WJE

SOLUTIONS FOR THE BUILT WORLD

Jefferson Barracks Bridge: A Case for Rehabilitation

TEAM Transportation Engineers Association of Missouri

March 14, 2024

www.wje.com

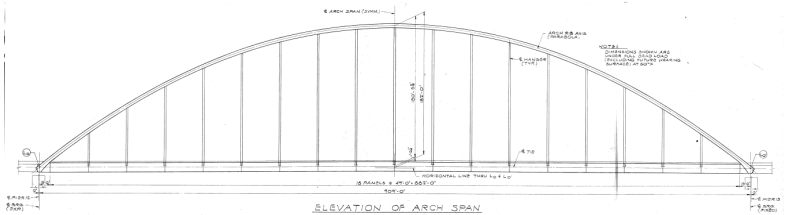
WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

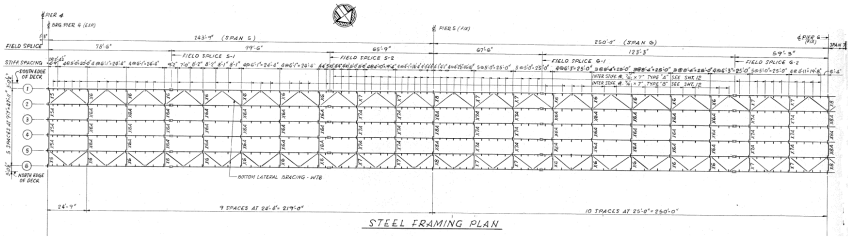
Wiss, Janney, Elstner Associates, Inc.

Jonathan C. McGormley, P.E., S.E.

NSTM Inspection

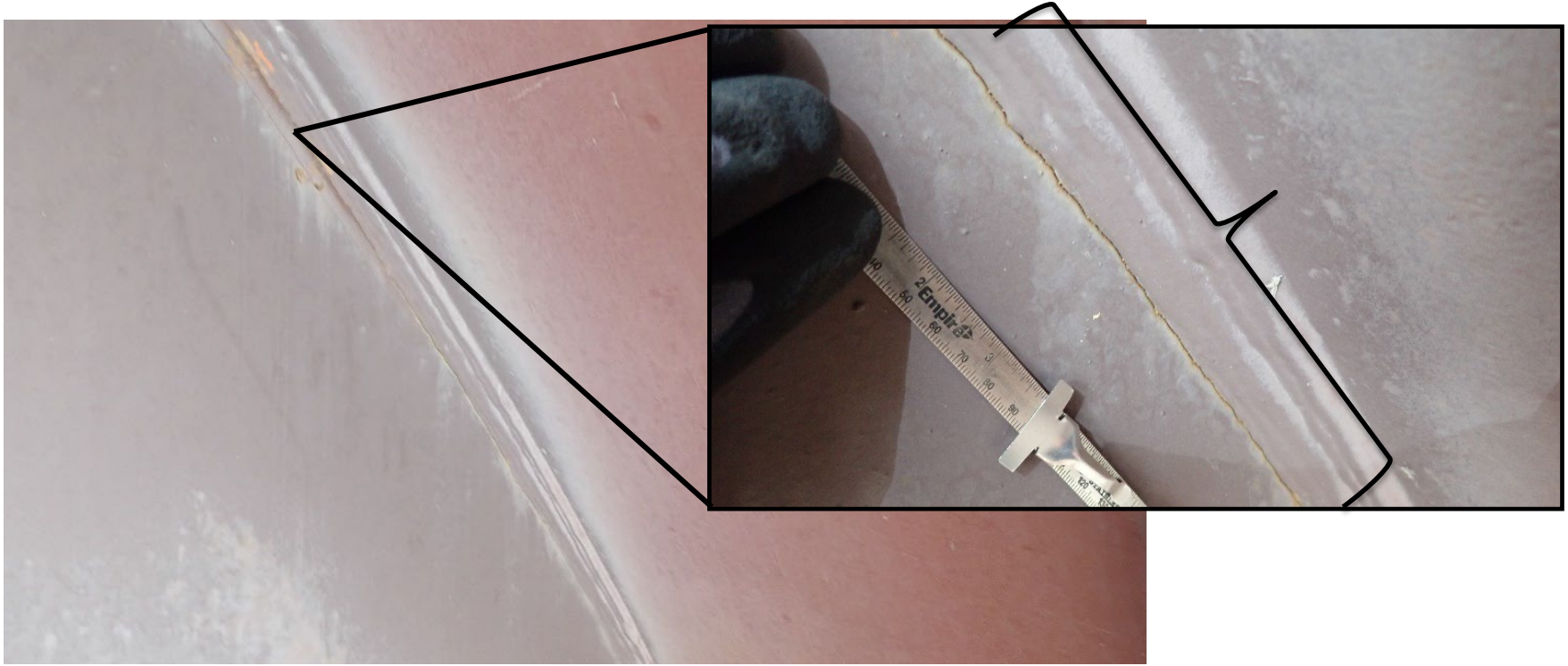
Jefferson Barracks Bridge





Arch to Tie Girder Connection

Arch to Tie Girder Connection

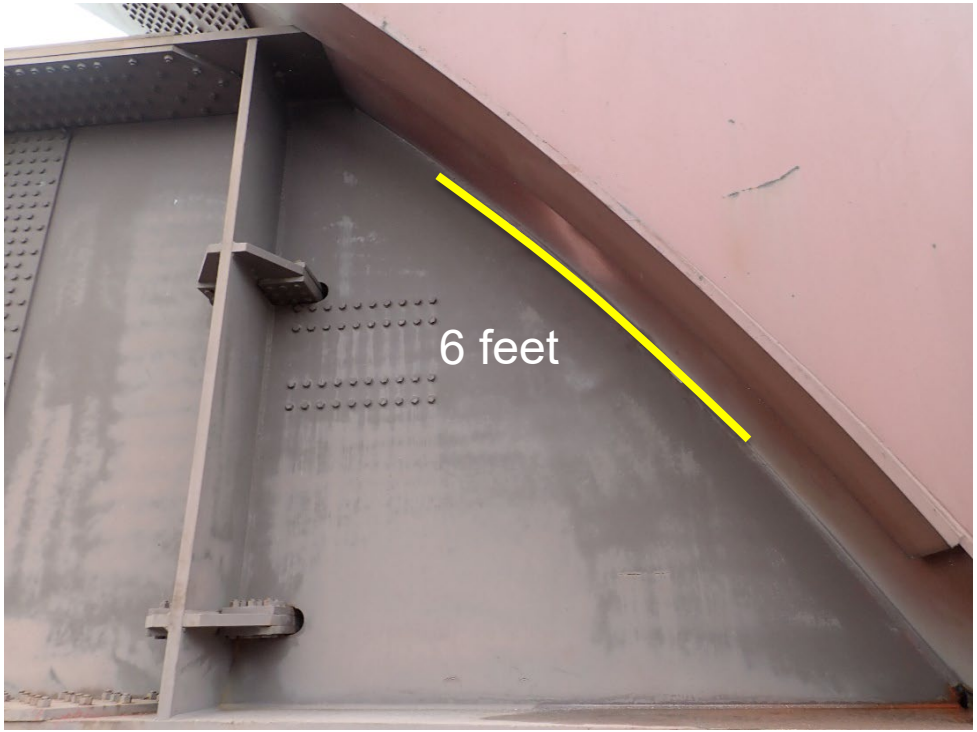


Magnet Particle Testing

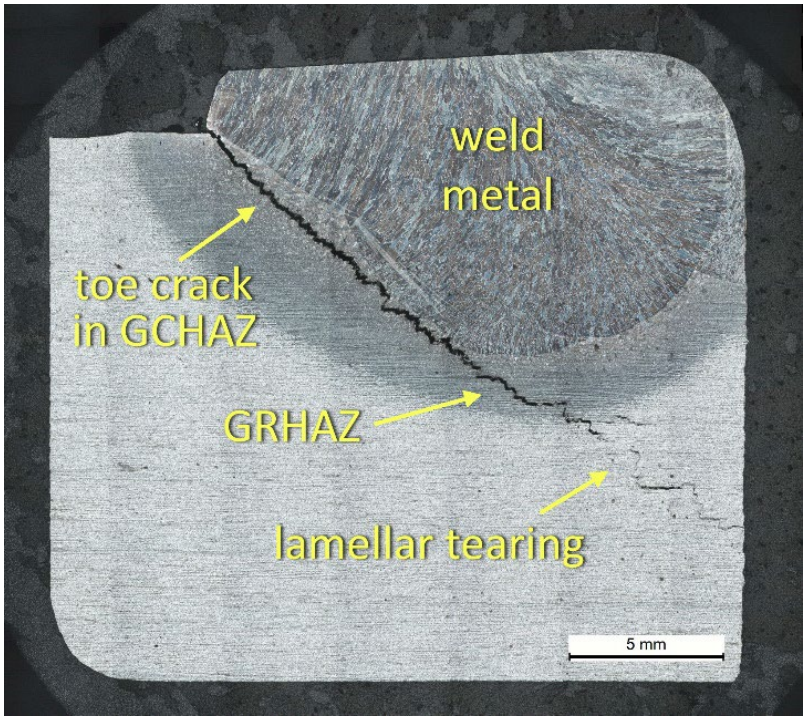
MT Inspection

MT Inspection

MT Inspection



Crack Investigation



Weld Repairs

- 300 deg F preheat for 1 hour
- Shielded metal arc welding
- Low hydrogen consumables
- 3-hour bake out
- MT root pass and after cool down

