

Sunshine Bridge Emergency Repair

2024

ALABAMA TRANSPORTATION CONFERENCE

2/6/2024

Chris B. Guidry, P.E.

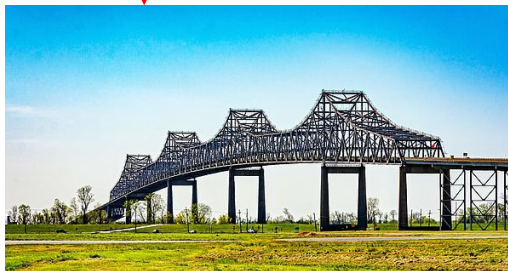
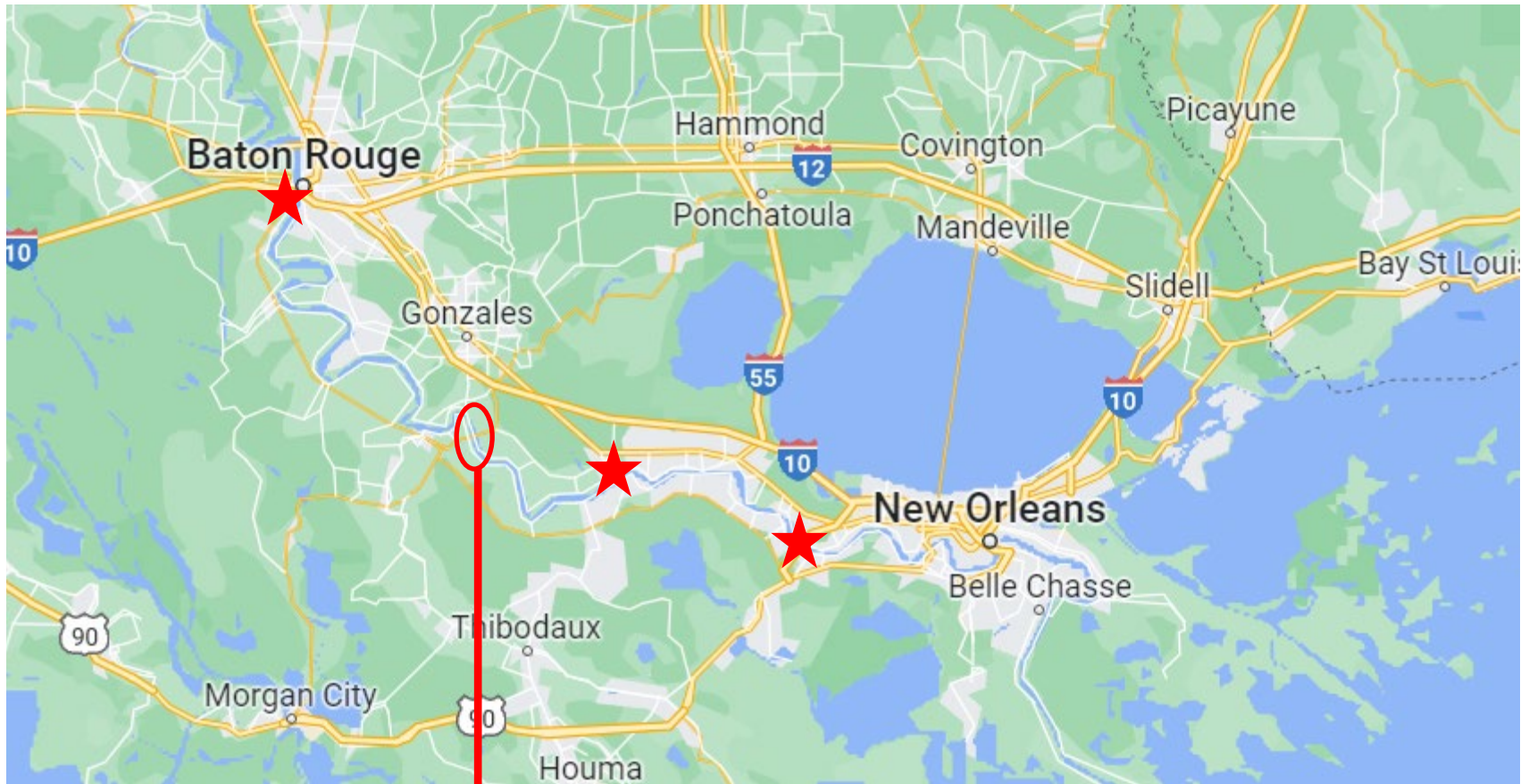
LADOTD Asst. Bridge Design Administrator



