Biomimicking - antifreeze concrete

Master's project in Building Materials, for the Master Program Structural Engineering and Building Performance Design

Background

In cold climates concrete will be exposed to frost and the water in the pore solution will freeze when the temperature goes below -8 to -10 °C. When the water freezes the ice formation will cause an expansion which generates stresses in the concrete which will lead to degradation.

The common solution today is to introduce air voids of microscopic sizes in the concrete matrix by adding an air entraining agent (AEA), a surfactant admixture, to the concrete when mixing. By the incorporation of air voids, water has space to expand when exposed to sub-zero temperatures, thereby reducing the internal pressure due to ice formation. However, there is no guarantee that the intended frost resistance is obtained since it is highly dependent on the air void system (size and distribution of air voids). Instead of using AEAs, which thus not prevent ice formation but rather gives space for ice formation to suppress the internal pressure when pore water freeze, a recent "disruptive" idea is to mimicking nature´s ability to tune and modify ice growth and formation. Thus, mimicking the ability of organisms to protect themselves from ice induced damages to survive in cold climates, like arctic regions, by use of cryoprotectants and antifreeze substances, like sugars and proteins, that inhibit ice formation and growth and/or lower the freezing point of water.

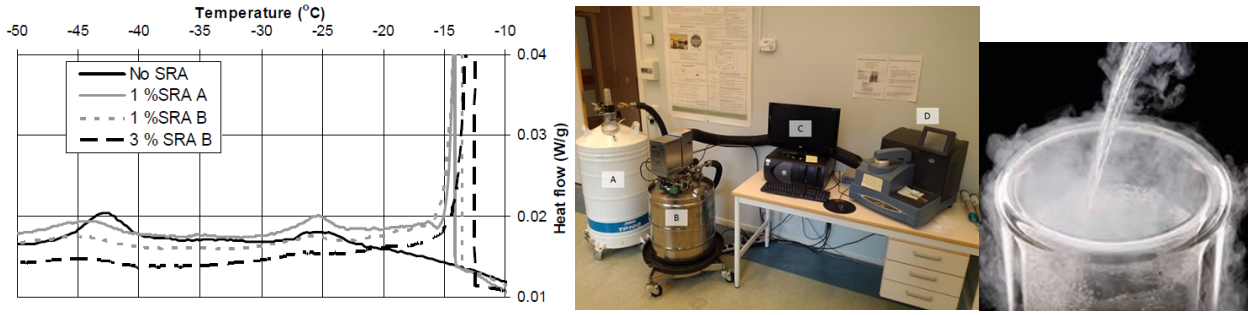

Figure 1. LTC scans for cement paste with different dosage of SRA. LTC equipment.

Purpose/Method

This master thesis proposal aims to investigate the impact of anti-freeze agent on frost resistance of concrete. This will be assessed by performing standard freeze-thaw tests (slab test according to SS 137244) and by assessing the influence with low temperature calorimetry to characterize the freezing behaviour. Diffusion and migration tests will be conducted to investigate effect on chloride ingress.

Thesis setup information

The master thesis will be carried at Chalmers University of Technology (building materials) and at Thomas Concrete Group. This Master Thesis work will be part of an ongoing project and is suitable for students interested in experimental work and concrete technology.

Supervisors

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