2013 WESTERN BRIDGE ENGINEERS’ SEMINAR

STAY-CABLE REPLACEMENT DESIGN

MISSISSIPPI RIVER BRIDGE
LULING, LOUISIANA

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kpf Consulting Engineers
Luling Bridge Background

• Opened to Traffic October, 1983
• 1st cable-stayed bridge in Louisiana
• 1st 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
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
- Ungrooved
- 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
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
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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

[Diagram showing a pylon and stay cables with cross ties at typical locations.]

[Image of a cylindrical object lying on a concrete surface.]

[Image of multiple horizontal tubes with connectors at intervals.]
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?