



2013 WESTERN BRIDGE ENGINEERS' SEMINAR

# STAY-CABLE REPLACEMENT DESIGN

MISSISSIPPI RIVER BRIDGE

LULING, LOUISIANA

September 5, 2013

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# Luling Bridge Background

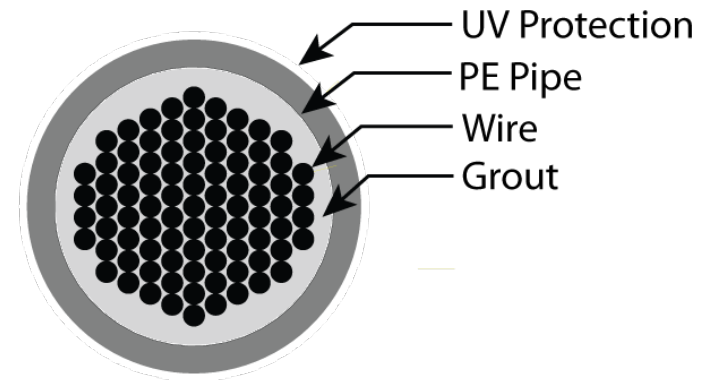
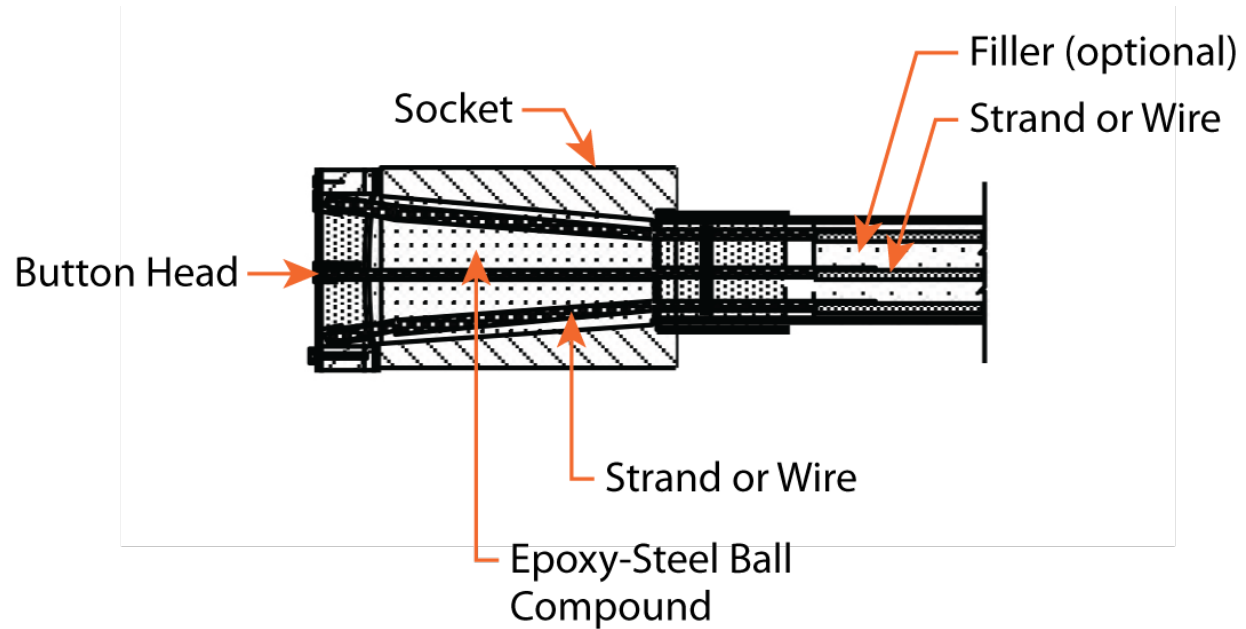
- Opened to Traffic October, 1983
- 1<sup>st</sup> cable-stayed bridge in Louisiana
- 1<sup>st</sup> Interstate cable stayed span
- All weathering steel – Japan fabrication
- Problems during construction
- Early signs of cable damage/corrosion