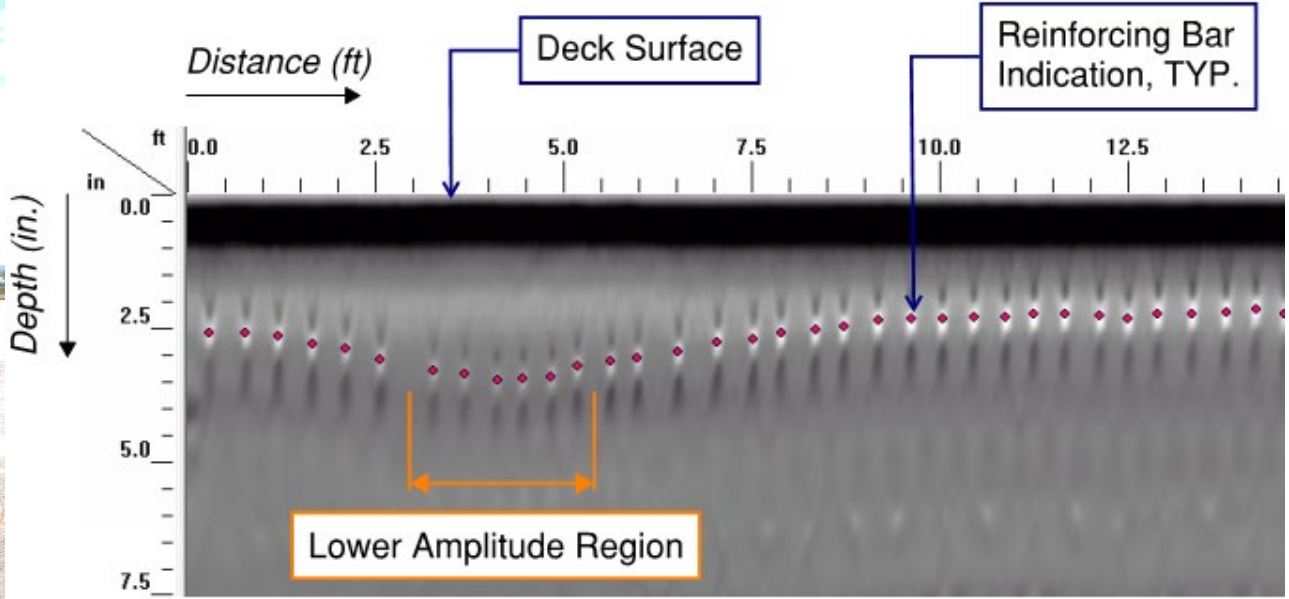
Weld Repairs

Weld Repairs

Investigation

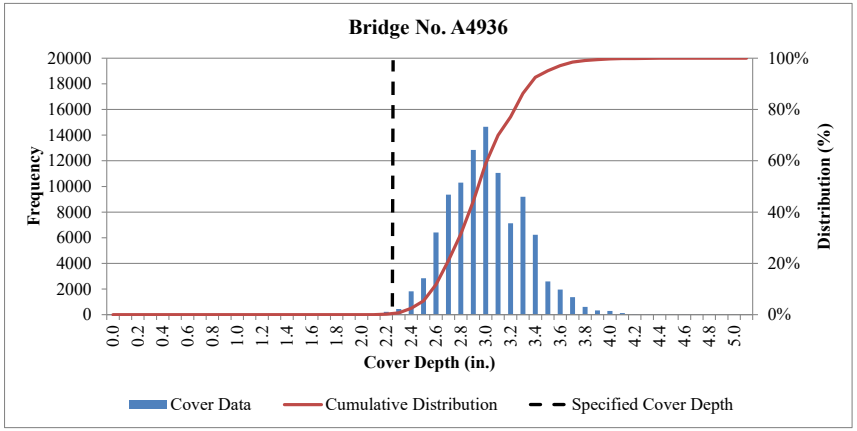
Deck Sounding and Crack Mapping

Reinforcing Steel Cover Measurements

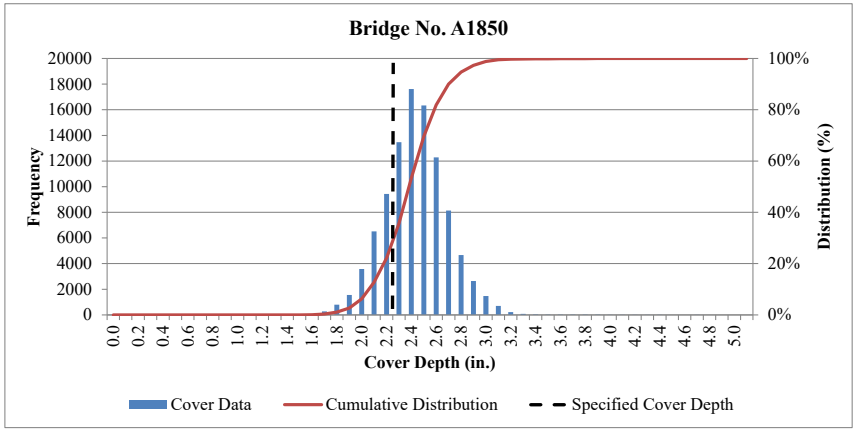


Reinforcing Bar Cover Measurements

Bridge A4936



Bridge A1850



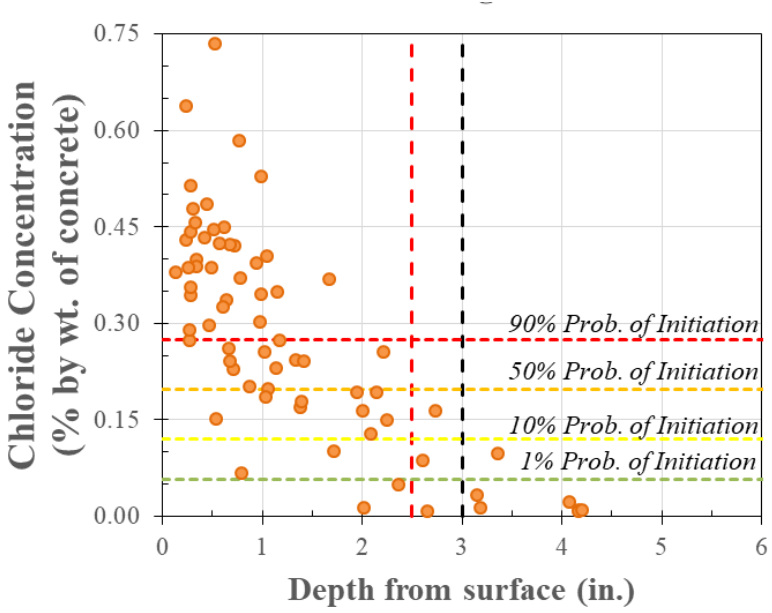
Tensile Strength Pull-Off Testing

Concrete Cores

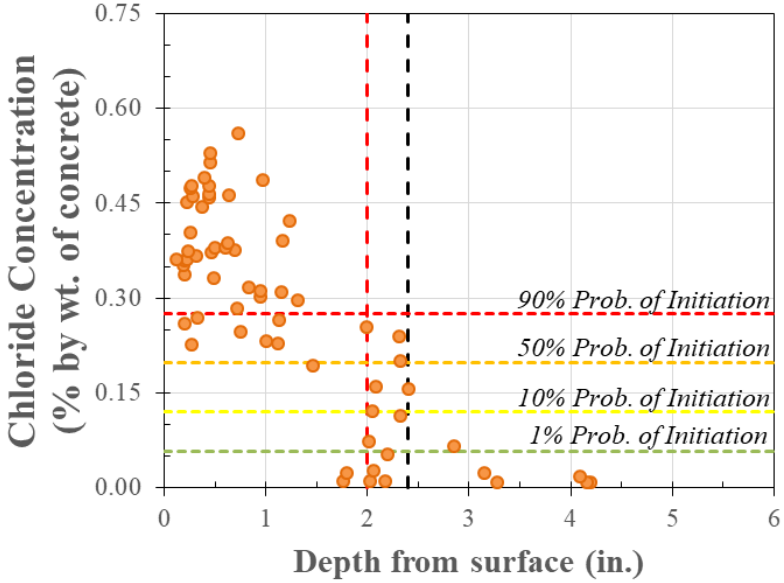
Condition of Epoxy

Chloride Concentrations

Bridge A4936



Bridge A1850



Bridge Deck Repair Options

- Deferred Rehabilitation
- Crack Repairs and Deck Surface Sealing
- Localized Concrete Patching and Sealing
- Hydro-demolition and Overlay installation
- Methyl methacrylate (MMA) or Epoxy Polymer Overlay
- PPC Overlay with Localized Concrete Patching

