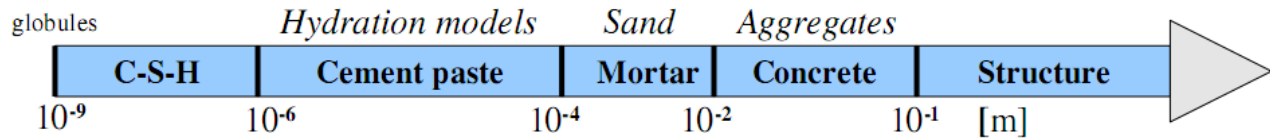
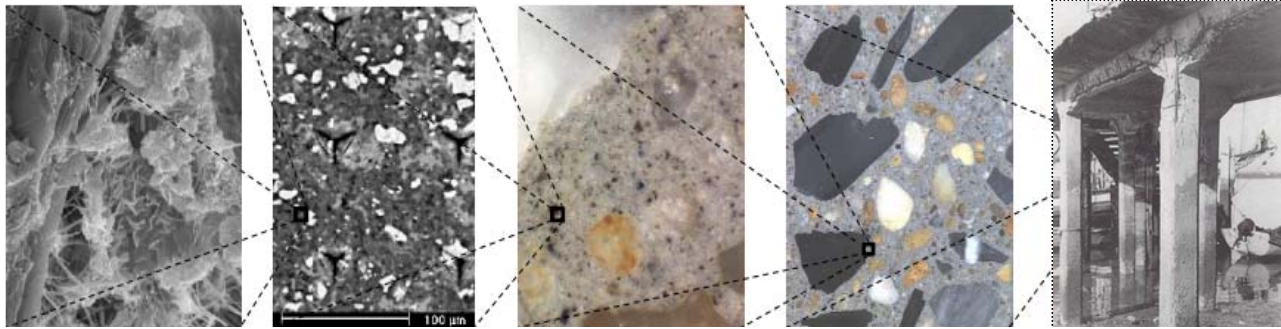


# Modeling chloride diffusivity of cement paste

Based on microstructure

RESEARCH SCHOOL  
INTEGRAL DESIGN OF STRUCTURES



### Subject

Chloride diffusion is one of the major problems that affect the durability of reinforced concrete structures. Cement paste is the basic part of concrete. So, the study of chloride diffusion is the most important issue in the research for steel corrosion in reinforced concrete structures.

### Goals

To propose a common method to model the chloride diffusion process through cement paste based on the microstructure of cement paste, the results of which can be regarded as basic input to simulate the chloride diffusion of mortar and concrete.

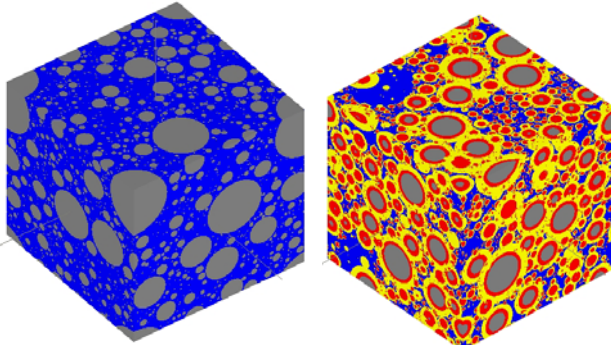


Fig. 2 Microstructure of cement paste at  $\alpha = 0$  and  $\alpha = 0.80$  ( $w/c=0.50$ )

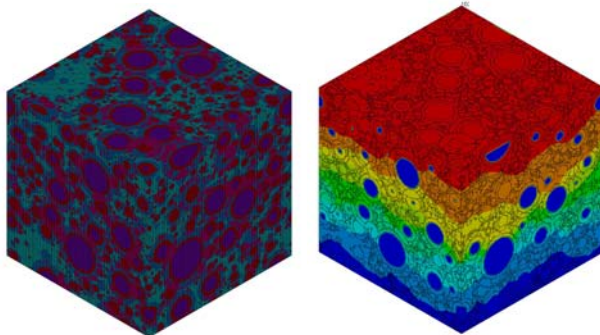


Fig. 3 FE model of cement paste and distribution of chloride concentration ( $w/c=0.50$ ,  $\alpha = 0.80$ )

