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Analysis of Integral Crystalline Waterproofing Technology for Concrete

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Abstract - *Concrete is one of the most commonly used construction material due to its versatility. It is one of the most durable building material which also provides superior fire resistance as compared to wooden construction and gains strength overtime. However, heterogeneous material composition makes it porous and susceptible to damage due to accession of moisture and other chemicals. Water infiltration, chloride diffusion and chemical attack can cause rapid structure deterioration that will lead to expensive repairs and even compromise the structural integrity, thereby, making concrete waterproofing of paramount importance. Traditional methods of protecting concrete typically involve the application of coatings but these are not effective for long time period as these deteriorate over time losing their adhesion to the surface and ultimately failing. A more effective and efficient way to waterproof concrete is to use its own permeability as a delivery system for waterproofing chemicals; a technology called Crystalline Waterproofing. This method plugs the concrete's natural porosity and bridges cracks with a non-soluble crystalline formation that becomes an integral part of the structure. This paper gives an insight into the mechanism, testing, application and advantages of crystalline waterproofing systems for concrete.*

***Key Words*: Admixture, concrete, coatings, crystalline, diffusion, moisture, waterproofing**

1. INTRODUCTION

Concrete is a mixture of rock, sand, cement, and water. The rock and sand form the aggregate base for the concrete, and the mixture of cement and water provides a paste which binds the aggregates together. As the cement particles hydrate and form calcium silicate hydrates, the whole mixture hardens into a rock-like mass. This process also produces soluble minerals such as calcium hydroxide, which lie dormant in the concrete.

Some quantity of water more than that required for the hydration of the cement is used to make the mixture workable. This extra water will bleed out of the concrete, leaving behind pores and capillary tracts which would permit the ingress of water and dissolved chemicals, thus allowing corrosion of the steel reinforcement and deterioration of the structure. Therefore, concrete is best described as porous and permeable material.

Porosity refers to the amount of voids left in concrete and is expressed as a percentage of the total volume. Permeability, on the other hand, is a numerical expression of the interconnection of voids and is the ability of liquid water to flow through porous material under pressure. It is measured 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 and durability of concrete structures. The lower the D'Arcy's Coefficient, the more impervious and higher quality the concrete. Although concrete with a low porosity may be relatively durable, it may still need a waterproofing agent to prevent leakage through cracks.

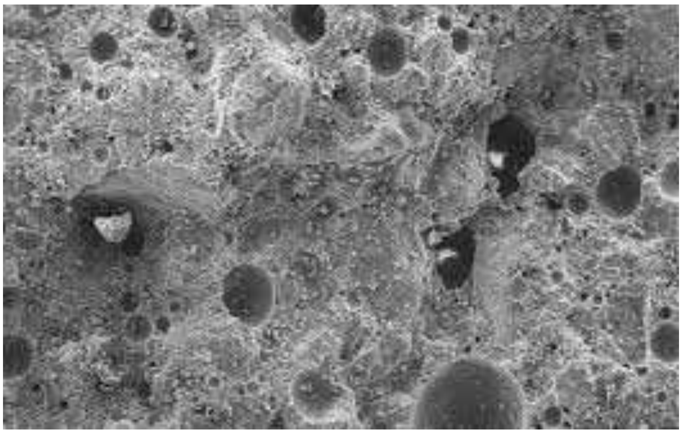

Fig. 1: A 5000 times Scanning Electron Microscope (SEM) Photograph of Concrete

Despite its apparent density, concrete remains a porous and permeable material that can deteriorate rapidly when in contact with water or the intrusion of aggressive chemicals, such as chlorides, sulfates and other substances. But there are other ways in which water can be transported through concrete which include macro cracks, micro cracks, capillary voids and in the form of water vapor by diffusion.

2. CONCRETE DETORIATION

Concrete deterioration can be due to adverse mechanical, physical, or chemical causes. It is often the case where one or more deteriorative mechanisms are at work by the time a problem is identified. In fact, in terms of deterioration of concrete due to physical or chemical causes, the mobility of fluids or gases through the concrete are nearly always involved. Important degradation mechanisms in concrete structures include the following:

2.1 Reinforcing Steel Corrosion

One of the biggest problems caused by water ingress into concrete structures is corrosion of reinforcing steel. This process is accelerated when chlorides are dissolved in water from de-icing salts or a marine environment. Rusting reinforcing steel expands manifolds its original size and creates pressures exceeding concrete's tensile strength.

