Evaluation & Life Extension of Cable Stayed Bridges

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In This Presentation

We will discuss:

- Quantifying Unseen Corrosion Using Appropriate NDT Methods
- Making Decisions Based On Hard Data - Not Guess Work
- Extending Service Lives
- Partnering with Clients to Solve Problems Cost-Effectively
CORROSION COST PROGRESSION

Cost of Maintenance

Condition of Structure

- Good: Preserve
- Fair: Extend Life
- Poor: Replace

Potential Failure

Critical Point

Internal Damage

First Visible Damage

Damage Accelerates
CABLE STAYED BRIDGE – KENTUCKY / INDIANA

Strands: - Greased, sheathed grouted inside HDPE duct
Total of 96 cables
PROBLEMS

- Voids in grout
- Varying grout quality
- Cracking of HDPE ducts
- Failed welds on ducts
- Water leaking through cracks in ducts
- Strands are exposed to water in the ducts
TOP OF TOWER (VIDEO)
Voids indicate problems but not all voids are problematic

Strands corrode when grout quality is non-uniform or bad

Corrosion has occurred when cable is completely filled with grout

Strands that are greased, sheathed, and encased inside a plastic duct have corroded and failed within seven years
TARGETED INSPECTION

- Electrical continuity of strands
- Void locations using GPR and thermography
- Grout quality and protective properties using corrosion rate tests and specific laboratory tests
- Determine wire/strand break using Magnetic Flux Leakage – then visual confirmation at select locations
Define time-to-criticality - measure the rate of corrosion of strands in in-situ conditions

Quantify present and future damage

We have successfully used our methodology to quantify corrosion in pre-stressed and post-tensioned structures
Identify small and large voids with GPR
BENEFITS OF SCS EFFORTS

- Areas of voids in the cable duct
- Any existing wire or strand break within the duct
- Extent of corrosion of strands in areas where water was found inside the cables
- Rate of corrosion of strands exposed to rain infiltration
- Proper rehabilitation typically costs only 20% - 25% compared to replacement
Mid-Bay Bridge - Florida

- 3.6 miles long
- Segmental precast concrete box girders
- 11 Tendons replaced in eight years
11 Tendons replaced in eight years
Cracking of PE duct
What factors contributed to tendon corrosion?
What corrosion related repairs were necessary?
- Fully grouted tendons
- Half Cell Potential: 90% probability of no corrosion
- Chloride Content of Grout: Well below corrosion threshold
FULLY GROUTED TENDON

- Broken Wire
- Heavily Corroded Wire
GROUT PH VARIATION

- pH = 6
- pH = 8
- pH > 12
TYPICAL ANCHORAGE ASSEMBLY
We identified factors causing corrosion problems
The Department replaced problem tendons
Problems – limited to one section of the bridge
Full replacement of the bridge was not necessary
BENEFIT

- The Department repaired the bridge while keeping it open to traffic
- Eight years later, no more tendon failures
- New specifications adopted by Florida DOT, AASHTO, ASBI
CONCLUSION

- Not all grout voids cause problems; low alkaline grout/varying grout quality increase corrosion rate
- Corrosion can occur even when tendons are filled with grout
- Significant corrosion has occurred when potential and chloride data showed otherwise
- Important to measure all factors that may be corroding the strands/cables
SCS Approach

Three-Part Service:
1. In-Depth Evaluation
2. Design of Life Extension Systems
3. Installation Inspection
Questions?

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EXAMPLES OF NDT
GROUND PENETRATING RADAR (GPR)
ELECTROCHEMICAL TESTS