

Waterproof Concrete With Site Supervision Ltd

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

Concrete Cancer, Salt, Sulphates, Acids and so on.

Concrete Cancer.

Concrete cancer was when certain aggregates at certain water concentrations reacted with the water and expanded, cracking the concrete open, especially where the concrete was thinnest against reinforcing steel.

The same aggregates are still used safely but in mixtures where the required chemical reactions take place instead of the unwelcome reactions that caused the spalling.

There have been no reported cases of concrete cancer in concrete produced by a readymix plant in the UK since the mid-1980s.

Excess Water in Concrete allows salt and oxygen to attack reinforcing steel.

So waterproof the concrete and keep salt and dissolved oxygen out.

The effects of excess water in concrete:

Concrete requires some water to hydrate cement.

About 22% water to cement by weight is enough to form some strength (for example a kerb mix).

Somewhere in the region of 35% water is enough to react with all the cement if the cement is a sample in a dish in a laboratory. In well compacted concrete there is not enough room for 35% water to react with much of the cement.

45% water by weight of cement is in many ways ideal in concrete since most of the cement will react before it runs out of space; so very strong concrete is easily achieved with sufficient pores completely closed off for well compacted concrete to be completely water, vapour and gas proof given enough curing time.

50% water is enough for very nearly all the cement to react because the extra water creates space. It is sufficiently meagre water for concrete to become waterproof but neither vapour nor gas proof.

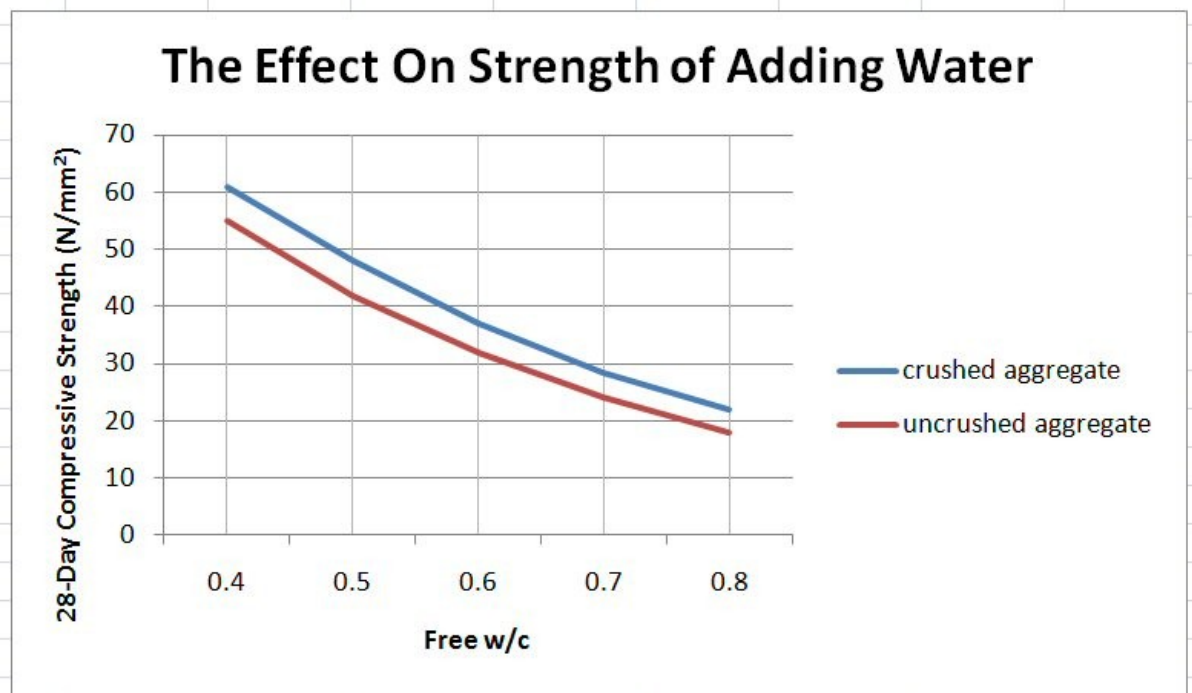
All the above water:cement ratios need real help from chemical additives to get enough workability for full compaction.

A lot of readymix concrete contains some WRA, water replacement additive, and 55% water. This is the most economical concrete with structural strength since there will always be some of the concrete that is just plain water. But long-term drying shrinkage is not too much of an issue in many cases.

