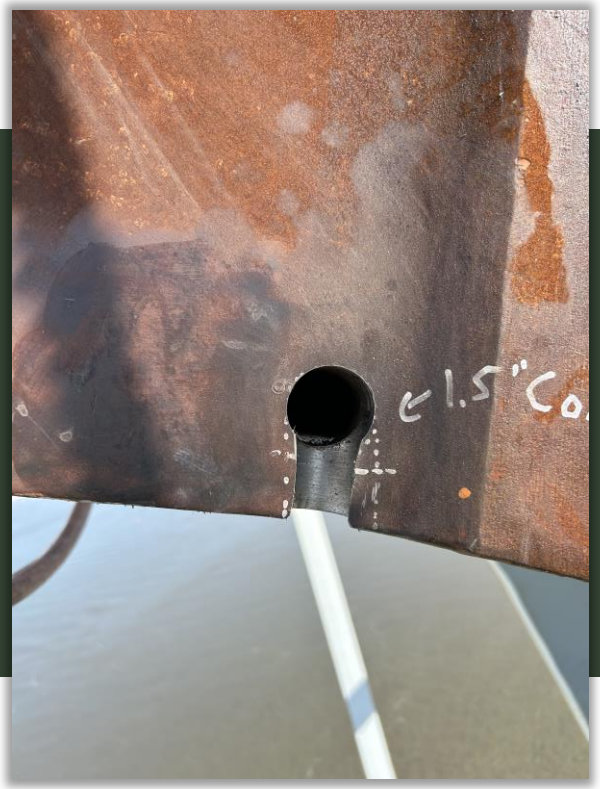
- Plating repair locations (42 total)

