PUTTING RESEARCH TO WORK

BRIEF

Reducing Corrosion on Fiberglass Wrapped Concrete Bridge Columns

In cold-weather states like Wisconsin, traffic often splashes deicing salts on concrete bridge columns, which causes premature deterioration of these columns. The chlorides may initiate corrosion of the steel reinforcing bars, especially the uncoated steel used in older construction, resulting in cracking, spalling and delamination. To prevent further chloride intrusion, WisDOT began wrapping fiberglass around the lower portion of deteriorating columns after repair.

What's the Problem?

Observed premature failures of fiberglass wrap have cast doubts on the effectiveness of the current practice. WisDOT needed to know whether further corrosion of the reinforcing steel may still be taking place even after application of the wraps. Knowing if this is the case and the rate of continuing corrosion would be helpful in planning maintenance and updating the wrapping practice to better protect these columns.

Research Objectives

The goals of this project were to gain insight into the occurrence and rate of corrosion in these columns and to document their expected life. With this understanding, WisDOT could then take action to stop the corrosion and determine what further investigation of other columns would be warranted. Additional objectives were to document existing literature on the corrosion process and other states' experiences in the use of fiberglass wrap or other options for reducing corrosion.

Methodology

WisDOT identified a number of bridges that had been treated with fiberglass wraps. The research team performed visual inspections of these bridges, using their own observations and previous WisDOT bridge inspections to select eight columns in four Wisconsin counties for in-depth evaluation; they based this selection on the overall range of column conditions, column and wrap types, wrap age, testing environment, safety and minimal traffic disruption.

Researchers then evaluated the integrity of the reinforced concrete in fiberglass-wrapped and non-wrapped columns through laboratory and field tests. They used imaging and integrity-measurement techniques such as ground penetrating radar, tomographic imaging and P-wave travel time profiling to establish the physical condition of the columns, and they took measurements of chloride ions and half-cell potential (the electrochemical potential that drives corrosion) to determine corrosion activity.

Results

The analysis revealed that while the fiberglass wrapping deters the ingress of chloride ions into the repaired concrete, wrapping does not reduce the corrosion rate in the bars if corrosion conditions such as high chlorine ion content persist inside the concrete columns, or if moisture and chlorine ions have access to the column above and below the wrap. Additional specific findings included:

- Chloride ion content measurements showed that the patching used in damaged columns reduced the chloride ion content below maximum recommended levels as set by the American Concrete Institute by replacing the contaminated concrete, but in heavily damaged columns, fiberglass wrapping did not reduce the chloride ion concentration.
- Sectional and vertical P-wave travel time tomographic images that provide spatial information of damaged zones in concrete columns indicated that most of the damage occurred in the zone facing traffic and that the damage in the columns seemed deeper than the 3-inch concrete cover.
- Half-cell potential measurements showed that corrosion activity continued even after the fiberglass was applied.

Investigator

"Rebar corrosion causes cracking, spalling and delamination of the cover concrete in reinforced concrete structures, which increases maintenance and rehabilitation expenses."

–Dante Fratta
University of Wisconsin–Madison
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Snow and deicing salts that are splashed on concrete bridge columns cause premature deterioration unless countermeasures like fiberglass wrapping are undertaken.

- Ground penetrating radar measurements showed greater-than-expected water content at the center of the lower or top portion of the column where little splashing had been anticipated.

Investigators produced several recommendations to improve the process of preserving concrete bridge columns through fiberglass wrapping:

- Using electrochemicals to remove the chlorine ions in deteriorating columns.
- Installing the fiberglass wrap at least 1 foot below the ground surface and 1 foot above the maximum expected snow/deicer splashing.
- Painting the columns with epoxy resin to create an impervious barrier to prevent corrosion.
- Monitoring the moisture and temperature during application of the wrap, as lower moisture can reduce corrosion as the wrap is applied.

Implementation and Benefits

The study report is being used by WisDOT to address structural issues that may have been caused by using this fiberglass repair technique. Going forward, WisDOT will analyze the chloride content of damaged concrete columns prior to installation of the fiberglass wrap. This study generated valuable data to enable more effective maintenance decisions and greater reliability for Wisconsin's bridges.

Further Research

WisDOT will continue to monitor and evaluate the performance of fiberglass wrapping and other maintenance practices to reduce corrosion activity in damaged bridge concrete columns.

Project Manager

"This study proved that the wraps work great for keeping chlorides out, but that proper preparation before installing the wraps is key to the longevity."

–Travis McDaniel
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