PENETRON®
ADVANCED WATERPROOFING & PROTECTION SYSTEMS

CONCRETE TEST AND CALCIUM TREATMENT BEFORE THE APPLICATION OF PENESEAL® PRO (RTU) ON OLD SURFACES LIKELY TO HAVE UNDERGONE CARBONATION

1. CONCRETE

Concrete is basically made up of sand, cement, aggregate and water. Water, which begins the products reaction, is added separately and the concrete slowly gains strength, as it transforms from its plastic state, to its solid state and beyond.

During this reaction and hydration of Portland cement, calcium hydroxide ($Ca(OH)_2$) is precipitated from the cement paste. This calcium hydroxide, also commonly referred to as “free lime” or “free calcium” is highly alkaline. This alkalinity provides a protective environment for the steel reinforcement against corrosion.

The calcium hydroxide is soluble in water, but remains locked in the concrete matrix. If and when cracks occur in the concrete, calcium hydroxide is leached from the matrix of the concrete by passing water. When inspecting the surface of leaking concrete, efflorescence (white staining) can be often seen in the form of a stalactites.

It is this calcium hydroxide ($Ca(OH)_2$), as referred to as “free calcium”, which PENESEAL® PRO relies upon in its reaction in the concrete, to produce a waterproof result. There are a number of factors that will influence the availability of this “free calcium”. These will be discussed below.

2. THE PENESEAL® PRO REACTION WITH CALCIUM

PENESEAL® PRO absorbs into concrete, reacting with “free calcium” to form a gel in the matrix and cracks. The product continues to remain active, when in contact with water and in the presence of “free calcium”.

If it is suspected that there is a low “free calcium” content, the concrete may need to pre/post-treated with a calcium solution to activate the product. Outlined below are some situations that may influence the amount of “free calcium”.

3. LOW FREE CALCIUM CONTENT

Carbonated Concrete

Concrete is generally gas permeable. It allows the ingress of gasses, such as carbon dioxide (CO_2). As carbon dioxide permeates the concrete, it reacts with the calcium hydroxide, to form calcium carbonate ($CaCO_3$) with a by-product of carbonic acid (Calcium Formate – CaCOOH). In doing so, the amount of “free calcium” is reduced and the carbonic acid reduces the alkalinity of the concrete. Note this calcium carbonate is insoluble and therefore not free to react with PENESEAL® PRO.

Cement Replacement Materials

Industrial by-products, such as fly ash, slag and silica fume, can be used to replace a certain percentage of cement in concrete. These materials also react with calcium hydroxide to create additional cementitious compounds. This secondary reaction in the concrete reduces the amount of “free calcium” available.

Leaking Cracks in Concrete

As concrete cracks and leaks, “free calcium” is leached from the matrix of the concrete and forms efflorescence (calcium carbonate) on the surface of the concrete. If the leak is not repaired, a significant proportion of the “free calcium” will be leached from the concrete in that areas.

4. SOURCES OF CALCIUM

There are three main forms of calcium in powder form, which we recommend as a supplement for concrete, when using PENESEAL® PRO. These are:

Calcium Acetate

Calcium Acetate is utilized for the majority of applications with PENESEAL® PRO. Note that it should be of specific quality. Food Quality [Formula $Ca(CH_3COO)_2 \cdot 2H_2O$]. This material is sometimes difficult to locate and can be obtained from PENETRON INTERNATIONAL LTD.

Calcium Oxide – also called “Quick Lime”

Calcium Oxide (CaO) is another source of calcium, but only used in special circumstances. Precautions should be taken, when handling this product, as it is very reactive with water and is exothermic (generates heat). Calcium oxide powder should always be added TO water in a slow and controlled manner. You should never add water directly to the calcium oxide powder itself. This material is available from cement manufacturers.

Ordinary Portland Cement

Ordinary Portland Cement may also be utilized, as it has a high calcium content. The cement is simply mixed with water at a very high/cement ratio, so that a slurry-like consistency is achieved.

NOTE:

1. We recommend using distilled water, when mixing calcium solutions. This will prevent bacterial growth in the solution, prolonging the storage life of the mixed material. Drinking water can also be used, but will reduce life to 1 week in a sealed container.
2. Do not use hydrated lime as a calcium source. This material is commonly available in hardware stores and is not soluble or reactive enough.

