

PLANISEAL WR

Hydrophobising migrating
protection for reinforced
concrete structures





**READY-MIXED SILANE-BASED
HYDROPHOBISING MIGRATING PRODUCTS
FOR PROTECTING THE SURFACE
OF EXPOSED CONCRETE**

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Hydrophobising migrating protection for reinforced concrete structures

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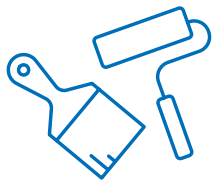
PLANISEAL WR

**Ready-mixed silane-based
hydrophobising migrating products
for protecting the surface of exposed
concrete**



Main characteristics

- Comply with Euronorm EN 1504-2 (products for the protection of concrete)
- Have no effect on the finish or breathability of substrates
- Migrate deep-down into substrates
- Protect reinforced concrete structures exposed to aggressive agents
- Considerably reduce water and chloride ingress, thereby preventing corrosion phenomena
- Prevent deterioration caused by freeze-thaw cycles, including when de-icing salts are present
- Suitable for protecting both new exposed concrete and restored exposed concrete
- May be applied over both horizontal and vertical surfaces of porous or compact concrete



The main **causes of deterioration** due to moisture in concrete

Concrete is a porous material and its level of compactness depends on the water/cement ratio employed to prepare the mix. The porosity within its structure provides an access route for moisture and for dissolved pollutants contained in the moisture. The main reasons concrete deteriorates due to the presence of water are as follows:

- 1) Freeze-thaw cycles
- 2) Aggression by sulphates
- 3) Aggression by chlorides
- 4) Alkali-aggregate reactions



Deterioration of concrete due to freeze-thaw cycles

Freeze-thaw cycles

This is due to the presence of water in its liquid state contained in the porosity of the cementitious matrix. Deterioration due to freeze-thaw cycles occurs when the amount of moisture exceeds what is known as “critical saturation”, which is around 92%. When water freezes its volume increases by 9%, thereby generating stresses which, in turn, lead to the formation of cracks in the concrete. The onset of this problem clearly depends on the porosity of the conglomerate and its saturation level. To prevent deterioration caused by freeze-thaw cycles, it is possible to work on several parameters:

- Limit the amount of micro-porosity (0.1-10 μm) by maintaining a low water/cement ratio in the concrete. In so doing, water ingress from outside the concrete is reduced.
- Mix the concrete so that the amount of macro-porosity (100-300 μm) is around 4-8% in volume, depending on the size of the aggregates in the mix, by including an aerating product in the mix design. Once ice has formed, any water that has not yet frozen is pushed inside macro-bubbles and passes through a network of capillary pores. The purpose of these macro-bubbles is to contain the particles of water and act as a kind of parking area for them. This will prevent the increase in pressure, following the increase in volume caused by freezing, which generates levels of stress high enough to cause the onset of cracking in the concrete.

Aggression by sulphates

Sulphate attack on concrete is due to the interaction of sulphate ions (SO_4^{2-}) with the products and materials in the cementitious matrix. Sulphate ions contained in the atmosphere, in the ground and in water penetrate into the pores of the cementitious conglomerate and interact with calcium hydroxide $\text{Ca}(\text{OH})_2$ to form gypsum. The gypsum, in turn, may then react with hydrated calcium aluminate (C-A-H) present in the concrete and form secondary ettringite, which causes swelling, cracking and detachment in the concrete due to an increase in volume. In cold and damp environments ($0-10^\circ\text{C}$ and R.H. $> 95\%$), and in the presence of calcium carbonates dispersed in the cementitious matrix (CaCO_3), sulphate attack is manifested by the formation of thaumasite, which basically “crushes” the concrete due to it losing its strength.

Aggression by chlorides

The ingress of chloride ions into the cementitious matrix is one of the main factors that limit the durability of reinforced concrete structures. Chlorides depassivate the rebar in the concrete by removing its film of protective, impermeable ferrous oxide and triggers the corrosion process when oxygen and water are present. This is why the most exposed structures are those near the sea, in direct contact with seawater along the shoreline and those treated with de-icing salts. The penetration of chlorides through the layer of concrete takes place in two ways:

- by capillary suction of seawater carrying chlorides;
- diffusion of chloride ions in the pores of the cementitious matrix saturated with water. The penetration rate of chlorides depends on the concentration gradient and diffusion coefficient, which are closely connected to the quality of the concrete; the higher the water/cement ratio, the higher the penetration rate of chlorides. Corrosion phenomenon reduces the section of the rebar and, as a result, triggers off a series of structural problems.



