Characterization of sorption cycles in the cement hydrates

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Sorption induced deformations in cementitious materials, attributed to the changes in moisture content, are potential causes for degradation and failure. Majority of the moisture movement is governed by the calcium-silicate-hydrate (C-S-H) phase, which is the binding matrix in cement-based materials. Hence, investigation of sorption response and the associated microstructural changes of C-S-H is imperative for durability assessments.

In this regard, this thesis shall report on the moisture response of representative (C-S-H) samples and the associated microstructural and dimensional changes upon subjecting to desorption-sorption cycles. Preliminary investigations focus on the synthesis of a suitable representative sample for performing such investigations. Both macro- and micro-scale characterizations were performed by using various techniques such as SEM, XRD, and TGA to ensure sample attributes. These representative samples were subjected to different curing temperatures to assimilate the role of morphology and pore structure of C-S-H. This facilitated in altering the populations of capillary pores (~5-50 nm), gel pores (~ 2-5 nm), and interlayer water (<0.5 nm) in these samples.

Both short and long-term approaches will be employed to record the subsequent moisture responses of these samples. This shall assist in uncovering the function of time scales, along with size, in the moisture response of the samples. A comparison of the moisture sorption isotherms with the nitrogen sorption isotherms will further elucidate the effect of different sorption fluids on the samples. This data would be employed in conjunction with various empirical, semi-empirical, and thermodynamic models to better elucidate parameters such as interaction strength of sorbent, fractal dimensions, and difference in the adsorption energy among others. ^{1}H NMR shall also be employed to corroborate these findings. These experimental findings shall also assist in poromechanics modeling of the cementitious materials. This thesis forms a part of the ERICA project and has received funding from H2020-MSCA-ITN ERICA project under Grant Agreement 764691.