Tech Brief

Evaluation of Corrosion Inhibitors

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HERE'S THE PROBLEM

Corrosion of reinforcement is a global problem; use of corrosion inhibitors to control corrosion of concrete is a well-established technology. Use of quality concrete and corrosion inhibitors is an economical, effective, and logical solution for new structures. While laboratory studies have been conducted on the performance of corrosion inhibiting admixtures, field-testing has been very rare.

AND, HERE'S THE SOLUTION

This research will be an evaluation of corrosion inhibiting admixtures on a new bypass constructed by the New Jersey Department of Transportation. Four new bridge decks will be used to analyze four corrosion-inhibiting admixtures and a fifth new bridge deck will be used as a control for comparison. Field concrete, obtained as the concrete for the individual bridge decks are placed, will be used.

THESE ARE OBJECTIVES…

- To determine the effectiveness of four different corrosion inhibitors in reducing corrosion of structural steel reinforcement in a structure.
- To conduct actual field-testing of corrosion inhibiting admixtures on new bridge decks.

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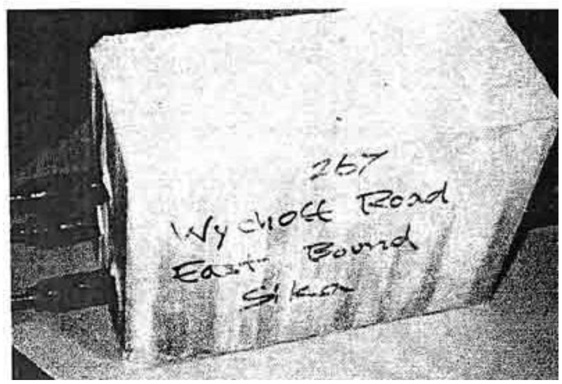
HERE IS WHAT WE DID…

In 1998, five new bridge decks under construction by the New Jersey Department of Transportation (NJDOT) for Route 133 were selected. The concrete used in four bridge decks had one of the following admixtures: DCI-S, XYPEX C-1000, Rheocrete 222+ or Ferrograde901, and had black steel bars. The fifth deck was used as a control for comparison, and had epoxy coated bars and extra black steel bars. This study was unique in that all of the samples for laboratory testing were prepared using concrete delivered at the construction site and used in the actual structures.

Since corrosion may not initiate for 10 to 15 years, accelerated corrosion tests in the laboratory were also used to evaluate these inhibitors. In addition to the cylinder strength tests, minidecks were prepared for accelerated corrosion testing. The bridge decks were instrumented for long term corrosion monitoring. Field evaluation began with three tests used to determine the physical characters (GECOR 6 Corrosion rate Meter, Concrete Surface Air Flow permeability Indicator, Electrical Resistance Test for Penetrating Slabs), as well as the corrosion protection provided by a particular admixture. The bridges were instrumented for corrosion testing, and monitored periodically for corrosion activity.

Laboratory samples were tested using ASTM G 109 to give early indication of the effectiveness of the admixtures.

Fresh concrete was tested for workability and air content. Compressive strength was obtained at 28 days. Variables analyzed were corrosion rate, corrosion potential, air permeability, and electrical resistance, to determine the performance of the individual admixtures.



Each admixture was ranked from best to worst, using an arbitrary point system of 5,4,3,2,1 to determine the best overall performer.

The following field tests were performed. The GECOR 6 Corrosion rate Meter was conducted to establish the kinematics of the corrosion process. The second field test was the Concrete Surface Air Flow permeability Indicator, a non-destructive technique used to determine the relative permeability of concrete surfaces. The third field test was the Electrical Resistance Test for Penetrating Slabs, which was used to establish the effectiveness of the concrete penetrating sealers and the resistance of unsealed concrete surfaces. The fourth procedure was the laboratory testing of the minidecks, where the effects of chemical admixtures on the corrosion of embedded steel reinforcement in concrete exposed to chloride was analyzed. This test method was used to provide a reliable means of predicting inhibiting and corrosive properties of admixtures to be used in concrete.

CONCLUSION:

The evaluation produced an overall best performing admixture, though the differences in the overall performance of the admixtures were not significant. The admixtures were ranked from best to worst in corrosion protection for each test.

In terms of scientific observations, XPEX provided the densest concrete. If the concrete can be kept free of cracks, this product will minimize the ingress of liquids, which will reduce corrosion. The other three admixtures provide a protection to reinforcement by providing a barrier and/or by reducing the effect of chlorides.

WHAT IS THE NEXT STEP?

Due to the fact that this study was linked to the construction of Route 133, the time schedule was altered. The test samples were prepared using the field concrete, and therefore the start of the experiments was delayed by more than 4 months. In order to obtain distinguishable differences, the laboratory-accelerated test should continue for a minimum of 6 more months.

Continued measurements should occur for another 2 years to determine long-term effects. In addition, the initial testing occurred when the bridge decks were not open to traffic, therefore, analysis over two winters under loading would provide more thorough results.

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A final report is available online at http://www.state.nj.us/transportation/research/research.html

If you would like a copy of the full report, please FAX the NJDOT, Bureau of Research, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Bureau@dot.state.nj.us and ask for:

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