Transport properties of calcium-silicate-hydrates from reactive dicalcium silicate binder

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Abstract

This project deals with the study of calcium-silicate-hydrate (C-S-H), as main binding phase in a hydrated cement paste. Studying the properties of pure C-S-H is not always straightforward, as in concrete we also find other hydrated products. The approach proposed to obtain a fully hydrated system formed only by C-S-H with similar properties as the one developed in ordinary Portland cement (OPC) based concrete is to utilize a newly developed high reactive calcium silicate binder. More insight is needed on how changes in chemistry of C-S-H affect the microstructure and different pore populations (gel and capillary pores) and hence the transport properties of small ions.

One main objective is to understand the influence of physical properties of C-S-H on the transport properties (e.g. diffusivity of small ions like chloride) through gel and capillary porosity. This will be carried out using a variety of characterization techniques and the possibility of coupling the experimental findings with modeling results will be considered. Porosity is a key parameter that is considered, as techniques like MIP and DVS will be used to get information about all the pore refinement and sizes in the nano-structured C-S-H formed in the hydrated matrix.

The C-S-H system that will be studied is obtained through hydration of a reactive dicalcium silicate binder. Preliminary research activities were focused on successfully synthesizing the binder with high hydraulic activity. This can be synthesized even at industrial scale with high purity degrees. Preliminary results show that this material can be almost fully hydrated before 7 days, with very low or even no amount of other hydrates (e.g. portlandite). Binder with fine particles was used for hydration studies, where morphology of the formed hydrates was observed and also its elemental composition under SEM to check the homogeneity of the formed product. By studying different C-S-H systems with different Ca/Si ratios, we can contribute to a better understanding of mechanical and transport performances of different types of composite cements, where the chemical composition of C-S-H is different from the case of OPC.

Transport test will provide more insight on the interaction of chloride with C-S-H and migration through the pore network. Chloride binding tests in C-S-H will be performed to assess the content of bound chloride that can be absorbed on C-S-H surface. Additionally, hydrated samples with saturated microstructure will be subjected to steady state diffusion test and rapid chloride diffusivity tests to evaluate how free chloride is transported through the porous network. This will be coupled with findings from the bulk immersion test, which will show the profile of total chloride content with sample depth.

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