KEIM Mineral Paints – Technical Digest

Concrete & Anti-Carbonation Protection

1. Carbonation of Concrete

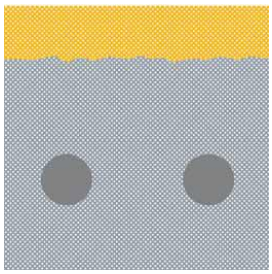
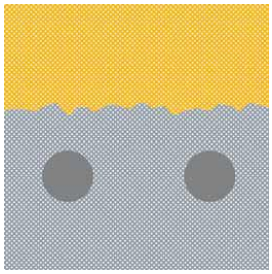
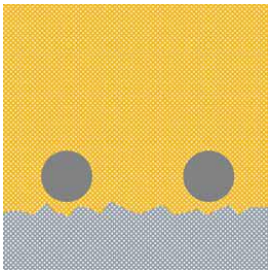
A major factor in concrete decay is carbonation, caused by Carbon Dioxide (CO2) in the atmosphere reducing the alkalinity of concrete. This in turn results in reinforcing steel becoming susceptible to attack by water and oxygen, causing corrosion of the steel and eventually spalling of the concrete. Sulphates from vehicle exhausts and chlorides from de-icing salts also contribute to concrete degradation.

Carbon Dioxide in the atmosphere reduces the alkalinity of concrete. The alkalinity of concrete is typically between pH12 and pH13, at these levels the highly alkaline nature of the concrete results in the formation of a passivation layer on the reinforcing bars, preventing corrosion. A drop in the level of alkalinity to a pH of below 9.5 eliminates the passivation and protection, making the concrete susceptible to attack by water and oxygen, leading to corrosion of reinforcing steel and eventually spalling of the concrete.

Causes of decay in concrete:

- weathering leading to erosion,
- water absorption leading to rusting of reinforcement ,
- insufficient concrete depth – corrosion of reinforcements,
- de-icing salts – chloride corrosion

2. Depth of Carbonation

1. 
2. 
3. 

1. Carbonation depth amounts to only a few millimetres and cannot extend as far as the reinforcement. Carbonation protection (CO_2-proofing) is not necessary. Where concrete quality is good and it is protected from the causes of concrete decay, carbonation is slight and eventually comes to a stop, with the depth reached being known as the maximum carbonation depth.
2. Carbonation has nearly reached the reinforcement layer. Carbonation protection is necessary in order to stop further progress. If carbonation penetrates deeper and reaches the reinforcement, the protection of the passivation layer around the rebar will be eliminated. If carbonation is stopped, the protection of the passivation layer will be retained and further decay of the concrete stopped.
3. The majority of the reinforcement is located in the already carbonated zone of the concrete. In this case, carbonation protection would be too late. The primary goal of surface protection is to protect the reinforcement from corrosion. If the concrete has already undergone carbonation, corrosion can only be prevented by waterproofing.

3. Carbonation Protection

There are different ways in which coating systems offer protection against carbonation.

The current DIN standard (German Institute for Standardisation) concentrates on barrier coatings to protect from the ingress of water and CO2 and whilst these issues are important the standard doesn't take into account the Klopfer method. The Klopfer method was previously the recognised standard for anti-carbonation protection which also understands that it is necessary for anti-carbonation coatings to be breathable which allows the free passage of moisture vapour, keeping the surfaces drier and free from the build up of moisture which can enable diffusion of CO2 and chlorides more easily into the concrete.

Standard barrier coatings which contain high levels of acrylic are likely to have low breathability which is more likely to lead to a build up of moisture behind the coating resulting in blistering and flaking of the paint effectively rendering the barrier useless. A barrier is also only as good as its edges –particularly at floor level will still be susceptible to ingress of moisture and de-icing salts which are more likely to become trapped behind the barrier coating.

Using the Klopfer test methods all mineral paints can be considered to give a high standard of protection to concrete surfaces.

4. DIN Standard Anti-Carbonation Protection

The products within our Keim Concretal range that conform to the standard EN 1504 part 2, class 1.3 are as follows:

- Keim Concretal C - This conforms to EN 1504 part 2, class **1.3**, 2.2 and 8.2.
- Keim Concretal W. - This conforms to EN 1504 part 2, class 2.2 and 8.2.
- Keim Concretal Lasur - This conforms to EN 1504 part 2, class 2.2.

The standard EN 1504 Part 2 class 1.3 is concerned with testing for anti-carbonation on the basis that the coating offers protection by nature of it being a barrier coating.

