Concrete Waterproofing with Crystalline Technology

Crystalline chemicals improve concrete durability, lower maintenance costs, and extend building life cycles

Provided by Xypex

By Stanley Stark, FAIA

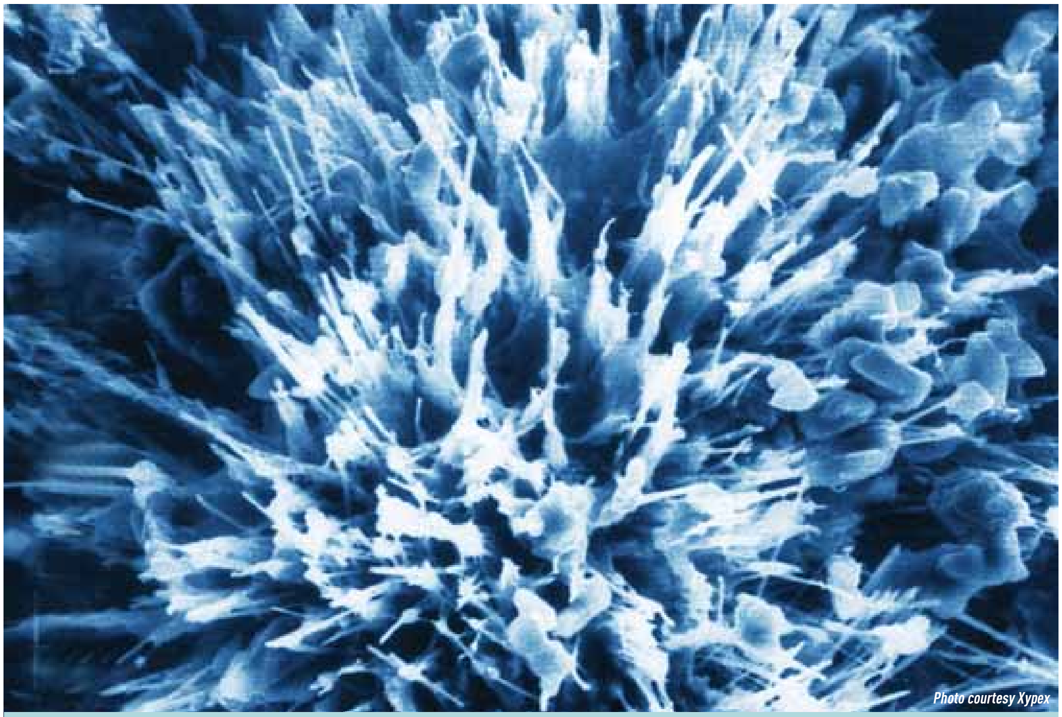

Photo courtesy Xypex

From foundations, floor slabs and exterior pre-cast panels, to water treatment facilities and underground urban infrastructure, concrete is one of the most commonly used building and construction materials. However, due to its composition, a mixture of rock, sand, cement, and water, concrete is often susceptible to damage and deterioration from water and chemical penetration.

These deleterious effects can be avoided through the use of crystalline waterproofing technology, which effectively improves the durability and lifespan of concrete structures, thereby reducing long-term maintenance costs. This article explores how crystalline technology provides a high level of performance to concrete mixtures, materials, and structures, and what design professionals need to know in order to specify and understand how this chemical technology will enhance building projects.

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CONTINUING EDUCATION

Use the learning objectives below to focus your study as you read **Concrete Waterproofing with Crystalline Technology.** To earn one AIA/CES Learning Unit, including one hour of health, safety, welfare credit, answer the questions on page 217, then follow the reporting instructions on page 225 or go to the Continuing Education section on *rchrecord.construction.com* and follow the reporting instructions.

LEARNING OBJECTIVES

After reading this article, you should be able to:

- *Understand how crystalline technology works with concrete to provide high performance waterproofing qualities.*
- *Explain the difference between porosity, permeability and the mechanics by which water is absorbed through concrete structures.*
- *Discuss how crystalline waterproofing technology improves the durability of concrete structures and reduces maintenance.*
- *Identify appropriate crystalline technology product applications for various types of concrete construction.*
- *Analyze how crystalline technology admixtures can impact building life cycle and project construction costs.*

The Nature of Concrete

The aggregate base of a concrete mixture is formed by rock and sand. This cement and water mixture creates a paste that binds the aggregates together. As the cement particles hydrate, or combine with water, they form calcium silicate hydrates. The mixture then hardens into a solid, rock-like mass.

