

EB I-70 Lewis & Clark Emergency Gusset Repairs

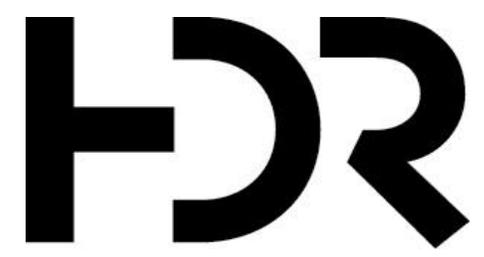
Andrew Spencer, P.E. - KDOT

Kevin Gribble, P.E. - HDR



March 5th, 2026

Project Partners



Agenda

- 1 Bridge History
- 2 Structural Safety Assessment
- 3 Discovery of L21 Gusset Defects
- 4 Emergency Repair Response
- 5 Construction



EB I-70 over Kansas River Lewis & Clark Viaduct
 Kansas City, KS

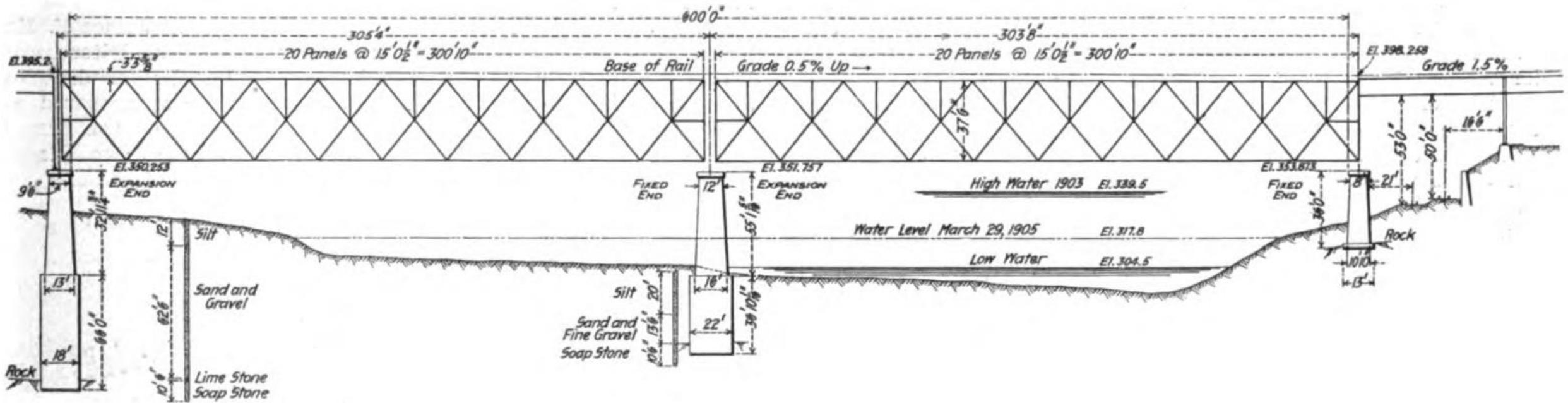


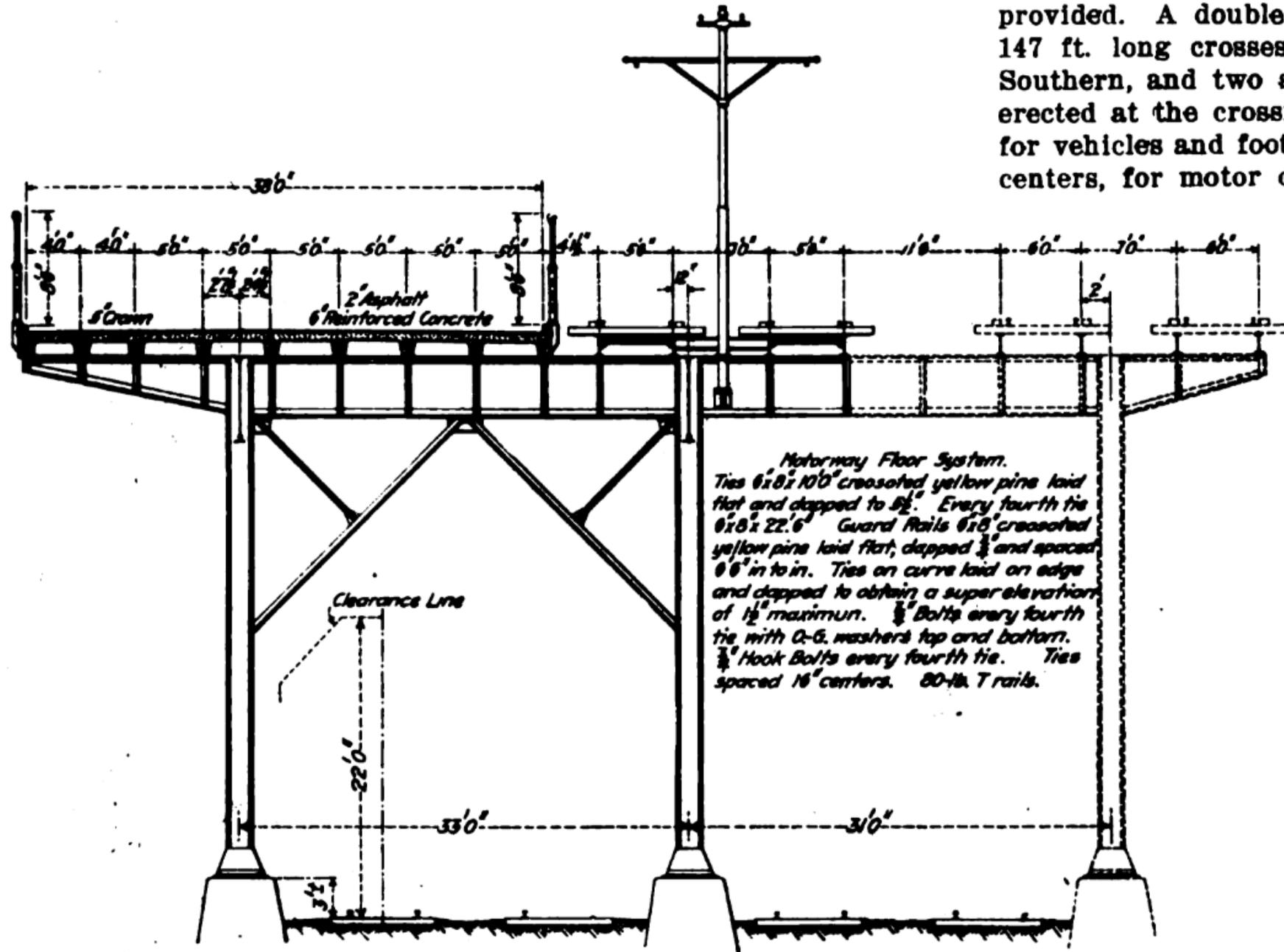
Fig. 4—Elevation of Bridge Over the Kaw River for the Sixth Street Viaduct.





Bridge 031

- Steel Viaduct Structure
- Built in 1907
- Kansas City, KS
- 71 Approach Spans
- 3750' Total Length
- River Unit Deck Trusses
- 2 Trusses, 300' each



over buildings, rain provided. A double 147 ft. long crosses Southern, and two sp erected at the crossi for vehicles and foot centers, for motor ca

Fig. 2—Cross Section Through Viaduct Showing Future Widening for Additional Tracks.





Then

- **Historic postcard from 1908 showing the bridge shortly after being built. Toll booth also visible. Looking east**







