Hale Boggs Memorial Bridge (I-310 Luling-Destrehan) Stay-Cable Replacement

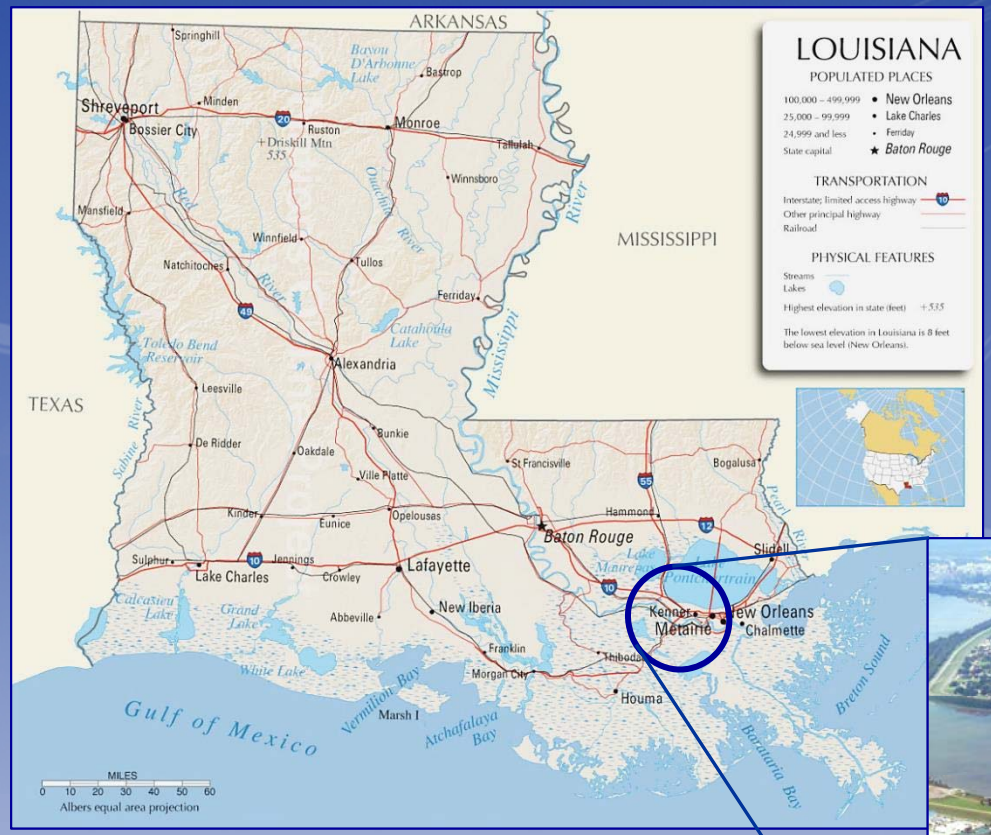
Outside New Orleans, Louisiana

By Michael W. Smart

INTERNATIONAL BRIDGE TECHNOLOGIES, INC.

Site Location

Hale Boggs Memorial (Luling-Destrehan) Bridge



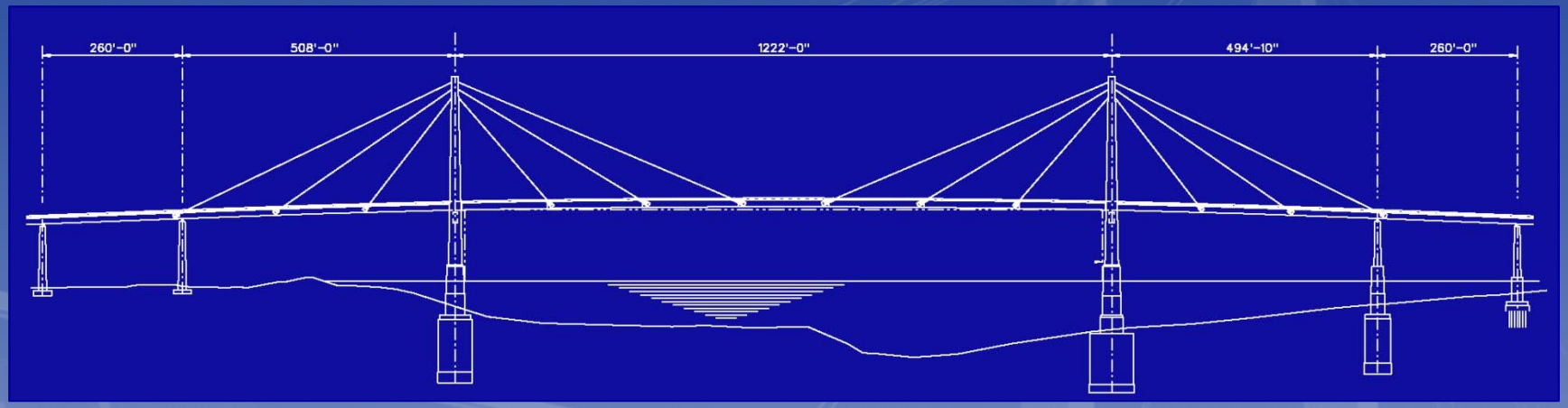
Hurricane Evacuation

Original Construction

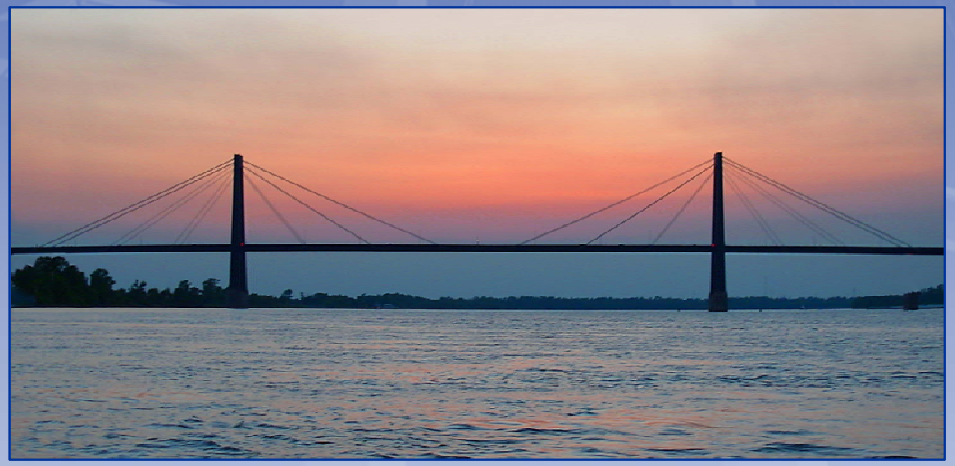
- Original opening date: Thursday, October 6, 1983

- All structural steel towers
- Orthotropic steel twin-box girder superstructure

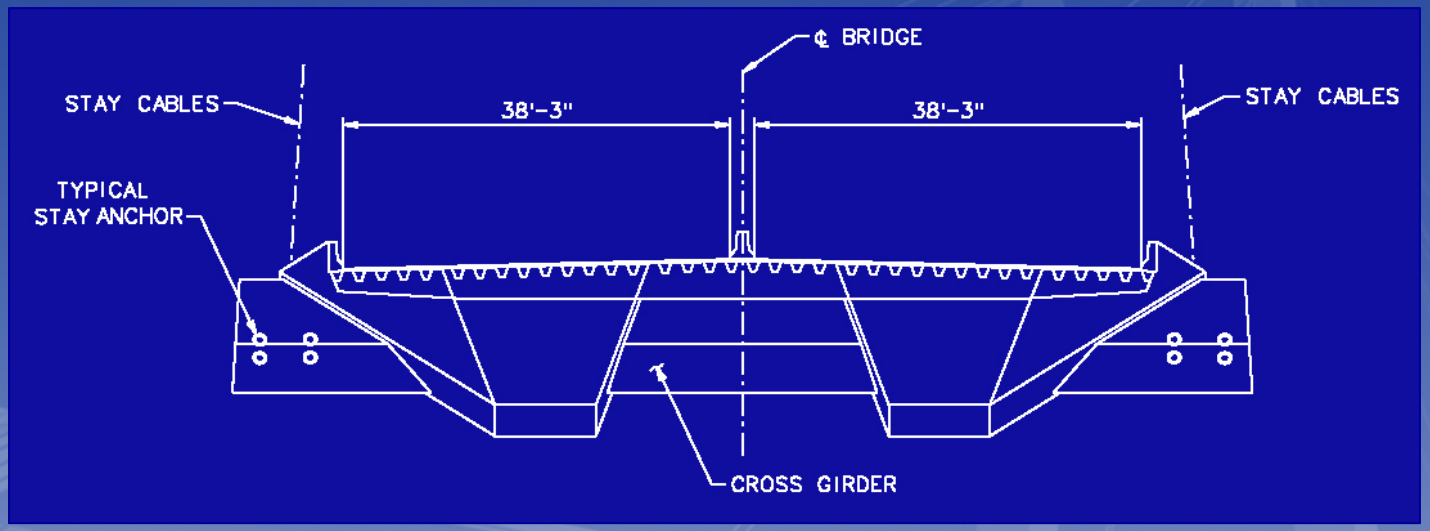
Main Bridge Characteristics



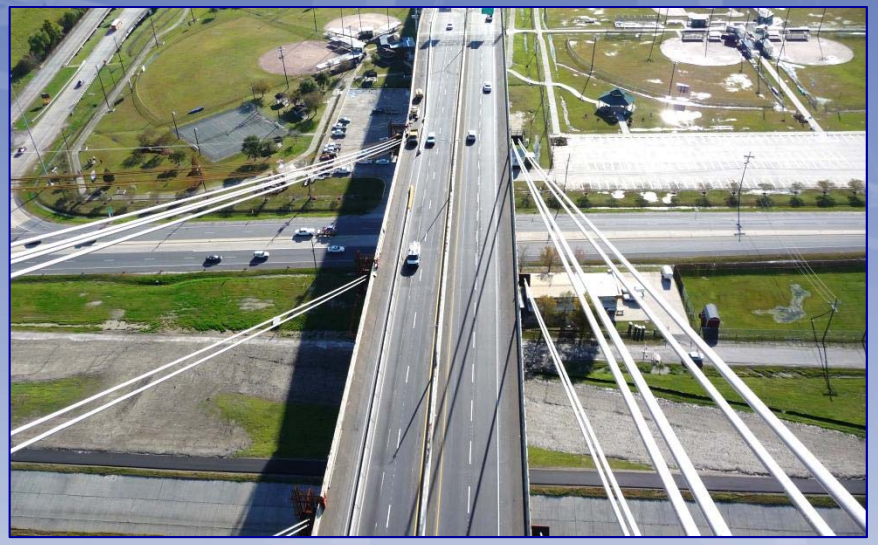
- 1222’ main span length
- 2745’ between expansion joints
- 400’ towers



Bridge Characteristics



- Overall Deck Width – 82’-0”
- 2 x 2 = 4 lanes total with shoulders
- 2- or 4-Stay Groups Anchored at Transverse Cross-Girders



Background

- Corrosion and water leakage at anchorages
- Cracking/splitting of cable cover pipes
- In 2002, LaDOTD initiated a project for structural evaluation of the stays

Stay Evaluation

Anchorage Condition

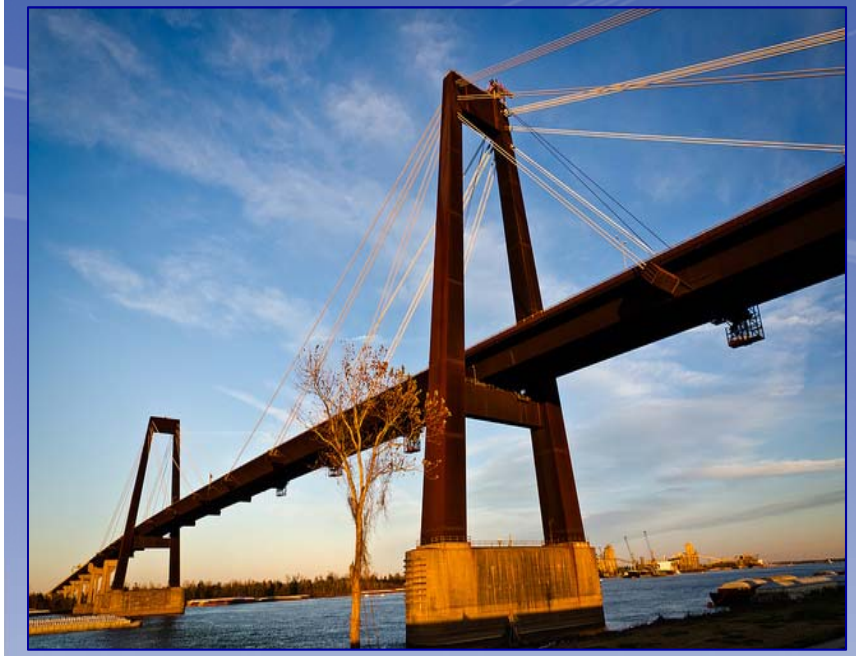
Stay System Condition

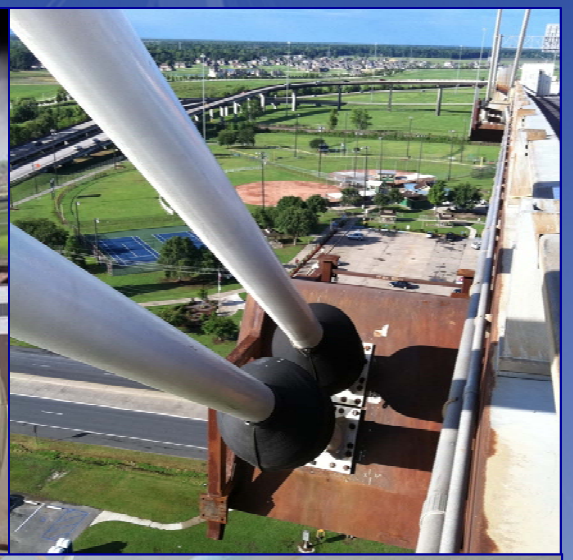
Summary of Evaluation

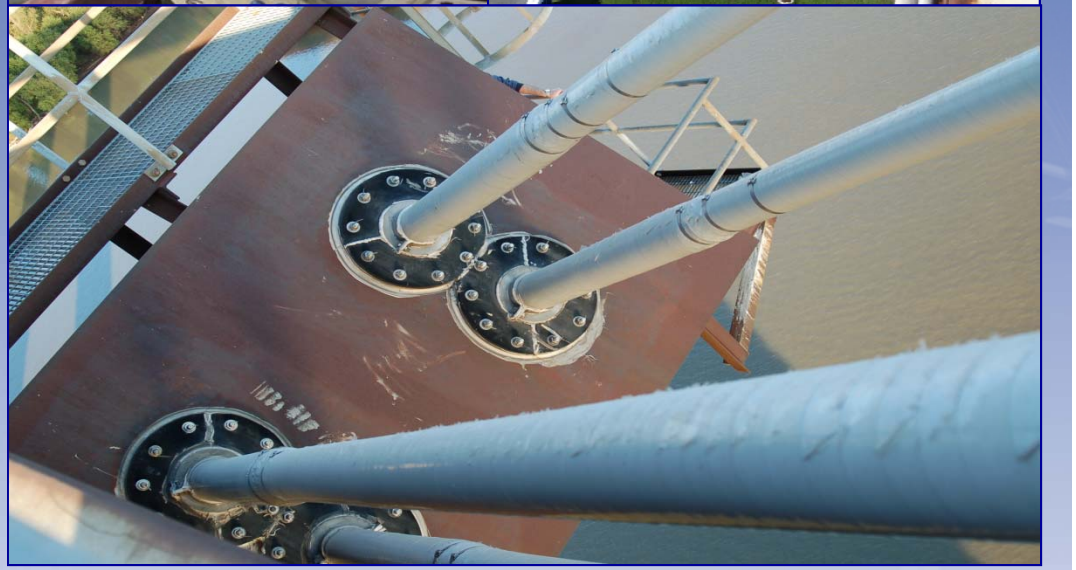
- 40 out of 72 cables rated critical
- Less severe damage in remaining cables
- Increasing rate of deterioration evident
- Timely corrective action required

