TECHSUMMARY July 2011

Statistical Internal Order No. 30000111 / LTRC Project No. 10-1C

Evaluation of Surface Resistivity Measurements as an Alternative to the Rapid Chloride Permeability Test for Quality Assurance and Acceptance

INTRODUCTION

Many entities currently use permeability specifications in portland cement concrete (PCC) pavements and structures. For those states using permeability specifications, the two test methods generally used are ASTM C1202 or ASTM C642. The drawback to these test methods is the length of time it takes to conduct the tests and the curing time required to test the concrete. More recently a surface resistivity device has become available to test the concrete at 28 days of age with a testing time of about five minutes compared to 56 days of age and two days of testing time.

This project investigated the use of a surface resistivity device as an indication of concrete's ability to resist chloride ion penetration for use in quality assurance (QA) and acceptance of high performance concrete (HPC).

OBJECTIVE

The objectives of this research were two-fold: (1) characterize the surface resistivity of concrete specimens produced in the laboratory and field conditions, and (2) characterize the rapid chloride permeability of said concrete specimens.

SCOPE

To meet the objectives of this project, samples were produced in laboratory conditions from five mixtures at three different water-to-cementitious ratios (w/cm) to produce a wide range of permeability values. These mixtures were tested for both surface resistivity and rapid chloride permeability at 14, 28, and 56 days of age. Field cast specimens, generally from the Caminada Bay Bridge project, were also tested for surface resistivity and rapid chloride permeability at 28 and 56 days of age.

METHODOLOGY

The cementitious materials for the laboratory portion of this study included: type I/II portland cement, class C and class F fly ash, and grade 100 and grade 120 ground granulated blast furnace slag locally available in the state of Louisiana.

Each of the cementitious materials was chemically characterized according to its respective ASTM standard. Laboratory test specimens were tested for rapid chloride permeability and surface resistivity at 14, 28, and 56 days of age. Field produced specimens were tested for surface resistivity and rapid chloride permeability at 28 and 56 days of age.

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Statistical analysis was used to determine the correlations between 14- and 28-day surface resistivity and the 56-day rapid chloride permeability. The effect of w/cm was also investigated.

CONCLUSIONS

The results of this study warrant the following conclusions. The surface resistivity measurements correlate well with rapid chloride permeability measurements across a wide range of permeability values and sample testing ages. Suitable correlations were found to exist between both the 14-day and 28-day surface resistivity values and the 56-day rapid chloride permeability values.

The standard deviation of the surface resistivity meter results are usually less than 3 kΩ-cm compared to 300 to 500 Coulombs from the rapid chloride permeability test. The surface resistivity meter is also able to identify great differences in w/cm ratios for the same mixtures.

The surface resistivity meter is very user friendly even when several issues arose with the operation and maintenance of the surface resistivity meter. The issues have since been resolved with a redesign of the meter.

RECOMMENDATIONS

The authors recommend full implementation of the surface resistivity meter and associated TR test method. Specifications should be developed around the test method for future design purposes. Implementation of the device will require the purchase of 11 surface resistivity meters, one for each district laboratory, central materials laboratory, and LTRC. A training program should be developed for training of district personnel. The training program should at a minimum include a short lecture detailing the background and theory of the surface resistivity meter, a tutorial video, and a proficiency exam.

The cost benefit analysis showed that implementation of the device will save the Department about $101,000 in personnel costs in the first year. It is estimated that contractors will save about $1.5 million in quality control costs. The cost benefit ratio for this project is estimated to be about 15.

Surface resistivity meter