# USES AND APPLICATIONS OF CONCRETE SEALER X-1

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## Introduction

Concrete Sealer X-1 has been used as a low-cost sealer for concrete for many years. When applied to concrete or masonry it reacts with calcium hydroxide and reduces the porosity and permeability of the concrete matrix. This serves to increase the hardness and chemical resistance which, in turn, increases the service life of the surface.

Concrete Sealer X-1 is a silicate-based, water-soluble penetrating compound which will not scratch or peel off. Unlike other sealants, which either repel water (e.g. silanes, silicones, stearates) or function as a physical barrier coating (e.g. epoxies, polyesters, vinyls), Concrete Sealer X-1 sinks into the concrete surface and reacts with portlandite to form C-S-H gel according to the following reaction:

$$Na_2SiO_3 + y\,H_2O + xCa(OH)_2 \rightarrow xCaO\text{-}SiO_2 + y\,H_2O + 2NaOH$$

As a result, the surface has enhanced properties such as decreased permeability, increased hardness and overall increased durability.

## How Does Concrete Sealer X-1 Function?

Concrete Sealer X-1 is an effective concrete sealant but like cement itself, it yields the best results to those who thoroughly understand how it works:

When dry cement is mixed with water, the cement particles begin to dissolve and react to form a calcium silicate hydrate (C-S-H). The volume of C-S-H is greater than the original unhydrated cement particles, so as C-S-H form it fills in porosity, providing strength and rigidity to the cement. Another by-product of cement hydration is calcium hydroxide. The presence of calcium hydroxide adversely affects the properties of cement because it is attacked by acids and other chemicals. It also trends to crystalize as hexagonal platelets near the paste/aggregate interface, resulting in a poorly packed (i.e. low density) weak area. Applying Concrete Sealer X-1, however, reduces the amount of calcium hydroxide near the surface because the silicate reacts with the calcium hydroxide to form C-S-H (see chemical equation below). As a result, the surface is less permeable, more resistant to chemical attack and overall more durable. The C-S-H gel formed from this reaction is insoluble in water and more resistant to acid and other chemical attack.

All concrete is porous, although the type and amount of porosity can vary greatly from one concrete to the next. These differences occur because of the water-to-cement ratio, amount of working, quantity and type of aggregate, temperature and various other factors. Depending on its quality, method of placement and curing, a standard concrete can contain a significant percentage of calcium hydroxide which also contributes to porosity when it dissolves. Therefore, it is essential to convert the calcium hydroxide to C-S-H in order to increase the life of the concrete.

The final strength and properties of concrete are impacted by the amount of C-S-H it contains relative to its porosity. Therefore, Concrete Sealer X-1 increases concrete strength by replacing soluble lime with the C-S-H. Concrete Sealer X-1 increases the density of concrete because C-S-H forms where the calcium hydroxide used to be and, since chemicals attack concrete (and rebar) by penetrating the pores, the presence of more C-S-H increases the durability of the substrate.

**How to Use Concrete Sealer X-1 for Concrete Treatment**

Fresh concrete should be properly cured for a minimum of seven days before Concrete Sealer X-1 is applied. The Concrete Sealer X-1 treatment may be satisfactorily applied to clean concrete at any later time.

**Surface Preparation**

Concrete Sealer X-1 should not be applied to any surface that has already been treated with compounds that might prevent penetration of the silicate (e.g. paint, oil) or that interfere with the conversion of free lime to C-S-H. Since Concrete Sealer X-1 may be less effective if there is no free lime near the surface, carbonated concrete should be abraded.

Before any concrete is treated, the area must be thoroughly cleaned. The surface should first be swept with a broom to remove any loose dirt. Then it should be scrubbed with soapy water. This will remove the film of consolidated dirt and expose the true wearing surface. To get the best penetration the floor should be allowed to dry thoroughly for a minimum of 24 hours after cleaning.

**Coverage and Application**

Each gallon of Concrete Sealer X-2 is expected to cover approximately 300 square feet of concrete with one coat but since the porosity of concrete varies greatly, the coverage will also vary(200-400 sq ft). The solution may be applied with a brush, roller, sprayer, or scrubbing machine for several minutes to obtain an even penetration. After the surface has dried for 2 to 4 hours apply a second application.

A “blooming” or “frosting” of excess product on the concrete surface should be removed immediately with a stiff brush. Properly treated concrete may be painted without any difficulty. However, there should be no Concrete Sealer X-1 residue on the surface prior to painting. Washing with hot water will remove the alkalinity that may be due to the Concrete Sealer X-1. An alkali-resistant paint should be used.

**Factors Affecting Concrete Sealer X-1 Penetration Depth**

Penetration depth is a critical property for penetrating sealers, such as Concrete Sealer X-1, to function effectively. The deeper the penetration, the greater the thickness of concrete strengthened, thus improving wear resistance, the life span of traffic surfaces and durability.

