

Resistivity Testing for Long Term Durability of Concrete

Findings from the FHWA Mobile Concrete Trailer (MCT)

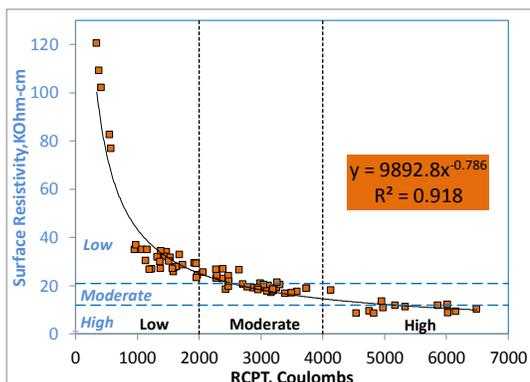
One of the major forms of environmental attack for concrete structures is chloride ingress due to salt water or deicing chemicals. Chloride ingress leads to corrosion of the reinforcement and subsequent reduction in strength, serviceability, and aesthetics of the structure. To mitigate this issue, designing concrete mixtures to resist chloride ingress and verifying mix properties during construction are key activities.

Traditional Test: Electrical Indication of Concrete's Ability To Resist Chloride Ion Penetration test (AASHTO T 277 /ASTM C 1202), more commonly referred to as the Rapid Chloride Permeability Test (RCPT), is the most widely used test method by state agencies for this purpose. This test measures the number of coulombs that pass through a 2" concrete specimen. This is a surrogate test for concrete permeability in that the number of coulombs passed is directly proportional to the permeability of concrete. One of the drawbacks with the RCPT test method is the time and labor required to run the test (approximately 2 days to prepare the test specimens and 6 hrs. to perform the test).

Using Surface Resistivity to Assess Permeability of Concrete

The Surface Resistivity (SR) test method requires four probes to be directly placed on the surface of a concrete specimen to measure its electrical resistance. The concrete's electrical resistivity is then calculated from the measured electrical resistance, the test specimen dimensions, and the spacing between the probes.

Correlation to RCPT: The MCT tested concretes from actual field projects across the country using the RCPT and SR tests. This data comprising of a wide range of range of cementitious materials, water cementitious ratios, aggregates etc., are shown in the graph below (X axis: RCPT and Y axis: SR). The correlation between the two is very good (note: the units of the two tests are different). Many laboratory studies across the country have shown similar correlation between these two tests.



MCT's Surface Resistivity versus RCP Test results

Item to be aware of: The method of conditioning the test specimens (lime water bath, moisture room, plastic molds at room temperature etc.) affects the readings of this test method. When specifying this test, the conditioning method should be clearly specified.

Reference 1: Rupnow, T. and Icenogle, P. (2012) "Evaluation of Surface Resistivity Measurements as an Alternative to the Rapid Chloride Permeability Test for Quality Assurance and Acceptance." Transportation Research Record: Journal of the Transportation Research Board, Vol. 2290

Benefits of using this Technology

- A very quick test
 - 2 minutes to perform
- Non-destructive
 - Allows for testing at different ages and specimens can be used for other tests
- Easy to use and handle
 - Does not require use of chemicals
 - Tests can be performed by one person.
- Economical (when compared to RCPT)
 - Cost savings of more than 90% due to reduction in testing time, labor, and equipment costs (Reference 1).
- Time Savings
 - Tests can be run earlier than 56 days to verify if 56 days specified minimum resistivity is achieved.
- Allows for greater number of measurements
 - Statistically more robust data.



Summary: Permeability of concrete impacts its long-term durability. The SR method offers agencies reduced testing time, effort, and cost for assessing concrete permeability compared to the RCPT. This technology can also be used for Quality Control by contractors for assessing the quality of their concrete. Quantified benefits of this technology (agency and industry) for one state (Louisiana) are published in Reference 1.