# Structural System



# Original Cable System

- Parallel 7-mm Wires
- Hi-Am Anchors
- HDPE Sheathing
- Grout Filled
- UV Protection Tape



# Project Background

- Cracking/splitting of sheathing pipes
- Rust staining & leakage - anchorages
- Signs of compromise in cables safety
- In 2002, LADOTD initiated evaluation of stay cables' condition

# Anchorage Inspection



# Cable Free Length Inspection





# Cable Inspection Vehicle



# Cable Damage

Longitudinal Split in PE



PE Damage

# Critical Damages

PE Damage / Exposed Grout



Exposed / Corroded MTE

# Inspection Summary

- 40 out of 72 cables were rated critical
- Remaining cables had less severe damages
- Increasing rate of deterioration evident
- Timely corrective action was needed
- Cable replacement selected over repair based on LCCA

# Cable Replacement Team

- Owner: Louisiana DOTD – Paul Fossier, Project Manager
- Prime Consultant: CTLGroup/Project Team – A. Ciolko, C. Ligozio, S. Wyatt
- Subconsultants:
  - Bridge Engineering Solutions
  - International Bridge Technologies
  - TranSystems
  - ABMB

# Cable Replacement Objectives

- Develop cost effective cable replacement design
  - Minimal engineering by contractors
  - Minimize impact to traffic and MOT requirements
  - Maintain structure capacity for live load, wind force, and construction load effects
- Greased and Sheathed stay cable system
  - Best available corrosion protection systems
  - Provide for future strand by strand replacement

# Cable Replacement Constraints

- Large spacing of grouped stays
- Unknown condition of original stay cables
- Limited work area, due to MOT constraints
- Size of replacement cables relative to original
  - Limited space in anchorage zones.
  - Potential for higher wind loads and wind induced vibration in new cables

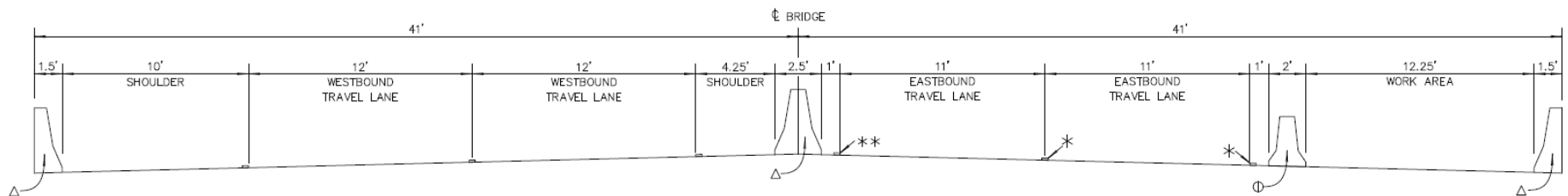
# Stay Cable Replacement Approach

- Replace in pairs, Symmetric to tower
- Use of Temporary Stay Cables
- Evaluation of anchorage zones to accommodate replacement cables from multiple suppliers
- Proposed use of Highline to minimize construction space requirements
- Addition of dampers and cable cross ties for vibration mitigation



# Maintenance of Traffic

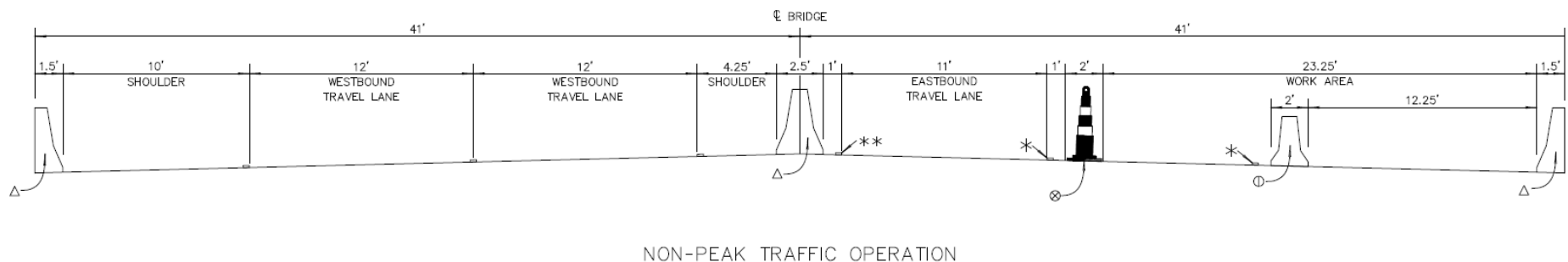
- Two traffic lanes maintained during peak traffic times
- Work Area: 12.25 ft width



