Experimental report

14/02/2021

Proposal: UGA-101 **Council:** 10/2019

Title: Studying rhe water in air entrained cement mortar after different moisture precondition and during freeze / thaw

Research area:

This proposal is a new proposal

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Samples: cement mortar

Instrument	Requested days	Allocated days	From	To
D50 T	2	2	12/02/2020	14/02/2020

Abstract:

This report concerns the experiment UGA-101 carried out at the D50 imaging station. The project is a collaboration between researchers at the Division of Building Materials and the Division of Solid Mechanics, both at Lund University, and the companies SIKA Sweden AB and Cementa AB.

Water is present in most of the degradation mechanisms that concrete is exposed to. When these mechanisms are studied experimentally to build models, it is very important that the moisture content in the material is controlled and correct. The aim for the experiment was to study the water and pore distribution in air-entrained cement mortar with varying moisture preconditioning using dual-modality neutron and x-ray tomography. Furthermore, in-situ freeze-thaw cycling of cement mortar was performed to visualize the evolution of the water distribution in the pores.
The test was divided into two parts. In the first part different moisture pre-conditionings was studied in four samples : (1) Dried at 40°C, (2) Capillary saturated, (3) cured moisture sealed (4) Vacuum saturated. The samples had a diameter of 10 mm and a height of 10 mm and were moisture sealed during the measurements. A voxel size of 7 µm was used for the neutron imaging and 19.5 µm for the x-ray imaging. An example of the analysis of the measured data for the vacuumed saturated sample is showed in figure 1. It was found that even for this tough conditioning method not all pores were filled.

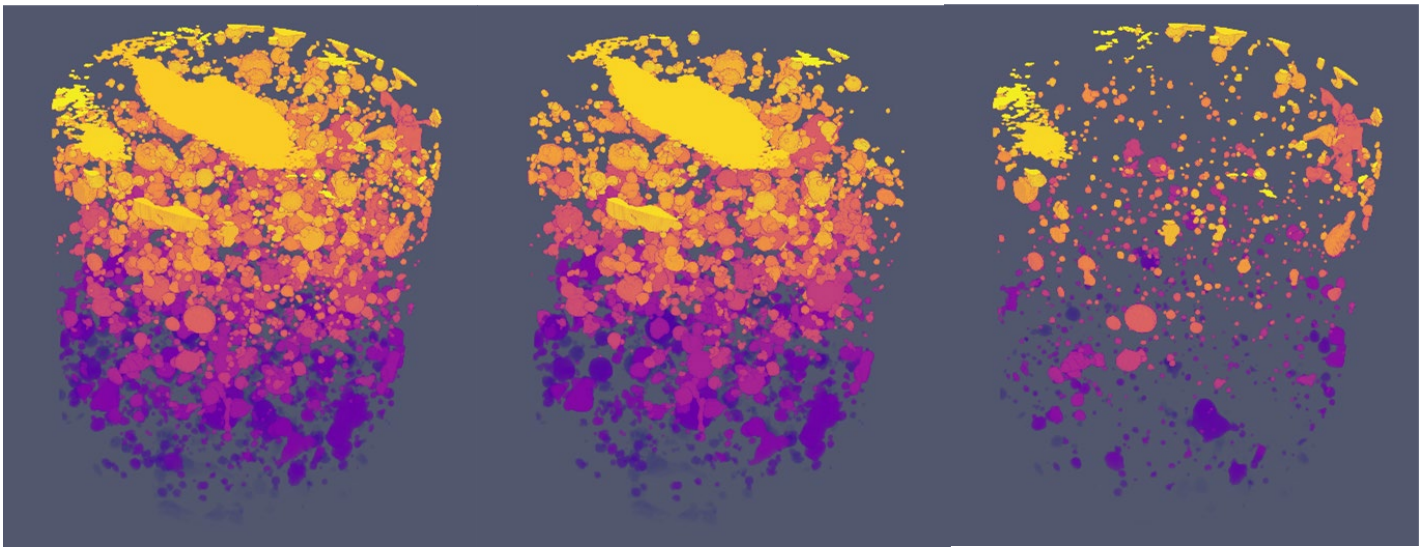

Figure 1. Left: all identified pores, middle:water filled pores, right: empty pores

In part two, an in-house built freezing device was used to study the evolving water distribution during freeze-thaw cycling. The device was based upon a Peltier element and circulation of a cooling fluid to reach temperatures well below 0◦C, see Fig. 2. A vacuum saturated cement mortar sample (outer diameter 10 mm, height 10 mm) with water on the top surface was subjected to three freeze-thaw cycles. The sample was imaged at each frozen/thawed state but due to time limitations, a full dual-modality dataset was only acquired before and at the first freezing as well as at and after the third freezing (in total four complete data sets). During the freezing, the temperature was lowered to approximately -13◦C measured in the sample and held constant during the imaging. A voxel size of 7 µm was used for the neutron imaging and 19.5 µm for the x-ray imaging.