Detachment of portions of concrete caused by the aggression by sulphates



Typical example of aggression by chlorides

Alkali-aggregate reactions

The alkali-aggregate reaction originates from the presence of aggregates containing reactive silicates in the concrete, which react with alkalis (sodium and potassium) and with water to form voluminous sodium silicate and potassium hydrate gel. The reactive aggregates near the surface of the concrete, and so more exposed to contact with water and moisture, increase in volume due to the formation of this gel and cause small portions of the concrete to lift up (pop-outs), or trigger off irregular macro-cracking which drastically limits the durability of the structure.

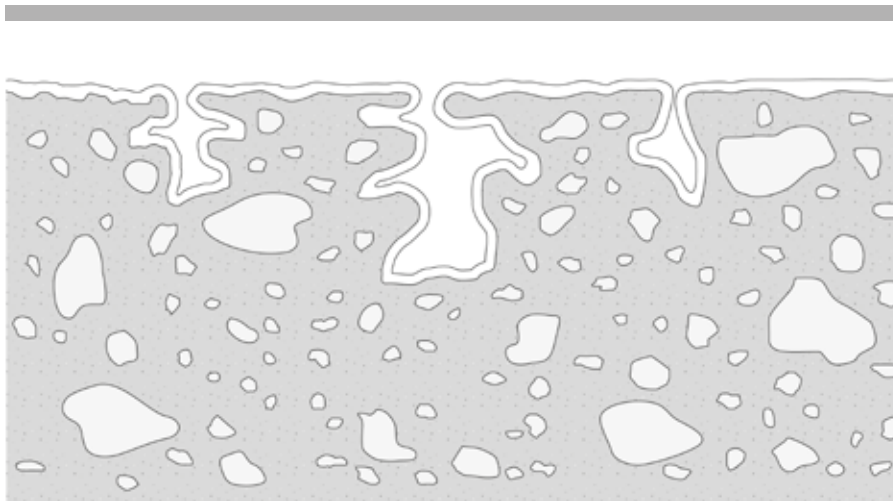


Typical example of alkali-aggregate reaction



Hydrophobic impregnation

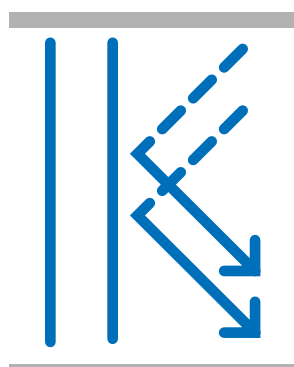
Whatever the type of deterioration, the most common cause is the presence of moisture in the concrete, which is why it is very important to limit the ingress of water as much as possible. Hydrophobic impregnation according to EN 1504-2 (*"Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 2: Surface protection systems for concrete"*) is defined as a treatment for concrete in order to obtain a water-repellent surface whose pores and capillaries are internally coated without being blocked in order to maintain their permeability to vapour.



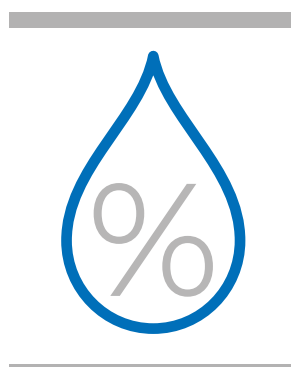
How hydrophobic impregnation works

This type of protection does not create a film on the surface of the concrete neither does it modify its external appearance, but allows the durability of structures to be increased quite considerably by creating a water-repellent effect.

EN 1504-9 defines the principles and methods associated with defects in concrete and indicates suitable techniques and interventions that may be carried out in order to satisfy these principles. Hydrophobic impregnation complies with Principle 1 [PI], Principle 2 [MC] and Principle 8 [IR].



Principle 1 (PI)
Protection
against ingress



Principle 2 (MC)
Moisture
control



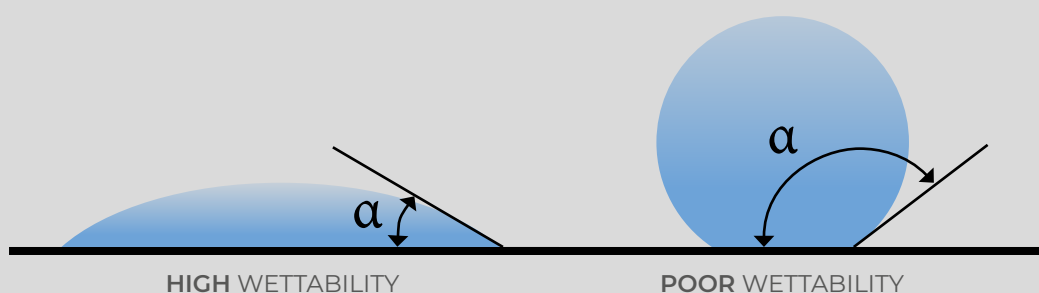
Principle 8 (IR)
Increasing
resistivity

Principle 1 [PI] (Protection against ingress) indicates all the methods and techniques that are able to reduce or prevent ingress of external agents such as water, other liquids, vapour, gas and chemical or biological agents.

