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Editorial
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Editorial

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The characterisation of cement hydration and the related properties is highly multi-disciplinary, involving cement chemistry, fundamental physics, traditional mechanics as well as multi-scale concepts. This issue of *Advances in Cement Research* highlights these features through six research papers, treating respectively the characterisation of hydration in multi-component binder systems, the adsorption of sulfate ions of hydrates and effect of carbonation curing on electrical properties at an early age, and the macroscopic/multi-scale study of properties of cement-based materials. Knowledge is gained from both experimental and modelling research, especially by way of some novel experimental devices such as Fourier transform infrared spectroscopy (FTIR) and non-contact electrical resistivity measurement (NC-ERM). It is believed that the audience can greatly benefit from this issue with broad coverage on cement research.

Cement is used more and more in multi-component binder systems thus the hydration processes and the related characterisation of hydrates occupy an important place in modern cement research. Under this context, the first two papers in this issue treat, respectively, the incorporation of nanosilica and the influence of grinding methods on the early-age properties of a multi-components binder system. Calabria-Holley *et al.* (2015) used the FTIR method to characterise the composition of the hydrates from ternary and quaternary binders. Characteristic bands were observed for different products: water and hydroxide bands (4000–2800 cm^{-1}), silica in calcium silicate hydrate (CSH) networks (1260–1000 cm^{-1}), alumino–silicates and carbonates (1034 cm^{-1}) and sulfate adsorption bands (1200–1100 cm^{-1}). The results showed that the bridging of silicate tetrahedral in a chain could be captured by FTIR analysis, and the addition of nanosilica into cement–fly ash binder resulted in more silicon-rich CSH networks. The grinding of cement particles is a rudimental technique in cement fabrication, and this technique was investigated by Ghiasvand *et al.* (2015) for multi-component binder systems to study the effect of inter-grading and separate grinding on the consistency, setting time, hydration heat and portlandite (CH) content in hardened pastes. The particle size distribution was not found to influence significantly these properties and the inter-grinding was judged less energy demanding by shorter grinding time.

Two chemical topics are touched on for the hardening process of cement: the carbonation curing of hardening mixes and adsorption of sulfate ions onto the CSH. Morshed *et al.* (2015) used a NC-ERM to investigate the hydration process of fresh mixes of cement pastes and concretes, and characterise the intake of CO_2 into hydration by the precipitation reaction. The authors observed the final resistivity of carbonation-cured samples was three to six times higher (pastes) and eight to 16 times higher (concretes) than the normally cured samples. Furthermore, the resistivity of carbonated-cured mixes showed no minimum during the induction period of hydration but increased constantly. The sulfate ions adsorption onto CSH products is regarded as one key factor for the possible delayed ettringite formation (DEF) in cement-based materials. Ma *et al.* (2015) studied the adsorption behaviours of CSH through synthesised CSH gels in their contribution. The basic observations were that the adsorption of sulfate ions was favoured by higher sulfate ion concentration in aqueous phases as well as the temperature rise, and the high alkalinity of aqueous hindered the sulfate sorptivity of CSH by electrostatic interactions. In other words, high alkalinity of interstitial solution of cement-based materials, in equilibrium with CSH, tends to retain more sulfate ions in the aqueous phase, favouring the DEF.

The properties of cement-based materials are treated in the last two papers at macroscopic and multi-scale levels. Ahmad *et al.* (2015) investigated the mechanical properties of ultra-high performance concrete (UHPC) with the compressive strength ranging between 90 and 150 MPa. The mechanical properties of UHPC ($w/b = 0{\cdot}14$) were investigated for the compressive strength and the elastic modulus in terms of the curing conditions (wet–dry cycles and heat–cooling cycles) and different fibre content. The results showed that the effect of fibre content was more pronounced for elastic modulus than for compressive strength, and the exposure conditions had little effect on the mechanical properties of UHPC except for the heat–cooling cycles increasing the compressive strength after six months. Zhao *et al.* (2015) proposed a multi-scale modelling of the intrinsic permeability of hardened cement pastes. The background of this analysis is to estimate correctly the pore pressure accumulation during the heating process, and to evaluate the spalling resistance of concrete exposed to fire. A model was proposed for the phase decomposition with the temperature rise and the corresponding permeability being solved through the effective medium theory at three levels (i.e. pozzolanic CSH and impermeable phases (level 1), CSH phases (level 2) and cement pastes (level 3)). The experimental validation seemed to support this three-level modelling. The contribution of this research, apart from the multi-scale model, highlights the necessity of fundamental properties modelling of cement-based porous materials for the sake of solving engineering problems of which the origin is on the pore level.

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