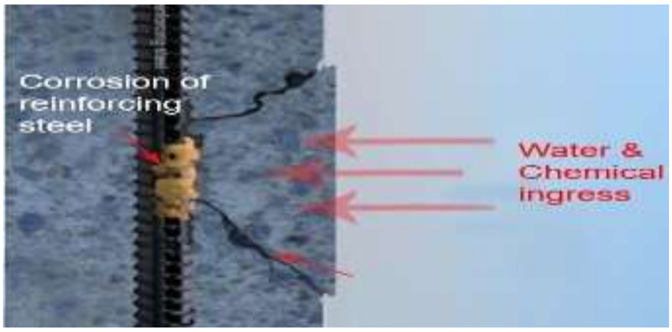

Fig. 2 : Corrosion of Reinforcing Steel

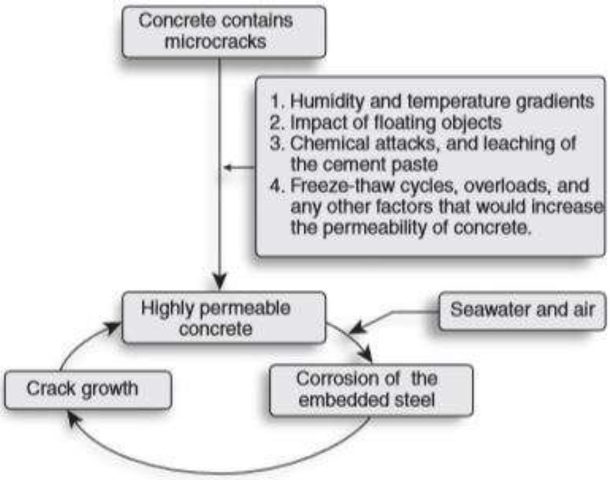

Fig. 3 : Diagrammatic presentation of damage to concrete from corrosion of reinforcement [1]

2.2 Freeze-Thaw Damage

When water freezes, it expands about 9%. As the water in moist concrete freezes, it produces pressure in the pores of the concrete. If the pressure developed exceeds the tensile strength of the concrete, the cavity will dilate and rupture. The accumulative effect of successive freeze–thaw cycles and disruption of paste and aggregate can eventually cause expansion and cracking, scaling, and crumbling of the concrete.

Fig. 4 : Freeze Thaw damage to concrete

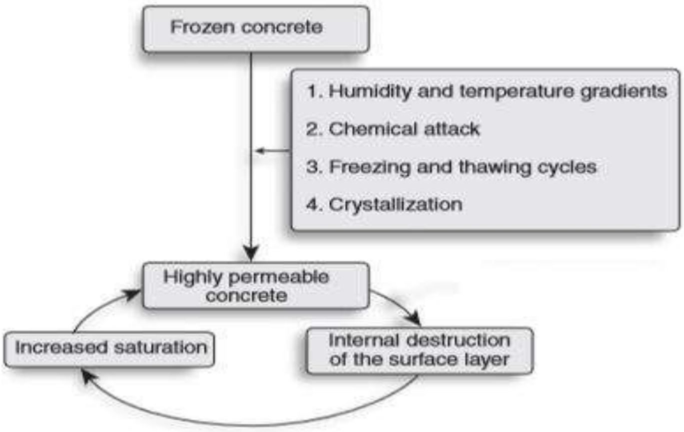

Fig. 5: Diagrammatic presentation of damage to concrete from cycles of freezing and thawing [2]

2.3 Alkali Aggregate Reaction

Alkali–silica reaction (ASR)/alkali–aggregate reaction (AAR) is a chemical reaction which takes place in aggregate particles between the alkaline pore solution of cement paste and silica in the aggregate. The reaction products occupy more space than the original silica, so surface reaction sites are put under expansive pressure.