Deck Expansion Joints - Modular

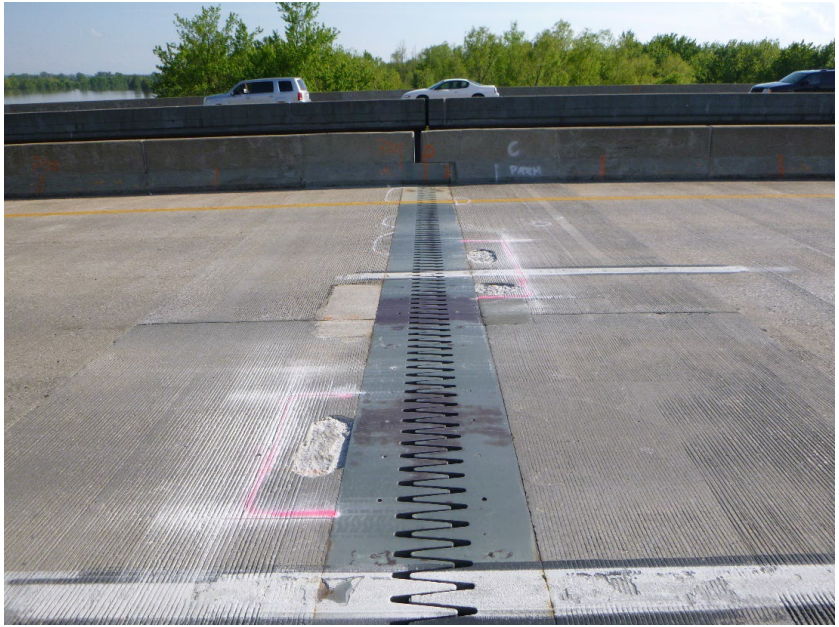
Bridge A4936

Bridge A1850

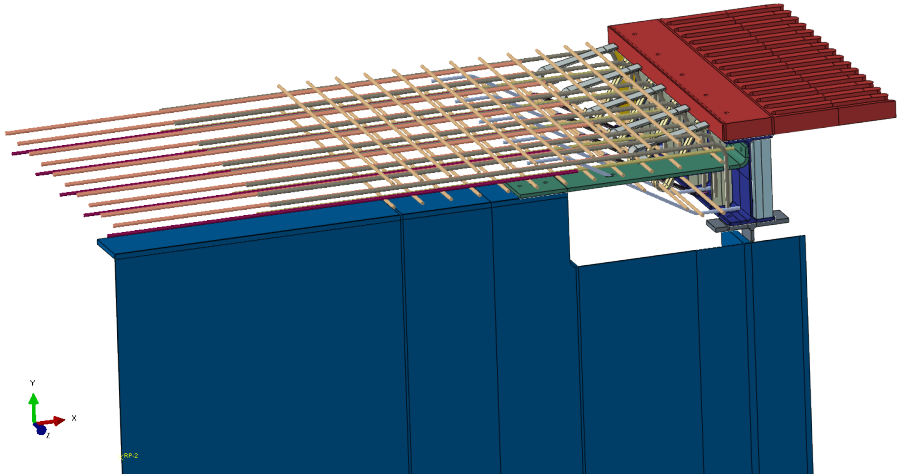
Deck Expansion Joints - Finger

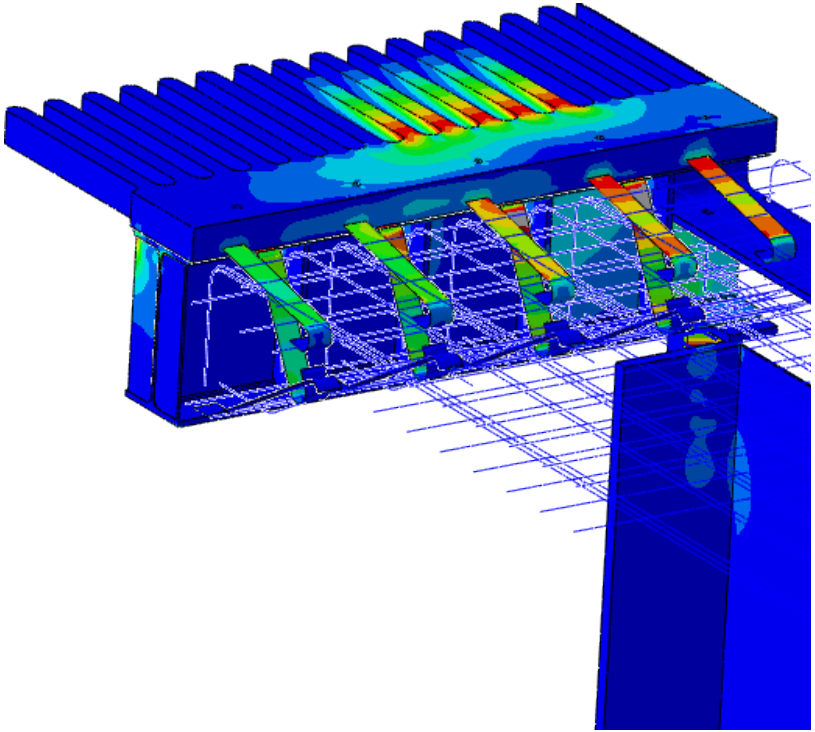
Bridge A4936

Bridge A1850



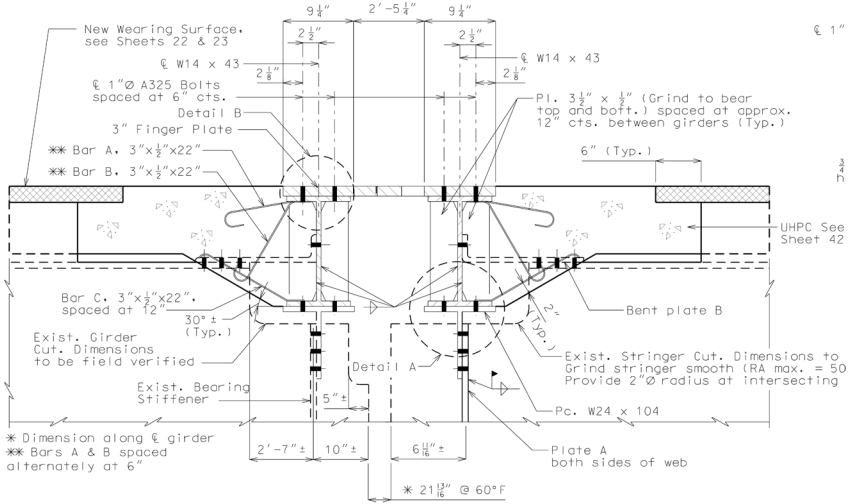
Deck Expansion Joints - Finger





Deck Expansion Joint Repairs

- Finger joints instead of modular joints
- Design heavy duty finger joint to prevent fatigue
- Use UHPC for joint headers
- Replace joint seals



Hanger Cable Corrosion

Hanger Cable Corrosion

Hanger Cable Repairs

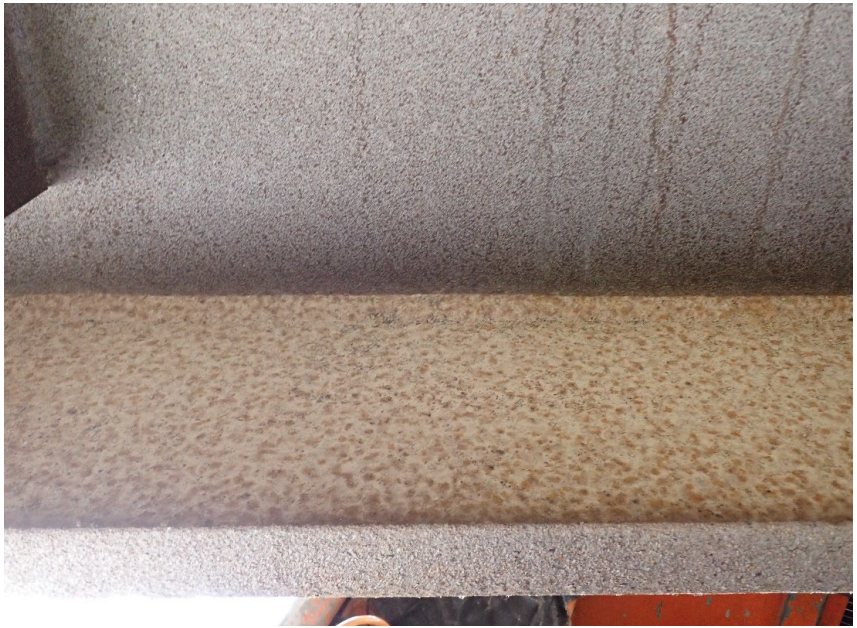
- Replace cables
- Coat cables
- Metalize cables
  - Different abrasive media to achieve required bond

Assessment of Weathering Steel

Condition of Weathering Steel

Failed Patina

Well-developed Patina

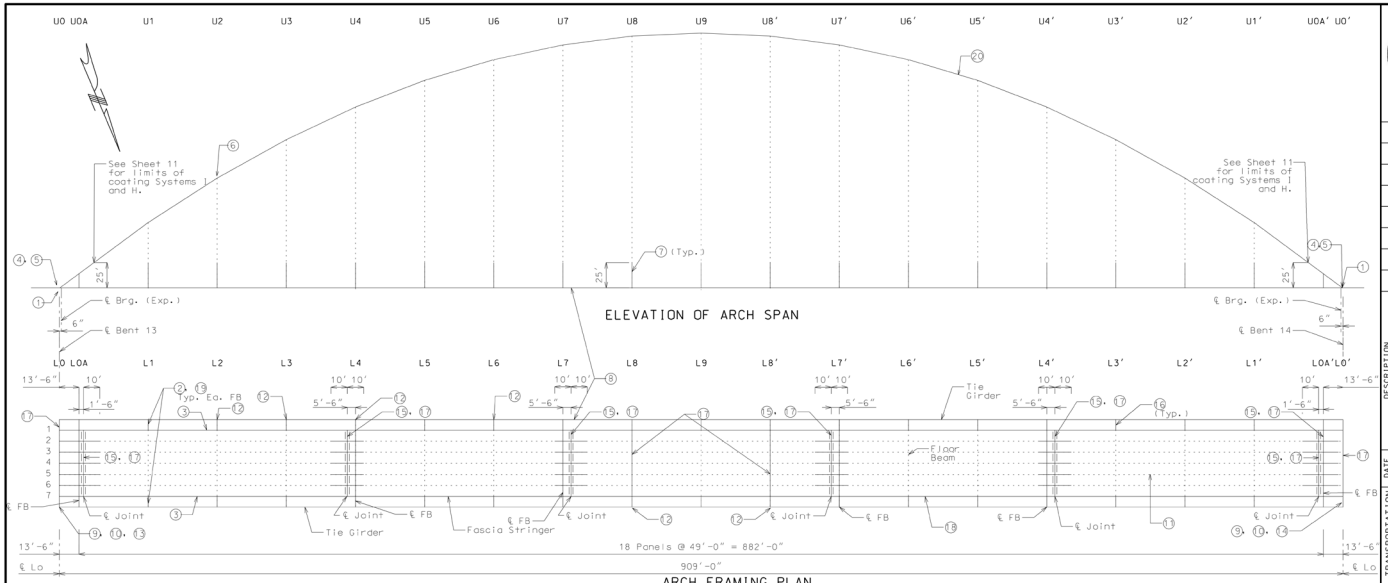


Condition of Steel Coating

Condition of Steel Coating

Steel Coating Repairs

- Confirmed superstructure elements are weathering steel
- Apply System H to fascia girders including top side of bottom flange
- Apply System H to arch elements from 25 ft above to below deck
- Apply System I to arches and bracing 25 ft and above deck
- Coat lower interior portions of arches



Retrofit/ Repair	General Location	Description
①	Arch to tie girder connection	Weld inspection and repair at arch to tie girder connections. See Sheets 13-14 and 16.
②	Floor beam to tie girder connection	Weld inspection and repair at floor beam to tie girder connections. See Sheets 15-16.
③	Drainage truss and walkway	Repairs to misc. components. See Sheets 17 and 18.
④	Arch chamber interior	Stair removal. See Sheet 17.
⑤	Arch chamber door	Gasket replacement. See Sheet 16.
⑥	Portal access door	Pin replacement. See Sheet 19.
⑦	Hanger cables	Metallizing of lower 25 ft. See Sheet 11.
⑧	Tie girder	Clean & coat. See Sheet 11.
⑨	Reinforced concrete bent	Concrete repairs. See Sheet 8.
⑩	Reinforced concrete bent	Clearance gauge installation. See Sheet 9.

Retrofit/ Repair	General Location	Description
⑪	Concrete deck and barrier curb	Concrete repairs, wearing surface and penetrating sealer installation. See Sheets 22 and 23.
⑫	Hanger cables	Replace hanger cables and remove and replace casting connections as part of weld inspection. See Sheets 15, 20-21.
⑬	Expansion joint, Bent No. 13	Replace existing modular joint with new finger joint. See Sheets 37-40,42 and 45.
⑭	Expansion joint, Bent No. 14	Replace existing finger joint with new strip seal joint. See Sheets 37,41,43 and 45.
⑮	Link joints	Replace existing joint seals with new preformed joint seals. See Sheet 46.
⑯	Floor beam ends	Clean & coat. See Sheet 11.
⑰	Floor beams and expansion devices	Clean & coat full length at joints and where indicated. See Sheet 11.
⑱	Stringer, exterior fascia	Clean & coat. See Sheet 11.
⑲	Walkway ladder repairs	Repair or replace ladder landing plates, each FB except L9. See Sheet 17.
⑳	Arch and struts	Clean & coat - System I from 25' above tie girder, System H below 25'. See Sheet 11.

Notes:

(#) Denotes location of retrofit or repair in Arch Span.

LOCATION OF RETROFITS, REPAIRS & COATING LIMITS - TIED ARCH SPAN

Designed S.G.
Detailed L.S
Checked J.C.M.

Note: This drawing is not to scale. Follow dimensions.

Sheet No. 7 of 49

LICENSE EXPIRES 12/31/2022

DATE PREPARED 10/1/2021

ROUTE 255 | STATE MO

DISTRICT BR | SHEET NO. 7

COUNTY ST. LOUIS

JOB NO. J6I3413

CONTRACT ID.

PROJECT NO.

BRIDGE NO. A18503

DATE	DESCRIPTION
9/28/21	VE STUDY

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION

105 WEST CAPITOL JEFFERSON CITY, MO 65102 1-888-ASK-MODOT (1-888-275-6636)

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

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Certificate of Authority No. 001448 Exp. 12/31/22

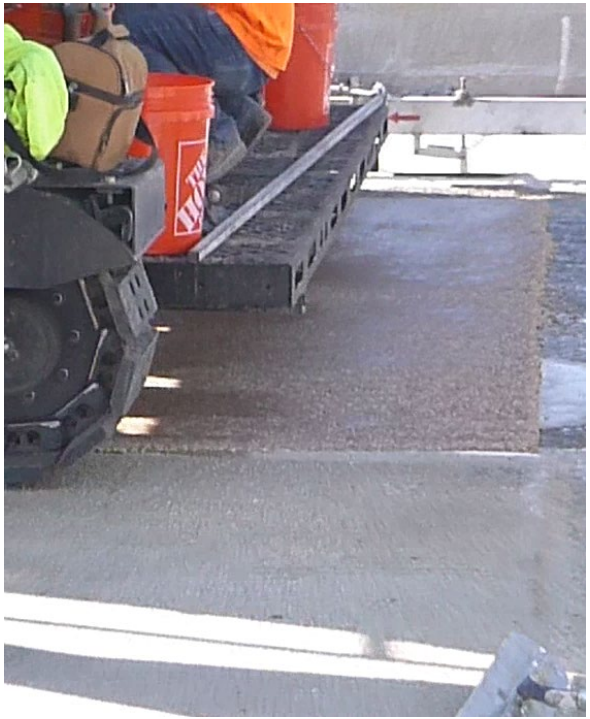
Rehabilitation Project

- 2-Year project with A4936 closed first to avoid modular joint failure during two-way traffic.
- One bridge closed during work with two-way traffic on the other
- A1850 going second provided lead time for 24 new cables at hanger brackets with crack repairs
- KCI Construction Company winning bidder at $49,997,800
- PPC for A4936 per plans and LMC for A1850 per alternate

