

Waterproof Concrete With Site Supervision Ltd

Because concrete isn't waterproof without experienced, close supervision.

Capillary Action in Concrete.

The sources of all this information are Wikipedia ([Capillary Action](#)) and (Portland Cement) and the series of four books for the post-graduate diploma of the same name "[Advanced Concrete Technology](#)". My comments are in black.

It is vital, in understanding waterproof concrete, that you appreciate that the narrower the route for water, the greater the pressure to get through.

Concrete contains water for two principle reasons, first to hydrate the cement and second, to make concrete workable enough to compact. The water of hydration chemically binds in the cement hydrates. The water in the concrete that was added to provide workability occupies a system of capillary pores within the concrete. (Testing and Quality 4.9.4)

Capillary action, or capillarity, refers to certain phenomena associated with the behaviour of liquids in thin tubes or in porous materials. Liquids, such as water, will tend to move "up-hill" (against the force of gravity) which does not normally occur in large containers. The interface between liquids, or a liquid and a gas, can form a meniscus or crescent shape.

The contact length (around the edge) between the top of the liquid column and the tube is proportional to the diameter of the tube, while the weight of the liquid column is proportional to the square of the tube's diameter, so a narrow tube will draw a liquid column higher than a wide tube.

Indeed the formula on Wikipedia (far too complex to reproduce here) has after it: Thus for a 2 m (6.6 ft) diameter tube, the water would rise an unnoticeable 0.014 mm (0.00055 in). However, for a 2 cm (0.79 in) diameter tube, the water would rise 1.4 mm (0.055 in), and for a 0.2 mm (0.0079 in) diameter tube, the water would rise 140 mm (5.5 in).

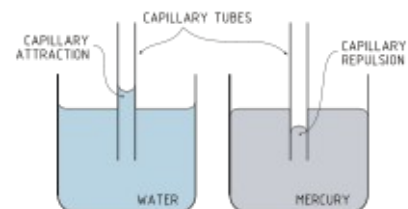
Imagine how far the water would push through the gap between cement grains. Cement grains are the result of crushing clinker so quite varied in size. The grinding process is

controlled to obtain a powder with a broad particle size range, in which typically 15% by mass consists of particles below 5 μm diameter, and 5% of particles above 45 μm . Taking an average of 20 microns the gap between would be about 20 microns diameter, or 10 microns radius. (It isn't a round gap so I am being quite approximate). Based on the figures from Wikipedia, water would rise through a 0.01mm radius **2.8m** before gravity held it back. Water doesn't need to rise to go through concrete. It can go sideways and downwards as well but 2.8m does give you an idea of the pressures involved.

PFA and GGBS particles can be far smaller than cement particles (it depends on the supplier because finer particles are better for concrete but mainly achieved by throwing away significant amounts of larger particles, so smaller and better costs more). Therefore the capillary action pressure can be greater still in concrete made with blended cement.

Lowering the free water content of the mix reduces the size and continuity of capillary pores and this can be achieved with water-reducing or high range water-reducing materials. Reducing capillary size alone does not necessarily reduce surface absorption and may even increase it as capillary suction increases with smaller diameter pores. (Constituent Materials 4.6)

This sketch, from Wikipedia, shows how mercury is repelled by the same tube that attracts water. Most waterproofing additives for concrete (animal fat from Sika and Pudlo, for instance) are unwettable, hydrophobic, which means that, like Mercury, it repels water and for that reason water will not get through by capillary action.



Dosage varies widely, depending on the type and the required level of performance. Two percent is common for the hydrophobic types, but may be 5% or more for the pore blockers. (ditto)

However, waterproof concrete additives can prevent water getting through cracks or areas of concrete not properly compacted.

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