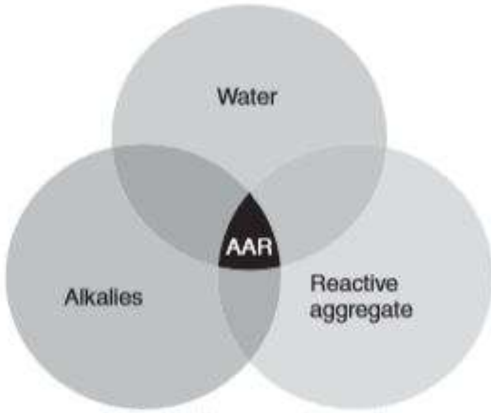

Fig. 6: Diagrammatic presentation of damage to concrete from alkali silica reaction [3]

At a certain point in time, the tensile stresses may exceed the tensile strength of the concrete, and cracks are formed. The alkali– silica reaction is the most common form of alkali–aggregate reaction, and in some areas, you can even get an alkali–carbonate reaction, which is a rare form of attack by an alkaline pore solution on certain types of dolomitic limestone.

2.4 Sulphate Attack

The deterioration of concrete structures is accelerated when aggressive chemicals such as sulfate salts (sulfates of sodium, potassium, calcium, or magnesium) found in soil or dissolved in groundwater and seawater penetrate concrete, causing an expansive reaction which attacks the cementing materials.

Fig. 7: Spalling of concrete due to sulfate attack

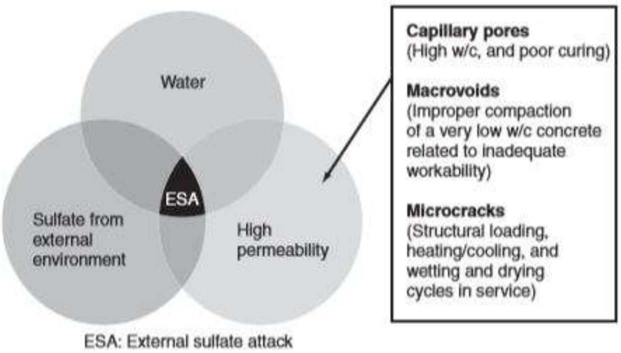

Fig. 8 : Diagrammatic presentation of damage to concrete from external sulfate attack [4]

3. CONCRETE WATERPROOFING

Water is the most destructive weathering element of concrete structures; water continues to damage or completely destroy more buildings and structures than natural disasters. Waterproofing techniques preserve a structure's integrity and usefulness through an understanding of natural forces and their effect during life cycle by placement of a barrier or membrane between the concrete and water. Internal membranes are created with waterproofing admixtures. External membranes are applied to the surface of the concrete nearly always on the positive side.

3.1 External Waterproofing Membranes

External membranes are divided into two sub-categories i.e. fluid applied membranes and sheet membranes

3.1.1 Fluid Applied Membranes

Fluid-applied waterproof products are liquid coatings containing a base of urethanes, rubbers, plastics, vinyl's, polymeric asphalts, or combinations thereof, which are applied to the surface usually by spraying or rolling.Fluid-applied membrane applications require that the termination of the membrane be carefully completed to prevent disbanding at the edge and potential water infiltration. Blistering will occur if materials are applied to wet substrates or if water finds its way behind the membrane since they are no breathable coatings.

Fig. 9: Fluid Applied Membrane

Fig. 10: Blistering of Fluid Membrane

The disadvantages of fluid membranes include:

a. Installation errors
b. Easily punctured during backfill
c. Specialty applicator, equipment, and expertise required
d. Breach affects integrity of entire system
e. Repair after failure requires excavation
f. Deteriorate over time
g. High carbon footprint
h. Require dry substrate
i. Require smooth surface

3.1.2 Sheet Membranes

Sheet membrane products are normally made from thermoplastics, vulcanized rubbers, and rubberized asphalts. The sheeting membranes can be applied as fully bonded to the substrate or un bonded. In either case, sheets must be overlapped and bonded to each other by adhesive or by heat welding. One exception is bentonite, which is a clay that swells when wet. It comes in sheets that are often just laid next to one another without being bonded. Apart from bentonite, most sheet membranes tend to be more durable than fluid applied membranes. They have a consistent thickness and will bridge openings in the concrete.

