8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

MODELING OF CALCIUM LEACHING FROM CEMENTED COMPOSITES COUPLED WITH MICRO-PORE STRUCTURAL REFORM

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Key Words: *Leaching, Micro-Pore Structure, Applications, Computing Methods.*

ABSTRACT

The applicability of concrete and geo-materials is being studied as a solidifying barrier for the geological disposal of radioactive waste, which contains materials with long half-lives. Thus, the period of stability required in durability design is specified to be several tens of thousands of years. Calcium leaching is one issue of crucial importance to be examined in the durability performance design and planning of such projects.

In this study, a computational system for predicting the long-term degradation of cement hydrates in both concrete composites and cemented soil is presented in terms of calcium leaching. The leaching of calcium ions from hardened hydrates is simulated as the multi-phase equilibrium of calcium in solid and liquid phases, and their transport is formulated by satisfying the thermodynamic requirements. Time-dependent properties of cement hydrates associated with cement hydration, microstructure development, moisture and chloride ion transports are evaluated by integrating calcium leaching and statistical models of chemo-physics.

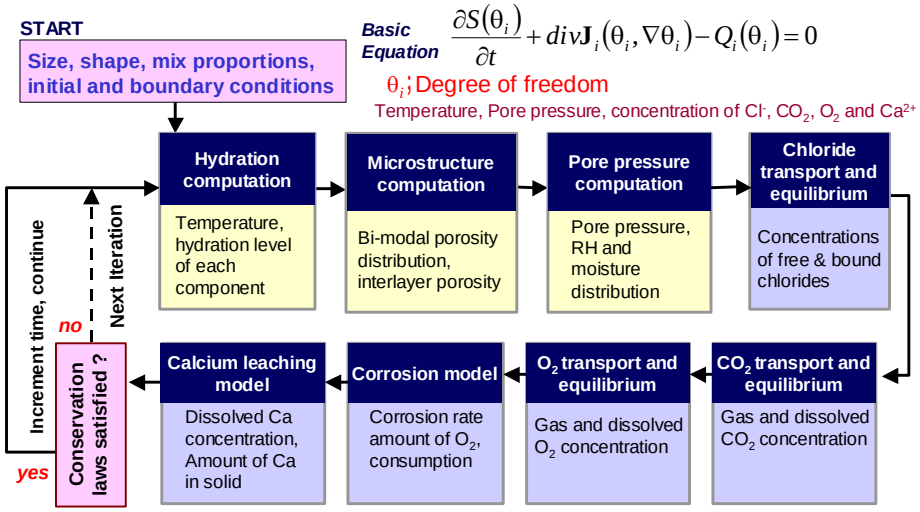

Figure 1 Multi-chemo physical simulation platform [1].

For developing the model of calcium leaching coupled with microstructure formation, the microstructure model is upgraded to take into account the influence of the temperature history and the content of calcium hydrates and C-S-H gel. Furthermore, the multi-chemo physical simulation is conducted on the extended micro-pore structure modeling, which may cover cemented soil by incorporating interlayer, gel, capillary pores and large-scale soil-grain voids.

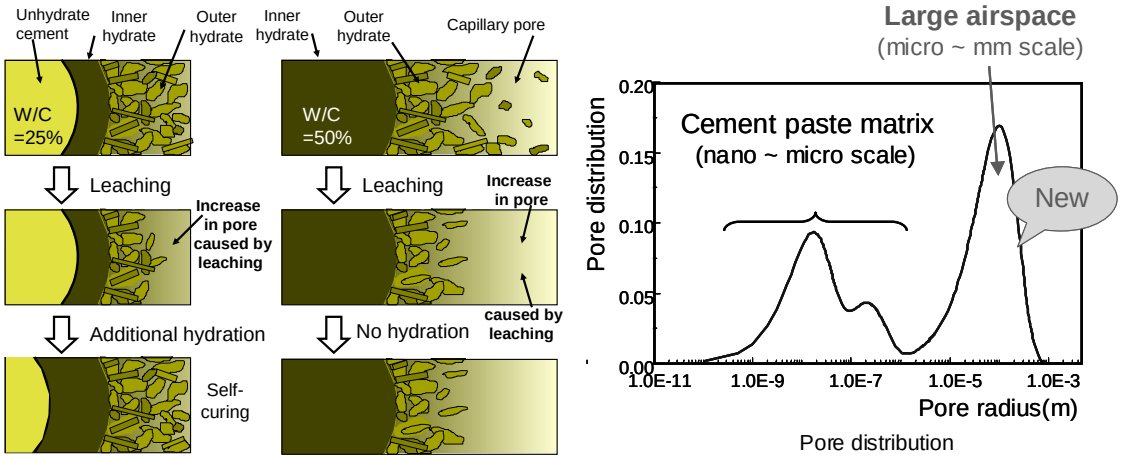

Figure 2 Transient modeling of reformed micro-pores and stochastic expression of multi-scale pores [2][3].

Through a series of comparisons with the experimental results, the proposed model shows reasonable predictions of microstructure formation and calcium leaching. The model further suggests that low water-to-cement concrete has a high resistance to leaching as “self-healing” takes place after leaching, and results in higher durability performance.

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