ESRF

Experiment title:
Dynamic diffraction studies on the hydration of calcium aluminates and its influence on the setting of high performance concrete

Experiment number:
CH65

Beamline:

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Report:

Background objectives

The objective of this proposal was to carry out preliminary experiments on the hydration of calcium aluminate cements in the presence of aggregates such as silica powder. Such mixtures are of technological relevance in the manufacture of high-performance concrete, a material that attains a compressive strength between 200 and 800 MPa (ten times higher than ordinary concrete).

Experimental details and treatment of the data

Mixtures of cement and aggregates with water at a w/c ratio of 0.4 were prepared and immediately placed on the beam at fixed temperatures ranging between 60 and 80 "C in most of the experiments. Energy-dispersive diffraction patterns were collected every minute to see the rapid evolution of the crystalline phases, appearing and disappearing. The individual diffraction patterns were plotted in a sequential fashion to reveal the time scale of events as in Figure 1.

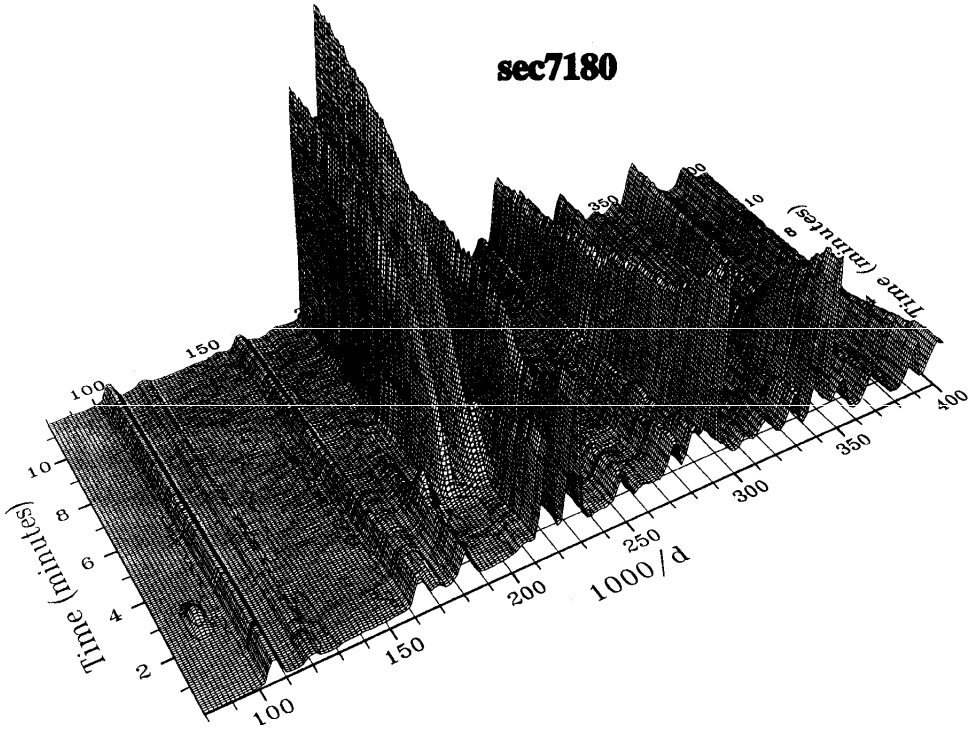

Figure 1. Sequential three-dimensional representation of energy-dispersive diffraction patterns taken during the hydration of a cement sample at 80 “C. The x-axis is expressed in 1000/d(Å).

Results and conclusions

Experiments carried out with pure components made to have comparative standards confirmed the findings using other synchrotrons facilities with different experimental setup. The presence of silica fume (as aggregate) in some cases delayed the hydration and in others did not affect it. The number of experiments conducted did not permit to attribute a role to the silica in the hydration of the calcium aluminates. Further experiments covering a wider range of temperatures will be necessary to answer this fundamental question. The reactions studied were quite fast. An example is shown in Figure **1,** where a mixture of cement SECAR71 with water at 80 °C hydrates in less than four minutes. **Another** interesting feature observed is the presence of two maxima around three minutes which correspond to the presence of a transient phase: C_2AH_8. These short-life events can only be spotted with high-flux sources.