TECHNICAL BULLETIN – TB082

SILICATE-BASED CONCRETE WATERPROOFING TREATMENTS &ARDEX FLOORING PRODUCTS

27th November 2024

INTRODUCTION & SCOPE

There are many different types of water vapour barrier on the market today, and while ARDEX has its own engineered system, detailed in the ARDEX Moisture Barrier Bulletin, we are continuously being asked to provide guarantees or give advice on the compatibility of ARDEX FLC over alternate water vapour barrier products.

This technical bulletin presents some issues and arguments for considering ARDEX FLC for use over barriers based on reactive silica species.

LITHIUM, SODIUM & POTASSIUM SILICATE MATERIALS

Materials based on Sodium Silicate are commonly used for cement and concrete treatment, and this is the oldest type, with others based on chemically related silicates appearing more recently. Lithium, Sodium and Potassium Silicates (called Alkali Metal Silicates) are made by the reaction of silica (sand) with Lithium, Sodium or Potassium Carbonates and contain a variable amount of chemically bound water. The resultant metal silicate is water soluble and must be kept at a high pH (alkaline) to remain stable. When the pH drops below 11, the silicate is destabilized and can polymerize.

When the Alkali Silicate sealer/waterproofer is applied to concrete or cementitious surfaces, the silicate component reacts with the free lime (Calcium Hydroxide) in the cement to form Calcium Silicates (an Alkaline-Earth Metal Silicate), which are insoluble and quite chemically unreactive. Efflorescence can be a side effect with carbonates being formed in the reaction and it also generates Metal Hydroxides (NaOH – Sodium Hydroxide or 'Caustic Soda' from Sodium Silicate and KOH - Potassium Hydroxide or 'Caustic Potash' from Potassium Silicate) which are highly alkaline and **must** be neutralized before any coatings can be applied. However, this can create problems with aggressive chloride salts, aggressive acids and excess wash water, which alters the concrete moisture content. If left in place, these alkaline salts can further react with Carbon Dioxide in the air to form Metal Carbonates, which form a surface crust and are still mildly alkaline.

SYSTEMS BASED ON REACTIVE SILICA

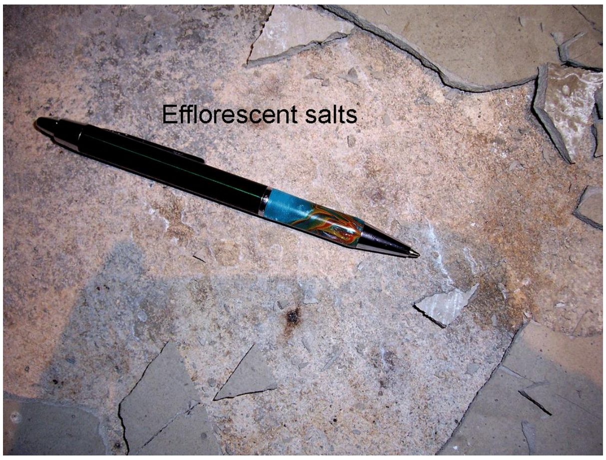
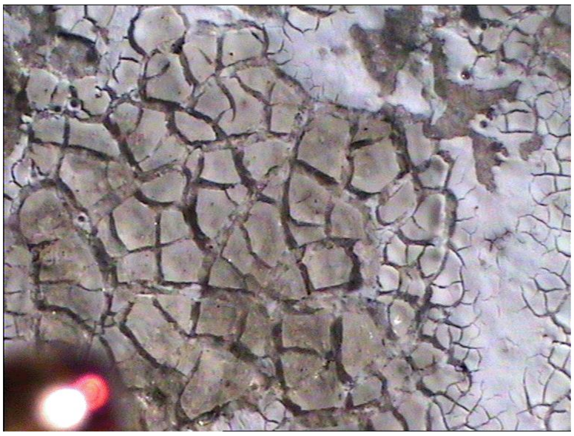
Other systems involve the same general reaction where a hydrated silicon oxide-based chemical reacts with the free lime in the cement. The first type is a silica sol, where reactive siliceous material is dispersed through a carrier liquid as a colloidal suspension. These materials are described as 'gel forming' and fill the matrix pores. The second type is defined as crystal forming and works by the growth of Calcium Silicate crystals into the pore structure, thereby blocking them. A third type is based on alkyl silicone, an organometallic species. Typically, an alkyl molecule, such as the methyl group, is attached to a metal silicate molecule. These materials react with atmospheric Carbon Dioxide to create an impermeable silicate material.

CRACKS

The gel or crystalline materials the reaction creates are designed to fill the pore spaces. However, they have limited ability to grow across cracks in the concrete. The maximum crack bridging width is around 0.25mm, meaning that a typical concrete slab with numerous cracks, commonly larger than this size, is likely to have many sites where moisture can penetrate.

RESULTANT CONCRETE SURFACE

The resultant silicate is generally unreactive (except to acidic species) and quite hard and glassy, sealing the surface and increasing wear resistance. This hardness and unreactivity mean that it is necessary to carefully examine the application of any subsequent coatings and materials. Also, any unneutralised alkali can react with polymeric materials and decompose them by alkali hydrolysis. Over time, the reactant produced by silicates and silica sols, calcium silicate hydrate, can react with carbon dioxide in the air and slowly convert to silica gel and Calcium Carbonate. This can result in the development of efflorescence-related salt deposits. Deposits of this type are a significant issue with damp slabs and lead to the formation of a contaminated and loose surface layer.