Without WRA, or if more water is added to standard readymix on site, concrete will have at least 60% water. This is truly excessive and there will be drying shrinkage issues later as well as rapid deterioration if road salt is present on the surface.

Excess water pushes the grains of cement apart and lives in inter-connected pores within the cement "glue".

The inter-connected pores are both weaknesses and passages for deleterious chemicals to get in and attack rebar. Clearly, the more excess water the bigger the pores and the more weakness in the concrete.



Assumed relationships between strength at 28 days and free w/c for concretes made with CEM1 Portland cement to BS EN197-1 (adapted from DoE, 1988).

Water Reducing Agents can reduce the water needed to get a certain workability but by definition (EN 934-2) they are limited to replacing 5% - 12% of water. They can be troublesome at doses higher than 0.08% (weight of cement) because of unwelcome secondary effects. WRAs cause bleeding and/or retardation at higher doses.

Polycarboxylate Ether (PCE) plasticisers (such as the Super Plasticiser in our RheoFIT 799) generally have minimal secondary effects. They are the newest additives available and already in wide use on mainland Europe and in the Middle East, for instance Dubai, but not so widespread in the UK yet. They can reduce water needed to compact concrete to as little as 30%.

WRA and Super Plasticiser additives coat cement grains with substance molecules thick so they do not add to the volume of concrete.

In this example mix design (from a readymix supplier) we are assuming 10% of water is replaced by 0.05% WRA.

C28/35 Pump Mix. CIIIA.
 20mm max size aggregate.
 Target: S2 slump.

Mass per cubic metre	Density	Volume per cubic metre
192Kgs Portland Cement	3.15	0.061m ³ (or 61 litres)
128Kgs GGBS	2.90	
764Kgs marine grit SSD	2.66	0.044
362Kgs 10mm S/S marine SSD	2.61	0.287
725Kgs 20mm S/S marine SSD	2.64	0.139
176 litres water added	1.00	0.275
16 litres WRA at 0.05% weight of cement		0.176
Aggregate to Cement Ratio 1:5.79		Total volume of materials
Water to Cement Ratio 0.55 (this is as well as WRA)		0.982m ³

Therefore the readymix supplier is assuming 18 litres of air will be left in each cubic metre of concrete after it has been compacted. This is quite usual and acceptable in concrete with WRA added. The air adds to the cohesiveness of the mix and helps reduce bleeding.

Of the 176 litres of water, only about 33% the weight of cementitious material will hydration. 33% of (192 + 128) is 105 litres.

Therefore about 65 litres of water per 1000 litres (one m³) of concrete will remain in the concrete after full hydration.

6.5% OF THE SET CONCRETE IS WATER.

Or, to put it differently, 70% of this concrete is aggregate and 30% is not.

Nearly 66% of the non-aggregate volume will be cement glue and about 33% will be excess water or air.

CLEARLY SO MUCH SPACE IS A WASTED OPPORTUNITY.

That is just an S2 mix, about 75mm slump, and after WRA replaced 10% of the water.

Without WRA, or a higher slump, there would have been another 25 litres or so of water-filled space in the set concrete. That would have cost 12% of the strength of the concrete. The C35 would be a C31 mix.

The danger, on site, is that operatives persuade the readymix driver to "give the concrete a drink". Adding water will make your concrete go a little further but push the grains of cement further apart reducing the strength of the concrete significantly.

On the other hand, replacing yet more water with super plasticiser rather than WRA, and using our waterproof concrete mix specification, can add strength to your concrete:

- Over twice the usual strength achieved in the first 24 hours
- Over 50N/mm² 28 day strength.
- Over 100N/mm² late-age strength possible with careful mix design and selected aggregates.

The benefit to take advantage of by reducing water content and increasing strength is to allow the designer to specify less concrete width to achieve design criteria, thereby saving a lot of concrete and a lot money.

And the proof?

This is why precast beams are so thin yet so strong - mix design and water control.

Sulphates.

Sulphates, whether in the ground or effluent treatment plants, eats the crystals formed from cement in concrete.

The solution, these days, is to use Pulverised Fuel Ash (PFA) in concrete. The sulphate will eat away cement crystals until it is

faced by PFA crystals where it is halted. Therefore no more than a fraction of a mm will be lost.

Acids.

In general acids eat concrete.

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