Special Considerations for Maintenance of the Sunshine Skyway Bridge

2014 NATIONAL BRIDGE PRESERVATION PARTNERSHIP CONFERENCE

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Presentation Outline

• Sunshine Skyway Bridge Overview

• Proactive Maintenance Program: Skyway Preservation Committee

• Post Tensioning Protection

• Improved Inspection and Maintenance Access

• Bridge Health Monitoring

• Strategy for a 100-year Bridge Life
Sunshine Skyway Bridge
Sunshine Skyway Bridge Location
Skyway Bridge History

• In May 1980, a major ship impact caused the south bound main span of the original bridge to collapse.
• A signature replacement bridge was envisioned.
• After a 5 year construction period, the bridge was opened to traffic in April 1987.
• The bridge was re-dedicated in 2005 as the “Bob Graham Sunshine Skyway Bridge” as the former Florida Governor had the vision to build this signature bridge.
• Owned and Maintained by the Florida Department of Transportation
• Asset Maintenance Contracted since 2004
Looking south
Looking North
• Post-Tensioned Precast Segmental Box
• 42 Continuous Stay Cables, 21 per Pylon
• Total Length: 4,000 ft
• Post-Tensioned Precast Segmental Boxes
• Post-Tensioned Precast Segmental Columns
• Length: 2,430 ft each
Cast In Place Deck on Prestressed Concrete Beams
Total Length: 13,000 ft
High level approach
High Level Approach Column and Dolphin
Proactive Maintenance Program

• Major Challenge: Preserve the Investment
• Response: Skyway Preservation Committee
Total Cost Per Year to Maintain
Major Maintenance Challenges

• Corrosive Environment
• Three types of bridges in one
• Access for Maintenance
The Preservation Committee exists to provide a forum whereby a select group of specialists come together twice per year to discuss a wide variety of issues that affect the current and long term health of the Skyway Bridge.
Sample Skyway Preservation Committee Meeting Agenda Items

• Recently completed repair contracts
• Accelerometers on Stay Cables
• Remove Anchorage Covers
• Stay Cable Tension Testing
• Median Interior Maintenance
• Corrosion Prevention (water line and foundation)
Post Tensioning Protection

  1. Enhanced PT system
  2. Multiple tendon Paths
  3. Fully grouted tendons
  4. Water tight bridge
  5. Multiple layer anchor protection
Where could water enter?

- Closure pour cracking
- PT anchor pour-backs
- Raised median
- Segment joints (dry and epoxy coated)
- Cracked Polyethylene Ducts
Where could water enter?
Sealing the Raised Median Barrier with Polyurea
Cable Stay / Median Barrier
Segmental Bridge Deck

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2013 Deck Sealing Test Area
Methyl Methacrylate

150189
First batch of material going down. Span 125 north bound lane.

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2013 Deck Sealing Test Area
Methyl Methacrylate
Polyethylene Ducts

- All External PT ducts had been wrapped with heat shrink sleeves by 2006.
- Ongoing maintenance includes localized repairs by asset maintenance forces.
Localized Heat Shrink Duct Wrap Repair
Special Inspection of Post Tension Systems

- The Post Tension System is a critical item to inspect and ensure proper performance
- Voids and segregated grout must be detected and corrected to ensure maximum life of post tensioning system
- Special inspection methods are needed beyond the routine visual inspection
Typical External Tendon Cross Section

- High Density Polyethylene Duct
- Strand
- Cement grout
Post Tensioned Tendon Inspection
State of the Art

• No single test method is able to effectively inspect and detect tendon voids and corrosion
• Current methods can be expensive and time consuming: Main Magnetic Flux
• Several methods may need to be combined to get better results
• The FDOT is supporting new development in non destructive testing
Cable Stay Repainting
Cable Stay Repainting

02/25/2008
High Level Approach Bearing Inspection
High Level Approach Maintenance

Transition Pier from Single to Dual Box Sections

Typical High Level Approach
Sealing Column Caps
Pier Cap Sealing Complete
Improved Inspection and Maintenance Access
Rappelling Tower

01/01/2005
Bore scope Inspection of Stay Saddles

Check for corrosion and coating condition

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Inspection of Stay Cables using High Lift
Inspection of Stay Cables using High Lift
Inspection of Stay Cables Using High Lift
New Access Hatches in Median
Inspection Inside Median Barrier
Sunshine Skyway Health Monitoring

- Integrated methods of monitoring bridge condition properties
Outline

• Need for Monitoring
• Existing Monitoring System
• Structural Health Monitoring Goals
Structural Health Monitoring (SHM)

• Why Monitor the Skyway?
  – Vital to regional and multimodal transportation
  – Help ensure 100 year design life is met
  – Detect problems between visual inspections
  – Post hurricane or impact evaluation
  – Provide live weather conditions for Traffic Management
Current Monitoring System

- Global Positioning System (GPS) Receivers
- Automatic Total Stations
- Weather Stations
- Analytical Model
GPS System

GPS Sensors:
- Leica GPRX 1200+RS500 Receivers
- Post-processed accuracy of 1 centimeter in x and y planes
GPS Receiver Locations
Automatic Total Stations

- Leica TCA2003 ATS on Dolphin 101
- Leica TM30 on Dolphin 104
- Accuracy to 1 millimeter
- Redundancy for GPS
ATS Prism on Tower
ATS Lines of Sight
Weather Station

- Weather Sensors
  - Wind Speed/Direction
  - Temperature/Humidity
  - Barometric Pressure
  - Internet-connected with live web-cams
  - Rain Gauge
Weather Station Website

• Tabular and graphical data available
• Website updated every 15 minutes
Structural Health Monitoring (SHM)

Goals:

• Design verification (with analytical model)
• Establish normal movement
• Extreme event monitoring
• Deterioration/settlement detection
Design Verification

– Theoretical estimation of time-dependent stay forces to compare with empirical test results

– Calibration/verification of GPS/ATS readings
Analytical Model

- Time-dependent frame analysis model
- MIDAS Civil software used
- Main model P6S (106) to P6N (117)
Wind Analysis Graphical Results

1.37 ft

1.01 ft

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Normal Operating Parameters
Extreme Event Monitoring

- Hurricane effects
- Ship Impact
- Wind/rain cable vibration
Future Goals

• Fully calibrated analytical model
• Establish thresholds of movement
• Additional permanent sensors
  – Strain measurements
  – Stay vibration measurements
  – Thermal measurements
• Automated alerts
Strategy for a 100 year Bridge Life:

• Continue a “Preventive” focused inspection and maintenance program
• Continue the "Skyway Preservation Committee” to sustain the vision for a 100 year life for the bridge
• Give special attention to long term Corrosion Prevention
Questions?
Thank you for participating

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