Steel Exploration at Blue Mesa

Nondestructive Testing and Repair of T-1 in Colorado

Blue Mesa Bridges - General Information

K-07-A

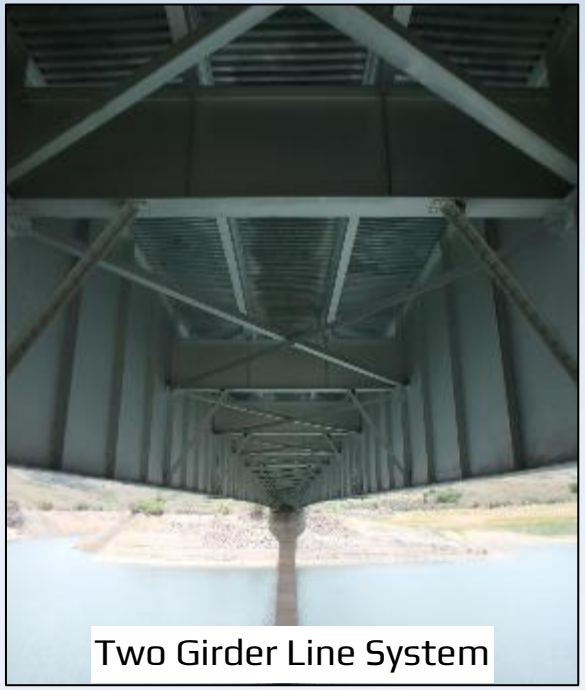
- US 50 over the Lake Fork at mile marker 132.69
- 6 Span, Continuous Composite Welded Girder bridge. 993ft, 300ft max span
- Spans 3, 4, and 5 are Non-redundant Steel Tension Members (NSTM).
- 2 total lanes, 1 lane each direction
- Built 1963, FAIR Condition

K-07-B

- US 50 over the Blue Mesa Reservoir at mile marker 136.16
- 10 Span, Continuous Composite Welded Girder bridge. 1,532ft, max span 360ft
- Spans 5, 6, and 7 are Non-redundant Steel Tension Members (NSTM).
- 2 total lanes, 1 lane each direction
- Built 1963, FAIR Condition

Blue Mesa Bridges - Existing Structure

The bridges main spans are composed of 100 ksi T1 Steel built-Up (welded) members and are NSTM (Non-Redundant Steel Tension Member) bridges



Two Girder Line System

Pin and Hanger

Timeline

April

Inspection and Design
April 8 - Start of Visual inspection
April 11 - Visual finding of first crack
April 18 - Visual finding of second crack
April 18 -Bridge closed to traffic
April 20 - Benesch, BDI, Michael Baker & Kiewit retained
April 22 - Begin NDE inspection & Design

May

K-07-B Inspection and Design
May 24 - UT Butt weld inspection completed
May 25 - K-07-B MT Fillet weld testing
May 31 - Critical Repair Plans issued

June

Inspection and Design
K-07-B MT Fillet weld testing

Construction
June 5 - Shop Drawings & Fab Start
June 11 - Begin Critical Repairs

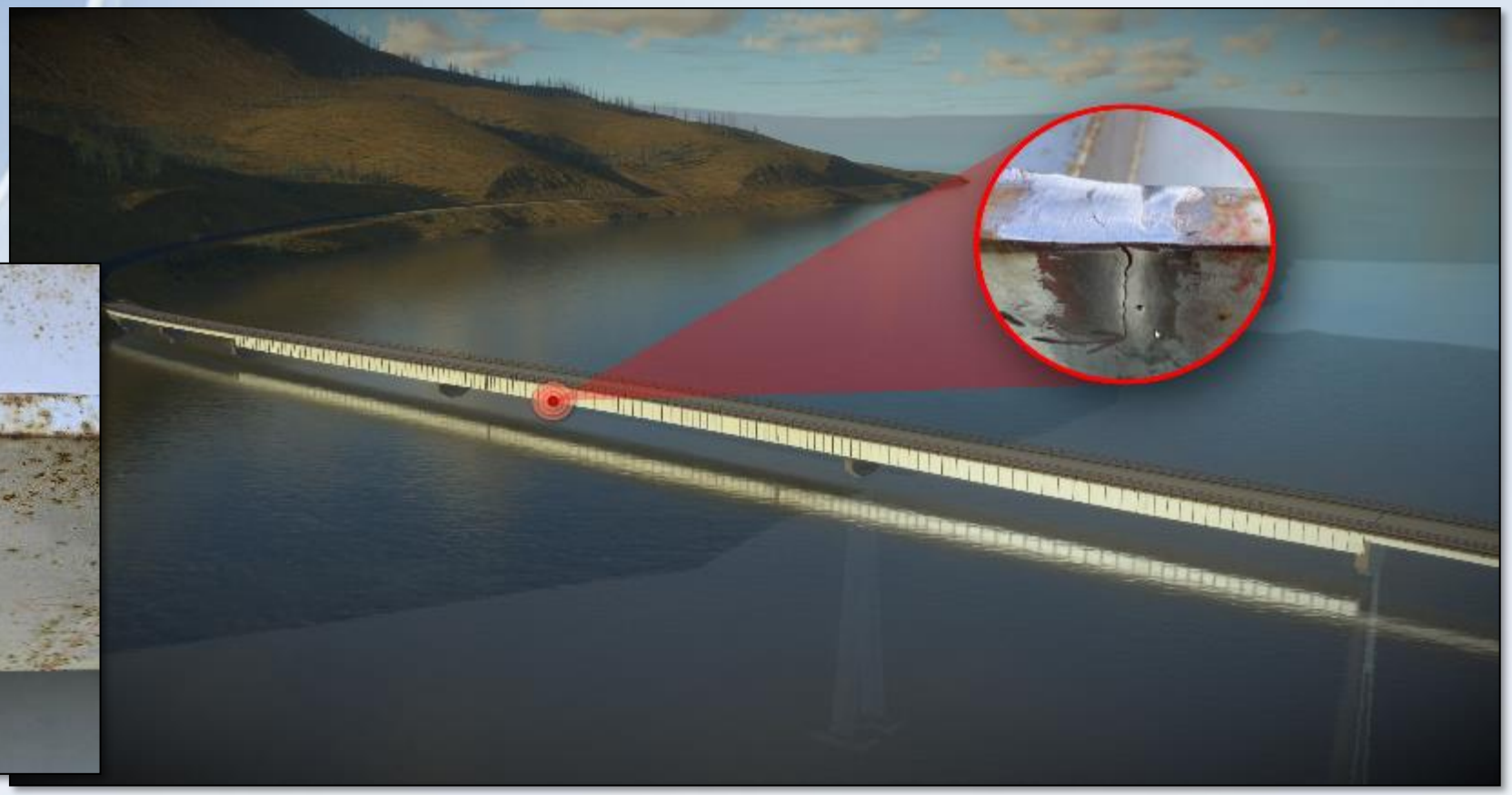
July-December

Inspection and Design
July 8-Aug 3 - K-07-A MT Fillet weld testing
Aug 1 - K-07-B Permanent repairs plans issued
Aug 11 - K-07-A Permanent repairs plans issued

