

TECHNICAL BULLETIN – TB082

SILICATE BASED CONCRETE WATER PROOFING TREATMENTS & ARDEX FLOORING PRODUCTS

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INTRODUCTION & SCOPE

There are many different types of water vapour barrier's on the market today and whilst 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 for the placement of Ardex FLC over alternate water vapour barrier products.

The information provided in this technical bulletin presents some issues and arguments for consideration should Ardex FLC be considered 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 Silicate (called Alkali Metal Silicates) are made basically by 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 to remain stable must be kept at a high pH (alkaline). When the pH drops below about 11, the silicate is destabilised and can polymerise.

When the Alkali Silicate based 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 neutralised before any coatings can be applied. However, this can create problems with aggressive chloride salts, aggressive acids and excess wash water which then alters the concrete moisture content. These alkaline salts if left in place 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

There are other systems which 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 described as crystal forming and works by growth of Calcium Silicate crystals into the pore structure, thereby blocking them.

A third type is based on an alkyl silicate which is an organo-metallic species. Typically an alkyl molecule such as the methyl group is attached to a metal silicate molecule. These materials work by reaction with atmospheric Carbon Dioxide to create an impermeable silicate material.

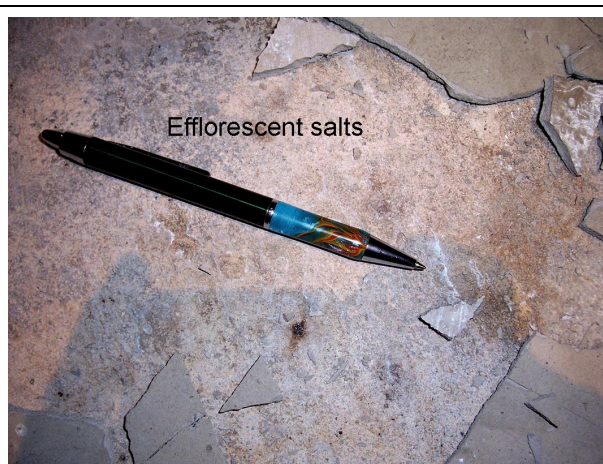
CRACKS

The gel or crystalline materials that result from the reaction are designed to fill the pore spaces. However, they have limited ability to grow across cracks in the concrete. The maximum cracking bridging width is around 0.25mm and so this means that a typical concrete slab which has numerous cracks, commonly larger than this size, is likely to have many sites where moisture can penetrate through.

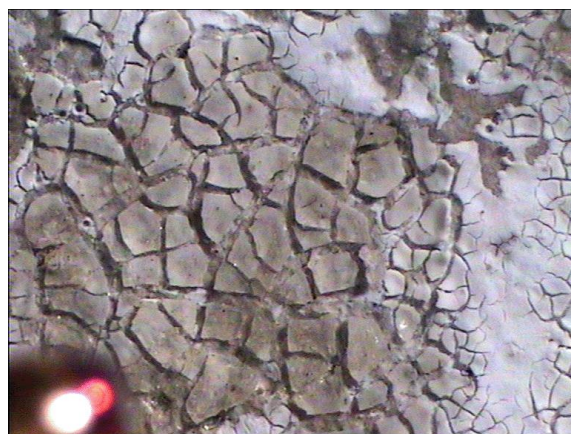
RESULTANT CONCRETE SURFACE

The resultant silicate as well as being generally un-reactive (except to acidic species), is quite hard and glassy, so seals the surface and increases wear resistance. This hardness and un-reactivity mean that it is necessary to carefully examine the application of any subsequent coatings and material. Also any un-neutralised 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 that has developed severe efflorescent salts deposits. The smoothing cement has debonded 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 actual volume occupied by the decomposed Calcium Silicate Hydrate material changes as well, since the silica gel and carbonate have differential crystal size and structure. 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 cements. Whilst 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 substrate-topping bond is tensile bond strength which is measured by a 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 cements which can be referred to as well, which specifies wet bond at 21 days (0.5MPa) and dry bond 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 cements 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 also suspended slabs, where the treatment is used a '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 makes the substrate comply with the moisture test results in AS1884-2012?
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/m²/24hrs), 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 of 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 2012.



IMPORTANT

This Technical Bulletin provides guideline information only and is not intended to be interpreted as a general specification for the application/installation of the products described. Since each project potentially differs in exposure/condition specific recommendations may vary from the information contained herein. For recommendations for specific applications/installations contact your nearest Ardex Australia Office.

DISCLAIMER

The information presented in this Technical Bulletin is to the best of our knowledge true and accurate. No warranty is implied or given as to its completeness or accuracy in describing the performance or suitability of a product for a particular application. Users are asked to check that the literature in their possession is the latest issue.

REASON FOR REVISION

24 month review. Changes to some text. Addition of ISO13007 and ASTM F3010.

REVIEW REQUIRED

24 months from issue

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