

Protectosil® – Your Partner in Building Protection




Protectosil®

 **EVONIK**
Leading Beyond Chemistry



For more than 50 years Evonik has been researching, developing, and producing silanes

The unique chemical structure of silanes unlocks a highly complex world of possibilities. Time and again, silanes have changed and improved a wide variety of applications – even making some possible to begin with.

In building protection, silanes provide unsurpassed durability and longevity to treated substrates without impacting function or aesthetic.

Protectosil® is one of Evonik's best-known brands and has been used in building protection for over 30 years. Our Protectosil® building protection portfolio includes graffiti protection, easy-to-clean and stone consolidation solutions, water repellents and corrosion inhibitors. Protectosil® products protect valuable structures while conserving resources and significantly reducing maintenance costs.

As a result of intensive research and development, new Protectosil® products are always being brought to the market, and with such a vast portfolio, a long-term solution can be found for almost any situation.

Protectosil® – Your Partner in Building Protection

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Our Protectosil® product portfolio offers numerous solutions to many building situations

Why Building Protection?

Protectosil® building protection products protect your buildings and your investments

With building protection products from Evonik you gain:

- longer maintenance cycles
- lower maintenance costs
- no change in surface appearance
- a longer lifespan and service life
- excellent resistance to chloride ion ingress

Many well-known buildings throughout the world are protected with Protectosil® building protection products. The use of these products can prevent serious damage such as:

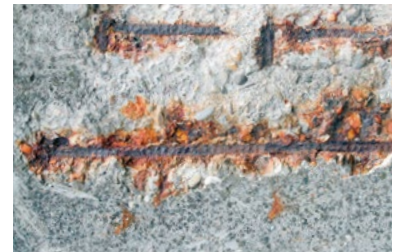
- corrosion of reinforcing steel bars in concrete structures
- efflorescence
- salt burst
- freeze-thaw damage
- acid rain attack
- algae, mold infestation, moss, and other contamination
- graffiti

The wide spectrum of Protectosil® building protection products enables you to choose the optimal product or product combination for almost any substrate:

- concrete
- brick
- natural stone
- sandstone
- marble
- granite

Protectosil® products can be divided into the following application categories:

- water repellency
- surface protection
- graffiti protection
- corrosion protection
- stone consolidation





Protectosil® protects the Opera House in Sydney, Australia

Protectosil®: A Global Success Story

.....
The Protectosil® brand has gained an excellent reputation in the field of building protection.
.....

Protectosil® has earned this success over the years through excellent product quality. The Protectosil® product range offers the appropriate solution

for every requirement. The Sydney Opera House in Australia, the Museum of Military History in Vienna, Austria, and the Victory Column on the Place Vendôme in Paris, France are just a few of our best-known projects.

Though not every one of our projects is high-profile, there's one thing they all have in common: the results exceed expectation – and the benefits always outweigh the costs.

How Do Protectosil® Water Repellents Work?



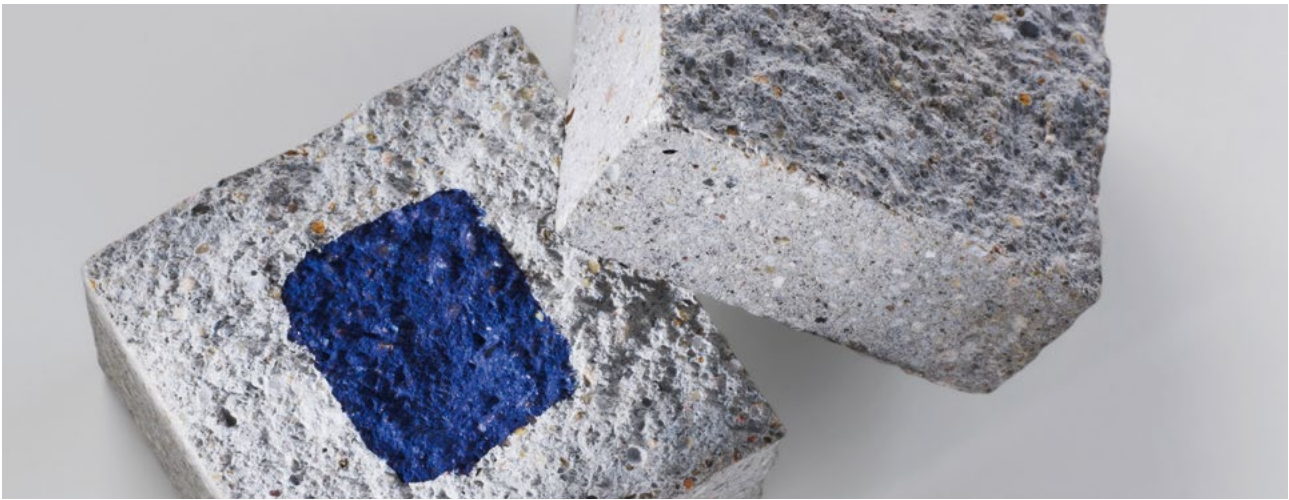
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Water intrusion is the driving force behind almost all damage to mineral building materials.
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The porous structure of mineral building materials allows for water and dissolved contaminants to penetrate from the surface into the interior of the structure via capillary action. This may cause a very wide range of problems, from the corrosion of reinforcing steel in concrete due to chloride intrusion or freeze-thaw damage from deicing salt.

Preventing the ingress of water into a structure significantly reduces the extent of potential damage. The key question is, how?

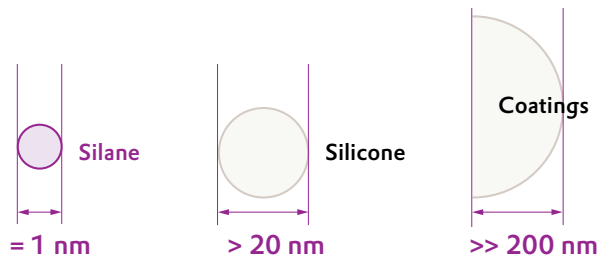
Treatment with Protectosil® offers a highly efficient level of protection: Protectosil® hydrophobic products bond permanently to the walls of the substrate pores, forming a hydrophobic protective layer. The substrate is thus permanently and effectively protected against moisture penetration. At the same time, treated substrates maintain 100 percent moisture vapor transmission, thus no liquid moisture is trapped in the substrate after treatment, allowing water vapor to escape from the interior without any problem. Protectosil® water repellents, which penetrate deep into the interior of the building material, have a protective action that allows water to bead off.



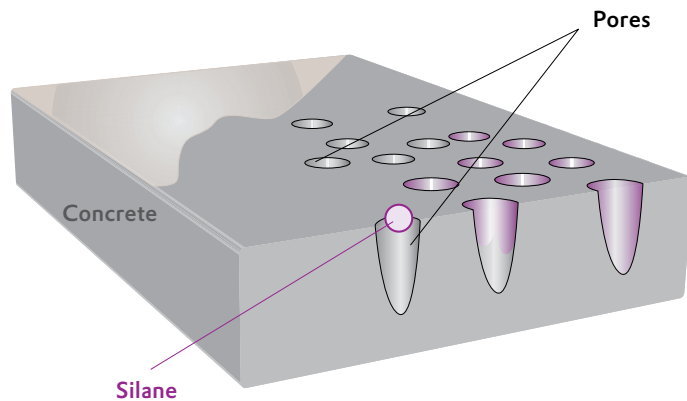


Protectosil® products offer deep penetration into the substrate resulting in a protective barrier that forms from within the structure

▶▶▶ In contrast to Protectosil® water repellents, film forming building protection agents, such as acrylic based systems, block and fill substrate pores. This prevents water intrusion into the substrate but similarly does not allow moisture vapor to escape.



Depending on environmental conditions, water vapor may condense within a building structure and can lead to the growth of dangerous mold. In addition, film forming coatings can be damaged or destroyed by the sun and other environmental exposures, allowing water to once again penetrate the building.



Protectosil®: deep hydrophobing for optimal protection

The molecule size of silane-based Protectosil® water repellents are significantly smaller than silicones and have very low viscosity.