Scope of Retrofit

Completely replace stay system – all 72 cables and other stay components







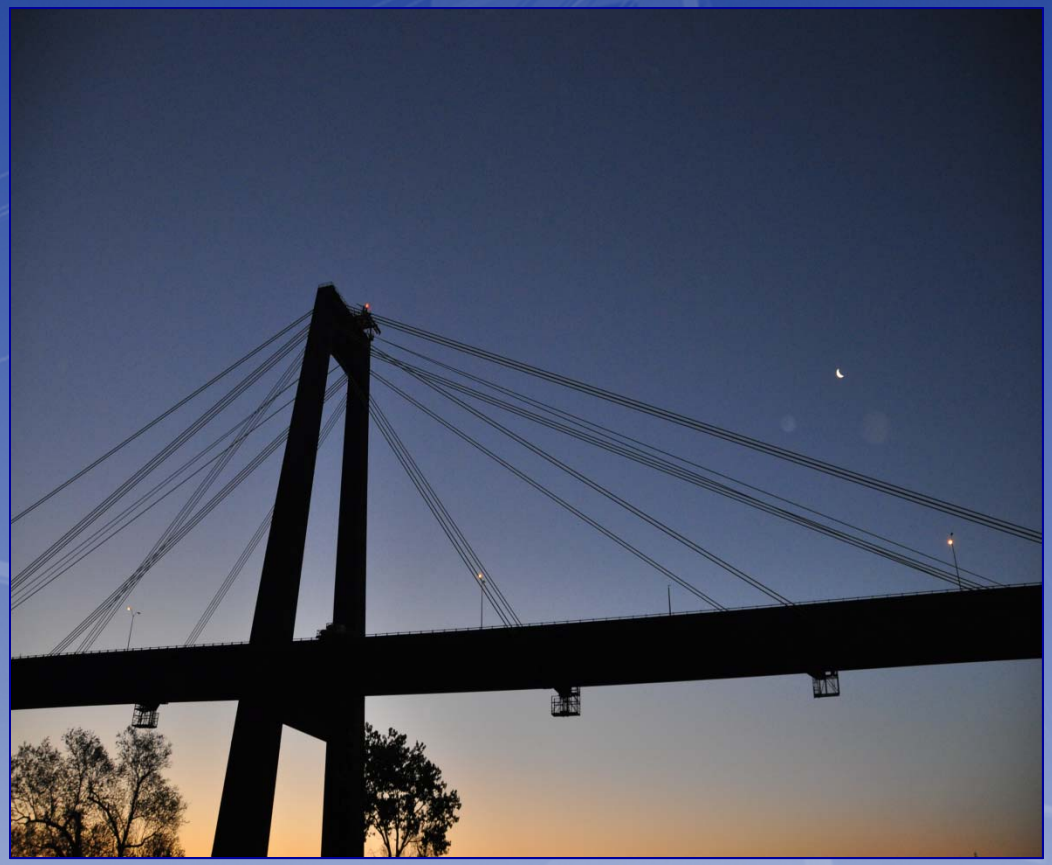
Scope of Retrofit

- Removal and storage of existing instrumentation
- Cleaning and modification of existing anchorage boxes
- Cleaning and sealing of superstructure
- Access hatch retrofit
- Fairing plate repair
- Web-enabled camera system
- Expansion joint replacement

Representative Projects?

Penang Bridge (Malaysia)

Stays conventionally spaced at deck

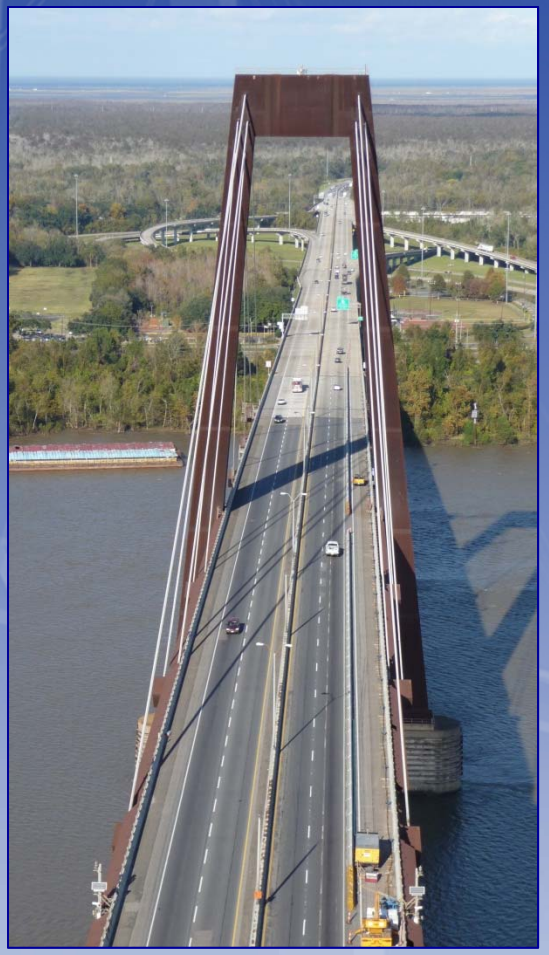


Luling Bridge

Stays widely spaced at deck

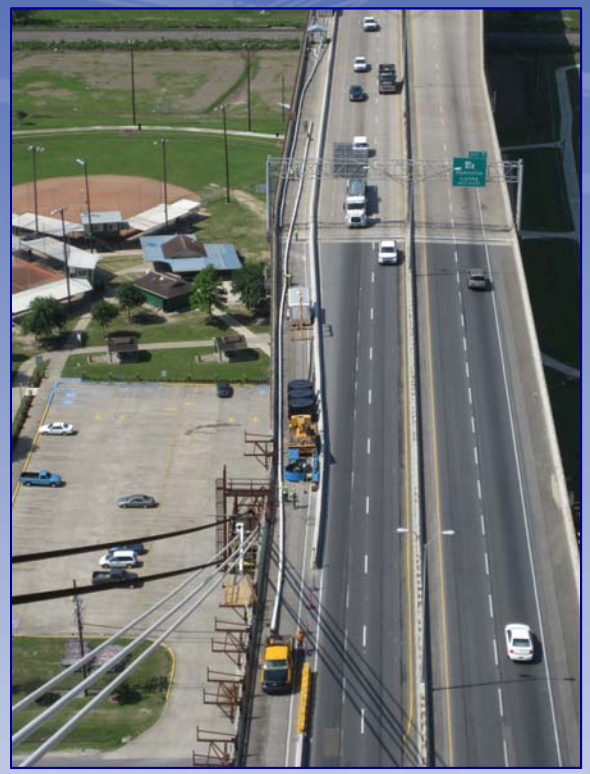
Design Challenges

- Widely-spaced stays
- Unknown condition of existing stay cables
- Maintain traffic without load restrictions
- Structural modifications to accommodate current conventional stay systems
- Corrosion protection: grout vs individually sheathed with filler
- Cable vibration control: dampers, cross-ties



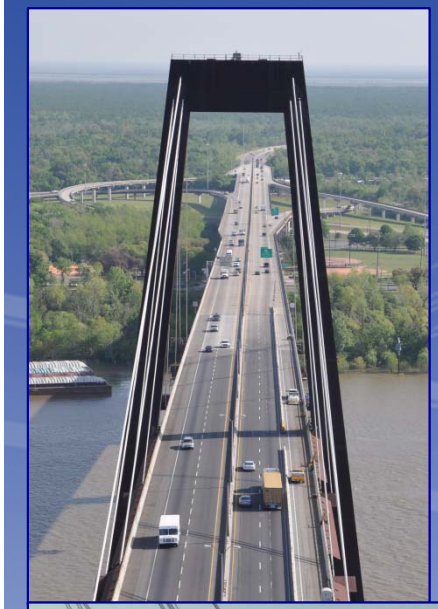
Construction Challenges

- Tight fit: original parallel wires vs parallel strands
- Access: limited space for operations
- Maintain traffic: minimal interruptions - especially critical during Mardi Gras and Saints Games
- Climate/weather: heat, humidity, potential tropical storms or hurricanes, thunderstorms, cold, rain



Stay Replacement Procedure

Operational Concerns



- **Working adjacent to and over traffic**
  - Vehicular traffic
  - Vessel traffic
- **Working at height**

Stay Replacement Design

Main Objectives

- Develop a cost effective stay system replacement design
- Minimize impact to traffic

Replacement Stay Cable Design

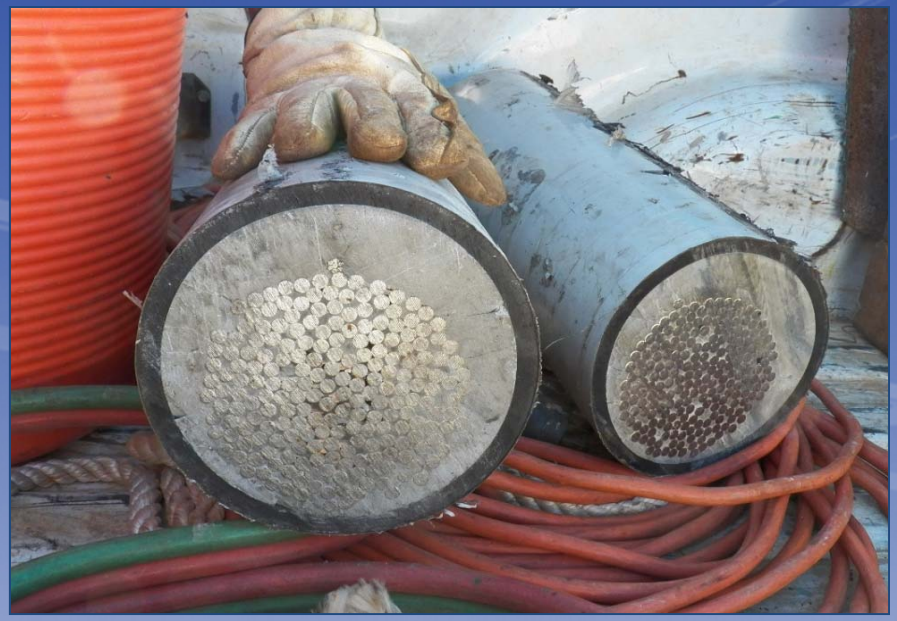
Possible Systems

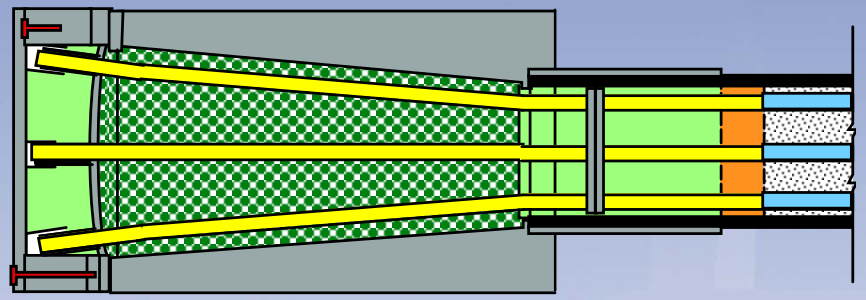
- Parallel Wire System – Similar to Original Design
  - 103 - 307 ¼" dia. 270 ksi bare wires
  - Wires Individually "button-headed" at anchors
  - Corrosion inhibiting material fills stay pipe
  - Entire stay cable is stressed
- Parallel Strand System - Preferred Retrofit
  - 61 - 72 0.60" dia. 7-wire 270 ksi strands, or
  - 57 - 68 0.62" dia. 7-wire 270 ksi strands
  - Strands Individually wedged at anchors
  - Individually greased and sheathed strands
  - Strand-by-strand stay stressing or entire stay cable can be stressed