July 2 - Critical repair complete
July 3 - K-07-B open to limited traffic
July 6 - K-07-B Begin Permanent Repairs
August 12 - K-07-A Begin Permanent Repairs

December 15 - Anticipated completion date

Bridge B
1st Determined Crack Span 6, GB, BF 11



Bridge B Access

Site Conditions

- Over Water
- Windy
- Cold
- Remote

Limitations

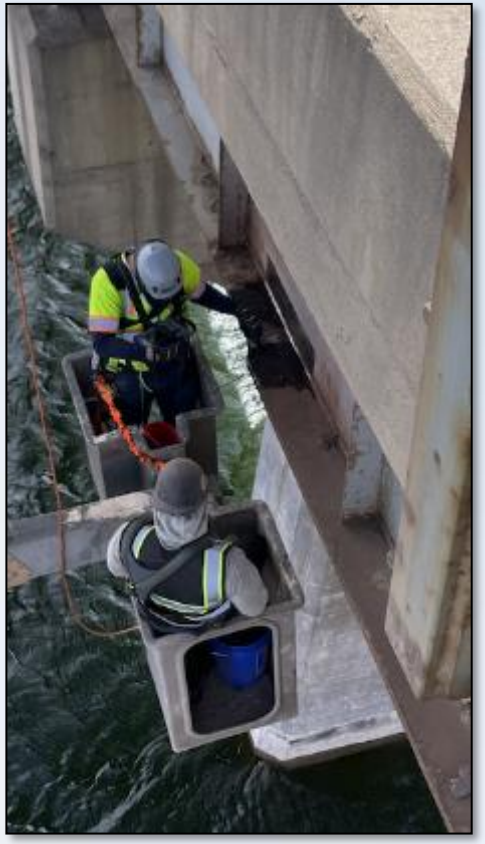
- Access
- Weight Restrictions
- Chromium Paint
- Night Work
- 300 Mile Detour

Bridge B
Paint Removal and UT of Butt Welds

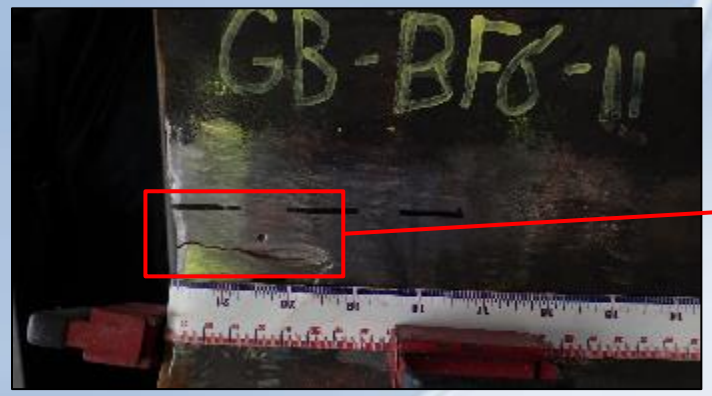
Ultrasonic Testing (UT)

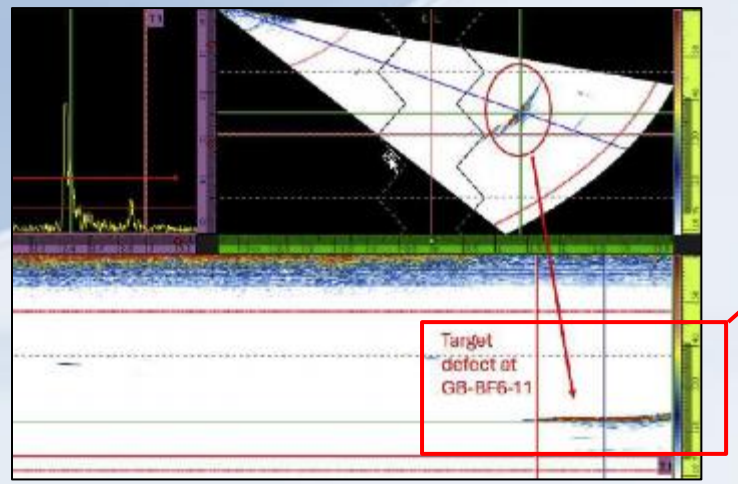
- AASHTO D1.5 Indication Classification
- UT and Phased Array UT (PAUT)
- Robotic PAUT scanning for efficiency of web scanning
- QA/QC of 10% locations (min.)

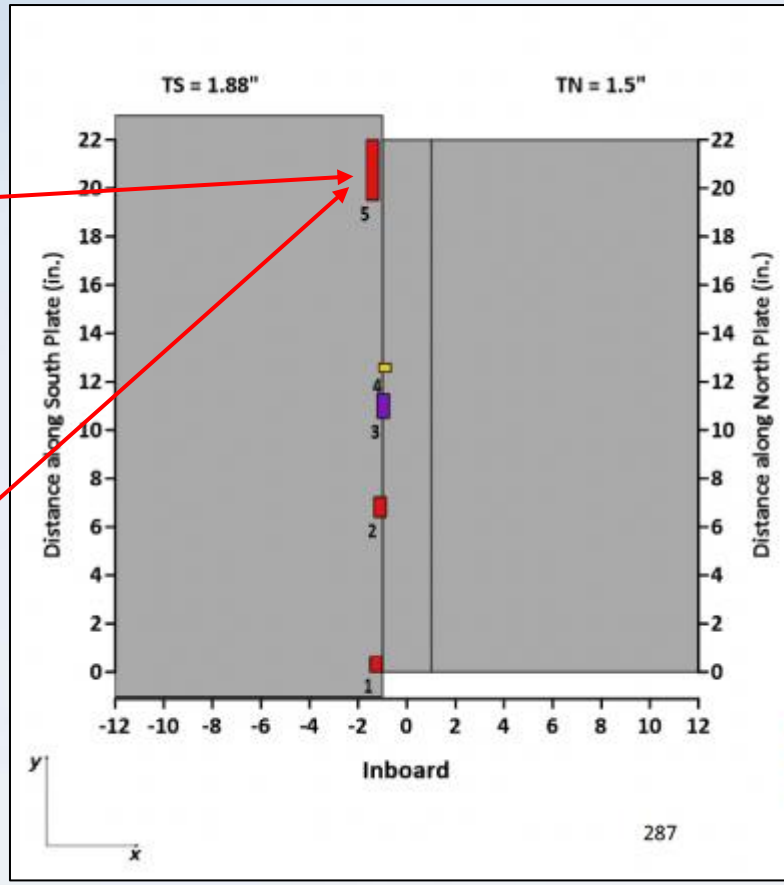
AWS Classification	Number
A	192
B Reject	17
B	11
C Reject	8
C	11
D	50
None	21