Fig. 11: Installation of sheet membranes

The disadvantages of sheet membranes include:

a. Prone to installation errors
b. Breach affects integrity of entire system
c. Repair after failure requires excavation
d. Deteriorate over time
e. High carbon footprint
f. Requires dry substrate for 28 days out before application,
g. Requires smooth surface for application

Fig. 12: Damaged sheet membrane

3.2 Internal Waterproofing

Internal waterproofing, also known as integral waterproofing, are products that perform their function within the pores of the concrete as opposed to on the surface. These products are designed either to migrate into the concrete from a surface applied carrier or are mixed right into the concrete during its production.

Integral waterproofing has the significant advantage of being extremely durable. Because they do not rely on preserving a continuous surface film, they are not subject to puncturing, tearing or abrasion. They are seamless and generally not reliant on skilled or careful workmanship in order to perform at their best. The admixture variety in fact require almost no labor at all and eliminate the need to schedule access and application time during construction.

Integral waterproofing products can be broadly categorized as belonging to one of two major groups: reactive or un-reactive.

3.2.1 Unreactive Products

Examples of unreactive products include sodium silicate, bentonite, water repellents, pozzolans and other SMC's. Some of these may have a reactive effect during the hardening of new concrete, but they do not reactivate in the presence of water so as a waterproofing agent they are considered unreactive. They function by simply densifying the concrete. Along this same vein, water reducing admixtures sometimes also claim to produce waterproof concrete.

The un-reactive products attempt to produce waterproof concrete by reducing its permeability to the point where water cannot flow through. However, they are inadequate when it comes to dealing with the inevitable joints and cracks that result in all concrete construction.

3.2.2 Reactive Products

Reactive products, on the other hand, are able to create truly waterproof structures because they can address moisture penetration through cracks and joints in addition to the mass concrete. They will respond to moisture by forming new chemical compounds with grow to seal off the incoming moisture. Essentially, all truly reactive products are crystalline in nature and grow crystal formations to block cracks, pores etc.

4 CRYSTALLINE WATERPROOFING TECHNOLOGY

4.1 Introduction

Crystalline waterproofing is manufactured in the form of a dry powder compound which comprises of Portland cement, very fine treated silica sand, and proprietary chemicals. Its applied as a coating material, admixture and dry shake. Crystalline Waterproofing Technology enhances the durability of concrete structures by pore-blocking mechanism, where in the pores, capillaries and micro-cracks in the concrete are blocked with a non-soluble, crystalline formation.

4.2 Waterproofing

Crystalline products contain special additives, which react with the by-products of cement hydration i.e. calcium hydroxide, sulphates and carbonates of sodium potassium and calcium as well as un-hydrated or partially hydrated cement particles, in the presence of moisture, initiating a chemical reaction producing a non-soluble crystalline formation. This crystalline formation occurs only in areas having presence of moisture. Thus it will form only in the pores, capillary tracts, and shrinkage cracks of the concrete. In the absence of moisture, these chemicals remain inactive in the pores of concrete.

4.3 Chemical Diffusion

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.

When concrete is saturated with water prior to applying crystalline waterproofing, a solution of low chemical density is placed in the pores, capillaries and other voids. When crystalline waterproofing is applied to the concrete, a solution of high chemical density is placed on 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.

4.4 Chemical Reaction

The crystalline waterproofing chemicals spread through the concrete and become available to the by-products 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 can take these chemicals to a depth of 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.

Fig. 13: Scanning electron microscope (SEM) view of a concrete pore filled with multiplicative crystalline formation, initial stages

4.5 Crystalline Structure Formation

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

Fig. 14 By-products of cement hydration precipitate in capillary tracts + Crystalline reactive chemicals = Crystalline initiation

Fig. 15 Fully developed crystalline structure

4.6 Crystalline Structure Penetration

Under ideal conditions, the reaction produced by the application of crystalline waterproofing materials on the concrete's surface can occur to a depth of 12 inch. This was demonstrated in Japan where a block of cast-in-place concrete approximately 16" square and 16" thick was produced. The concrete had a water/cement ratio of 0.65 to ensure that there was an extensive capillary system. A crystalline waterproofing coating was applied to the top side and the concrete block and was left outside under ambient conditions for 12 months. Full depth cores were taken and sliced into 2 cm slices and examined under an electron microscope. Crystallization had taken place up to 12" from the surface.