Concrete is also a water-based product. To make this mixture workable, easy to place, and consolidate, more water than is necessary for the hydration of the cement is used. This extra water, known as the water of convenience, will bleed out of the concrete, leaving behind pores and capillary tracts. Although concrete appears to be a solid material, it is both porous and permeable.

Concrete is both porous and permeable.

Water reducers and superplasticizers are used to reduce the amount of water in the concrete mix, and maintain its workability. However, pores, voids, and capillary paths will remain in cured concrete and can carry water and aggressive chemicals into structural elements that will corrode steel reinforcement and deteriorate concrete, thus jeopardizing the structure's integrity.

The Porous and Permeable Nature of Concrete

Concrete is best described as a porous and permeable material. Porosity refers to the amount of holes or voids left in concrete, is expressed as a percentage of the total volume of a material. Permeability is an expression of how well the voids are connected. Together, these qualities allow pathways to form that allow the movement of water into, and through, along with the cracking that occurs due to shrinkage.

Permeability, a broader term than porosity, is the ability of liquid water under pressure to flow through porous material. Permeability is described by a quantity known as the permeability coefficient, commonly referred to as D'Arcy's Coefficient. The water permeability of a concrete mix is a good indicator of the quality of the concrete for durability reasons. The lower D'Arcy's Coefficient, that is, the more impervious, the higher the quality of the material. Nevertheless, a concrete with low permeability may be relatively durable but may still need a waterproofing agent to prevent leakage through cracks.

Despite its apparent density, concrete remains a porous and permeable material that can leak and deteriorate rapidly when in contact with water or the intrusion of aggressive chemicals, such as carbon dioxide, carbon monoxide, chlorides, sulfates or other substances. But there are other ways in which water can be transported through concrete.

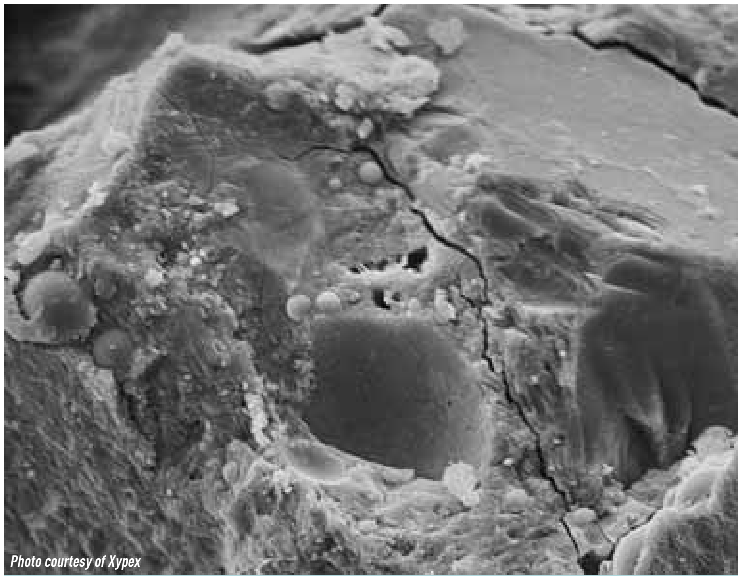

Photo courtesy of Xypex

Magnified view of microcrack.

Vapor Flow and Relative Humidity

Water also migrates in the form of water vapor as relative humidity. Relative humidity is water held in air as a dissolved gas. As water vapor heats up, it contains more water and exerts vapor pressure. Water can also be transported through concrete as vapor. The direction of flow travels from high vapor pressure, generally the source, to low vapor pressure, by a process of diffusion. The direction of flow could vary based on environmental conditions.

The direction of vapor flow is critical when applying waterproofing treatment in situations where an unbalanced vapor pressure gradient exists. Typical examples include:

- Applying a low vapor permeable membrane, such as a traffic deck coating over a damp concrete surface (even if the very top surface is dry) on a warm day will result in pressure vapor pressure build-up and pin-holing or blistering.
- Applying a coating or sealant to the outside of a building wall may trap moisture into the wall if the sealant is not sufficiently vapor permeable.
- Applying low vapor permeable flooring over a slab-on-grade where there is high subsurface moisture content may result in delamination of the flooring.