PEAK TRAFFIC OPERATION

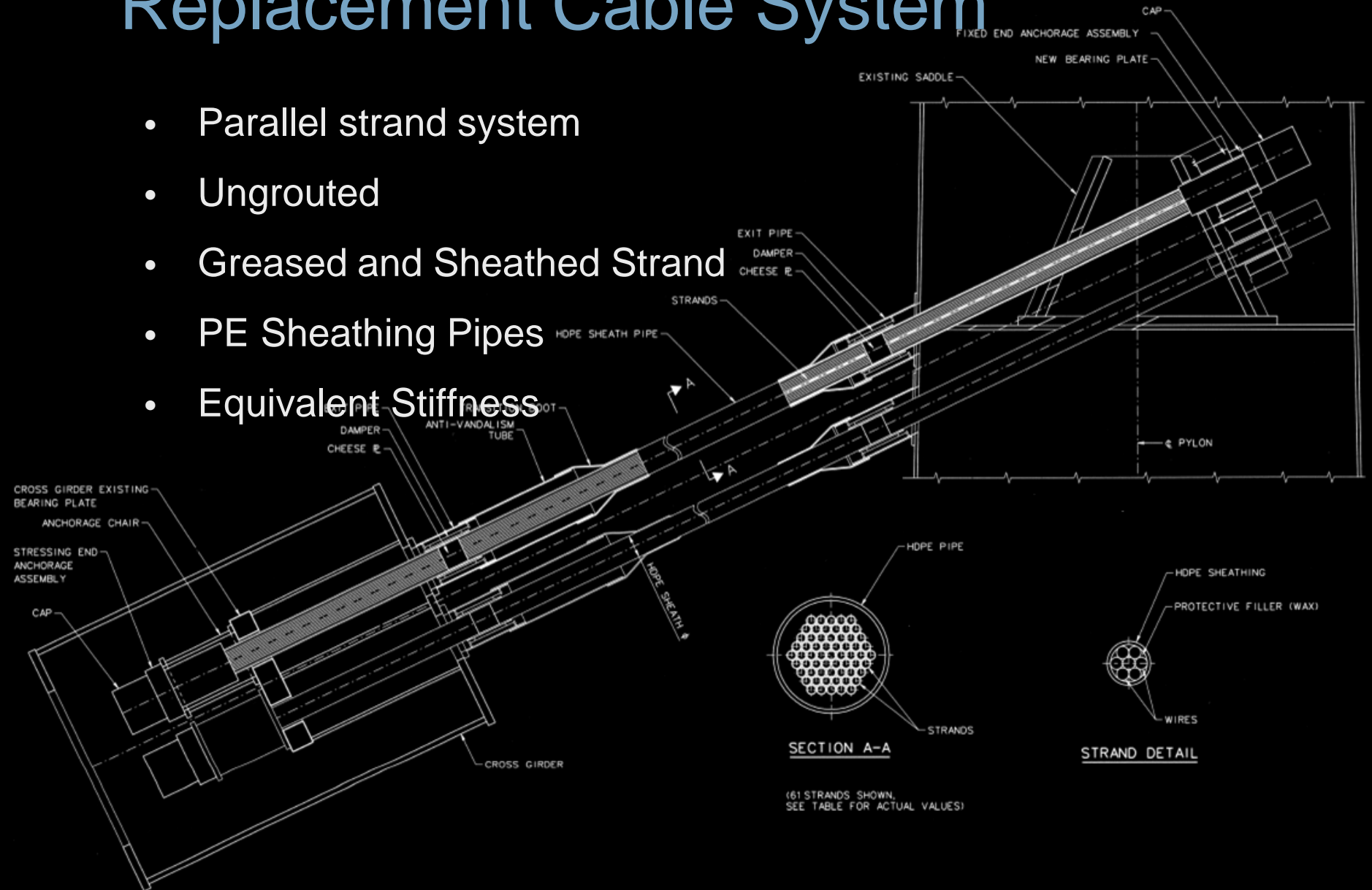
# Maintenance of Traffic

- Single lane provided during non-peak traffic
- Work Area:
  - 12.25 ft width behind barrier
  - Additional 9 ft width adjacent to barrier



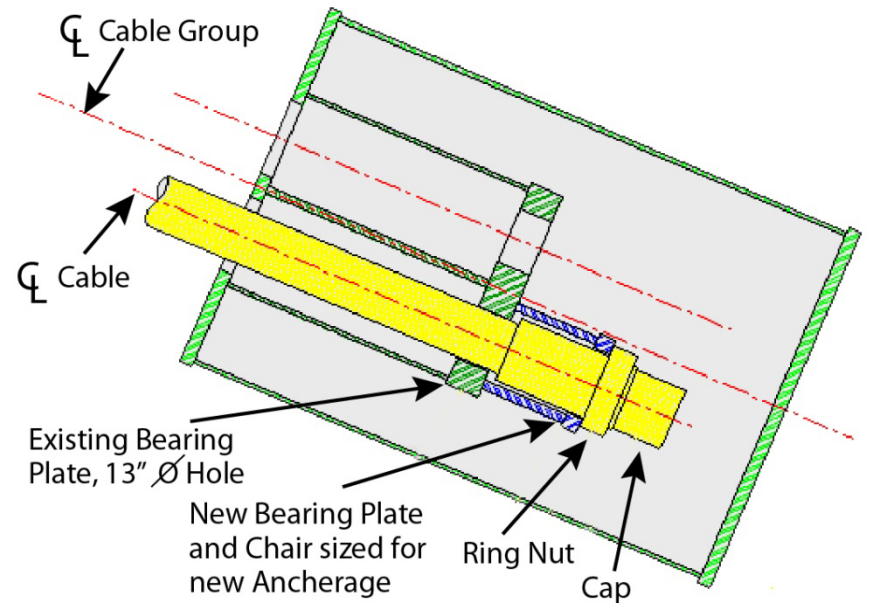
# Replacement Cable System

- Parallel strand system
- UngROUTED
- Greased and Sheathed Strand
- PE Sheathing Pipes
- Equivalent Stiffness



# Anchorage Zone Modifications

- Result of increased Cable Anchorage Sizes
- Designed to accommodate cables from several suppliers



