RachTR

An IIM Alumni Venture

Comparison of Silicates

Sodium, potassium, magnesium, and lithium silicates all react with calcium hydroxide (also referred to as "portlandite")—a byproduct of cement hydration—to produce calcium silicate hydrate (C-S-H), the same binder that results from adding water to cement and gives concrete much of its strength and hardness. In the hydration process, calcium hydroxide dissolved in water moves to the surface region of a slab where the silicates can react with it. This newly created C-S-H is deposited primarily in the pores and canals on the surface of a slab.

This reaction of soluble silicate with calcium hydroxide in concrete also produces alkali metal hydroxide, lithium hydroxide, potassium hydroxide, or sodium hydroxide, all of which could be detrimental to concrete if reactive aggregates and moisture are present. **There is also the potential of the silicate to form efflorescence, which is highest with sodium, lower with potassium, and lowest with lithium.** The function of the sodium, potassium, or lithium part of the silicate's function only is to stabilize and solubilize the silicate so it can remain in solution until it penetrates the concrete and then can react with the abundant calcium hydroxide found in the concrete. **Sodium, potassium, or the lithium ions typically do not react in concrete to any degree, so they are incidental to the primary benefits.**

Potassium Silicate

Mainly used in drilling applications and use in concrete hardening is limited.

Sodium Silicate

Sodium silicate is the common name for compounds with the formula $Na_2(SiO_2)_nO$. Also known as **waterglass** or **liquid glass**, these materials are available in aqueous solution and in solid form. The pure compositions are colourless or white, but commercial samples are often greenish or blue owing to the presence of iron-containing impurities.

Uses/Applications

Concrete treated with a sodium silicate solution helps to significantly reduce porosity in most masonry products such as concrete, stucco, and plasters. A chemical reaction occurs with the excess $Ca(OH)_2$ (portlandite) present in the concrete that permanently binds the silicates with the surface, making them far more durable and water repellent. This treatment generally is applied only after the initial cure has taken place (7 days or so depending on conditions).These coatings are known as silicate mineral paint.

Detergent

Water Treatment

Drilling Fluids

Adhesives

Dye Auxiliaries

Passive Fire Protection

Metal Repair

Automotive Repair

Lithium Silicate

Lithium silicate is $Li_2O.xSiO_2 + H_2O$ (x=4, 20, 4, 40 or 5, 80) and usually used in different concentrations depending on application. It exhibits following properties:

- Easier to handle than standard sodium and potassium products
- Safer concrete sealing
- Improved resistance to mechanical wear
- No efflorescence
- Longer service life than traditional floor coatings

The treatment of concrete surfaces with silicates does increase the resistibility by a better and more uniform compaction of the concrete structure. As a result the achieved higher strength leads to an increase of service life.

Lithium based silicates act as hardening agent for concrete. They react with the calcium hydroxide formed during the concrete hydration. The calcium-silicate-hydrates formed through this reaction do additionally reinforce the concrete.

Usually lithium silicates have lower viscosities than the corresponding sodium or potassium silicates and will thus penetrate deeper and more efficiently in the concrete layer where they will harden to the desired cohesion and strength. Contrary to sodium or potassium silicates, the lithium carbonates do not diffuse to the surface and therefore do not generate efflorescence.

Limitations

There are limitations to silicates' usefulness. It is important to note that silicates are not curing compounds, and the ASTM C 309–07 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete, specifically excludes silicates. It makes little sense to apply a silicate to a damp concrete surface that has its pore structure already full of water, which inhibits penetration and wastes the soluble silicate as any excess must be removed after treatment.

There are two things that occur in concrete with soluble silicate treatments. First, upon drying the silicate forms a glassy material that adds some, but very little, to the strength of the concrete surface. More importantly, after the silicate is deposited inside the concrete's pores, it reacts with calcium hydroxide slowly to form the C-S-H as discussed earlier. This chemical hardening and densifying takes place over the course of one to two weeks, not in a matter of hours. C-S-H provides most of the concrete's surface strength, and is useful particularly when applied to concrete that is porous or otherwise less than ideal.

Several manufactured lithium silicate densifier products are on the market. They are sold as just lithium silicate, silicate with a surfactant to facilitate absorption into the concrete, or with the addition of siliconates that also produce calcium silicate over time and improve gloss. Concrete surfaces are reactive with 10 to 12 pH ratings and this isn't changed with densifying. Therefore, substances used in the maintenance process with a lower pH can dull, haze, or damage floor surfaces.

Application Procedure

1. On soft to medium hard stones, use densifier after 100 grit diamond and then moving on to the next sequence of grits. On medium to hard stones, densify around 200 to 400 grit range.
2. The process to apply is spread the denisfier evenly on the substrate and leave it for 24 hours so as to allow it to penetrate and cure. After 24 hours, the next grit can be used**.**
3. Generally two rounds of densifier application are sufficient, but it all depends on the porosity and softness of stones. If desired one can apply it before 800 grit too for the third time.

Observations

1. Silicates have primarily been used in concrete strengthening and recently found its use in treating soft marbles to improve polish
2. **In case of soft marbles silicates act as sealers which improve the polish -ability of the surface on account of reduced porosity and increased surface density.**
3. Out of Sodium, Potassium and Lithium silicates lithium is the best alternative as it shows higher stability and lower wear with no efflorescence.
4. To improve polish of stones there are other alternatives as well which include epoxies. The process can be a mix of using silicates, silconates and epoxies depending on the nature of stone