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New Jersey Department of Transportation
Bureau of Research

Technical Brief

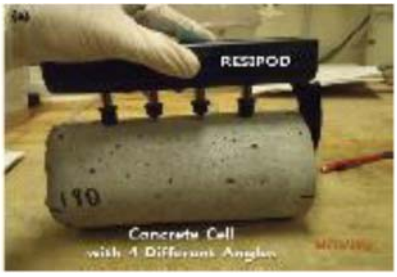
Evaluation of Surface Resistivity Indication of Ability of Concrete to Resist Chloride Ion Penetration

This research project provides the validation of the surface resistivity (SR) test as an alternative of the rapid chloride permeability (RCP) test requirement for high performance concrete used in New Jersey. The SR threshold proposed in lieu of chloride permeability threshold would be more economical and effective requirement in enhancing quality of construction.

Background

Concrete's ability to resist chloride penetration is a determining factor when evaluating durability performance. The RCP test is ineffective in assessing the chloride resistance of concrete and has many drawbacks; it is a laborious destructive test that provides an indication of chloride ion movement but with high variances. In contrast, the SR test is non-destructive, requires less training, and provides higher accuracy with less single-operator and multi-laboratory variation in results, thus reducing construction disputes and litigation efforts.

Research Objectives and Approach

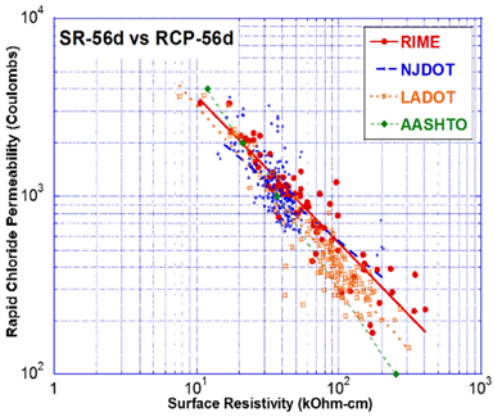


The main objective of this project is to evaluate the SR test method in accordance with AASHTO TP 95-11 and to provide recommendations to the New Jersey Department of Transportation (NJDOT). The objective can be achieved by determining the SR threshold based on validation tests and update the high performance concrete (HPC) Specifications for quality control and assurance. Given that the current standard is the RCP test, it should be evaluated the chloride permeability for each NJDOT HPC mix to compare with the surface resistivity. In order to validate the SR test in comparison with the RCP test currently used by NJDOT, a complete statistical analysis of test data was performed. A total of 44 mixtures including 26 laboratory and 16 field mixes are typical HPC mix designs used for bridge deck construction and rehabilitation in New Jersey. Various curing regimes including mist, lime bath and accelerated lime bath were introduced.

Findings

This project shows that the SR test can be an indicator of the chloride permeability of concrete in accordance. The SR as well as RCP tests were conducted on the same HPC specimens from laboratory and field mixes to develop a correlation through which a SR threshold is deduced. A parametric study was performed to study the effect of supplementary cementitious materials (SCMs) such as fly ash (Class F) and slag (Grade 100) and chemical admixtures such as accelerator and retarder on SR and RCP

measurement for the concrete specimens cured in several conditions. The RCP tests were conducted on 28, 56 and 91 days while the SR tests were conducted on 7, 14, 28, 56 and 91 days. Samples were cured in a 100% humidity room (moist curing) and a saturated $Ca(OH)_2$ solution bath (lime curing) at 73.5 ± 3.5°F, and an hot lime saturated solution bath (hot lime curing) at 100 ± 3°F. Based on the analysis results of this study, the following conclusions can be drawn from the results:



1. The effect of different curing regimes on SR and RCP measurements was minimal at an average of 3.8 %.
2. Hot lime curing has a significant impact on the SR and RCP measurements. SR results of hot cured samples at 28 days were comparable to moist or lime cured samples at 56 days, while RCP results of hot cured specimens at 28 days were comparable to results of standard temperature cured samples at 90 days.
3. The addition of SCMs to the mixture proportions favorably reduces the RCP measurements and increases the SR measurements. As opposed to a significant change in reading from 28 days to 56 days, a lower change was recorded between 56 days and 91 days because the SCMs have reached or are very close to reach their reaction time.
4. The SR threshold equivalent to an RCP value of 2000 coulombs (C) for the acceptance criteria is very close to limits from other state agencies. However, the SR threshold equivalent to the RCP value of 1000 C for the verification criteria is more conservative. There is a need to perform additional testing of mixes around 1000 C.
5. The recommended SR threshold limits for the verification and acceptance criteria for NJDOT HPC are 21 and 48 kΩ-cm, respectively.

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A final report is available online at: http://www.state.nj.us/transportation/refdata/research/. If you would like a copy of the full report, send an e-mail to: Research.Bureau@dot.nj.us.

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