



Project Summary

Texas Department of Transportation

0-1774: Effect of Wrapping Chloride Contaminated Structural Concrete with Multiple Layers of Glass

Background

The objective of this research project was to determine the long-term performance of structural concrete members with fiberglass-reinforced plastic (FRP) composite wrap. In a lab setting, researchers examined a wide range of variables using test specimens exposed to a corrosive environment. In the field, wrapped bridge elements were monitored at locations in the Lubbock District. Researchers' goals were to provide guidelines for implementing wrapping techniques that proved most effective in limiting corrosion damage, and to provide simple non-destructive methods to assess corrosion activity before the steel-reinforced element was structurally compromised.

What the Researchers Did

Specimens simulating pier caps and columns were placed in a specially designed exposure tank that was designed to represent a corrosive environment similar to that in which structural elements of a highway might be exposed. The conditions were intended to be especially severe in order to accelerate the corrosion process. The variables considered included the wrapping materials and resins, surface area of member wrapped, chloride content of fresh concrete, concrete surface condition, material used to repair damaged concrete, corrosion-inhibiting additives, and length of exposure (2 to 5 years).

Half-cell readings and visual observations were made throughout the exposure testing. When specimens were removed and autopsied, half-cell readings were taken over the entire surface of the specimens and samples were taken to determine chloride concentrations. Bars were removed from the concrete and the amount of corrosion activity was observed.

Lubbock District's FRP-wrapped bent caps and columns were annually monitored visually and electrically via reference probes that were installed in the repaired concrete elements before wrapping.

What They Found

- FRP reduced the corrosive activity in the test specimens by acting as a barrier to the ingress of chlorides and moisture. The increase in chloride concentrations in wrapped regions was lower than in unwrapped regions and reinforcement in the wrapped regions exhibited less corrosion. Even when chlorides were added to the concrete to accelerate the corrosion activity, wrapping lowered the migration of additional chlorides and reduced the available moisture so that corrosion in the wrapped regions was less severe.

Research Performed by:

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- FRP wrapping was effective in reducing corrosion activity in partially wrapped specimens but when a greater surface area was wrapped, the performance improved.
- The presence of cracks in the wrapped members did not reduce the effectiveness of the wrap.
- Both trademarked and generic wrapping materials were used. There was little difference in the performance of the materials in the exposure testing. The primary difference is the ease of application. The trademarked materials were easier to install and had an improved appearance.
- Specimens that were repaired before wrapping performed well if the permeability of materials used in repair was low. Latex-modified concrete performed particularly well as a repair material.
- Chloride inhibitors did not perform well and there was no conclusive evidence that corrosion activity was changed in specimens treated with inhibitors.
- Field evaluation of bridges in the Lubbock District that had been wrapped provided a means of evaluating the performance of wrapping techniques in the field. Probes and chloride contents indicated the onset of a fairly high probability of corrosion in some of those bridges, so it is important to continue to monitor and visually examine the condition of the reinforcement in those cases where severely damaged elements have been repaired and wrapped.

What This Means

- In highly corrosive environments, use of FRP wrapping is likely to extend the life of bridge structures. The quality of the installation is critical. The choice of epoxy and fiberglass materials can be left to the contractor but should be approved and monitored by Texas Department of Transportation personnel. As much of the surface area as possible should be wrapped.
- Where structural members are repaired before wrapping, the materials used should have low permeability. All corroded reinforcement should be cleaned. Care should be taken to prevent chlorides from penetrating through bridge deck joints and reaching the unprotected portions of top surfaces of bent caps, especially around bearing pads.
- Probes to monitor corrosion activity should be installed on selected structures. When elements are wrapped, it is impossible to monitor corrosion activity visually, take half-cell readings on the surface of the concrete, or easily extract samples to assess chloride concentrations.

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