Bridge B
UT/PAUT Analysis and Reporting







Condition Summary

Indication	Indication Rating	Length (in.)	Depth (in.)	X (in.)	Y (in.)
1	Annex J	0.63	0.83	-1.26	0
2	Annex J	0.83	1.35	-1.1	6.4
3	Annex J	1	1.3	-0.97	10.5
4	Annex J	0.36	0.7	-0.9	12.4
5	Annex J	2.5	0.81	-1.41	19.5

Legend

AWS Classification
A
B - Rejectable
C - Rejectable

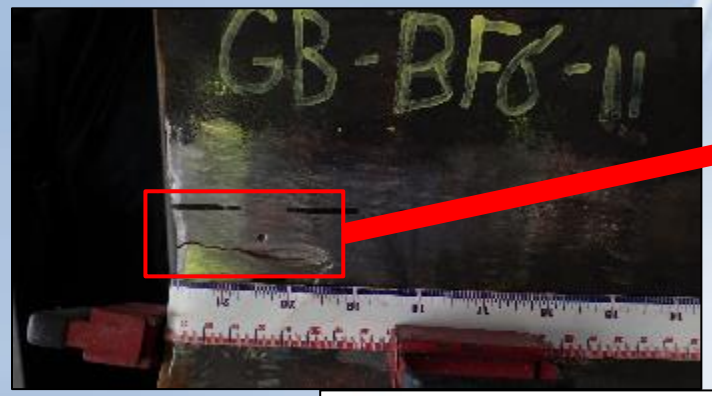
General Information

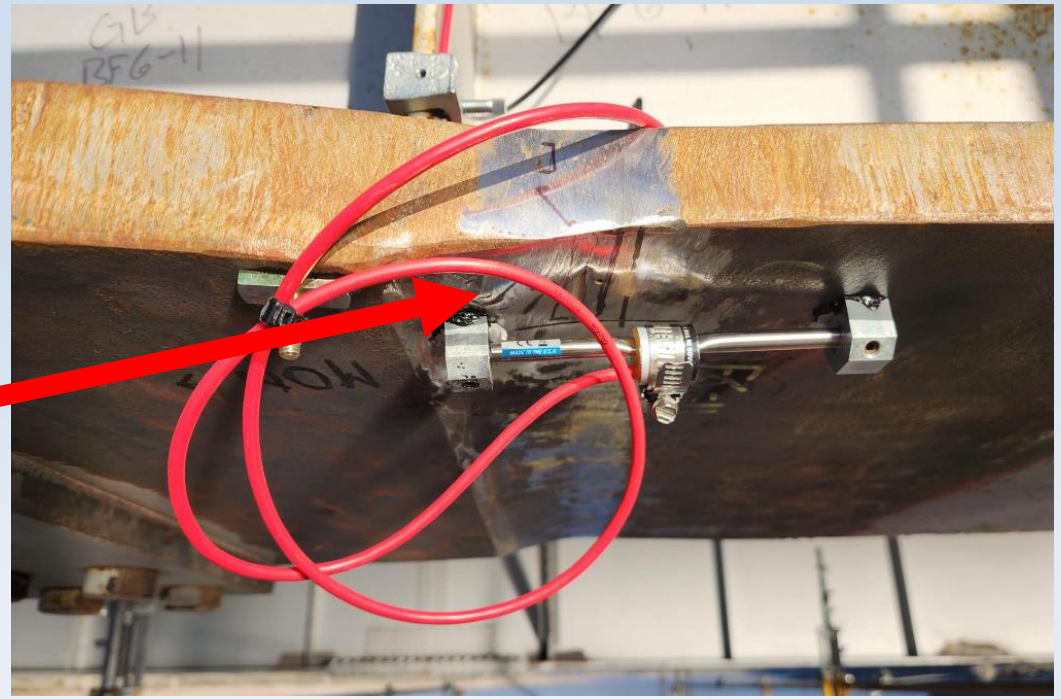
Project: 2404003-CO
Weld Location: GB-BF6-11
Scan Face: A
Facility Carried: US-50 K-07-B
Tested: 5/1/2024

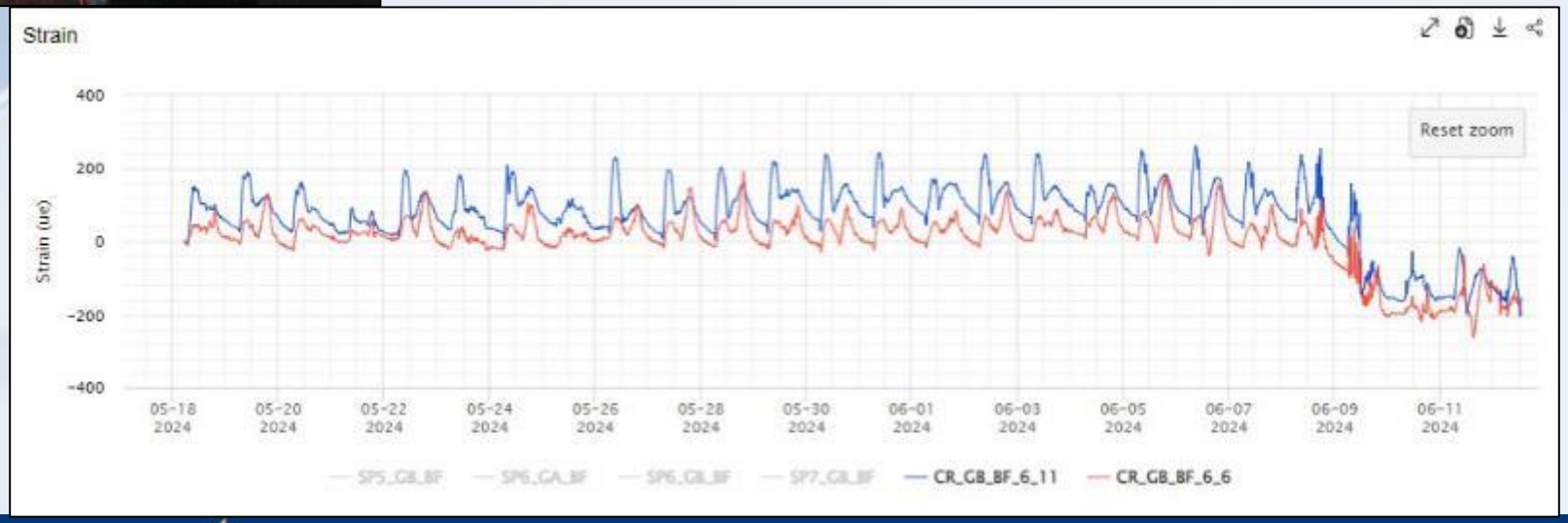
Analyzed by: JF
Reviewed by: SDB
Completed: 06/16/2024