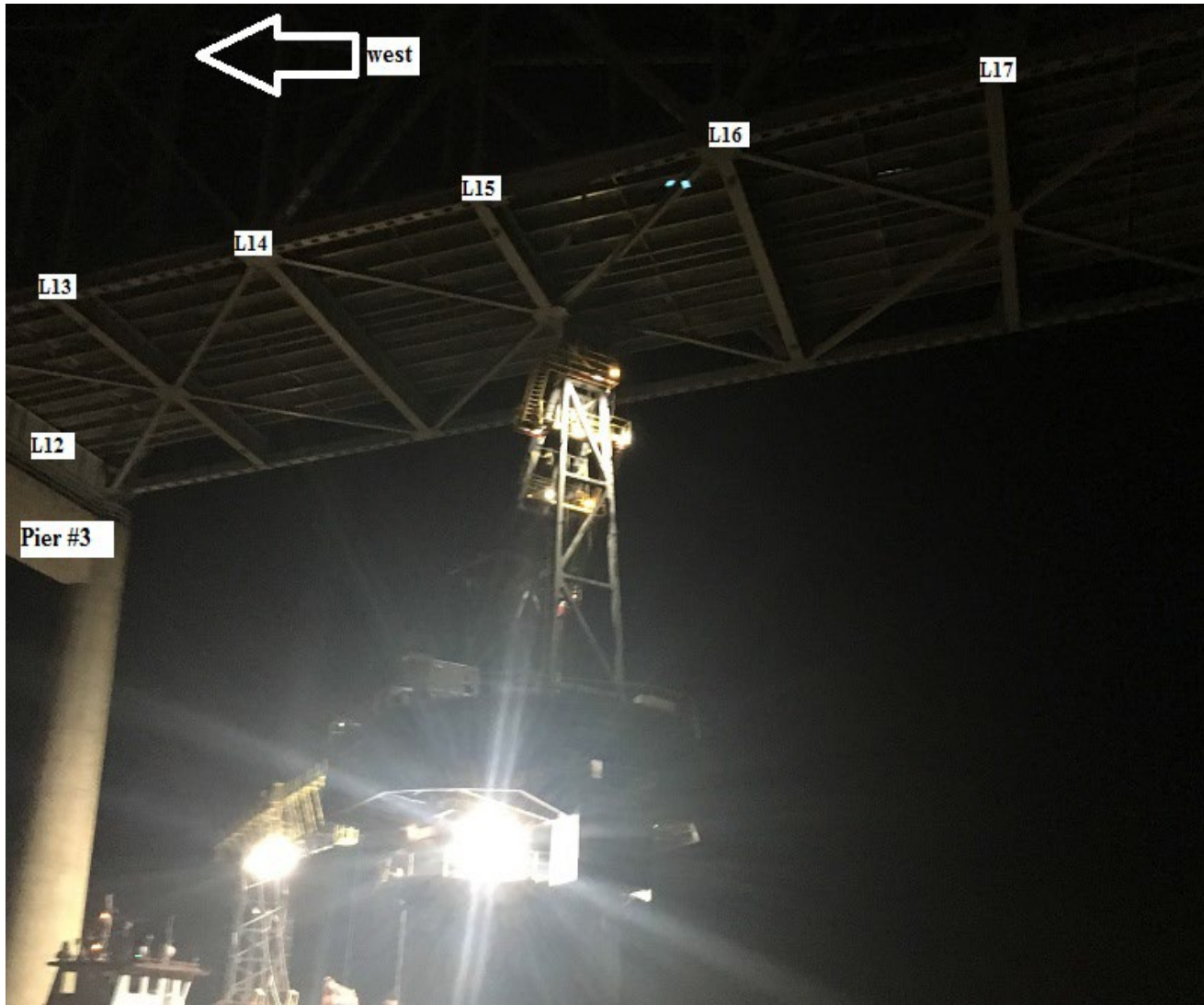
OUTLINE

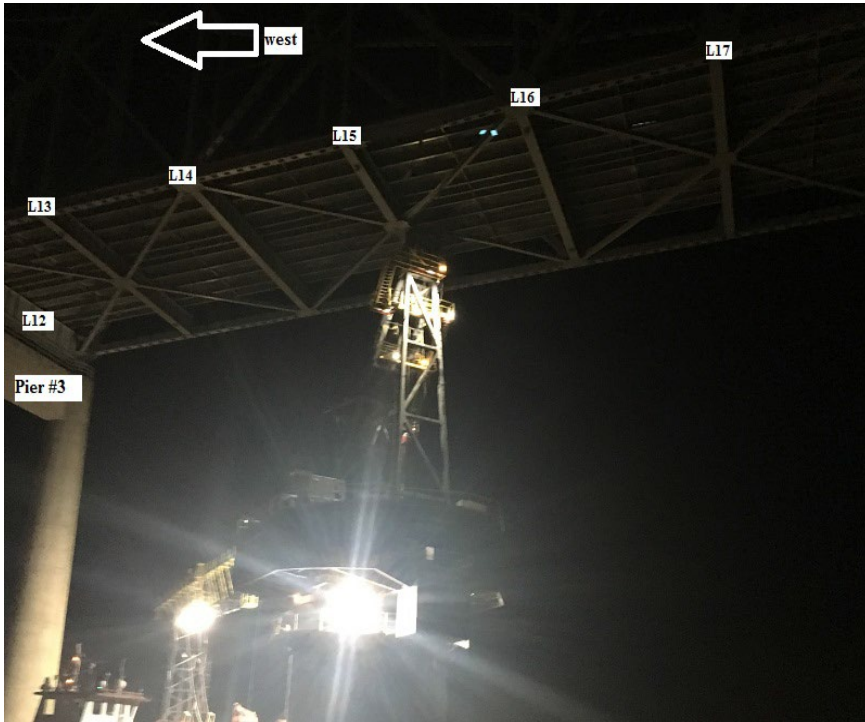
- Incident & Damages
- Repair
- Project Team
- Timeline

Incident



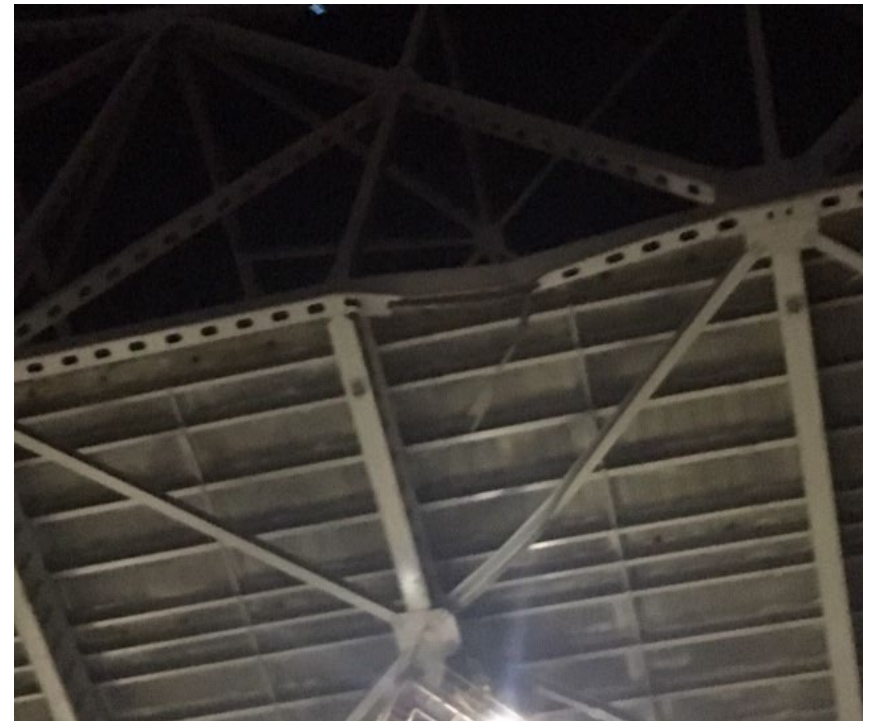
Sunshine Bridge over
Mississippi River on LA70
Built 1963
ADT 17,100



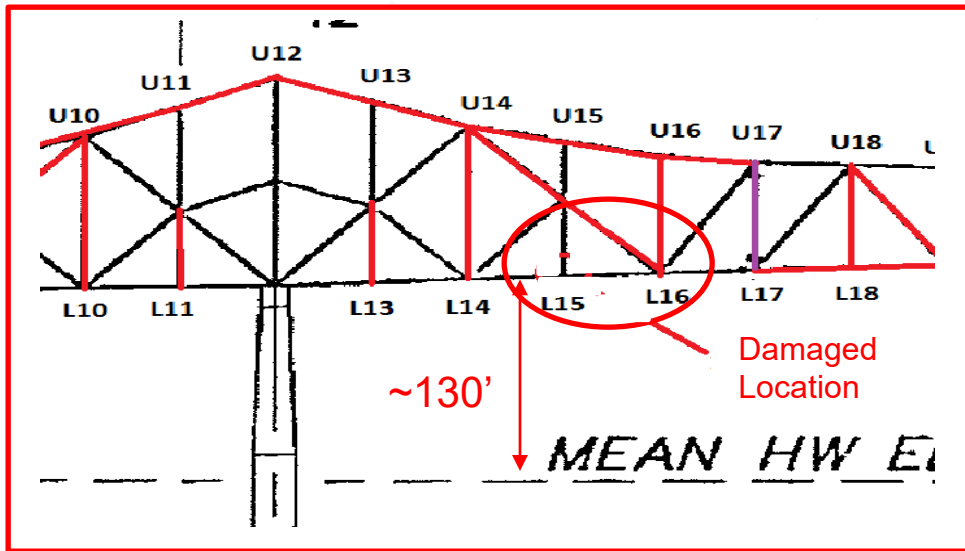
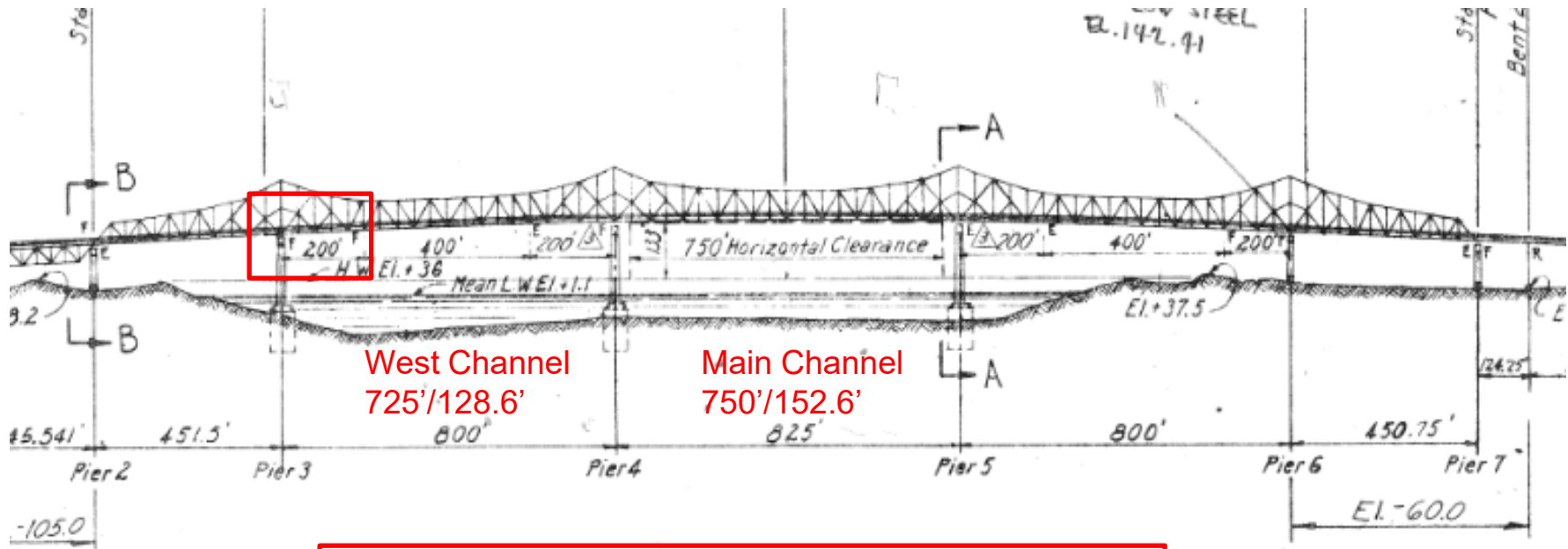