Now

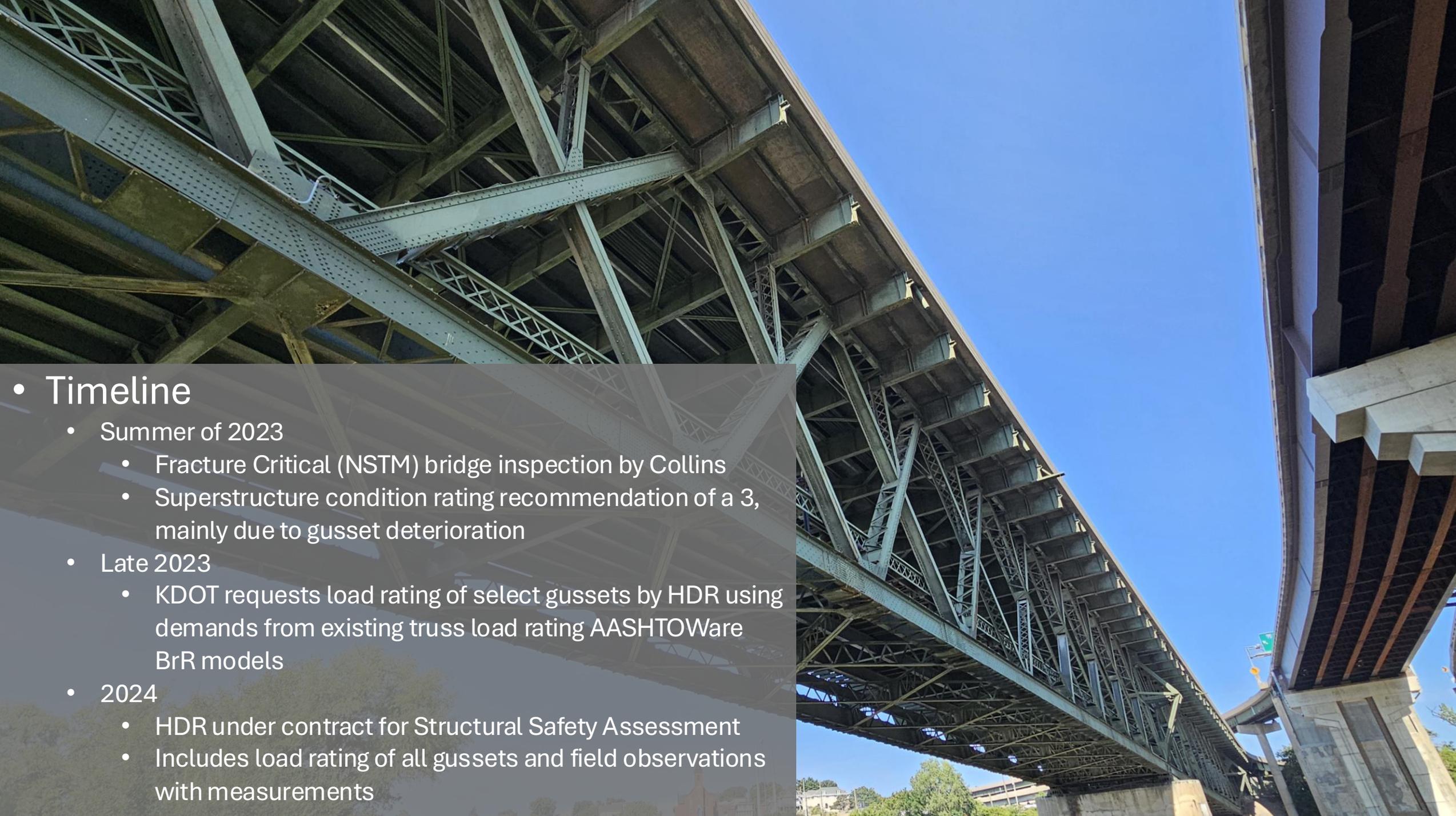
- **Current day, driving east with Google Earth**



Bridge Maintenance History

- 1907 – Built
- 1930 – Added new lower deck and steel approach spans to lower deck. Sway frames revised to portal bracing.
- 1955- Lower deck raised, lower approach spans raised and added. Raise girder spans with existing slab intact.
- 1963 – Approach Span Column bracket repair details
- 1981 – River pier repairs
- 1984 – Upper deck redeck, drainage details, steel repairs, painting, joint replacements
- 1988 – Strut repair
- 1998 – Column repair
- 1999 – Scour repair
- 2001 – Isolated painting and steel repairs
- 2006 – In-depth column repairs
- 2006 – Additional steel repairs
- 2006 – Pedestrian trail conversion of lower deck
- 2012 – Joint repairs
- 2014 – Overlay
- 2021 – Joint repairs / WB “Sister” Bridge Replaced
- 2024 – Gusset repair at L21, joint repairs





• Timeline

- Summer of 2023
 - Fracture Critical (NSTM) bridge inspection by Collins
 - Superstructure condition rating recommendation of a 3, mainly due to gusset deterioration
- Late 2023
 - KDOT requests load rating of select gussets by HDR using demands from existing truss load rating AASHTOWare BrR models
- 2024
 - HDR under contract for Structural Safety Assessment
 - Includes load rating of all gussets and field observations with measurements

Structural Safety Assessment

- Field Observations
 - Summer of 2024
 - Eyes on bridge – assess 10-15 year remaining life
 - Included rope access and boomlift from pedestrian walkway
 - Performed under live traffic
 - River Units (Trusses)
 - Member deterioration measurements
 - Gusset deterioration measurements
 - Verification of member sizes
 - Approach Units
 - Measurements of member sizes and deterioration



Structural Safety Assessment

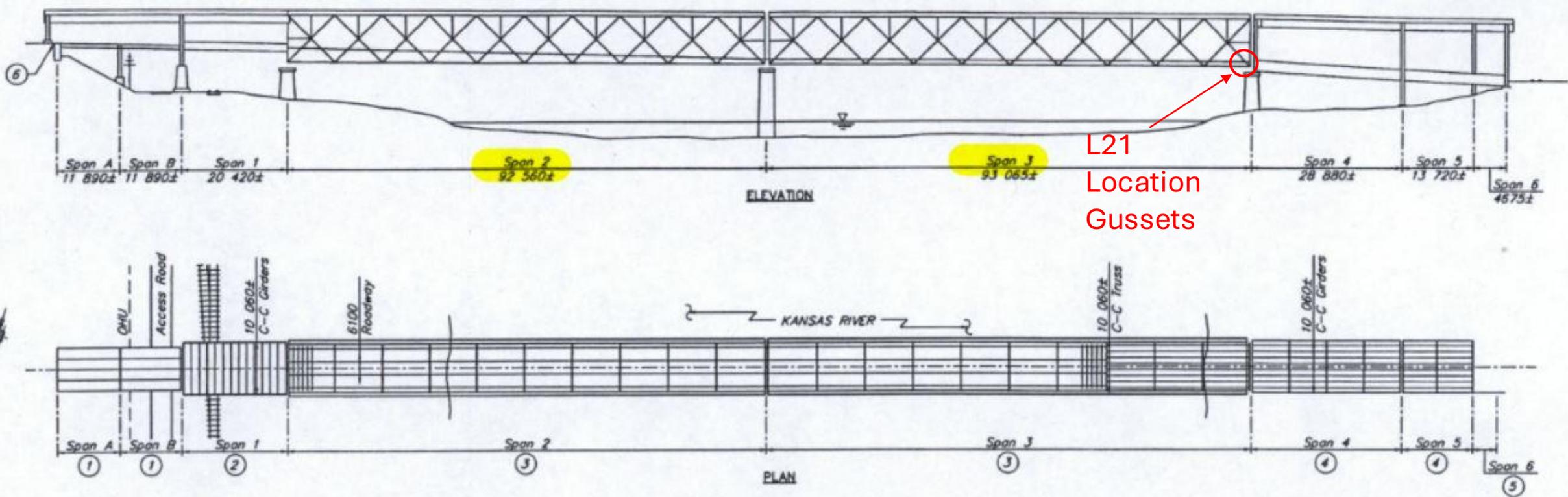
- Load Rating LFR
 - Approach Units
 - AASHTOWare BrR models of girders, floorbeams, and stringers
 - HDR spreadsheets for built-up columns
 - River Units
 - Added deterioration to existing BrR models from 2018 for trusses and floor system
 - HDR spreadsheets for gussets
 - Enveloped members, columns, and gussets as applicable utilizing symmetry of trusses and repetition of floor system and approach span geometry
 - Extensive load rating calculation package (3600 pages total)
- 35 HDR bridge staff involved in field observations and load ratings



Discovery of L21 Deterioration



L21
Location
Gussets



Discovery of L21 Deterioration

Discovery of L21 Deterioration

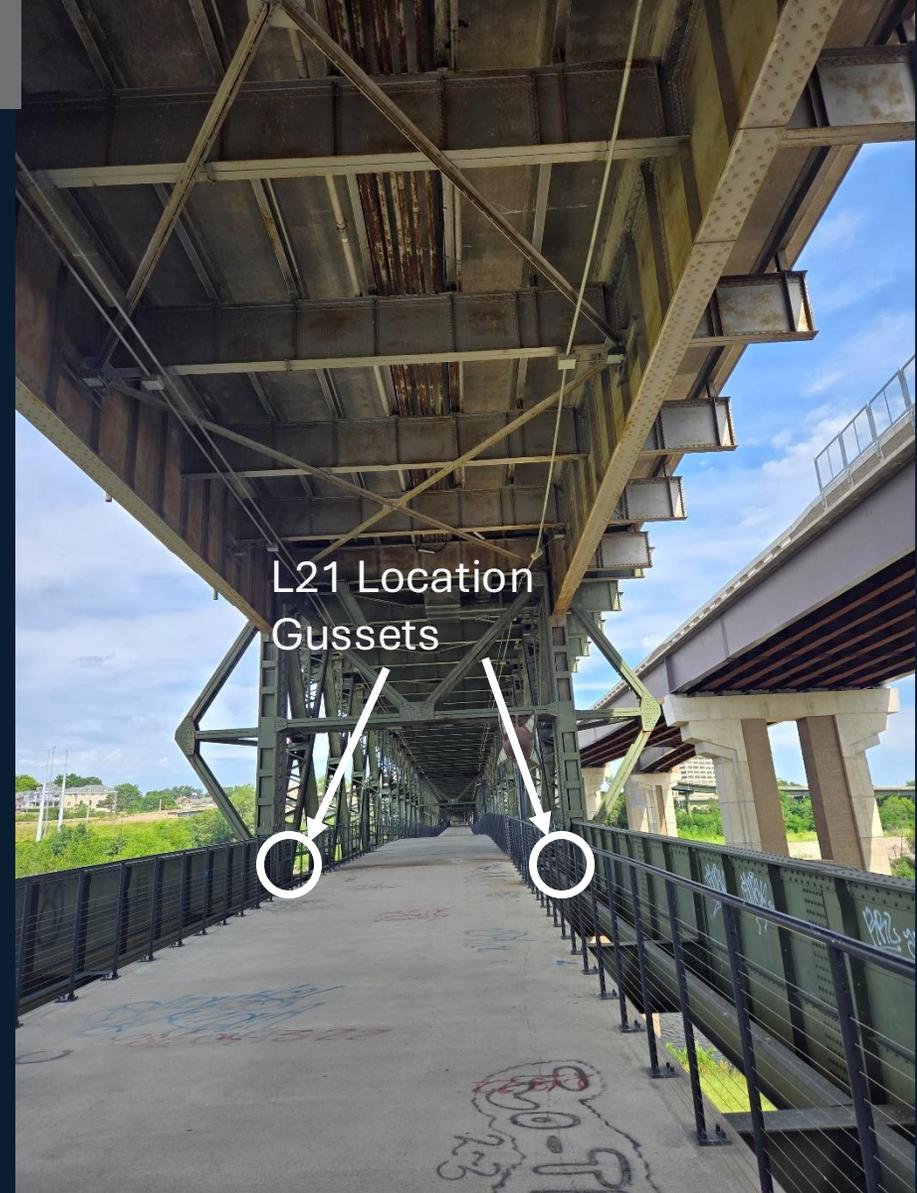


L21 Location
Gussets
(Both Trusses)