Generally, a low vapor permeable sealant or coating should not be placed on the downstream face of a building or structure. Either the vapor pressure or water pressure will act to damage and blister the membrane. Some types of coatings and water permeability reducing admixtures in the concrete accommodate considerable vapor movement, thus allowing them to be placed successfully on the downstream side. Primary examples are cement-based waterproof coatings and water permeability reducing admixtures.

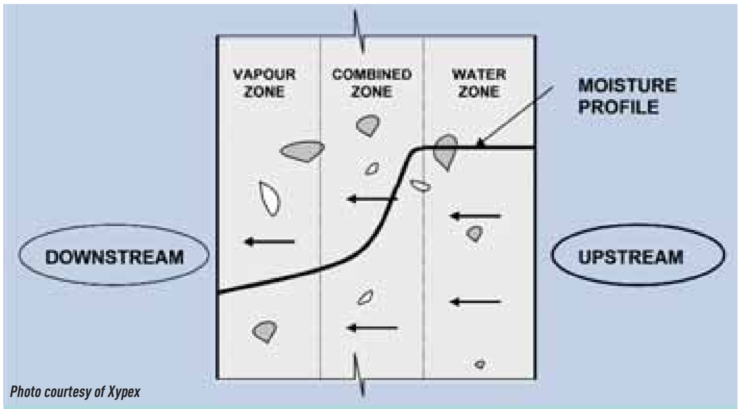

Photo courtesy of Xypex

Vapor flow through a foundation wall.

How Crystalline Waterproofing Technology Works

Crystalline technology improves the durability and performance of concrete structures, lowering their maintenance cost and extending their lifespan by protecting them against the effect of aggressive chemicals. These high performance qualities result from the ways in which the crystalline technology works, when used with concrete.

Crystalline waterproofing technology improves the waterproofing and durability of concrete by filling and plugging pores, capillaries, micro-cracks, and other voids with a non-soluble, highly resistant crystalline formation. The waterproofing effect is based on two simple reactions, one chemical and one physical. Concrete is chemical in nature. When a cement particle hydrates, the reaction between water and the cement causes it to become a hard, solid mass. The reaction also generates chemical by-products that lie dormant in the concrete.

Crystalline technology improves the durability and performance of concrete structures, lowering their maintenance cost and extending their lifespan by protecting them against the effect of aggressive chemicals.

Crystalline waterproofing adds another set of chemicals to the mixture. When these two chemical groups, the by products of cement hydration and the crystalline

Crystalline technology improves the waterproofing and durability of concrete by filling voids with a non-soluble, highly resistant crystalline formation.

chemicals, are brought together in the presence of moisture, a chemical reaction occurs. The end product of this reaction is a non soluble crystalline structure.

This crystalline structure can only occur where moisture is present, and thus will form in the pores, capillary tracts, and shrinkage cracks in concrete. Wherever water goes, crystalline waterproofing will form filling the pore, voids and cracks.

When crystalline waterproofing is applied to the surface, either as a coating or as a dry-shake application to a fresh concrete slab, a process called chemical diffusion takes place. The theory behind diffusion is that a solution of high density will migrate through a solution of lower density until the two equalize.

Thus, when concrete is saturated with water prior to applying crystalline waterproofing, a solution of low chemical density is also being applied. When crystalline waterproofing is applied to the concrete, a solution of high chemical density is created at the surface, triggering the process of chemical diffusion. The crystalline waterproofing chemicals must migrate through the water (the solution of low density) until the two solutions equalize.

The crystalline waterproofing chemicals spread through the concrete and become available to the byproducts of cement hydration, allowing the chemical reaction to take place. A crystalline structure is formed, and as the chemicals continue to migrate through the water, this crystalline growth will form behind this advancing front of chemicals. The reaction will continue until the crystalline chemicals are either depleted or run out of water. Chemical diffusion will take these chemicals about 12 inches into the concrete. If water has only soaked two inches into the surface, then the crystalline chemicals will only travel two inches and stop but, they still have the potential to travel 10 inches further, if water re enters the concrete at some point in the future and reactivates the chemicals.

Instead of reducing the porosity of concrete, like water reducers, plasticizers, and superplasticizers, the crystalline formation engages the material filling and plugging the voids in concrete to become an integral and permanent part of the structure.

Example of concrete deterioration caused rusting of the reinforcing steel.