Replacement Stay Cable Design

Possible Systems

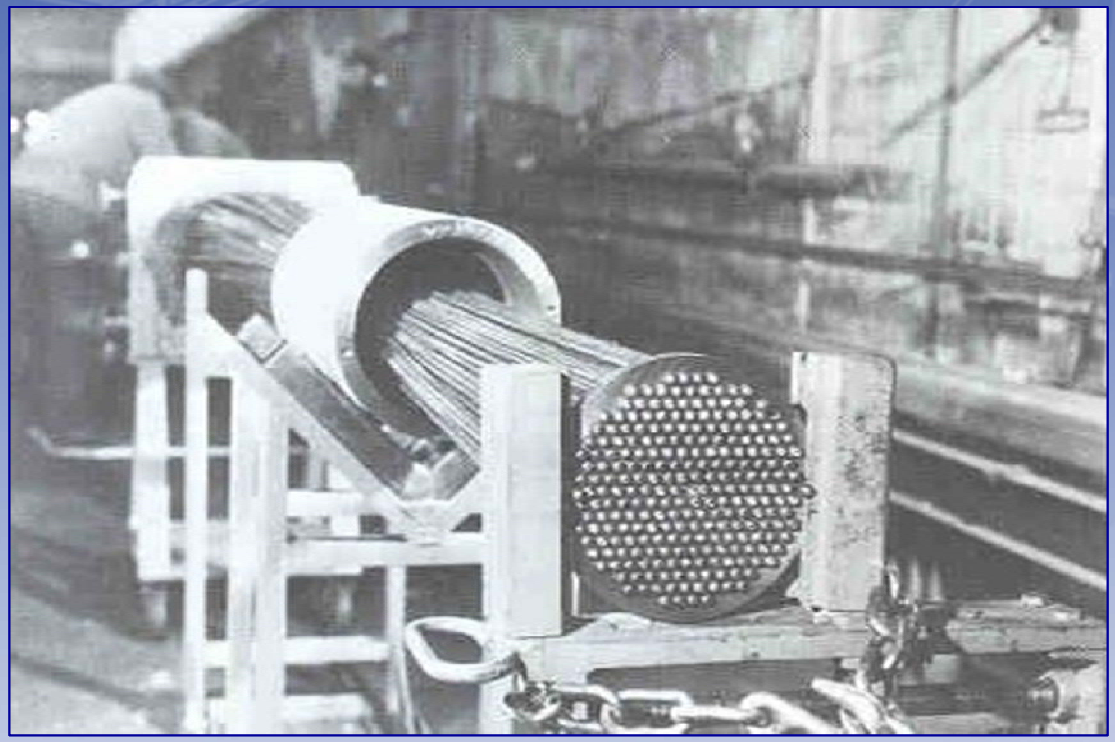
Original Design - Parallel Wire System

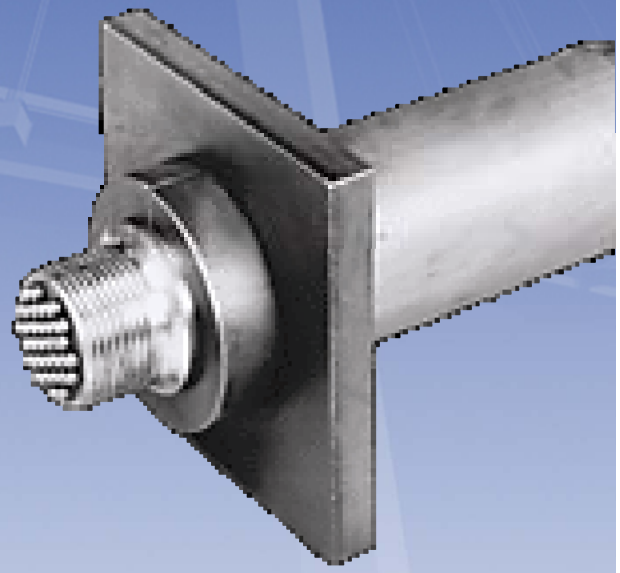




Parallel Wire System Advantages and Disadvantages

- Fewer modification to structure necessary
- Would require improved corrosion protection (compared to original stays)
- Individual wire replacement not possible
- Currently not available from U.S. manufacturers



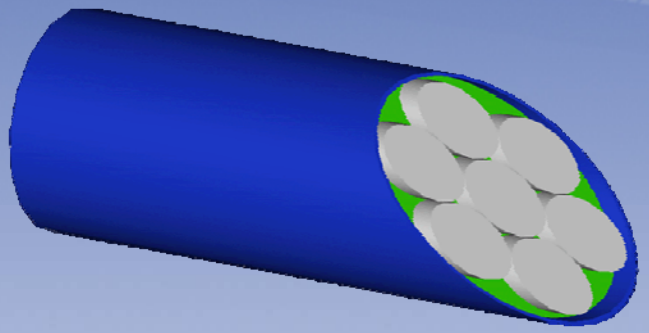


Parallel Strand System Advantages

- Available: at least 3 suppliers in U.S.
- Now used on most new cable-stay bridges

Parallel Strand System Advantages

- Individually greased and sheathed strands
- Current state of the practice for corrosion protection
- Individual strands more accessible
- Strand-by-strand (mono-strand) installation and replacement



Parallel Strand System Disadvantages

Stay cable anchorages are larger

- Required modification of the existing anchorage assemblies to accept the new system
- Extent of modifications depended on specific system selected

Parallel Strand System Disadvantages

Stay Sheath Pipes are Larger

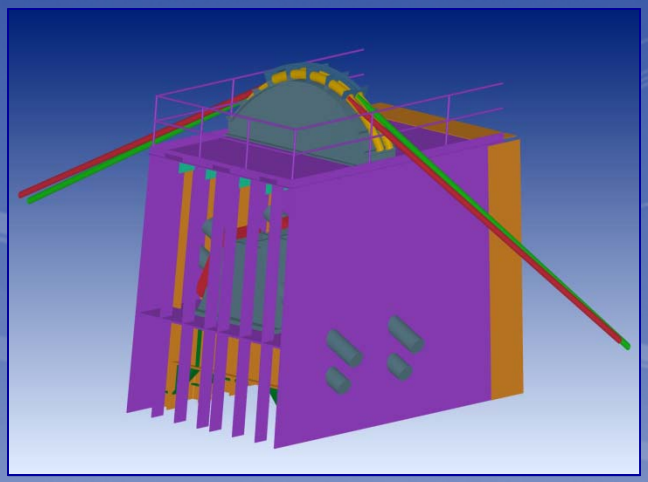
- Increased wind load on the stay cables
- Compact cables minimize increase but with potential constructability trade-offs

Stay Replacement - Concepts

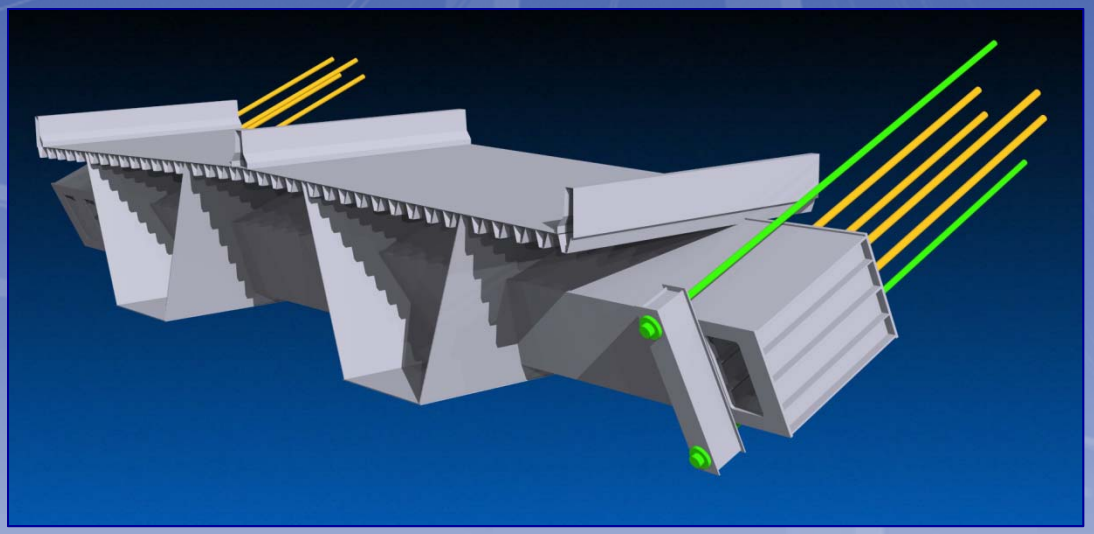
Temporary stay cables

- Minimizes stress redistribution in adjacent stays
- Allows normal use of the bridge during cable replacement