Discovery of L21 Deterioration



River Unit
Looking West



First Approach Unit Looking
West



Discovery of L21 Deterioration

View from Pedestrian Walkway of
L21B
(North Truss, South Truss Similar)



Vertical
L21-U21

Diagonal
M20-L21

Node L21





L21 Measurements

L21A South Truss

Inner Gusset Plate

1 = 0.193"

2 = 0.186"

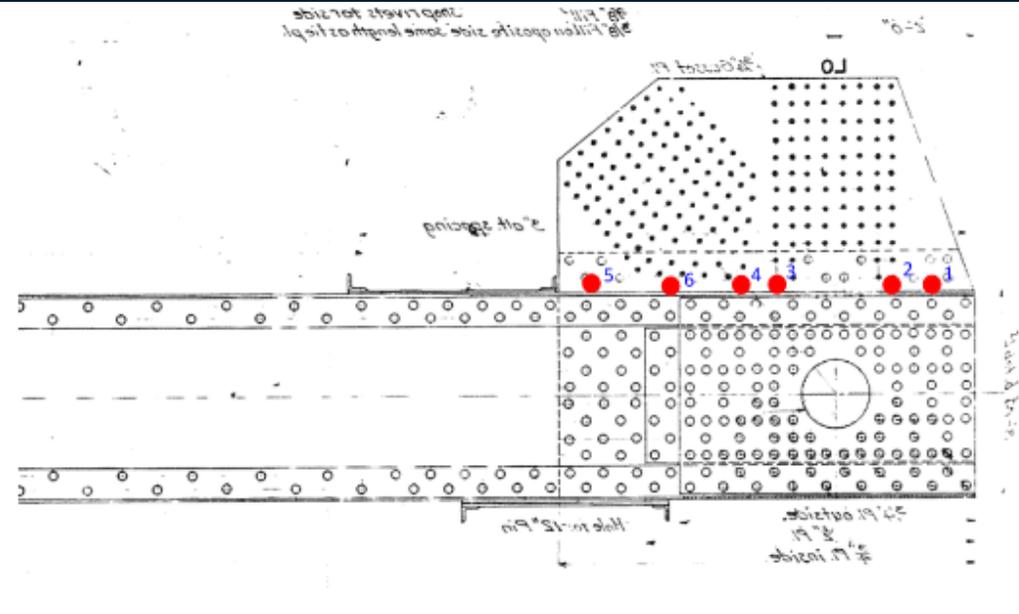
3 = 0.232"

4 = 0.208"

5 = 0.144"

6 = 0.18"

Avg = 0.19"



L21B North Truss

Inner Gusset Plate

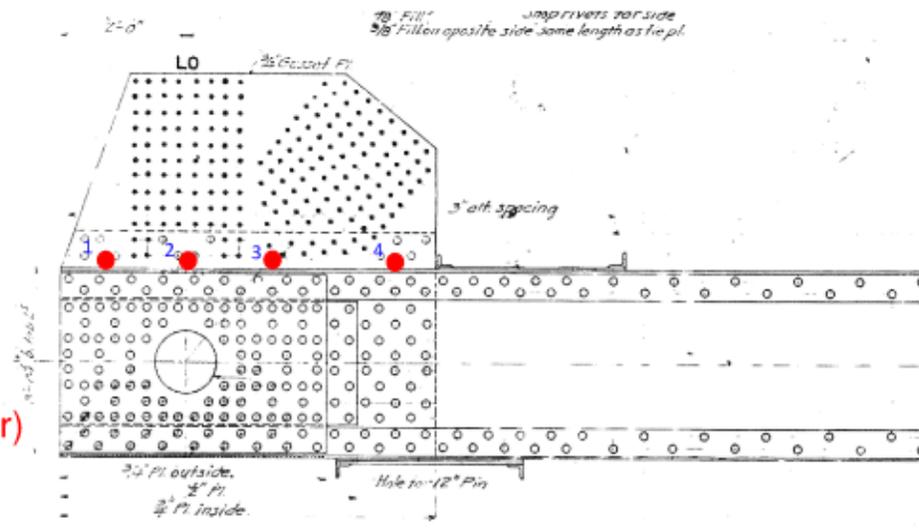
1 = 0.180"

2 = 0.32" (outlier)

3 = 0.198"

4 = 0.20"

Avg = 0.22" (includes outlier)



Findings at L21 Knuckle Gussets

- Heavy gusset plate corrosion found along shear plane
- As-built inner gusset plate thickness = $\frac{3}{4}$ "
- Significant capacity loss ~ 70-75% in inner plates
- Existing condition plate thickness
 - South Inner Gusset ~ 0.19"
 - North Inner Gusset ~ 0.22"

Assumptions

- 
- **Fy = 30ksi, per MBE**
 - **No pedestrian loading**
 - **LFR**
 - **HS20 Lane Loading for spans > 200ft**

Loads (HS20 Lane Load)

- **Diagonal M20L21 Unfactored: DL = 613 kips; Single-Lane LL+IM = 52 kips**
- **Resultant Horizontal Shear Force, DL Only = 384 kips**
- **Horizontal Shear Force per Plate, DL = $384/2 = 192$ kips**
- **Single Lane LL+IM (Centered between trusses) Horizontal Shear Force per plate = 16.2 kips**

Capacity

Steel plate shear capacity = $\Omega \times 0.58(A_g)(f_y) = 214 \text{ kips @ } 30 \text{ ksi}$

Steel plate shear capacity = $\Omega \times 0.58(A_g)(f_y) = 235 \text{ kips @ } 33 \text{ ksi}$

Omega factor summarized in MBE L6B.2.6.3 and AASHTO LRFD C6.14.2.8.3

6.14.2.8.3—Shear Resistance	C6.14.2.8.3	6-186 THE MANUAL FOR BRIDGE EVALUATION, THIRD EDITION
<p>The factored shear resistance of gusset plates, V_r, shall be taken as the smaller value based on shear yielding or shear rupture.</p> <p>For shear yielding, the factored shear resistance shall be taken as:</p> $V_r = \phi_{vy} 0.58 F_y A_{vg} \Omega \quad (6.14.2.8.3-1)$ <p>where:</p> <ul style="list-style-type: none"> ϕ_{vy} = resistance factor for truss gusset plate shear yielding specified in Article 6.5.4.2 Ω = shear reduction factor for gusset plates taken as 0.88 A_{vg} = gross area of the shear plane (in.²) F_y = specified minimum yield strength of the gusset plate (ksi) <p>For shear rupture, the factored shear resistance shall be determined from Eq. 6.13.5.3-2.</p>	<p>The Ω shear reduction factor is used only in the evaluation of truss gusset plates for shear yielding. This factor accounts for the nonlinear distribution of shear stresses that form along a failure plane as compared to an idealized plastic shear stress distribution. The nonlinearity primarily develops due to shear loads not being uniformly distributed on the plane and also due to strain hardening and stability effects. The Ω-factor was developed using shear yield data generated in NCHRP Project 12-84 (Ocel, 2013). On average, Ω was 1.02 for a variety of gusset-plate geometries; however, there was significant scatter in the data due to proportioning of load between members, and variations in plate thickness and joint configuration. The specified Ω-factor has been calibrated to account for shear plane length-to-thickness ratios varying from 85 to 325.</p> <p>Failure of a full width shear plane requires relative mobilization between two zones of the plate, typically along chords. Mobilization cannot occur when a shear plane passes through a continuous member; for instance, a plane passing through a continuous chord member that would require shearing of the member itself.</p>	<p>L6B.2.6.3—Gusset Plate Shear Resistance</p> <p>Gusset plates shall be load rated for shear yielding and shear rupture on relevant partial and full shear failure plane widths.</p> <p>Yielding:</p> $C = \phi_{vy} (0.58) F_y A_g \Omega \quad (L6B.2.6.3-1)$ <p>Rupture:</p> $C = \phi_{vr} (0.58) F_u A_n \quad (L6B.2.6.3-2)$ <p>where:</p> <ul style="list-style-type: none"> ϕ_{vy} = resistance factor for gusset plate shear yielding taken as 1.00 F_y = specified minimum yield strength of the gusset plate given in AASHTO Standard Specifications Table 10.2A (ksi) A_g = gross area of the plate resisting shear (in.²) Ω = shear reduction factor for gusset plates taken as 0.88 ϕ_{vr} = resistance factor for gusset plate shear rupture taken as 0.85 F_u = specified minimum tensile strength of the gusset plate given in AASHTO Standard Specifications Table 10.2A (ksi) A_n = net area of the plate resisting shear (in.²)