10/12/2018, 1:41am

Barge Crane– owned by Marquette Transportation Company Gulf-Inland, LLC strikes lower chord of truss

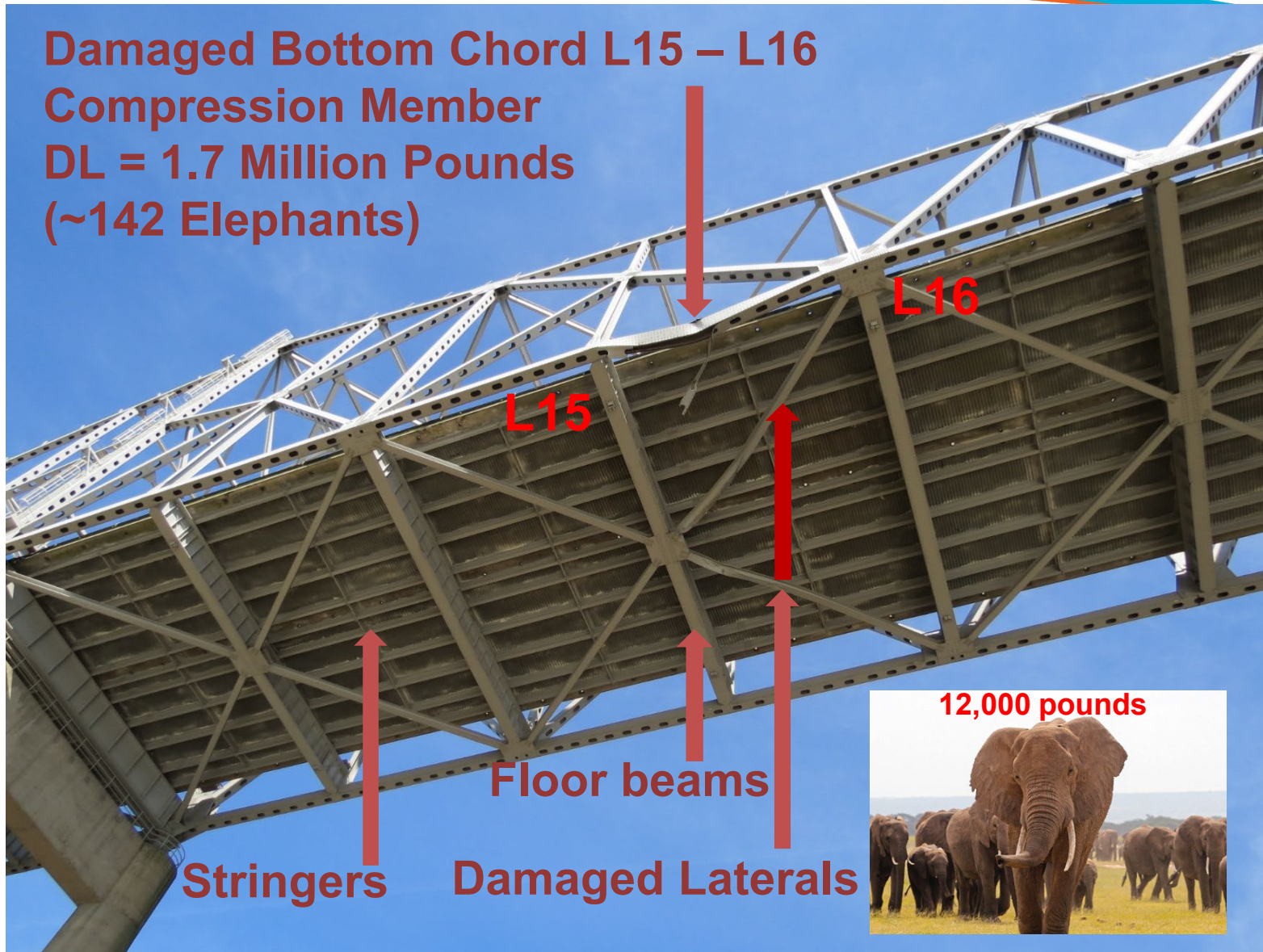


Probable Cause – inadequate voyage planning; vertical clearance information used by the pilot didn't reflect the actual clearance. (NTSB)





Damaged Bottom Chord L15 – L16
Compression Member
DL = 1.7 Million Pounds
(~142 Elephants)



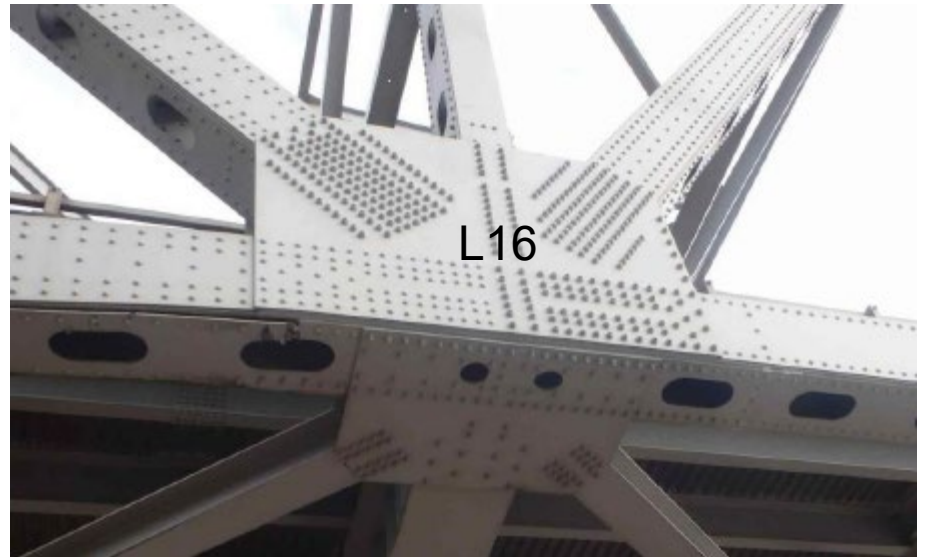
Where did these elephants go after impact?
How many trapped in the damaged chord?



APPROXIMATELY 16"
LATERAL DEFLECTION









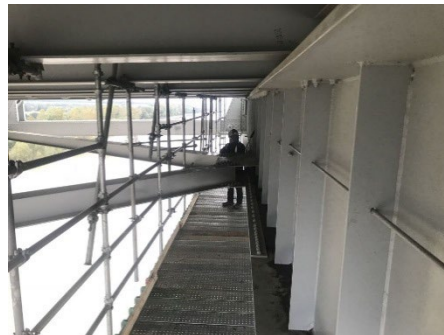
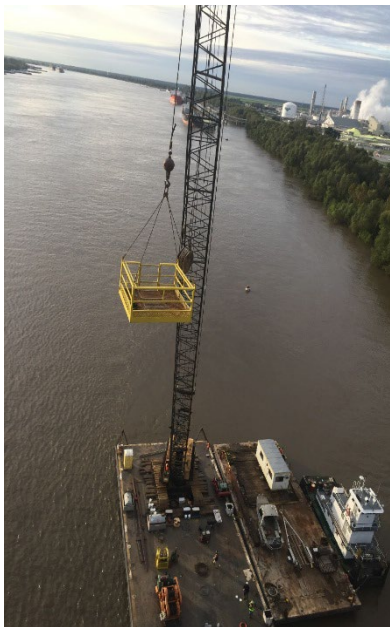
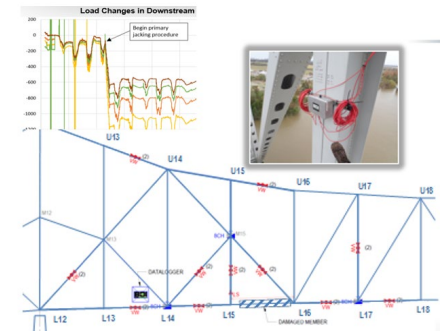
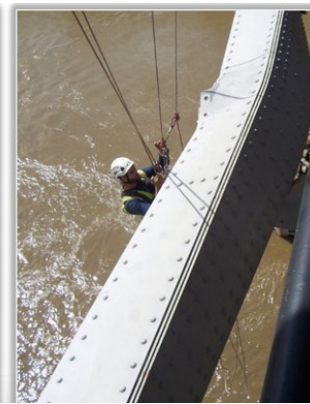