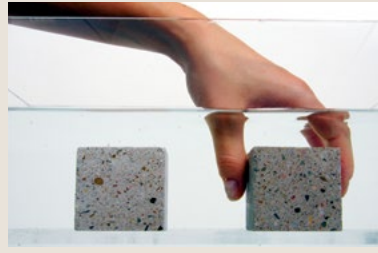
This allows Protectosil® molecules to penetrate deep into building materials to bond chemically and permanently to a pore's interior walls, resulting in the extremely effective hydrophobization of the pore structure. The diagram above shows this mechanism of action in a highly simplified form.

The deep penetration of this protective treatment offers two major advantages: Neither UV radiation nor mechanical wear can reduce or eliminate the protective action of Protectosil®.

Siloxanes, due to their molecular size of >20 nm, cannot penetrate the pore structure, and ultimately this action may be weakened by environmental pollution.



1 Two test specimens were used, one of which was hydrophobized with Protectosil® BHN while the other remained untreated.



2 Both specimens were dried for two weeks and then submerged in water in a basin for 3 hours, and 12 hours.



3 After submersion in water the specimens were broken apart and inspected visually.

Hydrophobing with Protectosil®: The Advantages at a Glance

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The use of highly effective molecules with low viscosity is critical for efficient hydrophobing.
.....

Protectosil® uses liquid monomeric alkylsilanes to create hydrophobic layers within a substrate. These molecules bond chemically with the building material, effectively preventing water from penetrating into the building envelope.

This has various advantages:

- Protectosil® water repellents offer deep protection that cannot be destroyed by UV exposure or abrasive load (e.g., traffic).
- The protective action of Protectosil® lasts significantly longer than that of a coating.
- Protectosil® water repellent products do not change the appearance of the substrate.
- After treatment with Protectosil® water repellents the surface can be treated further, for example with a colored paint.



4 After three hours of immersion in water, the unprotected test specimen absorbed water (the darker region in Fig. 4), with the exception of a small area in the center, while the specimen protected by Protectosil® BHN showed no discoloration due to water penetration.



5 After 12 hours, water completely penetrated through (darker coloration) the unprotected test specimen, while the specimen protected by Protectosil® BHN showed no water absorption.

Long term hydrophobic effectiveness

Beading effect is not the most appropriate indicator of hydrophobic effectiveness; the measurement of water uptake is more informative.

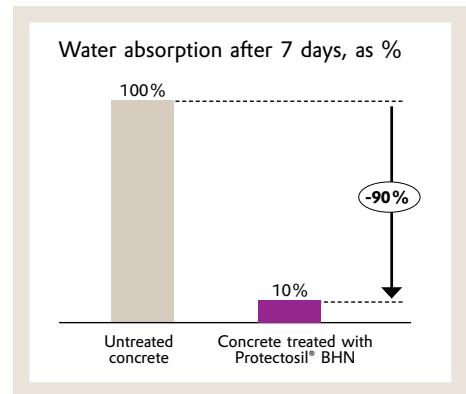
The measurement of water uptake can also be performed non-destructively on existing buildings using a Karsten (or Rilem) tube. Another common quality test consists of taking core samples and testing them in the laboratory.



Protectosil® BHN effectively prevents penetration of water.

The figures above show the results of a 3-hour and 12-hour test using two standard concrete test specimens.

The results show convincingly that even after 12 hours no water penetrated the specimen protected by Protectosil® (Figure 5).



Protectosil® BHN significantly reduces water uptake.

In further tests, a test specimen protected by Protectosil® BHN and an unprotected specimen were tested in a 10 cm water column for seven days. Compared with the unprotected concrete, water uptake in the treated test specimen was reduced by 90 percent.

Protectosil® Does the Job – Today, Tomorrow, and Decades Later

In many structures, such as bridges and parking decks, it is especially important to ensure durable and effective protection against the penetration of water. Protectosil® makes this possible, even where UV radiation or deicing salt severely stresses the structure.

The below diagram shows the reduction in water uptake of a bridge deck's concrete after 10 years of constant traffic exposure.

The higher the active ingredient content of Protectosil® used in application, the higher the reduction in water content after a long period of use.



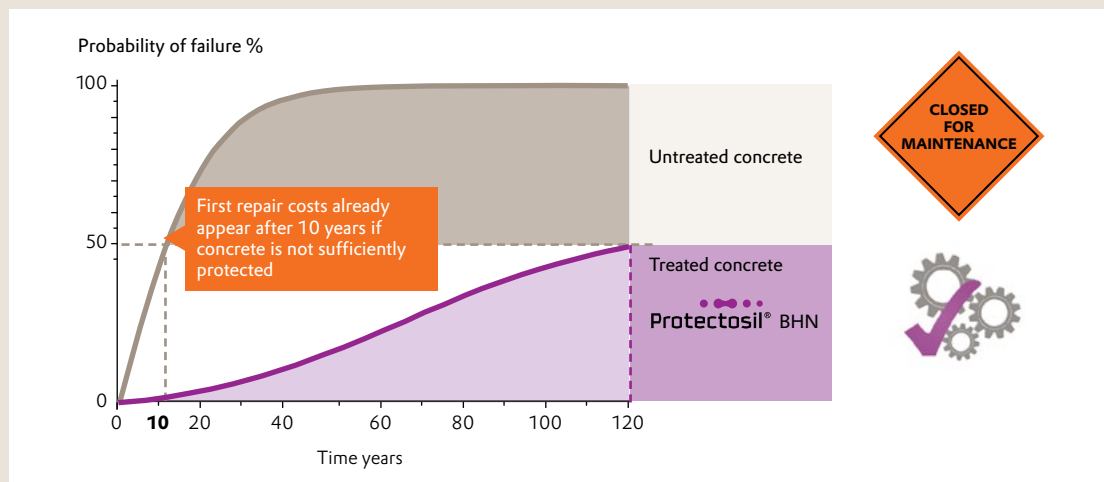
Case Study: Container Terminal, Zeebrugge, Belgium

Protectosil® BHN prolongs the service life of a structure to more than 100 years

The University of Leuven (Belgium) has been regularly monitoring the effectiveness of Protectosil® BHN on a quay wall of the container terminal in Zeebrugge, Belgium over a period of 12 years. The chloride penetration profiles that have been obtained over this period, along with data on a wide variety of material

properties, have allowed for modeling to be conducted to calculate the expected service life of a structure. The diagram below shows the probability of structural damage, and the service life predicted, on an untreated section of quay wall and a section treated with Protectosil® BHN*.

Predicted service life



Protectosil® water repellents are usually applied by the airless spray technique. Full effectiveness was shown to have been retained even after 12 years.

*Schueremans et. Al, Chloride Penetration in RC-Structures in Marine Climate: Proc. Int. Workshop on Durability of Reinforced Concrete, (2005 Qingdao, China) p. 169-179.

Penetrating Water Repellents Provide a Barrier of Protection



Protectosil® provides the Evonik building in Johannesburg, South Africa long-term protection against wind and weather

.....
Protectosil® water repellents can be combined with other coating systems such as paints and varnishes.
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When this happens, it is important to understand the adhesion of paints and coatings to a hydrophobized surface.

