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Guest Editorial

# Electrical monitoring and characterisation of cement-based systems

It was Adam Neville who wrote in his now classic text Properties of Concrete, *'Concrete and Steel are the two most commonly used structural materials. They sometimes complement one another, and they sometimes compete with one another so that structures of a similar type and function can be built in either of these materials. And yet, the engineer often knows less about concrete of which the structure is made than about steel'*. Concrete is, and will continue to be, a material of major importance; however, in order to fully exploit this material, to push this material to its limit, to use it in novel and exciting applications, engineers must fully understand the material they are using. Cementitious systems must be understood at all levels of magnification from the submicroscopic and microscopic levels where length scales are measured in terms of angstroms and microns up to the macroscale, where length scales are of the order of centimetres and metres. Highly sophisticated techniques are used to study and analyse binders at the angstrom and micron level – magic angle spinning, small angle neutron scattering, small angle X-ray scattering, nuclear magnetic resonance, scanning electron microscopy; X-ray diffraction; mercury intrusion porosimetry to name but a few. When one considers the techniques which are used to study concrete at the other end of the length scale they are positively crude by comparison, the slump test, the compressive strength (cube) test, the surface absorption (ISAT) test, to name but a few.

This special theme issue is set against this background. Its main aim is to show how the electrical response and characteristics of cementitious systems (pastes, mortars and concretes) can be exploited to obtain appropriate information at virtually all scale levels. Application of electrical methods to the study of cementitious systems is not new, as work can be traced back to the early part of the 20th century and there has been a steady trickle of work produced since these early days. Currently, the testing methodology is undergoing a renaissance, particularly with advances being made in instrumentation through the development of sophisticated electrical impedance analysers and the like. This suite of papers represents a collection of work from research groups within the European Union, Canada and The United States and range from durability studies on concretes through to fundamental studies on the setting of cement pastes. Regarding durability related research, it is the 'holy grail' of the engineer to develop a parameter which will quantify durablity and, perhaps, electrical methods have role to play in this respect. Work is presented as one of ongoing development, although it is evident from the papers presented that electrical techniques could be added to our armoury of methods in the study of this ubiquitous material.

Although considerable advances are now being in this testing methodology, I take this opportunity to raise problem that needs to be addressed, namely, the development of standardised test procedures. This includes, for example, electrode configuration, test-cell geometry, calibration procedures, operating voltages, signal frequency/frequencies. As researchers, we tend to develop our own testing protocols and, as a consequence, it is sometimes difficult to compare results or replicate tests from different laboratories.

No such issue would be complete without due acknowledgement to a number of people, not least to all of the authors who have contributed. Their interest, enthusiasm and efforts in the preparation and revision of their work is appreciated. Thanks are expressed to the referees for their timely review of these papers. Finally, I extend thanks to the Editor of Cement and Concrete Composites, Professor Narayan Swamy, for giving me carte blanche in the production of this special issue.

I hope that you find this issue of interest and, if it plants the seed of an idea in just one reader's mind, it will have been a success!


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## 1. Order of papers

1. Chrisp TM, McCarter WJ, Starrs G, Basheer PAM, Blewett J, 'Depth related variation in conductivity to study cover-zone concrete during wetting and drying' (Heriot-Watt University, Edinburgh).
2. Polder RB, Peelan W, 'Characterisation of chloride transport and reinforcement corrosion in concrete by electrical resistivity' (TNO, Netherlands).
3. Basheer PAM, Gilleece P, Long AE, McCarter WJ, 'Monitoring electrical resistance of concretes containing alternative cementitious materials to assess their resistance to chloride penetration' (The Queen's University of Belfast, Northern Ireland).
4. Zhang J-Z, Li JY, Buenfeld NR, 'Measurement and modelling of membrane potentials across OPC mortar specimens between 0.5 M NaCl and simulated pore solutions' (Imperial College, London).
5. Mason TO, Campo MA, Hixson AD, Woo LY, 'Impedance spectroscopy of fiber-reinforced cement composites' (Northwestern University, USA).
6. Perron S, Beaudoin JJ, 'Freezing of water in Portland cement paste: an A.C. impedance spectroscopy study' (University of Ottawa/National Research Council, Canada).
7. Smith A, Abelard P, Thummen F, Allemand A, 'Electrical characterisation as a function of frequency: application to aluminous cements during early hydration' (ENSCI, France).

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