Because these crystalline formations are within the concrete and are not exposed at the surface, they cannot be punctured or otherwise damaged like membranes or surface coatings. Crystalline waterproofing is highly resistant to chemicals where the pH range is between three and 11 under constant contact, and two to 12 under periodic contact. Crystalline waterproofing will tolerate temperatures between -25 degrees Fahrenheit (-32 degrees Centigrade) and 265 degrees Fahrenheit (130 degrees Centigrade) in a constant state. Humidity, ultraviolet light, and oxygen levels have no impact on the products ability to perform.

Crystalline waterproofing offers protection against the following agents and phenomena:

- Inhibits the effects of CO, CO2, SO2 and NO2, the gasses responsible for the corrosive phenomenon known as 'carbonation.' Carbonation is the process where exterior gasses create a corrosive phenomenon that softens the surface layers of the concrete. Carbonation testing shows that the multiplicative crystalline formations also reduce the flow of gases into concrete, thus significantly retarding the carbonation at the surface in which the alkalinity is reduced and the surface layer is softened.

Scanning electron microscope (SEM) view of a concrete pore before the application of crystalline waterproofing.

Scanning electron microscope (SEM) view of a concrete pore filled with multiplicative crystalline formation, initial stages.

- Protects concrete against alkali aggregate reactions (AAR) by denying water to those processes affecting reactive aggregates.
- Extensive chloride-ion diffusion testing shows that concrete structures protected with a crystalline waterproofing treatment prevent the diffusion of chlorides. This protects reinforcing steel and prevents deterioration that could occur from oxidation and expansion of steel reinforcement.

Michael Brown, P.E., principal with Golder Associates in Seattle, has used crystalline waterproofing in numerous applications, but notably on the Blackbird mine remediation project near Salmon, Idaho, which has very low pH acidic mine water flowing through concrete structures. "We use crystalline waterproofing technology as an additive to concrete to reduce permeability and provide protection for the epoxy coated reinforcing bar," said Brown.

The more traditional methods of protecting concrete, such as membranes and other coatings, may still leave it susceptible to water and chemical damage. Only with the addition of crystalline technology can the pores and microcracks that normally result from the process of setting and curing, allow concrete to be sealed.

Type of Construction and Appropriate Crystalline Technology Application

Crystalline waterproofing and protection technology is available in powder form and is mixed with water. Three different application methods include:

- Applied to the surface of an existing concrete structure, for example, a foundation wall or a floor slab.
- Mixed directly with the concrete batch at the plant as an admixture.
- Shaken as a dry powder, applied to green, or uncured, concrete and toweled into the surface.

Methods and Procedures of Crystalline Waterproofing Coating Applications

When applied to clean, bare and previously saturated substrate as a slurry mixture, the reactive chemical ingredients in crystalline waterproofing can penetrate up to 12 inches deep inside the concrete by using the water as the migrating solution in a process of chemical diffusion. As these chemicals penetrate through the capillaries and pores, the reaction with the mineral by-products of cement hydration creates the crystalline formation that fills the cracks or the pore.

Crystalline waterproofing can be applied by a brush or with spray-on equipment. To ensure the success of the application, care must go into the conditions under which the material is applied related to surface preparation, surface wetting, coat thickness, and curing time.

Because the crystalline waterproofing coating system has a unique chemical diffusing characteristic, proper surface preparation of the concrete is critical to the performance of the material. The concrete surface that will receive the crystalline waterproofing coating needs to have an open pore texture to allow the transfer of the reactive crystalline chemicals from the coating into the concrete substrate. The surface also needs to be clean and free of form oil, laitance and other foreign matter as this can potentially cause de-lamination of the coating.

The three common methods of concrete surface preparation are water blasting, sand blasting and acid etching. When water blasting, the pressure should be 3,000 pounds per square inch (psi) to 4,000 psi. Sand blasting is normally required when steel forms have been used and the concrete has a tight, mirror like finish. Acid etching can be accomplished using either muriatic acid or citrus-based products when the use of an acid is not environmentally acceptable.

Wetting the Surface

The coating systems require that the concrete be in a saturated, surface damp condition for the waterproofing to be effective. The active chemicals in the coating use water as a migrating or diffusing medium that allows the chemicals to transfer from the coating into the capillary tracts of the concrete. To make sure that concrete on vertical surfaces is saturated, wet the walls with clean water and allow the moisture to be drawn into the substrate for approximately ten minutes. Re-wet the walls a second time and allow to stand for 20 minutes.