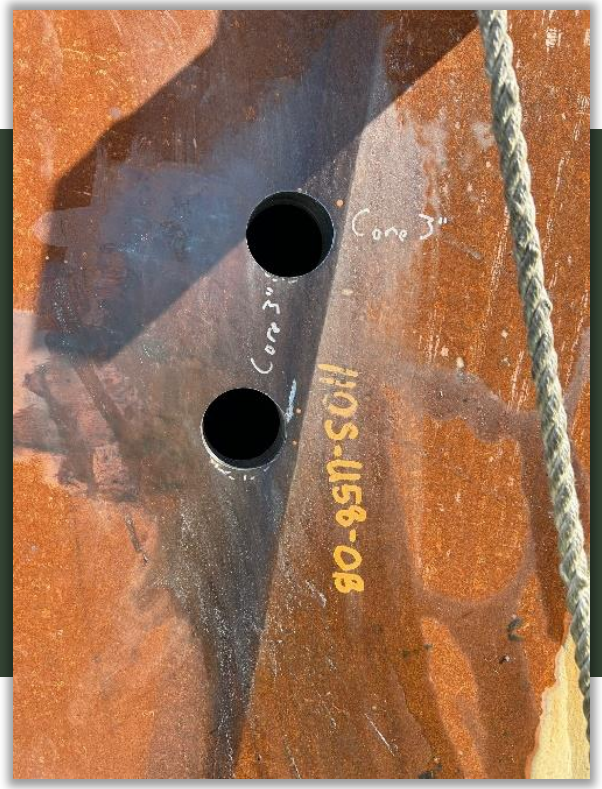


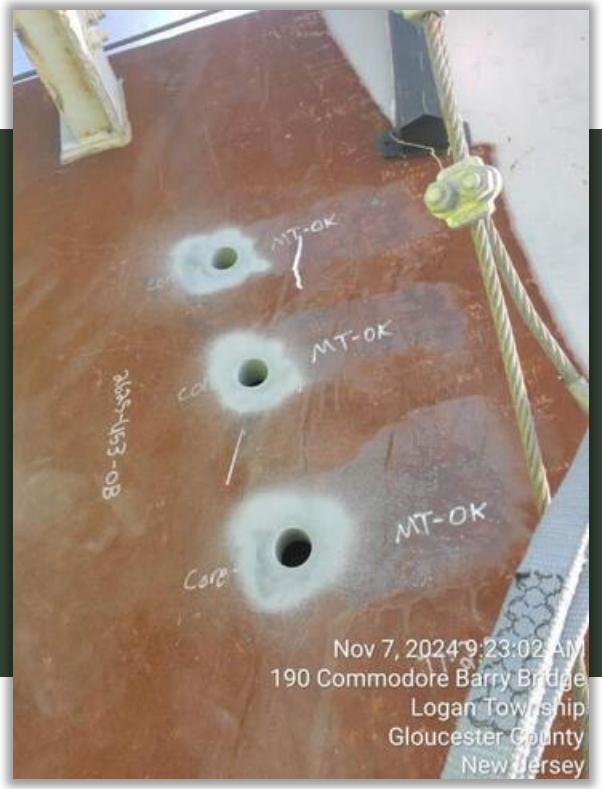


Typical Intermediate Repairs

- Intermediate repairs (multiple cores, cores with slots, 13 locations)



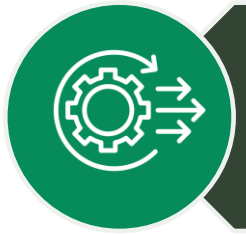




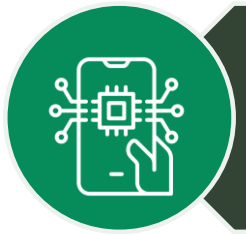
Lessons Learned

Emphasis on inspector qualifications

Ensure that you have ongoing QA for NDT



Many things can affect production rate



Invest in a testing management / tracking application

GFT

Thank You!

Ingenuity That Shapes Lives™

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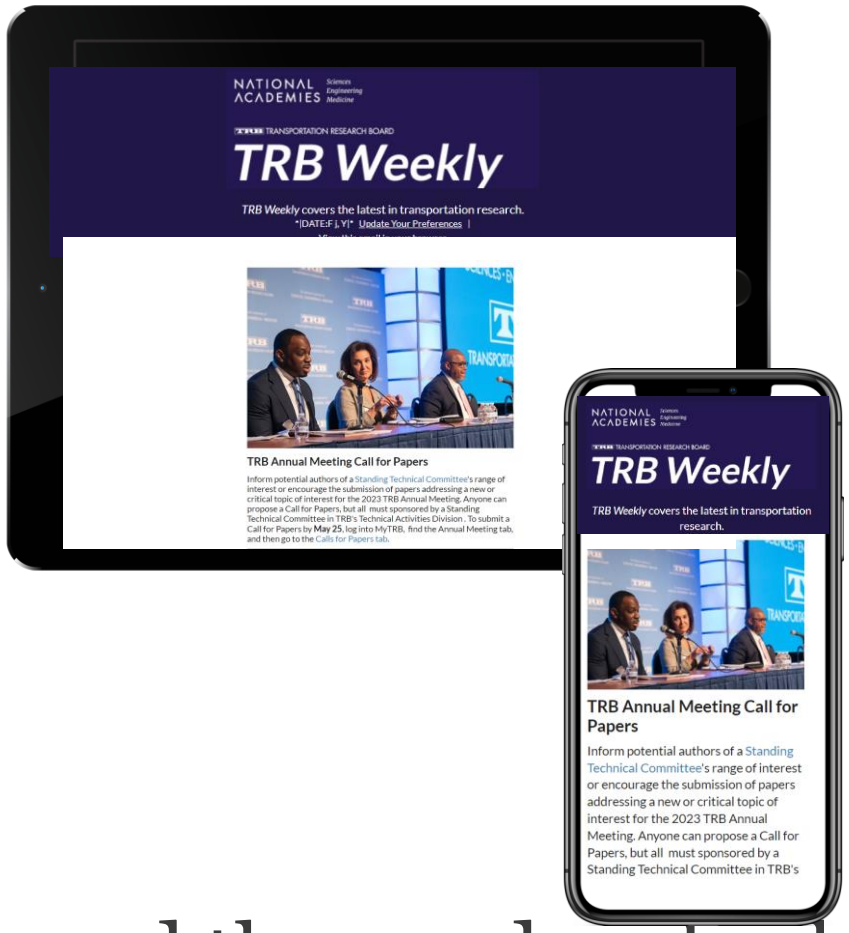