DEFECT LOCATION ID	PANEL	JOINT	MEMBER	UPSTREAM/ DOWNSTREAM	DEFECT TYPE	QUANTITY	REMARKS	PHOTOGRAPH	INSPECTOR	DATE ADDED TO TABLE
1	15-16	13	STRINGER 1	D5	CR. BRG STIFF. WELD	1	LEFT BOTTOM FLANGE	037-038	MJM	11/5/2018
1	15-16	13	STRINGER 1	D5	DAMAGED FASTENER	4	LEFT AND RIGHT BRG BOLTS (TWO EACH SIDE)	033,036-038	MJM	11/5/2018
1	15-16	13	STRINGER 1	D5	SHIFTED BRG	1	1/8" - 1/4" TO DONALDSONVILLE	033,036-038	MJM	11/5/2018
2	15-16	13	STRINGER 2	D5	DAMAGED FASTENER	3	RIGHT DIAPHRAGM CONN.	039	MJM	11/5/2018
2	15-16	13	STRINGER 2	D5	DAMAGED FASTENER	3	LEFT DIAPHRAGM CONN.	6042	JWHC	12/3/2018
2	15-16	13	STRINGER 2	D5	CR. BRG STIFF. WELD	1	LEFT BOTTOM FLANGE	041-043	MJM	11/5/2018
2	15-16	13	STRINGER 2	D5	SHIFTED BRG	1	1/8" TO DONALDSONVILLE	041-043	MJM	11/5/2018
2	15-16	13	STRINGER 2	D5	CR. SOLE PLATE WELD	1	LEFT - TO BRG PLATE	042-043	MJM	11/5/2018
3	15-16	13	STRINGER 3	D5	CR. BRG STIFF. WELD	1	LEFT BOTTOM FLANGE	044	MJM	11/5/2018
3	15-16	13	STRINGER 3	D5	SHIFTED BRG	1	1/8" TO DONALDSONVILLE	044	MJM	11/5/2018
3	15-16	13	STRINGER 3	D5	DAMAGED FASTENER	6	LEFT AND RIGHT DIAPHRAGM CONN.	044	MJM	11/5/2018
4	15-16	13	STRINGER 4	D5	CR. BRG STIFF. WELD	1	RIGHT BOTTOM FLANGE	045	MJM	11/5/2018
4	15-16	13	STRINGER 4	D5	SHIFTED BRG	1	TO DONALDSONVILLE	045	MJM	11/5/2018
4	15-16	13	STRINGER 4	D5	CR. BRG STIFF. WELD	1	LEFT BOTTOM FLANGE	046-047	MJM	11/5/2018
4	15-16	13	STRINGER 4	D5	DAMAGED FASTENER	6	LEFT AND RIGHT DIAPHRAGM	046-047	MJM	11/5/2018



49 locations
160+ misc. damages

Repair



Preparation work



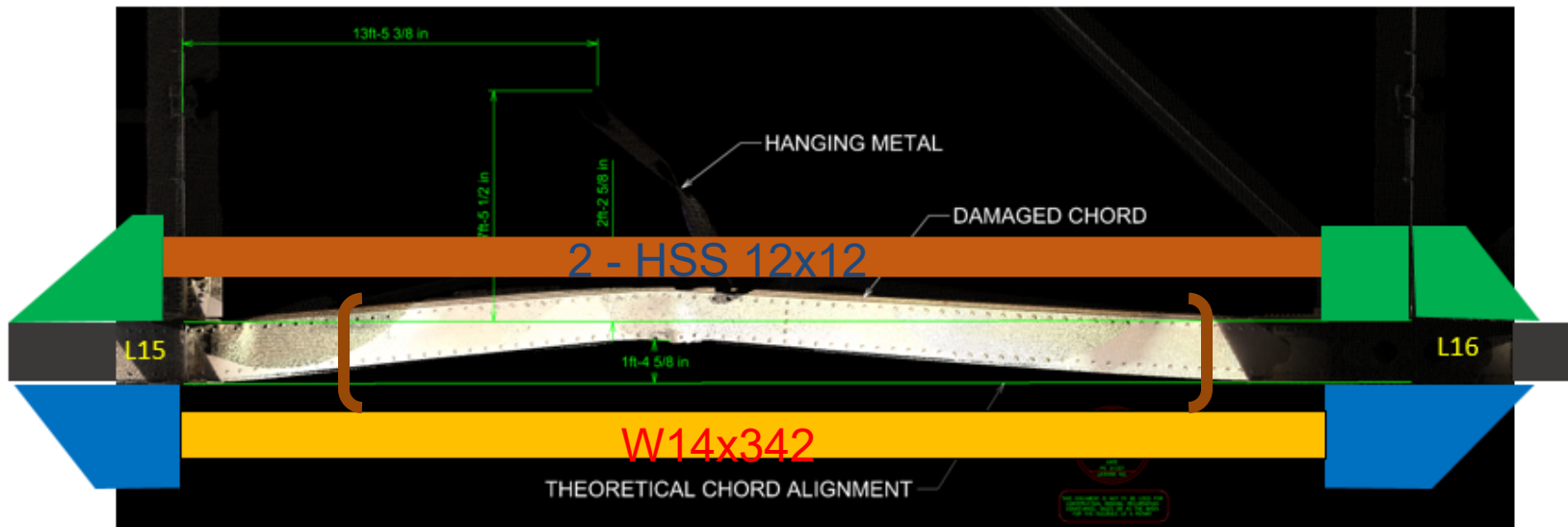
L15 (39.72') L16 (40') L17

Panel between L15 – L16 Shorten by ~ 3 3/8”