Arch Coating – Stage 1

Arch Coating – Stage 2

PPC



PPC

PPC

PPC

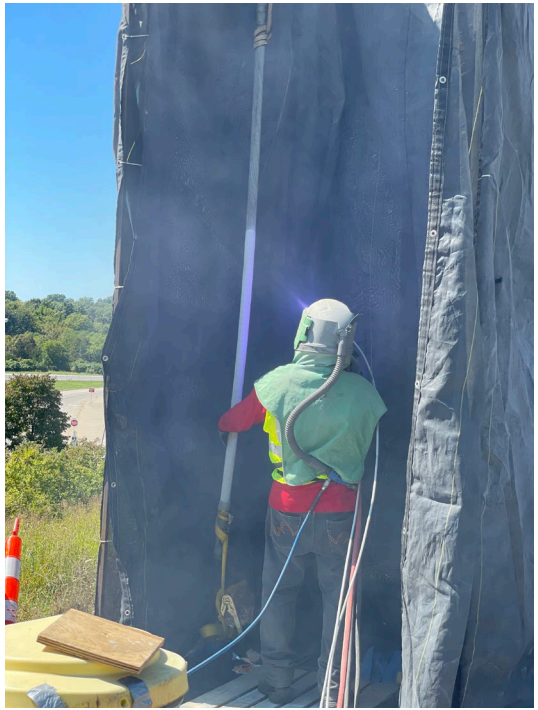
- Partial deck patches used PPC and placed before overlay
- Hand placed on shoulders
- Drivable within 6 hrs.
- Speed of placement led contractor to switch to PPC for A1850 structure despite additional cost

Joint Demolition

Heavy Duty Finger Joint

Bridge Deck Expansion Joints

Hanger Cable Metalizing



Hanger Cable Metalizing

A Case for Rehabilitation

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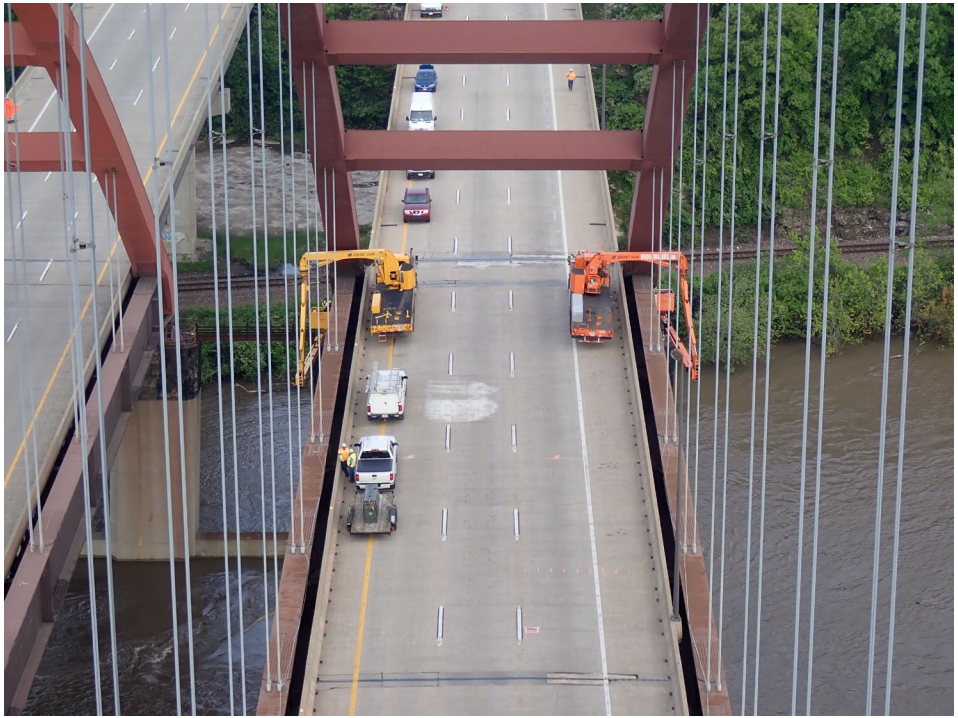
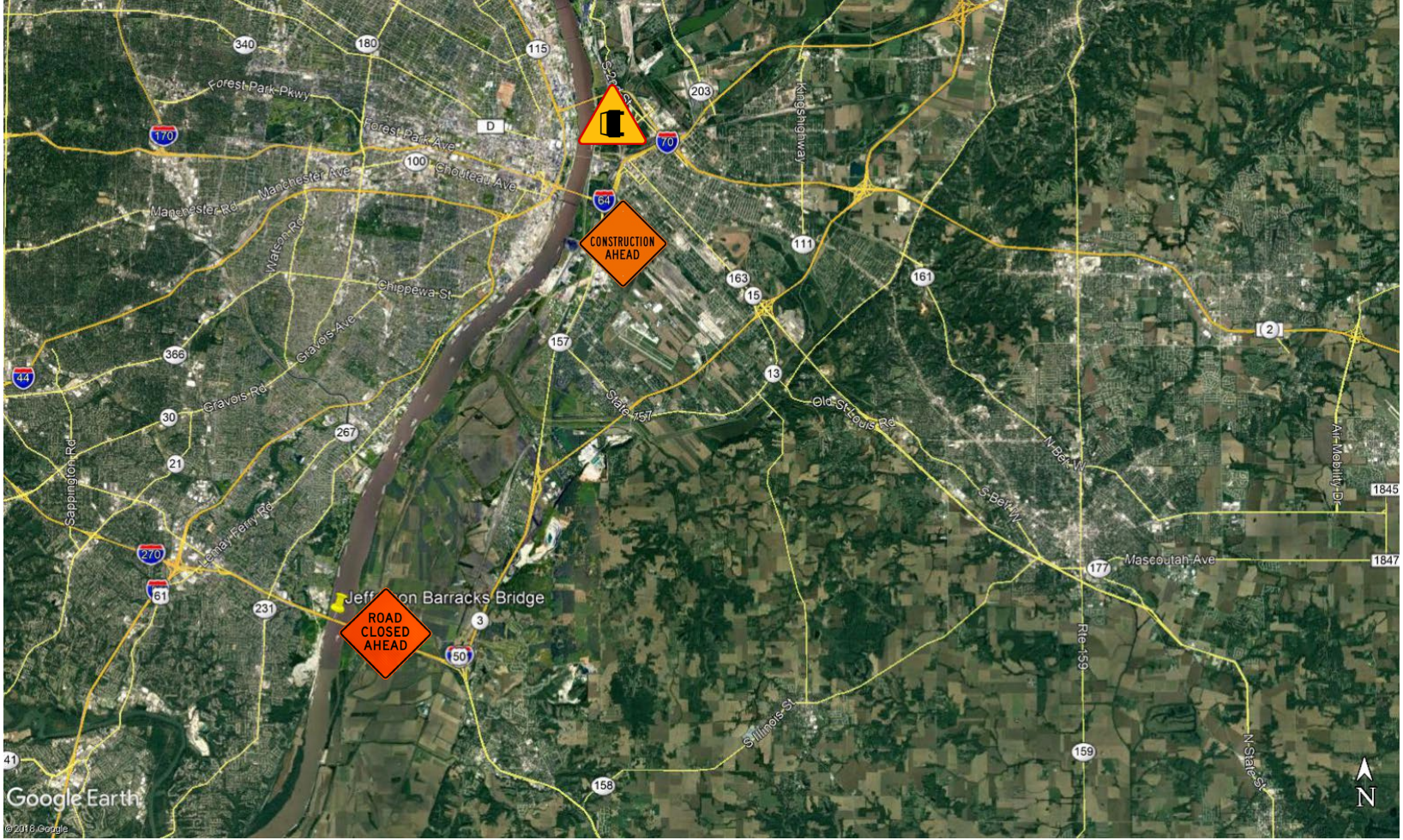
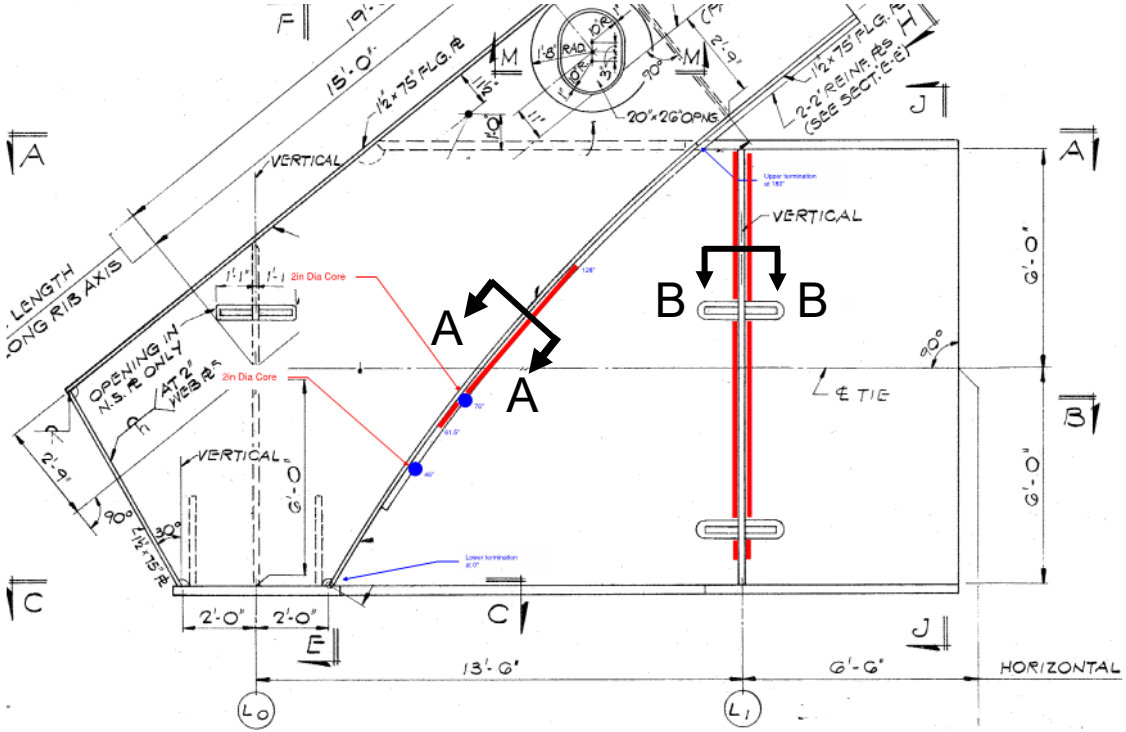
Questions?