Stay Replacement - Concepts

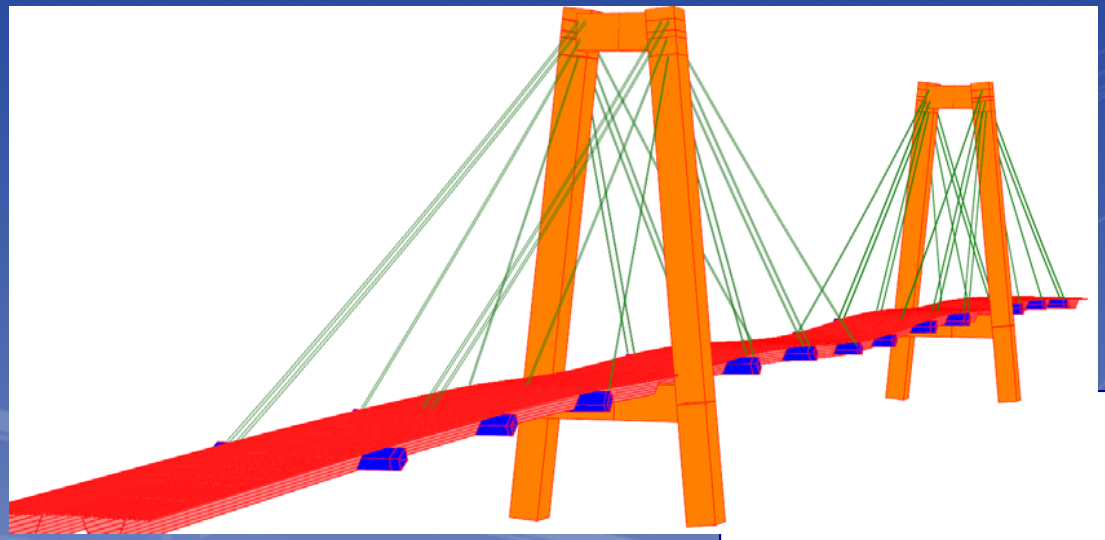


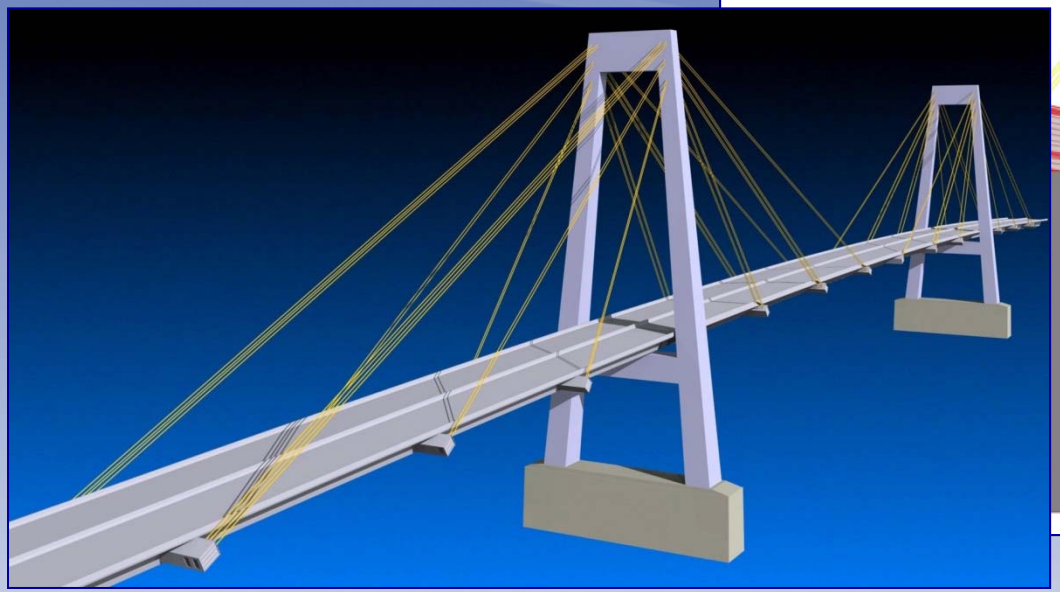
Temporary Saddle over Towers

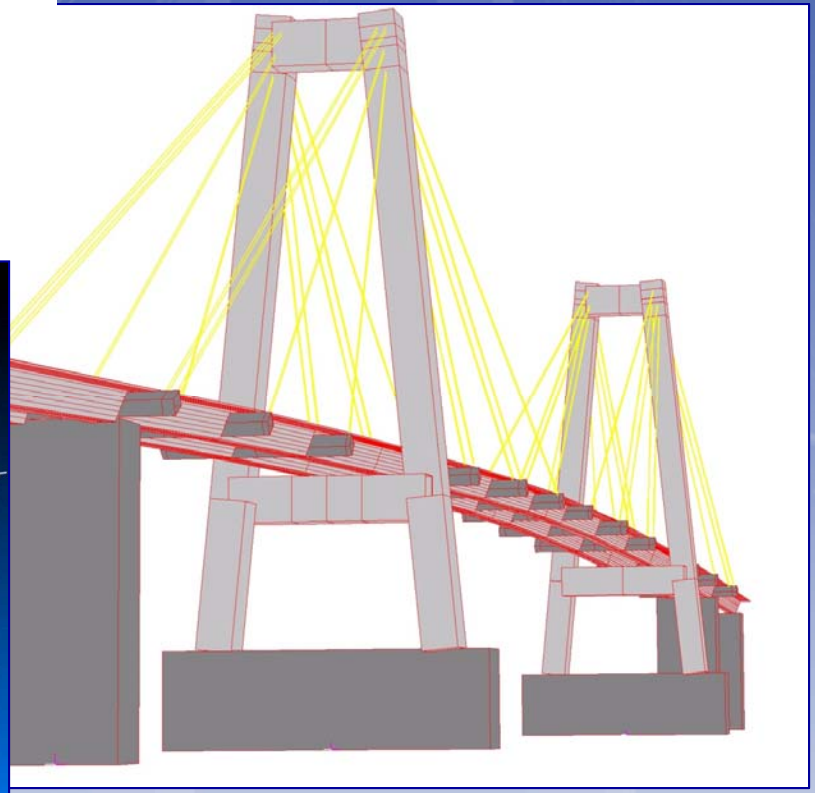


Temporary Whalers at Cross-Girders

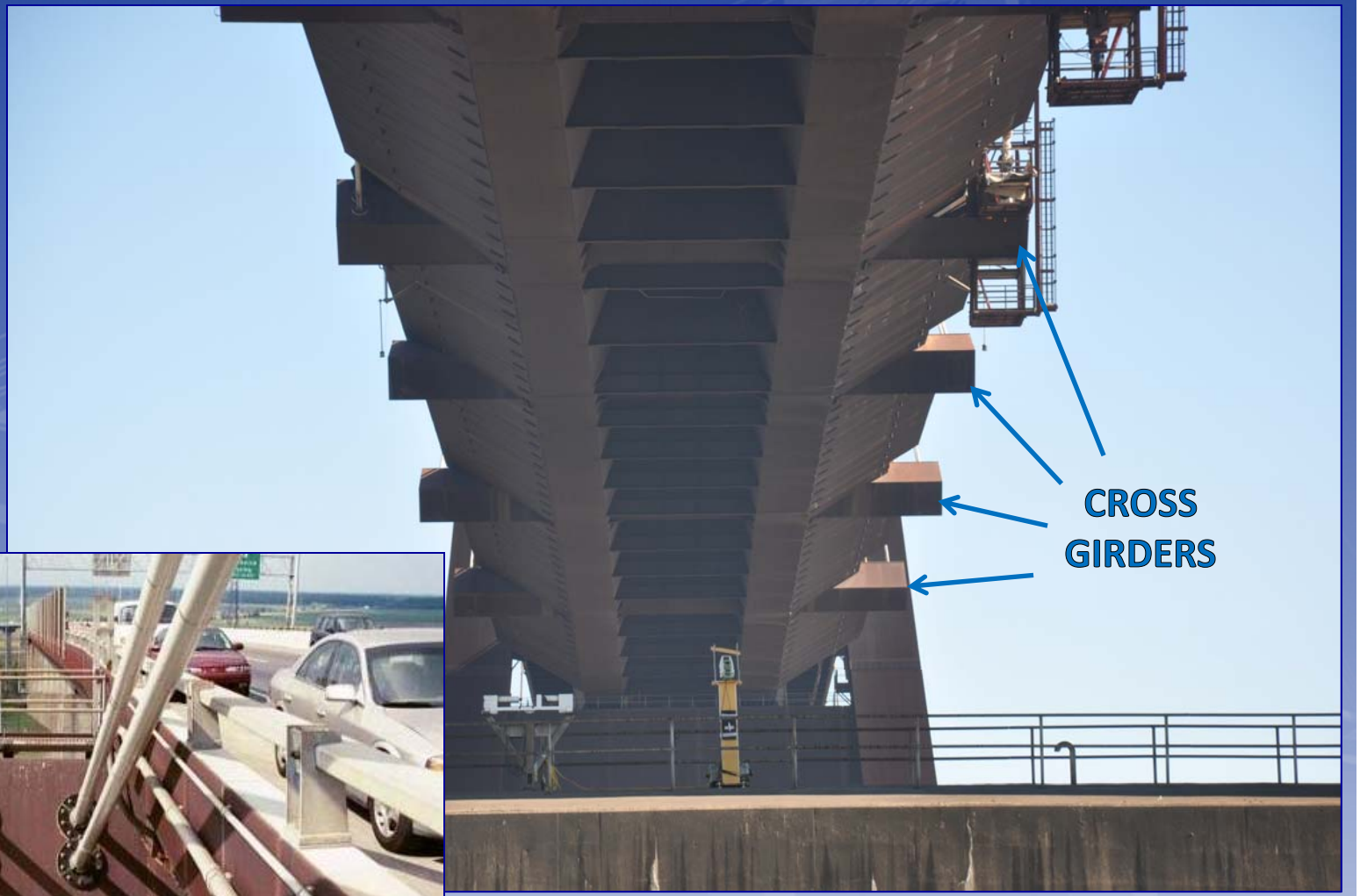
Modeling







Cross-Girder Stay Anchors



Stay Replacement

TEMP STAY CG PAIRS	TEMP STAY FORCE (kip)	TEMP STAY LENGTH (ft)
1 & 6	400	1,132
1 & 5	280	1,025
2 & 5	260	862
3 & 4	260	610

Photo for this slide provided courtesy of Kiewit Louisiana Company

Stay Replacement

Operations Sequence

- Install temporary support system x 4 zones
- Stress temporary stay cables x 3 (cross-girder pairs) per zone
- Lift-off, de-tension, & remove existing stay x 18 per zone
- Modify existing structure @ anchor locations x 18 per zone
- Install new stay x 18 per zone

Stay Replacement

Temporary support system

- Highline or cableway
- Tower mounted hoist
- Barge mounted crane

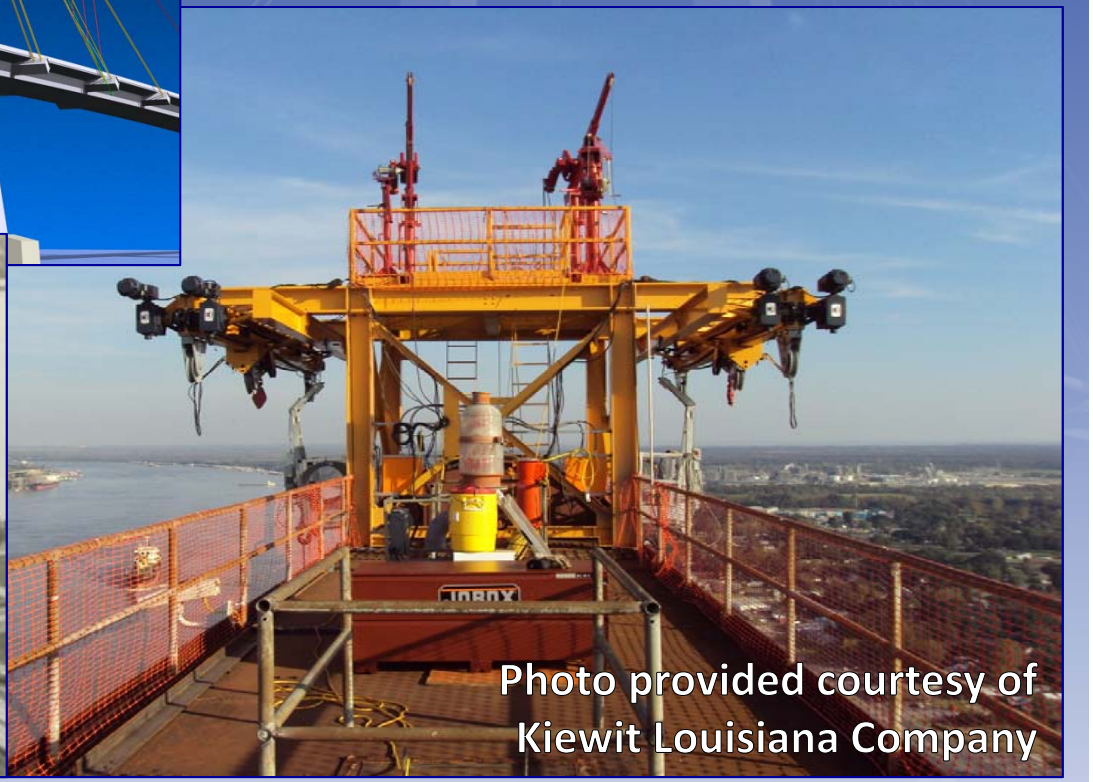


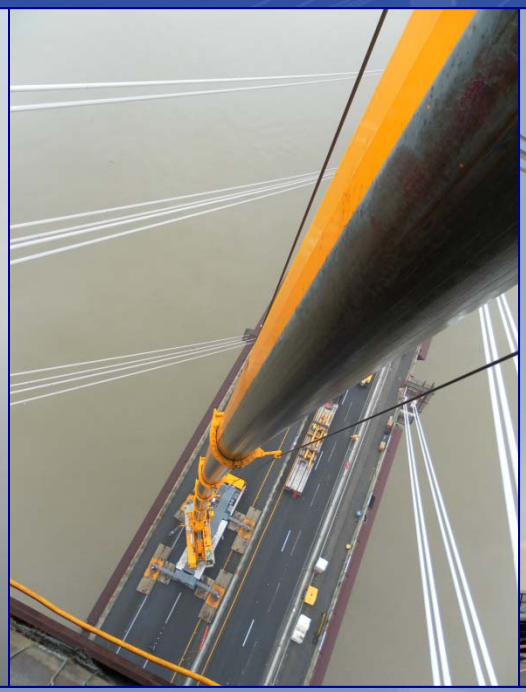
Photo provided courtesy of
Kiewit Louisiana Company

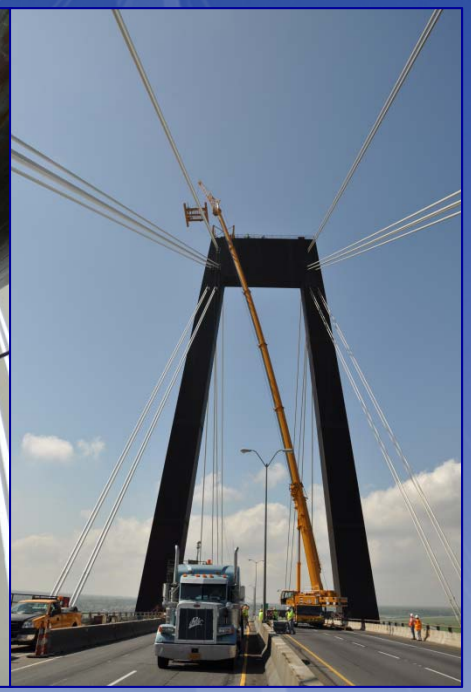
Stay Replacement

Install temporary support system

Service platform installed on top of tower to hoist equipment and stay system components

Stay Replacement

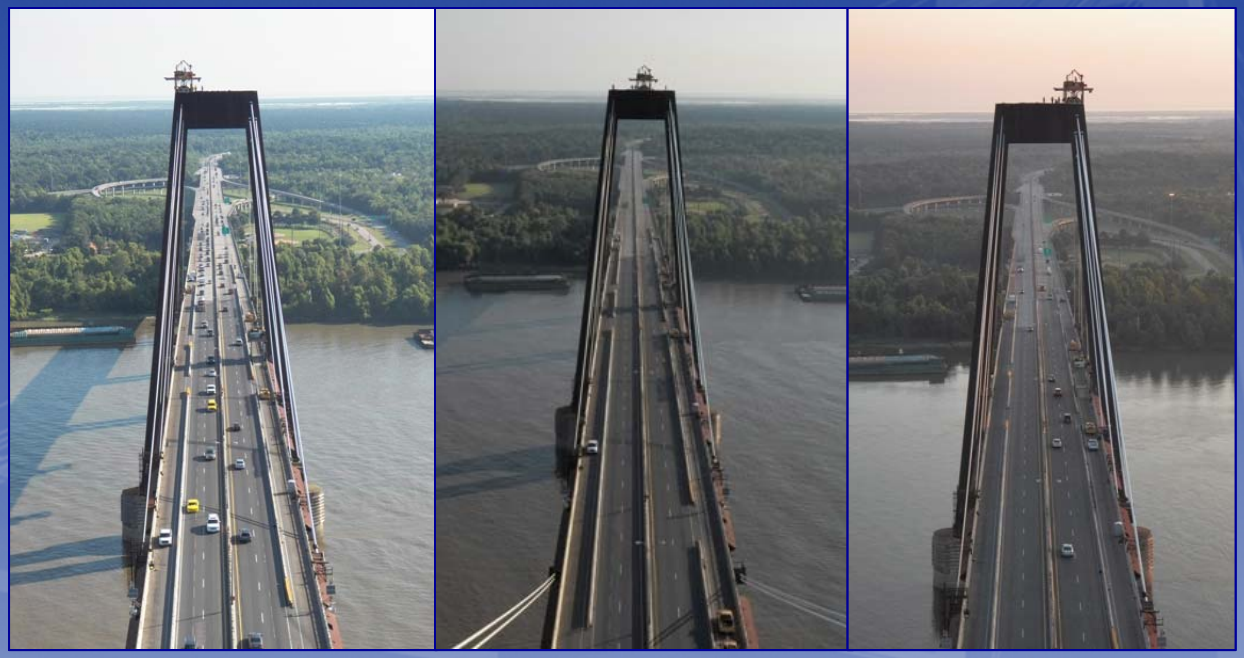




Install temporary support system

Service platform installed on top of tower to hoist equipment and stay system components

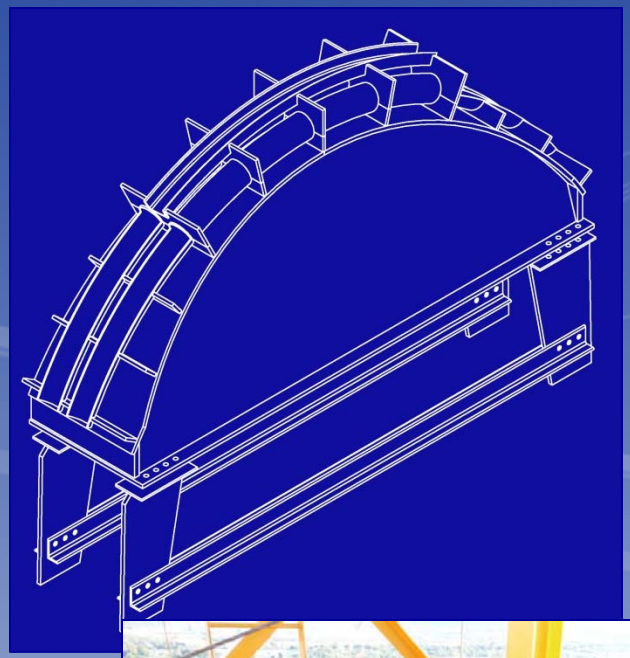
Stay Replacement



Re-locate temporary support system (adjacent zones)

