

## Effect of Carbonation on the Microstructure and Moisture Properties of Cement-Based Materials

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### ABSTRACT

We provide a comprehensive understanding of the effects of carbonation on the microstructure, and the moisture properties of cement-based materials made of ordinary Portland cement (OPC) and fly ash (FA). The bulk porosity is measured on a large panel of non-carbonated or fully carbonated cement pastes and concrete specimens by hydrostatic weighing and by mercury intrusion porosimetry (MIP). The carbonatable amount of CH and C-S-H (corresponding to the maximum degree of carbonation that is reached for these hydration compounds) is assessed when the carbonation mechanism is considered stabilised. The induced reduction in porosity is correlated with the calcium carbonate (CO<sub>3</sub>) content quantified by thermogravimetric analysis (TGA) and associated both with CH and C-S-H carbonation. The identified variation of molar volume occurring during the C-S-H carbonation is dependent on the CO<sub>2</sub> concentration and is different if pozzolanic C-S-H are considered since for this latter a negative difference of solid volume can be observed. The effect exerted by carbonation on the pore size distribution (PSD) is also elucidated by means of MIP and by analysing the diagrams of the spin-lattice relaxation time (T<sub>1</sub>) determined by Nuclear Magnetic Resonance of proton H (NMR). The proportion of coarse capillary pores (radius > 100 nm) increases with the degree of carbonation for materials of a high water/cement (w/c) ratio although a systematic reduction in total porosity for OPC systems is still measured. Moreover, this paper discusses the influence of carbonation on the water vapor desorption isotherms (WVDIs). An analysis of the T<sub>1</sub>-diagrams and the WVDIs of carbonated and non-carbonated materials made of OPC shows that the same fine-textured morphology of the C-S-H seems remains in spite of a partial decalcification and polymerisation.

### KEYWORDS

Carbonation, C-S-H, mercury intrusion porosimetry, NMR, water vapor sorption isotherm.

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