5. Keim Mineral Paints

Unlike conventional film forming acrylic 'barrier coatings', Mineral paints bond by penetration (silicification) of the binder into the substrate. A strong, permanent bond is created between the paint and the underlying substrate (e.g. render, natural stone, concrete). This potassium silicate binder is highly resistant to weathering, ensuring an extremely long-life protective finish, reducing the frequency of re-decoration cycles. Keim mineral paints do not flake and the binder does not disintegrate under the effect of UV light. They are resistant to acid rain and industrial pollution.

Keim mineral paints have no residual electrostatic charge, unlike oil based paints, and therefore do not attract dust. Over time they remain cleaner than oil based paints. The silicate structure is highly stable and able to resist acid and alkali attack while the inherent alkaline nature of Keim mineral paints delays the growth of fungi and algae spores.

Keim mineral paints contain high-quality, lightfast, mineral pigments and binders which exhibit the greatest UV resistance of all paint systems, and are absolutely weather-resistant. All Keim colours are unaffected by the action of weathering and UV radiation, ensuring no colour fade with the passage of time. Having a bright matt appearance, the crystal structure of Keim mineral paints gives a high level of light reflectance compared to oil based film forming paints of a similar colour.

Keim mineral paints are inherently non combustible, do not support the spread of flame and give off no noxious emissions due to their inorganic composition. Mineral paints are therefore ideal for use in safety critical public areas such as underground stations and tunnels, airports, schools and flats.

The micro-crystalline nature of the Keim coating system creates finite spaces between adjacent crystals, these voids are large enough to allow the free passage of vapour but small enough to prevent the ingress of driven rain. This imparts the Keim mineral paint system with high water vapour permeability. This high breathability enables humidity contained in building structures to be quickly released unhindered into the environment, avoiding moisture build up between coating and substrate.

6. Other Methods of Protection

In addition to the carbonation resistance as certified according to the barrier method (EN 1504 part 2, class 1.3, 2.2 and 8.2) there are other ways in which coating systems offer protection against carbonation.
Due to the high alkalinity (pH) of Keim mineral coatings they are also able to effect re-alkalisation of the concrete, and by their nature the potassium silicate within the coating diffuses into the concrete, increasing the alkalinity to a level where carbonation is unlikely to occur.

In addition, Keim Mineral Paints hold moisture in the pores at the surface of a coated structure, and carbon dioxide is unable to diffuse through water, unless under pressure.

Another important feature of mineral paints, particularly in large concrete structures is that the paint system takes on the same co-efficient of expansion as the mineral substrate to which it is applied, allowing existing or any possible future structural defects to be effectively monitored.

Summary of Protection

- Protection from steel corrosion and frost damage due to elevated water-repellence
- Protection from chloride corrosion due to absence of water transport
- Fast drying of concrete due to extremely low sd (H_2O) value (< 0.1 m)/high breathability
- Protection from progressive carbonation due to elevated CO_2 tightness
- Long-term colour stability due to pure mineral pigments (Fb Code A1)
- Retains original concrete appearance due to mineral matt surface

7. Keim Concrete Repair Materials

The Keim concrete repair system is based on cementitious and mineral constituents and is suitable for all forms of concrete substrate. The system consists of a range of materials that provide protection to both the concrete and steel reinforcing bars.

Keim Concrete Cleaner: Acidic concrete cleaner for the removal of release agents and surface impurities from concrete.

Keim Silan Primer: A silane based water repellent for use as a priming coat with Keim silicate paints to provide maximum resistance to water penetration without impairing the breathability of the substrate.

Keim Silan 100: Solvent free silane primer offering very high levels of water repellence and protection from deicing salts.

Keim Concretal MKH: Mineral cement based corrosion protector and bonding mortar.

Keim Repair Mortar: Pre-bagged non shrink cementitious repair mortar for large scale concrete reparation works.

Keim Fine Finishing Mortar: Pre-bagged cementitious fine finishing mortar for crack repair, filling of blow holes and surface equalisation.

8. Keim Concretal C

The paint system that conforms to EN 1504 Part 2 class 1.3 (anti carbonation) - Keim Concretal C.

Keim Concretal C is a high performance mineral coating which satisfies the requirement for a barrier coating under the relevant DIN standard.

Importantly it still retains the features of a mineral paint which we feel elevate its performance higher than other acrylic barrier coatings. This is in terms of the water vapour permeability whilst still being waterproof/repellant which in turn protects from water and frost damage and chloride corrosion. The chemical reaction has a consolidating effect as well as being both lighfast/colour stable and highly light reflective. Like all mineral paints Concretal C is light reflective and lightfast, with a matt, antistatic texture.

For further information regarding the features and benefits of Keim Mineral Paints please contact our sales office sales@keimpaints.co.uk or 01952 231250.