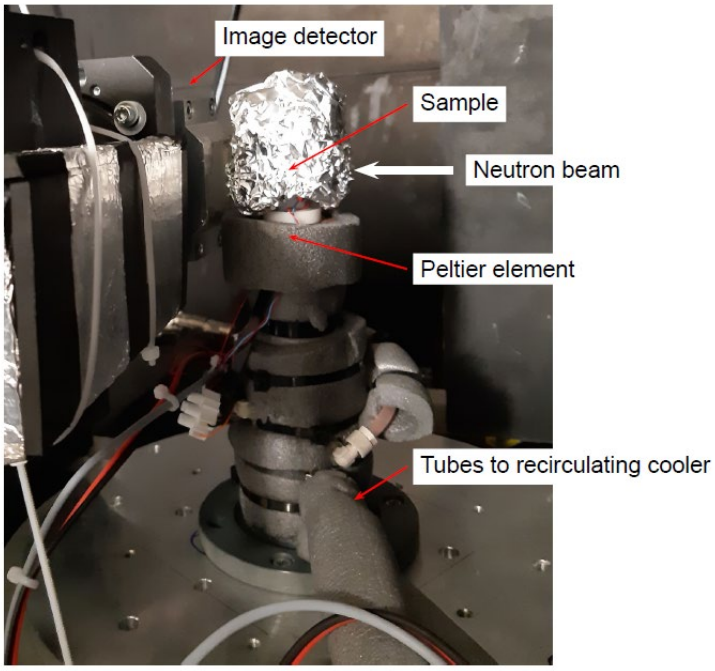

Figure 2. The freezing apparatus during testing.

The preliminary analysis of the sample during freeze-thaw cycling shows some small changes in greyscale value in the cement matrix during temperature cycling, fig 3. The analysis also shows small changes in relative water content of partially filled pores during temperature cycling, fig 4.

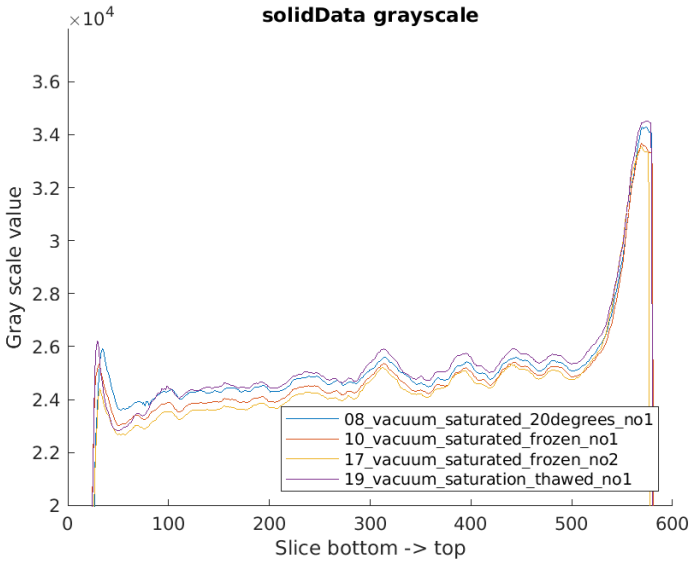

Figure 3. Greyscale during freeze/thaw testing.

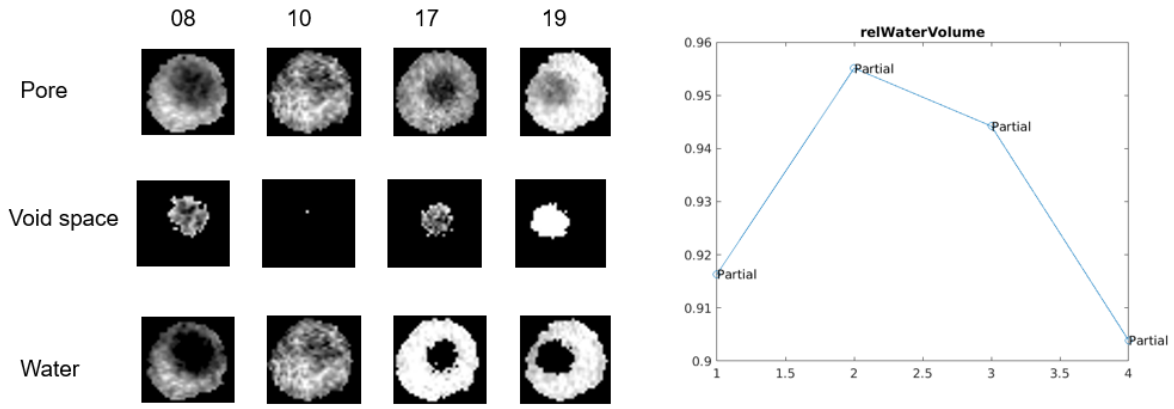

Figure 4. The change of water content in an air void during the freeze-thaw test.

Acknowledgement

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