Laboratory testing has proven that for the most common paints and coatings,

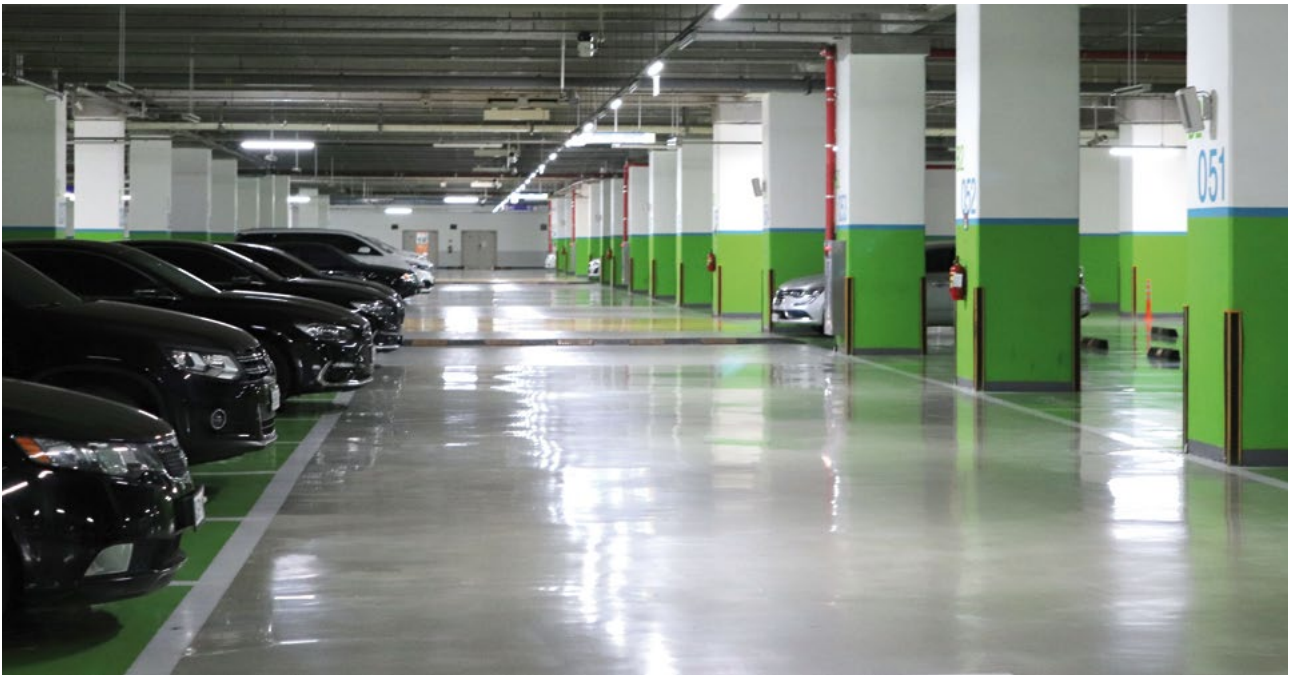
optimal adhesion to a Protectosil® hydrophobized surface has been achieved. Tests were performed in accordance with the specifications of TPOS₁₎ and ZTV-ING₂₎.

As described in the following Combination Systems section, the additional application of Protectosil ANTIGRAFFITI® over Protectosil® water repellents kept surfaces clear

of graffiti. The table to the right shows the results of various coatings on hydrophobized concrete surfaces in accordance with TPOS Pkt 5.2. The tests were performed with coatings based on styrene acrylic dispersions and methacrylate resins.

¹⁾ Technical Test Specifications for Surface Protection Systems

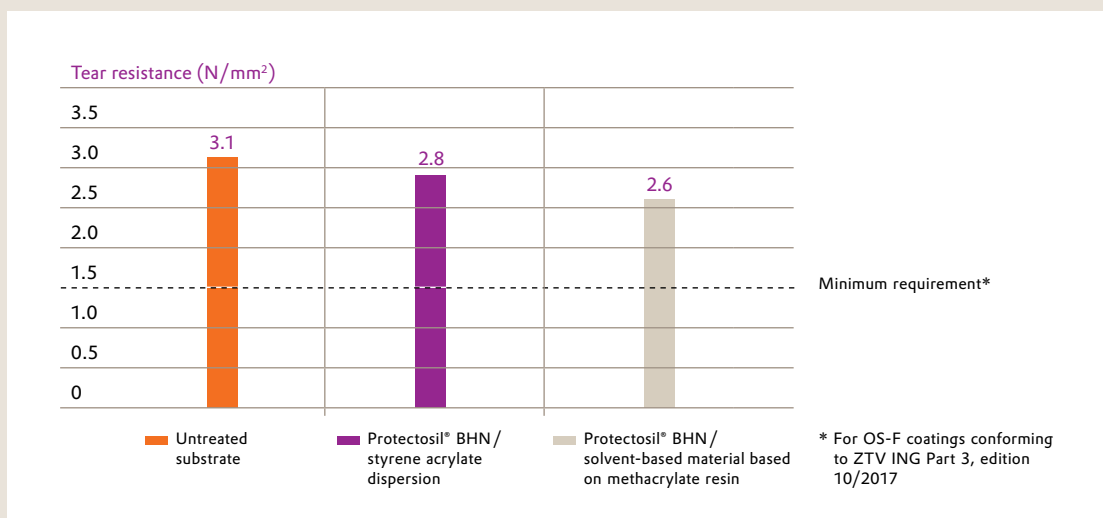
²⁾ Additional technical contractual terms and guidelines for protection and maintenance of concrete components, Bundesminister für Verkehr, 1990



Protectosil® water repellents protect the concrete underneath the coating

A test after freeze-thaw and various temperature cycles proves that the adhesion of styrene acrylate dispersions and solvent-based methacrylate resins is not negatively impacted by pretreatment with Protectosil® BHN.

Peel strength after the use of deicing salt and temperature change





Protectosil® shields the facade of the City Hall in Wesel, Germany

Surface Protection Against Water and Oil with Protectosil®

Effective and permanent

.....
The functionality of the building materials used in private and public buildings is just as important to consider as the function of the building itself.
.....

Hardly any building is constructed today without heavy consideration on how it can be built most effectively. Banks, shopping malls, train and subway stations, for example, are all important structures in modern day, and therefore must be protected and preserved. The Protectosil® portfolio consists of products specifically created for the protection of building

and structure surfaces. The right Protectosil® SC product can protect building surfaces, concrete facades, and walls against environmental influences, water staining, moss, algae, mold, soot and oil stains with high reliability over the long term. They do this by producing low-energy surfaces that are highly hydro- and oleophobic.

However, these oleophobic and hydrophobic products are not a substitute for hydrophobing. These dual functioning oleophobic and hydrophobic products offer minimal

penetration into the substrate and should be combined with an alkyl silane water repellent to achieve long term water repellency.

Unlike standard coatings, which seal the surface, Protectosil® products allow water vapor to escape so that moisture is not trapped in the interior; the building can breathe and is effectively protected.

A Range of Products for Long-Lasting Aesthetics



Budapest Castle in Hungary has been treated with Protectosil®

.....
The Protectosil® SC product range provides a cost-efficient solution for easy-to-clean surfaces that protects against stains, moss, and molds.
.....

The Protectosil® SC product range offers tailor-made solutions for long-term needs for a variety of construction materials. There are many products available depending on the type of surface protection desired and the preferred method of application.



- **NEW CONSTRUCTION**

Protectosil® offers outstanding protection against graffiti and staining.



- **HISTORIC LANDMARKS**

Protectosil® offers a range of products for protecting sandstone and other porous surfaces.



- **ENGINEERED STRUCTURES**

A range of application technologies allow fast and efficient protection of large projects.



- **MONUMENTS**

With Protectosil® surface protection, monuments are effectively protected against graffiti, with no change in their visual appearance.

Easy-To-Clean Surfaces with Protectosil®

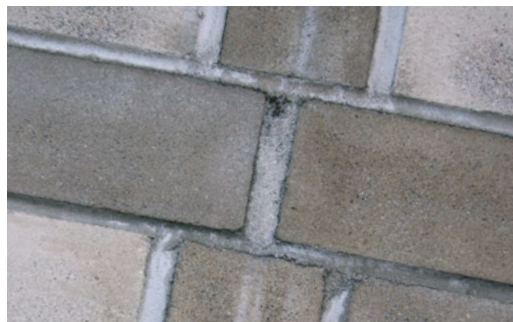
.....
Environmental influences, such as pollution, can negatively impact the appearance of facades.
.....

Whether it is mold, algae, moss, or soot, the Protectosil® SC product range ensures that surfaces can be easily cleaned, thus reducing maintenance costs. The Protectosil® SC product range offers the ideal properties for protection of porous substrates, such as sandstone and concrete, and is additionally ecofriendly as well as easy to apply.

After 18 years of weathering the difference is clearly visible.



