

Siva Corrosion Services, Inc.
materials and corrosion specialists

Can We Prevent This?



PA Concrete Conference
January 2008

Corrosion Issues of Prestressed and
Post-tensioned Systems

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Dangers of Tendon Corrosion

- Reduced cross section - increased stress on individual wires
- Increased stress - leads to wire breaks, which in turn can lead to further increase in stress
- Subsequent wire breaks - more frequent until the strand/tendon is completely lost

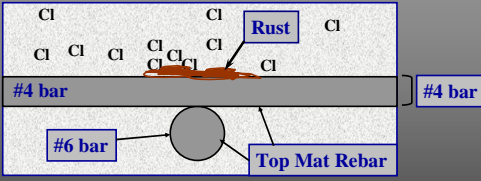
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Time to 50% Section Loss of a 0.5-inch Rebar



At 1 mil per year, time-to 50% section loss of 0.5-inch rebar is >100 years.

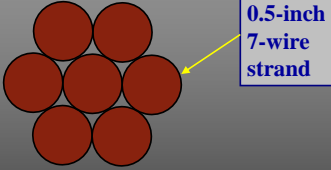
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Time to 50% Section Loss of a 0.5-inch Strand



At 1 mil per year, time-to 50% section loss of outer wires is about 25 years

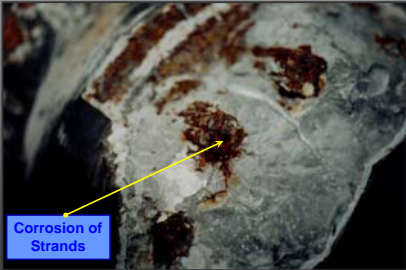
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Problems – Corrosion of Strands



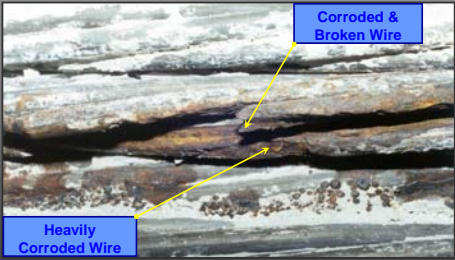
Corrosion of Strands

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Problems - Broken Wires



Corroded & Broken Wire

Heavily Corroded Wire

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When does Corrosion Initiate?

- When there is sufficient chlorides
- When the grout is carbonated
- When the combination of chlorides and partially carbonated grout results in conditions conducive for corrosion
- When the air voids and/or carbonated grout are in contact with the strands

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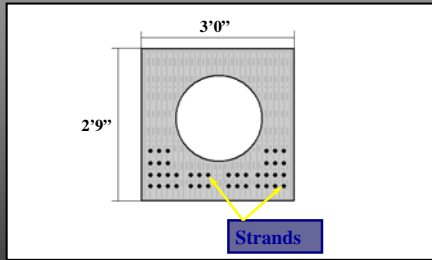
Types of Investigation

- Visual inspection – cracks, efflorescence, rust stains, misalignment, etc.
- Visual inspection can be misleading – Mid Bay Bridge.
- Non-destructive testing – must quantify the corrosion problem - not just identify it.

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Typical Box Beam



3'0"

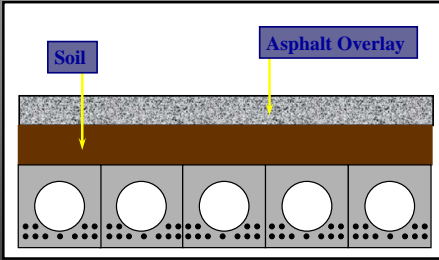
2'9"

Strands

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Box Beam Bridge with Asphalt Overlay



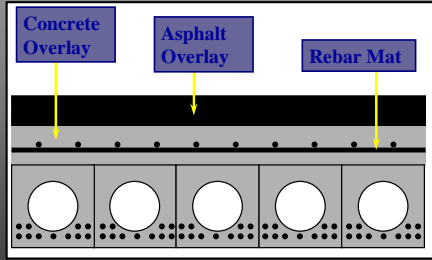
Soil

Asphalt Overlay

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Box Beam Bridge with Concrete and Asphalt Overlay




Concrete Overlay

Asphalt Overlay

Rebar Mat

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
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 **Strand versus Rebar Corrosion**

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- Rebar corrosion results in delamination and spall.
- Minor section loss (<5%) of rebars leads to delamination and spall.
- Even significant strand corrosion (complete wire break) may not lead to delamination or spall.
- Minor cracks may be the only visible sign provided by box beam bridges.


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 **What Does it Mean?**

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- Visual evaluation - not sufficient for PT structures.
- Measure section losses and the rate of corrosion at critical points.
- Document the quality of the material surrounding the strand/tendon.
- Calculate time-to-criticality.

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 **SCS Experience**

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- Evaluated several box girder bridges.
- Evaluated both external and internal tendons.
- Visual inspection alone can be misleading.
- Quantifying corrosion is a must to define future section loss.
- Define section losses to be used in the structural analysis to determine remaining strength.


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 **Corrosion Rate Measurement**

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 **How Do I Use this Information?**

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- In addition to visual inspection, document the quality of the concrete/grout at key locations.
- Determine the rate of corrosion of strands and expected future section loss.
- Perform structural analysis to determine remaining strength.

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 **Why Do We Need Corrosion Investigations?**

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- Quantify and not just identify corrosion problems.
- Incorporate corrosion data in structural capacity calculations.
- **Identify and extend the life of critical beams so that the entire structure is not lost due to premature deterioration of a few beams.**

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