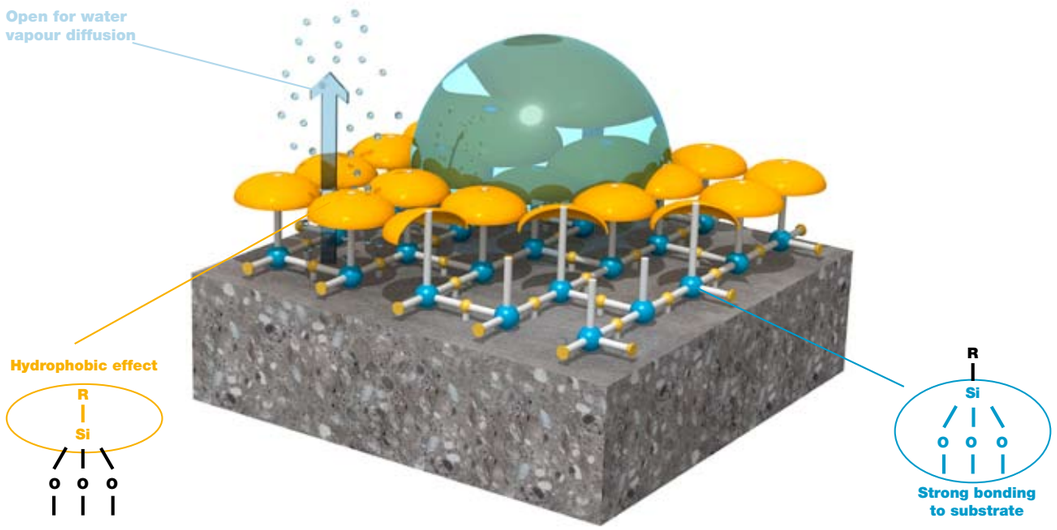
Sika Technology and Concepts
for Hydrophobic Impregnations

Innovation & Consistency | since 1910

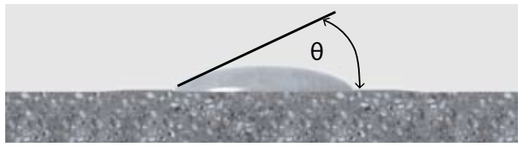
What is a Hydrophobic Impregnation and How Does it Work?

A hydrophobic impregnation is a surface applied, invisible, non-film forming protection system, that can very effectively increase the durability of a concrete structure. Due to the small size of the mono-molecular layer, there is little or no change in its aesthetic appearance. Compared to film forming coating systems, the surface applied hydrophobic impregnations penetrate the surface pores and capillaries, so that they are internally lined but not filled. Hydrophobic impregnation treatments change the surface tension of mineral substrates including concrete, render and brickwork; this produces a water-repellent surface to keep water and aggressive water soluble salts out, such as chlorides and sulphates.



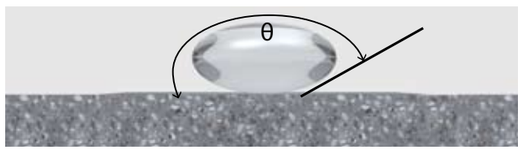
Hydrobhobic effect

The surface tension of a non treated mineral substrate is higher than that of liquid water. Therefore, the attraction from the substrate to the water is also higher than the inter-attraction of the water molecules. This results in the absorption of the water by the mineral substrate.



Hydrophilic material θ ⟶ 0°

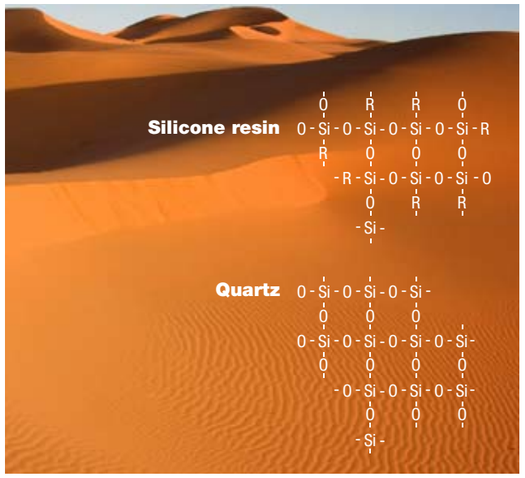
The presence of the hydrophobic impregnation in the pores at the surface of the substrate reduces this surface tension significantly. The inter-molecular attraction of the water molecules is then much higher than the attraction of the water into the substrate. This results in the surface repelling the water.



