The Other Waterproofing Option

INTEGRAL CRYSTALLINE WATERPROOFING TECHNOLOGY

Concrete Basics

History

1. Major construction product that has been used for years.

2. Can be molded or formed into virtually any shape

Concrete Basics

Composition

1. Is a heterogeneous composition of coarse and fine aggregate particles held together with a cement paste. The paste is the “glue” made from cement and water that hardens due to a chemical reaction called hydration.

2. Cement paste normally constitutes 25-40% of the concrete’s total volume. *The paste is porous and is prone to water movement through pores and micro cracks present in the paste*.

3. The quality of the concrete depends on the quality of the paste and aggregate, as well as the bond between the two. In properly made concrete, every aggregate particle should be covered with paste and the spaces between the aggregate particles completely filled with paste.

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Durability

1. Defined as its resistance to the degradation process such as weathering, chemical attack,abrasion,impact and physical strains.

2. The life expectancy is dependent on 1) the choice and proportion of ingredients, 2) quality of workmanship,3) the conduct of proper curing process. If any one of these areas are missing, the durability of the concrete is compromised.

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Deterioration of Concrete

1. Due to lack of durability, rather than deficient strength.

2. Concrete structures can become unserviceable due to gradual weakening arising from concrete deterioration and steel corrosion.

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Degradation Mechanisms

1. Concrete deterioration can be due to adverse mechanical, physical, or chemical causes. In most cases, one or more of these mechanisms is at work long before the degradation is observed.

2. In terms of deterioration of the concrete due to physical or chemical causes, the mobility of fluids or gases through the concrete are nearly always involved.

3. Important degradation mechanisms in concrete structures include the following a) Corrosion of reinforcing steel, b) Alkali-Aggregate Reactions, c) Carbonation, d) Sulfate attack, and e) Freezing and thawing.

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Corrosion of Reinforcing Steel

1. Common Causes

   A. Localized breakdown of the passive film on the steel by chloride ions.

   B. General breakdown of the passive film by neutralization of the concrete, predominately by reaction with atmospheric carbon dioxide.

2. Passive layer

   A. Steel embedded in hydrating cement paste forms a passive oxide layer which adheres to the steel surface and gives complete protection from corrosion. The maintenance of the passive layer is conditional on the adequately high Ph of pore water.

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Carbonation

1. Occurs when Ph of pore solution drops as low as 8.5. At this level, the passive film on the steel is no longer stable and corrosion begins.
2. The rate of Carbonation increases significantly if the concrete has a high permeability due to porous paste, porous aggregate, and high water to cement ratio, low cement content, short curing time, or poor consolidation.
3. Carbonation does not actually hurt the concrete, but the lowering of the Ph directly effects the passive layer protection that leads to the corrosion of the embedded steel.
4. Corrosion of the reinforcing steel will eventually lead to the failure of the concrete. Steel expands as it corrodes. The resulting stress will generally fracture the concrete cover. These cracks provide a path for water to carry oxygen and corrosive chemicals to the steel.

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1. Alkali-Aggregate Reactions (AAR)

A. Is the reaction between the active mineral constituents of some of the aggregate and the sodium and potassium alkali hydroxides in concrete.

B. Alkali-Aggregate Reactivity forms, a) Alkali-Silica, b) Alkali-Carbonate, both result in the swelling of the concrete.

C. Indicators of the presents of AAR are, a) network of cracks (map cracking), b) closed or spalled joints, c) displacement of different portions of the structure.

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Sulfate Attack

1. Attacks concrete by reacting with hydrated compounds in the hardened cement paste. The expansive reactions can induce sufficient pressure to disrupt the cement paste resulting in the degradation of the concrete.
2. Sulfate attack is not common, but can occur where soil is high in sulfate.

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Freezing and Thawing damage

1. When water freezes to ice, it occupies 9% more volume than when it was a liquid. If water is filling the pores of the concrete, the results can be very damaging.

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Water penetration is the root cause of concrete failure.

1. Note that in every case, it is the presence of moisture or water within the concrete that is at the root of the destructive process.

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Durability and Permeability

1. Permeability determines the vulnerability of concrete to external forces and in order to be durable, concrete must be relatively impervious.
2. The durability of concrete is fundamentally based on the permeability of concrete.

Concrete Basics

Permeation

1. Controls the ingress of moisture, ionic and gaseous species in concrete.
2. Since water or water born chemicals affect the durability of the concrete, the permeability of the concrete is the major factor in its longevity.

Concrete Basics

Transport Mechanism

1. The ingress of deteriorating substances takes place through the pore system in the concrete matrix or micro cracks. There are several factors that determine the rate at which a substance flows through the concrete matrix, 1) Diffusion,2 Capillary Action, 3) Permeation.
2. Diffusion is the process by which fluid can pass through concrete under the action of a concentration gradient. It is defined as “ the transfer of mass by random motion of free molecules or ions in the pure solution resulting in a net flow from regions of high concentration to regions of lower concentration of the diffusing substance”.
3. Capillary Action transports liquids through porous solid by way of surface tension acting in the capillary pores.
4. Permeability is defined as the ease with which a fluid can flow through a solid.