Service platform was side-shifted on rollers without deck-mounted cranes

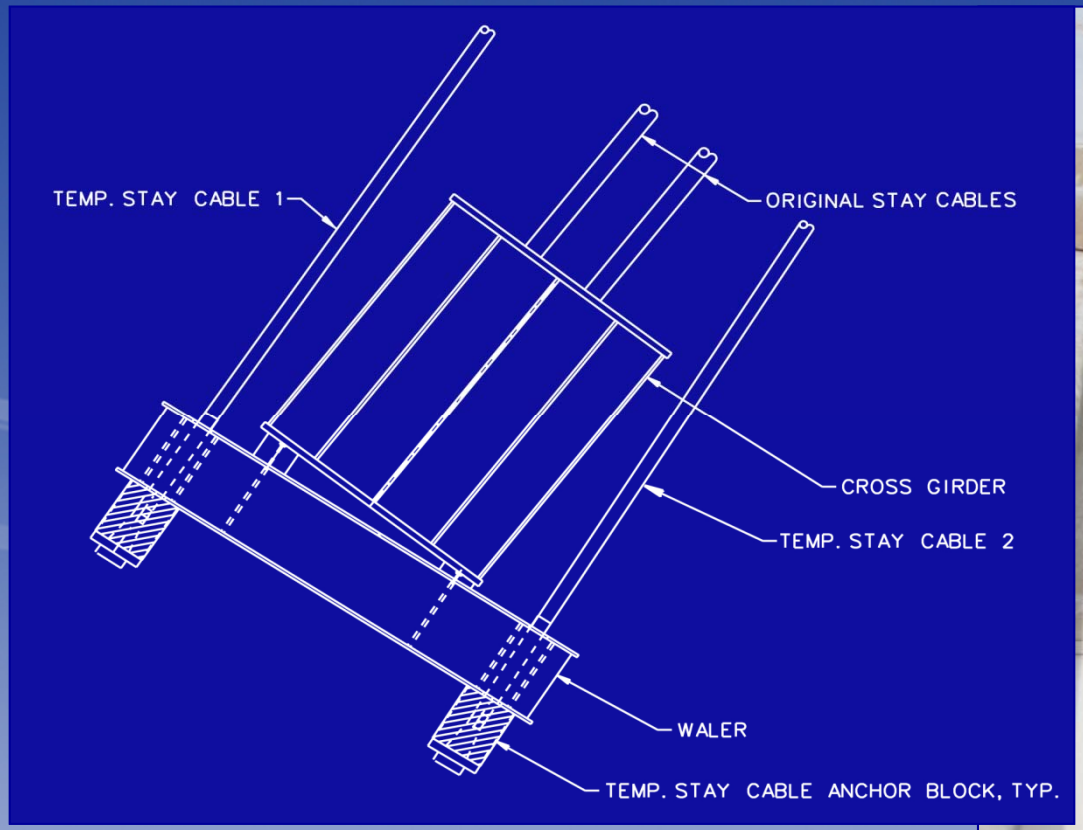
Stay Replacement

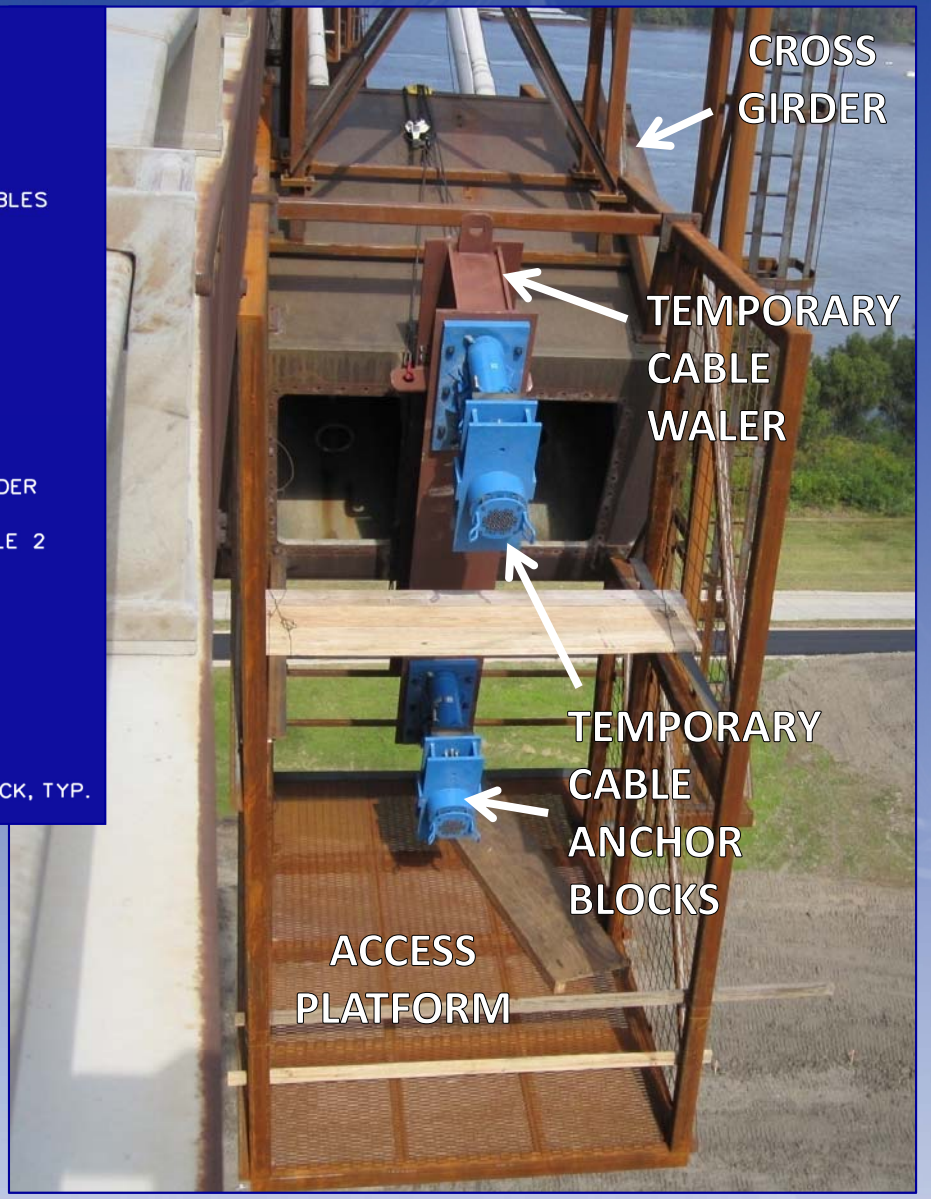


Install temporary support system

- Temporary cable saddle mounted at top of tower
- Top of tower strengthened locally beneath saddle

Stay Replacement





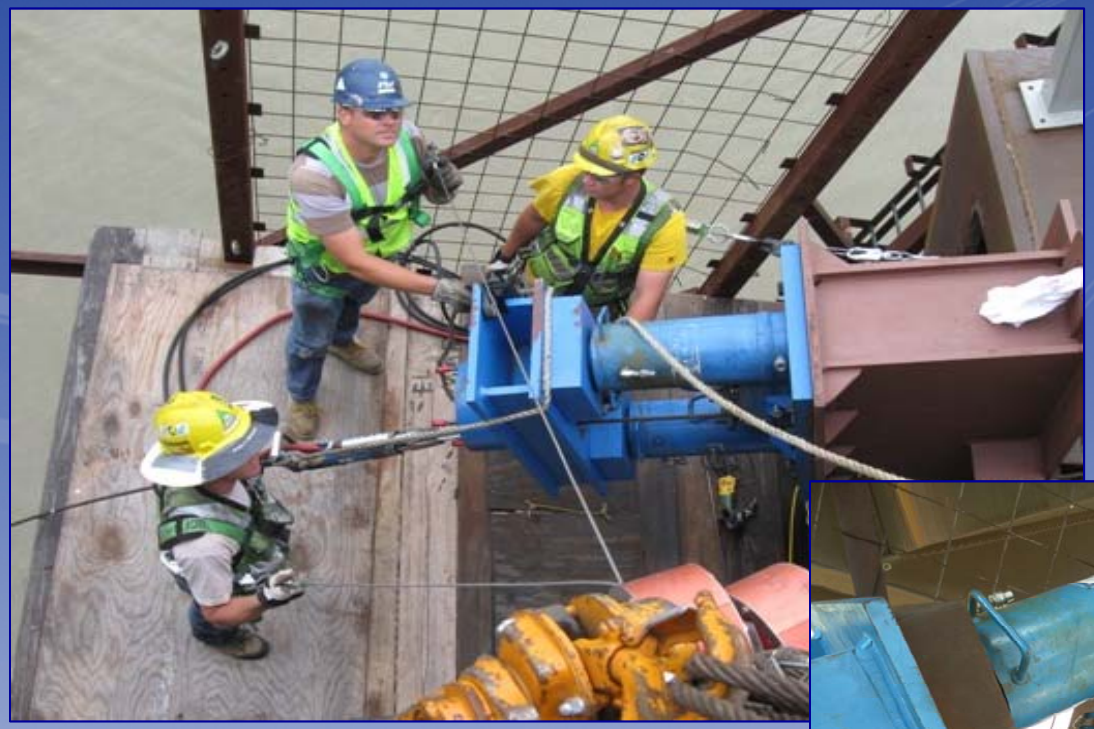
Install temporary support system

- whaler at deck cross-girder

Stay Replacement

Install temporary cables

Stay Replacement

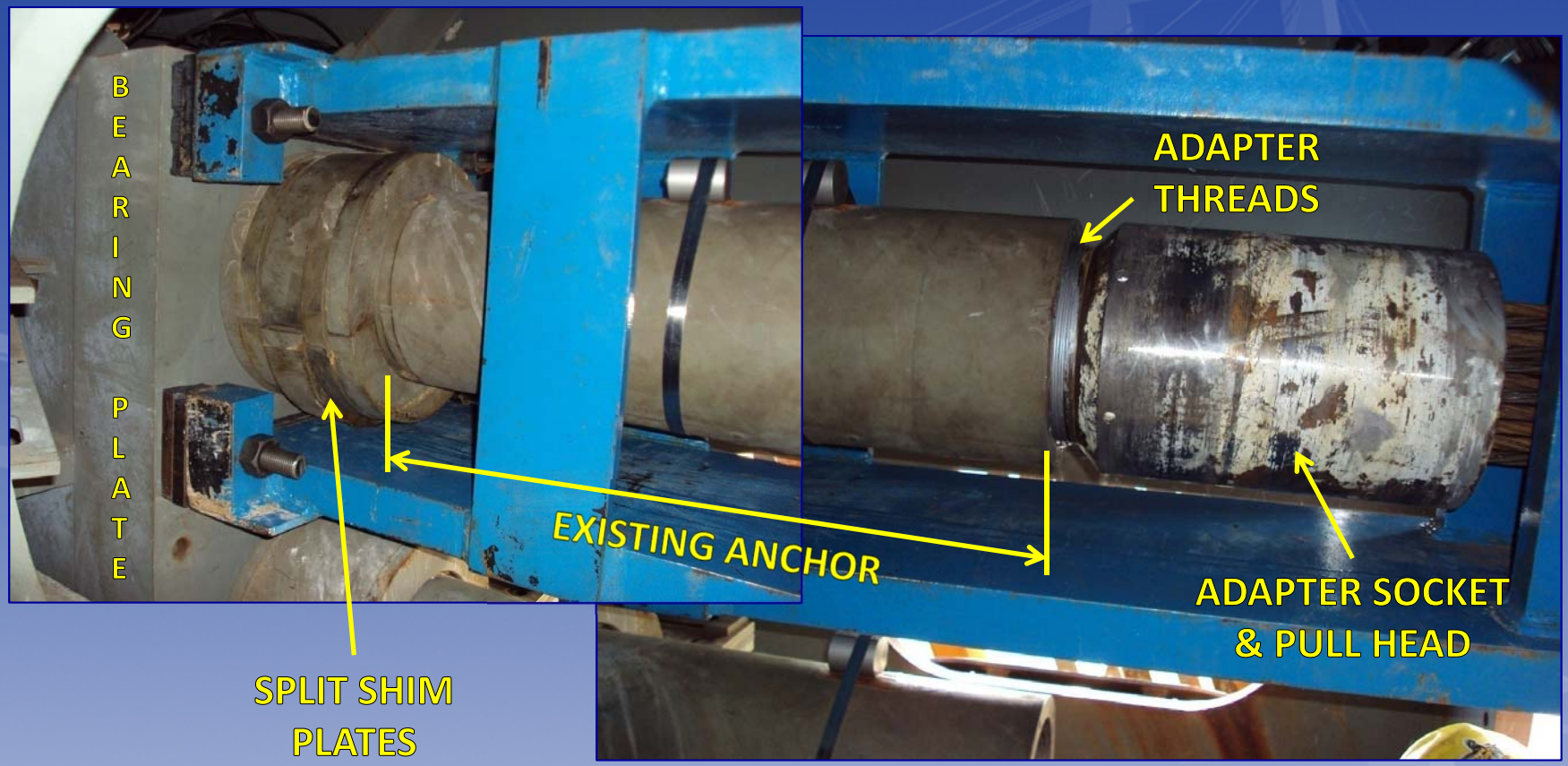


Stress temporary cables at deck cross-girder

Stay Replacement

Mobilize pair of jacks to simultaneously de-tension pair of existing stays

Stay Replacement



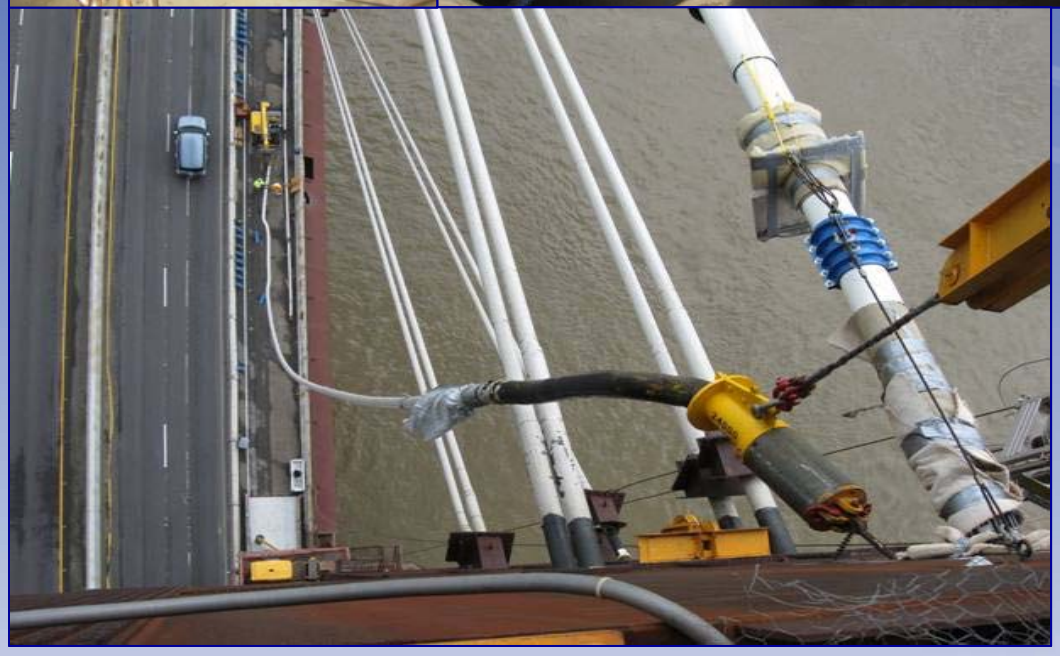
- Perform lift-off test of stay to determine replacement cable stressing force
- De-tension pair of existing stay cables simultaneously at deck cross-girders