Principle 2 [MC] (Moisture control) is the principle that gives indications on methods to regulate and maintain the moisture content of concrete.

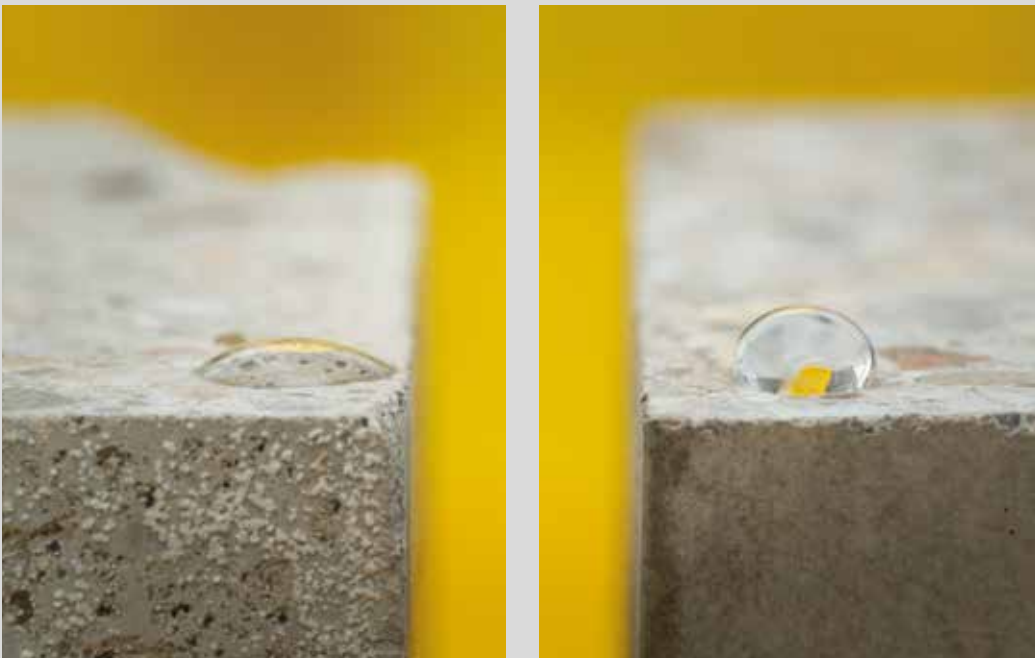
Principle 8 [IR] (Increasing resistivity) is closely associated with Principle 2, in that by reducing the moisture content of concrete by treating the surface, it is possible to limit the flow of ions into the structure and, as a result, reduce the probability of triggering deterioration phenomena due to corrosion processes.

The term “hydrophobic” means the ability of a material to resist absorbing water from its surroundings, to resist holding the water and to resist propagating the water inside the material. The **hydrophilic** or **hydrophobic** capacity of a surface is identified by measuring the contact angle a water droplet forms when it comes into contact with the surface. The contact angle (α) is defined as the angle formed by the tangent of the liquid-fluid interface and the tangent of the solid surface.

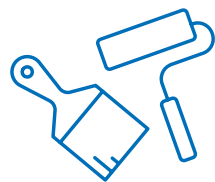


Comparison between a hydrophilic surface and a hydrophobic surface

In the case of **hydrophilic** capacity and, therefore, its affinity with water, the contact angle formed $\alpha < 90^\circ$. The smaller the contact angle, the more hydrophilic the surface. The opposite is true for **hydrophobic** capacity, which is identified by the formation of a contact angle $\alpha > 90^\circ$. The larger the contact angle, the more hydrophobic the surface, until a condition of super-hydrophobic capacity is reached for contact angles of more than 150° .



