Project Summary

Texas Department of Transportation

0-4825: Corrosion Performance Tests for Reinforcing Steel in Concrete

Background

Corrosion of steel reinforcement occurs throughout many structures in Texas and has received significant interest at the state and national levels. Much research is underway on how to make structures more corrosion-resistant, and the construction and engineering industries are developing new products to potentially improve the corrosion resistance of our nation's infrastructure. State highway agencies (SHAs) could benefit from the use of materials that make the highway system more durable.

With the large number of new corrosion-resistant products being introduced to the market and the large number of requests to use these new materials, SHA personnel have become overwhelmed. However, not testing potentially value-adding products could result in continued corrosion and deterioration. Standard corrosion tests can take significant time to assess a product – especially if the system is corrosion-resistant and common measures cannot be measured until corrosion initiates – with some research reportedly taking more than 10 years to generate results. New methods and procedures are needed that can quickly and economically assess new materials.

What the Researchers Did

Researchers from TTI evaluated four accelerated test procedures and compared the complexity, costs, and outcome of the results from each accelerated test with those of the standard test procedure commonly used to assess new materials, ASTM G109, Standard Test Method for Determining Effects of Chemical Admixtures on Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments. Although the ASTM test was specifically written to evaluate chemical admixtures, it is commonly used to assess the performance of new steel types, coatings, supplementary cementing materials, and other materials and systems (i.e., combinations of materials).

The four accelerated test procedures included the rapid mini-macrocell (MM) test, the Concrete Corrosion Inhibitors Association (CCIA) test, the accelerated chloride threshold (ACT) test, and a modified version of the ASTM G109 test (samples were exposed to elevated temperatures). The research project consisted of evaluating five reinforcement types (ASTM A615, ASTM A706, epoxy-coated, galvanized, and SS304), two water-cement ratios (0.45 and 0.55), and three quantities of chemical admixtures. In addition, epoxy-coated reinforcement was evaluated in as-received, drilled-damage, and file-damaged states and the galvanized reinforcement was assessed in as-received and damaged states.

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What They Found

The research team found that the MM test procedure is relatively simple and economical to perform. They recommend that this test method be used to compare the performance of uncoated reinforcement and different constituent materials. This method is not recommended for assessing the performance of galvanized or epoxy reinforcement.

If a quantitative assessment of materials is needed, the researchers recommend the CCIA or ACT test. Both tests are more complex than the MM test and require specialized electrochemical equipment (potentiostats) to perform the assessment, but both can provide quantitative measurements of the critical chloride threshold, a key performance parameter for assessing the service life of infrastructure systems exposed to corrosive environments.

Of the test methods assessed, no accelerated test methods could be recommended for assessing the performance of epoxy-coated reinforcement. The modified G109 test can be used for assessing the performance of galvanized reinforcement.

The researchers also recommend that SHAs develop procedures in which producers of new products submit a request for assessment, and if SHA personnel determine that the new product could be appropriate for use in infrastructure systems, that the producer bear the cost of having the product assessed at an independent laboratory selected by the SHA. If the SHA (or a representative of the SHA) requires independent testing to validate the findings, it is recommended that this testing be performed by another test agency at the same time as the independent agency is performing their tests.

What This Means

The research findings indicate that both qualitative and quantitative accelerated test procedures are available to assess most new products. By implementing the testing and evaluation plan proposed above, more products can be assessed in a shorter time period, possibly leading the way to use of better corrosion-resistant products and resulting in more-durable structures. It is anticipated that manufacturers of new products will have more products assessed in the future by the SHAs, as the time required to assess new products can be significantly reduced with the newly proposed tests and testing procedures.

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