In hot weather, when evaporation rates are high, it may be necessary to soak the concrete overnight. This can be accomplished using either soaker hoses on the top of the wall, that allows water to flow down the vertical surfaces, or a series of sprinklers can be used if the wall is less than 12 to 15 feet.

If water is not readily available on the job site, the saturation of the concrete should be done early in the morning, when evaporation rates are low and before the concrete begins to heat up. In difficult conditions of hot sun and wind, it is better to attempt small areas that can be controlled, rather than large areas at one time. In hot weather, the use of an evaporation retarder to help keep moisture in the concrete can be considered.

In cold weather, saturation of the concrete should only take place when the ambient temperature is going to be above 33 degrees Fahrenheit for 24 hours.

Coating Application

The crystalline waterproofing coating materials are mixed with water at a ratio of five parts powder to two parts water by volume for brush application, and five parts powder to three parts water by volume for spray application. The coverage rate is 1.25 to 1.5 pounds per square yard per coat. At this rate, a 60-pound pail of material will cover 360 to430 square feet, and a 50-pound bag will cover 300 to360 square feet of surface area.

Coatings can be applied by brush, hopper gun or specialized spray equipment. When using a standard six-inch masonry brush, one person can mix and apply approximately 80 to100 square feet per hour per coat. A hopper gun or texture gun uses a two-person crew with one person mixing material and the second person spraying. The gun uses a three-eighths inch nozzle and operates at roughly 25 psi. A two-person crew can apply the coating at a rate of 400 to500 square feet per hour per coat.

Specialized spray equipment is operated with a three-person crew. At application rates of 1200 to1500 square feet per hour per coat, it is necessary to have all materials pre-measured in order to keep up with the spray equipment capacity. When using this type of equipment, the best procedure is to pre-measure the powder into at least five or six large buckets (five gallon pails) and pre-measure the water. This is done on the basis of five parts powder to three parts water by volume.

On vertical surfaces, the standard application procedure is to start at the top of the wall and work down. When using spray equipment, the first coat of material can be back-brushed using a 20-inch wide janitors broom with a soft bristle or a finisher's broom. This helps ensure an even coverage rate and minimizes any run down of the coating.

When a second coat is specified, it needs to be applied no later than 48 hours after the first coat. Under normal conditions, the crystalline waterproofing coating will begin to set up in two to three hours and application of the second coat can be done at this time. If the first coat has dried out, it should be lightly moistened with water prior to the second coat being applied. Failure to do so may result in lack of bond between the two coats.

When applying the coating materials to a concrete structure, it is better to break the job up into manageable segments rather than try to complete large areas at one time. This becomes even more critical when the weather is hot or windy. ■

CLICK FOR ADDITIONAL REQUIRED READING

The article continues online at ***archrecord.construction.com/resources/conteduc/archives/0601xypex-1.asp***. To receive AIA/CES credit, you are required to read this additional text. The quiz questions below include information from this online reading. To receive a faxed copy of the material, call Xypex Chemical Corp. at 800-961-4477.

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INSTRUCTIONS

Refer to the learning objectives above. Complete the questions below. Go to the self report form on page 225. Follow the reporting instructions, answer the test questions and submit the form. Or use the Continuing Education self report form on *Record's* website—*archrecord.construction.com*—to receive one AIA/CES Learning Unit including one hour of health, safety, welfare credit.

QUESTIONS

1. Porosity is a measure of:
a. Density
b. Voids as a percentage of volume
c. Liquid flow rate
d. Relative compressive strength
e. Unit weight

2. Concrete is permeable and porous due to:
a. Poor workmanship
b. Insufficient curing time
c. Incorrect concrete mix
d. Voids created by water in the mix and cracking due to shrinkage
e. Flaws in the formwork

3. Concrete surface coatings and membranes susceptible to all of the following except which?
a. Puncture
b. Deterioration and wear
c. Blistering
d. Delamination
e. Poor adhesion

4. D'Arcy's Coefficient is an indicator of:
a. Permeability
b. Porosity
c. Density
d. Design strength
e. Deflection

5. Crystalline technology offers protection against all of the following except which?
a. Carbonation
b. AAR
c. Chloride ion diffusion
d. Oxidation due to water penetration
e. Heat migration promoting cracking