Sheet 1 of 1

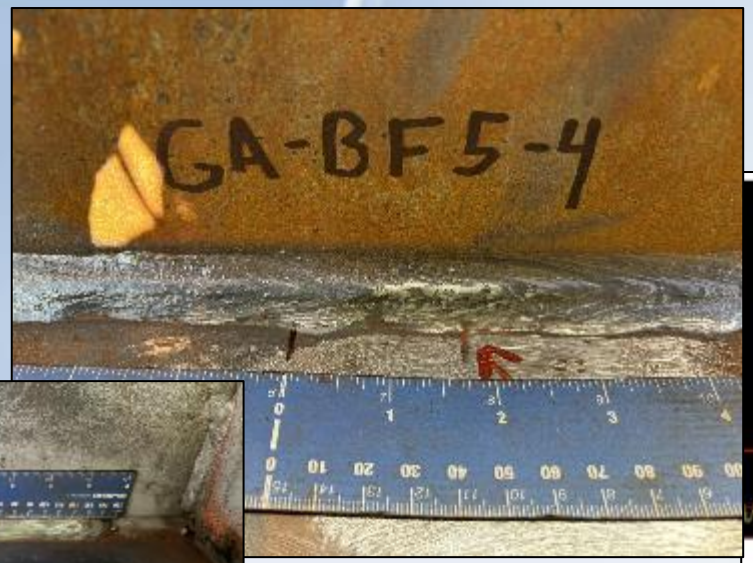
Bridge B
Crack Monitoring

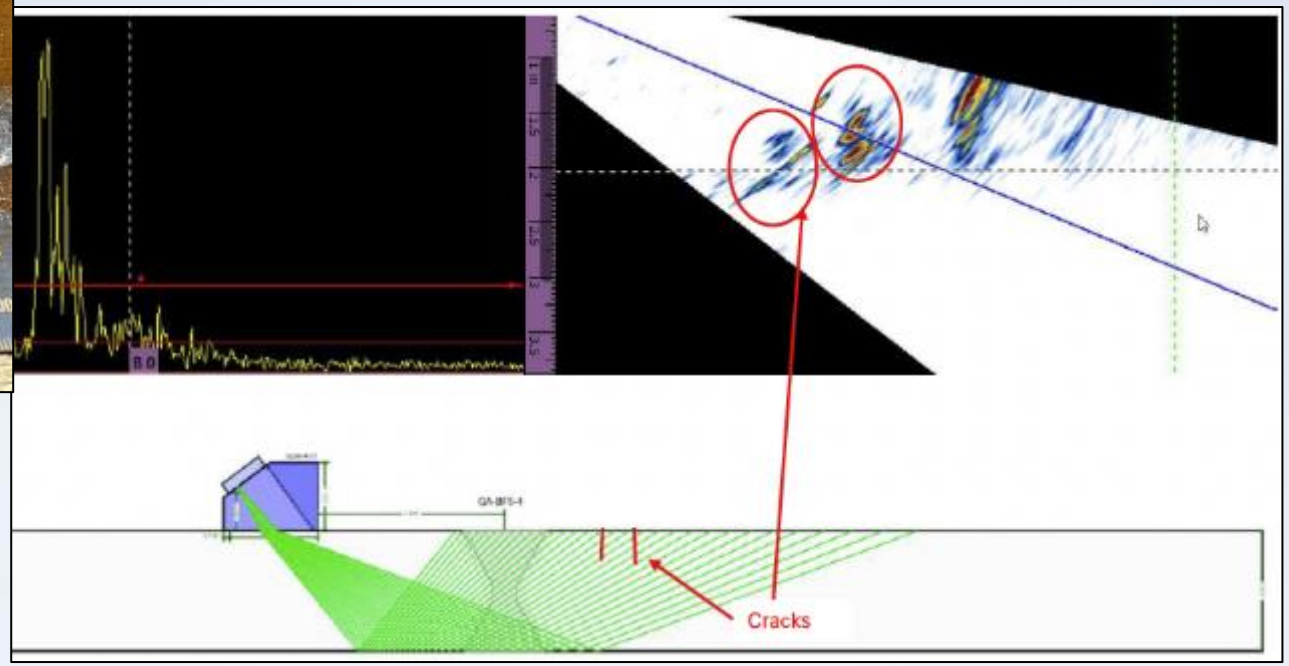






Bridge B
Secondary Web-Flange Fillet weld testing

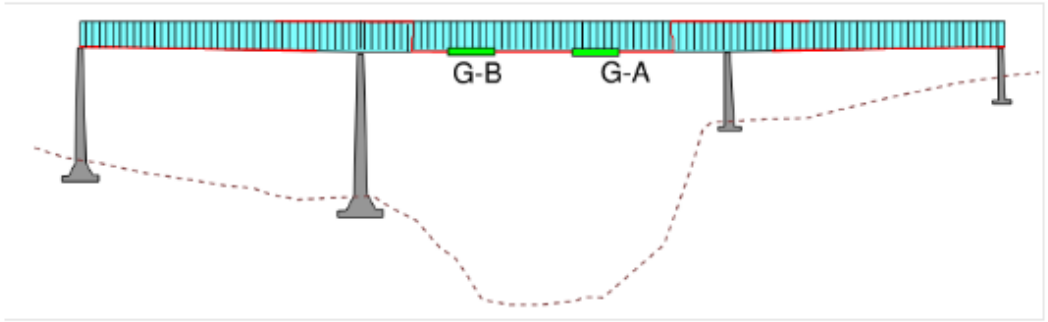
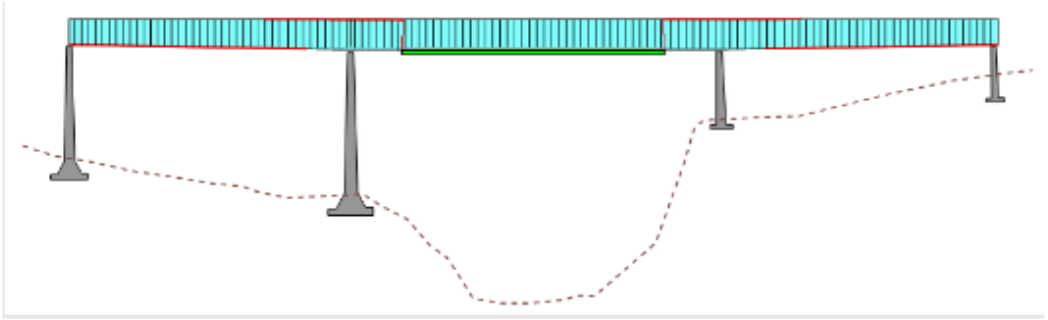