Concrete Basics
Conclusion

Low porosity/ Penetrability of concrete to moisture is the first line of defense against frost damage, acid attack, sulfate attack, corrosion of steel embedment and reinforcement, carbonation, alkali-aggregate reaction, efflorescence, and other concrete ailments.

Dampproofing vs Waterproofing

Dampproofing

1. Applied as a surface coating or integral part of concrete.
2. Hydrophobic
3. Designed to prevent water from absorbing and wicking through wet concrete.
4. Will not resist water under pressure. Structures under hydrostatic pressure must be waterproofed.

Hydrophobic vs Hydrophilic

- Hydrophobic or water repellent products repel water by increasing hydrophobicity. They reduce absorption, but are not enough to resist significant water pressure.
- Hydrophilic chemicals absorb and utilize water to catalyze and react with cement particles to produce elongated crystalline structures. These structures physically block pores, cracks, and ITZ to sufficiently resist the penetration of water under pressure.

Positive and Negative-Side Waterproofing

Positive side is where the concrete comes in contact with the water.

Negative side is where the waterproofing is applied to the “dry side” of concrete. Negative side waterproofing provides easy access for remedial type projects.

Waterproofing Materials

External Membranes

1. Fluid-Applied membranes
2. Sheet Applied membranes

Waterproofing Materials

Fluid-Applied Membranes

1. Urethane, rubber, plastic, vinyl, polymeric asphalts, or combinations of the above.

2. Applied by spray or rolling

3. Easy to apply, conforms to surface texture, do not have to seam.
4. Care must be taken at termination edge to avoid disbonding.

5. Blistering or pin holes may develop if substrate is damp or wet, since membrane is not breathable.

6. Controlling thickness is difficult.

7. Most fluid systems are not durable and will not resist abrasion, weathering, or UV degradation.

Waterproofing Materials

Sheet Membranes

1. Normally made from thermoplastics, vulcanized rubber, and rubberized asphalt.
2. Applied either fully adhered or loose, must be seamed.
3. Bentonite is made of clay; the clay swells when wet. Sheets are overlapped, not seamed.
4. Sheet goods are more durable than fluid applied, have a consistent thickness, and bridge openings in concrete.
5. Suffer from adhesion problems.
6. Little tolerance for rough or irregular surfaces.
7. Seams can fail.
8. Both fluid-applied and sheet membranes systems are prone to punctures. Water traveling under the membrane makes leak repair difficult.

Waterproofing Materials

Internal Waterproofing

1. Known as integral waterproofing, are products that perform their function within the pores of the concrete as to on the surface.
2. Designed to migrate into the concrete from a surface applied carrier or mixed into the concrete during its production.
3. Extremely durable.
4. Not subject to punctures, tearing, or abrasion.
5. Seamless.
6. Reactive and Un-reactive

Waterproofing Materials

Un-reactive

1. Bentonite, Water Repellents
2. Some may have a reactive effect during hardening of the new concrete, but do not reactivate in the presence of water.
3. Act as a densifier to concrete.
4. Attempt to make concrete waterproof by reducing permeability to the point water can't flow through it. However, it does not have the ability to regenerate thus as the inevitable joints or cracks appear, water has clear access to the substrate.

Reactive

1. Are able to create truly waterproof structures because they can address moisture penetration through joints and cracks, in addition to the mass concrete. They respond to moisture by forming new chemical compounds which grow to seal off moisture. Essentially, all truly reactive products are crystalline in nature and grow crystal formations to block cracks, pores and ITZ.

Waterproofing Materials

Crystalline Waterproofing

1. Has been used for over 100 years in Europe and North America. Most countries in the world are using this system.
2. When applied to concrete, crystalline chemicals create a reaction that causes long narrow crystals to form and fill pores, capillaries and hairline cracks. As long as moisture is present, the crystals continue to grow. Once the concrete has cured and dried, the crystalline chemicals remain dormant, until another dose of water causes the chemical reaction to begin again and grow crystals to shut off the water.
3. The ability of crystalline products to self heal is one of their most unique and dramatic benefits.
4. Seals cracks on average of 0.4-0.5mm. Real world experience often produce results of cracks up to a millimeter being sealed.
5. Incorporating crystalline technology into concrete ensures that minor cracking that occurs even years later can self heal without any outside intervention. This dramatically reduces long-term maintenance and repair costs.
6. Crystals can take days, even weeks to form, but become a permanent part of the concrete.
7. Will not crack, peel, tear, or wear away, even against high hydrostatic pressure.
8. Perfect for blind wall application.
9. Protects reinforcing steel by preventing water borne contaminants and chloride-laden liquids.
10. Saves time on construction schedules since it can be applied to green concrete. No need to wait for membrane application, back filling can start right away.