6. Crystalline technology works by which mechanism?
a. Plugs holes and voids with a solid cement material
b. Reacts with concrete to fill voids and cracks with crystalline growth
c. Shifts aggregate material into the voids
d. Fill voids with a plastic water resistant material generated by chemical reaction
e. Seals openings and channels within 2" of the surface

7. Carbonation is the process where:
a. Air bubbles form within the concrete
b. Carbon migrates from reinforcing steel to the surface staining the concrete
c. Exterior gasses create a corrosive phenomenon, which soften the surface layers of the concrete
d. Steel reinforcement oxidizes.
e. Water is trapped within the concrete

8. Crystalline waterproofing surface application can penetrate up to:
a. 12 inches
b. 10 inches
c. 8 inches
d. 4 inches
e. 2 inches

9. For surface crystalline waterproofing applications under normal conditions, the treated surface should be:
a. Sprayed six times a day
b. Sprayed three times a day for two to three days to prevent premature drying
c. Maintained in a saturated condition for two days
d. Saturated for one day, sprayed three times daily for the next day
e. Saturated for only one day only

10. The major threat created by the diffusion of chlorides is:
a. Surface delamination
b. Reduction of the bond between cement and aggregates
c. Increase in the volume of voids in the concrete
d. Softening of the concrete
e. Oxidation and expansion of steel reinforcement

Curing

Moist curing of the waterproofing system is essential for proper performance and is extremely important for two reasons. First, it uses water as a diffusing medium, which allows the reactive chemicals to transfer from the coating into and through the saturated concrete substrate. If adequate curing of the crystalline waterproofing does not take place,evaporation will first dry out the coating and then begin to pull moisture from out of the concrete. As the concrete substrate dries out, it will prevent further chemical transfer from occurring, crystallization will not take place and thus no waterproofing effect will be achieved. Second, crystalline waterproofing uses a sand and cement coating as a carrying agent for the active chemicals, and it is necessary to properly cure the coating so that it hardens and bonds properly to the concrete. Curing of the treatment is achieved either by spraying with water or through the use of a specialized evaporation retardant.

Curing the crystalline waterproofing coating should begin as soon as it has hardened sufficiently, so as not to be damaged by a fine spray. Under normal conditions, the treatment will be ready for moist curing two to three hours after application. This is accomplished by misting with a fog spray of clean water at least three times a day for two to three days to prevent early drying.

In warm climates or on hot windy days, more curing will be required to keep the coating from drying out. This can be done by misting the coating five or six times per day for two to three days. Curing should be carried out is if 70 percent of the coating is dry and 30 percent is still damp. In this case, then the next fog spray should be applied.

During the curing period, protect treated surfaces from damage by rain, frost, and freezing temperatures. If plastic sheeting is used for protection, it must be raised off the waterproofing coating to allow sufficient air circulation. The overall process of crystalline formation may take two to three weeks to reach full maturity.

Use of Crystalline Waterproofing as an Admixture for Concrete

Adding crystalline waterproofing treatment to the concrete mix at the batch plant ensures that the crystalline formation occurs uniformly throughout the structure, rather than penetrating from the surface, as would be the case with a surface application. This admixture reduces the water loss, resulting in less shrinkage and increased compressive strength. When the technology is used as an admixture, the same chemical reactions take place. However, the construction cost is significantly reduced, because the labor associated with a surface treatment application is eliminated.

The crystalline waterproofing admixture is added to concrete at the time of batching. The sequence of procedures for addition will vary according to the type of batch plant operation and equipment. For most mixtures, the dosage rate is two to three percent, based on the Portland cement content.

While crystalline waterproofing admixtures are compatible with superplasticizers, air entraining agents, water reducers, fly ash, and other ingredients may be used to improve the performance of modern concrete mixes. When specifying crystalline waterproofing as an admixture, design professionals should verify that all elements in the concrete mix are compatible with each other.

