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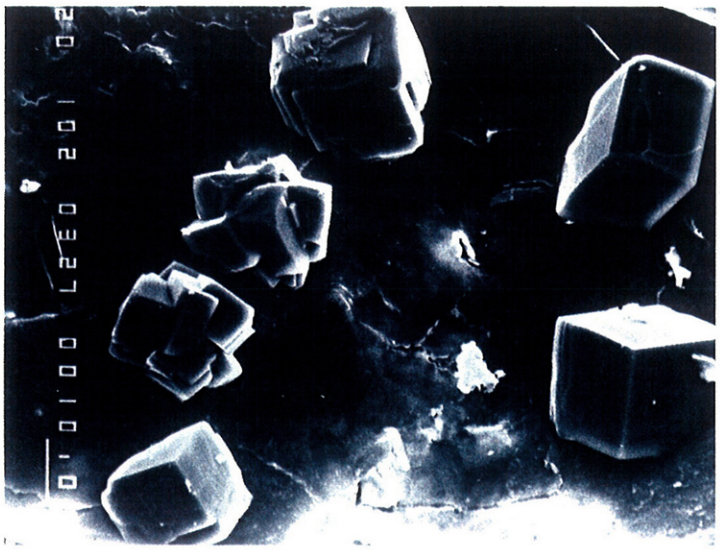
Stopping water intrusion

Concrete crystalline waterproofing the right choice for demanding projects.

By Les Faure



Below the water table, preventing the deterioration of concrete structures, a problem induced by water penetration, often needs to work both ways: stopping water from coming in, and protecting the concrete from corrosive water/vapor formed in the interior.

This double-edged objective was a top priority for Conrad Ettmayer, P.E., LEED AP, the structural engineer overseeing the three-phase construction of the Wisconsin Institutes for Medical Research (WIMR) at the University of Wisconsin in Madison. Ettmayer is principal and director of structural engineering at Harwood Engineering Consultants, based in Milwaukee.

The three project phases consist of three towers, the first of which serves as headquarters of the UW Carbone Cancer Center. The tower also is home to imaging sciences, with medical physics occupying the lower level and radiology on the first floor.

For Ettmayer, part of his attention focused on an underground concrete utility tunnel below the entire structure (including the tower's first two floors, which also are underground). The tunnel is completely submerged below the water table. The cruciform-shaped tunnel totals about 800 linear feet with internal dimensions averaging 8 feet-by-8 feet.

"When you have high-pressure steam lines, chilled lines and electric lines all winding through a tunnel where people have to walk, it would be dangerous from a safety standpoint for water to infiltrate through the concrete walls. Not to mention that water penetration can lead to concrete and interior steel corrosion," Ettmayer said. "At the same time, the lines themselves can produce water or humidity, which can attack the concrete from the interior."

Ettmayer and the general contractor, Oscar J. Boldt Construction, decided the challenge of rendering the tunnel watertight was beyond the capability of an exterior membrane alone, and wanted a "belt-and-suspenders" approach. They decided to formulate the tunnel's concrete with Xypex Admix C-1000 crystalline waterproofing admixture to prevent water intrusion.

The crystalline technology uses water in the capillary tracts as a diffusing medium to carry waterproofing chemicals into the concrete. The chemicals migrate through the waterways of the saturated pore network, where they react and grow non-soluble, needle-like crystals that plug the pores. Within a couple weeks of crystal growth, liquids can no longer pass through and the transmission of gases is significantly restricted. The effect is integral and permanent.

Jeff Niesen, vice president for construction management at Boldt, said the site of the project itself presented unique water challenges. "The variety of soils on-site couldn't easily be made to resist the groundwater pressure from the adjacent Lake Mendota – the surface of which is about level with the worksite – so they had to change the site dewatering method from suction to deep well," Niesen said.

FROM LEFT TO RIGHT:
By means of diffusion, the reactive chemicals in the crystalline technology use water as a migrating medium to enter and travel down the capillaries of the concrete. The process precipitates a chemical reaction between the crystalline chemicals, moisture, and the byproducts of cement hydration, forming a new non-soluble crystalline structure. This integral structure fills the capillary tracts, rendering the concrete waterproof.