Treated with Protectosil® SC CONCENTRATE (without cleaning)



Untreated (without cleaning)

Case Study: Stadelhofen Train Station, Zurich, Switzerland

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The Stadelhofen train station is a concrete building exposed to harsh weather conditions and frequently used by travelers.
.....

During renovation, all surfaces were cleaned and protected with Protectosil® BHN and Protectosil® SC 60 via airless spraying. This has protected the station and will allow it to remain beautiful with less maintenance required.



Tailor-Made UV and Weather Resistant Surface Protection System

Weather resistance is an important indicator for long-term effectiveness of Protectosil® SC products.

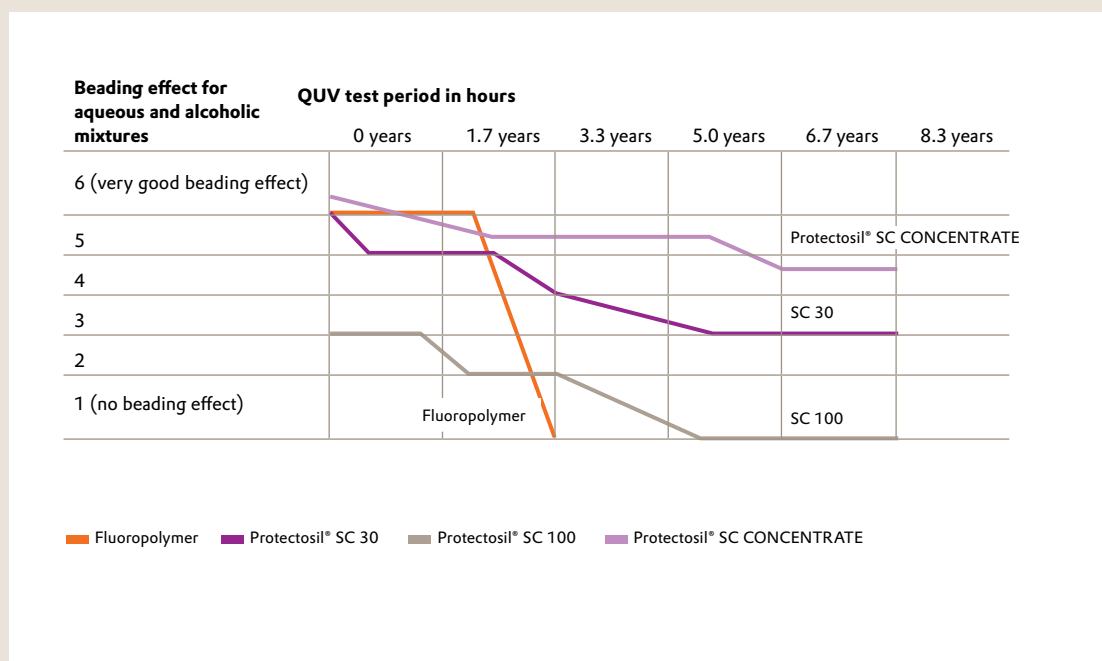
Weather resistance can be tested outdoors, which is very time consuming, or in a laboratory using special UV weathering bulbs, in accordance with EN ISO 11507 (QUV test). A comparison of the respective performances and damage profiles indicates that 1 year of outdoor weathering (for weather conditions in Southwestern Germany)

corresponds to about 300 hours of accelerated weathering. Tailor-made products ranging from Protectosil® SC CONCENTRATE to Protectosil® SC 100 cover the entire range of long-term effects.

The diagram below shows the action of various Protectosil® SC products. The beading effect, which is an indicator of the ease of cleaning, is reduced over time by weathering (due to wear caused by sunshine, rain, or snow).

The beading effect of Protectosil® SC CONCENTRATE persists longer than that of Protectosil® SC 100. It should be noted that all Protectosil® SC products have much higher weathering resistance than fluoropolymers.

Long-term effect of various Protectosil® SC products on red sandstone



Long-Lasting Water Repellent Effect with Protectosil®

Buildings must be protected against damage caused by water and the substances that are dissolved in it.

To improve aesthetic appearance, a silicone-resin or silicate paint is often used on building surfaces and may need an easy-to-clean or antigraffiti surface treatment. The Protectosil® brand offers a large selection of building protection agents. Most products are highly compatible with the above-mentioned paint systems so that optimal results can be achieved. The combination of Protectosil® water repellents (such as Protectosil® BHN)

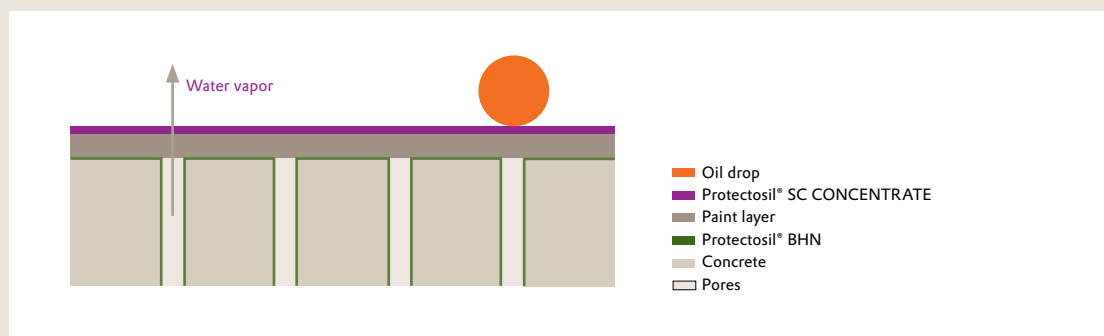
and surface protection products (the Protectosil® SC series) create the best possible long-term protection for a building.

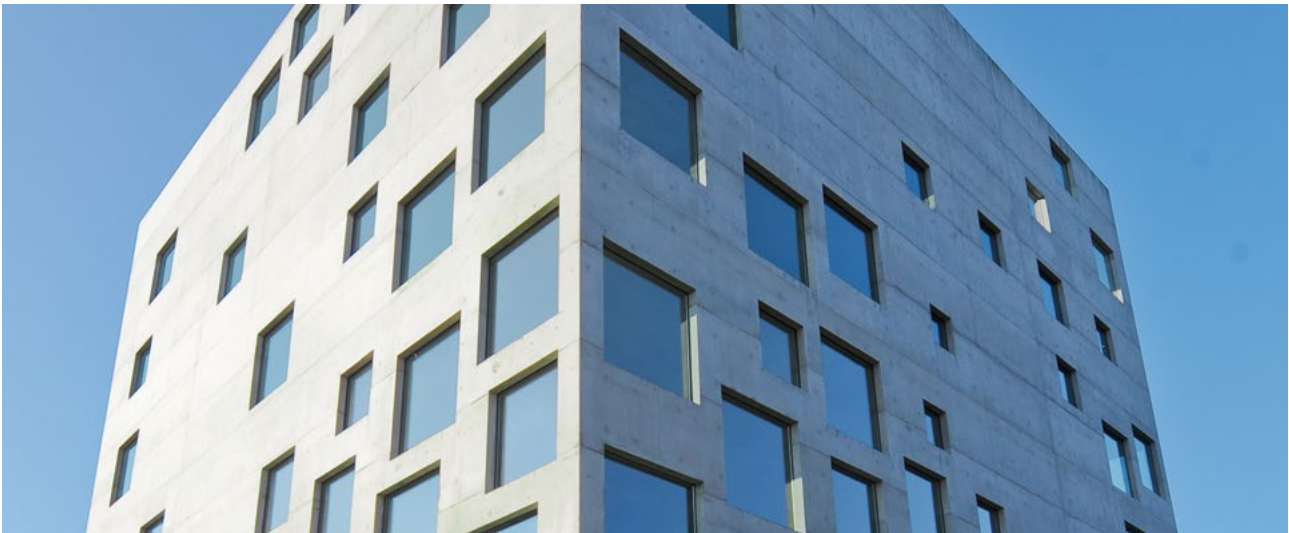
If, for example, Protectosil® BHN was initially applied to a wall which was then painted with a silicone-resin paint and lastly, treated with Protectosil® SC CONCENTRATE, the color of the silicone-resin paint is protected against soiling and fading which improves the lifetime of the paint and makes the need to repaint less frequent. Even if paint is damaged by UV radiation or cracks, the building

structure remains protected against penetration of water and pollutants because of the initial application of Protectosil® BHN.