Load Ratings 0.64 k/ft (Assumes no ped loading)

○ Operating Rating Factor (ORF) = $(\text{Capacity} - 1.3\text{DL}) / (1.3 \text{ LL} + \text{IM})$

ORF with single lane on center of bridge = **0 @ 30 ksi**

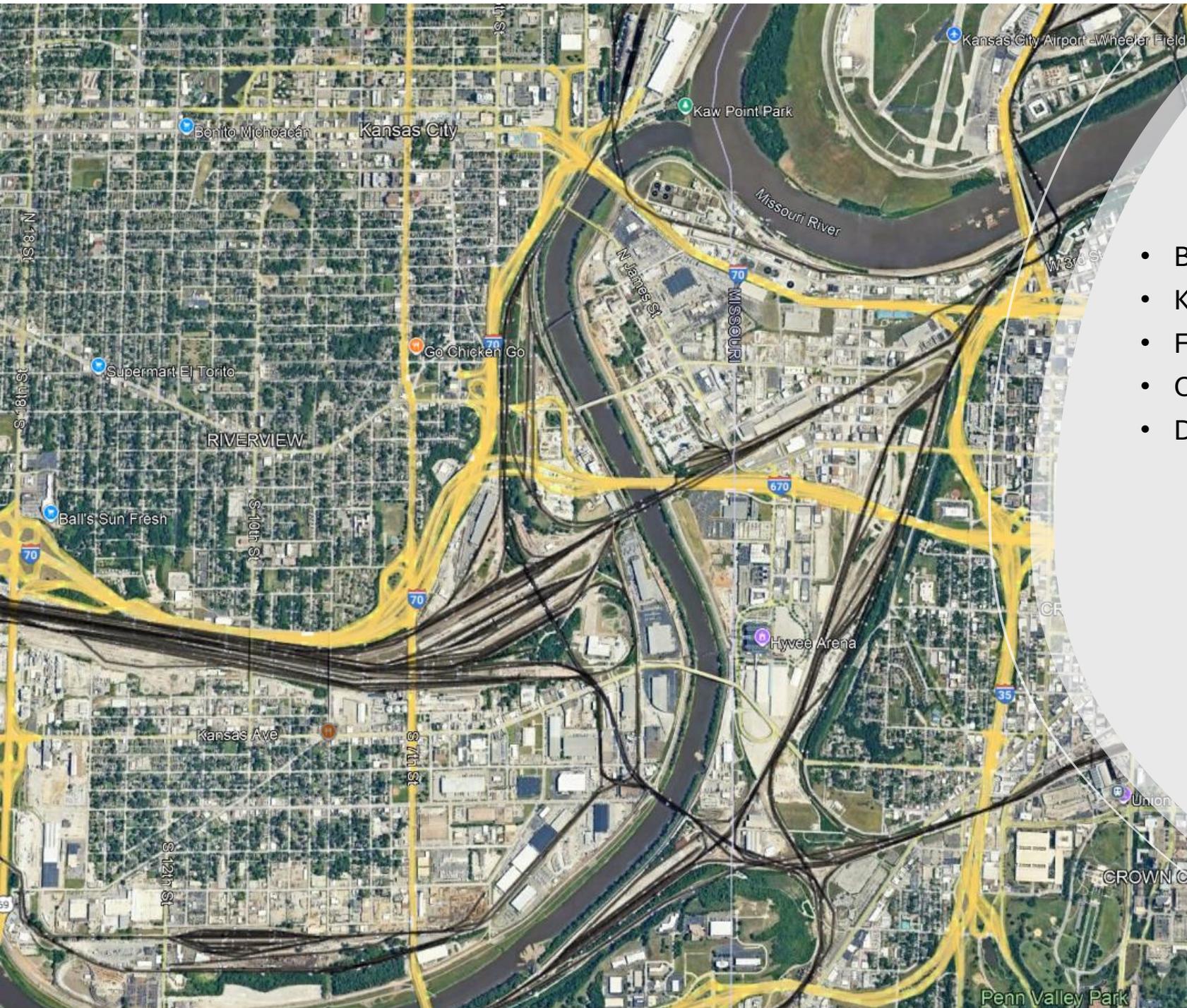
ORF with single lane on center of bridge = **0.46 @ 33 ksi**

○ Check with Rating Factors; $(\text{Capacity} - 1.12\text{DL}) / (1.3 \text{ LL} + \text{IM})$

RF with single lane on center of bridge = 1.07 @ 30 ksi

○ Check with Rating Factors; $(\text{Capacity} - 1.24\text{DL}) / (1.3 \text{ LL} + \text{IM})$

