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TOTAL CONCRETE PROTECTION

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PRAH vs. PRAN
The difference between absorption testing and permeability testing

Over the past few years crystalline admixtures including Penetron Admix have been widely established and accepted as the only true Permeability Reducing Admixtures for Hydrostatic conditions (PRAH) as classified by the American Concrete Institute (ACI).

Crystalline admixtures are hydrophilic materials that react with water in concrete to form an insoluble crystalline structure that seals pores, micro-cracks and capillaries. The formation of crystals in the capillary matrix significantly reduces concrete permeability. The result is a permanently dry concrete structure that is protected against the ingress of water and water-borne chemicals even under high hydrostatic pressure.

This method of protection has been proven to significantly slow down deterioration processes in concrete, enhancing durability and extending the service life of treated structures.

Contrary to crystalline admixtures, hydrophobic or water repellant chemicals such as pore blockers, fall under the category of Permeability Reducing Admixtures for Non-Hydrostatic conditions (PRAN). These materials can include various soaps, oils and long-chain fatty acids and are designed to repel water by covering the walls of pores and capillaries with a water repellant lining.

Due to their repellant mode of action hydrophobic materials are effective in reducing capillary absorption under non-hydrostatic conditions. Therefore manufacturers of these materials usually recommend absorption testing to demonstrate the performance of their products.

Common standards for capillary absorption testing include ASTM C1585 (Standard Test Method for Measurement of Rate of Absorption of Water by Hydraulic-Cement Concretes) and BS EN 1881-122 (Testing Concrete Part 122: Method for Determination of Water Absorption).

The general procedure to measure absorption of water into a treated concrete sample used in these standards is done by drying the specimen in an oven to ensure no water or moisture is contained. The weight of the dry sample is recorded before it is submerged in water for several minutes/hours. After the sample is removed from the water the weight is determined again and the water absorption is calculated according to a formula defined in the respective standard. The obtained results are usually compared against a control sample.

"Absorption tests are suitable for PRAN's as they do not apply water under pressure. Hydrophobic pore blockers only have a limited resistance against hydrostatic pressure mainly due to the fact that the capillaries are not physically blocked. The repelling function only withstands low water pressure in order to minimize water ingress due to rain or dampness."

The main reason for this is that hydrophobic materials are unlikely to coat all pores uniformly. In addition larger voids and cracks cannot be sufficiently protected. This usually results in a hydrostatic pressure resistance of only a few centimeters of water head. If the pressure rises higher the repellent effect is negated and "overpowered" and water will be able to penetrate into the concrete through the still open capillary system. In addition, new cracks will be left unprotected by hydrophobic materials and pose a risks for water ingress. In contrast, crystalline admixtures will re-activate in the presence of water (hydrophilic), form new crystals and "self-heal" new cracks in concrete.

Absorption testing is not recommended for crystalline admixtures. Due to their hydrophilic nature water is initially absorbed into the hardened concrete. This water will trigger the chemical reaction that forms the insoluble crystalline structures that will in turn seal all micro-cracks and concrete capillaries. Once the capillaries have been sealed, no further water will be able to penetrate into the concrete. Therefore absorption values obtained after several minutes/hours (depending on the selected standard) of testing may be misleading and should not be used to interpret the waterproofing performance of a hydrophilic product.

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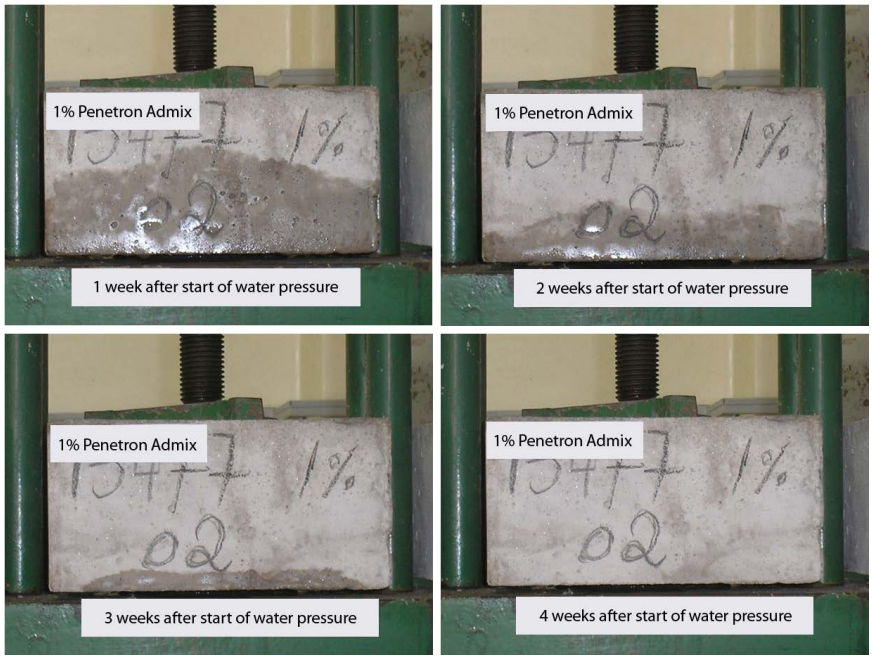
"The recommended and correct way to test the performance of crystalline admixtures (PRAH) are permeability tests. These tests apply water under pressure and will give a better indication of the performance of the product under hydrostatic conditions."

Suitable and internationally accepted test standards include DIN 1048 pt. 5 (Testing concrete: Testing of hardened concrete), BS EN 12390-8 (Testing Hardened Concrete. Depth of Penetration of Water under Pressure) and ASTM D5084 (Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Parameter).

Permeability tests observe the penetration of water under pressure into treated concrete samples. Depending on the applied standard, water is introduced into a hardened concrete sample, which has been cured for 28 to 35 days, under pressure (e.g. 5 bar) over a fixed amount of time (e.g. 3 days). Immediately after the pressure is released the water penetration into the sample is measured (e.g. in mm) by splitting the sample. Results of the treated sample are usually compared against a control sample.

These tests apply water under pressure and, contrary to absorption tests, are able to give an indication of the admixture's performance under hydrostatic conditions. **Since a lot of the water applied during this test is taken up by the crystalline reaction to form crystals, a true performance indication can be achieved by repeating the test cycle over several weeks (see 4 weeks test images below).**



Conclusion:

- Capillary absorption testing is suitable to evaluate Permeability Reducing Admixtures for Non-hydrostatic conditions (PRAN) including hydrophobic pore blockers, as it doesn't involve applying water under pressure.
- Hydrophobic admixtures are used in applications that are not subjected to hydrostatic pressure, such as repelling rain or minimizing dampness.
- Capillary absorption testing is not recommended for crystalline admixtures due to their hydrophilic nature and initial surface water absorption to obtain the water necessary for the reaction.
- Crystalline admixtures are hydrophilic materials that are capable to withstand high hydrostatic pressure. To measure and compare the performance of concrete treated with a crystalline admixture permeability testing has to be undertaken.

References:

- ACI 212.3R-10 "Report on Chemical Admixtures for Concrete, November 2010
- ACI Education Bulletin E4-12 "Chemical Admixtures for Concrete", January 2013
- BS 1881: Part 122: 1983 "Testing Concrete Part 122: Method for determination of water absorption"
- ASTM C1585-04 "Standard Test Method for Measurement of Rate of Absorption of Water by Hydraulic-Cement Concretes"
- DIN 1048 pt.5 "Testing concrete/Testing of hardened concrete (specimens prepared in mould)", June 1991