

VALIDATION OF WATER TRANSPORT TESTS BY ^1H MAGNETIC RESONANCE PROFILING

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Introduction

Water transport in concrete is the key to most degradation processes. However, most of the methods used for testing water transport properties are empirical and have no scientific background. Those tests give no information on the state of water or the saturation regarding distance from surface. Better understanding of those tests is very important for future use especially for high performance materials with new binders to predict long-term performance. Nuclear magnetic resonance (NMR) is an established method for both pore structure analysis and water transport in porous media. Therefore it is an appropriate technique for comparison, but no standard procedure exists and results are not easily comparable.

Non-destructive testing of water content on large samples

A non-destructive test method for moisture content could be very useful during building phase, maintenance and repair works as well. A recently developed one-sided NMR setup allows the investigation of concrete samples larger than the equipment itself. A spatial resolution of water profiles up to 25 mm depth is possible. The aim is to be able to use a one-sided NMR on site within a standard procedure that can be readily applied and easily interpreted and understood. Both the test protocol and the instrument, which were developed under laboratory conditions, require commissioning and refinement in an industrial setting. The current paper explains the calibration of the measurement and the optimisation of data acquisition and analysis for concrete.

Investigation of conventional water transport test methods

Water profiles obtained by NMR are compared to standard capillary absorption and permeability test results. Early results indicate that the colour change often used to mark water ingress is a poor indicator of actual moisture uptake. For example, Figure 1 shows the water profile acquired after 24 hour capillary sorption experiment.

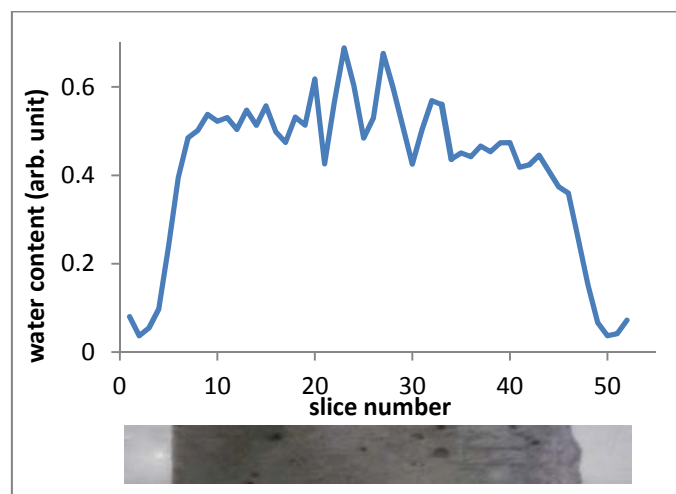


Fig. 1 Capillary sorption water profile by NMR with cross section below

The sample was in contact with water on the left side. The (photographic) cross section of the sample is shown underneath. The sample is darker to a depth of only about 15 mm from the left, but NMR shows water take-up well beyond this. Results indicate that the colour change is due to a larger capillary porosity filling up with water.

Long-term capillary sorption was carried out up to four weeks. It showed that the water in the capillary porosity decreased despite constant water supply during the experiment. Figure 2 shows the profiles of the same sample taken at different times on CEM I sample.

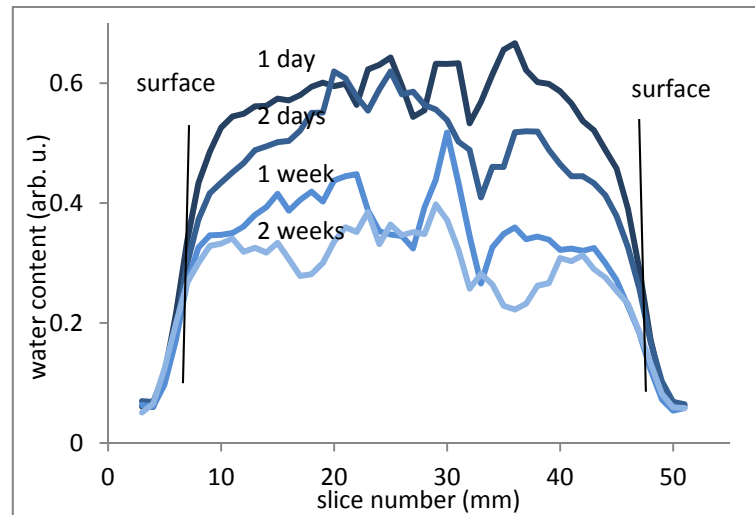


Fig. 2 Capillary sorption water profile by NMR at different times

The capillary porosity is significantly reduced after 1 week. Sample was in contact with water on the left side. The results indicate swelling in the capillary porosity. The water profiles are affected by the change in both the pore size and the total amount of porosity. Results show that this phenomenon is similar regardless of binder system and curing, the water content is reduced by about 30% and the capillary pore size is smaller after one week. The water content does not significantly change after two weeks.

Permeability tests were also carried out and investigated by NMR. Results indicate that the water content does not noticeably change despite a visible water penetration line.

Conclusions

The test method is calibrated and tested on several concrete mixes and it is suitable for on-site use. Results indicate that the conventional concrete water transport tests based on visual observation provides little information of water penetration depth.

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