RF with single lane on center of bridge = 1.01 @ 33 ksi

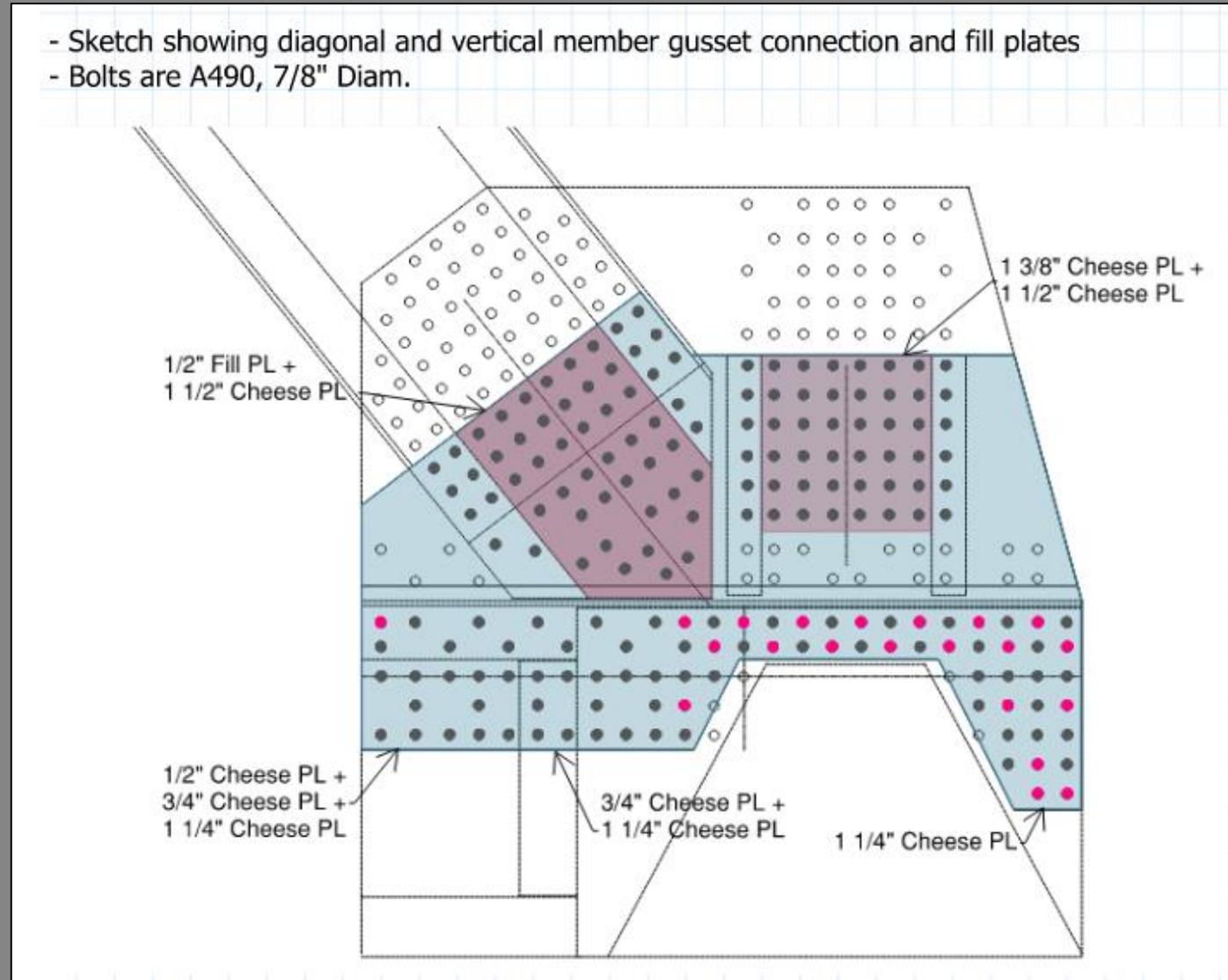


Bridge Closure Impacts

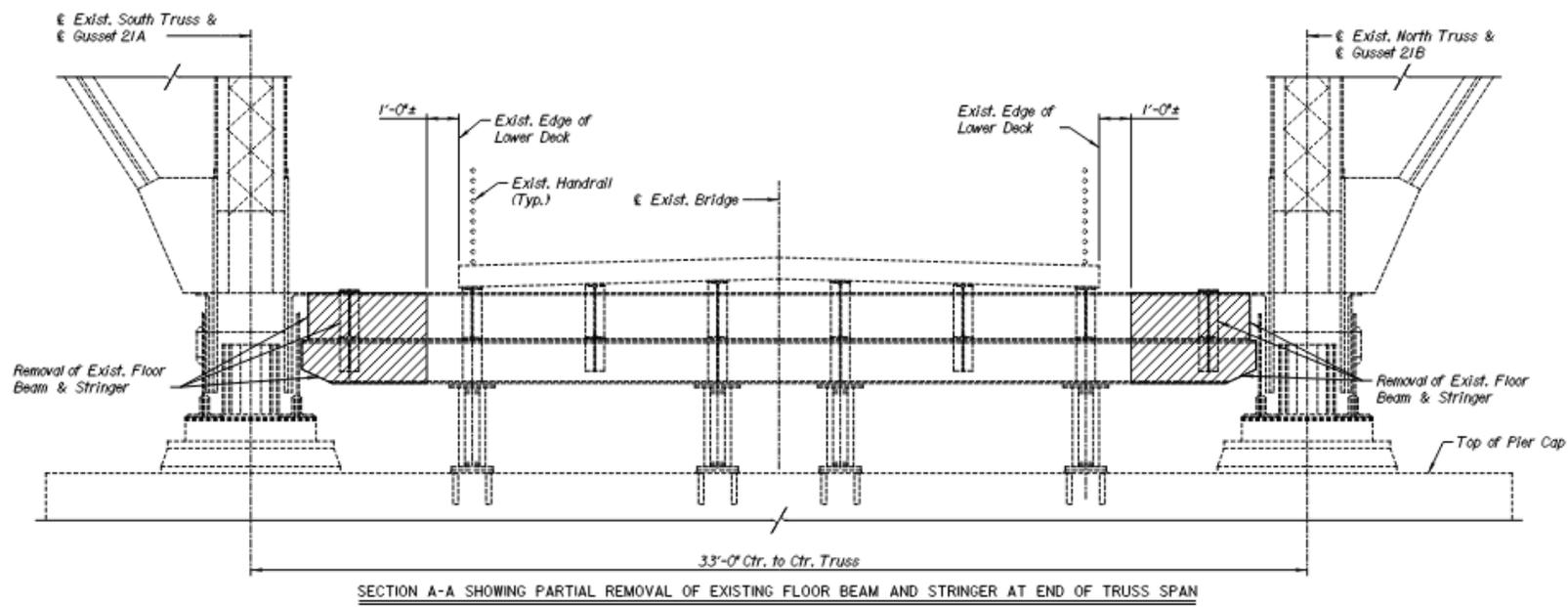
- Bridge Closure
- KCK, KCMO connection
- Fairfax District
- Central Ave, Kansas Ave both closed
- Detour to 670

Repair Connection Design

- Determine capacity of diagonal and vertical member connection to repair plate
 - Bearing capacity (L6B.2.6.1)
 - Slip critical (10.57.3)
 - Bolt Shear Capacity (L6B.2.6.1)
 - Fill plate reduction factor varies throughout repair connection
 - Ranged from 0.53 to 0.62
- Determine capacity of final eccentric connection
 - Determine centroid of all bolt groups
 - Bolt Shear controlled, critical point on lower portion of connection
- End Result
 - Added bolts in lower connection
 - 7/8" Diameter HS Bolts, 8" Length
 - 1" Proposed Gusset

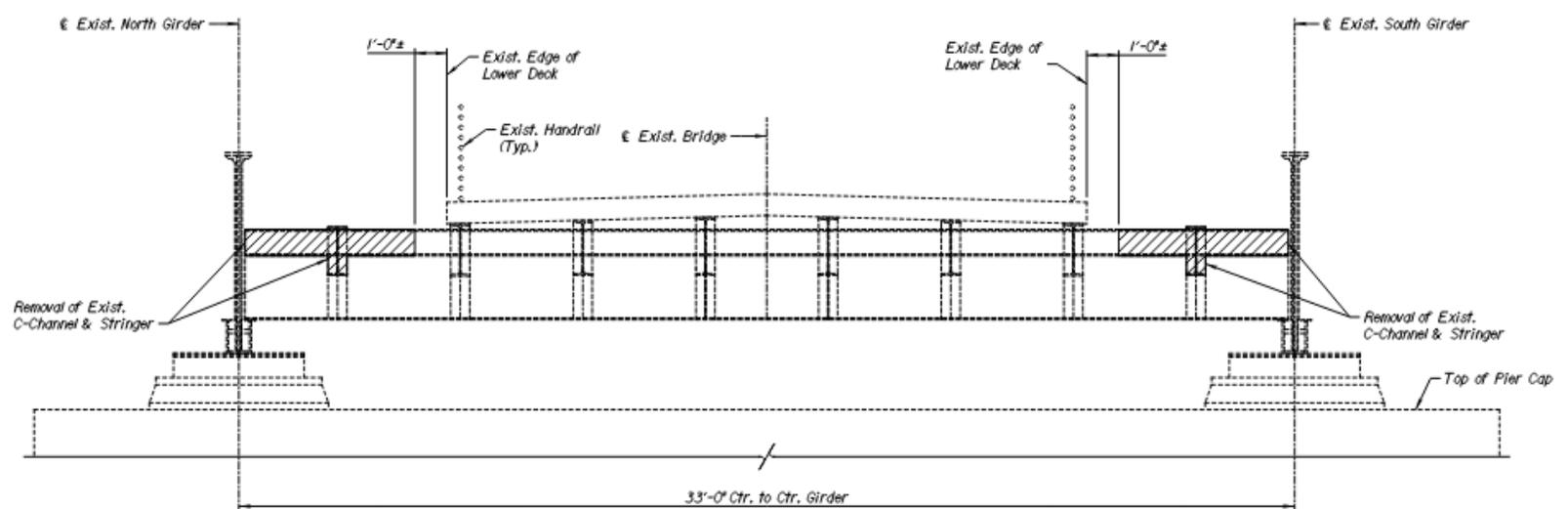


STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS	70-105 KA-7583-02	2024	14	27



SECTION A-A SHOWING PARTIAL REMOVAL OF EXISTING FLOOR BEAM AND STRINGER AT END OF TRUSS SPAN

 Indicates material to be removed



SECTION B-B SHOWING PARTIAL REMOVAL OF EXISTING FLOOR BEAM AND STRINGER AT END OF LOWER DECK APPROACH SPAN

Notes:
 For location of Section A-A and B-B, see Sheet No. 13
 As directed by the Engineer, the Contractor shall touch up paint on all existing steel cut or damaged by removals. This work is subsidiary to the bid item "Bridge Painting (AI Epoxy Mastic w/ Acrylic Sys)".
 Contractor shall take care not to damage existing girders, stringers, floorbeams, deck, handrail bearings, and truss members to remain. For the convenience of the Contractor, if existing handrail is removed, Contractor shall re-install it in-kind at no additional cost to the state.

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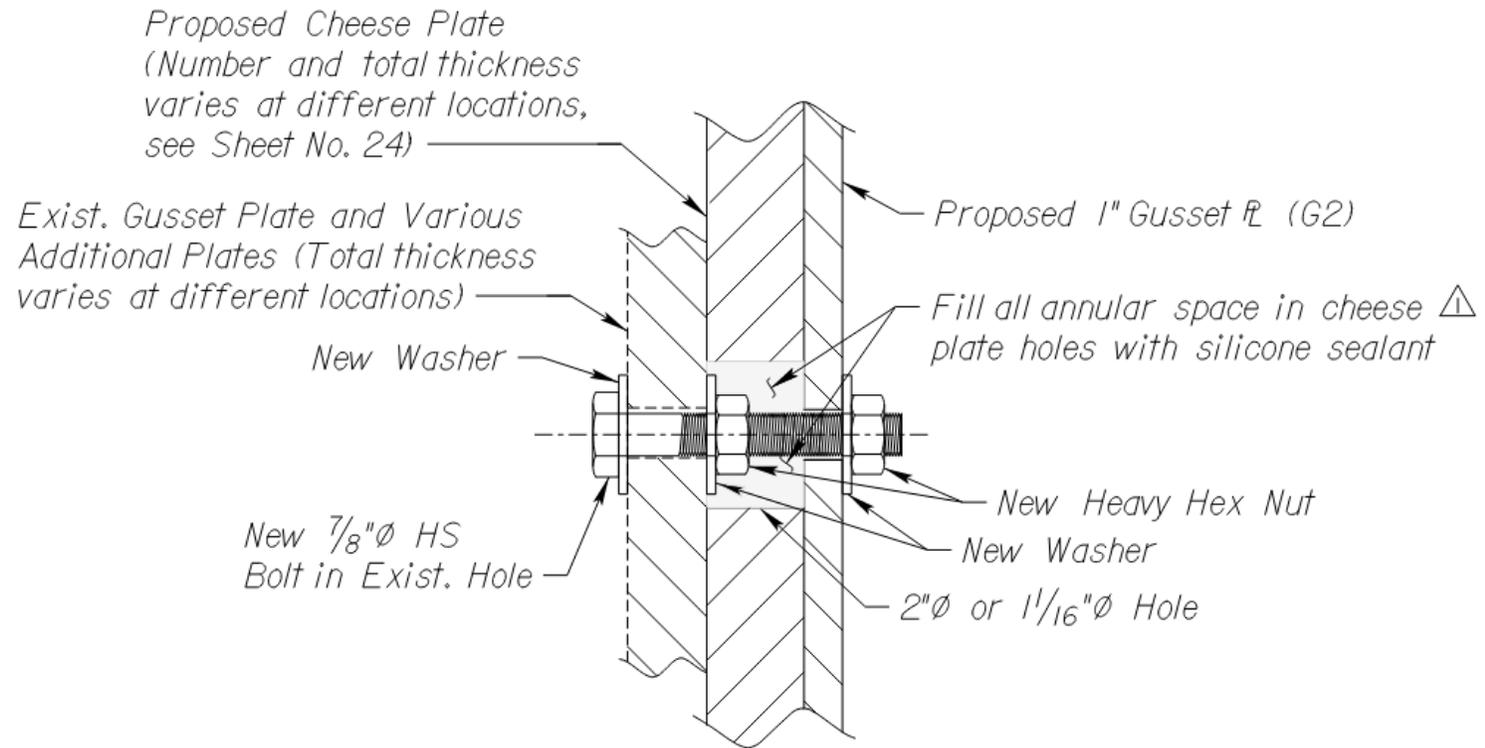
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DESIGNER	CHECKED	APPROVED	IN CHARGE	DATE
DESIGNER	REVISION	APPROVED	REVISION	DATE