Fig. 16: Crystalline waterproofing on concrete surface

4.7 Crystalline Properties

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.

4.8 Advantages

Crystalline waterproofing system offers the following advantages:

a. Replaces unreliable exterior membrane systems
b. Penetrates deep into concrete-many inches over time
c. Self-seals hairline cracks-minimum .5 mm (.02 in.)
d. Reactivates in the presence of moisture-even years later
e. Effective against hydrostatic pressure-up to 140 m (460 ft) of head pressure
f. Waterproofs from any direction (i.e. positive or negative side)
g. Impervious to physical damage and deterioration

h. Easy to apply and reduces potential for human error
i. Due to the non-toxic nature of the material it can also be used for potable water storage areas.

4.9 Durability and Performance

4.9.1 Testing

Crystalline waterproofing has been extensively tested by independent testing laboratories in North America and around the world.

4.9.1.1 Permeability

Hydrostatic water pressure tests such as the U.S. Army Corps of Engineers CRD C 48-73"Permeability of Concrete," which measures the amount of "throughput," and DIN 1048-5 "Testing concrete; testing of hardened concrete," which measures the depth of penetration, are the most effective at demonstrating the effectiveness of crystalline waterproofing technology.

The appropriate apparatus for the CRD C 48-73 "Throughput Method" procedure is shown (Figure 17) where water pressure is applied to the top face of the specimen in a sealed pressure cell. Any leakage through the specimen can be collected and measured from the opposite face, which is exposed. Permeability testing results using this method show that crystalline waterproofing treated samples are completely sealed up to a pressure of 405 feet of water head (175 psi), which is the limit of the test apparatus. [5]

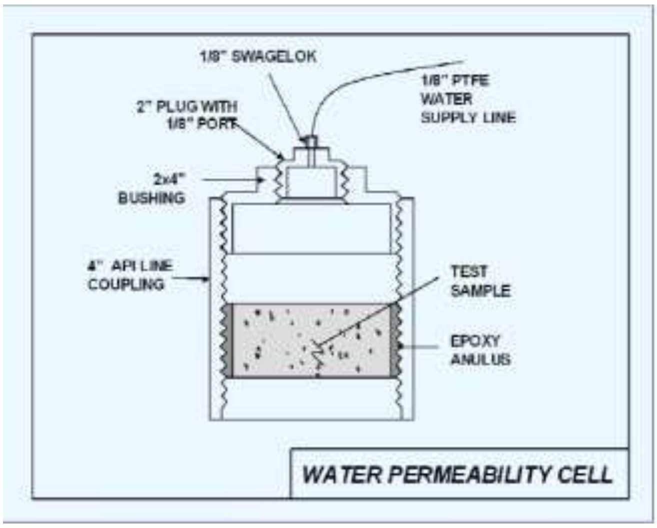

Fig. 17: Apparatus for the CRD C 48-73 "Throughput Method" for determining permeability

In this test (CRD C 48-73) six crystalline admixture treated samples and six untreated concrete samples were tested for water permeability. Increasing pressure was applied in increments over seven days and then maintained at seven bars (224 ft. head of water) for ten days. Five of the six reference samples showed water flowing through on the sixth day and increasing throughout the test period. The results of this test, completed in Singapore, showed zero flow of pressurized water through the concrete sample treated with crystalline admixture, in comparison to significant flows through five of the control samples.

Sample Reference		Control Concrete						Treated Concrete					
Date of Cast		22/01/97						14/01/97					
Date of Coring		30/01/97			20/02/97			22/01/97			2/12/97		
Age of Curing (days)		8			29			8			29		
Specimen Size (mm)		150 x 50						150 x 50					
Specimen Reference		1	2	3	1	2	3	1	2	3	1	2	3
Volume of water moving through the sample (mL)													
At 1 bar on	1st day	0	0	0	0	0	0	0	0	0	0	0	0
At 2.4 bar on	2nd day	0	0	0	0	0	0	0	0	0	0	0	0
At 4.2 bar on	3rd day	0	0	0	0	0	0	0	0	0	0	0	0
At 7.0 bar on	4th day	0	0	0	0	0	0	0	0	0	0	0	0
	5th day	10	0	4	10	0	0	0	0	0	0	0	0
	6th day	30	20	25	74	13	0	0	0	0	0	0	0
	7th day	65	20	60	78	20	0	0	0	0	0	0	0
	8th day	70	30	60	45	10	0	0	0	0	0	0	0
	9th day	70	30	60	35	10	0	0	0	0	0	0	0
	10th day	70	30	60	46	10	0	0	0	0	0	0	0