Two Repair Goals

- Restore Original Geometry
- Restore Load – 1700 k or 142

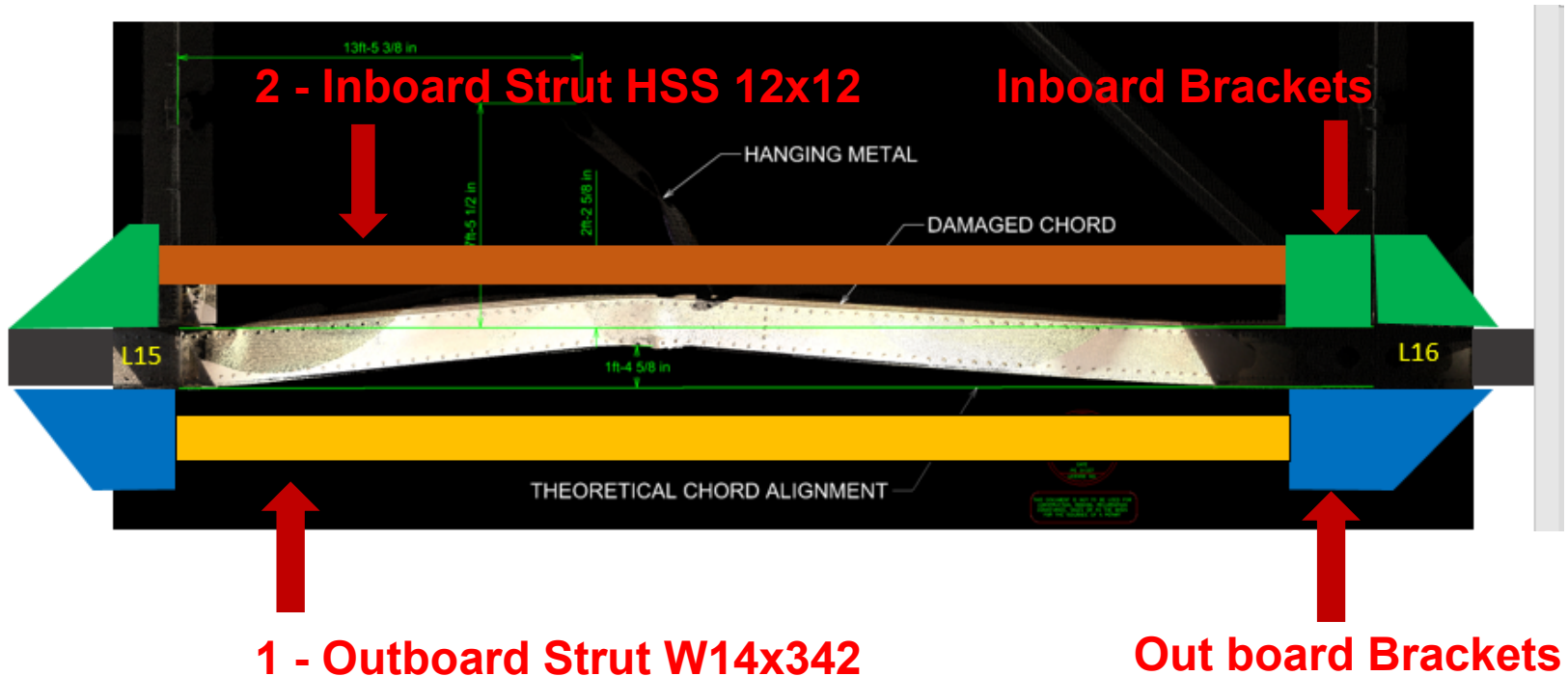




Repair Steps

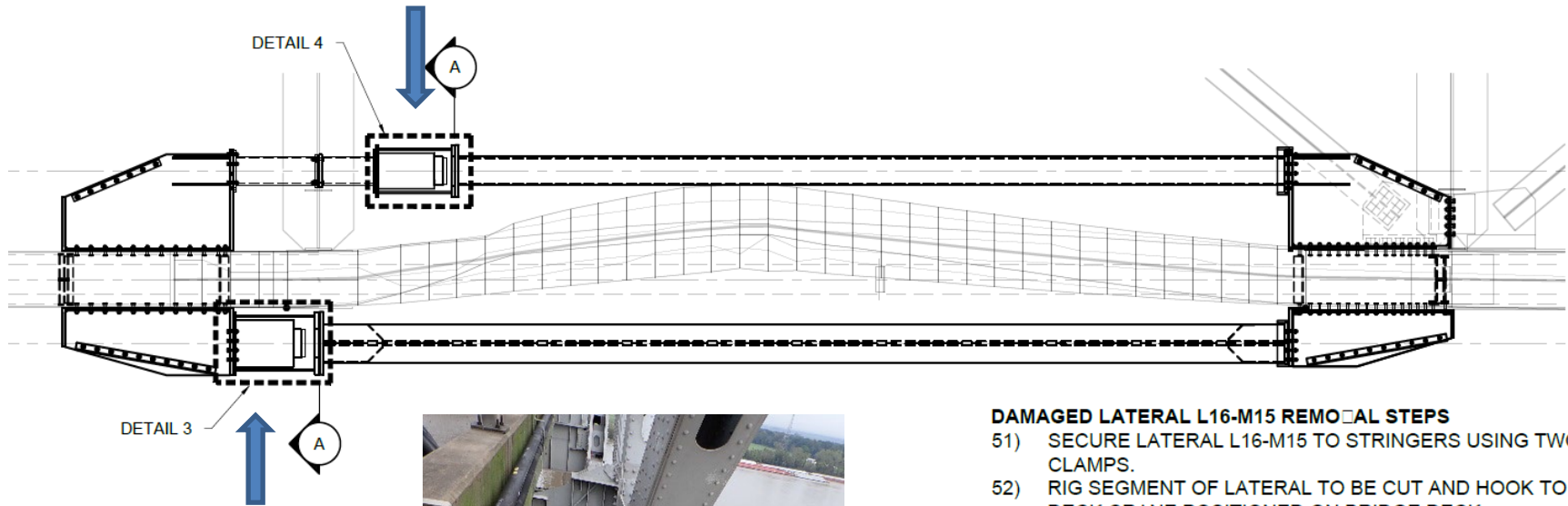
1. Design, fabricate, and install jacking frame (load bypass system)
2. Apply jacking load to the estimated remaining comp. in the chord and then cut middle section of damaged chord
3. Heat straightening remaining ends
4. Jacking the structure to original geometry
5. Install replacement chord and splice ends
6. Transfer load from jacking frame to the replacement chord

Step 1a – Design Jacking Frame



Jacking System Capacity = $1.5 \times 1,700,000 \text{ lbs} = 2,550,000 \text{ lbs}$

2 - 500 Ton Jacks



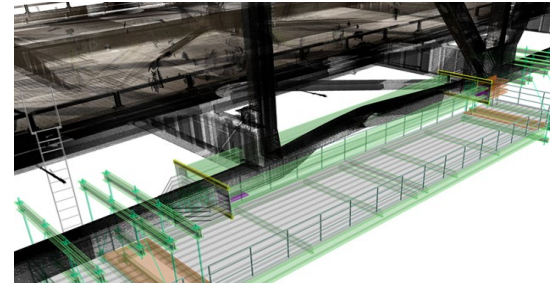
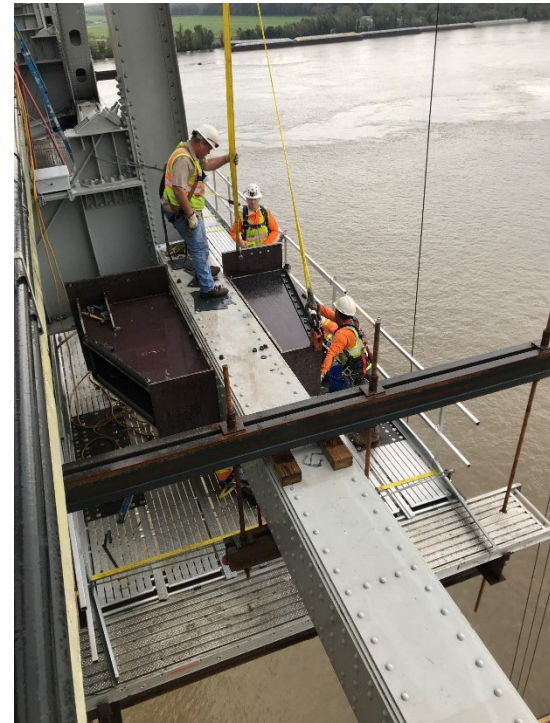
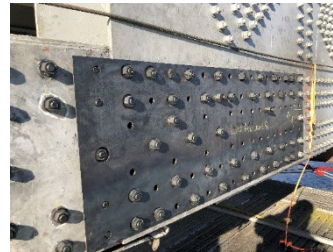
1000 Ton Jack