Bolt Installation

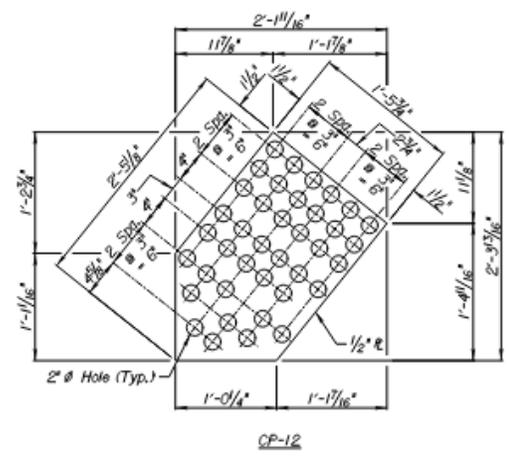
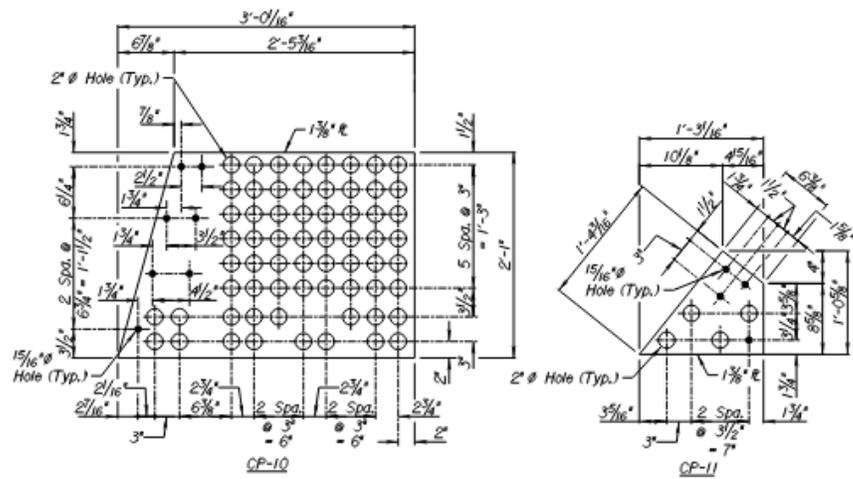
- Double Nut Detail and Procedure – HDR used on Texas Corpus Christi Harbor Bridge Rehabilitation in 2009

RIVET REMOVAL PROCEDURE

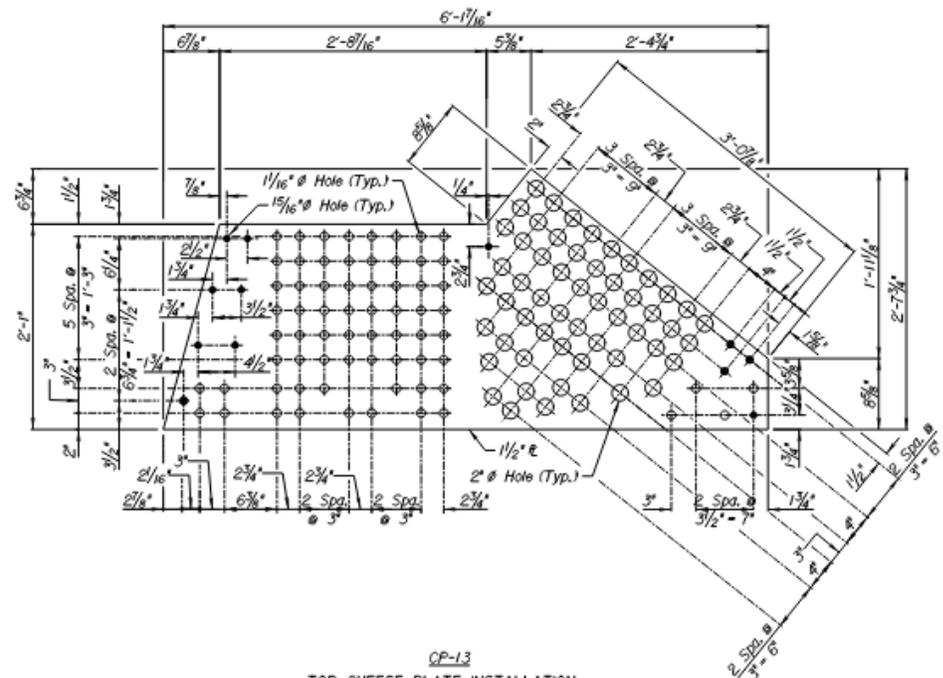
1. Remove individual existing rivets at locations shown in the removal detail. A maximum of 4 rivets may be removed at any given time.
2. Repair any damaged paint resulting from the rivet removal.
3. Install New HS Bolts with nut in existing rivet holes. See "Rivet Replacement Detail" on this sheet.
4. Tighten nut to 30 kips of pretension on the bolt using Contractor provided calibrated wrench.



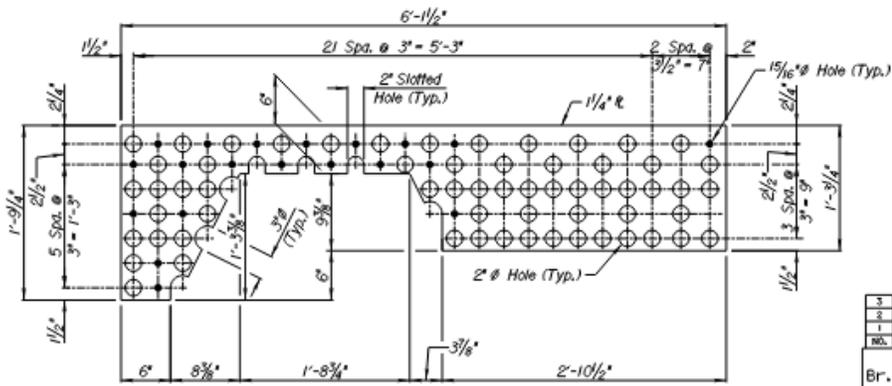
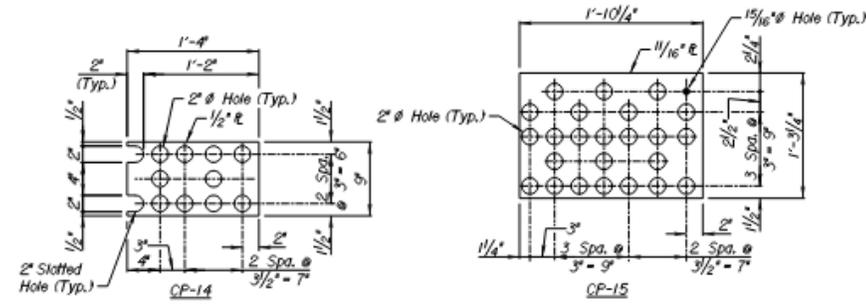
FINAL BOLT INSTALLATION DETAIL - EXISTING RIVET LOCATION