This combination of products allows for durably beautiful and breathable facades.

Combination of hydrophobing, façade paint, and easy-to-clean effect





Protectosil® protects the facade of the "Design School Zollverein" in Essen, Germany

Long-term effectiveness of Protectosil® SC CONCENTRATE used in conjunction with silicone-resin paints

There are functional as well as aesthetic reasons for combining building protection agents.

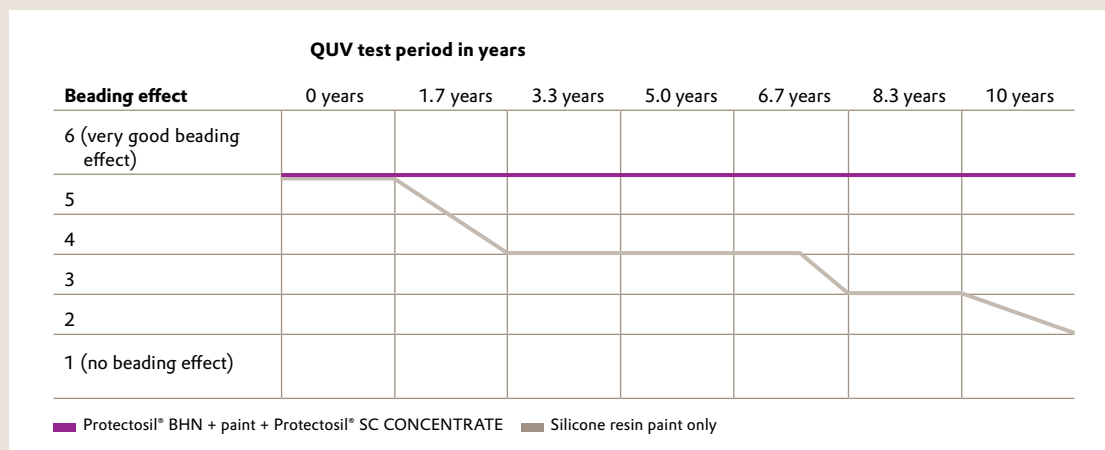
From a functional viewpoint, the building envelope can be protected against moisture intrusion with Protectosil® BHN. From an aesthetic viewpoint, Protectosil® SC

CONCENTRATE protects against algae, moss, mold, and dirt.

The diagram below illustrates the effect of Protectosil® SC CONCENTRATE in increasing the long-term resistance of a silicone-resin paint to water- and oil-based dirt. When exposed to greater than 2,000 hours of accelerated

weathering, the beading effect of the paint decreases, while the improved protection offered by Protectosil® SC CONCENTRATE remains unchanged when exposed to over 3,000 hours of accelerated weathering (corresponding to 10 years of outdoor weathering).

Long-term effect of combined building protection agents



Effective Graffiti Protection with Protectosil®



Protectosil ANTIGRAFFITI® SP protects the marble mosaic CHORUS/WTC in New York, USA

.....
Keeping buildings free of graffiti is a difficult task, especially when the job must be done quickly, efficiently, and cost effectively.
.....

Protectosil ANTIGRAFFITI® and Protectosil ANTIGRAFFITI® SP are the right products for the job. The more a building is used by the public, and the less protected it is, the higher the probability that it will be targeted by graffiti artists. The longer that graffiti remains visible and is not removed from a building, the more likely it is that other graffiti artists will compound

the damage. Protectosil ANTIGRAFFITI® offers the exact protection needed to successfully counter these risks.

Once an artist starts spraying a surface protected with Protectosil ANTIGRAFFITI®, it becomes immediately clear that paint cannot adhere to the surface: the spray paint runs, and the graffiti cannot be created as planned. Many graffiti artists give up in frustration. Even a small motif or "tag", the signature of a graffiti artist, cannot be completed.

Since the surface is protected with Protectosil ANTIGRAFFITI®, paints and marker inks can be quickly and easily removed. After a preliminary check, commercially available cleaners can be used. Fast and consistent removal of graffiti at the very outset means effective protection against graffiti. This is an efficient and cost-effective way to protect buildings.



Application of Protectosil ANTIGRAFFITI® SP



Cleaning of a wall with graffiti art

.....
Protectosil® is easy to apply.

Protectosil ANTIGRAFFITI® can be quickly and cost effectively applied using the simple HVLP (high volume low pressure)* spray method. Short drying times of 10 to 60 minutes allow several treatments to be applied without long waits, depending on the substrate.

Protectosil ANTIGRAFFITI® SP offers even greater flexibility. This semi-permanent graffiti protection system can be applied by the HVLP spray technique or by brush or roller.

SIMPLE APPLICATION MEANS:

- use of standard devices
- fast drying time
- not having to wait long to apply several coats

Quite often it is only a "tag" (a short signature), made with spray paint or marker ink, that sprayers leave behind – but even defilement of this type can be removed immediately.

Graffiti can be easily removed from a surface protected with Protectosil ANTIGRAFFITI® or Protectosil ANTIGRAFFITI® SP, using a high-pressure cleaner (< 12 bar) or a brush and chemical cleaner.

Depending on the composition of the graffiti paint, water or ethanol may be all that is required. In other cases, the use of a commercially available graffiti remover is recommended to free the surface from graffiti and tags. High water pressure equipment of the type shown top right is suitable for fast cleaning of large, flat surfaces protected with Protectosil ANTIGRAFFITI®.

SIMPLE CLEANING MEANS:

- low manpower requirements
- cleaning entirely by hand
- no specialist skills required

* <http://www.wagner-group.com>



Graffiti Protection That's Nearly Invisible

A special advantage of Protectosil ANTIGRAFFITI® systems is their near-invisible protective action.

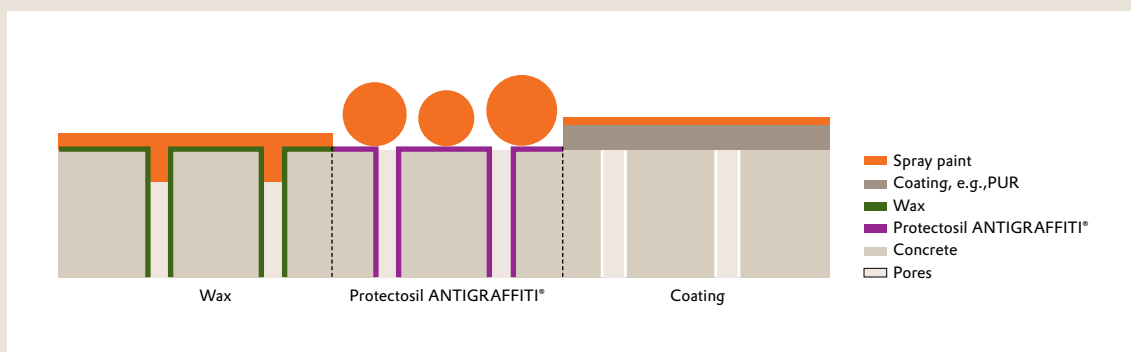
Protectosil® offers effective protection for a variety of substrates, without altering their external appearance. Protectosil® is not a coating in the conventional sense. The diagram below shows the efficient mode of action for protecting surfaces against liquid or oily substances. Protectosil

ANTIGRAFFITI® produces an effective beading effect without sealing the surface of the building material as, for example, polyurethane systems do. The water vapor permeability of the substrate is thus retained.

Protectosil ANTIGRAFFITI® and Protectosil ANTIGRAFFITI® SP repel water and oil, which means that surfaces treated with them repel aqueous and oily soils. Neither water-

based nor oil-based paints, coatings, or marker inks can penetrate into the pores of the building material or adhere to them, so that images and signatures run off and the sprayers do not obtain the effects they want.

