Silica Fume and KIM®

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When concrete producers want to modify the properties of concrete, supplemental cementing materials (SCM'S) can be used to achieve the intended goal. These materials are added to the concrete at the time of batching and are typically a replacement for a portion of the Portland cement. Silica Fume is a very common SCM that is frequently used to increase the strength and durability of a concrete structure. Used in the right proportion it can also reduce the overall cost of the concrete.

Even though silica fume densifies concrete, it is not a waterproofer. Under hydro-static pressure, other forms of waterproofing are required. This article explains the technical nature of silica fume and its compatibility with Kryton's KIM admixture for completely waterproof concrete.

Silica Fume (Micro Silica) is a by-product from the manufacture of ferro-silicon alloys and silicon metal. It results from the reduction of high purity quartz with coal in electric arc furnaces. Silica Fume contains 85% to 98% silicon dioxide and has an average particles size that is 100 times smaller than cement particles. They are extremely fine spherical glassy particles.

Owing to the fineness and the high glass content, concentrated silica fume makes an efficient pozzolanic material[1]. The high specific surface of condensed silica fume results in increased water demand when the material is incorporated into concrete. Silica Fume, used as a supplementary cementitious material, increases compressive strength and densifies concrete.

Despite low initial permeability, silica fume is not without limitations. The use of silica fume in concrete shows a tendency for plastic shrinkage[2], drying shrinkage[3] and cracking resulting in water penetration and corrosion of reinforcing steel. This increased densification of the concrete often creates an illusion of waterproofing capability. In actuality the use of silica fume will accelerate the deterioration process when cracking occurs.

KIM admixture relies on Kryton's Krystol® technology to waterproof concrete. Krystol is a blend of proprietary chemicals containing hydration promoting materials that create vast amounts of crystals within the pores and capillaries of the concrete matrix. KIM decreases water demand, increases compressive strength, mitigates shrinkage cracking and provides permanent waterproofing.

KIM reduces the common cracking effect of Silica Fume concrete

- KIM reduces volume of bleeding per hour while increasing the hours in which bleeding occurs without allowing the surface area to dry prematurely due to evaporation.
- KIM lowers the heat of hydration resulting in a lower temperature during the concrete's natural hydration process.

The above factors allow for a reduction in shrinkage of the concrete during the hydration process. This reduction is a direct contribution to reduced cracking within the concrete structure.

Due to the inherent nature of concrete, cracking can also be expected after the initial shrinkage has become irrelevant. In denser silica fume, concrete the amount of cracking over a period of time is often greater. Water then penetrates through the cracks. This in turn leads to the corrosion of reinforcing steel and an accelerated deterioration of the concrete. KIM admixture's ability to self-seal micro cracking is a distinct advantage. Even the most dense silica fume concrete cannot stop water penetration through micro-cracks.
When a micro-crack occurs in a Silica Fume/KIM mix concrete, and water begins to penetrate the structure, KIM will immediately react with the un-hydrated cement particles and the water – causing crystals to grow throughout the crack. This will effectively seal the cracked area and protect the reinforcing steel from the corrosion process.

Silica Fume Powder.

The use of KIM has been proven in many countries to be the most effective method of waterproofing and protecting reinforcing steel against

- Embedded Metal Corrosion
- Corrosion-Induced Cracking And Spalling
- Dissimilar Metal Corrosion
- Post-Tension Strand Corrosion
- Structural Steel Corrosion

As an added advantage the use of KIM provides protection against

- Reductions in Structural Capacity
- Chloride Penetration
- Cast-In Chlorides
- Carbonization
- Exposure to Aggressive Chemicals
- Freeze-Thaw Disintegration
- Alkali-Aggregate Reactions
- Sulfate Attack
- Problems Resulting From Drying Shrinkage
- Moisture Transmission
- Moisture Content Volume Change
- Damage Caused by Thermal Movement Cracks
- Hydrostatic Pressure

In instances where Silica Fume is required, KIM may be used to provide an excellent method of increasing concrete density, quality, compressive strength, appearance and structural life, while effectively reducing the limitations of Silica Fume.

[1] A Pozzolanic Material is a material that doesn't have cementitious capabilities by itself but will form cementing compounds together with water and calcium hydroxide.

[2] Plastic shrinkage is a result of the rate of evaporation exceeding the bleed rate causing the surface area to crack.

[3] Drying shrinkage is a result of contraction of the concrete as it dries. An increased water content of the freshly mixed concrete will increase drying shrinkage.