TOP CHEESE PLATE INSTALLATION



TOP CHEESE PLATE INSTALLATION

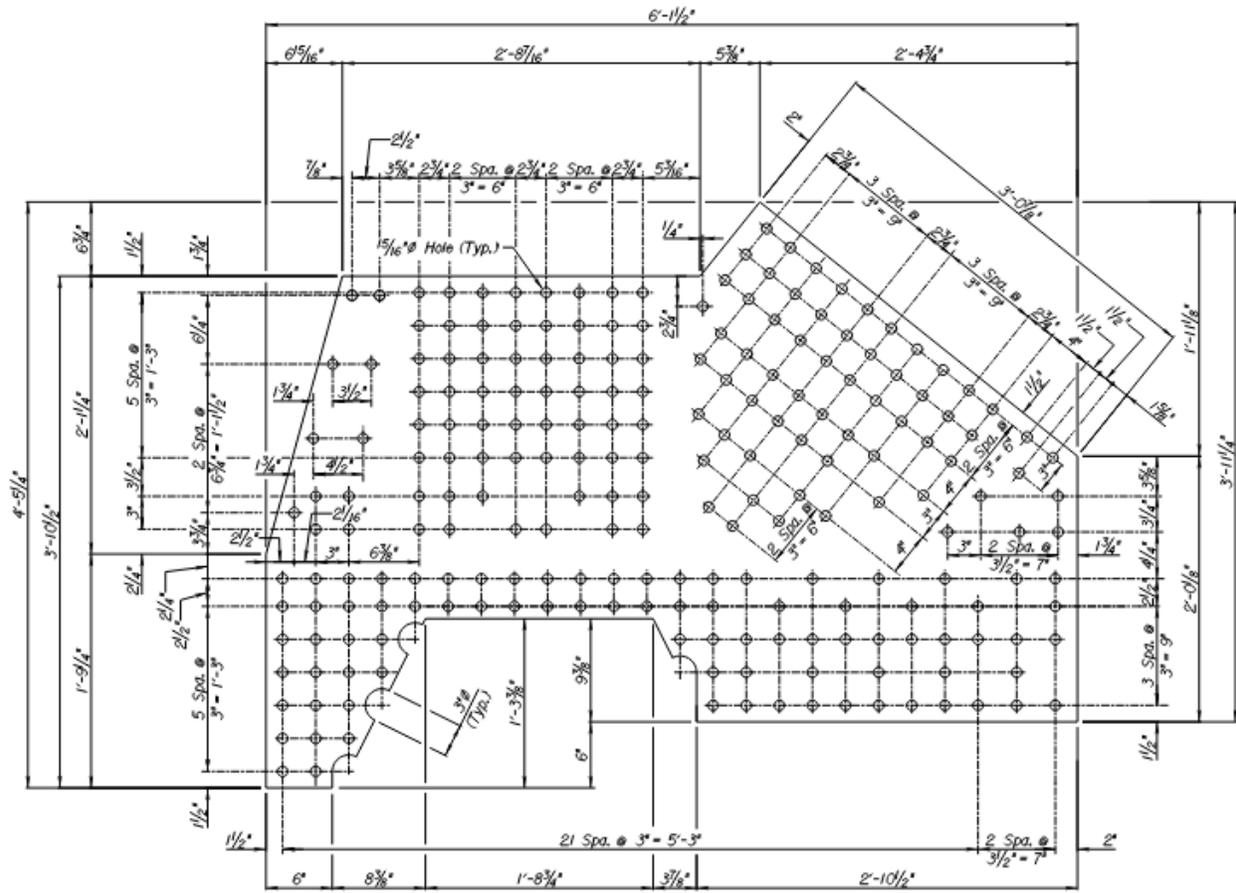


BOTTOM CHEESE PLATE INSTALLATION

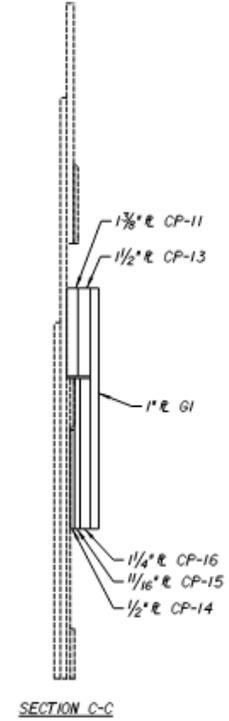
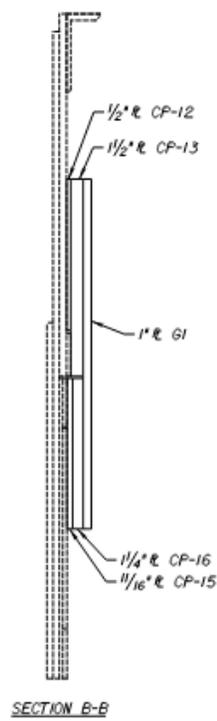
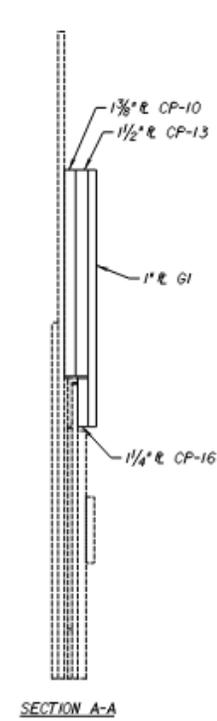
Notes:
 All holes in cheese plate shall be shop drilled. All measurements are based on preliminary field measurements. Contractor to field verify all measurements prior to fabrication of plates. Any differences in measurements need to be reported back to the Engineer prior to fabrication of plates.

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Br. No. 70-105-17.40 (031)				
L21A INSIDE FACE GUSSET REPAIRS (2 OF 4)				
EB I-70 OVER KANSAS RIVER				
Proj. No. 70-105 KA-7583-02 Wyandotte Co.				
SHEET NO. OF ISSUED	APP'D			
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L2IA INSIDE GUSSET PLATE INSTALLATION



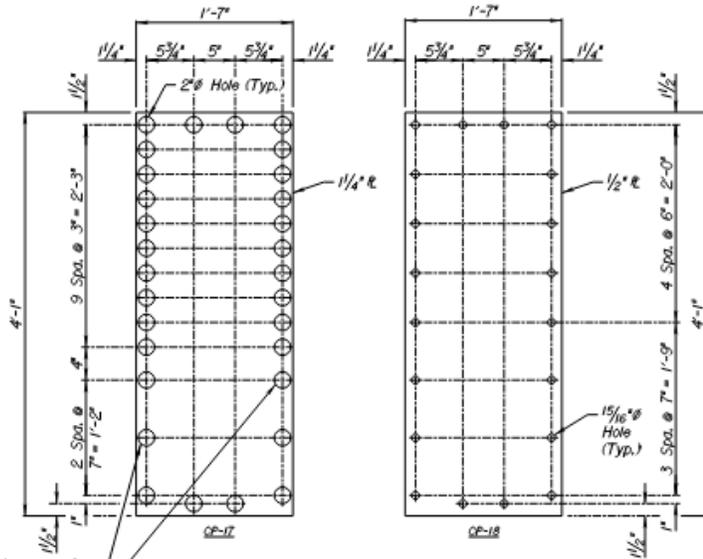
Notes:
For Location of Section A-A, B-B and C-C, see Sheet No. 18

All measurements are based on preliminary field measurements. Contractor to field verify all measurements prior to fabrication of plates. Any differences in measurements need to be reported back to the Engineer prior to fabrication of plates.

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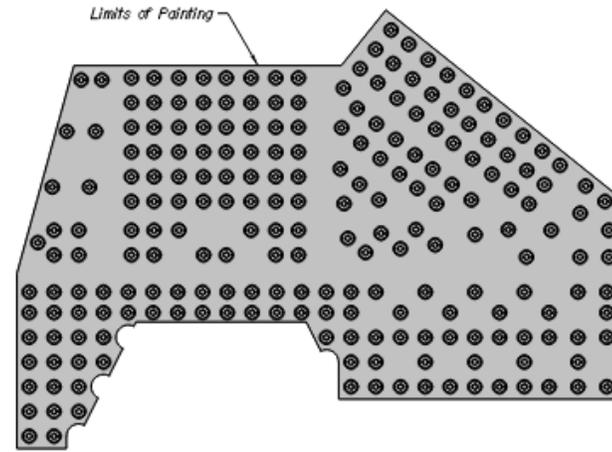
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EB I-70 OVER KANSAS RIVER				
Proj. No. 70-105 KA-7583-02 Wyandotte Co.				
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STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS	70-105 KA-7583-02	2024	21	27

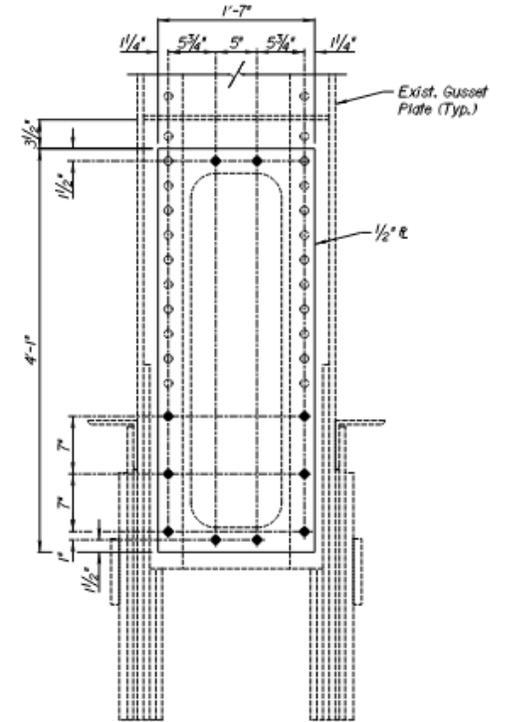


△ Fill all annular space in cheese plate holes with silicone sealant (Typ.)

ACCESS PORTAL COVER PLATE INSTALLATION



L21A GUSSET INSIDE FACE PAINT DETAIL



ACCESS PORTAL COVER PLATE EAST SIDE OF KNUCKLE

Note:
After installation of Access Portal Cover Plate, clean and paint the cover plate and all bolts, washers and nuts.

See "Final Bolt Installation Detail - Field Drilled Holes" and "Final Bolt Installation Detail - Existing Rivet Location" on Sheet No. 18.