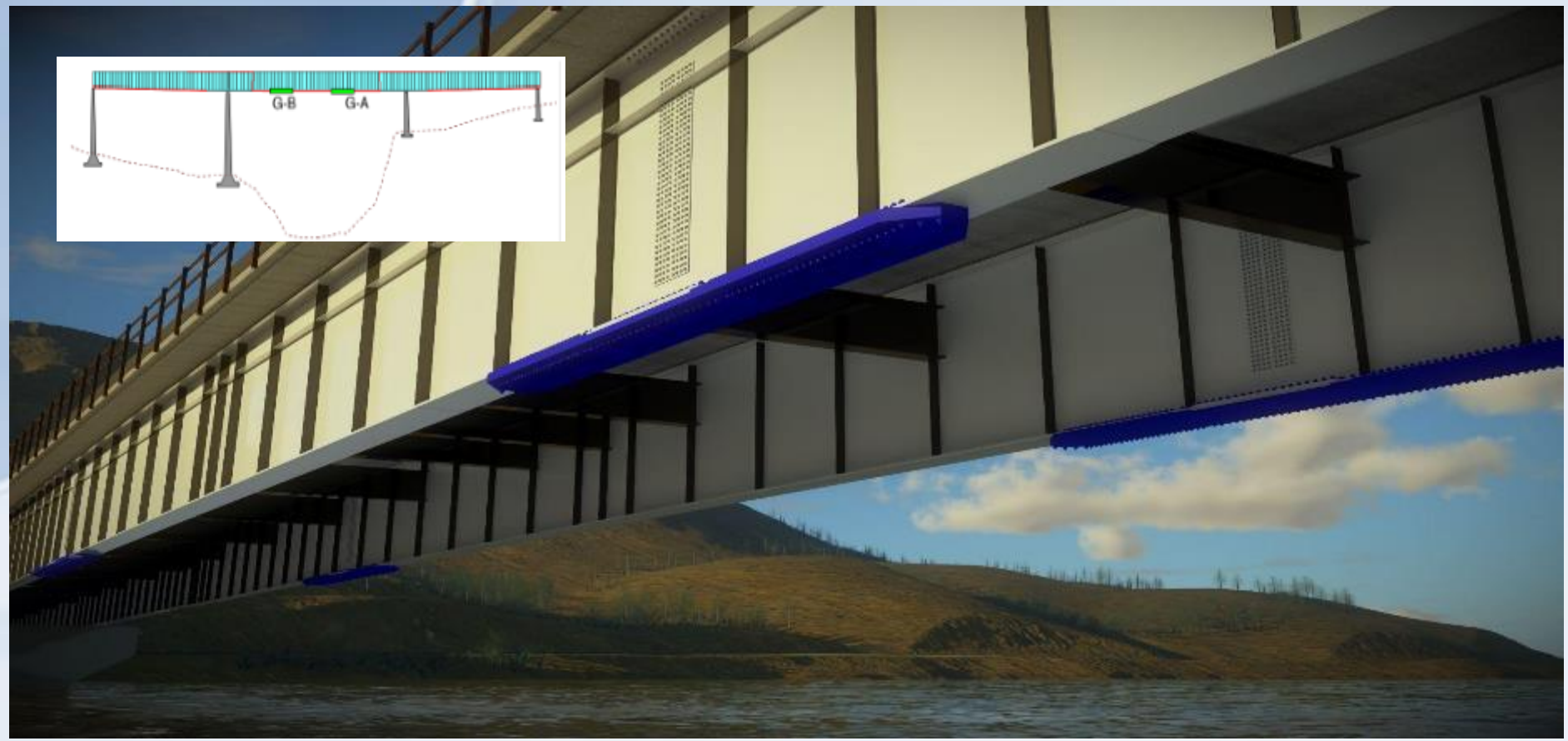
Bridge B - T1 Butt Weld Defects Map

Bridge Item (Span 5,6 & 7)	5/21/2024
Total Tension Splices	118
Tension Splices UT Tested	118
Indications Found in Welds	289
Repair Locations (estimates)	118
Number of Surface Cracks	5 (2 Flange)

Bridge B Critical Repair Options

Options	Sketches	Risks or unknowns	Schedule[1,2]	Relative cost[1]
Local Plating		• Increases complexity if additional defects are later found. • Relative costs increase with the number of defects found.	1 – 3 Months	$
Suspended Span Bottom Flange Only		• Material availability • Does not address any additional finds outside of suspended span. • Effect of weight on pin and hanger and cantilever	2-4 Months	$$

Bridge B
Critical Repairs - Designed for speed



Bridge B
Critical Repairs

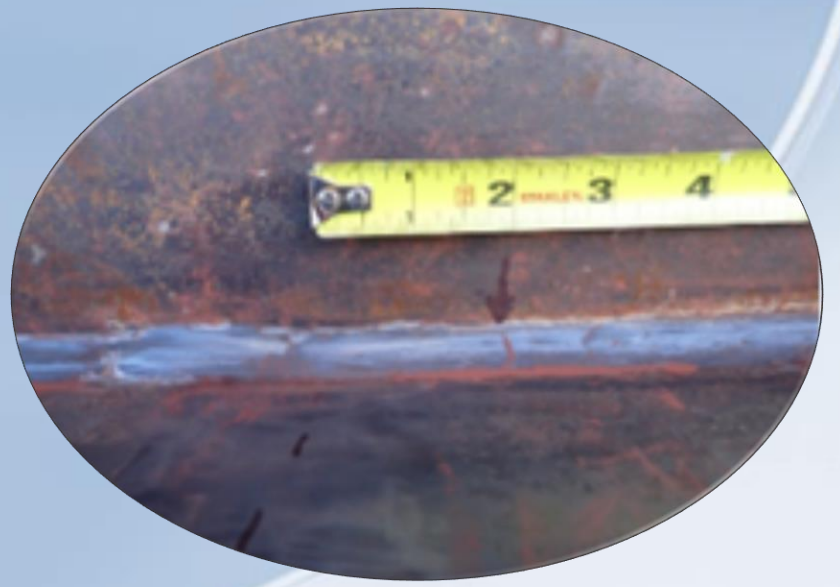
- Open for July 4th
- Address flange to flange surface indications
- Use material that is immediately available
- Detail considering the loading limitations