### Results

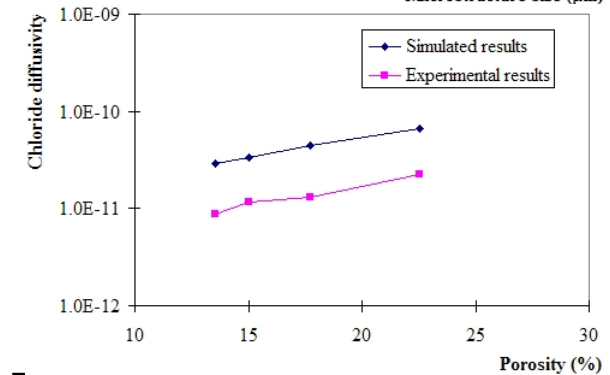
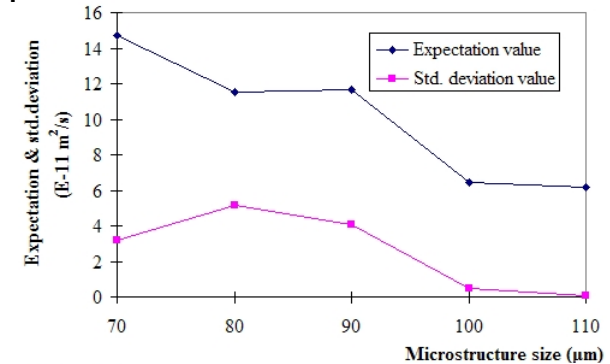


Fig. 4 The relationship between chloride diffusivity and REV size and porosity of cement paste ( $w/c=0.5$ )

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## Subject

Chloride diffusion is one of the major problems that affect the durability of reinforced concrete structures. Once, the chloride concentration in the concrete reaches a certain level, the corrosion process of embedded steel bars starts. Cement paste is the basic part of concrete. So, the study of chloride diffusion is the most important issue in the research for steel corrosion in reinforced concrete structures.

## Goals

The main objective of this research is to propose a common method to model the chloride diffusion process through cement paste based on the microstructure of cement paste, the results of which can be regarded as basic input to simulate the chloride diffusion of mortar and concrete.

## Research Question

What is the real mechanism of diffusion of chloride ion in hardened cement paste? What is the relationship between chloride diffusivity and microstructure characters of cement paste, i.e. porosity, tortuosity, degree of hydration, curing time? What is the size of representative element volume (REV) for modeling chloride diffusivity of cement paste?

## Strategy

Based on microstructure of cement paste generated from HYMOSTRUC3D, the cement paste is divided into five phases, capillary pore, inner hydration product, outer hydration product, contact hydration product and un-hydrated cement particle. The diffusivity parameter of each phase is determined and diffusion equation with boundary conditions can be solved by finite element (FE) approach. The distribution of chloride concentration and flux through the outer surface can be obtained. Using Fick's law, the chloride diffusivity can be calculated.

## Expected Results

The microstructure of cement paste will be transferred into finite element (FE) model. The size effect of microstructure on chloride diffusivity will be studied, the results of which will be used to determine the representative element volume (REV) of modeling. The influence of microstructure characters of cement paste on chloride diffusivity will be evaluated.

## Preferred Partners Applications / Sponsors

Durability of cement-based materials / Construction consulting and design organizations

## Prime Publication / Prototyping

- Wang, J., Chen, J., **Zhang, M.** (2007)

Flexural fatigue behavior of layered hybrid fiber reinforced concrete (LHFRC), Journal of Wuhan University of Technology (Materials Science Edition), 2007, 22(3):560-563.

- Wang, J., **Zhang, M.**, Zhang, J. (2008)

Pore properties of eco-material for erosion control of slope and its fractal features, Key Engineering Materials, 2008, 461-464.

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- Wang, J., **Zhang, M.**, Guo, X. (2009)

Nonlinear stability analysis on the concrete casting step of long-span concrete-filled steel tube arch bridge, Materials Science Forum, 2009, (614):275-282.

## Research Period

October 2008 – October 2012