MIDCAL RESEARCH & DEVELOPMENT

<u>The benefits of DIS to concrete under acid / chemical agent attack</u>

The susceptibility of Portland cement concrete to adverse agent contamination generally results from three inherent characteristics, permeability, alkalinity and reactivity. Degrees of permeability can vary in different concrete installations. Even extremely high quality concrete has some degree of permeability. Liquid penetration into concrete is often accompanied by a reaction with one or more of its constituents, such as cement, aggregates, or imbedded steel. Subsequent possible leaching of the concrete's cement hydration compounds, or deposition of extraneous crystals, or crystalline reaction products can degrade concrete's appearance, integrity, strength and durability, ultimately causing its early failure.

The alkaline hydrated cement binder of concrete readily reacts with acidic substances. A reaction usually accompanied by extraneous formation or removal of concrete's soluble reaction products, eventually resulting in its disintegration. The rate of the extent of chemical attack is increased by an increase of aggressive agent concentration in solution. Dry non-hygroscopic do not attack dry concrete, however, wet or moist reactive solids will attack it, as will aggressive liquids and solutions. Temperature also effects the rate of chemical attack indirectly since as the temperature rises, moisture content of the concrete becomes reduced, making it dryer, but however, more permeable to additional fluids. As temperature falls, it can sometimes cause sufficient normal shrinkage to create small open cracks, which allow even greater penetration of contaminants into concrete's interior.

The extent of chemical attack depends greatly on concrete permeability, the ease with which liquids can travel through concrete's pore system. If concrete is very permeable, so that liquids can travel right through its thickness, calcium hydroxide will be leached out very quickly, leaving behind deposits of calcium carbonate, formed by the reaction of calcium hydroxide with carbon dioxide. Calcium carbonate is whitish in color and, in most cases, makes its presence apparent by floating to the surface, in the form of efflorescence. Efflorescence is generally not harmful, however, extensive leaching of calcium hydroxide leaves concrete more vulnerable to chemical attack, since its pore void percentage is increased, also making it progressively weaker.

Many agents can attack concrete and destructively alter its chemical composition by means of reaction mechanisms, which are partly or incompletely misunderstood. However, these agents have to be able to penetrate into concrete's interior, MIDCAL's DIS can prevent this. DIS, where applied to concrete's surface, readily penetrates to its interior, from its surface porosity bottom to its matrix top, where DIS reacts with concrete's internal constituents, producing a 100% solids, insoluble barrier, within just seconds following the DIS application. Immediately, following barrier formation, the concrete becomes protected against further contaminant penetration past its surface porosity. DIS, while still in solution form, due to its special molecular make-up, is the only liquid capable of penetrating this special barrier.

NOTE: This unique DIS precipitated barrier should not be confused with temporary, soluble, weakly linked, large pore, thixotropic gels, that are formed using sodium silicates, through free lime reactions, which has proven detrimental to long-range concrete integrity.

The unique barrier consists of distinct spherically-shaped particles, containing pore sizes significantly smaller than the treated concrete's micro porosity, allowing concrete to still breath, while not allowing free water, moisture, or other liquids to pass into its interior. Free water, already present inside the concrete, prior to treatment with DIS becomes chemically tied-up in the DIS precipitated barrier, even participating in the barrier formation, rendering that internal water harmless to the concrete itself. Excess free water, if any, not utilized in barrier formation, is either purged out of the concrete or occupies the special barrier material porosity, where it is not free to migrate. Also, water, which occupies the barrier's porosity, becomes postured in a stretched position due to the very small, spine-shaped configuration porosity of the specially formulated material. Since stretched water assumes density similar to that of ice, should a hard freeze occur, this already stretched water does not further expand, therefore, it will not cause freeze damage to the concrete.

Furthermore, the special barrier material is able to absorb and chemically tie-up water / moisture because its molecules are water saturated only on their inner side, in precipitate form, therefore, possessing residual valences which attract only substances that are hydrophilic, such as water or moisture, repelling hydrophobic substances, such as oil. DIS precipitated barrier particles have a surface film of bound water, which can only be released, at abnormally high temperatures. Subsequently, water or moisture content of the barrier material, even under extremely dry conditions, will never get lower than 6.5% of its total water capacity, unless baked out at temperatures of 115 degrees C or higher. However, should the unlikely event of complete hydration of the special barrier material occur, such as involvement in a fire, this special material will readily rehydrate , upon exposure to water or moisture. Also, the DIS precipitated unique barrier material is capable of dehydration without a significant loss of surface area inside concrete's porosity. Also, should this material become filled with water to capacity, it becomes impervious to anything else, including water.

The most significant factor in DIS' ability to preserve concrete is that it's barrier effectively hydrostatically stops liquid / pollutants (including undriven gases) from going into the DIS treated concrete's interior, eliminating major sources of reactant material that may eventually destroy the integrity of its matrix component, concrete's main strength component. Not only does DIS preserve concrete integrity, to expand its useful lifespan, but also works to preserve imbedded steel. DIS has the unique ability to significantly enhance Portland cement concrete without altering its physical characteristics, nor does DIS impair surface traction or bond quality, making DIS applicable to all concrete installations, whether traffic bearing or not. DIS improves past carbonation effects, if any.