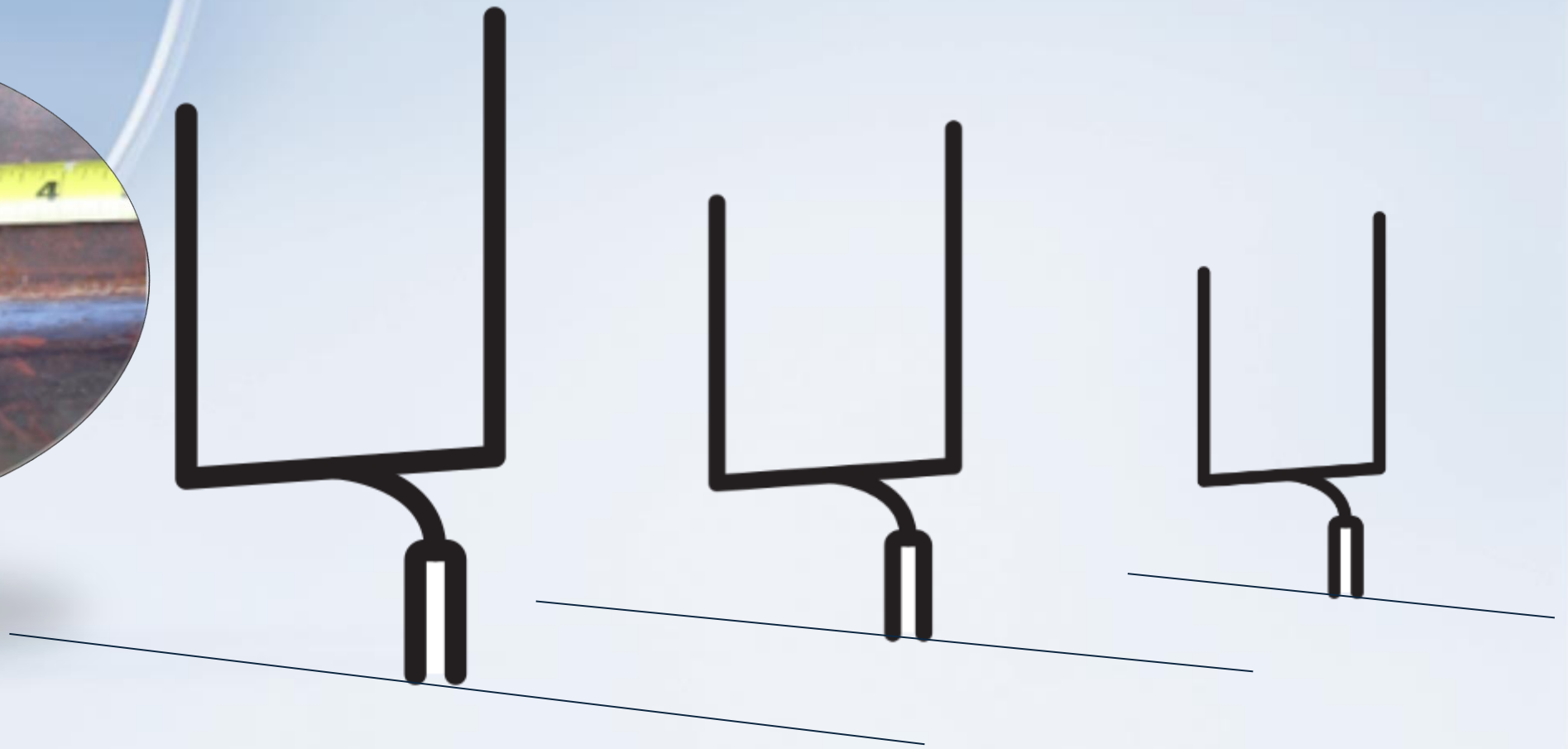
Bridge B Permanent Repair Options

Design Drivers

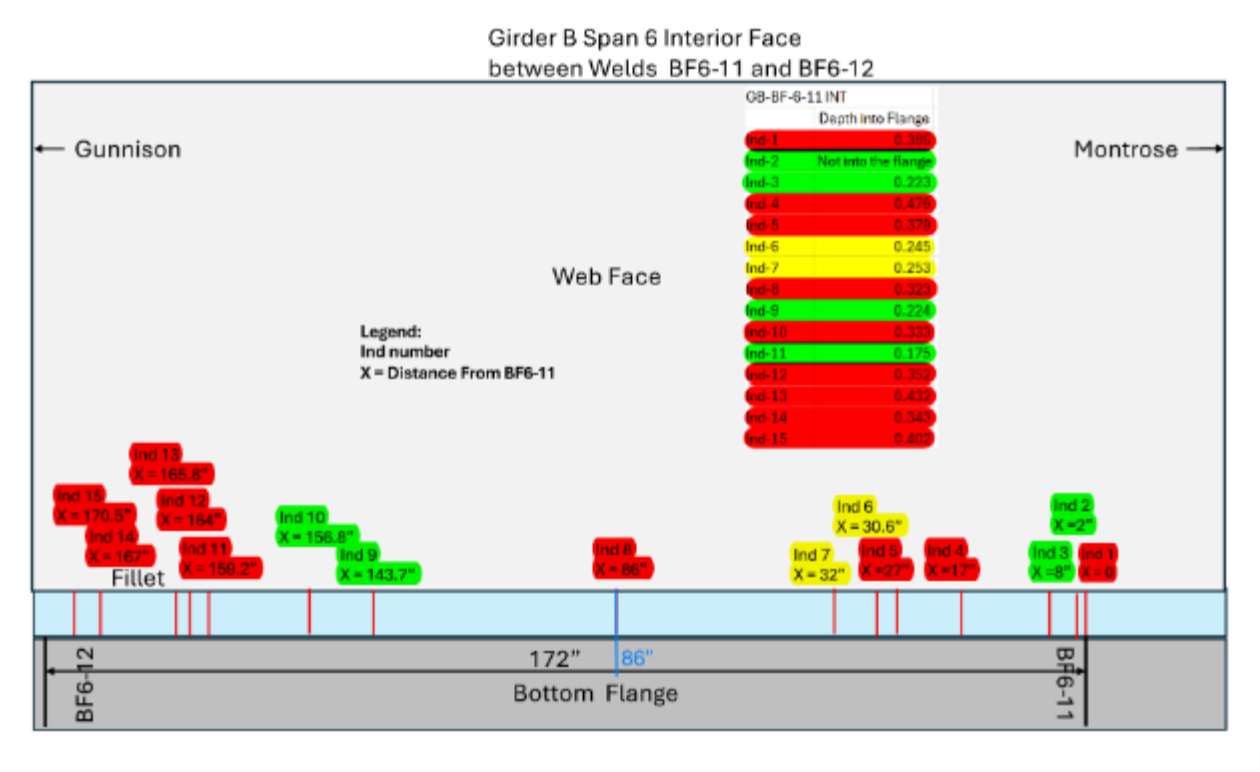
- Construction duration
- Material availability
- Schedule Risk
- More testings