## LEGEND

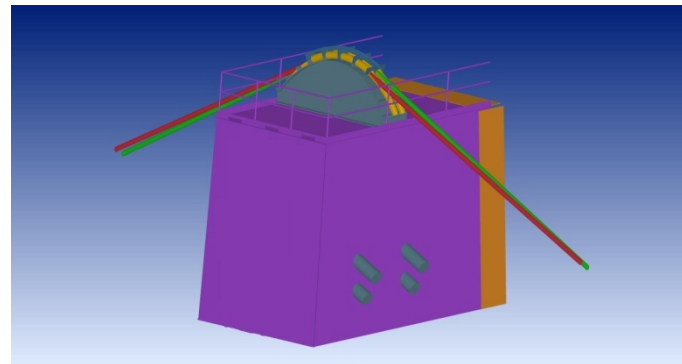
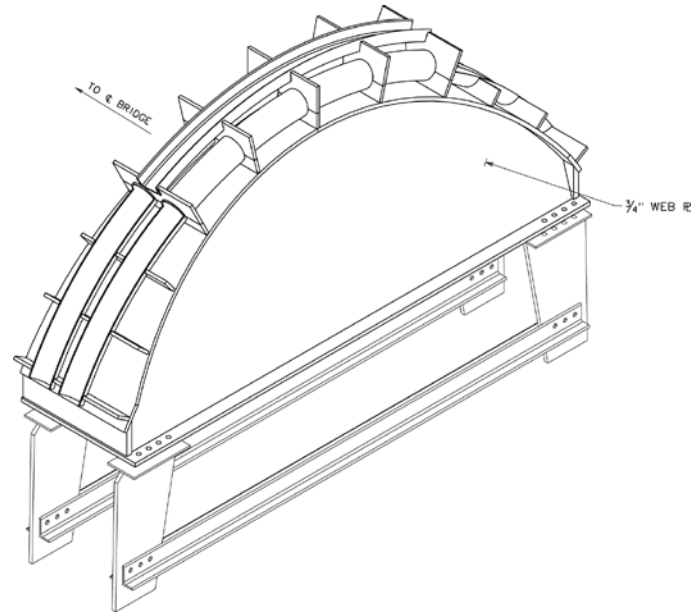
- Existing Cross Beam
- Existing Anchorage Plate
- New Anchorage Chair
- New Cable

# Temporary Cables

- Prevent stress increase in existing cables
- Allow normal use of the bridge during cable replacement
- Design provided

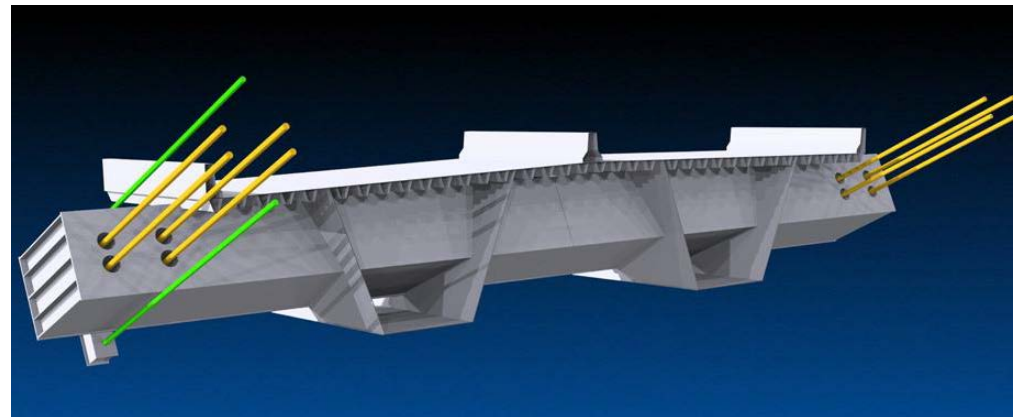
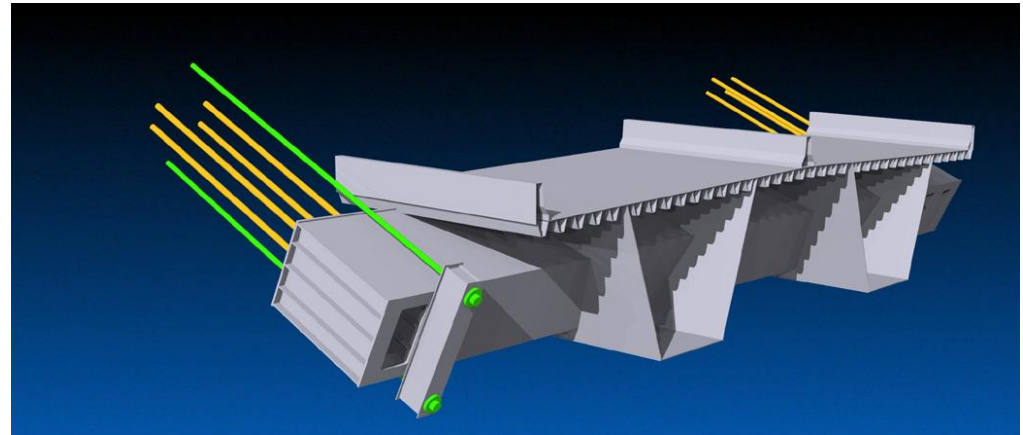
# Temporary Cables - Saddle

