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Numerical Strategy to Simulate Seawater Ingress in RC Concrete Blocks Exposed to Wetting-Drying Cycles in Field Conditions During 19 years

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1 Introduction

A hydration and reactive transport model considering precipitation/dissolution of mineral species with their kinetics and surface complexation (on C-S-H) were developed in order to simulate seawater ingress in 7 concretes. Numerical results were compared to experimental data on concretes exposed in field conditions in tidal zone during 19 years after a couple of curing days. Regarding all the phenomena to consider, severe hypotheses were done such as saturated materials and 19 curing years in order to identify if such severe hypotheses are sufficient to give a good approximation of chloride ingress. Four HPCs with (M75SF, M100SF) or without silica fume (M75, M50) and 3 normal-strength fly ash concretes (M25FA, M30FA, M50FA) were studied (Baroghel-Bouny *et al.*, 2013). Total chloride content profiles were measured after 2, 4, 10, 16 and 19 years of exposure. Calculations were managed with TOUGHREACT software. The chemical part uses the thermodynamical database Cemdata18. Hydration simulations were obtained thanks to the model developed by Cerema (Lavergne *et al.*, 2018). Such an approach leads to a limited number of input data: chemical and mineralogical composition of binder, concrete mix-design, average bulk porosity and effective diffusion coefficient of concrete.

2 Results and Discussion

Knowing the limited number of input data and the difficulty to catch all the phenomena, the numerical simulations show hopeful results, especially for concretes with fly ash (see **Figure *1***). In addition, the model is able to quantitatively simulate chemical and mineral zonation (magnesium, sulfur and chloride-rich zones) as reported by (Jakobsen *et al.*, 2016) For OPC and concretes with silica fume, numerical results underestimate chloride content. For OPC, although numerical model considers porosity change due to mineral precipitation/dissolution, it is not able to simulate increase of apparent diffusion coefficient as observed on experimental data. Further investigations must be done in order to observe if cracks are visible. For concretes with silica fume, underestimation cannot be fully explained yet. One explanation can be the lack of additional chloride content coming from reactions between chloride and remaining anhydrous phases. Indeed, by analyzing results of hydration calculations, results show that anhydrous phases are still present even after 19 years and that additional chloride content can exist.

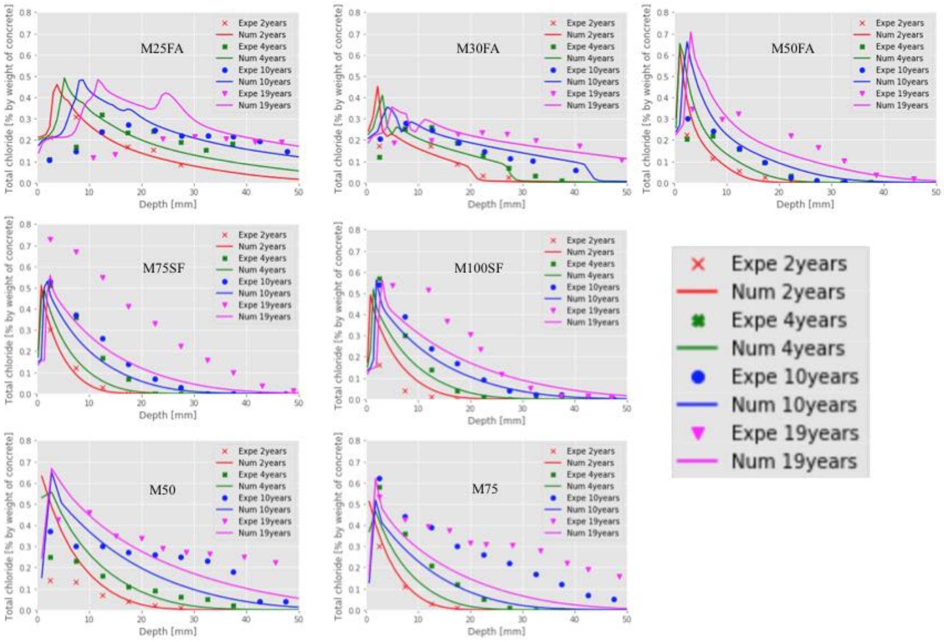

Figure 1. Comparison between experimental data and numerical results for total chloride profiles for 2, 4, 10, 16 and 20 years of exposure (19 curing years).

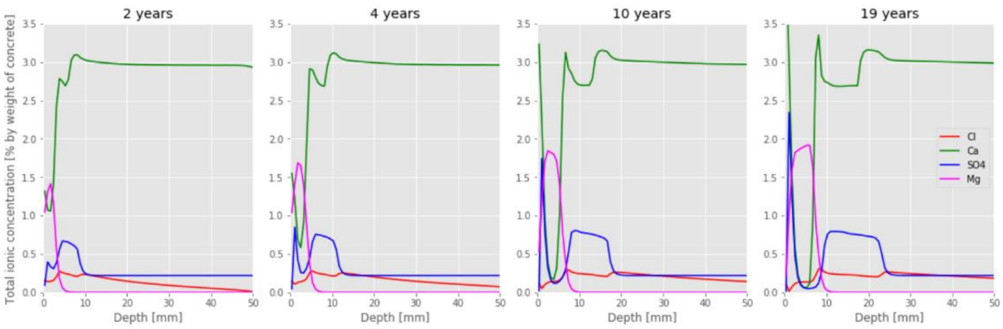

Figure 2. Ionic species ingress after 2, 4, 10, 16 and 20 years of exposure (19 curing years).

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