Hydrophobic effect: comparison between a test sample with no treatment and a test sample treated with Planiseal WR 85 Gel



The **Planiseal WR** range



The products from the **Planiseal WR** range are particularly recommended for protecting all reinforced concrete structures exposed to aggressive agents and, thanks to their particular composition, they may be applied on the vertical and horizontal surfaces of porous or compact concrete, directly on new concrete, on restored concrete and on concrete that has yet to show signs of detachment. This line of products was specially developed to guarantee high performance properties in terms of durability and protection for structures, while at the same time to have no effect on the appearance of the substrate. The application of products from the **Planiseal WR** range on the surface of concrete offers a number of advantages:

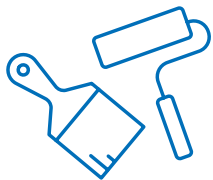
- Drastic **reduction** in the **absorption of water and chlorides**;
- **Prevention** of **corrosion** of steel reinforcement;
- **Increase** in **durability** of both new and repaired structures;
- **Protection** of structures in **exposed concrete** without changing their appearance;
- No **film** on treated surfaces.



Drop Effect on a surface treated with Planiseal WR

The **Planiseal WR** range includes the following products:

- **Planiseal WR 40**;
- **Planiseal WR 100**;
- **Planiseal WR 85 Gel**.



Planiseal WR 40

Planiseal WR 40 is a ready-to-use 40% silane-based, hydrophobising, migrating liquid in water emulsion applied on the surface of reinforced concrete structures in two coats. The second coat may be applied while the first coat is still wet, as long as it has penetrated into the substrate. Thanks to its composition, **Planiseal WR 40** can protect medium-quality concrete surfaces from degradation caused by pouring rain, without changing the aspect and breathability of the substrate. The product is particularly recommended for floor slabs, front edges of balconies, stringcourses.

Planiseal WR 40 has the following characteristics:

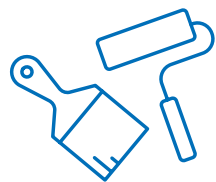
- Liquid with low viscosity and solvent-free;
- Penetrates quickly into the surface of concrete;
- Ready to use;
- Active substance content of around 40%;
- May be applied with a roller or brush;
- Consumption: 0.1-0.2 kg/m² per coat.



Mixing of **Planiseal WR 40**



Application of **Planiseal WR 40** by roller



Planiseal WR 100



Planiseal WR 100 is a ready-to-use pure silane-based, hydrophobising, protective, migrating liquid applied on the surface of reinforced concrete structures in two coats. The second coat may be applied while the first coat is still wet, as long as it has penetrated into the substrate.

Planiseal WR 100 is particularly recommended for protecting all reinforced concrete structures exposed to aggressive agents such as chlorides and to damage caused by freeze-thaw cycles. Thanks to its special formulation, **Planiseal WR 100** may be applied directly on both vertical and horizontal surfaces of porous and compact concrete, on new concrete and on concrete that has already been repaired. The product is particularly recommended for the protection of piles and abutments on bridges and viaducts, floor slabs, structures in marine environments such as quaysides, jetties, pre-fabricated reinforced concrete structures and concrete foundations. Thanks to its special composition, the product travels through the capillary pores and penetrates deep down into concrete to form a hydrophobic coating.

Planiseal WR 100 has the following characteristics:

- Liquid with low viscosity and solvent-free;
- Penetrates quickly into the surface of concrete;
- Ready to use;
- Made from pure silane;
- May be applied by spray, with a roller or brush;
- Consumption: 0.1-0.2 kg/m² per coat.



Application of **Planiseal WR 100** with a roller



Application of **Planiseal WR 100** by spray



Planiseal WR 85 Gel

Planiseal WR 85 Gel is a ready-to-use, hydrophobising, protective, migrating, silane-based thixotropic impregnating gel applied on the surface of reinforced concrete structures in a single coat.

Thanks to its high level of thixotropy, **Planiseal WR 85 Gel** has a high contact time which allows it to penetrate deep down into the substrate, including vertical substrates, and into compact, high-quality concrete, thereby extending the service life of structures. Thanks to its special composition, it penetrates deep down into concrete through capillary action and forms a hydrophobic coating that protects concrete against deterioration. It can be successfully used in all the structures that require a high level of protection and penetration such as piles, floor slabs and abutments on bridges and viaducts, and for all structures in marine environments. **Planiseal WR 85 Gel** has the following characteristics:

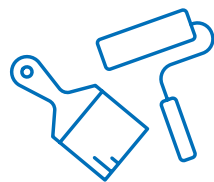
- Solvent-free gel;
- High contact time;
- High penetration depth;
- Ready to use;
- Active substance content of around 85%;
- May be applied with a roller or by airless spray;
- Consumption: 0.3-0.5 kg/m² in a single coat.