- Top of Pylon
- Light weight
- Geometry Fits all Cable Groups
- Limited tower strengthening



# Temporary Cables - Waler

- Lower Cross Beam
- Set from Deck
- Limit stresses in Cross beam ends



# Temporary Support System

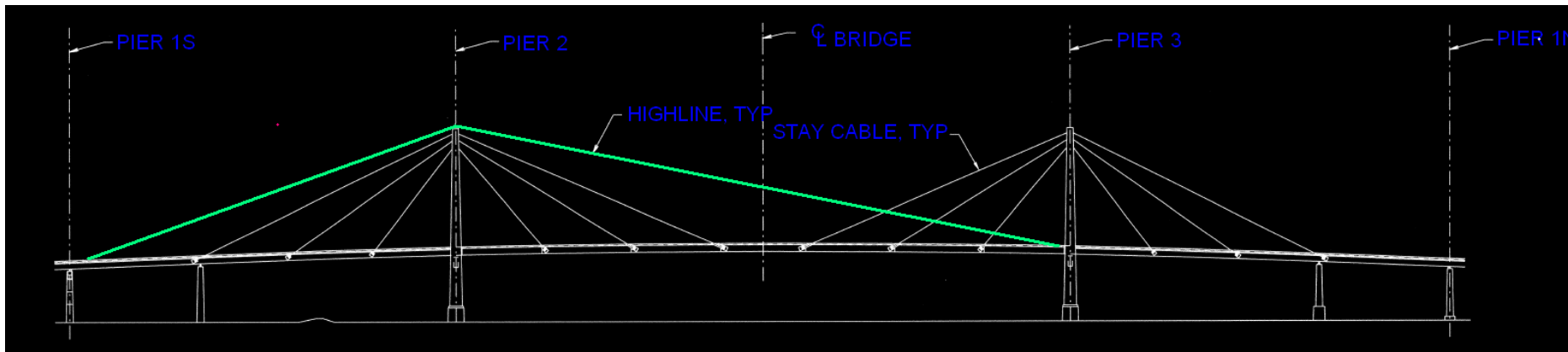
- Provide means of supporting stay cables during removal and installation operations
- Design developed assuming Highline or cable way to Limits Work zone requirements
- Schematic Design of Highline Provided
- Final Design by Contractor