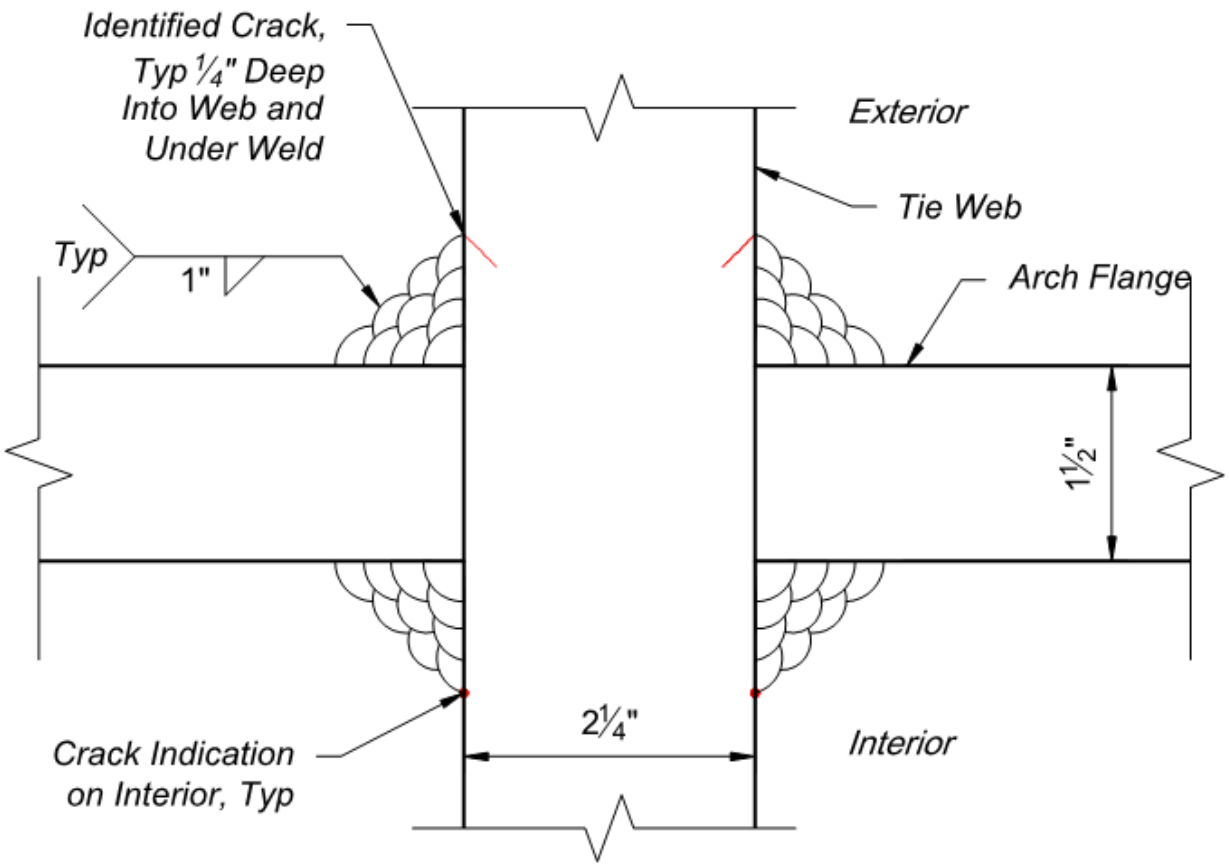
Bridge Closure



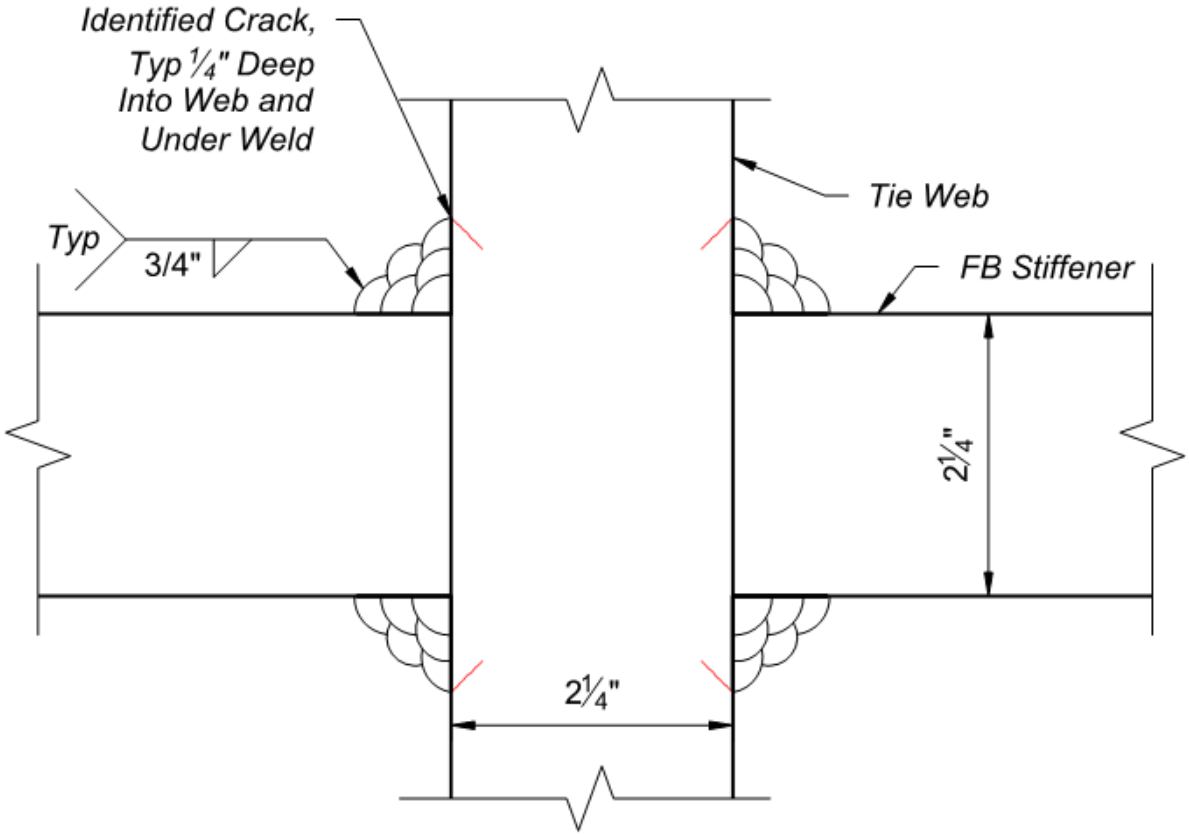

CONSTRUCTION AHEAD
ROAD CLOSED AHEAD
Jeff on Barracks Bridge
Forest Park Pkwy
Forest Park Ave
Manchester Rd
Manchester Ave
Chouteau Ave
Watson Rd
Chippewa St
Gravois Ave
Gravois Rd
Sappington Rd
Lindy Ferry Rd
State 157
Old St Louis Rd
N Broadway
S Broadway
Air Mobility Dr
Mascoutah Ave
Rte 159
Illinois St
N State St
Kingshighway
Google Earth
© 2018 Google
N

Tie Girder Connection Details



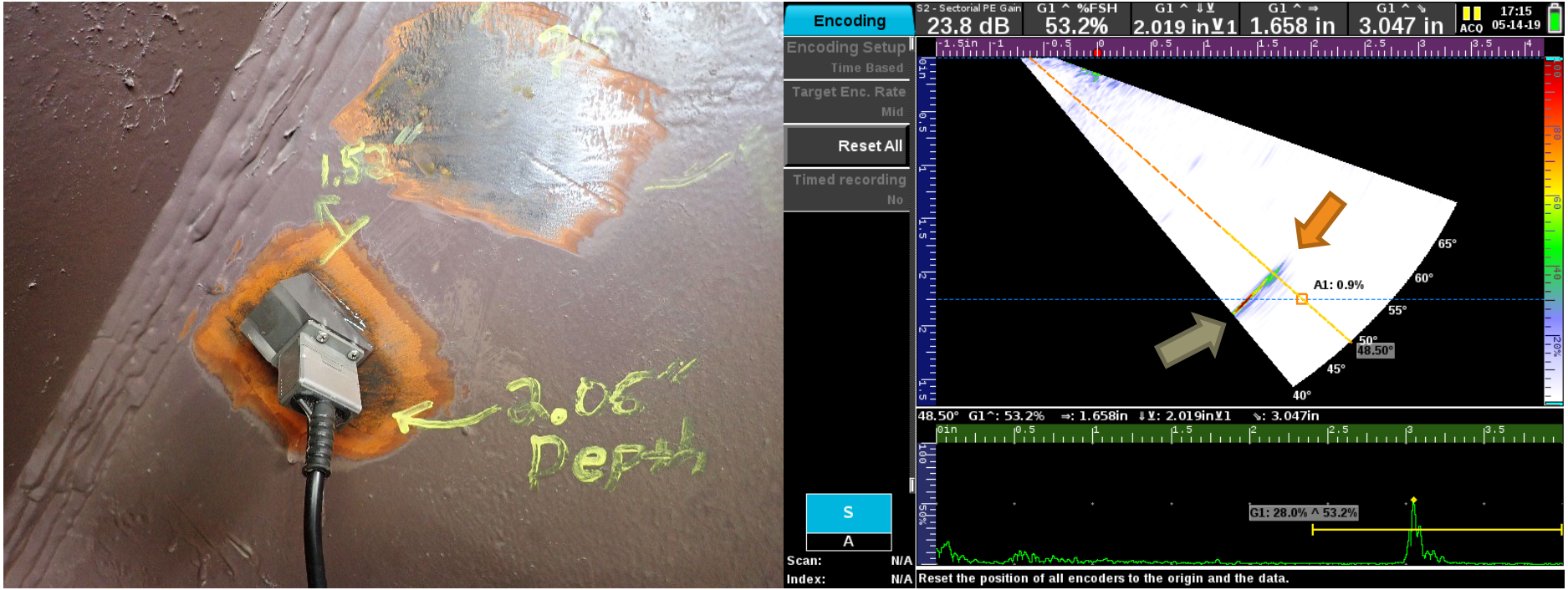

Identified Crack,
Typ ¼" Deep
Into Web and
Under Weld
Exterior
Tie Web
Typ
1"
Arch Flange
1½"
2¼"
Crack Indication
on Interior, Typ
Interior

Section A-A


Identified Crack,
Typ ¼" Deep
Into Web and
Under Weld
Typ
3/4"
Tie Web
FB Stiffener
2¼"
2¼"