Fig. 18: Hydrostatic Water Pressure Test - CRD C 48-73 - U.S Army Corps of Engineers

In DIN 1048 permeability test, the depth of pressurized water penetration in the untreated control concrete samples on the left exceeded the maximum 50mm permitted by the DIN standard. Water penetration in the crystalline treated samples on the right was only a few millimeters. All samples were 27.5 Mpa (4,000 psi) concrete. [6]

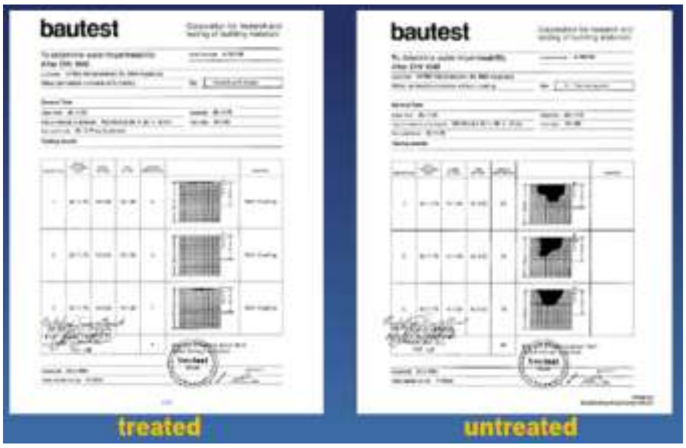

Fig. 19: DIN-1048 permeability test

4.9.1.2 Compressive Strength Testing

Crystalline waterproofing improves compressive strengths by approximately 5% -10%. Klienfelder's laboratory in California evaluated the compressive strength on concrete containing crystalline admixture. Samples were procured from a parking deck in Los Gatos. At 28 days the compressive strength of the crystalline admixture sample measured 7160 psi as compared to the control sample which had a compressive strength of 6460 psi (44 MPa). At 56 days the compressive strength of the admixture sample measured 8340 psi compared to the control sample at 7430 psi.

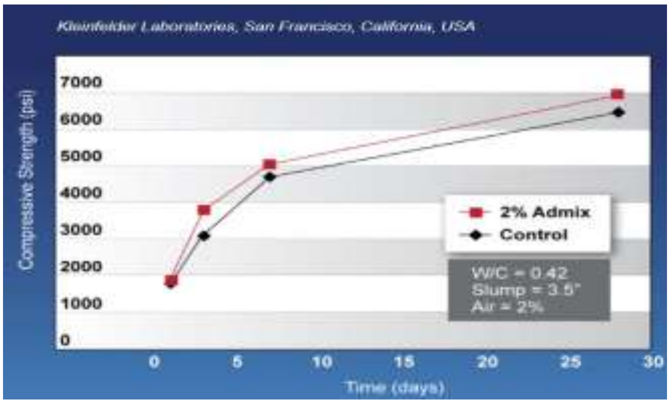

Fig. 20: Compressive strength test of Crystalline waterproofing applied concrete vs normal concrete

4.9.1.3 Chemical Durability Testing

Crystalline waterproofing protects concrete against alkali aggregate reactions (AAR) by denying water to those processes affecting reactive aggregates. Extensive chloride-ion diffusion testing performed at Australian Centre for Construction Innovation, University of New South Wales, Sydney 2003 also shows that concrete structures protected with a crystalline waterproofing treatment prevent the diffusion of chlorides. This protects the reinforcing steel and prevents deterioration that could occur from oxidation and expansion of the steel reinforcement. Crystalline addition increases time to corrosion by a factor of 5.

