Effect of the drying technique on the sorption properties in cementitious materials

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Abstract

A good understanding of the nano-pore structure gives insight in several concrete properties like compressive strength, permeability and durability aspects. Dynamic water vapour sorption tests may be used to study this porosity, but the technique is difficult to interpret as the microstructure is very sensitive to stress, drying and rehydration due to humidity exposure.

The removal of interlayer water held by gel pores in C-S-H or chemically bound water can also cause considerable microstructural shrinkage. As all drying techniques more or less dehydrate C-S-H and ettringite, they cause a restructuration of the C-S-H, changing the C-S-H in denser ones.

Several drying techniques were studied. These include: no-drying, freeze-drying, oven-drying at 40°C and 105°C, air-drying in the presence of silica gel (20±2°C), vacuum-drying (20±2°C), and the solvent-exchange-method in methanol and isopropanol followed by vacuum-drying (20±2°C). The effect of these various drying techniques on the sorption characteristics in cementitious materials was studied by means of dynamic water vapour sorption tests. To prevent carbonation, the samples were always stored together with soda lime. Thermo-gravimetric analysis was used to elucidate carbonation.

Freeze-drying changed the microstructure due to thermo-mechanical stress in the inner C-S-H. Oven-drying removed part of the non-evaporable water, dehydrated C-S-H, ettringite and AFm phase, and caused thermo-hydric stresses due to differential expansion. Capillary stresses due to receding water menisci may also induce a modification of the textural properties of the sample.

Oven-drying and air-drying proved to cause carbonation, which is unwanted to study the microstructure. Methanol reacted with C-S-H but isopropanol seemed to be inert with cementitious compounds.

The ideal drying technique, which can preserve the microstructure and can remove only the non-bound water, does unfortunately not exist. All drying techniques affect the microstructure in their own way. Only vacuum-drying and the solvent-exchange-method with isopropanol proved to be acceptable drying techniques to prepare specimens for water sorption analysis.