Acceleration of LC^3 cement hydration by nanosilica and quartz

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Limestone Calcined Clay Cements (LC^3) has emerged in last decade as a promising low-carbon alternative to conventional *Ordinary Portland Cement (OPC)* [1]. *LC^3* cement typically contains 50% of Portland clinker, 30% of calcined clay (e.g. metakaolin), 15% of ground limestone and 5% of gypsum. The calcined clay is activated during the hydration process by calcium hydroxide, generated in the Portland clinker hydration, and provides similar cementing products (C-H-H and C-A-S-H gels). While the 28-days strength of concrete based on *LC^3* can be compared with conventional cements [2], the weak point of *LC^3* systems lies in their rate of strengthening – the lower clinker content is responsible for the slower strength gain, compared to *OPC*, what results to slower construction progress. The cement hydration can be accelerated by number of inorganic and organic substances [3] however these accelerating admixtures are well established in conventional cements, not in *LC^3*. Nanosilica was identified as one of promising accelerating admixtures [4] as well. In this work, nanosilica and fine-ground quartz (as a cheaper alternative) were tested as the *LC^3* hydration accelerators.

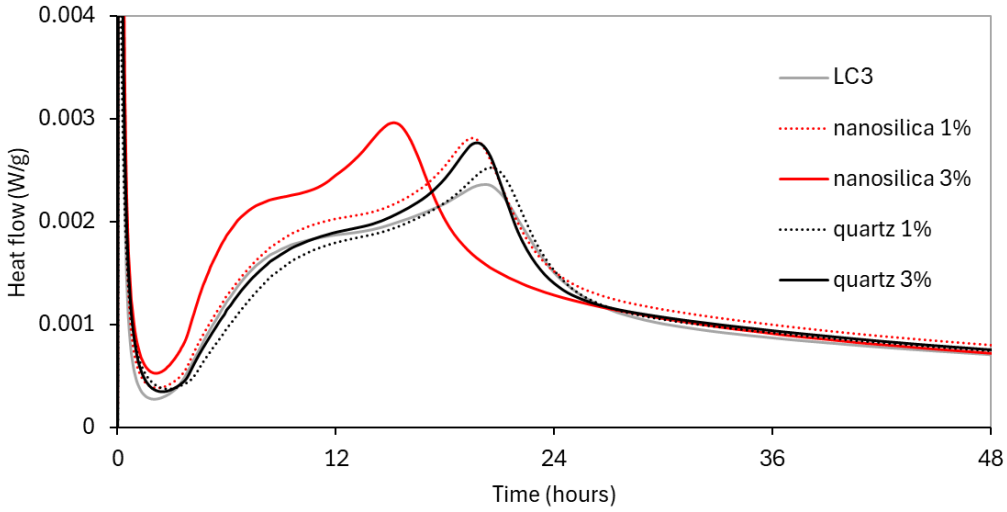


Figure 1. *Results of isothermal calorimetry in LC^3 mixtures without and with hydration accelerators.*

The isothermal calorimetry is adopted in cement research as time-effective screening method for identification of admixtures´ effect on the hydration course; the most important information lies in position and area (corresponding to hydration heat) of the *main hydration peak*. The two named admixtures were dosed in two levels. 1 and 3% by mass with respect to the clinker. The experiment revealed (Fig. 1) that both admixtures are accelerating the hydration, especially at higher dosage. Nanosilica (d_{50} 50 nm) was more efficient than quartz (d_{50} 28 μm), likely due to its smaller particle size. These systems were further studied by means of *in-situ* XRD in order identify the specific influence on admixtures on course of crystallization of portlandite, AFm and AFt phases, which are participating in the hydration and hardening/strengthening process.

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