Mode of action of various antigraffiti systems: substrate after spraying attacks



Water Vapor Permeability: The "How" and the "Why"

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Protectosil ANTIGRAFFITI® ensures that surfaces are protected against various graffiti paints and coatings.

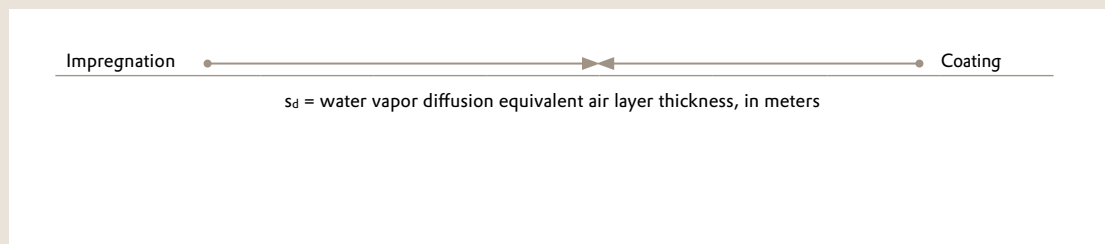
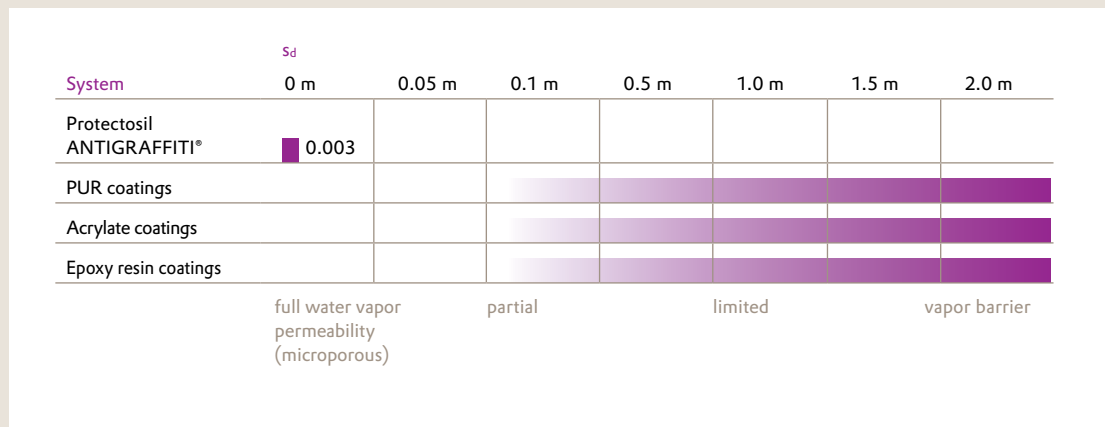
Water vapor permeability must additionally be preserved to protect the building material. Traditional coatings seal the surface of a substrate so that water vapor can only escape to a limited extent, if at all. By contrast,

with Protectosil ANTIGRAFFITI®, water vapor can escape almost unhindered from the interior of a treated material.

Convincing proof is offered by the s_d value, a measure of how permeable a membrane is to water vapor, which in Protectosil ANTIGRAFFITI® is only 0.003 m.

This is considerably lower than in polyurethane (PUR), acrylate, or epoxy resin systems, which have s_d values of 1.0.

Graffiti protection systems compared: water vapor permeability





Concrete wall after removal of graffiti

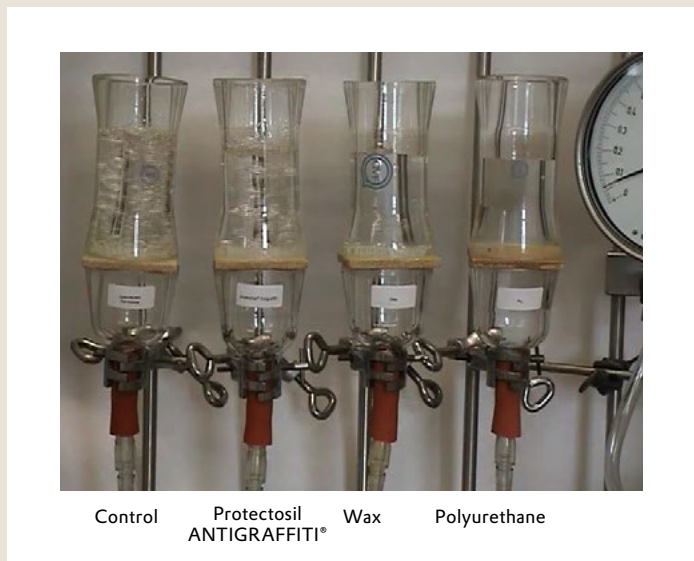
FREE MOVEMENT OF WATER VAPOR MEANS:

- no damage to the substrate through trapped moisture
- optimal building climate
- retention of the natural surface structure

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Protectosil® graffiti protection products are solvent-free and environmentally friendly.

During the development of Protectosil ANTIGRAFFITI®, Protectosil ANTIGRAFFITI® PRIMER, and Protectosil ANTIGRAFFITI® SP, sustainability was highly important. Solvents and other potentially hazardous substances were avoided. As a result, Protectosil® graffiti protection products contain almost no VOCs (volatile organic compounds) and no special precautions are required during application.

Unique water vapor permeability



SOLVENT-FREE MEANS:

- water-based
- environmentally compatible
- not hazardous to health

Protectosil ANTIGRAFFITI® Protects Permanently

Antigraffiti systems can be divided into three classes: temporary, semi-permanent, and permanent.

Temporary systems must be reapplied after each cleaning while permanent systems can withstand more than ten cleanings before the surface protection has to be refreshed. Protectosil ANTIGRAFFITI® molecules bond chemically to the building surface and are weather resistant, so that long-term protection is ensured.



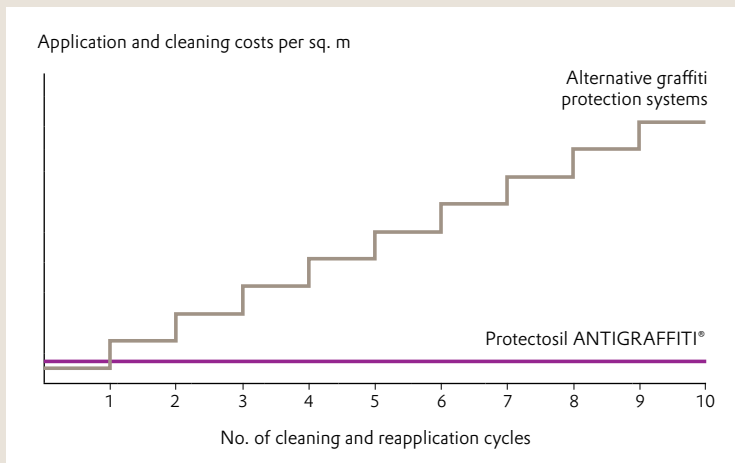
Protectosil ANTIGRAFFITI® protects the white marble facade of the State Theatre in Darmstadt, Germany

PERMANENT MEANS:

- UV-stable
- weather resistant
- no reapplication needed even after several cleaning cycles

Some types of sandstone and dense concrete tend to darken. If this effect is not desired, pretreatment with

Protectosil® BHN is recommended to avoid darkening, with no loss of durability or water vapor permeability.



Protectosil ANTIGRAFFITI® is cost effective.

The costs per square meter of pure product and the application costs for it are comparable with those for permanent polyurethane systems. Temporary systems appear at first glance to be more reasonably priced but need to be reapplied after each cleaning. In terms of overall costs, Protectosil ANTIGRAFFITI® offers significant advantages over these systems.

Corrosion Protection with Protectosil®

Extended service life and low maintenance costs for reinforced concrete structures

.....
Corrosion of reinforced concrete structures such as buildings, bridges, and parking garages cost billions of dollars to repair each year.
.....

Therefore, it is important to prevent corrosion of the reinforcing steel on which the stability of the structure depends.