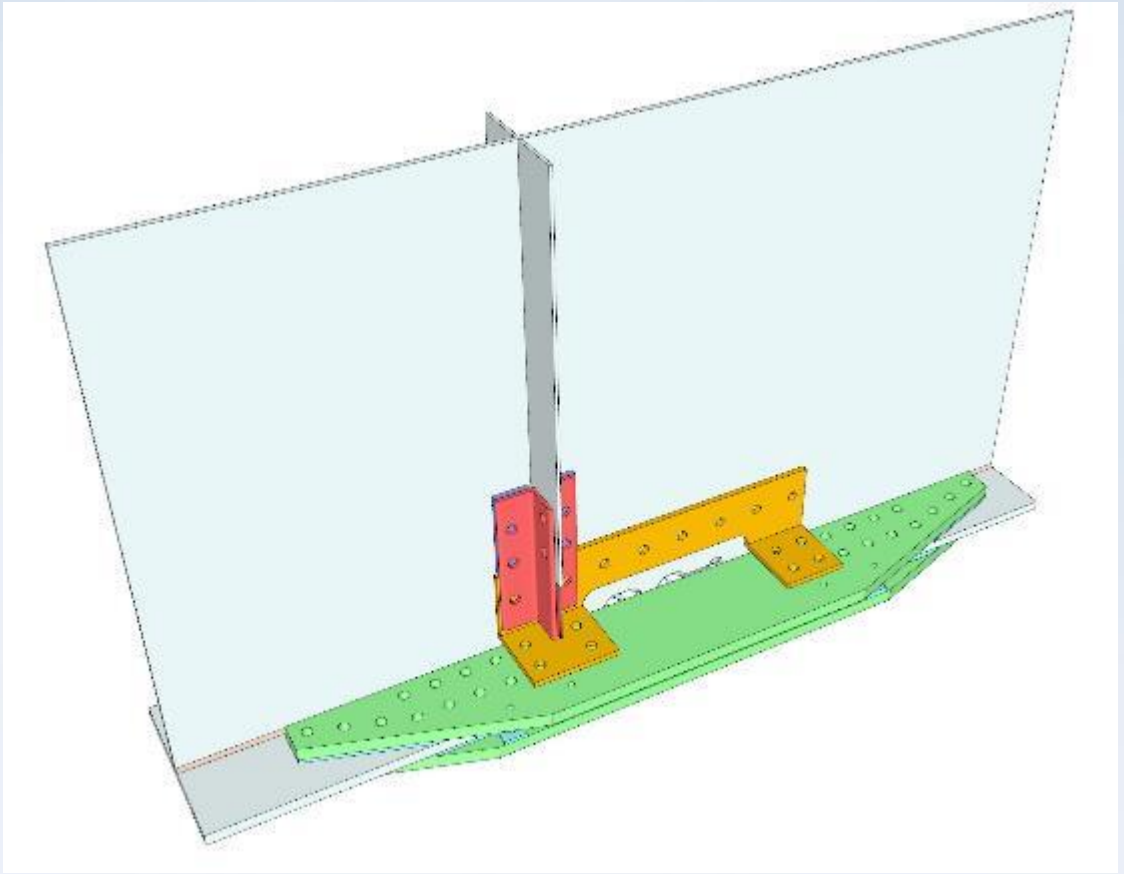
Moving the goalposts





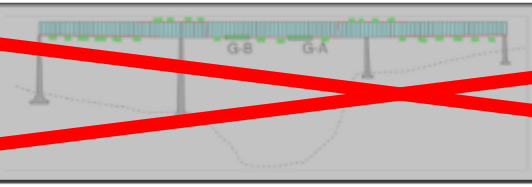
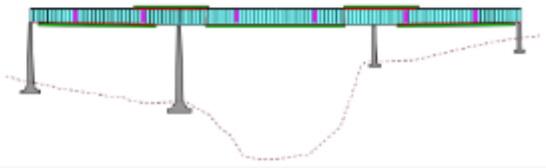
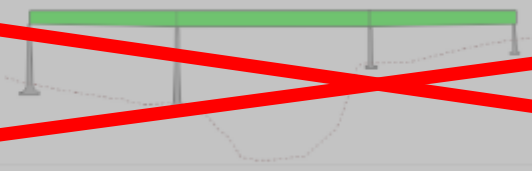
Fillet Weld Cracking