Dry-Shake Application of Crystalline Waterproofing for New Slab Construction

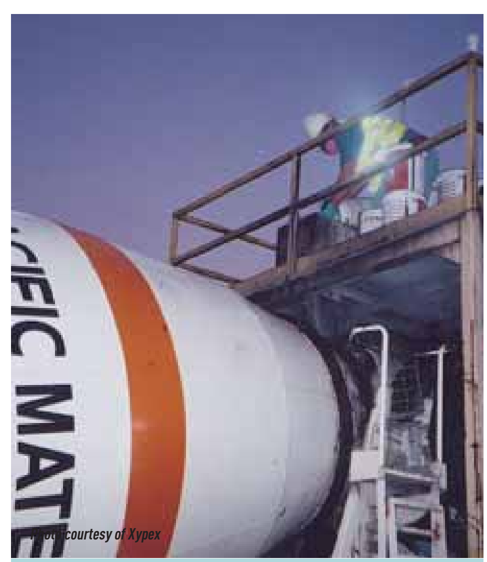
Crystalline waterproofing can also be applied by the dry-shake application method, like floor hardeners to new slabs while under construction. This process requires the crystalline powder compound to be sprinkled onto the surface of slabs with the use of a mechanical spreader after concrete is placed, consolidated, and leveled. The powder is then worked into the surface of the slab during the normal finishing process with a power trowel. Crystalline waterproofing is also available combined with synthetic floor hardeners to both waterproof and harden floor slabs. Typical applications for the dry-shake application are basement slabs and warehouse floors.

Negative Side Waterproofing

Existing basements that are subject to water seepage or vapor transmission through foundation walls and floors can be treated by the application of crystalline waterproofing and protection on the negative side, or the inside, of the structure. Surface coatings will blister and peel when moisture seeping through the concrete dissolves soluble minerals and deposits them on the surface, under the coating, in the form of efflorescence, a white powdery substance that forms on the wall surface. Because crystalline waterproofing penetrates into the concrete, plugging the pores beneath the surface, it does not depend on surface adhesion and will not blister and peel off, like surface barriers. "I specify crystalline waterproofing on virtually every one of my projects as an admixture for the retaining side of walls where applied membranes cannot be used," says Mel Cole, FCSI, an architectural specifier in Soquel, California.

Brushed on surface application

Sprayed on surface application.



Added to the concrete mix

Vapor transmission through basement floors and walls is a common problem that may lead to damp, musty odors. Testing has shown that the application of multiplicative crystalline technology under these conditions will reduce vapor flows as much as 50 percent, which in most cases, will result in a drier environment.

Three Case Studies

The effective use of crystalline waterproofing technology products is illustrated by the following projects.

As an admixture

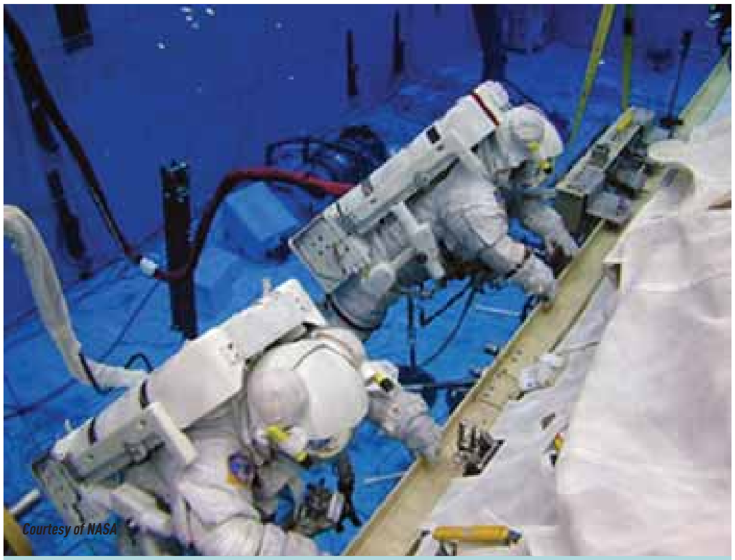
The triple tower development designed by architect Hijjas Kasturi as a new headquarters building for Maybank in Kuala Lumpur, Malaysia involved diaphragm wall construction, incorporating a nine level underground parking garage. A crystalline technology admixture was selected to control of the heat of hydration, reduce shrinkage cracking, give the slab enduring 'self healing' capacity, waterproof the concrete, and increase strength and durability. Peak temperature for the first mass pour was approximately 69 degrees Centigrade, and the differential temperature was approximately 12 degrees Centigrade.

The basement slab required approximately 24,000 cubic meters of the admixture, dosed masscrete, or a large volume concrete pour. In September 1997, the initial pour of approximately 13,200 cubic meters was conducted over a 60-hour period. This project was the third largest continuous concrete pour conducted in the world, and the largest in Southeast Asia.