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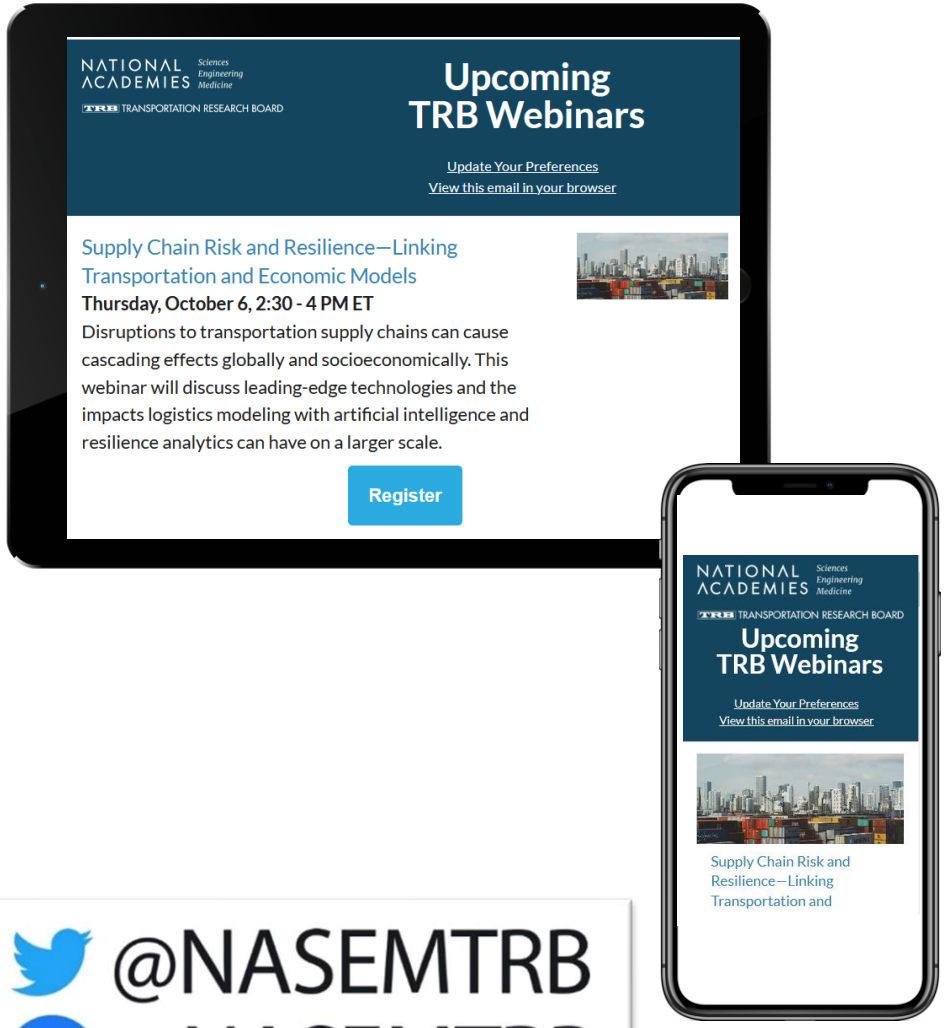

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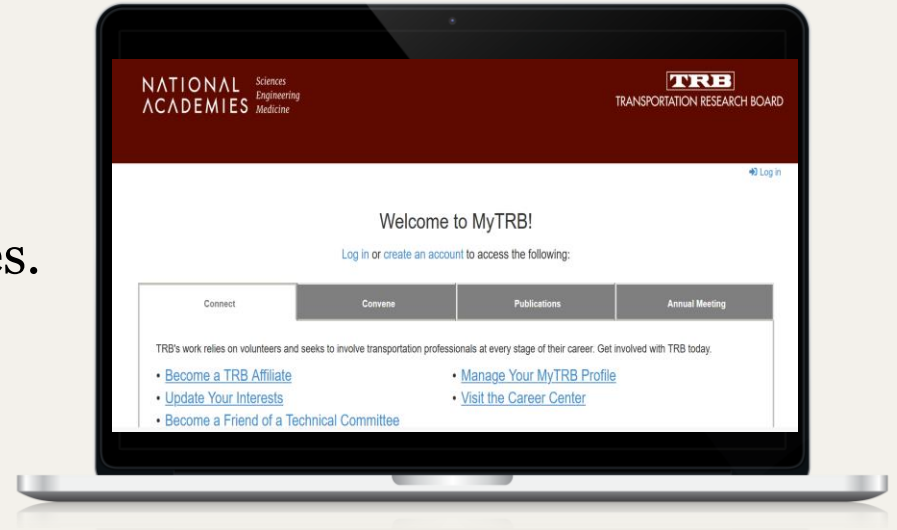