Damage to reinforced concrete structures can happen when chloride ions dissolved in water penetrate into the concrete. Chlorides can be introduced to reinforced concrete through the use of deicing salts during winter time or salt spray in coastal environments. Potential damage from

chloride-induced corrosion ranges from spalling at the concrete surface to pitting of the embedded rebar, endangering the stability of the entire reinforced concrete structure. This requires cost- and labor-intensive repairs.

High-performance Protectosil® products have been developed to protect reinforced concrete structures exposed to high amounts of chlorides.

Water is the transport medium for chloride ions. If the chloride ions reach the steel reinforcement, corrosion can initiate. In order to prevent corrosion, it is necessary to either stop penetration of the water soluble

chlorides into the building material, or to permanently prevent the chlorides from penetrating through to the surface of the steel reinforcement.



The 7,000 piers of the Hangzhou Bay Bridge in China are anchored in the seabed. Protectosil® CIT protects them against penetration of water and chemicals



The parking areas of Universal Studios in Orlando, Florida, USA have been protected against corrosion by Protectosil® CIT

Protectosil® Corrosion Protection Products

Protectosil® products can be used for various applications and types of use

	SURFACE APPLICATION	CONCRETE ADMIXTURE – COMPONENT OF CONCRETE FORMULATION
Existing building	yes	no
New construction	yes	yes

Protectosil® corrosion protection products have a unique and effective mechanism of action consisting of two sub-mechanisms.

1. The organofunctional silane reacts with the components of the concrete, developing hydrophobic properties. This reduces the further penetration of water and the pollutants, such as chloride ions, dissolved in it.

2. The organofunctional silane also bonds to the surface of the steel reinforcement, thus helping to rebuild the protective passivating layer on the steel surface. Protectosil® corrosion protection products have been proven effective in environments where existing chloride content is significantly above the critical chloride threshold at which corrosion is initiated.

Protectosil® for Existing Structures



Protectosil® CIT protects 90,000 square meters of concrete decking on the Commodore Barry Bridge in Pennsylvania, USA against corrosion. After application, the bridge was able to be used by cars and trucks shortly after the road surface had dried, which was roughly 1 hour.

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Protectosil® products developed specifically for existing buildings and materials can be applied, with standard spray equipment, directly to the appropriately cleaned surface.
.....

As soon as the Protectosil® material has penetrated into the substrate, road surfaces, for example, can immediately be opened again for use. When using Protectosil® the shutdown time of any roadway or bridge is kept to a minimum.

For newly constructed reinforced concrete structures, Protectosil® can significantly improve their longevity and durability right from the start.

Years of Experience with Protectosil® Corrosion Protection Products



The quay wall of the Zeebrugge container terminal in Belgium is protected with Protectosil®

.....
Protectosil® CIT is an organofunctional silane corrosion protection system from Evonik, particularly developed for very dense reinforced concrete surfaces.
.....

This scientifically proven corrosion protection makes Protectosil® CIT the first choice for repairing corrosion

damage. Protectosil® CIT has been successfully used throughout the world since the mid-1990s.

Protectosil® CIT Proven to be Effective in Chloride Contaminated Structures

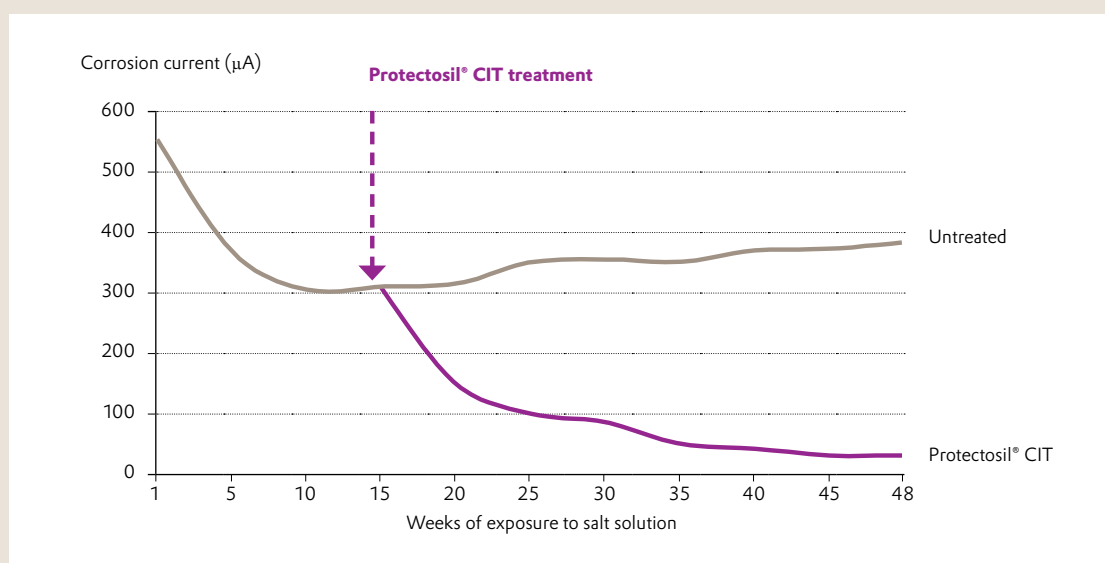
Protectosil® CIT effectiveness has been confirmed through several independent external test institution reports and a multitude of worldwide references.

WJE Associates, tested Protectosil® CIT on concrete samples in accordance with the guidelines of the US Federal Highway Administration. In these tests, two concrete test samples, one treated with Protectosil®

CIT and one untreated, were subjected to cyclic loading with 15 percent salt solution. The corrosion current generated was recorded. The untreated reference sample immediately showed a steadily increasing corrosion current, while no corrosion activity of any kind could be detected over the entire test period in the samples treated with Protectosil® CIT.

The protective properties of Protectosil® CIT have additionally been confirmed with measurements on several reference projects.

In the case of the Monroe County Parking Garage, an approx. 45-year old building in Pennsylvania, USA, the corrosion current was measured in 1996 and the corrosion rate was found to be $0.68 \mu\text{A}/\text{cm}^2$, indicating active corrosion. >>>

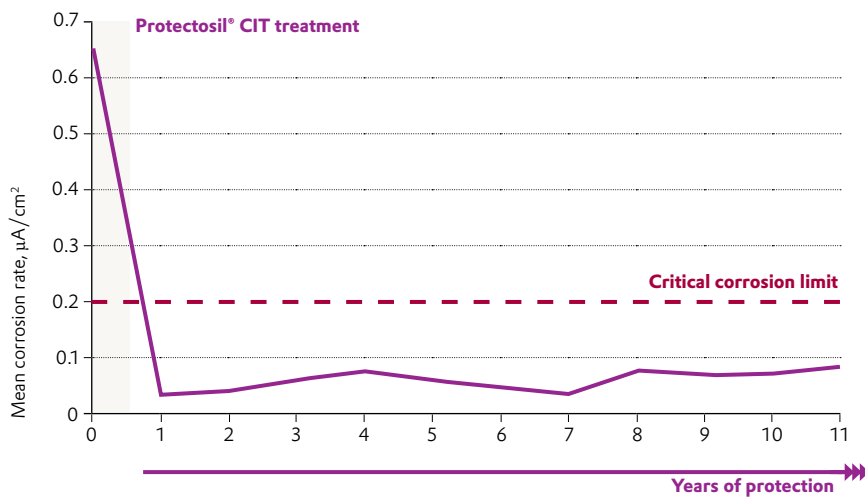


The result: Protectosil® CIT reduces the corrosion current in the actively corroding test samples by 90%



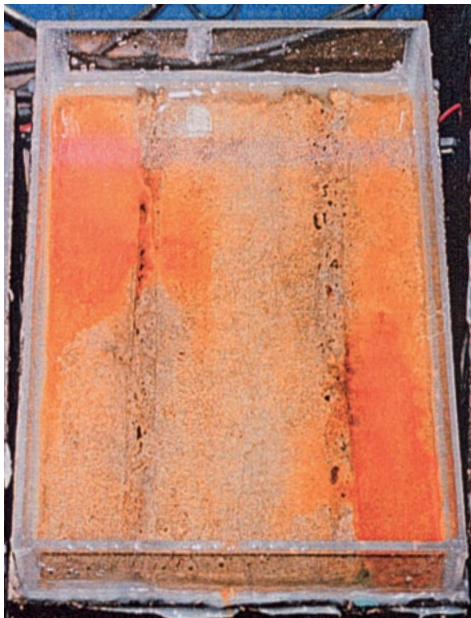
The Monroe County Parking Garage is protected with Protectosil® CIT against deterioration by corrosion

- ▶▶ For values under $0.2 \mu\text{A}/\text{cm}^2$, passive corrosion is present, with only a very small probability of damage appearing. The measurements carried out during the test period show that even in a building that has been damaged by corrosion, one-time use of Protectosil® CIT reduces the continued corrosion of the reinforcing steel. Protectosil® CIT can reduce corrosion to the extent that the corrosion rate remains significantly below the critical current density over the long term, thus extending the time to when repairs would have to occur again.