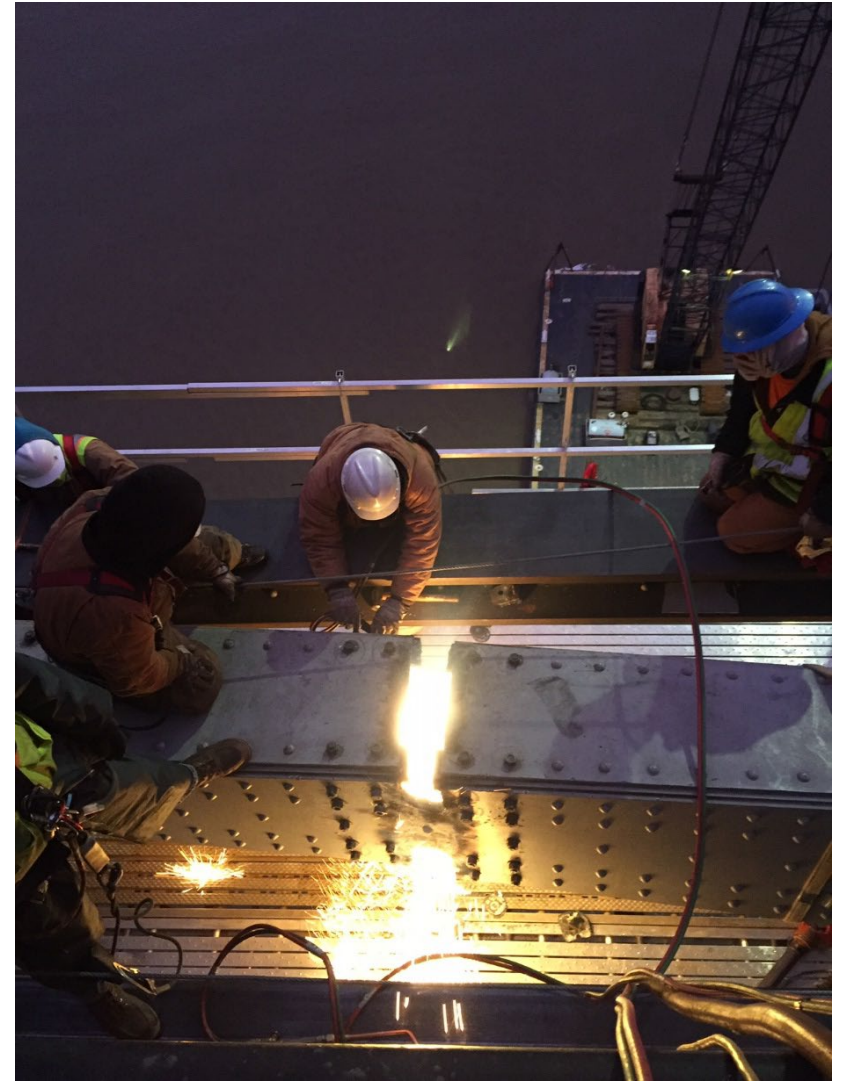
DAMAGED LATERAL L16-M15 REMOVAL STEPS

- 51) SECURE LATERAL L16-M15 TO STRINGERS USING TWO BEAM CLAMPS.
- 52) RIG SEGMENT OF LATERAL TO BE CUT AND HOOK TO CARRY DECK CRANE POSITIONED ON BRIDGE DECK.
- 53) CREATE DOGBONE STRAIN RELIEF PER DETAIL 2 IN LATERAL APPROXIMATELY 3 FT FROM L16 END
- 54) ADJUST JACK PRESSURES PER PROCEDURE
- 55) SEVER LATERAL
- 56) UNBOLT LATERAL AND REMOVE SEGMENT

Installation Procedure 50+ Steps



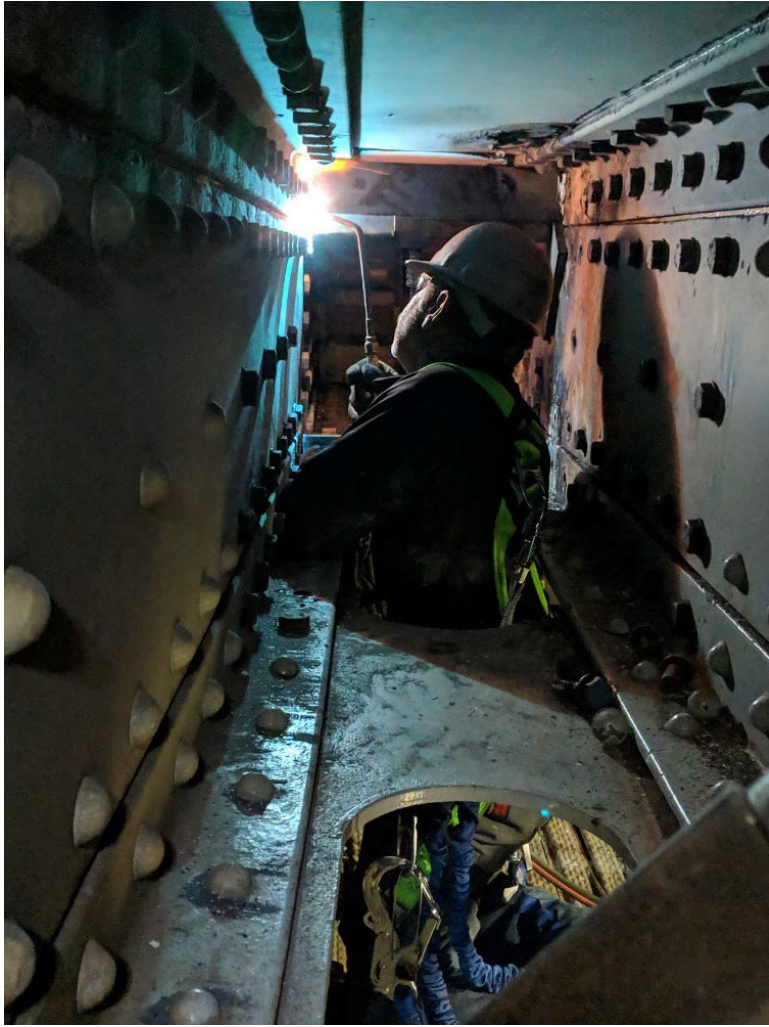
Step 1b – Install Jacking Frame

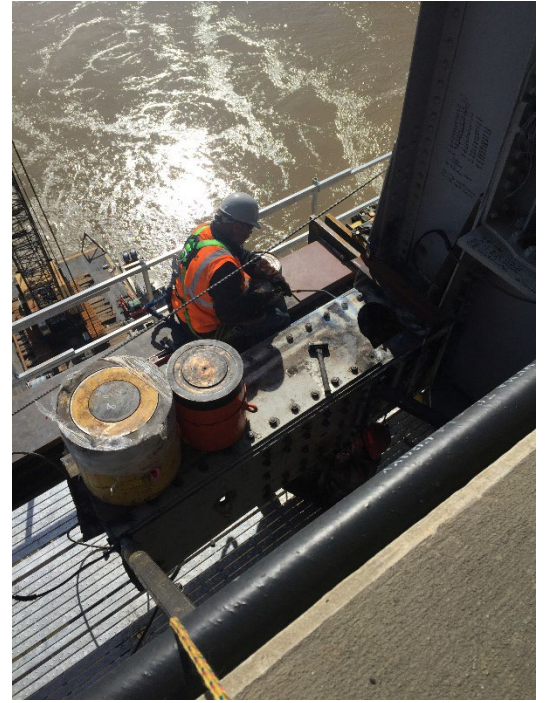
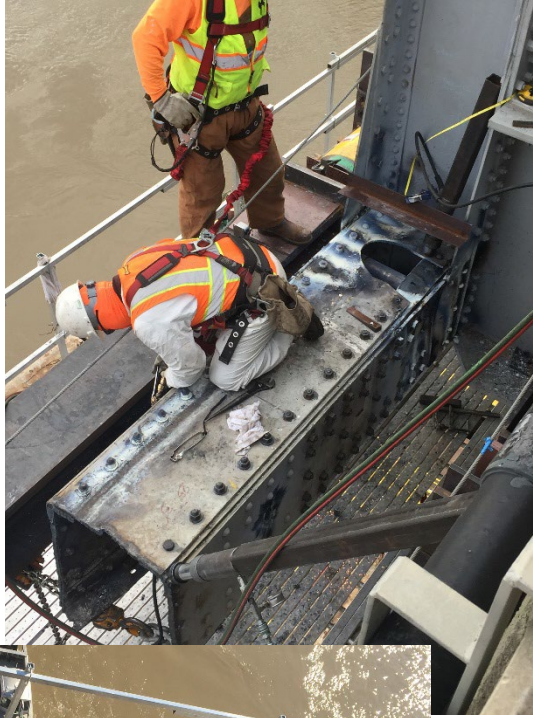


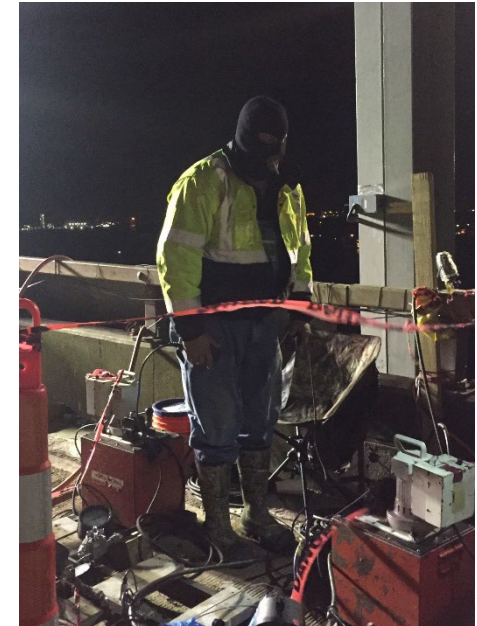
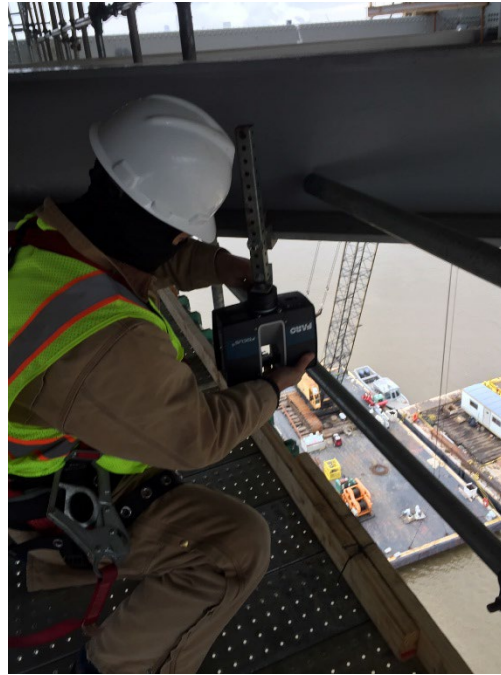
Step 2 – Cut Damaged Chord