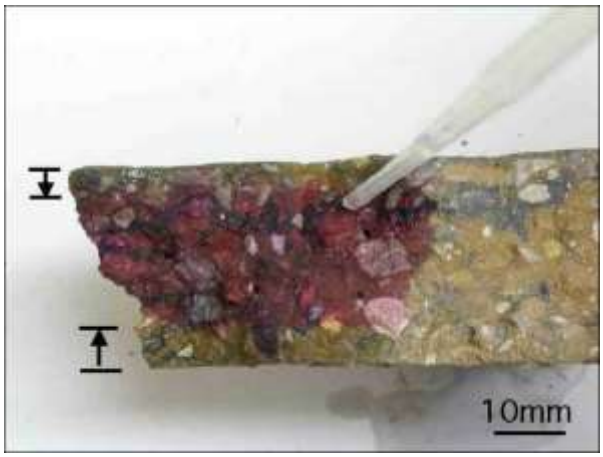
5. CARBONATION TEST

Carbonation test is held with a solution phenolphthalein ($C_{20}H_{14}O_4$), 1% strength, in isopropyl alcohol. Phenolphthalein is an indicator that changes its colour at pH 8,6. Its colour is clean at pH less than 8.6, while its colour is purple at pH above 8.6. The typical pH of sound, non-carbonated concrete is above 10, while fully-carbonated concrete has a pH of about 8.4. The higher the pH of the concrete matrix, the brighter the purple colour of the indicator.

Surface must be clean, without any laitance or other coatings and must be grinded up to sound concrete surface. A few drops of the phenolphthalein 1% solution is poured on the surface of the concrete, by dropper, and wait 1-2 minutes, until the change of its colour. It is highly recommended to repeat the test on several spots on the surface for more reliable results.

Alternatively, you may take a core sample and pour a few drops of the phenolphthalein 1% solution on it, by dropper, and wait 1-2 minutes, until the change of its colour (purple-clear), regarding to carbonation levels.

NOTE: The colour change will be apparent, where the solution has been poured. It is expected that there will be carbonated layers on the surface of the core (clear colour) and non-carbonated concrete layers in the middle (purple colour), as it is depicted below:



6. MIXING INSTRUCTIONS

Calcium Acetate

1. Take 5.5 lb (2.5 kg) of calcium acetate and place in a clean plastic 5.3 gal (20 Lt) drum.
2. Fill drum with water.
3. Shake the contents until all the powder dissolves.

The result will be 5.3 gal (20 Lt) of calcium acetate solution at approximately 12.5% strength. Add 4 parts of water to create 2.5% solution when required.

7. FOR CARBONATED/OLD CONCRETE

1. Firstly treat the concrete area with PENESEAL® PRO, as per application specification. Proceed with the first watering at 2 – 6 hours only.
2. For the second watering use a 2.5% solution of calcium acetate to be sprayed liberally on the surface.
3. Use normal water on Day 3 for the third watering.

8. FOR A CRACK REPAIR

This methodology can be followed when a crack is difficult to seal, or has been leached of calcium over time.

1. Ensure crack is free of surface laitance. Water blasting may be required. Allow concrete to dry.
2. Flood crack and surrounding surface with PENESEAL® PRO. Ensure material is penetrating the crack. A squeegee may be required to keep moving the PENESEAL® PRO over the crack. If PENESEAL® PRO is passing through the concrete, tape the underside to allow it to pond in the crack. Alternatively cement powder can be wiped onto the surface, which will flash-set on contact with PENESEAL® PRO.
3. Allow PENESEAL® PRO to become touch dry (2 – 6 hours), then apply 15% calcium acetate solution to crack.
4. On Day 2, treat with PENESEAL® PRO again. When dry spray with water.
5. On Day 3 undertake final watering.
6. Remove tape after 7 days.
7. Alternatively, post to crack grinding, damp the surface with water and then apply PENETRON®, by brush. After approximately half an hour and before PENETRON® gets dry, apply PENECRETE MORTAR®, by pressuring the material well into the crack.

If crack still leaks, repeat steps 1 to 3. Small voids may be present in the crack.

NOTE: If this does not work, then it is safe to assume a void exists in the crack beyond the product ability to work. (Refer to *Severe Crack Repair*).

9. SEVERE CRACK REPAIR

Contact PENETRON HELLAS at this stage for technical advice. Use this treatment, only if previous crack repair with calcium solution is not successful.

1. Using an angle grinder, cut a 5-10 mm groove into the slab at 90º. Then make two additional cuts at 45º. This result should be an arrowhead grind.
2. Spray PENESEAL® PRO into the cavity. DO NOT WATER.
3. Mix up expandable, plasticized grout in a small container, until a putty like consistency is achieved.
4. Place the grout (indicatively PENETRON® GROUT) into the cavity, forcing the material deep inside the arrowhead grind.
5. Allow for some minimal expansion, when cured at the top of the cavity. The expanding material will rise slightly.

The expansion nature of the grout will lock the patch into the cavity. PENESEAL® PRO will grow in both directions, bonding the mortar into the patch to the substrate, and at the same time alleviating any shrinkage around the patch.

10. CONCLUSION

Some variation in the above methodologies may occur from site to site. If you are uncertain of your site characteristics, contact PENETRON HELLAS for technical advice.

The application details described above do not constitute a construction project, but a technical proposition, according to relevant projects and to our knowledge and experience up to date. For more information, regarding the appropriate use, treatment and storage of Penetron products, please consult PENETRON HELLAS, *Product Data Sheet* and *Material Safety Data Sheet* for every product you use.

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