Application of **Planiseal WR 85 Gel** by spray

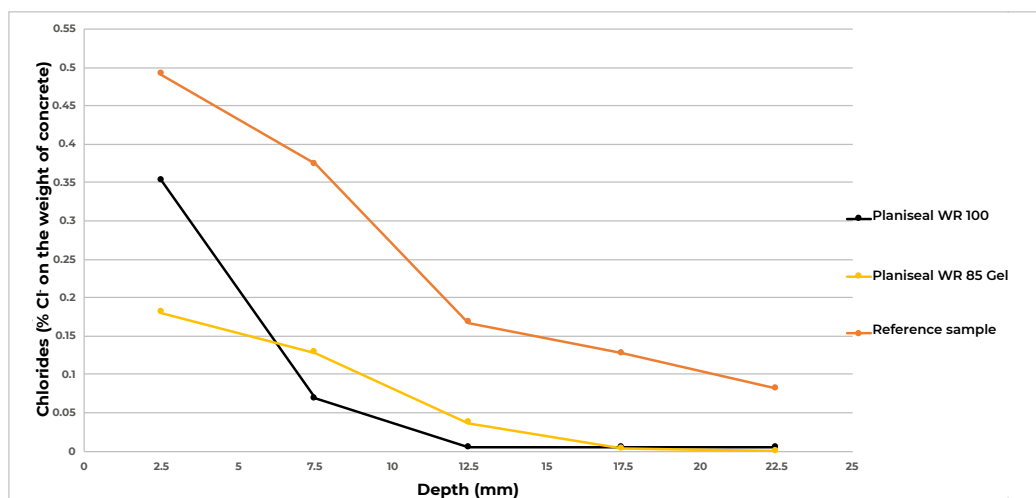


Penetration depth of a concrete test sample treated with **Planiseal WR 85 Gel**



Chloride diffusion

Planiseal WR 100 and **Planiseal WR 85 Gel** drastically reduce the diffusion of chlorides and prevent the corrosion of rebar. The graph below shows the results of tests carried out to show the reduction in chloride ion diffusion on test samples treated with **Planiseal WR 100** and **Planiseal WR 85 Gel** and on test samples with no treatment. The tests were conducted in compliance with NT Build 515. To carry out the tests, a series of samples were prepared using concrete with a water/cement ratio of 0.45 and cured in a climate simulation chamber. Before being tested, the samples were maintained for 7 days at +20°C and 60% R.H. and then immersed in 15% NaCl solution for 56 days. After 56 days, the chloride content of all the samples used in the tests was measured at various depths. The graph below was produced based on the results obtained. Using the graph, the reduction in chloride ion diffusion was calculated as the difference in percentage of the area below the line representing the treated samples compared with the area below the line representing the samples without treatment.



Tests according to NT Build 515 to calculate the reduction in chloride ion diffusion

Below are the results obtained using **Planiseal WR 100** and **Planiseal WR 85 Gel**:

	REDUCTION IN CHLORIDE ION DIFFUSION
Planiseal WR 100	63%
Planiseal WR 85 Gel	70%

Main characteristics of the Planiseal WR range

	TEST METHOD	REQUIREMENTS ACCORDING TO EN 1504	PLANISEAL WR 40	PLANISEAL WR 100	PLANISEAL WR 85 GEL
PENETRATION DEPTH	EN 1504-2 (table 3, n. 19)	Class I: < 10 mm Class II: ≥ 10 mm	Class I: < 10 mm	Class I: < 10 mm	Class II: > 10 mm
WATER ABSORPTION AND RESISTANCE TO ALKALIS	EN 13580	Absorption ratio < 7.5% compared with untreated test sample	5.2%	4.3%	5.6%
		Absorption ratio < 10% after immersion in alkali solution	9.1%	5.9%	7.5%
DRYING SPEED COEFFICIENT	EN 13579	Class I: > 30% Class II: > 10%	Class I: 54.3%	Class I: 54.5%	Class I: 42%
LOSS IN MASS AFTER FREEZE-THAW CYCLES WITH DE-ICING SALTS	EN 13581	The loss in mass at the surface of the impregnated test sample must take place at least 20 cycles after the non-impregnated test sample	$\Delta C = 32$	$\Delta C = 46$	$\Delta C > 20$
REDUCTION IN CHLORIDE ION DIFFUSION	NT Build 515	/	/	63%	70%



EVERYTHING'S OK WITH MAPEI

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