Step 3 – Heat Straightening







Jacking Up to 2.1 Million Pounds at 50k increments. Critical, Slow, and Long Process 100+ Steps

Step 4 – Jacking Structure to Original Geometry

Jacking Monitoring System



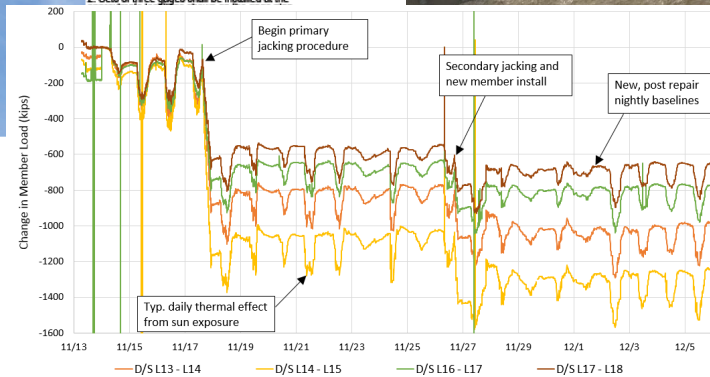
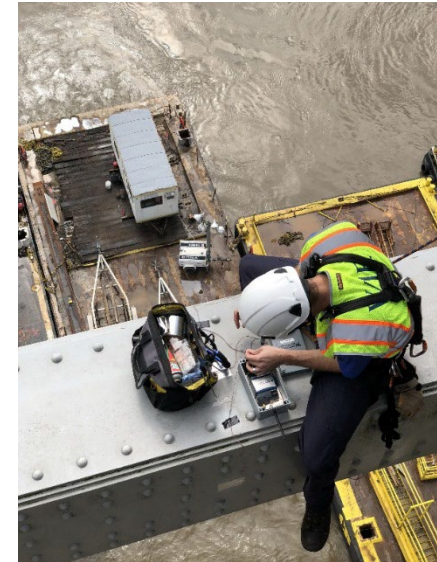
INSTRUMENTATION GAGE PLAN

Gage Set ID	Member	Type	Gage Count	System
1	L16-FR17	Axial strain	3	NI wireless
2	L16-L17	Axial strain	3	NI wireless
3	L16-U17	Axial strain	3	NI wireless
4	L16-U16	Axial strain	3	NI wireless
5	L16-M15	Axial strain	3	NI wireless
6	L15-M15	Axial strain	3	NI wireless
7	L14-L15	Axial strain	3	NI wireless
8	L14-M15	Axial strain	3	NI wireless
9	L14-U14	Axial strain	3	NI wireless
10	L15*-L16*	Axial strain	3	NI wireless
11	L15-L16	Axial strain	3	Campbell wired

* Denotes upstream chord joint.

Live video camera (mounted to L14-M15)

Notes
 1. All strain gages shall be 0.125 in., 350 ohm, axial series, vehicular gages, as manufactured by Talec.
 2. Sets of three gages shall be installed at the

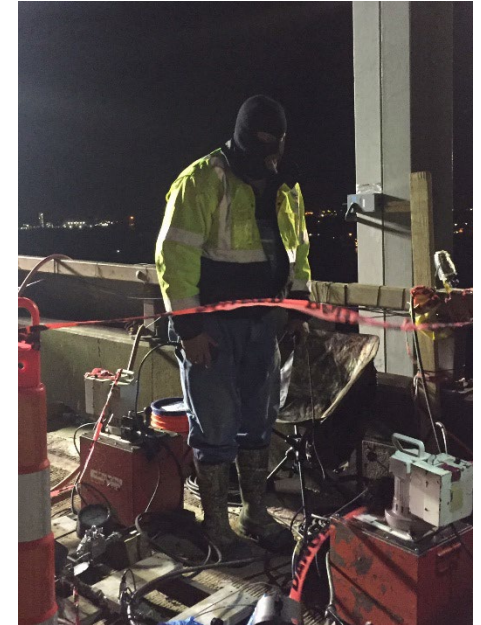
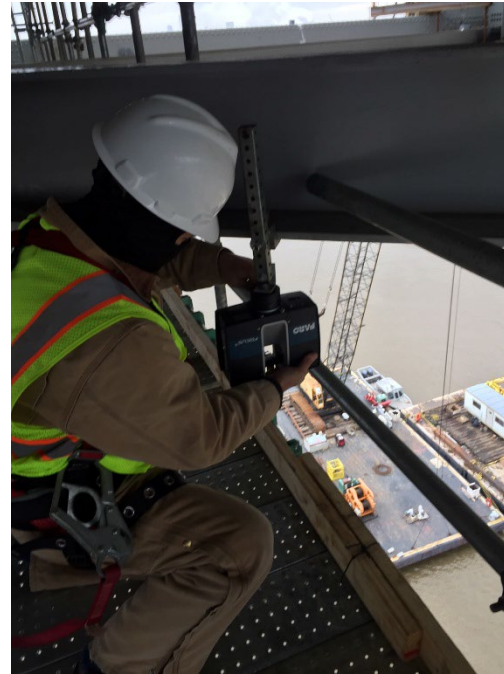




Step 5a – Install Replacement Chord



Step 5b – Splice Ends



20-25 -> 2000
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 100-25 -> 2000



Step 6 – Transfer Load from Jacking System to New Chord

Before and After Photos



LOUISIANA DEPARTMENT OF
TRANSPORTATION & DEVELOPMENT



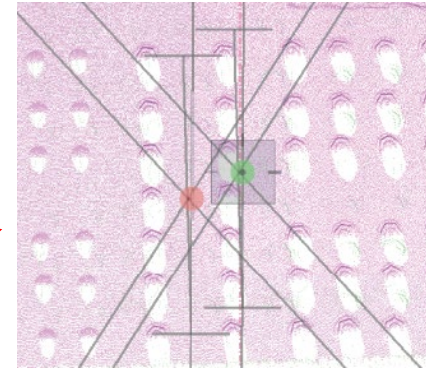
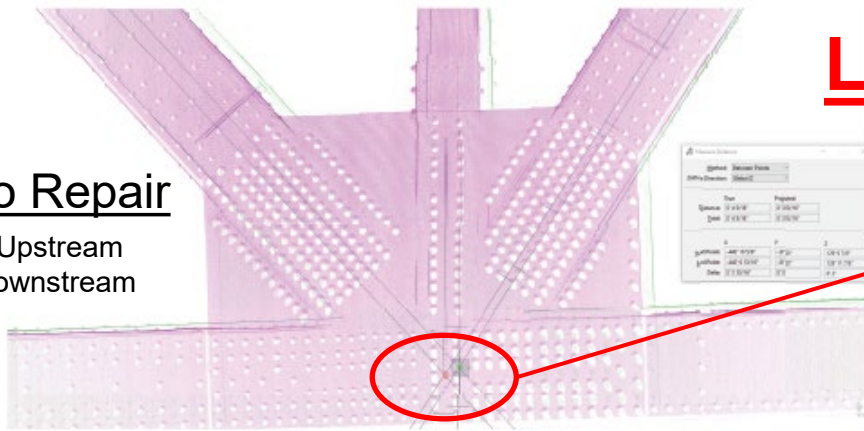
L15 (39.72') L16 (40') L17