Photos this slide provided courtesy of Kiewit Louisiana Company

Stay Replacement

Extract de-tensioned existing stay

Stay Replacement



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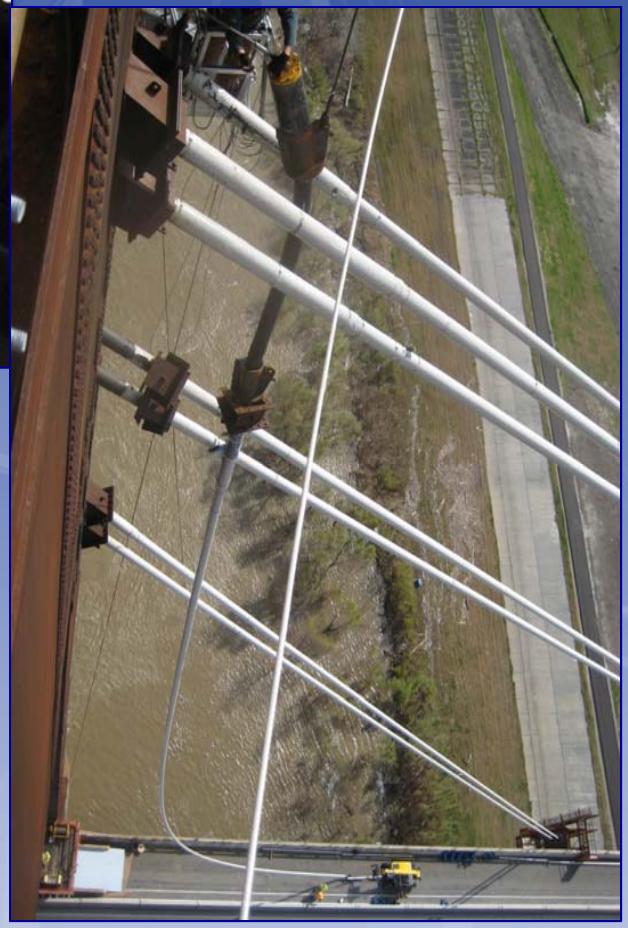

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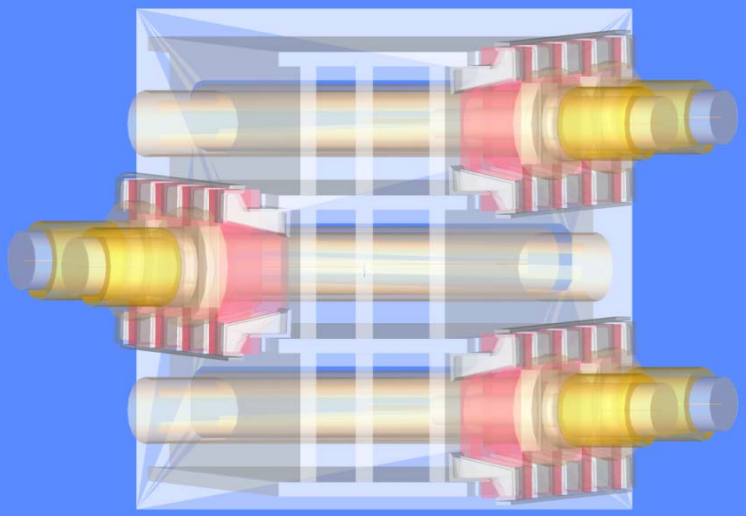
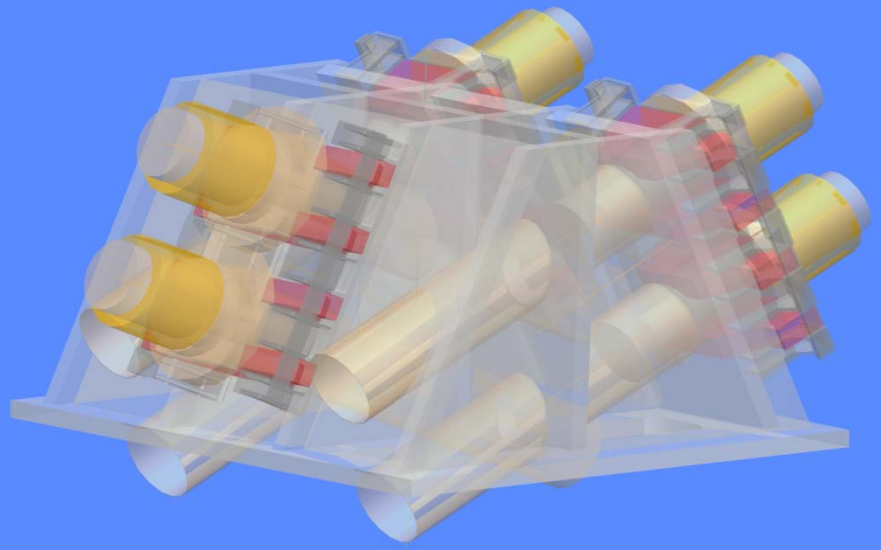
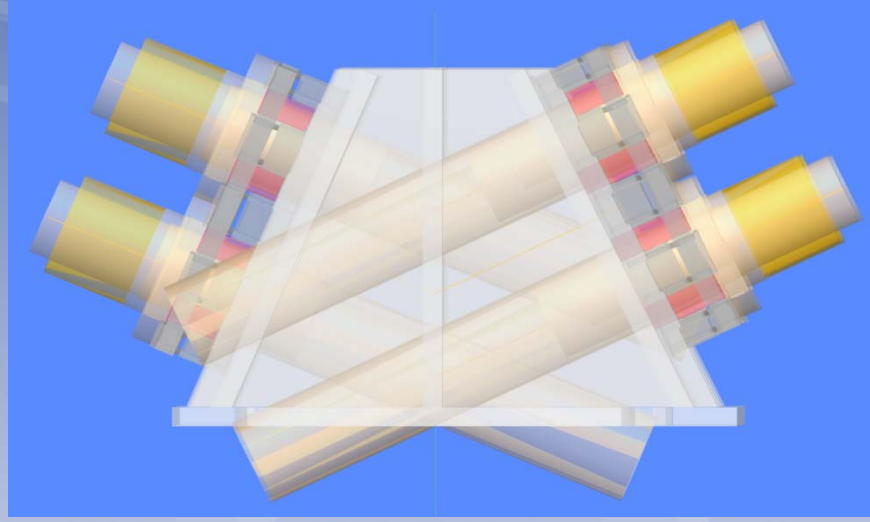


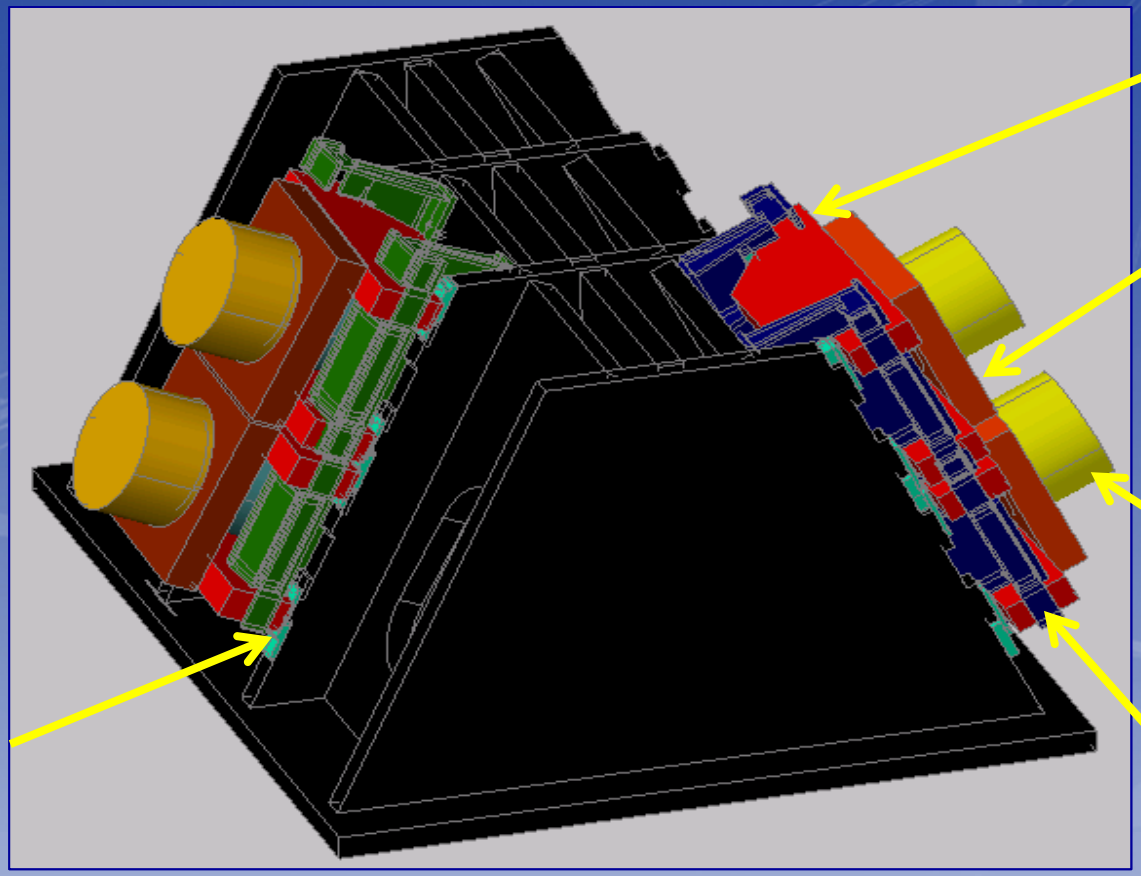




Modify existing structure at anchor locations

Tower anchor modifications

Stay Replacement



Modify existing structure at anchor locations

Tower anchor modifications

Stay Replacement

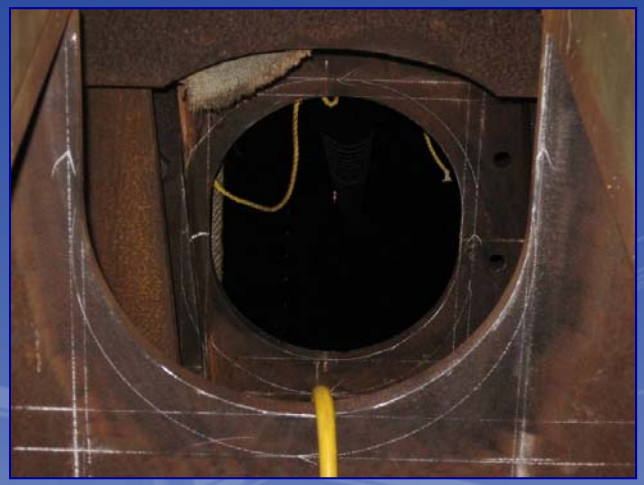
Existing Anchors

New Anchor

Modify existing structure at anchor locations

Tower anchor modifications

Stay Replacement

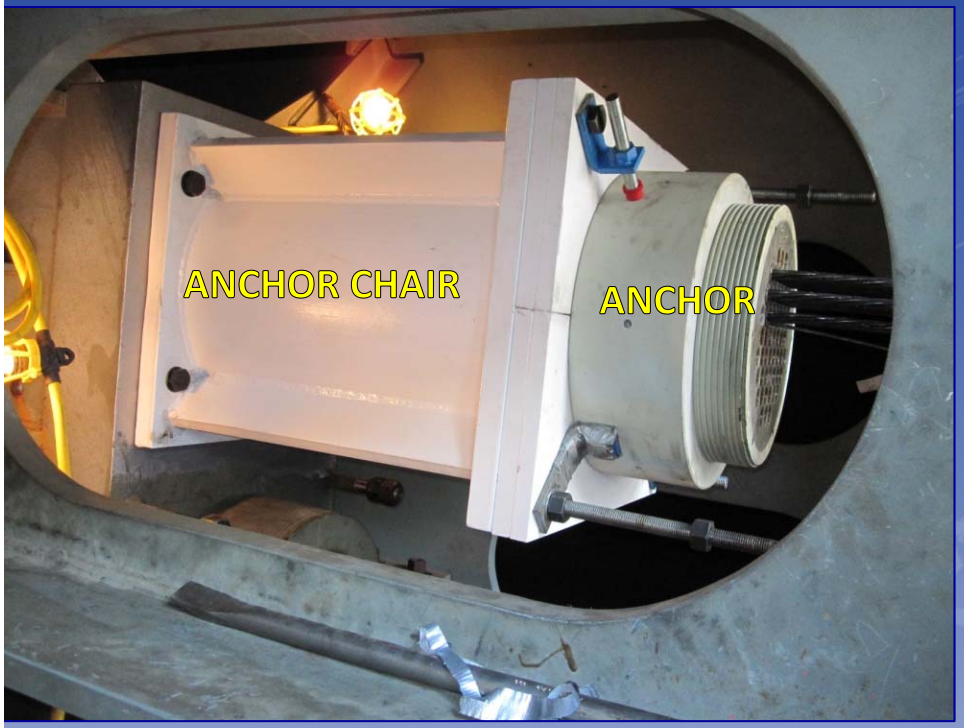





Modify existing structure at anchor locations

Tower anchor modifications – enlarge openings through thick anchor plates

Stay Replacement



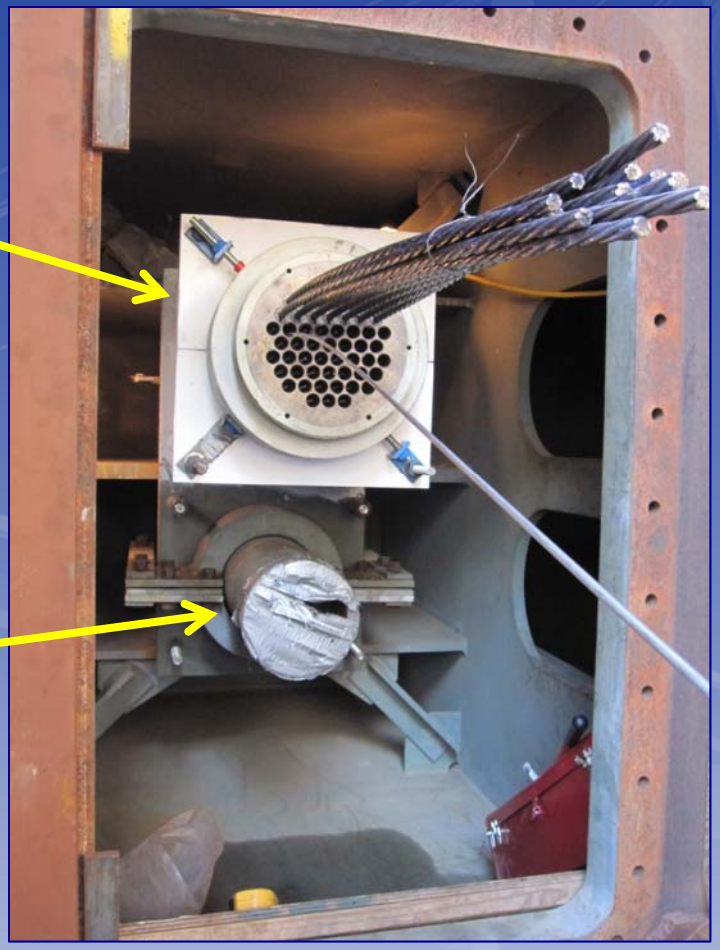
Modify existing structure at anchor locations