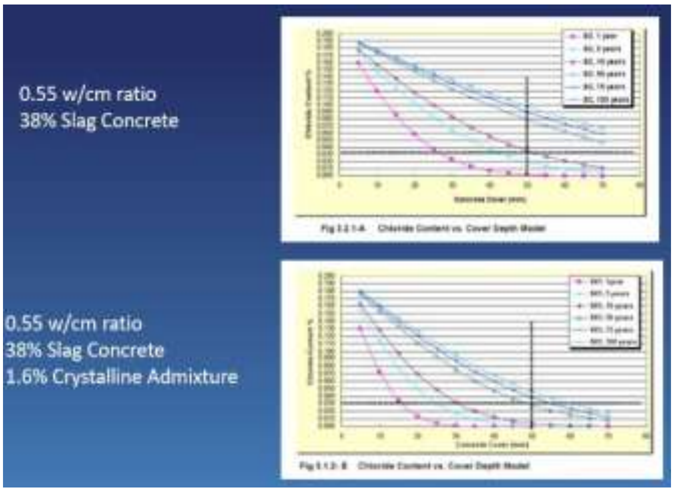

Fig. 21: Chemical durability testing of crystalline waterproof concrete – Chlorides

In another chemical resistance test performed at Iwate University, Tokyo, Japan, cement mortar specimens were prepared for full immersion in a bath of sulfuric acid (the control or untreated samples are on the left hand side of the photograph and the crystalline treated samples are on the right). The samples were submerged in a solution of 5% sulfuric acid for 100 days. The crystalline waterproofing treatment reduced the erosion of the concrete mortar to 1/8 that of the untreated specimens.

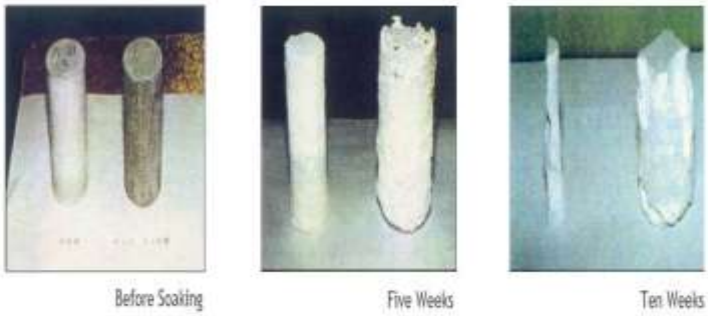

Fig. 22: Chemical durability testing of crystalline waterproof concrete – Sulphates

4.10 Application Methods

Crystalline waterproofing products are available in powder form. There are three different application methods:

a. Surface applied coating for an existing concrete structure
b. As an admixture.
c. Dry shake application for fresh concrete

4.10.1 Surface Applied Coating

Crystalline waterproofing as a coating system can be brush-applied or sprayed. The crystalline waterproofing coating system has a unique chemical diffusion characteristic. Hence, for efficient results, workmanship, viz. surface preparation, surface saturation, dosage and curing, etc. is highly important.

4.10.1.1 Surface Preparation

Concrete surfaces where crystalline waterproofing coating is to be carried out should have an open pore texture to allow the transfer of the crystalline additives from the surface coating into the concrete. The surface also needs to be clean and free of dirt, mould release oil, and other foreign matter as this can clog the pores and prevent the effective diffusion of the additives into the concrete.

Surface preparation may be carried out by water jetting, sand blasting or acid etching. When water blasting, the pressure should be 3,000 to 4,000 psi. Sand blasting is normally required when steel formworks have been used and the concrete has smooth finish. Acid etching can be accomplished using either muriatic acid or citrus-based products when the use of an acid is not environmentally acceptable. It is advisable to clean the area again with water after acid etching to neutralize the surface.

4.10.1.2 Wetting The Surface

Another pre-requisite for an efficient crystalline waterproofing system is that, the concrete surface should be in a saturated, surface damp condition. This is to facilitate the diffusion of the chemicals from the coating into the capillary tracts of the concrete. For vertical surfaces, walls have to be wetted with clean water for about ten hours. In conditions with hot sun and wind it is better to proceed in small convenient areas at a time.

