BUILDING DESIGN+CONSTRUCTION

Concrete That Fears Water No More

By Dave Barista, Managing Editor -- 12/1/2007

Concrete is one of most durable manmade materials, but it has one fundamental flaw: as it hardens, concrete becomes porous. It essentially becomes a “hard sponge” that allows water to bleed through the surface, causing damage to the concrete's chemical composition and steel reinforcement.

To combat water penetration in concrete structures, Building Teams typically apply any number of waterproofing methods, depending on the application. The most common approach, especially for below-grade structures constructed beneath the water table, is to line virtually every square inch of concrete with waterproofing membrane. When done right, this method is virtually foolproof. However, the materials and labor can be quite costly, and installation can impact the critical path schedule.

One technology offers a simpler—and potentially faster and cheaper—solution to waterproofing concrete structures. So-called “hydrophobic” or water-resistant concrete takes waterproofing down to the molecular level. Each manufacturer's technology works a little differently, but the basic approach involves adding special admixtures to standard concrete at the ready-mix plant that react with the water, cement, and aggregate to create a water-repelling composition (see sidebar on p. 48).

Water-resistant concrete admixtures are not new—manufacturers like Cementaid have been marketing the technology for more than 30 years. But the technology is gaining popularity for nonresidential building applications as Building Teams look to reduce material and labor costs and compress project schedules.

“Just looking at the cost of the waterproofing membrane alone versus the cost of waterproof concrete admixtures, membranes can be about 40% more, depending on the thickness of the slab and other design details,” says Jack Avery, SVP and project manager director with Sellen Construction, Seattle. Waterproofing membranes cost $6-10/sf, according to Avery, and are tied to the price of oil, which of course is rising.

For that reason, more contractors like Sellen Construction are considering water-resistant concrete for building projects, especially those that involve below-grade construction, such as parking structures, lower levels, and subbasements. “The most ideal application is for waterproofing 'bathtub' structures that are below the water table,” says Avery.

Sellen is currently working on such a project in Seattle's South Lake Union neighborhood, an 188,000-sf biomedical research laboratory and 96,000-sf office atop three levels of below-grade parking. Developed by Seattle-based Vulcan Real Estate and designed by Perkins+Will for the University of Washington School of Medicine, the project is the second phase of a three-phase research complex that will total more than 800,000 sf of lab and office space for over 1,000 UW medical researchers and employees.

Since breaking ground in spring 2006, Sellen and its ready-mix supplier Stoneway Concrete, Renton, Wash., have mixed and poured nearly 2,700 cubic yards (about 65,000 sf) of water-resistant concrete (supplied by Hycrete, Carlstadt, N.J.) for the complex's slab-on-grade and foundation walls. The approach virtually eliminated the need for waterproofing membrane on the foundation and slab portions of the project, saving up to two weeks of installation time and more than $150,000 in membrane materials cost (see sidebar below).

With the water-resistant concrete, waterproofing the slab was as simple as installing the rebar and pouring the structural slab. “That was our waterproofing,” says Avery.

“Without using Hycrete, we would have had to over-excavate in order to pour a 'rat' slab on which to apply the waterproofing membrane,” he says. “Then we'd have to pour another protection slab over the membrane and the structural slab on top of that. All that takes time, and there's a cost to putting those extra slabs in, as well as the cost of the membrane itself.”

Avery says pouring and placing the water-resistant concrete “is pretty much the same” as standard concrete, but recommends that Building Teams pay close attention to water stop details at cold joints or poured joints. “In membrane applications, you may not have to worry as much about water stop details because you're going to cover the joints,” he says.

Avery envisions other applications for hydrophobic concrete, including water storage tanks for rainwater harvesting and temporary roofs.

“In high-rise construction, the critical path is often through the skin and getting a roof on the building so you can build it out,” says Avery. “There is the potential to pick an interim floor, say floor 20 in a 40-story building, and pour that floor with this concrete and get a fairly good water-resistant roof. There are some interesting opportunities with this technology.”

Economic Analysis for waterproof concrete at UW Medicine Phase 2

Location	Area (SF)	Depth (inches)	Waterproofing Membrane Cost (per SF)	Cost of hydrophobic concrete (per SF)	Total Cost	
					Membrane	Hydrophobic
Foundation Walls	9,600	12	$6.00	$3.70	$57,600	$35,520
Slab on Grade	55,950	12	$6.00	$3.70	$335,700	$207,015
Total Cost					$393,300	$242,535

How Waterproof Concrete Works

There are two major manufacturers of waterproof concrete additives. Each system works a little differently.

Hycrete, based in Carlstadt, N.J., offers an admixture that is essentially a water molecule with a long hydrocarbon attached. The molecule reacts with metallic ions present in the water, aggregate, and cement. From this reaction, a precipitate is formed that fills the capillaries of the concrete, thus repelling water and shutting down capillary absorption. Hycrete also protects the reinforcing steel by chemically bonding to the steel surface and creating a monomolecular film. www.hycrete.com.

Australia-based Cementaid's Everdure Caltite uses two ingredients: a slump-retaining superplasticiser that reduces the batching water requirements, thus controlling the volume of the capillary network in the concrete; and a hydrophobic and pore-blocking liquid that changes the surface tension of the cement hydrates and capillary surfaces. This produces a permanently modified concrete matrix and capillary system that is water-repellent throughout its entire mass. Everdure Caltite also forms polymer globules that move with the bleed water and collect in the capillaries. When the hardened concrete is subjected to water under pressure, these globules coalesce to form a physical “plug,” blocking the capillary and preventing further water entry. www.caltite.com.