Texas A&M Transportation Institute

Texas Department of Transportation

PROJECT SUMMARY REPORT

0-7167: Evaluate Performance of Sealers and Coatings Applied to TxDOT Bridge Substructures

Background

Sealers and coatings protect concrete bridge substructure elements from chloride-induced corrosion and extend the useful life of existing bridges. Their application is a common practice by the Texas Department of Transportation (TxDOT). Although concrete-penetrating surface treatments, Type X waterproofing, silicone resin paint, or opaque sealers are generally specified depending on a district or engineer's preference, no quantitative research has been performed to evaluate the corrosion protection benefits of these commonly used sealers and coatings and verify the suitability and effectiveness of the commonly used surface preparation methods.

Therefore, TxDOT identified developing a laboratory-based test protocol to evaluate the performance of commonly used sealers and coatings as an important research need. Practice guidelines and recommendations developed through this research will be used to ensure effective product selection and application that will protect substructure concrete from chloride-induced corrosion and extend the service life of bridges.

What the Researchers Did

Researchers from the Texas A&M Transportation Institute developed a systematic laboratory-based performance evaluation test protocol to evaluate the effectiveness of representative coating/sealer products. Tests investigated how they resisted moisture and chloride ingress through substructure concrete and achieved adequate adhesion performance (for coatings) under both normal and accelerated weathering conditions (ASTM D5894). Water absorption (ASTM D6489) and sorptivity tests (ASTM C1585) were conducted to evaluate moisture resistance. Rapid chloride penetration testing (RCPT) (ASTM C1202), chloride ponding (ASTM C1556), and direct corrosion-measuring tests (steady-state and accelerated methods) were conducted to evaluate the chloride-induced corrosion resistance of the tested sealers/coatings. An accelerated weathering test using QUV and QFOG chambers was conducted to evaluate the weathering resistance of the selected coatings and sealers.

A compound rating system was subsequently developed to rank the products based on their relative performance under each of these performance tests and the assigned weightage factors for these tests. The key findings from limited field validation studies and the relevant findings from laboratory-based performance evaluations were used to provide recommendations on:

- Selecting a surface preparation method depending on substrate concrete (with or without previously applied coatings) conditions evaluated by the pull-off adhesion strength (POAS) measurements.
- Maintaining a proper surface moisture content.
- Ensuring optimum application by measuring the wet film thickness (WFT)/dry film thickness (DFT).

Finally, a draft of practice guidelines and recommendations in the form of a decision-making tool (systematic stepwise approach) was developed to ensure the effective selection and application of

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sealers and coatings and adequate protection of substructure concrete from corrosion.

What They Found

The performance of sealer and coating materials is directly related to their interaction with the concrete substrate and the environmental conditions. Researchers found that surface preparation plays an important role in the effective performance of coating products. Concrete surfaces should be clean and free from moisture and surface roughness as per International Concrete Repair Institute guidelines. A moisture meter was found to be effective in monitoring the concrete surface moisture condition. However, further work is needed to develop guidelines for defining the optimum surface moisture content before the application of coatings/sealers.

Monitoring WFT (during application) and/or DFT (after application) using a portable DFT-measuring gauge can help ensure effective application of coatings, while measuring depth of penetration should be useful to ensure optimum application for sealers. However, further work is needed to validate the effectiveness of these methods.

All sealers and coatings should be evaluated by the developed test protocol, which comprises multiple tests before field application, to assess their effectiveness in protecting against moisture and chloride ions ingress. The sorptivity test was found to be effective in assessing protection against moisture ingress, whereas RCPT, chloride ponding, and accelerated corrosion tests were found to be effective for assessing chloride-induced corrosion protection. POAS measurements, both in the laboratory and field, have great potential to evaluate the long-term effectiveness of coating materials.

The compound rating system facilitated effective product ranking. The solvent-based coatings and sealers performed better at preventing moisture and chloride ingress into the concrete substrate than the water-based coatings. Because the products showed varying degrees of weathering resistance, adjusting the compound rating system through the incorporation of the weathering effect with a suitable weightage factor is recommended for long-term performance predictions of the products. This process is expected to increase product selection effectiveness, depending on specific project requirements. Additionally, to perform faster product evaluation, the use of a laboratory testing protocol employing a minimum number of tests (e.g., sorptivity, RCPT, adhesion strength, etc.) was found to be promising.

What This Means

The developed test protocol is expected to provide effective laboratory-based product evaluation and subsequent product selection (depending on project requirements before field applications).

Further reduction of the laboratory protocol-based product evaluation time (the current protocol needs about 5–6 months) by changing the concrete substrate (e.g., use of concrete with poor transport properties) and reducing the number of tests was identified as important further work. Once the protocol is finalized, testing many products and then updating the ranking system are recommended in order to generate a database that will facilitate a rapid selection of a suitable product for a field project in the future.

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