DEVELOPMENT OF A STANDARD ACCELERATED CORROSION TEST FOR ACCEPTANCE OF POST-TENSIONING GROUTS IN FLORIDA

BACKGROUND

Recent corrosion problems found in Florida's post-tensioned bridges demonstrate the importance of quality grouting materials and proper grouting techniques to the service life of these bridges. Portland cement grout is commonly used to fill the voids in post-tensioning ducts after the tendon is stressed. Portland cement grout provides a protective barrier and a high alkaline environment, and it bonds the tendon to the duct to allow higher tendon stresses to be developed in the tendon.

Grout performance problems have usually been related to insufficient filling of the grout space due to low fluidity and to inadequate bleed resistance. During the investigation of the Mid-Bay Bridge, researchers found evidence to indicate that serious structural problems can result from poor grouting of the post-tensioning (PT) tendons. Recent testing also indicates that voids in grouted tendons, combined with an aggressive environment, can lead to significantly high corrosion rates and, ultimately, tendon failure.

FDOT compared the performance of prepackaged grouts and field-formulated plain grouts, and subsequently required the use of prequalified, prepackaged grouts on all PT bridge construction. FDOT specifications require that prepackaged grouts proposed for use in filling post-tensioning ducts must be tested using the accelerated corrosion test (ACT) method as outlined in Appendix B of the "Specification for Grouting of Post-Tensioning Structures" published by the Post-Tensioning Institute. However, the ACT was not fully developed and needed further work.

OBJECTIVES

The goal of this research was to further develop the ACT test for use in Florida. Specific objectives included the following:

1. Study the influence of using IR [i.e., current (I) multiplied by resistance (R)] compensation during the ACT test, because it likely skews results for grouts of significantly different resistivities.

2. Develop a test method to evaluate the bleed-resistance of a grout that combines both pressure effects and strand-wicking effects. The test will simulate these effects to approximate as closely as possible the actual condition in a tendon.

FINDINGS AND CONCLUSIONS

Researchers tested four different types of grout (i.e., plain, with corrosion inhibitor, with silica fume, and with fly ash) at three different ages (7, 28, and 56 days). Tests were conducted both with and without IR compensation. On average, the increase in time-to-corrosion when IR compensation was not used was 11 to 46%, but reached values as high as 149%.

The ACT test can take several months to run for a good quality grout, so an alternate method was developed that can provide initial results immediately after the grout has cured. Linear Polarization Resistance (LPR) provides a method by which the grout can be qualified more quickly than waiting for the time-to-corrosion results. Until further LPR and ACT direct correlations are done, a polarization resistance value of 700 $k\Omega\text{-cm}^2$ should be used. While a set limit would not be recommended as a single pass-fail criterion, in this case, it provides a restrictive first level of testing so that the ACT can be avoided for some grouts. Grouts that do not meet this criterion but pass the ACT should not be penalized. The LPR method also is useful during new mix grout development as a quick evaluation technique.

Researchers also developed a new method, the wick pressure test (WPT), to evaluate bleed resistance in grouts. The WPT combines the positive attributes of the two other test methods that are currently available.

BENEFITS

This research resulted in test specifications for the ACT that can be incorporated into the Florida FDOT specifications. The most significant recommendation is that the test results be compared to the results from a qualifying grout tested using the same equipment and strand. The current minimum 1,000 hour requirement should be eliminated. These improvements to the specifications will result in improved quality control of the prestressing grout and, ultimately, improve the service life of post-tensioned concrete bridges in Florida.

In addition, the WPT should provide improved ability to determine the bleed resistance of grouts and, thus, selection of the most appropriate grouts. Bleed-water can be a significant factor in the development of corrosion and lead to tendon failure and costly repair; thus, this more effective test method provides an additional tool for fighting corrosion and optimizing tendon service life.

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