Legend

- Existing rivet, to remain
- Existing rivet holes filled with new 7/8" HS Bolt
- Field Drilled 15/16" Hole

△ 2024-10-16; Added silicone sealant to cheese plate holes

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2				
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NO.	DATE	REVISIONS	BY	APP'D
KANSAS DEPARTMENT OF TRANSPORTATION				
Br. No. 70-105-17.40 (031)				
L21A INSIDE FACE GUSSET REPAIRS (4 OF 4)				
EB I-70 OVER KANSAS RIVER				
Proj. No. 70-105 KA-7583-02 Wyandotte Co.				
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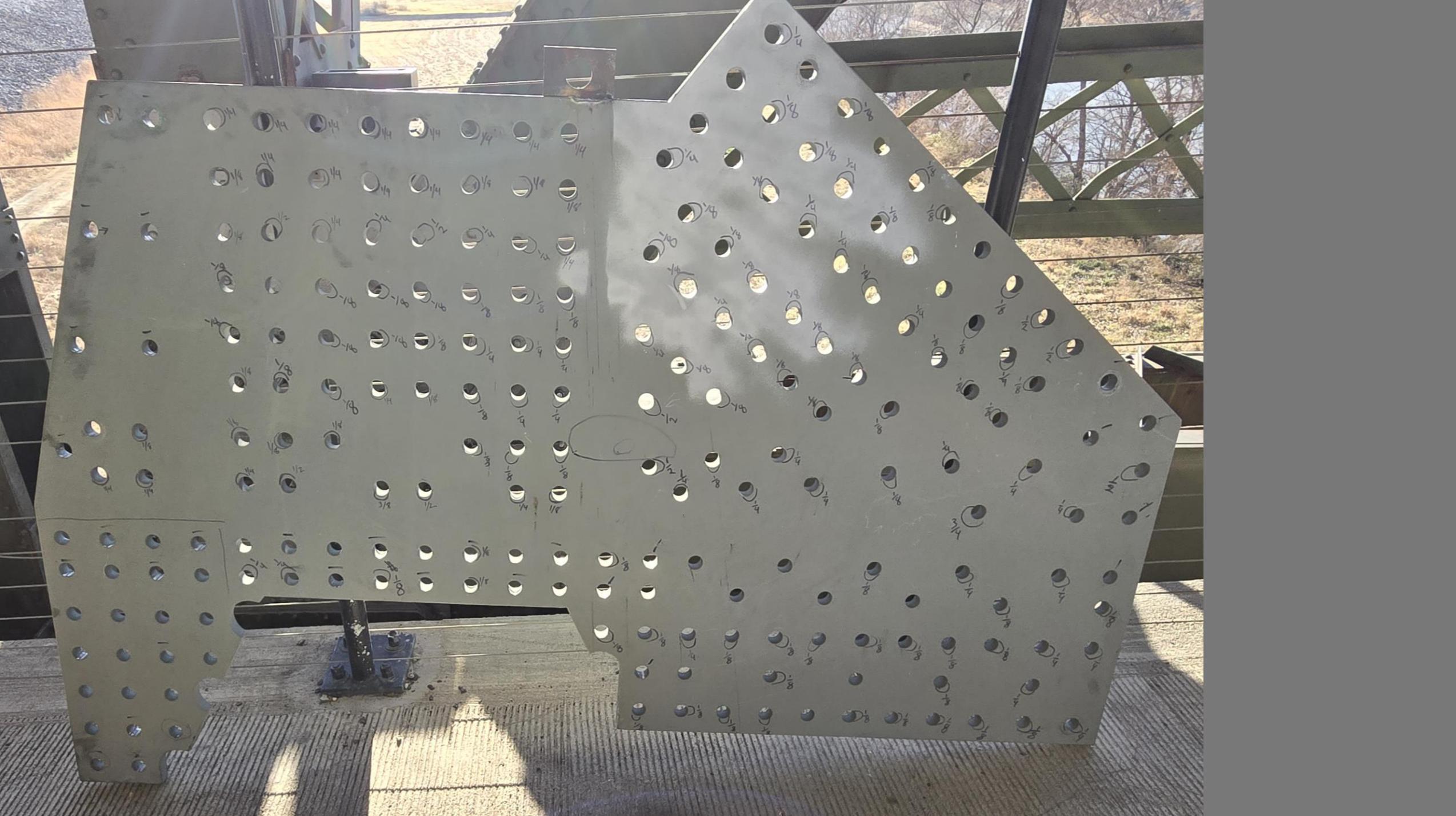
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 Plot Date: 10-16-24











Gusset Repair Photos



L21 South Inner Gusset Repair



L21 North Inner Gusset Repair

Gusset Repair Photos





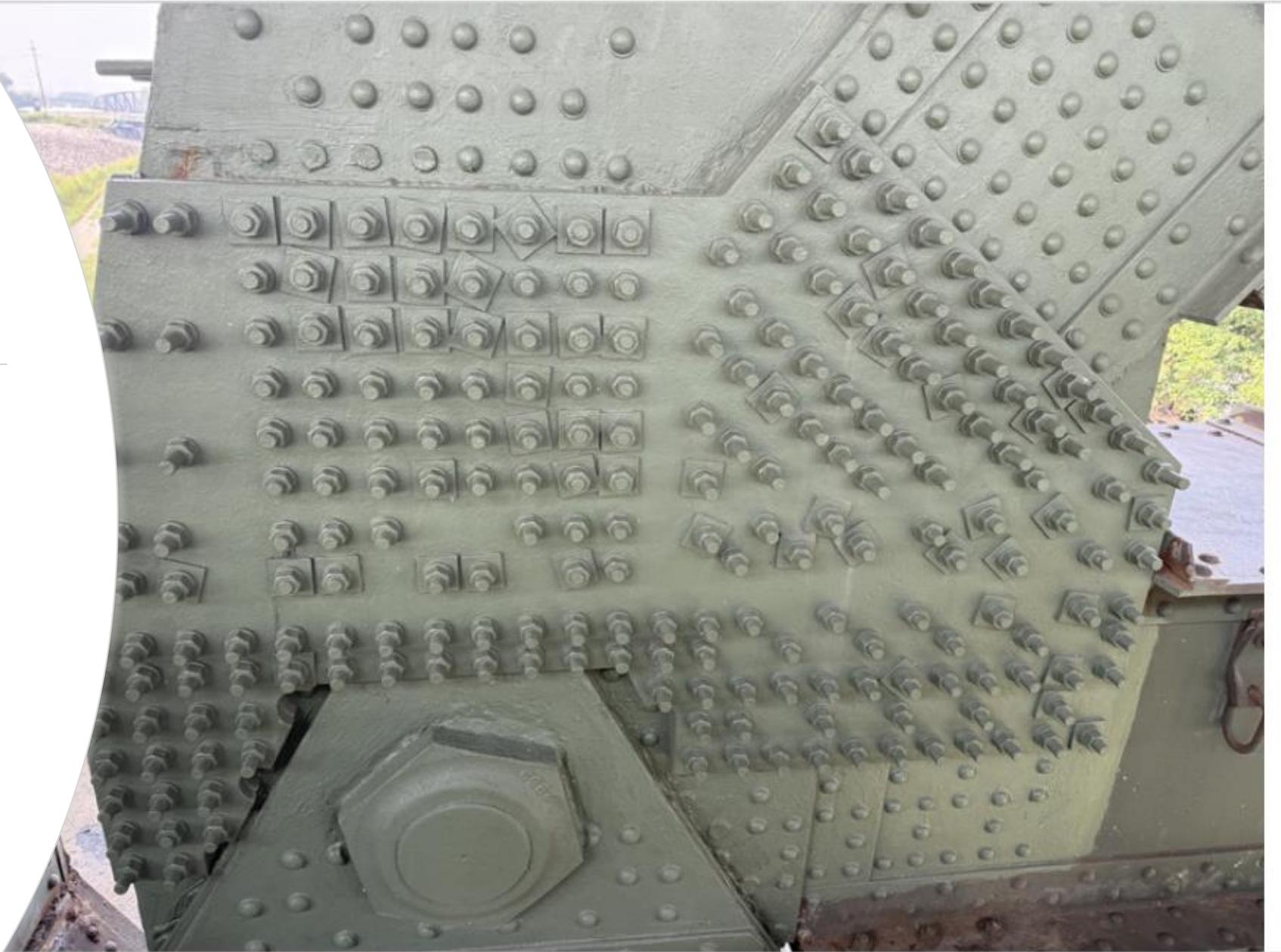




45. L21B, view of repaired interior gusset plate

Repair Timeline

- September 5th, 2024 – Bridge Shut Down, emergency traffic control in place, remainder of structural safety assessment accelerated with additional rope access team
- October 10th, 2024 – Plans delivered to KDOT
- November 7th, 2024 – Precon meeting, construction by Clarkson Construction Company begins
- December 20th, 2024 – Construction complete, Bridge Reopened
- February 7th, 2025 – Structural Safety Assessment Report and Recommendations Complete



10. Typical inside gusset repair

Special Thanks

- HDR working quickly and diligently to get bridge back open safely.
- KDOT staff for responding to the emergency and acting on it swiftly.
- KDOT Area Staff Ryan Barrett and Amy Pope for assisting with shutdown and detour in the middle of a workday.
- Clarkson Construction Company for completing the complicated repair.



Questions?