Hydrophobic material θ ⟶ 180°

Strong bonding to substrate

The silicone resin network produced by this application is very similar to quartz. The only difference is the organic group R, which is responsible for the water repellent properties. This similarity between these chemical structures helps to explain the extremely durable bond to most mineral substrates.



Why to Use an Hydrophobic Impregnation?

In buildings and civil engineering structures, water should generally be kept out and away to prevent deterioration and damage, with subsequent loss of value and/or function. In addition to the problems of water penetration and damp, water ingress can also bring many other deleterious soluble materials into the substrates, including salts such as chlorides and sulphates, plus other aggressive influences. There are therefore several different reasons for using a hydrophobic impregnation:

Durability Aspects

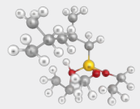
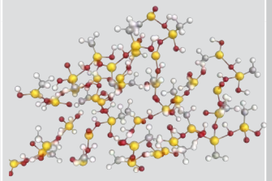
- To prevent further damage to the substrate from freeze/thaw attack, alkali silica reaction (ASR) etc., by preventing the ingress of water
- To prevent further damage to the steel reinforcement by limiting the substrate water content, chlorid and other aggressive salts ingress to the structure
- To provide increased protection as a hydrophobic primer underneath a protective coating treatment; as if there are cracks or defects in the coating due to surface defects, then the hydrophobic impregnation prevents the future penetration of water and soluble aggressive agents in the areas of the crack or defect.

Aesthetic / Comfort Issues

- To protect the structure without changing the visual aspects (e.g. for landmark structures)
- To reduce the extent of efflorescence or salt damage
- To reduce the growth of micro-organisms on the surface (algae, moss, lichen, etc.)
- To reduce the effects of pollution (staining, dirt pick up, etc.)
- To improve the the thermal insulation, by effectively drying out the external walls

Technologies and Characteristics

Hydrophobic impregnations are generally based on Silanes, Siloxanes, Siliconates, or a blend of these materials. Due to the individual chemistries of these material technologies, each has its own individual features which leads to a very useful and wide range of different characteristics and properties. The table below provides an overview of the main differences between these 3 technologies.

	Material Technology		
	Silane	**Siloxane**	**Siliconate**
Molecular structure			
	■ Small (Size: ~ 0.4 – 1.5 nm)	■ Medium to Large (Size: ~ 3 – 30 nm)	■ Small (Size: ~ 0.3 – 0.6 nm)
Polarity	Unpolar	Unpolar	Polar
Penetration	■ High (due to small molecule size)	■ Lower (due to larger molecule size)	■ Very low (the substrates are also polar)
Type of Material	■ Water dispersed ■ Organic solvent based ■ Pure active chemical	■ Water dispersed ■ Organic solvent based	■ Water dispersed
Characteristics	■ Alkali resistant ■ High volatility ■ High mobility ■ Highly concentrated ■ No darkening of substrate	■ Alkali resistant ■ Good water “beading” (water repellent effect)	■ Not alkali resistant ■ Requires CO_2 for the reaction to take place ■ Good water “beading” (water repellent effect)
Typical Substrates	Concrete & Mortar	Concrete & Mortar	
		Bricks	Bricks
		Natural & Artificial Stones	Natural & Artificial Stones
		Tiles	Tiles

Note: The information given above and on the next page is in respect of the technology and not directly related to any specific products performance, as this can also vary significantly according to the concentration used, the combination of active ingredients and the carrier type (water or solvent).

