Estimation of transport properties of model cement microstructures

Alan McCreanor and Alex Routh

BP Institute and Department of Chemical Engineering and Biotechnology, University of Cambridge

am775@cam.ac.uk

Abstract

Concrete is a porous medium with a highly complex microstructure, with characteristic lengths spanning seven orders of magnitude. Although it is a material of vital importance, little is known about its long-term performance. The reactions leading to degradation of concrete structures are mediated by the presence of moisture. Modelling the transport properties of concrete is thus a vital step towards understanding its durability.

Direct solution of the equations governing fluid motion at the pore scale, using methods such as finite element or lattice Boltzmann, are computationally intensive and are limited to small scales in order to maintain sufficient spatial resolution. This limitation restricts simulations to aggregate-free cement pastes. An alternative approach, network modelling, uses simplified versions of the transport equations and allows flow on much larger scales to be modelled.

A network model for porous media including partially permeable regions has been developed. This model allows the effects of both the capillary pores and the C-S-H porosity on the transport properties to be investigated. The large-scale, spatially resolution-free nature of the model also permits the simulation of mortars and concretes. The model has been applied to simulated cement paste microstructures to calculate the permeability of cements as a function of porosity and saturation. In addition, the imbibition behaviour and effective diffusivities for both water vapour and dissolved species can be estimated.