Deck anchor modifications

Stay Replacement

NEW DECK ANCHOR

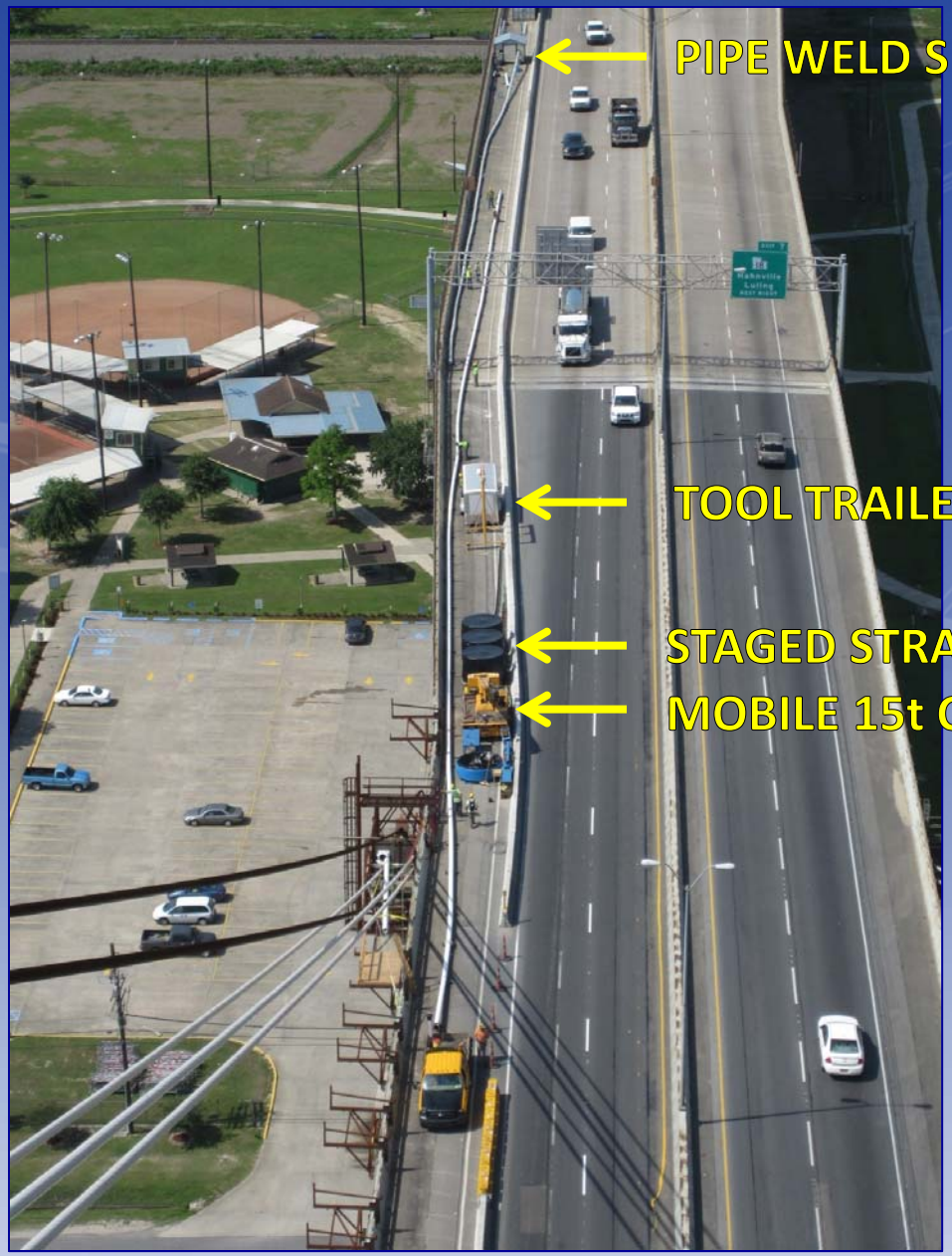
EXISTING DECK ANCHOR



Modify existing structure at anchor locations

Deck anchor modifications

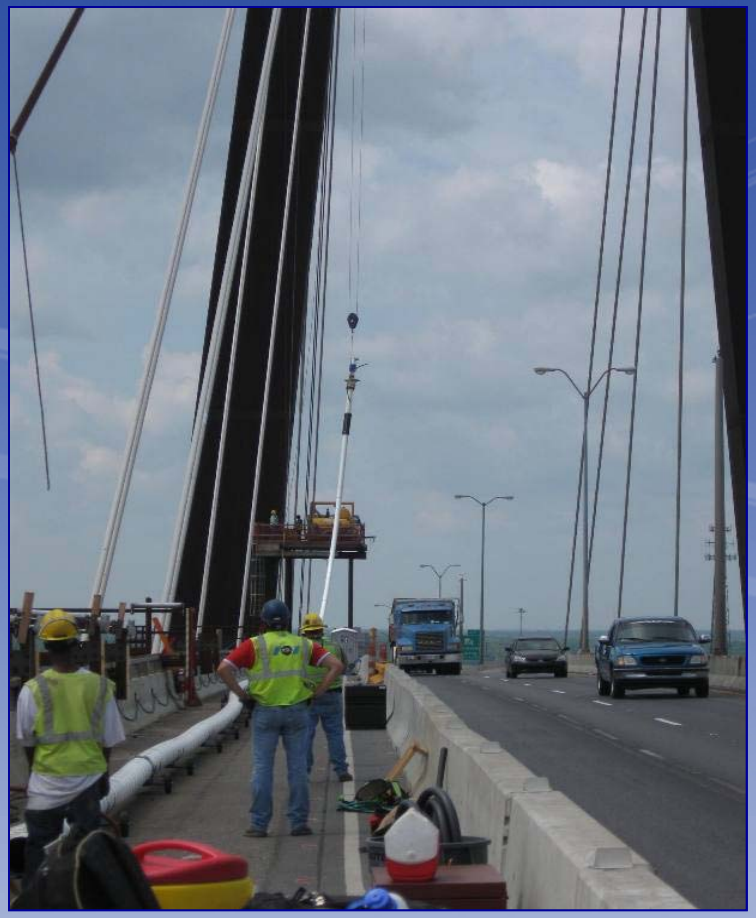
Stay Replacement



Install new stay

Assemble new stay pipe on deck

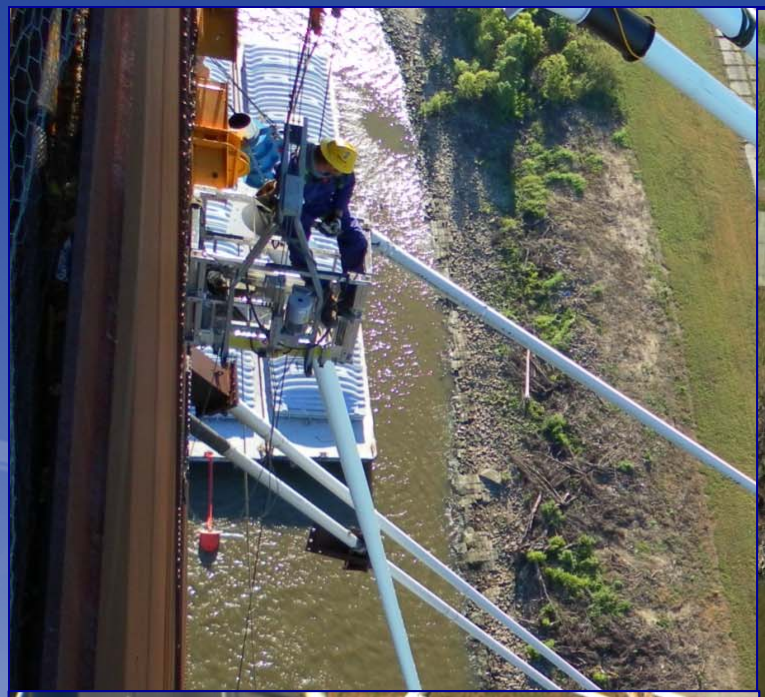
Stay Replacement

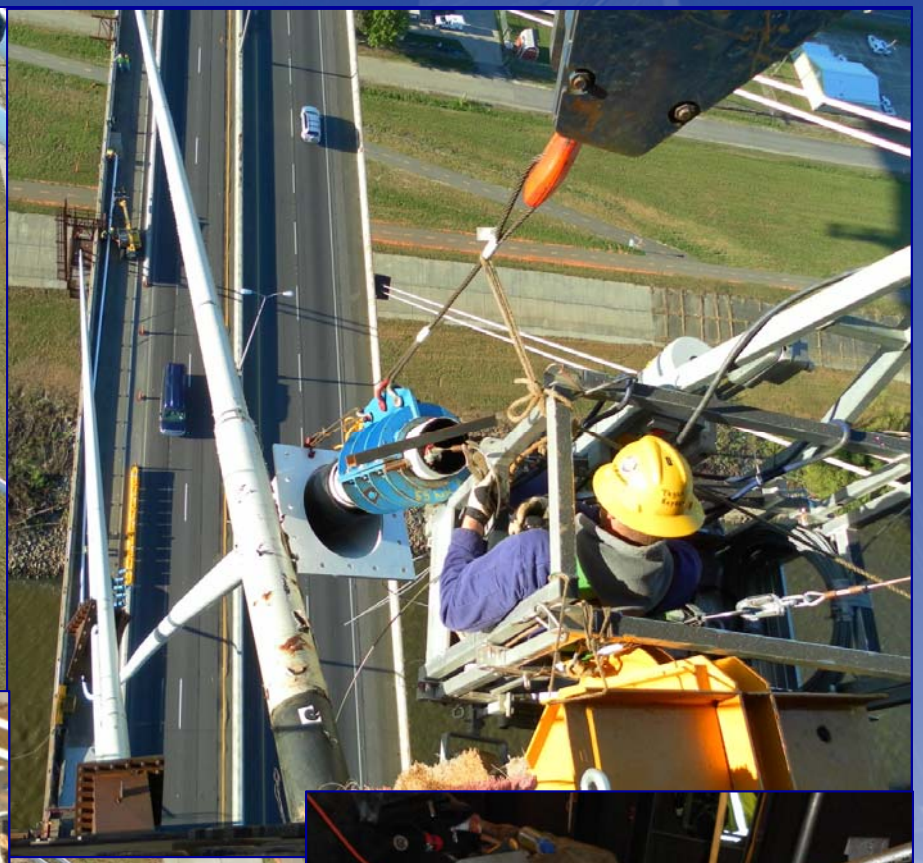


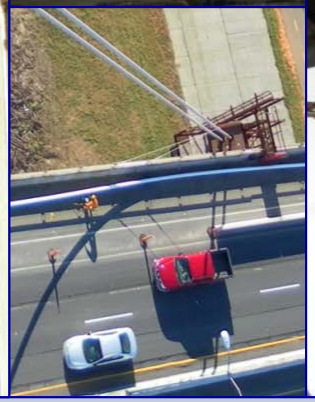
Install new stay

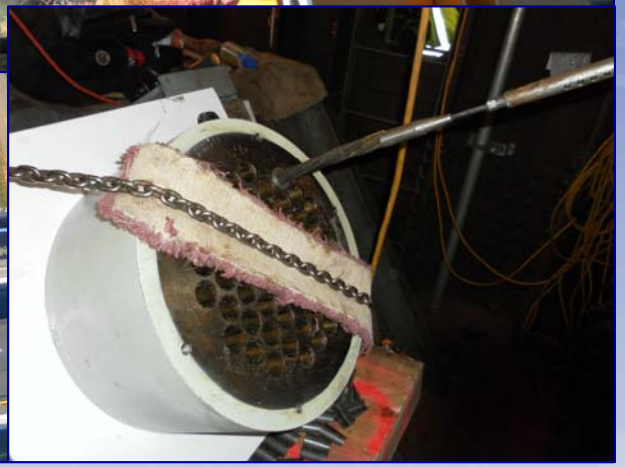
Hoist new stay pipe from deck

Stay Replacement









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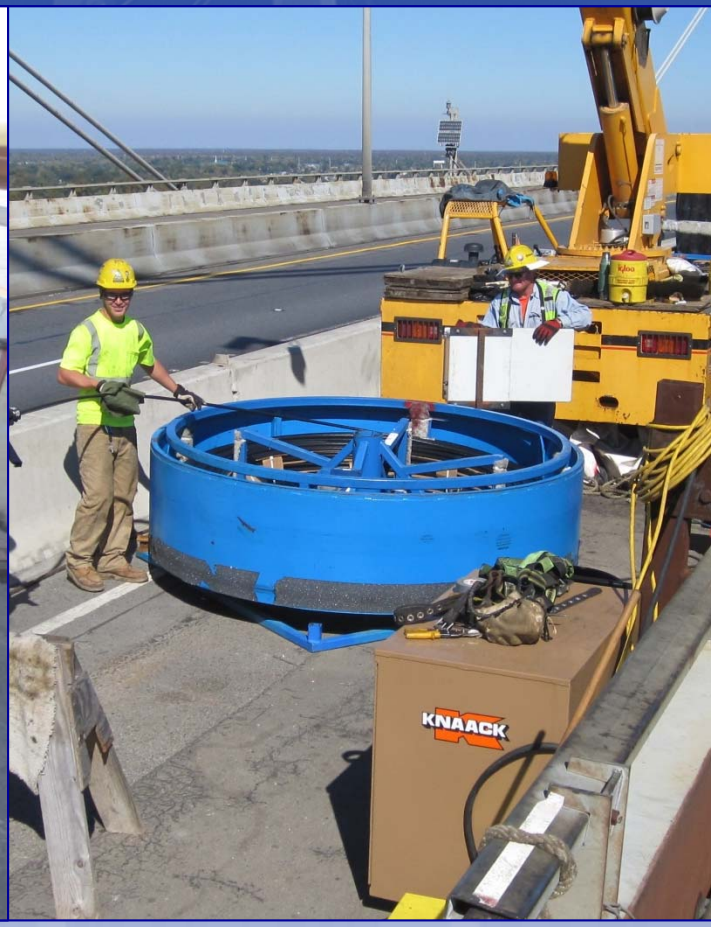