Section B-B

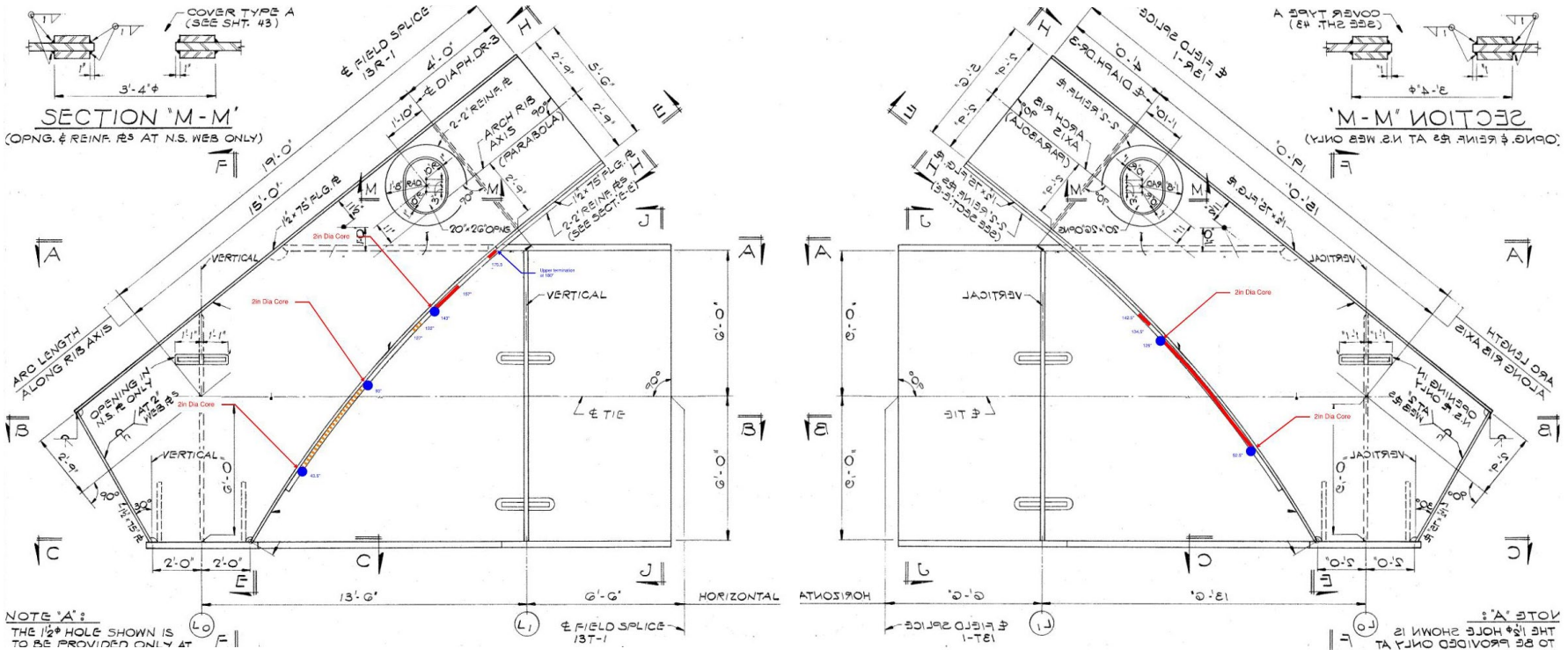
Nondestructive Evaluation of Cracks


1.53"
2.06"
Depth
Encoding
S2 - Sectorial PE Gain
23.8 dB
G1 ^ %FSH
53.2%
G1 ^ ⇓⊻
2.019 in⊻1
G1 ^ ⇒
1.658 in
G1 ^ ⇘
3.047 in
ACQ
17:15
05-14-19
Encoding Setup
Time Based
Target Enc. Rate
Mid
Reset All
Timed recording
No
S
A
Scan: N/A
Index: N/A
A1: 0.9%
65°
60°
55°
50°
48.50°
45°
40°
48.50° G1^: 53.2% ⇒: 1.658in ⇓⊻: 2.019in⊻1 ⇘: 3.047in
G1: 28.0% ^ 53.2%
Reset the position of all encoders to the origin and the data.

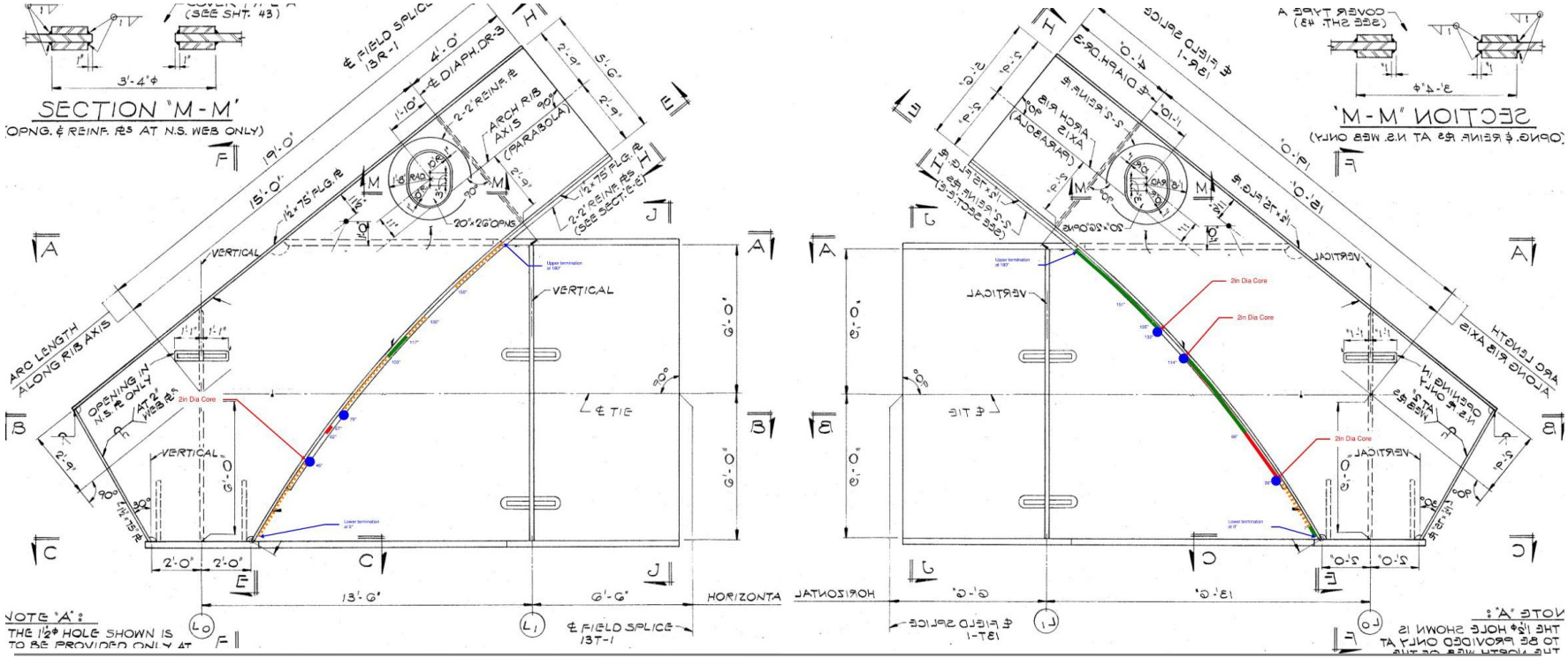

WJE
FALL SAFETY TRAINED CONTRACTOR
EXPIRES 12
1 2 3 4 5 6 7 8 9 10 11 12
WJE
4 Years
WJE
5 Years


WJE

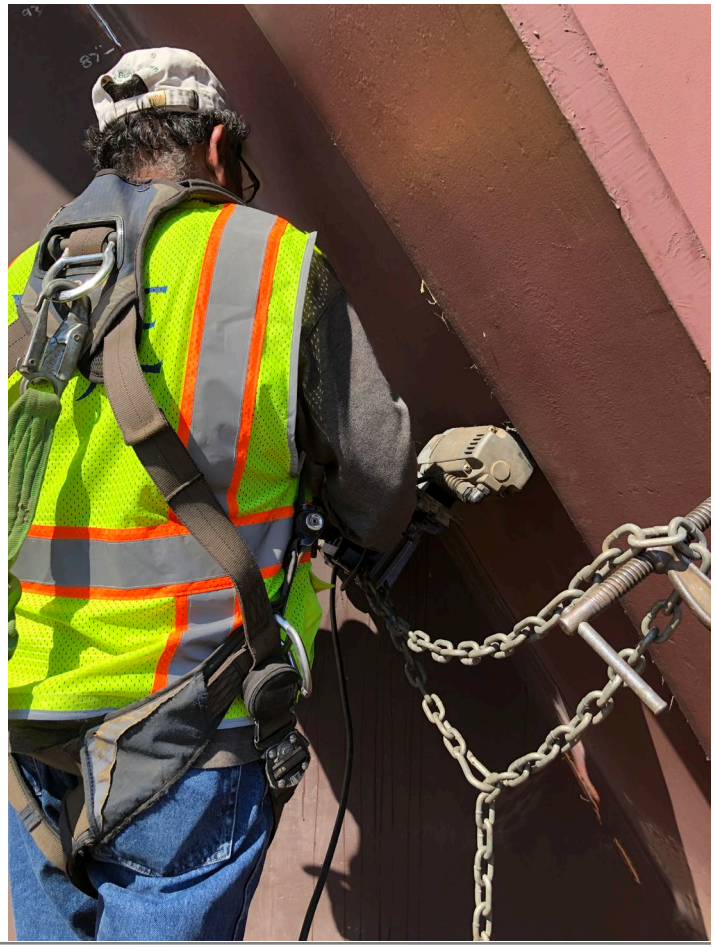
South Tie Girder (View looking North)



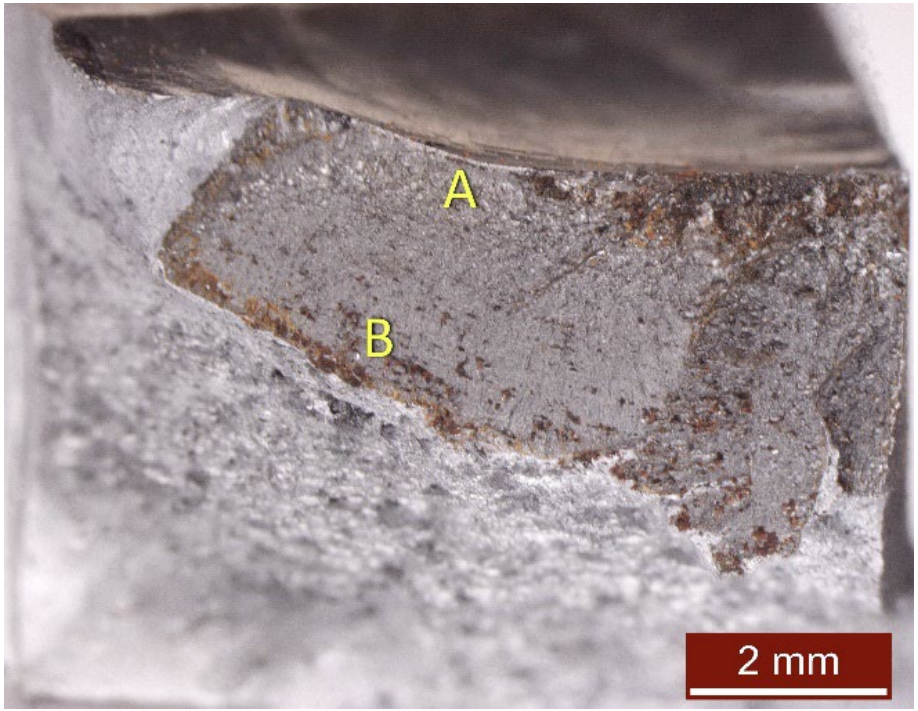
North Tie Girder (View looking South)