The desirable depth is about ¼inch (6mm) with a minimum of about _inch (3mm). However the regular attainment of such penetration will require considerable care in surface preparation and in assuring that the concrete is properly dry. The quality of the concrete will also be a major factor in the depth of penetration obtained. Penetration depths may be greater with poor quality porous concrete while a 6mm depth may not be possible with high-quality dense concrete.

**Substrates for Concrete Sealer X-1 Treatment**

Concrete Sealer X-1 can be used to treat concrete walls and floors, storage tanks, building blocks, roadways, driveways, runways, warehouse floors, and other types of masonry surfaces.

**Safety and Handling**

Concrete Sealer X-1 constitutes a family of moderate to strongly alkaline products. As such, it warrants careful handling to prevent injury or discomfort. The Material Safety Data Sheets (MSDS) for this product list all handling precautions and required safety equipment and is available upon request from Stone Technologies. Concrete Sealer X-1 is completely inorganic and, as such, does not present a hazard such as low flash point or flammability. Please refer to the MSDS prior to handling and use.

**ASTM Testing of Concrete Sealer X-1**

Four standardized tests or characterization methods were used to quantify the effects of Concrete Sealer X-1 when used on concrete as follows:

**Summary of Standardized Tests**

| Test | Property |
|---|---|
| NCHRP 244 | Chloride penetration |
| AASHTO T-277-83 | Chloride permeability |
| Scanning Electron Microscopy | Surface morphology characterization |
| ASTM C 418 | Abrasion resistance |

**1. NCHRP 244 Testing and Results**

The samples were laboratory concrete with w/c = 0.48, 16.9% OPC, 40.2% coarse aggregate, 34.8% sand and air entrainer. Concrete Sealer X-1 was applied with a brush and after 20 minutes of drying, a second coating was applied. The samples were analyzed for chloride permeability (AASHTO T-277-83) and chloride penetration (NCHRP 244) and was also viewed in the scanning electron microscope (SEM).

Because the NCHRP 244 test may be unfamiliar, a brief description follows:

1. 4-inch cubes are cast, demolded after 1 day, and lightly sandblasted on the seventh day. Throughout these first 7 days and for the next 14 days, the cubes are cured in plastic bags at 23°C. The cubes are weighed every 7 days.
2. The cubes are then removed from the bags and stored in air at 23°C, 50%RH. Three samples are coated after 1 day of air drying, 3 more after 5 days, and 3 more after 21 days. After being coated, the samples are returned to the curing chamber to complete a total of 31 days curing in air. Five samples are not coated but serve as the controls. During this period the cubes are weighed periodically.
3. All of the coated samples plus three of the controls are immersed in a 15% NaCl solution for 21 days and weighed periodically.
4. Samples are removed from the solution and returned to the chamber at 23°C, 50% RH for 21 days. Again, they are weighed every few days throughout the 21-day period.
5. At the end, the samples are crushed and analyzed for Cl.

For the NCHRP 244 chloride penetration test, the results showed that the weight gained during immersion in NaCl was 30% less for treated sample than for the untreated sample, indicating that less chloride is penetrating into the coated concrete. This was further supported by analyzing for chloride in the bulk sample.

**2. <u>AASHTO T-277-83 Testing and Results</u>**

Chloride permeability was measured on 6-month-old laboratory specimens. The results are shown below. The control samples for 1 and 28 day treatment ages are the same as the treated samples (values for 5-hour data are presented instead of normal 6-hour because the 28-day control sample began to overheat after 5 hours of the test). The treatment resulted in about 21.8% improvement for the 1-day samples and 32.0%improvement for the 28-day-old samples.

**<u>Chloride Permeability Results</u>**

| **Treatment** | **Age of Coating** | **Charge Passed After 5 Hrs (Coulombs)** | **% of Control** |
|---|---|---|---|
| Control | 1 day | 12599 | -- |
| Concrete Sealer X-1 | 1 day | 9979 | 79.2 |
| Control | 28 days | 13219 | -- |
| Concrete Sealer X-1 | 28 days | 8993 | 68.0 |

**3. <u>Scanning Electron Microscopy (SEM) Results</u>**

SEM micrographs of uncoated and coated concrete showed a stark contrast in surface texture is evident; the untreated sample appeared rough and pitted, but the treated sample is smooth. Silicone X-ray dot maps showed the brightness of the coated specimen indicating the abundance of silicone on the surface. Conversely from the calcium dot map the untreated sample appeared very bright, whereas the treated sample was much darker as a result of the calcium being covered by the layer of Concrete Sealer X-1. The implication of these results is that the coated surface would be less susceptible to detrimental reactions involving calcium, for example acid attack of portlandite.

**4. <u>ASTM C 418 Testing and Results</u>**

Commercial paving blocks were used in these tests. The lower the abrasion co-efficient in this test the higher the abrasion resistance of the concrete block. An untreated block produced an abrasion co-efficient of 0.72 and a block treated with Concrete Sealer X-1 produced an abrasion co-efficient of 0.24. This represents a 67% decrease in the abrasion co-efficient for the paving block treated with Concrete Sealer X-1.