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PATCHY MICROSTRUCTURE OF CEMENT PASTE INVESTIGATED BY NEUTRON AND SYNCHROTRON X-RAY TOMOGRAPHY

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It has previously been shown [1-2] that concretes and mortars exhibit a patchy microstructure of hardened cement paste (hcp), i.e. a microstructure in which dense areas of hcp are sharply delineated from porous areas. Similarly, patchy microstructure has also been observed in samples of hardened cement pastes with embedded water-saturated light-weight aggregates [3,4] and superabsorbent polymers [5]. While the presence of the patchy microstructure in hcp influences macroscale material properties, the reasons for its occurrence are yet to be fully understood.

Here we report on the results of combined neutron (NT) and synchrotron X-ray (SRμCT) tomography investigation of one sample of early-age cement paste of water to cement ratio (wcr) of 0.28. The cement paste was tomographed by X-rays (TOMCAT beamline, PSI) and neutrons (ICON beamline, PSI) both before and after setting.

The patch domains revealed by SRμCT correspond to areas that exhibit higher than the average signal for the cement paste in the NT acquired before cement paste setting. These areas of higher porosity exhibit major decrease in the neutron tomography signal in the experiments performed after the setting time.

Based on these observations, we suggest that the inhomogeneity that leads to the patchy porosity observable in the cement pastes in the hardened state is present in the material structure already at the very early ages after mixing/casting and that the porous patch domains originally exhibit higher than average wcr. Some possible mechanisms of occurrence of the observed patchy microstructure are proposed.

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Primary author: Dr TRTIK, Pavel (EMPA Dubendorf)

Co-authors: Dr KAESTNER, Anders (Paul Scherrer Institut, Neutron Imaging and Activation Group); Dr MÜNCH, Beat (EMPA Dubendorf); Dr PINZER, Bernd (Paul Scherrer Institut, Swiss Light Source); Dr LEHMANN, Eberhard (Paul Scherrer Institut, Neutron Imaging and Activation Group); Prof. WEISS, Jason (Purdue University); Dr TRTIK, Karel (Czech Technical University in Prague, Faculty of Civil Engineering); Dr JEFIMOVS, Konstantins (EMPA Dubendorf); Prof. STAMPANONI, Marco (Paul Scherrer Institut, Swiss Light Source); Dr LURA, Pietro (EMPA Dubendorf); Dr MATEUSZ, Wyrzykowski (EMPA Dubendorf)

Presenter: Dr TRTIK, Pavel (EMPA Dubendorf)

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