Panel between L15 – L16 Shorten by ~ 3 3/8”

L16

Prior to Repair

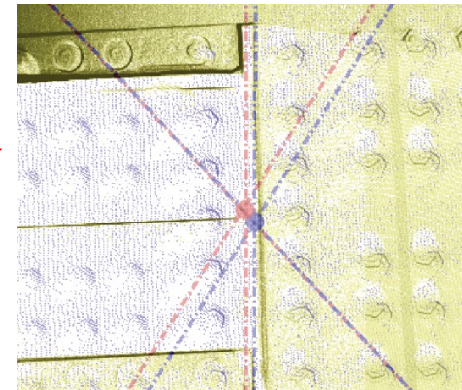
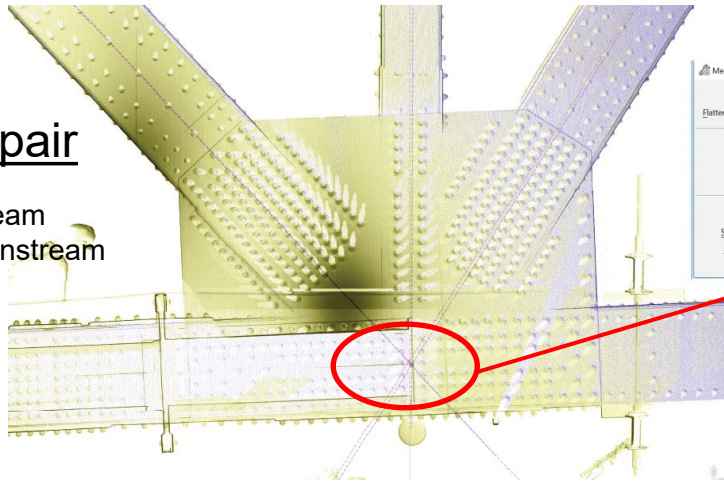
Green – Upstream
Pink – Downstream



	X	Y	Z
Start Point:	-440' 10 5/8"	-31' 0"	129' 9 7/8"
End Point:	-440' 6 13/16"	-31' 0"	129' 11 7/8"
Delta:	0' 3 13/16"	0' 0"	0' 2"

After Repair

Gold – Upstream
Purple – Downstream



	X	Y	Z
Start Point:	104' 2 3/4"	144' 10 7/8"	-4' 8"
End Point:	104' 2 1/16"	144' 10 7/8"	-4' 7 3/16"
Delta:	0' 0 5/8"	0' 0"	0' 0 13/16"

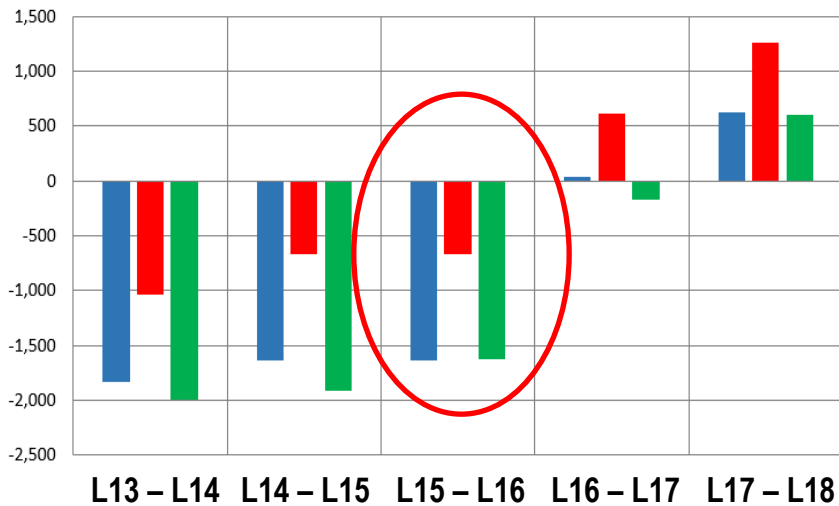
Geometry Restored

Damaged Bottom Chord L15 – L16
Compression Member
DL = 1.7 Million Pounds
(~142 Elephants)

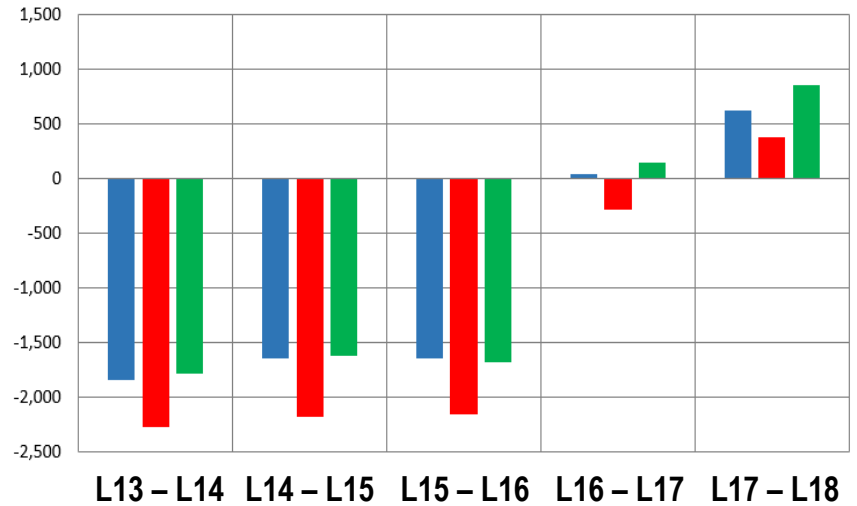


Where did these elephants go after impact?
How many trapped in the damaged chord?

Downstream Bottom Chord Load Changes in Kips



Upstream Bottom Chord Load Changes in Kips



■ As-built Dead Load ■ Dead Load After Collision ■ Final Post-Repair Dead Load

Load Restored



NTSB MAB-20-29

- Bridge Damage \$6.7 M; Crane Damage \$8,500
- Bridge closed for 49 days, significant traffic impact
- No pollution or injuries

***After 49 days (working 24/7)
Sunshine Bridge Reopened to
Traffic on 12/1/18***

Timeline

- 10/12/2018 (Day 1) Sunshine Bridge was Hit and Closed
- 10/12/2018 (Day 1) Survey, Inspection, Repair Concept Started
- 10/20/2018 (Day 9) Crane Barge and Temp. Access in Place
- 10/22/2018 (Day 11) Repair Concept Verified on Site and Finalized
- 10/26/2018 (Day 16) Primary Work Platform Installed
- 11/04/2018 (Day 24) Jacking Frame Design and Shop Drawings Completed
- 11/08/2018 (Day 28) Jacking Frame Fabricated and Shipped
- 11/13/2018 (Day 32) Jacking Frame Installed
- 11/17/2018 (Day 36) Damaged Chord Removed
- 11/25/2018 (Day 45) Heat Straightening Completed
- 12/01/2018 (Day 49) Replacement Chord in Place; Geometry and Load Restored; Bridge Reopened to Traffic!

Lessons Learned

- Thermal loads must be considered in the design of jacking system (300k-400k).
- Heat straightening of impact damaged member is more challenging than heat damaged member.
- 3D scanning is a very useful tool in damage documentation, conflict/clash detection, and checking geometry during jacking.
- Attaching new members to existing damaged/distorted members and gusset plates requires tremendous preparation effort (templates, filler plates, accurate measurements, etc.).

Project Team



Design Team



Industrial Solutions Inc.
Thomas Industrial Coatings
Southern Synergy

Contractor's Team



Project Engineer

CEI





Damage Assessment,
Inspection, Structural
Analysis and Monitoring, CEI,
& QC/QA
BDI -Instrumentation



Jacking/Load Bypass
System, Jacking/Repair
Procedures & Jacking
Monitoring



Work Platforms,
Replacement Chord,
Bottom Lateral & Misc.
Repair



Topo Survey, Laser
Scanning/Damage
Documentation, Conflict and
Clash Detection, Movement
and Displacement
Monitoring during Jacking



Project Engineer,
Communication and
Coordination



Prime
Contractor



Jacking Sub-
Contractor



Jacking Framing
Fabricator



Heat Straightening



Replacement Chord
and Misc. Steel
Fabricator

Industrial Solutions Inc. – Secondary Work
Platforms

Thomas Industrial Coatings – Painting

Southern Synergy – Roadway Work

