Florida Department of Transportation Research

Characterization of New and Old Concrete Structures Using Surface Resistivity Measurements
BD546-08

Because of its extensive coast, much of Florida's transportation infrastructure is exposed to salt water. Chloride ions in salt water can migrate through concrete and corrode reinforcing steel, which weakens support structures in several ways, therefore, the diffusivity of chloride ions is an important indicator of the durability of reinforced concrete. Concrete permeability can be measured in existing structures by coring the concrete and testing it in a laboratory, but this method is labor-intensive and time consuming.

Surface resistivity has proved to be a good measure of concrete permeability in the lab. Conductivity in porous materials like concrete is related to the permeability of fluids and the diffusivity of ions. Therefore, electrical resistivity serves as an indirect measure of how easily chloride ions can penetrate concrete. Resistivity of partially submerged concrete varies relative to the water line, tending to be higher both in submerged regions and those far above the water line that are usually dry. In the intermediate zone, the splash zone, the mixture of chloride and oxygen and the alternation of wetting and drying make this region of support structures the most susceptible to chloride intrusion and steel corrosion of reinforcing steel.

In this project, Florida Atlantic University researchers investigated how to apply surface resistivity measurements in the field. The standard Florida Department of Transportation method, the Wenner probe, was used on partially submerged components of over 60 Florida bridges. The basic approach was to measure surface resistivity and to correlate it with laboratory-measured chloride diffusion coefficients of core samples taken from tested support structures.

Researchers found a resistivity gradient that varied with elevation and was due to the degree of saturation. They developed a conditioning procedure as part of the field testing to increase the moisture content of the concrete. Resistivity

The piles that support the Key Royale bridge, studied in this project, are constantly subjected to the effects of salt water.

was measured over two days. Two-inch concrete cores were taken near the area where surface resistivity measurements were made. These cores were used either for wet surface resistivity measurements or to obtain chloride profiles. The profiles were used to estimate apparent chloride diffusivity. Wet surface resistivity was achieved after a few weeks of exposure in a high humidity chamber.

A second component of this project aimed at understanding how resistivity varies over time depending on concrete mix and environmental exposure and with and without reinforcing steel. Chloride ion migration rate through concrete is affected by the ratios of cement, aggregate, and sand in the mix, and so five different concrete mixes were prepared. Three sample groups were prepared with uniform composition, and two had layered compositions in order to investigate the multiple layer effect. Two probe spacings were used. Numerical modeling was performed to calculate factors that corrected for the finite geometry of laboratory samples and for the presence and absence of rebar.

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