General Requirements and the Appropriate Types of Technologies

For Durability:

	Material Technology		
	Silane	**Siloxane**	**Siliconate**
Penetration depth	***	**	–
Increasing of freeze/thaw de-icing salt resistance	***	**	–
Alkali resistance	***	***	–
Reduction of aggressive agents ingress (chlorides, sulphates, etc.)	***	**	**
Reduction of steel reinforcement corrosion	***	**	–

For Aesthetics:

Risk of darkening the substrate	***	**	***
Risk of efflorescence	***	***	**
Protection against moss and algae growth	**	***	***
UV Resistance	***	***	***
Water beading (water repelling effect)	**	***	***
Reduction of dirt pick-up	**	***	***

For Application:

Volatility of active substance	**	***	***
High coverage per coat	***	**	**
Sensitivity to early rain	***	***	–
Sensitivity to damp substrates	***	**	–
Material cost	**	**	***

Key: *** Best technology for this criteria, ** Good technology for this criteria, – Non-preferred technology for this criteria

Standards and Specifications
(Examples)

Europe

According to European Standards EN 1504 part 9, hydrophobic impregnations can be used on reinforced concrete structure for:

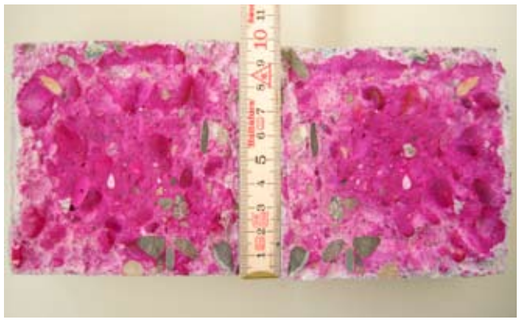
- Protection against ingress (Principle 1, Method 1.1),
- Moisture control (Principle 2, Method 2.1)
- Increasing resistivity (Principle 8, Method 8.1)

Hydrophobic impregnations shall comply with the European Standards EN 1504 Part 2 that describes the relevant requirements for durability and protection.

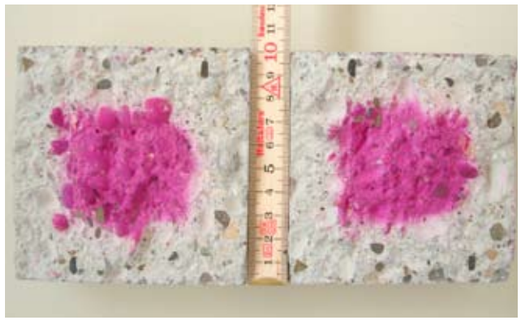
The main performance characteristics for all intended uses are:

- Depth of penetration in a specific type of concrete
- Water absorption compared to untreated concrete and resistance to alkalis
- Drying rate

Plus when relevant for weathering and exposure conditions; resistance to freeze / thaw cycles with de-icing salts is an additional performance requirement.



Low penetration depth (Class I)



Deep penetration depth (Class II)

North America

In the United States of America, there are various standards and guidelines (NCHRP 244, Federal Specification SS-W-110C, etc.) that define the different criteria that hydrophobic impregnation products should comply with:

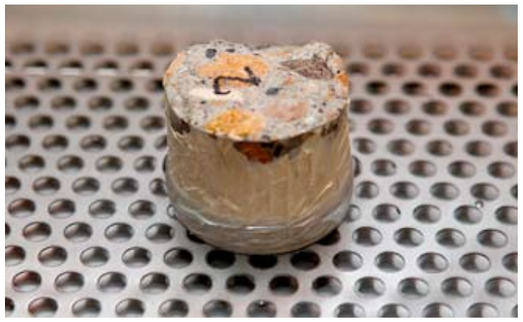
As an example:
In the **N**ational **C**ouncil **H**ighway **R**esearch **P**rogram standard:

- Reduction of water absorption compared to an untreated specimen
- Reduction of chloride ion diffusion compared to an untreated specimen.

