Biomimicking - antifreeze concrete

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

Background

Today it is well established that the anthropogenic emissions of carbon dioxide (CO_2) is the major cause for the global warming, and a potential threat to mankind. According to the latest IPPC report, Climate Change 2022 – Mitigation of Climate Change, it is impossible to meet the Paris Agreement of a global temperature increase below 2.0 °C (preferably maximum of 1.5 °C) without large scale removal of CO_2 from the atmosphere. The report also states that 50% of the reduction of CO_2 emission must come from large CO_2 emitting industrial sectors, such as cement and steel industries.

The production of Portland cement (PC) clinker, the reactive part of cement, stands for about 7% of the global CO_2 emissions. During the clinker production, CO2 is emitted both from the calcination process in which calcium carbonate ($CaCO_3$) is converted to lime (CaO) and from combustion of fuel. The major emission source is the calcination process, which constitutes 60% of the total emissions.

A hot topic in this day and age is carbon mineralization, where CO_2 is removed from the atmosphere by capture and storage (CCS) techniques in which the captured CO_2 can be utilized (CCU) to make valuable low-carbon products by mineralization (CCUM). Materials that have high alkali content and rich in calcium and/or magnesium are suitable for CCUM, and these can be used to produce novel types of alkaline supplementary cementitious materials (SCMs). Suitable materials are different steel making slags, combustion ashes, mine tailings and recycled concrete fines.

Purpose/Method

This master thesis proposal aims to investigate CO_2 mineralization of different alkaline materials and the chemical composition of these materials will be determined by XRD and TGA. Moreover, their potential reactivity will be assessed by isothermal conductive calorimetry (RILEM R^3).

Thesis setup information

The master thesis will be carried at Chalmers University of Technology (building materials) and at Thomas Concrete Group. The work will be conducted in cooperation with the global admixture supplier SIKA. 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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