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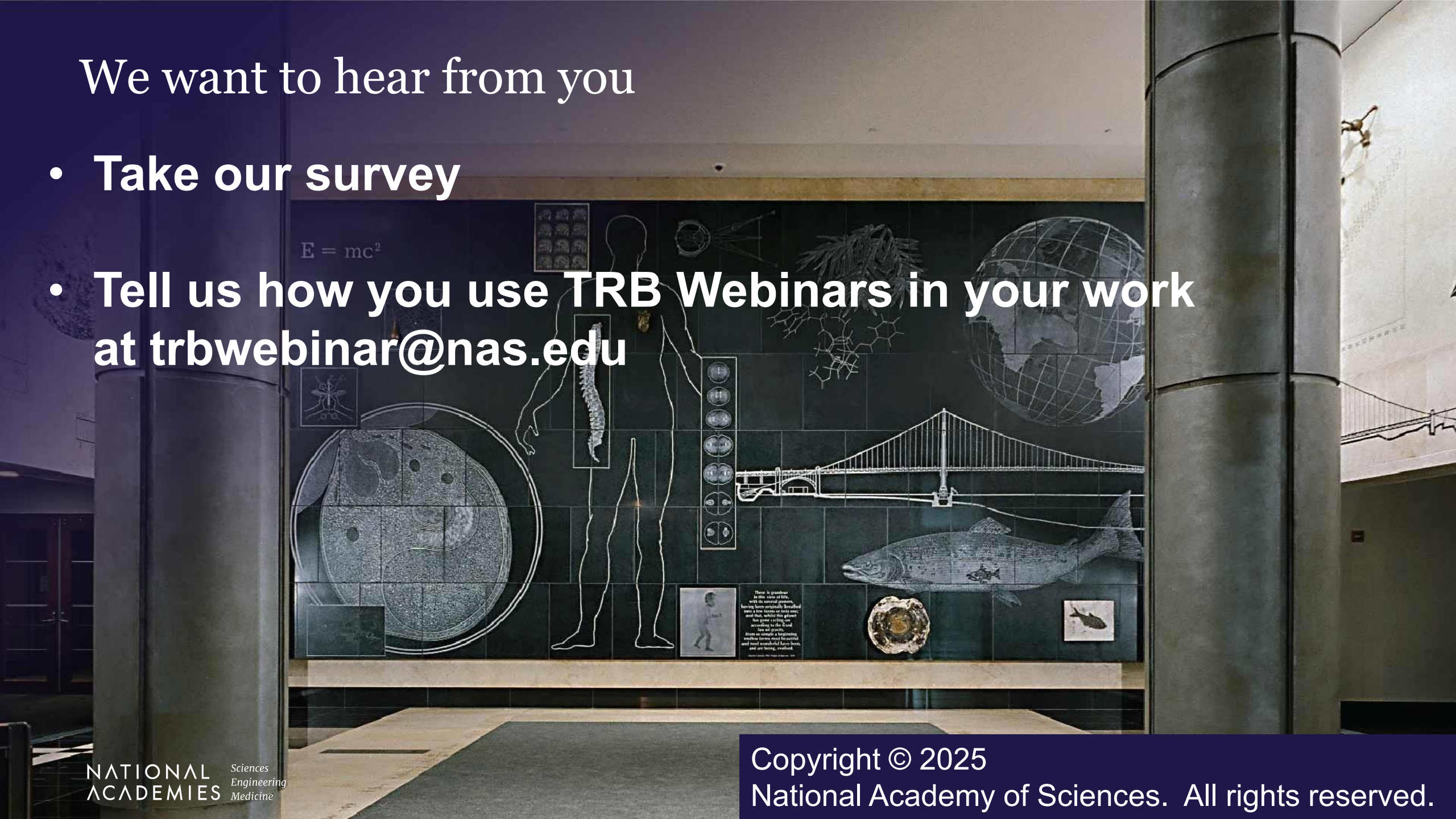

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