

Waterproof Concrete With Site Supervision Ltd

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

Curing Concrete. Needs and Methods.

CURING. From BS 8110, 1997. "The process of preventing the loss of moisture from the concrete whilst maintaining a satisfactory temperature regime."

The purposes of curing concrete are not usually to do with strength. Even in the hottest weather in the UK the concrete deeper than the cover to steel reinforcement is unlikely to be affected by drying and most structural elements will gain adequate strength for their purpose regardless of curing or weather.

But attaining waterproof concrete, durability, abrasion resistance and a crack-free surface all require curing whenever the weather is close to freezing or likely to dry the fresh concrete surface.

If the surface of the concrete can dry out before the concrete is sufficiently hardened:

- the surface can shrink and crack (plastic cracking);
- hydration (hardening) can cease prematurely;
- carbonation can occur which can lead to steel reinforcement corrosion later as well as preventing still-fresh concrete being re-wetted;
- the surface can be weak.

Waterproof concrete has less water (to cement) than normal structural concrete so losing, say, 1 litre of water from 1 square metre of surface has a worse effect on waterproof concrete than it would on ordinary RC35.

Therefore, the point at which waterproof concrete needs curing measures is in less detrimental conditions than for a normal RC35.

What are curing measures?

Anything that reduces evaporation from the concrete surface is a curing measure. Measures include any formwork, spraying or ponding with water, covering in a saturated material like sand or hessian or covering in something waterproof like plastic sheeting or an acrylic coating.

What if curing is interrupted?

If curing is interrupted early, for instance the formwork is removed, hessian dries out, the space between a plastic sheet and the concrete gets too hot in the sun or the polythene sheet blows off, then the surface can dry after all and if the chemical reaction in the concrete stops then the damage is likely to be done. When the relative humidity in hardening concrete drops the chemical reaction changes and carbonation occurs instead of concrete crystals being formed. The carbonation is weak and, later, carbon dioxide might get through and attack the reinforcing steel. But in the short term carbonation blocks the concrete pores so even if a slab was resprayed with water, that water might not get down to cement that halted its reacting so that concrete would never restart the chemical reaction or gain any more strength.

So curing is vital in drying conditions and it is vital that the curing remains in place.

An excess of water is better than a covering, whether a sheet or the formwork left on, but since any curing that remains is much, much better than excellent curing that is interrupted, the best practical curing method for walls and columns is to leave the formwork on until the surface has gained sufficient strength. Horizontal top surfaces are best kept wet.

“In reality the best curing method is the one that actually gets done, and done well”. Bryan Marsh.

When to use curing methods.

The biggest influences are concrete temperature and wind. Although air temperature and the relative humidity of air influence concrete drying, warm concrete over 25°C and winds over 10mph have significant effects that quickly increase with more temperature or more wind.

As previously pointed out, structural strength is not greatly affected neither will waterproofing be greatly affected in members at least 200mm deep.

Important:

The exception is the part of the slab that will have a wall on top because there should be no route for water ingress horizontally under the wall. Plastic shrinkage must be prevented under waterproof walls yet to be cast.

Protection to the steel reinforcement is always very important. Durability and abrasion resistance are often important as well.

Therefore curing might be considered on an average day in the UK: where surface quality is vital ranging to all concrete should be cured in warm conditions with a decently strong breeze.

Concrete 35°C loses water to evaporation twice as fast as concrete at 20°C which loses water twice as fast as concrete at 10°C.

Concrete that is allowed to freeze before it has sufficient strength is weakened permanently.

Concrete members of considerable size (certainly more than 300mm across their smallest dimension) could suffer if their core is curing at a far higher temperature than their surface because, when the entire element cools, the centre will contract more than the outside causing tension stresses that might crack under the designed load.

How long should curing methods be employed?

Until the drying conditions change or up to 5 days is generally a safe rule for the UK.

OPC concrete (waterproof concrete), on average, achieves $\frac{3}{4}$ of its strength in 5 days so most of the water within it would have formed into concrete crystals by then and it would be harder than before for remaining water to escape as evaporation. In hot conditions this might be sooner. In cold conditions it would take longer but the concrete might not need any curing measures.

Normal RC35 concrete has a blend of cement with an alternative (such as PFA) and cures far more slowly. Alternatives to cement are so much harder to restart than OPC that it is often thought they never restart the chemical reaction if it is interrupted. But blended cements do not get as hot curing so they would not need curing measures as often. The alternatives to cement also tend to finer preventing drying off better than pure OPC.

Conclusion.

When concrete can dry, particularly because the concrete is warm or it is breezy, the concrete should be cured.

The best slab curing is to keep it wet in the way that is easiest for you to KEEP it wet.

The best wall curing is to leave the formwork on.

Do not forget that walls have horizontal tops. The tops might need hessian kept wet.

And don't pretend that good curing of bad concrete will give you good concrete. It won't.

References:

Within the concrete industry: quarrying, cement manufacture, readymix and so on, there is a post-graduate diploma one can study for and a series of four text books contain all the necessary knowledge to obtain it. These are "Advanced Concrete Technology" edited by John Newmam and Ben Seng Choo. I have read large parts of these books and this information paper is written as a direct result of the understanding I have gained, particularly from the chapter "Curing" by Bryan Marsh in the Volume 'Concrete Properties'

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This paper on curing is incomplete because it is aimed at the use of waterproof concrete.

Leaching, rapid cooling, vibration and impact are all valid reasons for curing measures but have been excluded.

Internal thermal gradients have only a brief mention because water proof concrete is not usually more than 300mm thick within which the issue does not cause concern.