Fracture of hydrated materials

What is the contribution of water to mechanical stability and durability of hydrated materials?

Organisers : Nicolas BAIN (ILM, CNRS), Maxime VASSAUX (IPR, CNRS)

From natural materials to high-performance composites, water is ubiquitous in materials and has a major influence on their mechanical stability. On an atomic scale, the water contained in collagen or cellulose controls inelastic properties through a complex network of hydrogen bonds [1]. The same applies to cements, where the dynamics of the water molecules intercalated between the C-S-H layers determine creep and hardening kinetics [2]. These observations extend to the relationship between a polymer and its solvent. On a mesoscopic scale, in more highly hydrated materials such as slurries, gels and earth materials, water content determines both short- and long-term mechanical stability [3]. The amount of water content also determines the susceptibility to damage from thermal loading cycles (freezing) [4].

The aim of this mini-symposium is to organise the sharing of knowledge between communities interested in the fracture of hydrated materials, in order to cross viewpoints and approaches, which is as fundamental as it is applied. This sharing will be organised by discussing methods for characterising the structure and dynamics of water and hydrated materials, and by discussing thermodynamic models (phase diagrams) and mechanical models (constitutive laws). It will also involve reflection on common open questions: (i) how does the structure of water, at different scales, interact with the initiation and propagation of cracks? (ii) is it possible to reinforce materials with water? (iii) what type of forces can water generate within a material? And many other wonders...

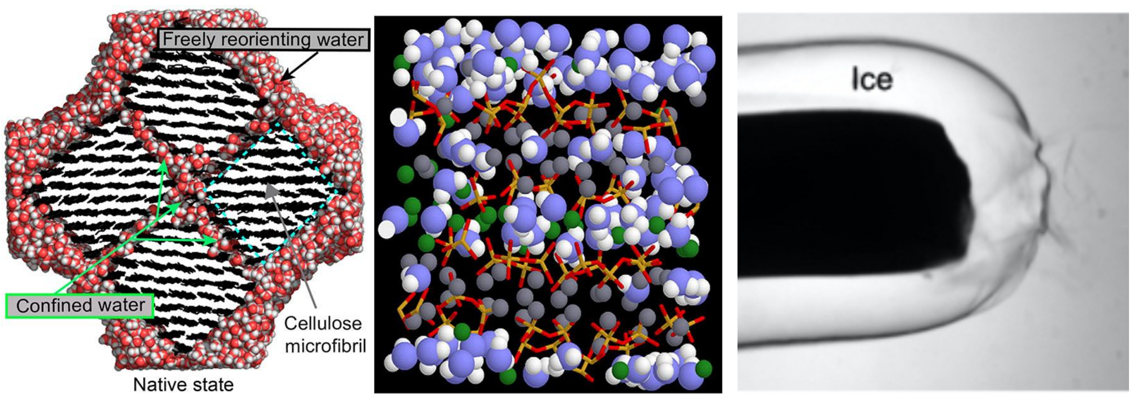

Figure: Organisation of water molecules (left) in a cellulose microfibril [1] and (centre) in cement, or rather a stack of C-S-H sheets [2]. (right) Freezing induced fracture in a hydrogel [4].

[1] Chen, P. et al. *J. Phys. Chem. Lett.* 13.24 (2022); [2] Bullard, J.W. *Cem. Con. Res.* 41.7 (2011); [3] Jaquin, P. A., et al. Geotechnique 59.5 (2009); [4] Yang, S. et al. arXiv:2401.12871 (2024)