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Characterisation of pore structure development of alkali-activated slag cement during early hydration using electrical responses

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Abstract

This paper describes the results of a study investigating early age changes in pore structure of alkali-activated slag cement (AASC)-based paste. Capillary porosity, pore solution electrical conductivity and electrical resistivity of hardened paste samples were examined and the tortuosity determined using Archie's law. X-ray computed micro-tomography (X-ray μCT) and Scanning electron microscope (SEM) analysis were also carried out to explain conclusions based on electrical resistivity measurements. AASC pastes with 0.35 and 0.50 water-binder ratios (w/b) were tested at 3, 7, 14 and 28 days and benchmarked against Portland cement (PC) controls. Results indicated that for a given w/b, the electrical resistivity and capillary porosity of the AASC paste were lower than that of the PC control, whilst an opposite trend was observed for the pore solution conductivity, which is due to AASC paste's significantly higher ionic concentration.

Further, capillary pores in AASC paste were found to be less tortuous than that in the PC control according to estimations using Archie's law and from the results of X-ray μCT and SEM analysis. In order to achieve comparable levels of tortuosity, therefore, AASC-based materials are likely to require longer periods of curing. The work confirms that the electrical resistivity measurement offers an effective way to investigate pore structure changes in AASC-based materials, despite threshold values differing significantly from PC controls due to intrinsic differences in pore solution composition and microstructure.

Keywords

Pore tortuosity, alkali-activated slag cement, pore solution, electrical resistivity, capillary porosity, X-ray μCT