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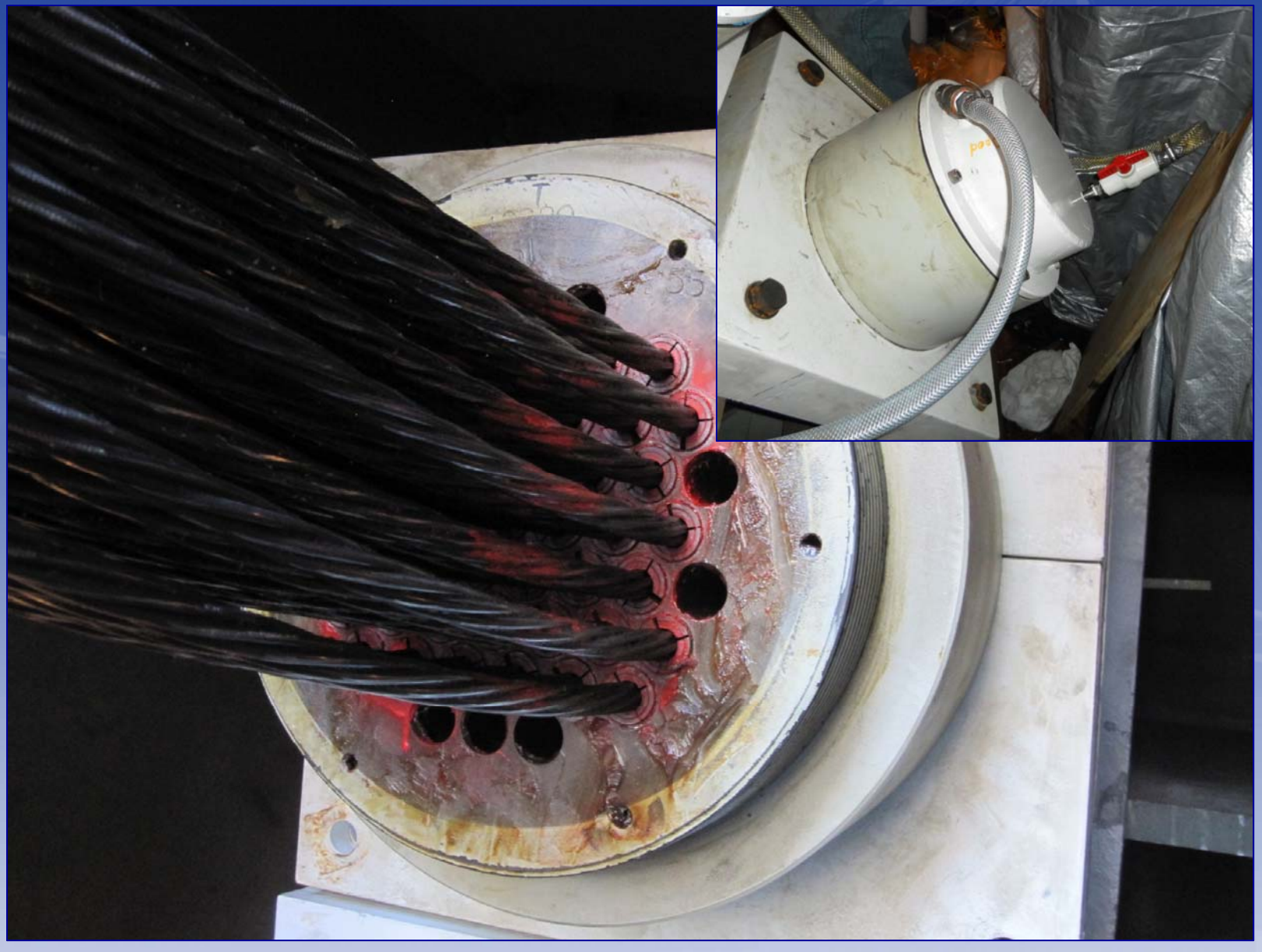
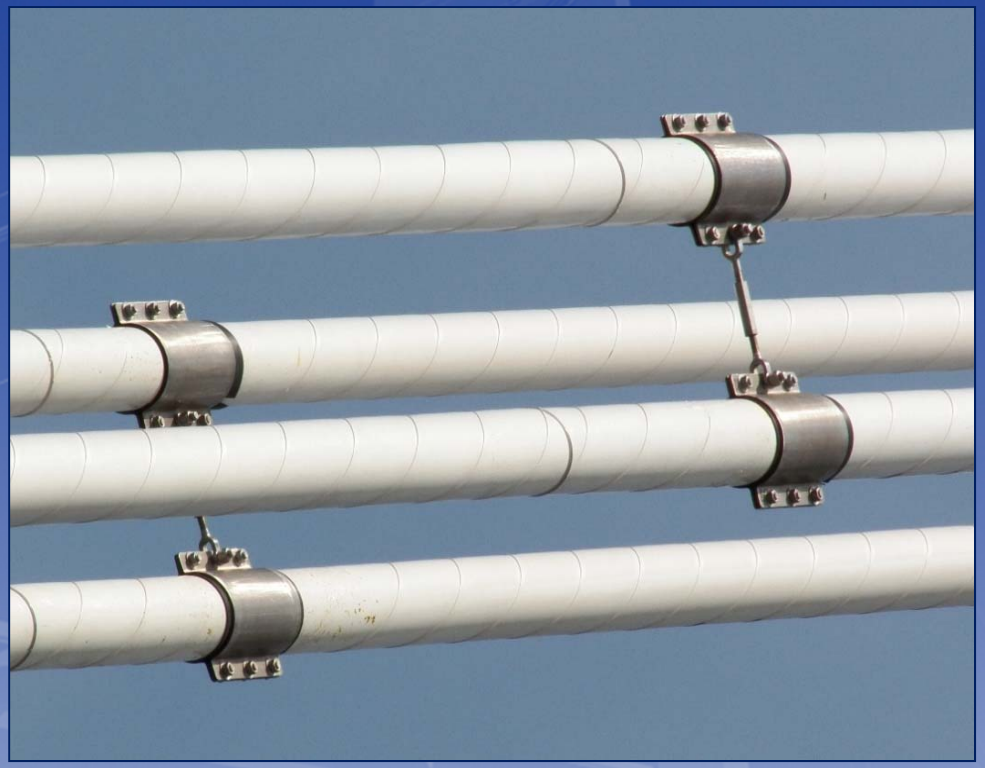
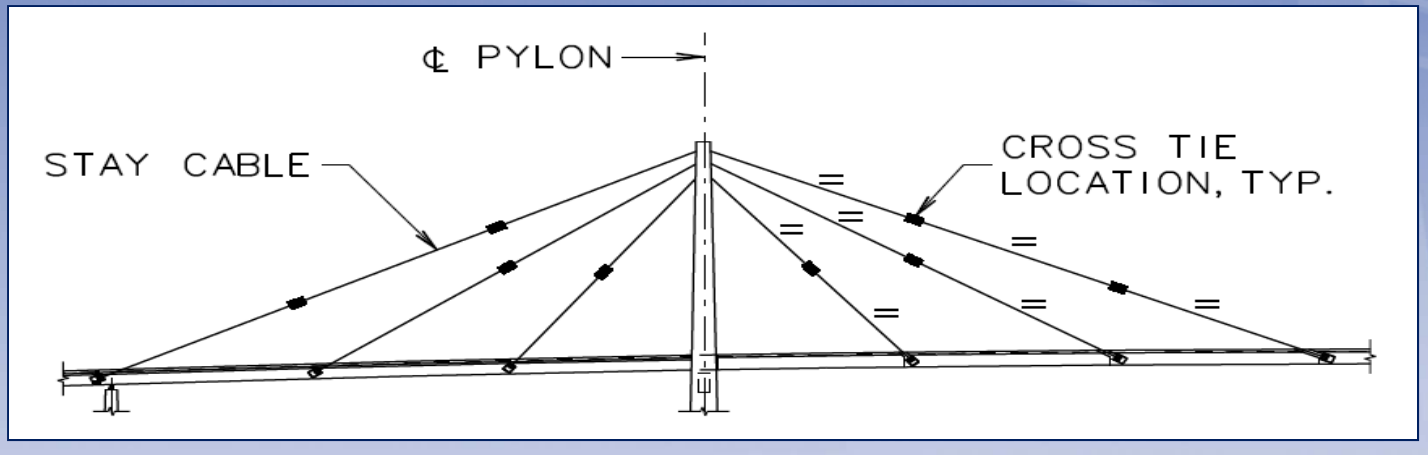


Stay Replacement

Stay Replacement





Lessons Learned / Reinforced

- Partnering
- Demonstrated need for modern PTI provisions:
  - Replaceable strands
  - Stay loss / replace
  - Access
  - Corrosion Protection
  - QA/QC
- Retrofit – expect differences between design and as-built condition

Credits

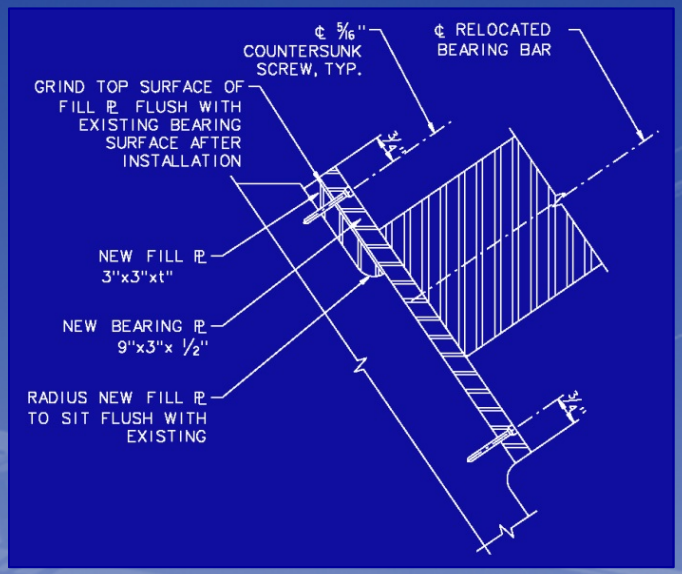
Bridge Engineering
Solutions, P.C.

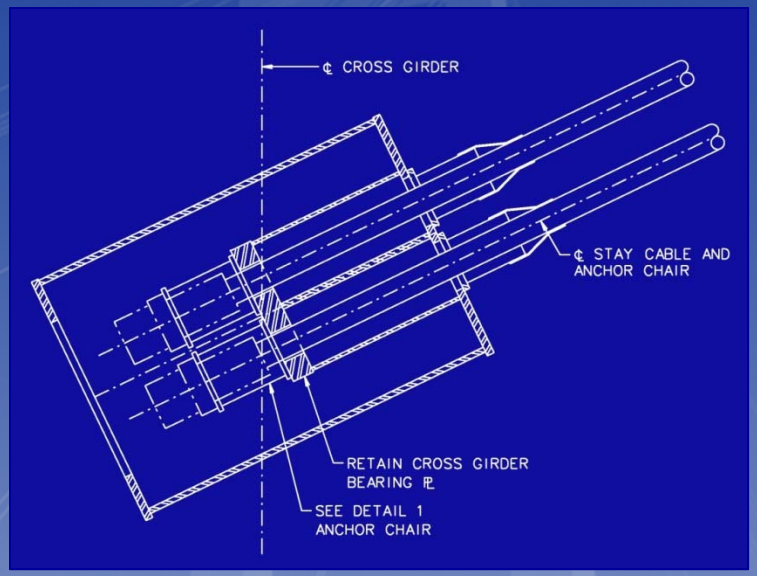
ABMB Engineers, Inc.

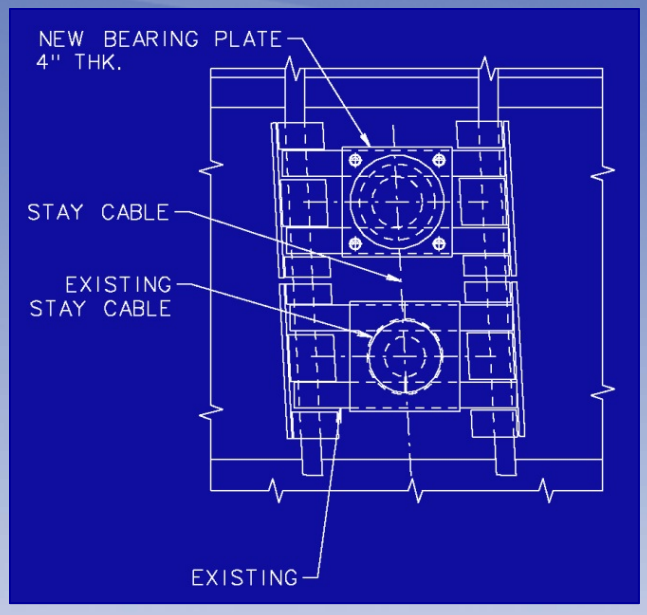
Original Main Bridge Designers: **Frankland & Lienhard / Modjeski and Masters**
Original Contractors: **Williams Brothers (Superstructure) / Massman Johnson (Substructure)**

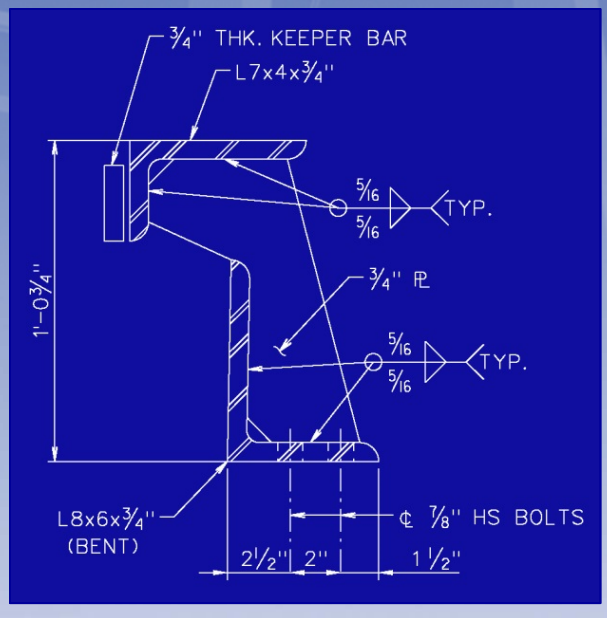

Thank you!
Questions?
INTERNATIONAL
BRIDGE
TECHNOLOGIES, INC.

Details


℄ 5/16" COUNTERSUNK SCREW, TYP.
℄ RELOCATED BEARING BAR
GRIND TOP SURFACE OF FILL PL FLUSH WITH EXISTING BEARING SURFACE AFTER INSTALLATION
NEW FILL PL 3"x3"xt"
NEW BEARING PL 9"x3"x 1/2"
RADIUS NEW FILL PL TO SIT FLUSH WITH EXISTING


℄ CROSS GIRDER
℄ STAY CABLE AND ANCHOR CHAIR
RETAIN CROSS GIRDER BEARING PL
SEE DETAIL 1 ANCHOR CHAIR


NEW BEARING PLATE 4" THK.
STAY CABLE
EXISTING STAY CABLE
EXISTING


3/4" THK. KEEPER BAR
L7x4x3/4"
5/16
5/16
TYP.
3/4" PL
1'-0 3/4"
5/16
5/16
TYP.
L8x6x3/4" (BENT)
℄ 7/8" HS BOLTS
2 1/2"
2"
1 1/2"