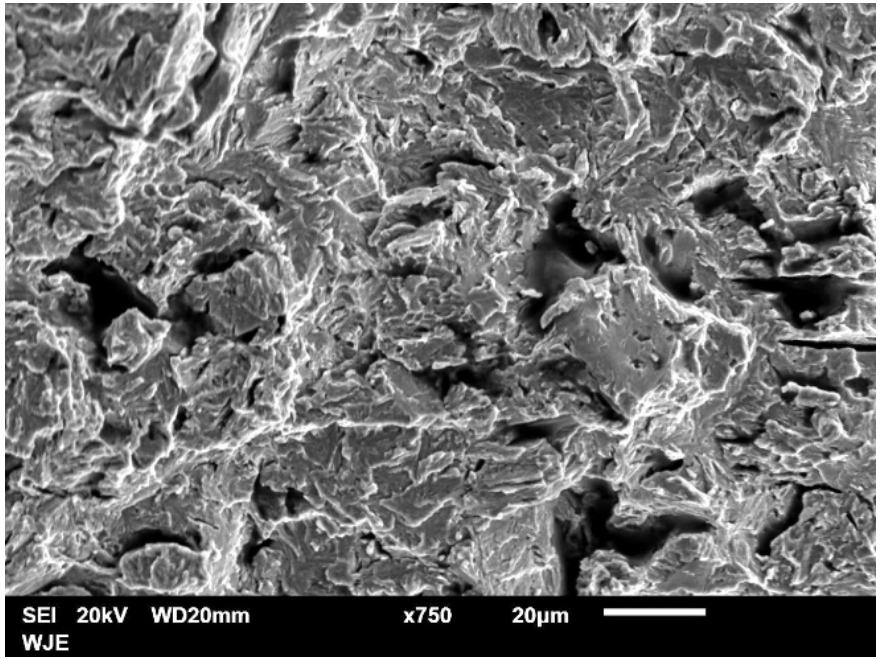
Core Extraction, Laboratory Evaluation, and Material Studies



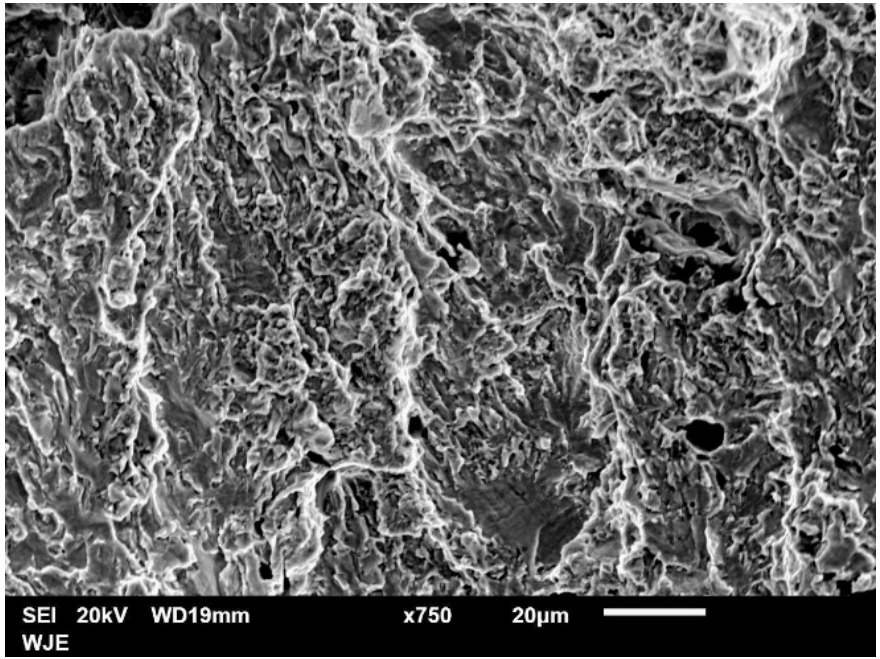

toe crack indication


A
B
2 mm

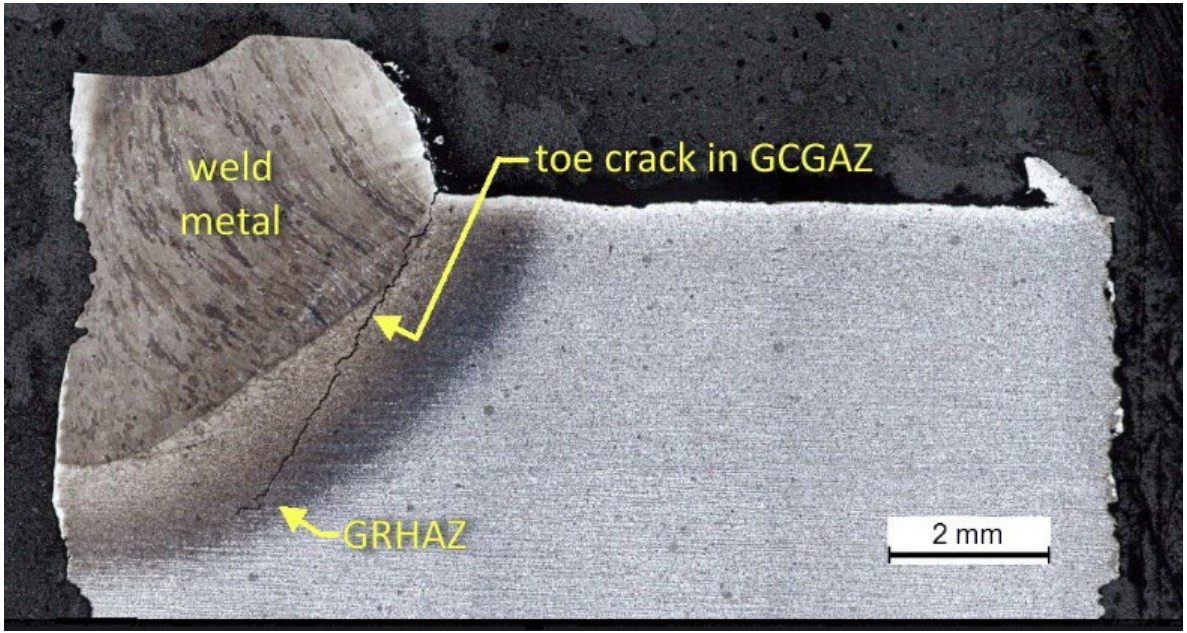
Surface A - GCHAZ



Surface B - GRHAZ



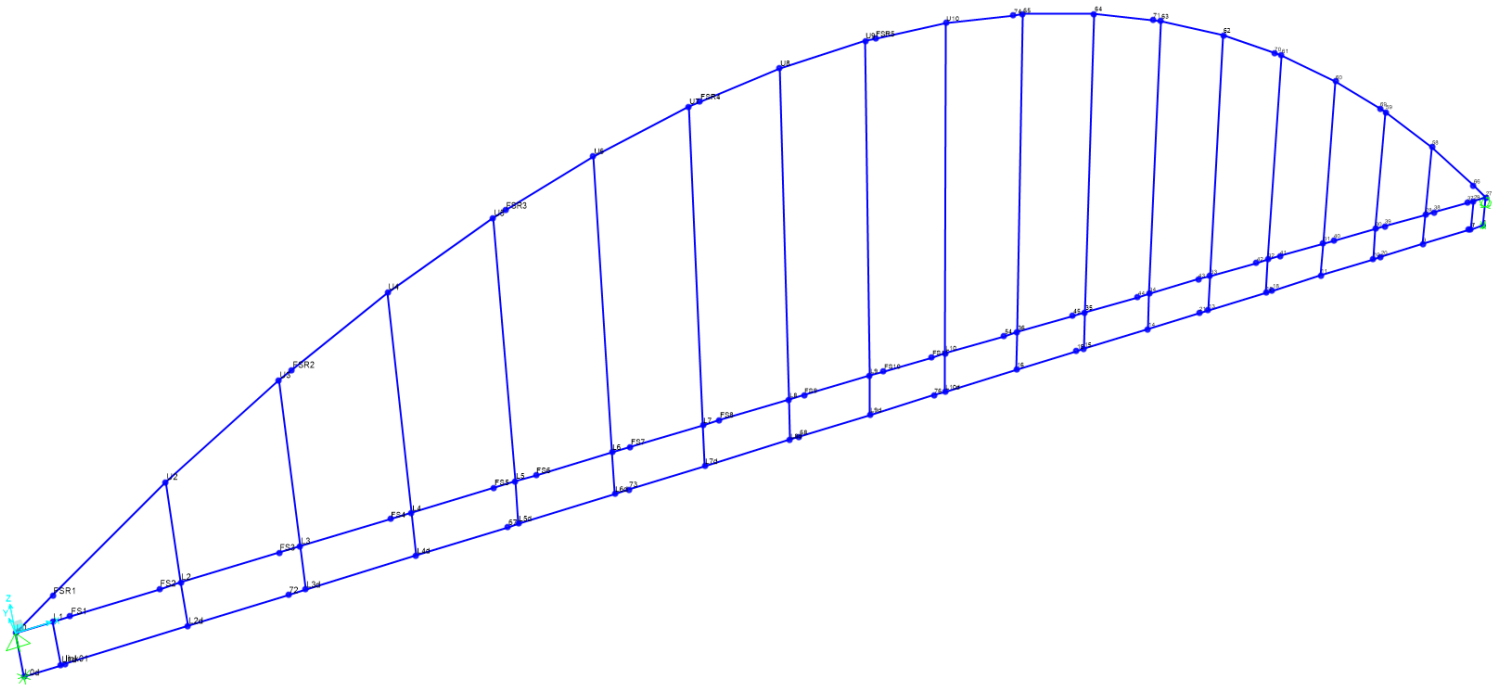

NE-80
toe crack indication


weld
metal
toe crack in GCGAZ
GRHAZ
2 mm

Findings?

- No evidence of crack growth by fatigue.
- Bridge can be reopened to limited traffic.
- Cracks should be repaired to avoid brittle fracture