The initial concern was that the tunnel, being submerged, could possibly float, thus endangering some of the research and medical care operations. To prevent that eventuality, the tunnel was overbuilt with extra-thick concrete casing for weight, to keep it from moving. Also, the concrete was formulated with the crystalline waterproofing admixture to prevent water intrusion.

Niesen said that seeing is believing.

"As expected, the tunnel's interior has remained dry," Niesen said. "The way the Xypex technology works allows you to see where it has done its job. You can actually see where the crystallization has occurred to plug a hairline crack."

Ettmayer said his engineering firm has started using crystalline waterproofing as a "standard operating procedure" for tunnels subject to the water infiltration risk. "I'm a believer in it," he said.

The crystalline technology also was recently used in another university-owned medical research and services building in Albuquerque, N.M.: The University of New Mexico's Tri-Services Laboratories building. The complete building measures 187,000 square feet. Adjacent to the University of New Mexico Health Sciences campus, the $86 million, five-story building (one story is partially below grade) will accommodate the New Mexico Department of Health Scientific Laboratory Division, the New Mexico Department of Agriculture Veterinary Diagnostic Services and the New Mexico Office of the Medical Investigator.
George H. Bradley, P.E., principal and senior partner at Chavez-Grieves Consulting Engineers, Inc. in Albuquerque, served as the project's structural engineer.

"The Tri-Lab building has a lower level that has full soil retaining at one end and no soil retaining at the other end of the building due to the slope of the site," Bradley said. "The architect was concerned about water intrusion into this lower level. Of course, waterproofing was provided at the outside of the concrete retaining walls as well as a vapor barrier below the slab-on-grade. However, since this building was a high profile state office building, he was looking for additional waterproofing to be certain of its success. We suggested that Xypex be utilized as an admixture in the concrete walls and the concrete slab-on-grade. It was utilized and as far as we are aware, it is performing satisfactorily."

Concrete waterproofing by crystallization – used in the construction industry for 40 years in more than 70 countries – takes advantage of concrete's inherent water permeability to deliver crystalline chemicals that plug the material's pores and bridge micro-cracks that occur as the concrete dries and shrinks.

The crystalline waterproofing technology can be easily introduced into new concrete as an admixture, a dry-shake product, or a surface-applied coating. For existing (i.e., cured) concrete, surface-applied coatings are used.

Because concrete is permeable to liquids and gases, porous conditions can create multiple problems within a building or other structure due to moisture penetration. The infiltrating water, and harmful chemicals dissolved within, also can compromise the concrete.

The key to waterproofing concrete as a means of corrosion-prevention in below-grade applications is density. This includes wastewater treatment plants. Paul Steward, P.E., vice president, structural engineering services, at Thatcher Engineering in Minneapolis, is a veteran of more than 50 WWTP projects, from new construction to forensic corrective work.

"When done right, concrete waterproofing by crystalline technology does an excellent job of densifying the concrete, making it more resistant to chemical attack," he said.

Concrete waterproofing by crystallization is generally less costly and more convenient than external barrier approaches. Crystalline waterproofing makes the construction process greener by eliminating the

A portion of the University of Wisconsin School of Medicine concrete was formulated with crystalline waterproofing admixture to prevent water infiltration.

Concrete waterproofing through crystallization was recently used in the construction of the University of New Mexico's Tri-Services Laboratories building in Albuquerque, which is partially below grade.

need for membranes manufactured with plastics, asphalt, polymer resins, solvents, aromatics and other materials with high energy manufacturing costs.

A November 2010 report about concrete waterproofing using crystalline technology (ACI 212.3R-10) by the American Concrete Institute noted that "the crystalline deposits develop throughout the depth of the concrete and become a permanent part of the concrete mass… (and) resist water penetration against hydrostatic pressure."

Concrete waterproofing using crystalline technology is an integral and permanent solution – as well as reliable, green and less costly. Concrete waterproofing by crystallization also provides everyone in the design and construction community, including structural engineers, one other important benefit: peace of mind.

Les Faure is the advertising and promotion director for Xypex Chemical Corporation (www.xypex.com). He has been working with crystalline concrete waterproofing for 25 years.