Florida Department of Transportation Research

Permeability of Concrete – Comparison of Conductivity and Diffusion Methods

BD536 (7/07)

Steel-reinforced concrete bridge structures can deteriorate rapidly in a marine environment because chloride ions in salt water are able to penetrate the concrete. Corrosion begins when ions reach the metal, weakening the bridge structure and shortening its service life. Chloride resistant concrete mixes have been developed for marine bridges. These mixes have potential to slow the onset of corrosion, reduce maintenance costs, and extend a bridge's useful life.

Tests are needed to determine the amount of chloride resistance of different concrete mixtures. Resistance can be measured by soaking concrete samples in salt water until the metal starts to rust, but it takes up to a year of continuous immersion to get results. Several faster procedures that use the electrical conductivity of saturated concrete to predict chloride ion penetration are available. FDOT contracted with the University of Florida to compare the accuracy of four rapid test procedures with two long-term immersion tests.

Surface resistivity test conducted on a concrete cylinder. SR is a rapid, nondestructive method to estimate long-term concrete permeability.

Comparison tests were done on concrete made using nineteen different mixes comprised of local Florida materials. Sample concrete cores from six bridges at different locations were also examined for actual chloride penetration. Data gathered from the cores was used to evaluate the accuracy of the rapid tests. Based on the results of this research, FDOT has elected to move from the rapid chloride permeability test method to surface resistivity (SR). SR requires less preparation time and is easier to conduct, saving both time and money when nondestructively evaluating proposed concrete mix designs for durability. Researchers also developed a rational procedure for nondestructively evaluating early age concrete. Thus, the rapid tests, unlike the immersion test, provide additional data that increase confidence in predicting durability and should contribute to the development of concretes with longer service life.

The results of corrosion are visible in the spalled concrete and exposed corroding steel reinforcement.

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