# Schematic Highline Design

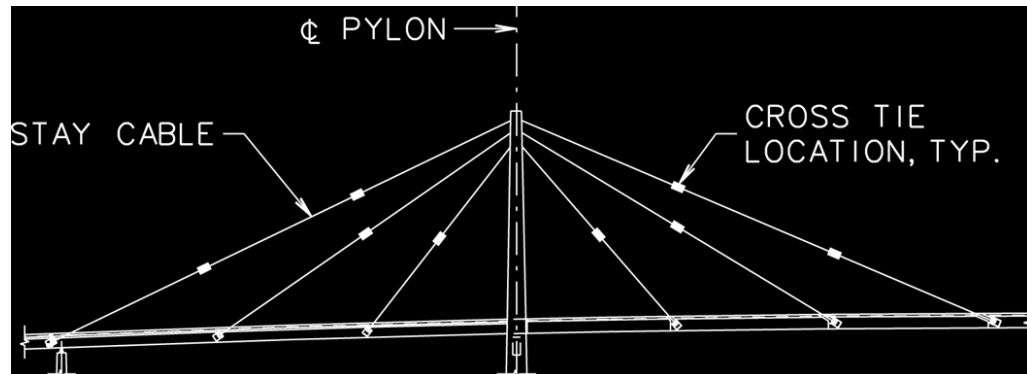
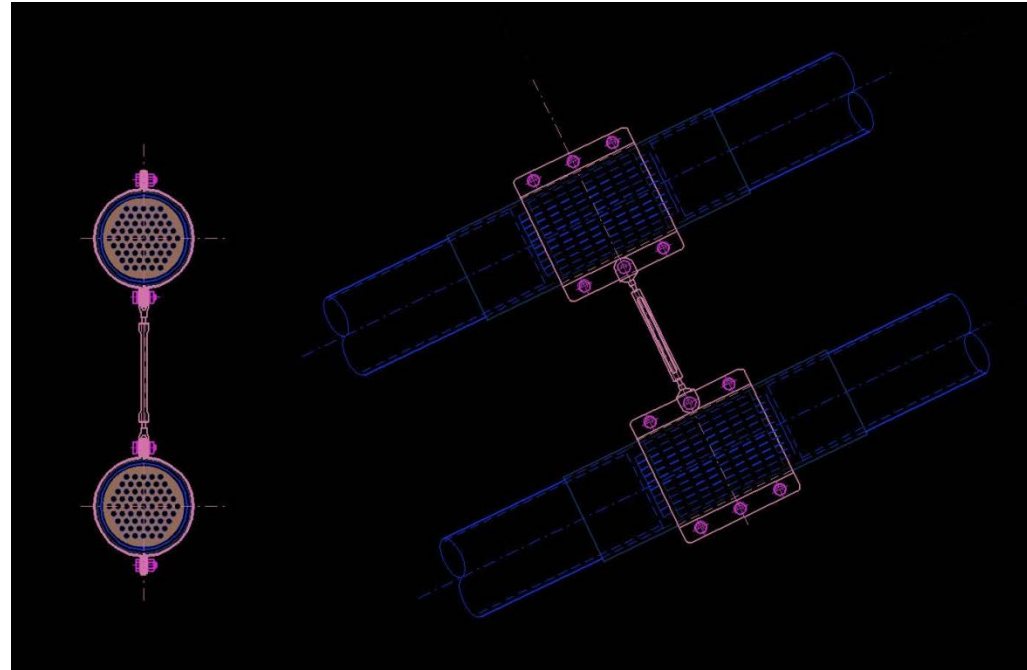
- Supported by Saddle at Tower

- Lower Anchorage tied to Superstructure



# Cable Cross Ties

- Mitigate potential wake galloping
- Ties between vertical cables
- Detailed to preserve strand replaceability



# Stay Cable Replacement Procedure



# Stay Cable Replacement Procedure



# Stay Cable Replacement Procedure



# Stay Cable Replacement Procedure



# Stay Cable Replacement Procedure



# Stay Cable Replacement Procedure





# Stay Cable Replacement Procedure



# Construction Bidding Summary

- LaDOTD Project: 450-37-0022
- Engineers Estimate: \$34.9 mil
- Bid Opening: 2/25/2009
- Top 3 Bidders: \$30.5 to \$36.7 mil
- Low Bid: \$30.5 mil (Kiewit)