Excavation and diaphragm wall for Maybank Headquarters, in Kuala Lumpur, Malaysia. Architect: Hijjas Katsuri; courtesy Xypex.

As an Applied Product

For the National Aeronautics and Space Administration (NASA) Neutral Buoyancy Tank, a two-coat application of white crystalline waterproofing was applied to the 50,000 sq. ft. Lab Tank. This tank is used to train astronauts for space walks necessary during construction of the space station. The white crystalline waterproofing treatment was chosen as a replacement for a white pool paint finish because of its longer life span and lower maintenance requirements. McDonnell Douglas performed the design work prior to their acquisition by Boeing.



NASA Neutral Buoyancy Tank. Courtesy of NASA.

As a Dry-Shake Application

The slabs of the a 110,000 sq. ft. distribution facility for Duracell in Cleveland, Tennessee, were waterproofed with a dry-shake application of crystalline waterproofing incorporating a floor hardener to increase the abrasion resistance of the floor to fork lift traffic.

Other Applications

The material produced in dry powder from crystalline waterproofing products reduces shrinkage and cracking to a wide range of other concrete elements. Crystalline technology can improve the performance of bagged mortar mixes, stuccos, and concrete. The performance of precast concrete panels, as well as precast elements, such as pipes, box culverts, and manholes can also be enhanced.

Conclusion

Although concrete may appear to be a simple product to put together, it requires a highly engineered approach. In an increasingly competitive design and construction environment, where high performance requirements, such as longer life cycles, more durable concrete, and value engineering are expected, careful consideration must be paid to basic requirements, such as the concrete, water, and cement ratio; cementing materials, and more sophisticated chemical admixtures.

Effective use of crystalline waterproofing technology will reduce the porosity and permeability of conventional concrete, and provide the high performance advantages and benefits that building owners and design professionals have come to rely upon in design and construction projects.

GLOSSARY

Admixtures – These are chemical ingredients that can be included in a concrete mix to enhance performance and modify characteristics. They include plasticizers, water reducers, set retarders and accelerators.

Aggressive chemicals – These include a wide range of chemicals that often come in contact with concrete. Examples include chlorides in coastal zones, sulfates often found in soils, and effluents in wastewater.

Calcium silicate hydrate – A substance formed by the hydration of cement in concrete and is the material that binds aggregates together.

Cement – Cement is a substance, when mixed with water, forms a paste that brings together the other elements of the concrete mixture (aggregates, sand, steel reinforcement) and hardens into a rock-like mass. Hydraulic cement specifically hardens with water. Portland cement is the general type of cement used in construction and has calcium sulfate as a prime component.

Chlorides – Salts that will penetrate concrete structures carried by moisture in coastal zones or de-icing salts.

Delamination – A process that occurs when a surface application of crystalline waterproofing does not adhere properly to a concrete surface. Delamination is usually due to improper surface preparation, inadequate wetting of the substrate or premature drying in hot weather.

Efflorescence – A substance caused by the deposit of soluble salts and calcium on the negative side of concrete surfaces after they have been carried to the surface by moisture flow through the concrete.

Green concrete – Refers to concrete that has reached an initial or final set but is not yet fully cured. Concrete will remain green for 7 to 28 days.

Heat of hydration – This refers to the heat generated by the reaction (hydration) of Portland cement and water. In mass concrete pours, this reaction can generate very high temperatures. Ice is sometimes used in concrete mixes to reduce the heat produced by hydration.

Laitance – Is the result of a process during which a layer of weak nondurable material (cement plus small aggregate particles) is brought by bleeding water to the surface over wet concrete.

Masscrete or mass concrete – This is concrete poured in very large volumes. Examples include thick slabs, large retaining walls, and dams. When concrete is poured in a large mass, the heat of hydration will generate large temperature releases, followed by rapid cooling resulting in shrinkage and cracking. Coolant systems, admixtures, retarders, and crystalline technology waterproofing all play a role in overcoming these problems.

Plasticizers – Chemical ingredients used to improve the workability of concrete mixes without resorting to adding more water to the mix.

Retarders - Set retarders are used in hot weather to delay the initial set of concrete mixes.

Saturation level – Refers to the amount of water in concrete, expressed as a percentage of the porosity or void space.

Slurry mixture – This is a mixture of water and any finely divided insoluble material like Portland cement or aggregates in a suspension. The advantage of a slurry mixture is that it flows easily.