	
A damp concrete floor treated with a reactive silica-based treatment has developed severe efflorescent salt deposits. The smoothing cement has de-bonded off the powdery surface.	Photomicrograph of primer that has been decomposed by alkali hydrolysis as a result of contact with the damp treated concrete shown in the picture on the left

The volume occupied by the decomposed calcium silicate hydrate material also changes since the silica gel and carbonate have different crystal sizes and structures. In general, there is a reduction in volume, which may open voids and pores.

ARDEX AUSTRALIA EVALUATION OF SILICATE WATERPROOFING

Ardex Australia has conducted limited tensile bond testing of reactive silica-based materials for compatibility with ARDEX smoothing cement.

While the normal product performance parameters detailed on the datasheets are features such as compressive strength, ball hardness, and bending strength, which are intrinsic to the cement, the properties of the substrate directly affect the topping bond strength.

The normal measure for a substrate-topping bond is tensile bond strength, measured by pulling the material off the substrate with a load measuring device. In Australia, there is no relevant standard for smoothing cement performance, so ARDEX adopts the ISO Standard 13007 (Australian Standard AS4992-2004) for ceramic tile adhesives as the de facto benchmark for bond strength, the required figure being a minimum of 0.5MPa. Also, there is a Chinese national standard for smoothing cement, which can be referred to as well, which specifies wet bonds at 21 days (0.5MPa) and dry bonds at 28 days (1.0MPa).

The test results indicate that when the treated and correctly prepared concrete substrate remains dry, the tensile bond performance of smoothing cement used with either ARDEX P82 or P51 primer is satisfactory and safely exceeds the bond requirements that ARDEX considers acceptable. Examples would be new slabs with correct DPMs in place under the concrete and suspended slabs, where the treatment is used as 'green slab sealing'.

In contrast, when the concrete is 'wet', that is the testing simulates a damp slab, the bonding performance was reduced ('wet' concrete would refer to older slabs subject to ongoing rising damp and hydrostatic pressure). For some ARDEX products the bond strength fell below the 0.5MPa minimum, and for others the reduction in bond strength whilst still exceeding the minimum value, is up to 50-60% of that in dry conditions. This implies that concrete is permeable to water vapour, if not liquid water itself. A few products which are alkali sensitive were significantly degraded.

EVALUATING SILICATE SYSTEMS

To assist customers evaluating the claims of compatibility of silicate waterproofing systems and ARDEX products, it is prudent to ask the following questions:

1. Can the waterproofing suppliers advise the preparation procedures to remove any salts, grease, oils purged to the surface (a common claim for these types of material)?
2. What form of surface preparation and/or neutralisation of the surface is recommended?
3. What products and procedures would be necessary to seal off cracks and fractures in the concrete?
4. Has any evaluation been done by the suppliers of compatibility with ARDEX products, or can they supply a list of successful jobs?
5. Does the silicate product provide a water vapour transmission rate that enables the substrate to comply with the moisture test results in AS1884-2021?
6. Does the product comply with the maximum allowable water vapour transmission rates required by the US based "Resilient Floor Covering Institute" of 3 Pounds per 1000 sq feet per 24 hours? (15gms/m^2/24hrs), or the recent and stricter ASTM F3010 which requires a permeability of less than 0.1 Perms for epoxy barriers?

   ARDEX Technical Bulletin TB040 covers details of permeability of the ARDEX Moisture Barrier system which is designed to work with ARDEX smoothing cements. ARDEX Technical Bulletin TB006 describes the full system in detail, and ARDEX Technical Bulletin TB172 discusses 'green slab' applications.

NEUTRALISING EXISTING SILICATE TREATED CONCRETES

Where the concrete is known to be subject to ongoing moisture problems, and has been treated with a silicate-based material, the following process can be used to treat the surface before application of ARDEX WPM300.

Warning – This process uses Phosphoric Acid which may require dilution from high concentration, normally 85%. When diluting concentrated acids always add the acid to the diluent water with constant stirring, NEVER add water to the acid as this can result in the acid boiling and spraying around.

The use of Hydrochloric, Sulphuric are not recommended. Dilute Acetic Acid may be used; however the strong odour normally precludes use in areas already occupied.

The use of acids requires personal protective equipment including acid resistant boots, gloves, aprons and safety eyewear (goggles or face shields). Adequate ventilation for the work area must be available.

1) The concrete surface is mechanically prepared to remove any crusts and hard surface layers.
2) The concrete is washed down with <10% Phosphoric Acid and the effervescent reaction is allowed to subside.
3) The surface is then thoroughly washed down with clean water and allowed to dry off. Note that the resultant wash water may be classified as contaminated waste and require capture and appropriate disposal. Local regulations as applied by the relevant bodies such as the EPA, local councils and 'WorkCover' should be consulted.
4) When surface moisture has gone, the concrete can then be treated with the ARDEX Moisture Barrier System as per TB006.

CONCLUSION

The compatibility of ARDEX floor smoothing cements with most silicate based waterproofing materials has not been evaluated by ARDEX Australia.

On the basis of ARDEX's test program, ARDEX Australia cannot guarantee the performance of moisture sensitive products or systems over concrete treated with silicate-based products where long term moisture suppression is the purpose of the silicate system application.

Where the treatment has been applied to concrete as a curing compound or a hardener, the slab is not subject to moisture problems, and correct surface preparation has been performed, adequate performance of ARDEX smoothing cements with ARDEX P51 primer should be achieved. Should the concrete subsequently develop damp slab problems, the ongoing performance of applied products cannot be guaranteed.

ARDEX Australia is not in a position to guarantee or comment on the effectiveness of silicate based waterproofing in reducing moisture emissions down to a level that would comply with the requirements of A.S.1884 2021.