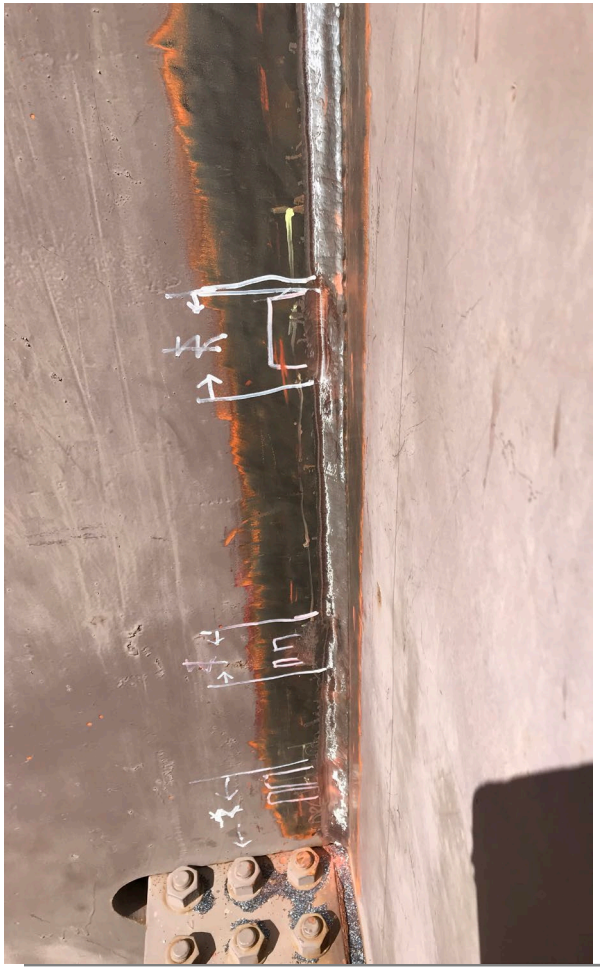
Structural Analyses

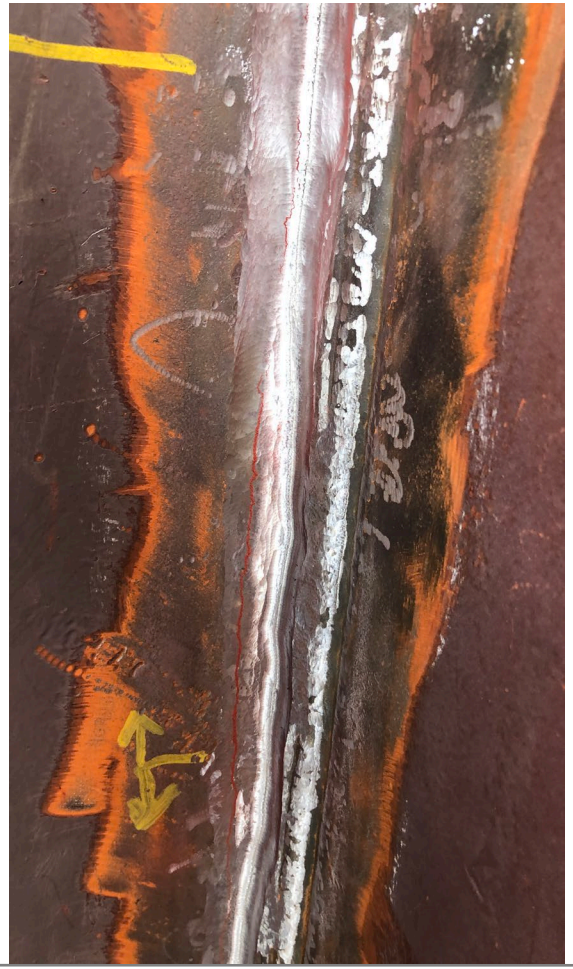


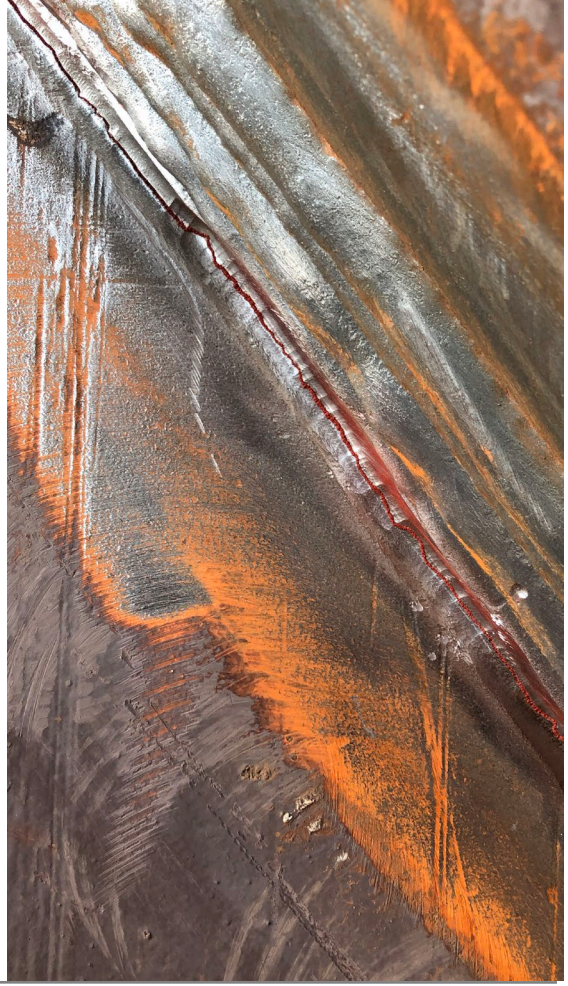
Weld Repair Process

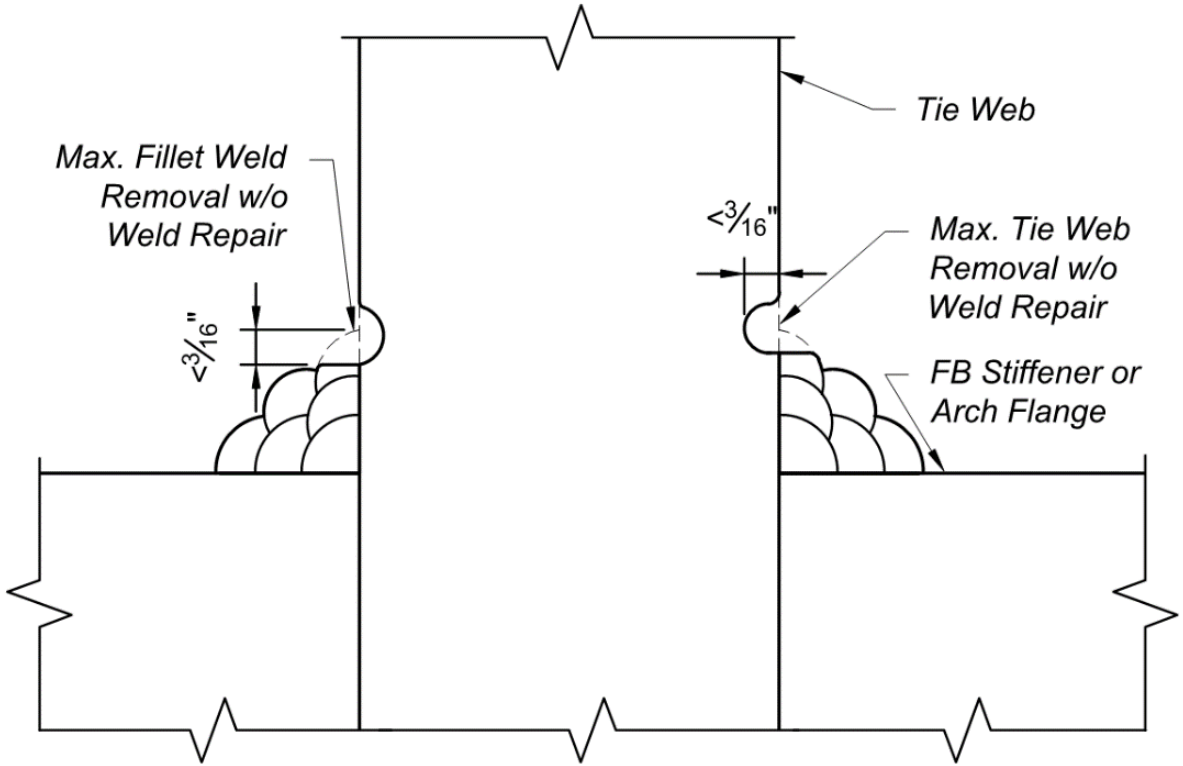
1. Grind cracks to remove indications
2. Continue grinding as needed, verifying crack removed using MT
3. Preheat weld repair area to 300° F for minimum 1 hour
4. Install weld using SMAW with E7018 electrodes with H4R rating
5. MT root pass and maintain 300-450° F interpass temps.
6. MT intermittently and at completion of repair
7. Provide 3-hour bake-out at 300° F for a minimum of 3 hours
8. MT after cool down


MSA



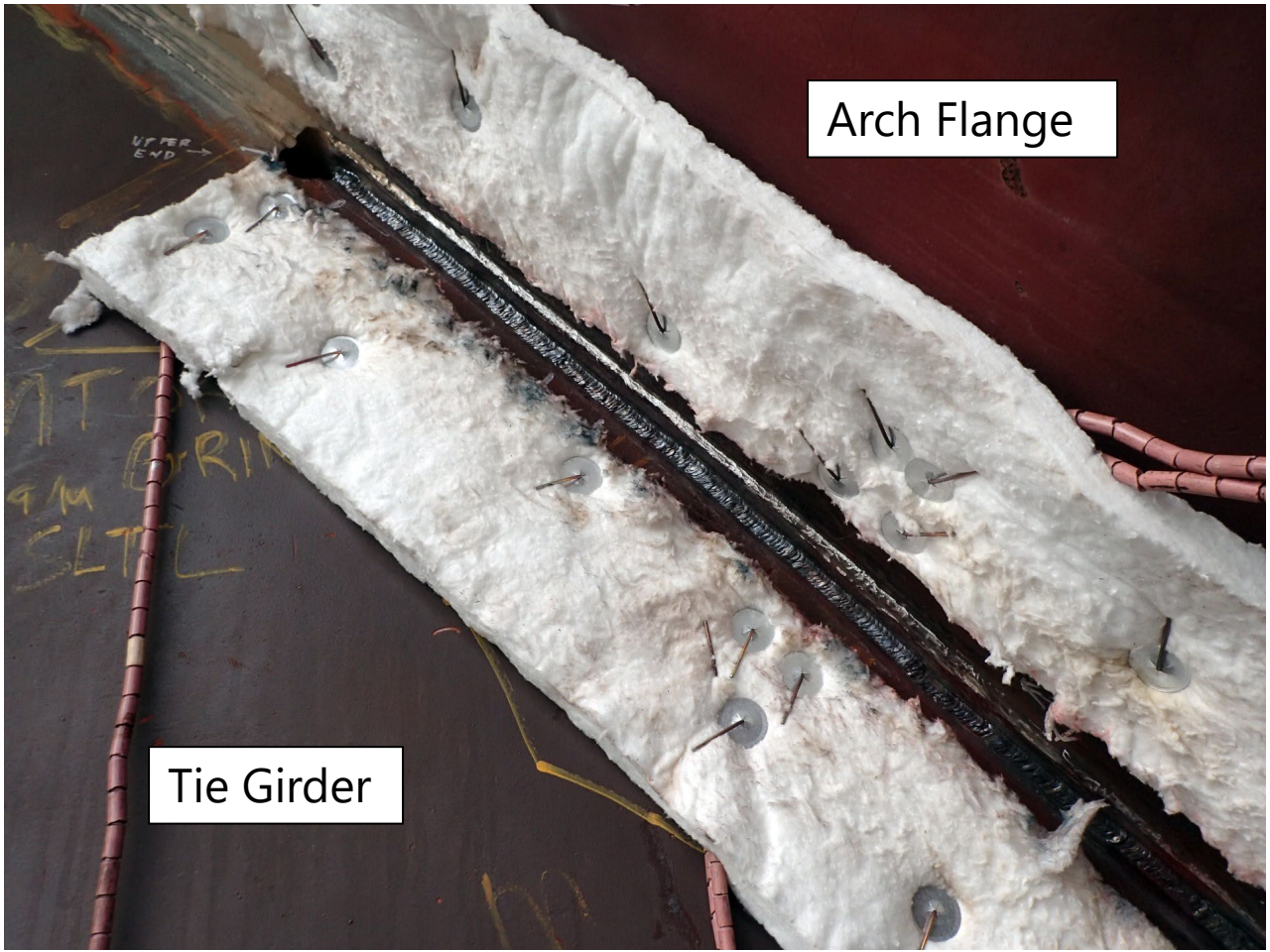





Tie Web
Max. Fillet Weld Removal w/o Weld Repair
<3/16"
<3/16"
Max. Tie Web Removal w/o Weld Repair
FB Stiffener or Arch Flange


MT
5/19/19
SLT
MT/MT
OK
5/20/19
Root
Pass
Only


REVOLVER
BREWING
SafeRing
SDS


Arch Flange
Tie Girder

Conclusions

- Visual observations could not detect the cracks
- Hydrogen-induced cracking the likely cause
- No evidence of crack growth over nearly 40 years
- High restraint and plate thickness contributed
- No strict controls in place on base metal surface cleanliness or weld consumable moisture levels.
- Other structure constructed under FCP

Acknowledgments

- Missouri Department of Transportation
- Illinois Department of Transportation
- St. Louis Bridge Construction Company (General Contractor)
- Rednour Steel Erectors (Weld Repairs)
- TEAM Inc. (Heat Applicators)