Figure 1: Slab pour using poker. Good concrete compaction reduces potential water paths through concrete.

# Water-resistant concrete for below-ground applications

***Alan Sleigh** of **Triton Systems** reveals an industry secret and encourages* Concrete *readers to share it. The secret is how to ensure success when using water-resistant concrete. But first some background…*

Concrete is a highly versatile, multi-use material. Installed correctly, on its own, water-resistant concrete has proved to be a highly effective, single structural waterproofing solution keeping many deep basements very dry. It's also very cost effective. However, against a changing background led by major insurance providers such as NHBC and Premier, it's now more often combined with another waterproofing solution – especially in habitable environments (as in Grade 3: BS 8102[1]).

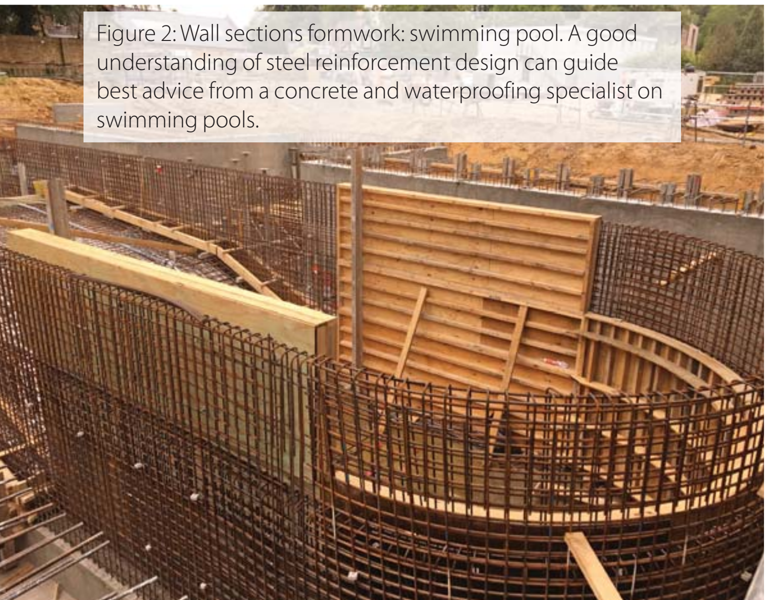

Figure 2: Wall sections formwork: swimming pool. A good understanding of steel reinforcement design can guide best advice from a concrete and waterproofing specialist on swimming pools.

Moving up the scale, concretes for specific applications such as industrial flooring, chemical resistance and higher-than-usual durability, require a more considered and controlled manufacturing environment. Water-resistant concrete is an example of where it needs a tightly controlled batching environment, especially when the focus is on a thorough mixing in of a water-resisting admixture and ensuring a denser matrix property than a regular concrete.

When using water-resistant concrete – produced by the addition of a crystalline admixture – for structural waterproofing, the objective is to achieve a well-placed and cured concrete that will provide a much higher resistance to water ingress, especially for applications where water-resisting structures are to be built using concrete alone. This is usually achieved by a reduction in the water:cement ratio as a starting point, to help reduce the general permeability of the concrete and to ensure that there is enough cementitious content to activate the crystalline admixture initially. Alternative water-resisting admixtures that are not crystalline based also rely on this 'densification' of the matrix and combine this with pore-blocking properties. This universal base mix with a little less water has the added benefit of producing a more durable concrete for many applications and is achieved by incorporating other plasticising admixtures to regain or aid consistence.

So, once a water-resistant concrete has been designed to take into account the required strength, the application, the environment, the minimum binder content, any consistence and sustainability requirements or aggregate specific considerations – and is safely on its way to site – does that mean we have done all we can to ensure success? Well, no it doesn't and this is where the secret will be shared. There is another vital ingredient – and that is the use of good concrete practice on-site.

## On-site

Once the correct water-resistant concrete has arrived on-site, good practice is absolutely crucial if it is to perform effectively for the long term. For example, the temptation to add water to the concrete to aid placement can be detrimental as it will negate the benefits of the denser matrix that is so important to water-resistant concrete mix designs. Adding just a little (say up to 50 litres per load) may not immediately be seen as problematic. However, deep inside the concrete, the pore structure will have opened up a little, increasing the opportunity for dampness or moisture to penetrate into or through the finished mix. This may not result in an early manifestation of damp or water ingress right through the concrete section thickness, but the opportunity for moisture to reach embedded steel reinforcement has increased and with it the increased risk of early corrosion. With steel reinforcement cover depths as low as 25mm on occasion, a good dense cover of the steel is essential (Figures 1 and 2). Although uncontrolled

Figure 4: Under-slab insulation. Appropriate curing methods are vital to achieve watertight solutions. Below-slab insulation can contribute to heat build during hydration stages.

Figure 3: Pumped slab pour. Concrete permeability can be adversely affected by adding water on-site and should be avoided.

Figure 5: Awkward configuration. Concrete sections and connections can be complex. A combination of concrete knowledge and waterproofing knowledge is invaluable.

Figure 6: Prepared kicker joint. A properly prepared and compacted construction joint provides excellent water resistance when combined with a waterbar.

adding of water is now rare, those who are unaware of the consequences occasionally add considerable amounts on site (Figure 3).

Once placed, during its early stages of hydration (curing), the concrete then needs to be protected from the adverse effects of extreme heat, cold and premature evaporation of water. This is to ensure the correct chemical reactions within the binders (PC/GGBS/fly ash, etc) can take place and create sufficient strength to resist early-age cracking influences.

During these early stages, the concrete can generate significant heat (Figure 4) of its own (exothermic reaction). While this reaction can act as a form of built-in anti-freeze during the cold months, it still needs to be managed by allowing it to take place without any sudden exposure to a colder environment, such as when the formwork is stripped too early and results in thermal shock – similar to taking a hot glass from the dishwasher and putting it in the freezer. The rapid cooling on the surface of the concrete fights with the expansive forces going on in the centre of the section and results in cracking.

Cracks caused by shrinkage from evaporation of the water may not be too detrimental from an engineering perspective (Figure 5) but water-resistant concrete with cracks can result in leaks and this should be a key focus for the installing team. Protection from freezing by the use of frost blankets in winter months will help protect the concrete.

Another potential cause of water ingress is areas of under-compaction or 'honeycombing', particularly at or around the slab/wall (kicker) joint (Figure 6). Although these can be repaired later through simple rake-out and repair or more extensive resin injection techniques, the objective again should be to avoid it happening in the first place by using all appropriate compaction tools. Repairs are time-consuming and expensive and will look unsightly in exposed areas.

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So the secret is out. The adoption of good concrete practice on-site is the extra vital ingredient to ensure the success of a water-resistant concrete project. When the water-resistant admixture supplier visits your site, give the company a warm welcome. It will be there to help you reduce the risk of water ingress and achieve a successful outcome to your project – not to make your life more difficult. ■

**Reference:**

1. BRITISH STANDARDS INSTITUTION, BS 8102. *Code of practice for protection of below ground structures against water from the ground*. BSI, London, 2009.