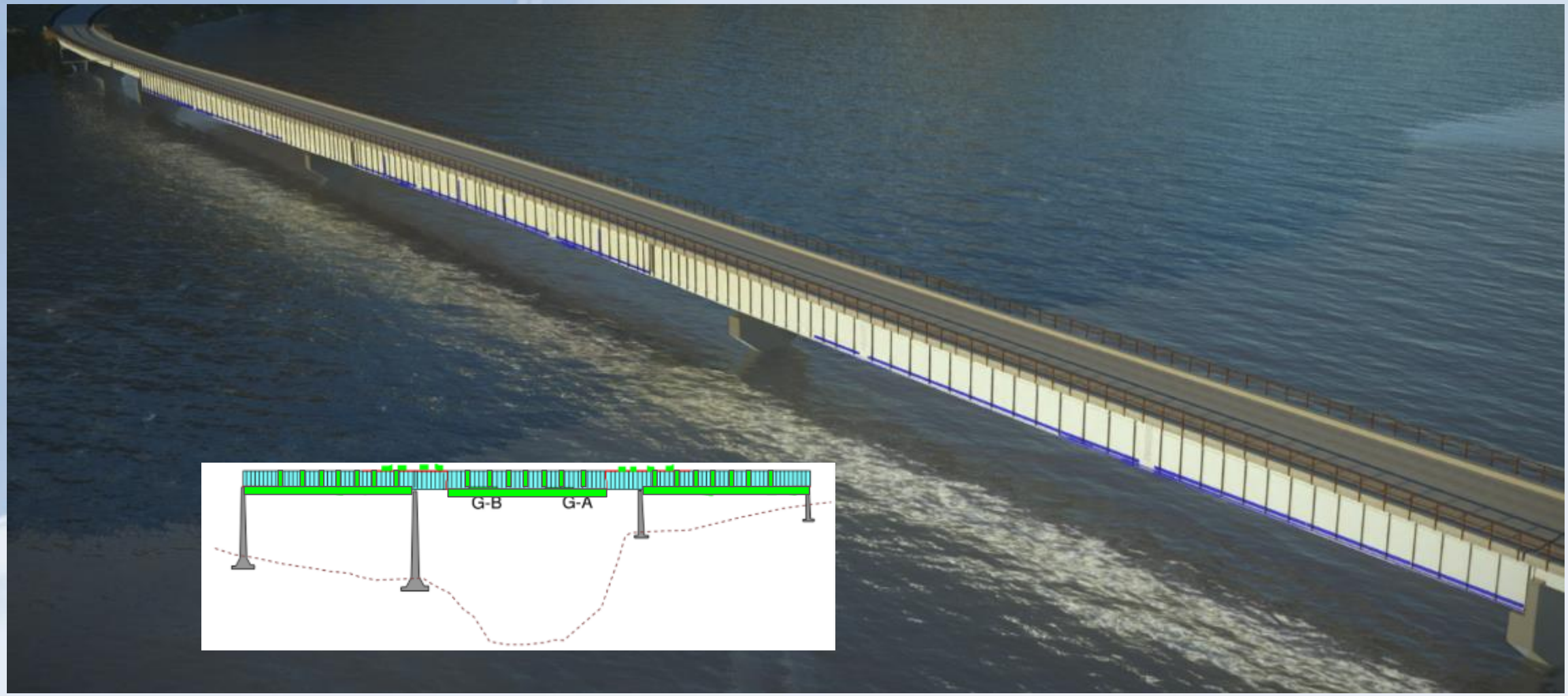


Bridge B Permanent Repair Options Drivers

- Prevalence of fillet weld cracks
- Substructure capacity
- Availability 100 ksi material
- Schedule risk
- Historic bridge

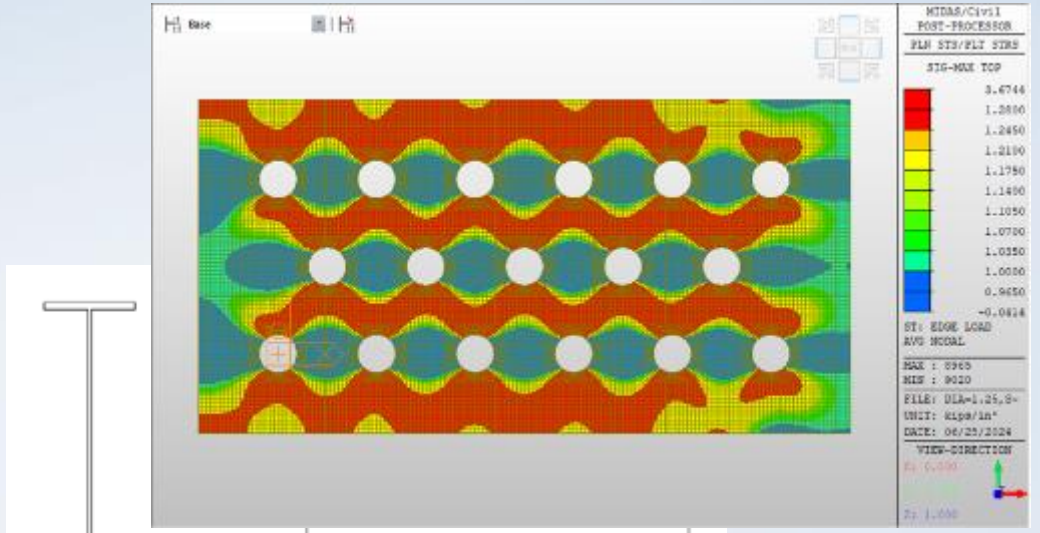
Options	Sketches	Risks or unknowns	Schedule[1,2]	Relative cost[1]
Local Plating		• [illegible] complexity if additional defects are later found. • Relative costs increase with the [illegible]	1 – 3 Months	$ - $$$
Global Plating		• Material availability • Sequence of construction • Negative effects of additional weight • Schedule risk due to design complexity	4-7 Months	$$$
Superstructure Replacement		• Long material lead times • Strength and condition of existing [illegible] piers and foundations.	6-12 Months	$$$$
Full Bridge Replacement		• Environmental, geotechnical, and other considerations	>12Mo	$$$$$

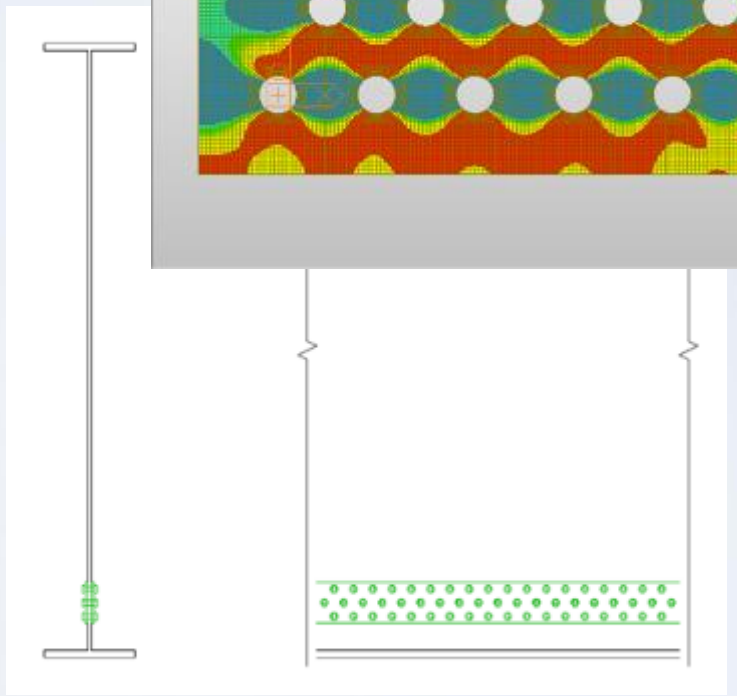
Permanent Repair schematic



Innovative Crack Arrest Strategy

- Orientation of principal stresses is critical
- These stresses are variable through web
- Typical Dog bones detail would have overlapped
- Collaboratively with Purdue developed detail that drives potential cracks to adjacent bolt holes





Fun Facts & Acknowledgements

Repairs at a glimpse

- 410 tons of additional steel
- 55,000 Bolts

Partners

- CDOT Region 3 and Staff Bridge
- Benesch
- Bridge Diagnostics, Inc.
- Coating Specialists
- eO
- Kiewit
- Michael Baker International
- Stantec
- Ulteig
- W&W AFCO
- Dr. Robert Connor

Questions?

Jacob O'Brien, PE
Colorado Department of Transportation

Keely Matson, PE
Michael Baker International

Shane Boone, PhD, PE
Bridge Diagnostics, Inc.