TECHNICAL ADVISORY 10.11

KRYSTALINE WATERPROOF CONCRETE

Reduction of Carbonation When Using Krystaline Admixtures

Carbonation of concrete is a chemical process leading to reinforcing steel deterioration and concrete failure over time. Carbonation occurs as a result of carbon dioxide entering the concrete and reacting with water and calcium hydroxide $Ca(OH)_2$, ultimately resulting in their conversion into calcium carbonate $CaCO_3$ and concrete deterioration.

Carbon dioxide CO_2 enters via the air and reacts with any water molecules present (relative humidity or direct contact with water) in the concrete. In the presence of moisture, CO_2 changes into dilute carbonic acid H_2CO_3.

The carbonic acid H_2CO_3 in turn reacts with the calcium hydroxide $Ca(OH)_2$ producing calcium carbonate $CaCO_3$ and water H_2O. This process causes concrete to lose its alkalinity (the pH value lowers), causing reinforcing steel to lose its protection against corrosion.

Lower pH values (less than 9.5 or 10 depending on the source) result in the deterioration of the passive layer (the protective film around the reinforcing steel), thereby reducing the resistance to corrosion and eventually leading to the deterioration of the reinforcing steel.

The build-up of corrosion expansion of the reinforcing steel leads to further complications such as cracking, spalling, and eventually failure of the reinforcement.

There are several factors that affect the rate of carbonation. They include:

- Presence of water in the pore structure
- Quantity of calcium hydroxide in the concrete
- Quality of the concrete
- Quality of concrete permeability
- Depth of reinforcing steel cover
- Time

Fig. Example of negative effects of carbonation to reinforcing steel *(Source: Reinforcement Corrosion and Structural Safety Group of the Eduardo Torroja Institute)*

How does Krystaline reduce the risks of Carbonation?

1) Krystaline admixtures eliminate the water from within the pore structure. If the concrete is dry, the carbon dioxide stays in its gaseous form and will not react with the calcium hydroxide in the concrete.

2) Krystaline admixtures increase the C-S-H content of the concrete while reducing the calcium hydroxide. Reduced calcium hydroxide content results in reduced calcium carbonate generation.

3) Krystaline admixtures increase the general quality of the concrete giving it characteristics of higher concrete grades. This provides the concrete with notable reductions in the micropore structure reducing the volume of carbon dioxide entering the pore structure.

4) Krystaline admixtures reduce concrete permeability thereby reducing the development of carbonation.

5) Krystaline admixtures become part of the concrete and are never used up. They will continue to function even years later to eliminate any future water penetration and to self-heal cracking. This will reduce the effects of carbonation over time.

Krystaline meets all requirements to be considered highly effective against carbonation of concrete.

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