

Preconditioning of Specimens - Drying Influence on Alkali-Activated and Geopolymer Mortar

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1 Introduction and Experiment Description

Accelerated procedures for durability tests of OPC mixtures are often applied to alkali-activated materials (AAM) without any modification, although the raw material used and physico-chemical reactions are different. These tests usually require a preconditioning of the specimens at temperatures ranging from 45°C to 105°C. Alkali-activated binders contain gels and hydrates that can be affected and even destroyed at these temperatures. Thus, the effects of the preconditioning conditions on AAM need to be assessed, in order to avoid a deterioration of the specimens that could lead to misleading interpretations of durability tests.

Four alkali-activated mortars with a water/binder ratio of 0.4 were studied: a metakaolin-based geopolymer, two formulas of activated GGBS (GGBS-carbonates and GGBS-silicates) and a mixture of 50% metakaolin with 50% GGBS activated by silicates (Mk-GGBS-silicates). Normalized samples were endogenously cured for 28 days at 20°C, then dried until mass stabilization in different environments (20°C, 40°C, 60°C, 80°C, 105°C and 125°C).

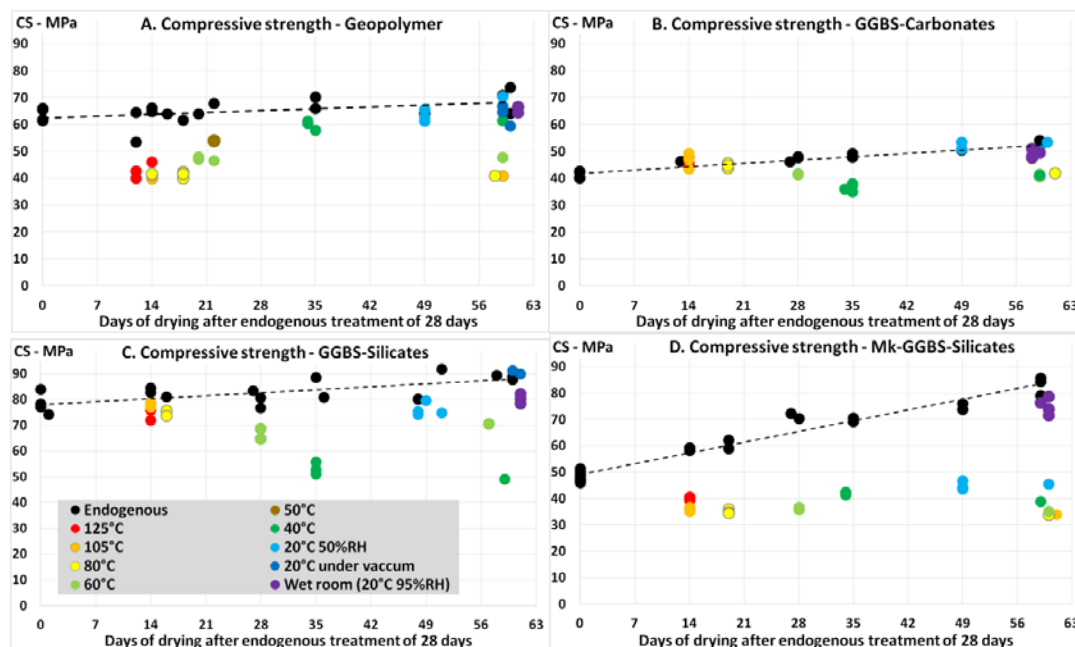


Figure 1. Compressive strengths of mortars cured in endogenous conditions (black spots) or dried at different temperatures (after endogenous treatment of 28 days). The legend inserted in C is valid for all figures.

Geopolymer drying at a temperature above 60°C is fast, but increases the measured pore size, and affects the compressive strength by 40% as a consequence. It is likely that this will affect the permeability of the material. Using a temperature below 20°C takes a lot of time, is not efficient, but does not affect the CS and the pore size. Between 20°C and 60°C there may be a drying optimum. A drying temperature of 40°C may be more appropriate for geopolymer, as it has less impact on the mechanical strength. Drying ramps could be tested to see if the fall of strength is due to the kinetics of drying or to the temperature itself.

As regards to GGBS-carbonates and GGBS-silicates, drying at $T \geq 80^\circ\text{C}$ is fast, does not affect CS and slightly increases the measured pore size. In contrast, this study highlights that the material should not be dried at temperature close to 40°C, otherwise it could lead to significant loss of mechanical strengths.

Finally, the Mk-GGBS mixture activated with silicates seems to cumulate the drawbacks of both alkali-activated systems. Whatever the temperature used, a high degree of damage to the mechanical strengths is observed, correlated with an increase of the porosity. For such mixtures, drying by solvent exchange or by freeze-drying might be interesting, but this type of drying can only be performed on small samples.

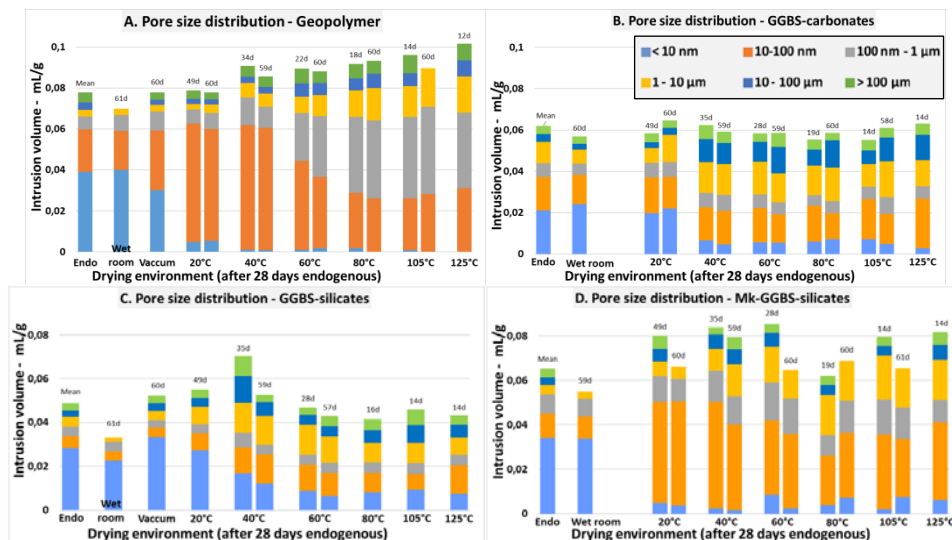


Figure 2. Pore size distributions. Endo is the average of the samples conserved under endogenous conditions, analyzed at different ages. Biggest porosities are sometime missing due to porosimeter low vacuum problem.

This work is part of the L2A chair (alkali-activated binders) grouping industrial partners EDF, VINCI, ECOCEM, ARGECO, VICAT and BASF with the LMDC research laboratory.

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