Coupling nano and meso-scale structure of cement paste: A key to the mechanisms that control properties

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Abstract

Cement paste has complex engineering properties that are governed by many, often nonlinearly coupled, variables. An important example of particular engineering importance is the so called Pickett effect, where volume changes that occur under the influence of applied load and/or during drying and rewetting exhibit a strong nonlinear coupling. The mechanisms that control irreversible deformation must be accompanied with changes in the microstructure, and these changes must be quantitatively evaluated. Connecting mechanisms, microstructure and properties requires both model and experiment. While models at the finest scales are emerging and models at the micron scales are mature, the meso scale represents fertile ground for investigating mechanisms of deformation. This provides information about the packing of solid particles and the structure of gel pores between the particles. The changes in structure can be documented, which gives strong hints about the mechanisms that control irreversible deformation. Furthermore, with some assumptions about the physical properties of water in the smallest pores, mechanisms for nonlinear coupling emerge. Some of the hypothesis presented should help formulate specific questions that will drive research in the near future.