Study of ettringite morphology and packing in the context of concrete 3D printing

Duration of the internship: 6/7 months

Starting date: February/March 2024

Location: Université Gustave Eiffel, Laboratoire Comportement physico-chimique et durabilité des matériaux (CPDM), Bâtiment Bienvenüe 14-20 Bd Newton 77447 Champs sur Marne

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Requested profile: Master's degree student in materials science or civil/chemical engineering. Taste for experimental work and a good level in English is required.

Description:

Concrete 3D printing has recently emerged as a revolutionary technique for the construction industry, allowing greater design flexibility, while increasing material optimisation and simplifying the manufacture of products with complex shapes. However, to be printed, the behaviour of the concrete in the fresh state must be carefully controlled. In this context, there is a compound that plays a crucial role but is poorly studied in the literature: ettringite.

Ettringite is the main hydration product of cement in its early stages of reaction, and therefore the driving force of the evolution of its rheology. Characterised by its precipitation in the first minutes of reaction as needle-shaped crystals, it has the potential to significantly disrupt the packing of the particles that comprise the anhydrous cement pastes (whose shape is, in most cases, closer to spheres), and therefore their fresh-state behaviour and their potential applications. This feature, which can be a major drawback in traditional concrete, represents an opportunity in the field of 3D printing, since understanding the effect of ettringite on packing and rheology would provide major advances in the design of 3D-printed concretes.

For this study, the synthesis of ettringite will be carried out under different chemical environments to create diverse crystal morphologies (see Figure 1), which will be assessed by means of optical and electronic microscopy techniques. Then, its packing will be studied by centrifugation, individually and in combination with other materials composed of non-elongated particles. Potentially, the study could be extended to the analysis of the packing of cement pastes under different ettringite-growing conditions, including the addition of supplementary cementitious materials or accelerators typically used in 3D printing.

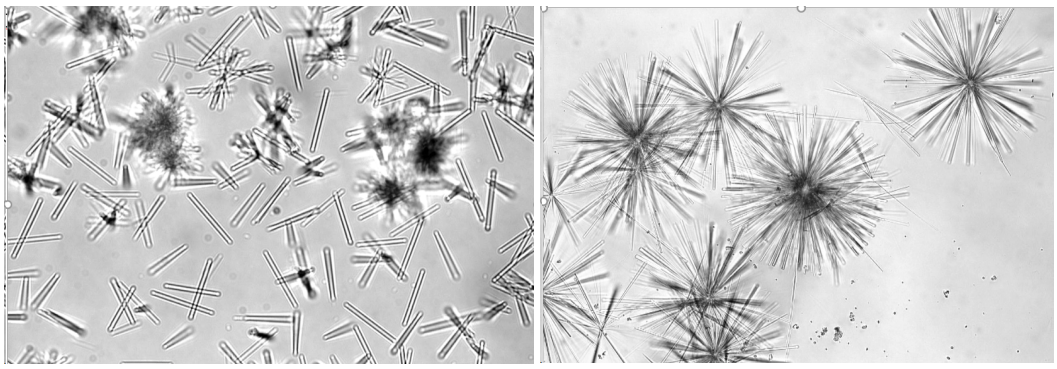

Figure 1. Examples of ettringite morphology depending on the growing environment.