Fig. 23: Surface preparation by water jetting for surface applied coating of crystalline water proofing

4.10.1.3 Coating/Spraying Application

The crystalline waterproofing coating materials are mixed with water at a ratio of 2.5-3 parts powder to 1-part water by volume and is applied with a brush at a coverage rate of 1.0 - 1.25 kg per Sqm for 2 coats. Coatings can be applied by brush, hopper gun or specialized spray equipment's.

a. When using a standard 6" masonry brush, one person can mix and apply approximately 80 to100 square feet per hour per coat.
b. 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 400-500 square feet per hour per coat.
c. Specialized spray equipment is operated with a three-person crew. At application rates of 1200 to 1500 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.

Fig. 24. *Coating Application*

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" 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.

4.10.1.4 Curing

Curing of the crystalline waterproofing system is crucial for efficient and effective performance and is particularly important for two reasons:

a. Crystalline waterproofing uses water as a medium for diffusion of the chemicals from the coating into the saturated concrete substrate. In case of inadequate curing, evaporation will first dry out the coating and then begin to pull moisture from concrete. This prevents the effective diffusion of the chemicals into the concrete substrate.

b. Curing also ensures proper hardening of the coating and adhesion of the coating to the concrete surface. Curing has to be carried out by spraying with water

Curing should begin as soon as the coating has hardened sufficiently. Under normal conditions, curing can begin two to three hours after coating, and can be done by misting with a fog spray of clean water at least three times a day for two to three days. In warm climates or on hot windy days, the frequency of curing has to be increased. During the curing period, treated surfaces must also be protected from rain 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.

4.10.2 Crystalline Waterproofing Admixture

The crystalline waterproofing admixture can be supplemented to concrete at the time of batching as well as at the site immediately before pouring of the concrete which then forms part of concrete and helps in making it dense and watertight. Only joint treatment is required after concrete sets and hardens as major part of the waterproofing activity is completed during concreting itself.

Crystalline waterproofing admixtures are compatible with other chemical admixtures such as superplasticizers, air entraining agents and water reducers. These can also be used in conjunction with mineral admixtures such as fly ash, and other supplementary cementing materials.

Homogeneous dispersion of the additives throughout the structure is ensured by adding crystalline waterproofing chemicals to the concrete mix, rather than penetrating from the surface as would be the case with a coating application. This is most efficient in areas such as raft slabs, retaining walls, etc. Crystalline waterproofing admixtures also help to reduce concrete shrinkage and increase compressive strength. Moreover, the construction costs, especially waterproofing costs are significantly reduced when crystalline admixture is added directly to the concrete mix because only the construction joints have to be treated after the hardening of the concrete. Hence labour required for surface treatment application is eliminated and the time required is reduced.

4.10.3 Dry Shake Application

Crystalline waterproofing can also be applied by the dry shake application method to new slabs during construction. In this method the crystalline powder is sprinkled onto the surface using a mechanical spreader and worked into the slab during the normal finishing process with a power trowel. Dry-shake crystalline waterproofing is also available with a synthetic floor hardener to waterproof as well as increase abrasion resistance of floor slabs.

Fig. 25: Crystalline Waterproofing by Dry Shake Application Method

4.10.4 Negative Side Waterproofing

Crystalline waterproofing can be applied on negative side i.e. the inside of the structure of existing basements that are subject to water seepage through foundation walls and floors. Since crystalline waterproofing penetrates into the concrete and blocks the pores beneath the surface, it does not depend on surface adhesion and therefore will not peel off.

Crystalline waterproofing is highly effective when applied to the negative side of existing concrete structures subjected to water pressures. Crystalline coatings use water as diffusing medium and are therefore ideally suited for this purpose. 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 crystalline technology under these conditions will reduce vapor flows as much as 50 percent, which will result in a drier environment.

5. CONCLUSION

In today's modern competitive design and construction environment where benchmarks such as durable concrete and value engineering are required to be met, the effective use of crystalline waterproofing technology can provide the high performance advantages and benefits that design and construction professionals have come to rely upon in design and construction projects. As compared to the standard waterproofing systems which possess many disadvantages, the crystalline waterproofing system ensures a denser concrete and chemical resistance by becoming a part of concrete. Thus crystalline systems prove to be highly beneficial for waterproofing structures which will be in contact with water during its life time.

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