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Discussion

### Using Electrical Tests as Durability Indicators

A discussion of: A resistivity based approach to optimising concrete performance,  
Nadelman E and Kurtis K. Concrete International V36 No.5 May 2014

The authors should be congratulated for their interesting paper which confirms that resistivity measurements give a good indication of concrete durability. However figure 1 is slightly misleading because there are no free electrons in concrete. Electric current in concrete is carried by charged ions in the electromigration process as described by the Nernst-Einstein equation. This equation shows that the conductivity will be proportional to the diffusion coefficient as noted in the paper; but it will also be proportional to the concentration of mobile ions. One of the key ions will be the hydroxyl ion arising from the calcium hydroxide (lime) which is a product of cement hydration but is depleted by the pozzolanic reaction with materials such as fly ash or metakaolin after the first few days. This will directly decrease the conductivity of the pozzolanic mixes regardless of their porosity and tortuosity giving an unrealistically optimistic indication of their potential durability.

The process in the RCP test is slightly more complicated because the charge carrier of interest is the chloride ion which is available in effectively unlimited quantities in the reservoir. However, if this is to flow into the concrete, Kirchoff's law requires that charge is conserved and another carrier carries the current away. The current carried by the chloride ions is therefore also limited by the hydroxyl ion concentration and this test also gives optimistic values (i.e. low Coulomb values) for pozzolanic mixes.

It is a matter of great concern that practitioners using electrical tests may mistakenly believe that their pozzolanic concrete is a lot more durable than it actually is.

Reference: P A Claisse, Transport Properties of Concrete: Measurement and Applications (Woodhead Publishing Series in Civil and Structural Engineering)  
ISBN 978-1-78242-306-5. Publication May 2014.