TRANSCENDING THE PORE STRUCTURE OF A CEMENT PASTE WITH THE LATTICE BOLTZMANN METHOD

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Introduction

A 3D lattice Boltzmann model is used to calculate the water and gas permeabilities of partially saturated model cement pastes. The lattice Boltzmann model comprises permeable micron-sized capillary pores, weakly-permeable nano-porous calcium silicate hydrate (C-S-H), and impermeable solid inclusions. The multi-scale problem is addressed by using an effective media approach based on the idea of partial bounce-back. The model cement paste microstructures are generated with the platform **µic**. The critical parameters, C-S-H density and capillary porosity, are taken from ^{1}H nuclear magnetic resonance relaxation analysis. The distribution of water and air is defined according to the Kelvin-Laplace law. It is found that when the capillary porosity is saturated with a fluid, the calculated intrinsic permeability is in good agreement with measurements of gas permeability on dried samples (10^{-17} – 10^{-16} m^2). However, as the water saturation is reduced, the calculated 'apparent' water permeability decreases and spans the full range of experimentally measured values (10^{-16} – 10^{-22} m^2). It is concluded that the degree of water saturation is the major cause for variation in experimental permeability measurements. It is further concluded that the role of the weakly-permeable C-S-H, emitted in earlier modelling studies, is critical for determining the permeability at low saturation.

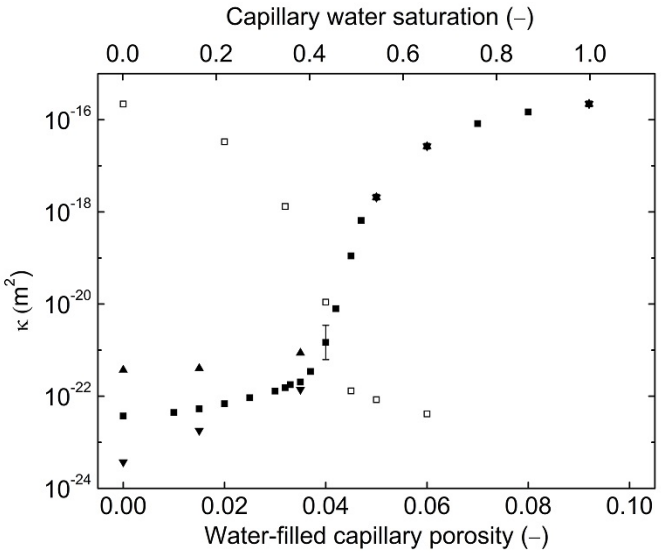

Fig. 1: Simulated 'apparent' intrinsic permeability as a function of the degree of water saturation. When the penetrating fluid is water, the C-S-H permeability is 7 x 10^{-22} m^2 (▲), 7 x 10^{-23} m^2 (■) or 7 x 10^{-24} m^2 (▼). When the penetrating fluid is gas, the C-S-H permeability is zero (□).

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REFERENCES:

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