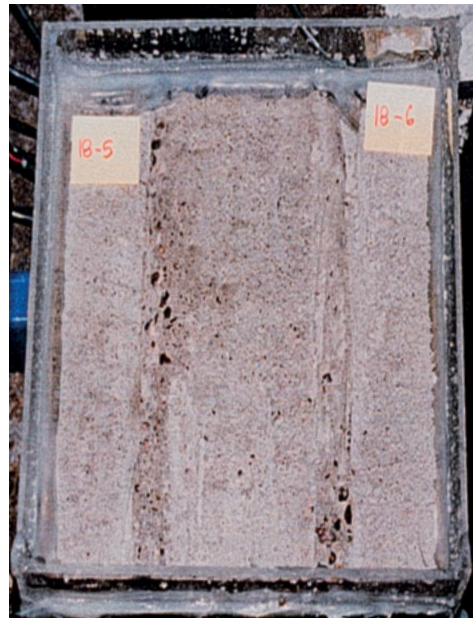


Protectosil® CIT Also Works on Cracked Concrete

Test samples after 12 weeks of storage in a 15% NaCl solution



Untreated



Treated with Protectosil® CIT

WJE Associates, carried out another test on concrete samples with 0.3 mm cracks on the reinforcing steel (see photo on the left).

Some of these test samples were

treated with Protectosil® CIT while others remained untreated.

All of the test samples were exposed to a 15 percent salt solution for about 12 weeks. Following the test,

corrosion was clearly seen in the untreated test samples. The samples protected with Protectosil® CIT showed no corrosion.

¹⁾Wiss, Janney, Elstner Associates Inc.

Protectosil® Corrosion Protection in Formulations for New Reinforced Concrete Structures

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Protectosil® corrosion protection products have been developed for use as admixtures in concrete.
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These include concrete repair mortars and special concretes for new structures built in high-chloride environments, including those present in port facilities, road construction, and parking garages. In the mixing process for these building materials, active ingredients are homogeneously distributed throughout the matrix to form a permanent fixed protective layer on the surface of the reinforcing steel.

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Protectosil® corrosion protection products are available in powder form and as an aqueous emulsion.
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For applications in concrete, Protectosil® WA CIT bears a CE label



and is categorized as a water resistant admixture for concrete according to EN 934-2:T9. The performance of the Protectosil® products, however, exceeds these requirements by far.

Protectosil® DRY CIT is designed in powder form in order to formulate high class concrete repair mortars with durable corrosion protection properties. It was awarded the Innovation Prize in the Products of

High Architectonic Quality category at DEUBAU by the architecture journals AIT, ABIT, and xia Intelligente Architektur.

Materials formulated with Protectosil® corrosion protection agents have outstanding wetting properties, with no effect on surface appearance, breathability, and subsequent coating adherence to the treated concrete.

Long-Term Corrosion Protection Properties Confirmed by Independent Testing Agency

Proof that Protectosil® protects against corrosion has been obtained from external tests by the SGK (the Swiss Society for Corrosion Protection) based on a practically oriented test scenario involving cyclic chloride loading and drying.



A single test cycle lasted 7 days and consisted of loading with a salt solution followed by a subsequent drying phase. As a rule of thumb, 2 load cycles can be considered equivalent to one year. To assess the corrosion activity in embedded reinforcing steel, spe-

cially fabricated measurement sensors were placed in concrete cover of 10 mm, 30 mm, and 50 mm.

The chloride content in the test specimen continuously increased over the duration of the test. Continuous



Appearance of the sensors after a 520-day test load (calculated period of 30-35 years)

	Chloride content at the depth of the sensor, relative to cement content	Sensors after 520-day test
Reference	5.8 M%	Heavy corrosion pitting: 
Protected with Protectosil®	1.6 M%	No evidence of corrosion: 

It is generally acknowledged that the critical corrosion-inducing chloride content is 0.8% relative to cement content.



Damage done to an unprotected specimen

▶▶ recording of the corrosion currents at the individual sensors therefore provided specific information on the start of corrosion activity, without the need to destroy the test sample.

At the conclusion of the test, the chloride content values determined by

the sensors at various depths in the concrete, as well as assessment of the visual appearance, provided information on corrosion activity and damage to the test sample interior.

The SGK tests offer convincing proof that Protectosil® corrosion protection

agents very effectively protect embedded reinforcing steel against corrosion and damage over the long term, even when the chloride content significantly exceeds the critical corrosion triggering threshold.

In-House "LOLLIPOP" Corrosion Test

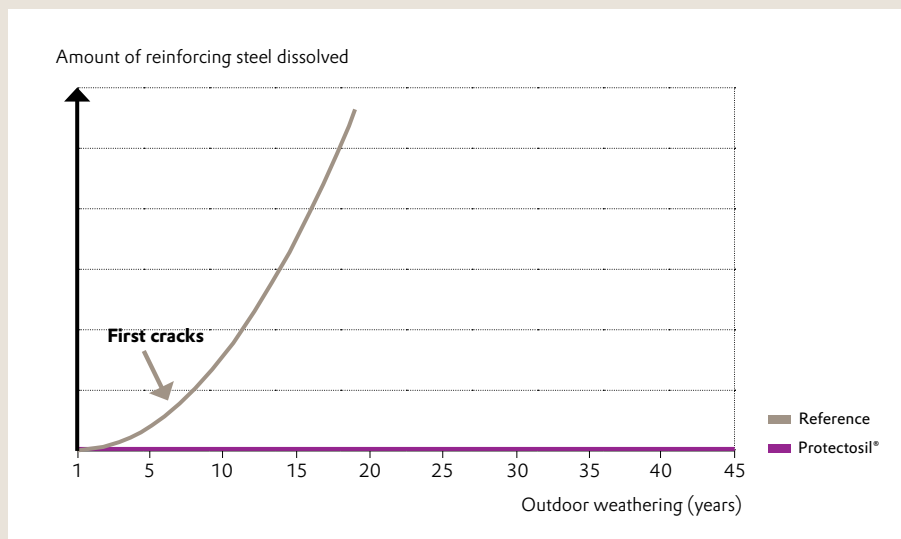
A non-destructive in-house method has been developed to investigate the interaction between Protectosil® products and a wide variety of building materials such as concrete, repair mortars, and corrosion protection coatings.

The procedure for this laboratory test is similar to that for the SGK tests: all generated corrosion currents are recorded, and after every cycle the

building material is inspected for visual damage such as cracking or discoloration.

Using Faraday's law, the corrosion currents that are obtained can be used to calculate the amount of reinforcing steel that has dissolved. Below is a diagram of the typical behavior of a reference mixture compared with a test sample protected with Protectosil®.

The reference sample shows corrosion activity from the first test cycle, and cracks on the surface after a time span of 7 years. The sample protected with Protectosil®, on the other hand, shows no corrosion activity or damage, even after a test period of about 45 years.





Laboratory test in progress

EVONIK OPERATIONS GMBH

Business Line Silanes
Rodenbacher Chaussee 4
63457 Hanau
Germany

protectosil@evonik.com

<https://www.protectosil.com/product/protectosil/en/contact/>

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