Concrete Property Test

Permeability 4-1: Rapid Chloride Ion Penetration

National Concrete Pavement Technology Center
www.cptechcenter.org

Purpose – Why Do This Test?

The ability of concrete to resist the transportation of chlorides is an important factor in its potential durability. If chlorides can be prevented from reaching any steel in the concrete, then the risk of corrosion is reduced.

The test method also provides an indirect measure of the permeability of the concrete, a critical parameter in all durability-related distress mechanisms. The lower the permeability, the longer the concrete will survive chemical and environmental attack.

Principle – What is the Theory?

The permeability of concrete can be indirectly assessed by measuring the electrical conductance of a sample of concrete.

Test Procedure – How is the Test Run?

The test is described in ASTM C 1202. A 2-in. thick section is obtained from a 4-in. diameter pavement core or lab molded cylinder. The core section is completely saturated with water in a vacuum apparatus. Electrical current is passed from one side of the core section to the other side while it is contained within a cell that has a sodium chloride solution on one side of the core and a sodium hydroxide solution on the other side. The electric current is applied and measured for six hours.

Test Apparatus (figure 1)

- Vacuum saturation apparatus: Completely saturates the sample.
- Sodium chloride solution.
- Sodium hydroxide solution.
- Sealed cell: Holds the core specimen with each liquid solution on opposite sides of the core section and has electrical leads for connecting a DC electrical source.
- DC power supply: Provides constant DC power to the test specimen.
- Voltmeter: Measures and records volts and amps on both sides of the core specimen.

Test Method – Refer to ASTM C 1202 for Comprehensive Guidance

1. Completely saturate the core section with water.
2. Place the saturated core section in the sealed cell containing the two different sodium solutions on either side of the core section.
3. Connect the power supply and voltmeter.
4. Apply a 60-volt DC current across the cell for six hours.
5. Convert the ampere-seconds curve recorded from the test to coulombs.

Output – How Do I Interpret the Results?

The electrical current is conducted through the concrete by chloride ions that migrate from one side of the core section to the other side. Higher permeability will result in a higher current being carried through the core section.

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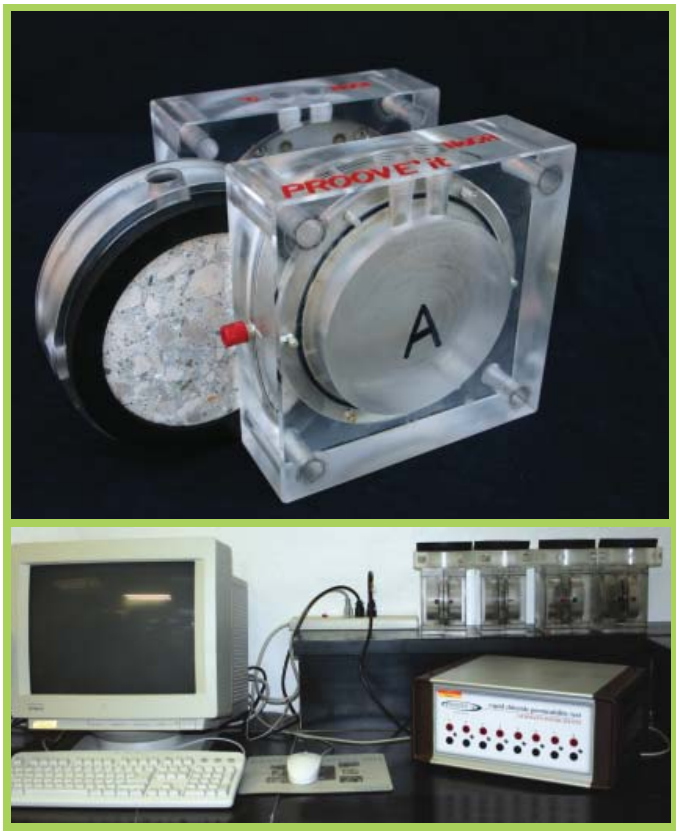

Figure 1. RCP test equipment

FOR MORE INFORMATION
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The test results are expressed in coulombs, and the permeability of the concrete is classified according to table1. Note that differences within the range of 1,300 to 1,800 coulombs are not significant.

Table 1. Relationship Between Coulombs and Permeability

Coulombs	Permeability
Greater than 4,000	High
2,000 to 4,000	Moderate
1,000 to 2,000	Low
100 to 1,000	Very low
Less than 100	Negligible

Construction Issues – What Should I Look For?

Mixture design issues that can influence permeability include the following:

- Lower water-cementitious materials ratio will lead to lower conductivity.
- Use of fly ash; ground, granulated blast-furnace slag; and silica fume will generally reduce conductivity.

Paving process inputs that influence permeability include the following:

- Improved consolidation will reduce conductivity.
- Premature final finishing when excessive bleed water is present will increase surface permeability.
- Proper curing will reduce conductivity.

APRIL 2008

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This test summary is one of a set of summaries originally published in chapter 7 of the *Testing Guide for Implementing Concrete Paving Quality Control Procedures* (Fick, G., Iowa State University, Ames, Iowa, 2008). The testing guide is a product of a 17-state, Federal Highway Administration pooled-fund project, Material and Construction Optimization for Prevention of Premature Pavement Distress in PCC Pavements, TPF-5(066). The project was managed by the National Concrete Pavement Technology Center at Iowa State University.