# Construction Highlights



# Maintenance of Traffic



# Detension & Lower Cables



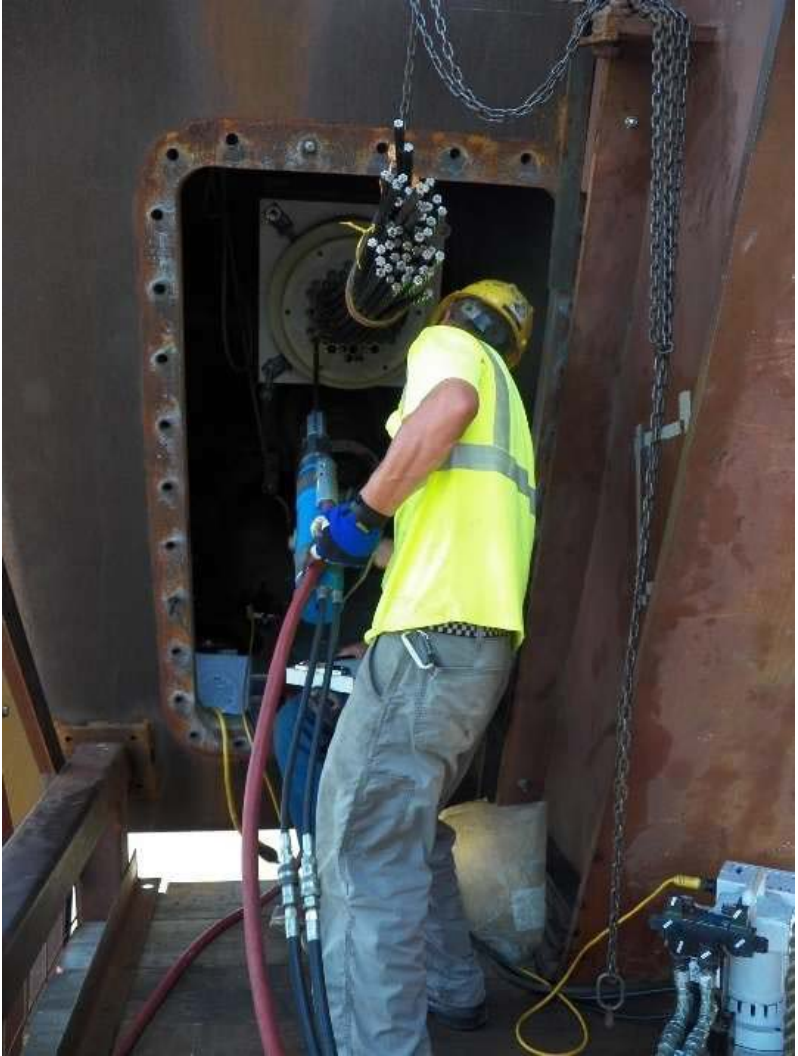
# Modify for New Cables



# Hoist New PE Pipe



# Install Strands and Stress

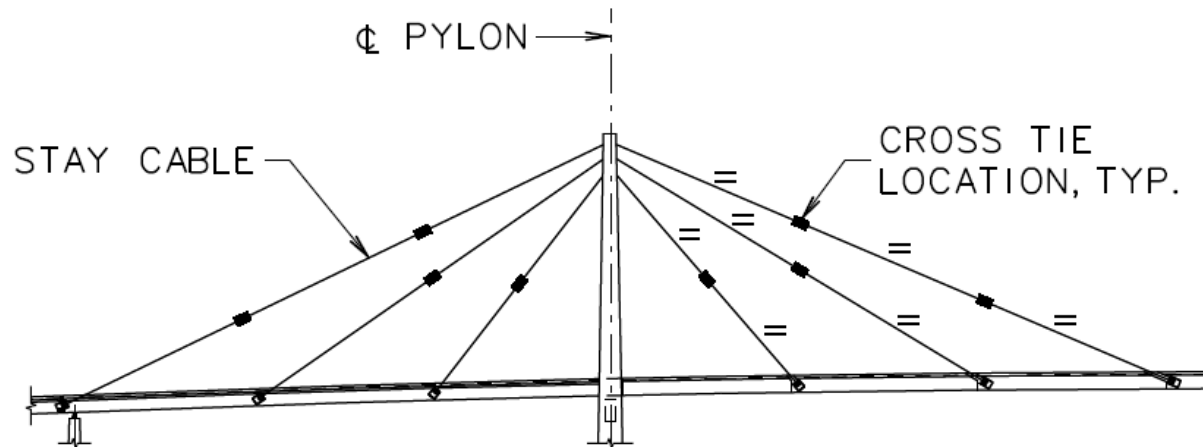




# Construction - Dampers



# Construction - Other Vibration Suppression



# Summary

- Cable condition inspections 2002-2006
- Cable replacement design 2007-8
- Construction project bid February 2009
- Construction NTP September 2009
- Zone 1 (25%) complete February 2011
- All Cables replaced September 2012

# Questions?



06.11.2006