In Canada, there are also performance specifications regarding hydrophobic impregnations, including the Alberta Standard B388 and the Quebec Department of Transport MTQ Standard 3601:

As an example:
In the Alberta Standard B388 the follow requirements are defined:

- Reduction of water absorption after surface abrasion
- Reduction of water absorption after alkali exposure
- Minimum water vapour transmission compared to an untreated specimen



Water absorption test

Water vapour transmission test

Specific Requirements for Different Types of Structures

Bridges

Main Requirements

- Deep penetration of the hydrophobic impregnation
- Reduction of water absorption
- Reduction of chloride ion diffusion
- High freeze-thaw / deicing salt resistance
- UV resistance

Recommended Technology: **Silane based (liquid or cream type)**

Silos, Chimney and Cooling Towers

Main Requirements

- Deep penetration of the hydrophobic impregnation
- Reduction of water absorption
- High freeze-thaw resistance
- UV resistance

Recommended Technology: **Silane or Siloxane based (liquid type)**

Marine Structures

Main Requirements

- Deep penetration of the hydrophobic impregnation
- Reduction of water absorption
- Reduction of chloride ion diffusion
- UV resistance

Recommended Technology: **Silane based (liquid or cream type)**

Buildings

Main Requirements

- Reduction of water absorption
- Reduction of efflorescence
- Reduction of dirt pick-up
- UV resistance

Recommended Technology: **Siloxane or Siliconate based (liquid type)**

The Process for Ensuring the Quality of Works

Product Evaluation and Selection

To define the appropriate material, the consumption required and the best application method for different concrete structures to reach their defined performance requirements, test application areas should generally be applied on site. Afterwards, cores should be taken from the test areas to analyze and confirm the actual performance achieved, including the measured penetration depth and water absorption reduction at different depths. All of these results regarding the product type, material consumption rate and application method, can then be used to determine the best cost/benefit ratio and make the specific product selection for each project.

Condition survey of the structure and substrate	Application of the test areas	Confirmation of performance on test cores	Final Specification and Method Statement
■ Pre-classification of the substrate ■ Estimation of material consumption for different test areas	■ Selection of the application method ■ Selection of best application tools	■ Penetration depth ■ Reduction of water absorption ■ Reduction of chloride absorption	■ Product / Material selection ■ Consumption rate ■ Application method / tools

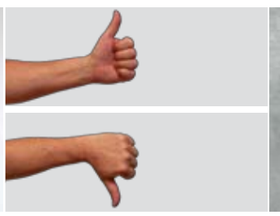



On Site Quality Assurance

Once the specific product and application details have been defined, the necessary Quality Control and Quality Assurance procedures, both during and after the application, also have to be defined and then carried out for control and to ensure that the required performance criteria are actually achieved.

Product records	Performance testing	Acceptance criteria	Corrective actions
■ Documentation ■ Batch-Nr. ■ Site conditions	■ Refractive index on the material ■ Water absorption ■ Penetration depth	■ Compliance with the required specifications	■ IF REQUIRED: re-application or additional applications ■ Re-testing for specification compliance






Sika Competence in Complete Concrete Protection

Fully Compatible and Complete Protection Systems

Reinforced concrete civil engineering structures are usually designed to last a very long time. However due to the extreme exposure conditions, with potential concrete damage and reinforcement corrosion related problems, owners and their engineers face considerable challenges to actually achieve this design life.
From our considerable expertise and long-term experience, Sika has developed a full range of integrated concrete protection systems that can address all of the issues related to achieving this required durability. Using hydrophobic impregnations in combination with **Sika® FerroGard®** corrosion inhibitor technology, Sika is able to provide unique, cost efficient protection systems which will protect the steel reinforcement and the concrete structure as a whole. In general, there are three different levels of these protection systems:

System 1:
Durable concrete protection

1. Sikagard® deep penetrating hydrophobic impregnation

Typical Use

- For exposed concrete structures showing no visible concrete defects (crack width <0.3 mm)

System 2:
Durable concrete and reinforcement protection

1. Sika® FerroGard® corrosion inhibitor
2. Sikagard® deep penetrating hydrophobic impregnation

Typical Use

- For severely exposed or weak concrete with a high risk of steel corrosion

System 3:
High performance protection for extreme conditions

1. Sika® FerroGard® corrosion inhibitor
2. Sikagard® deep penetrating hydrophobic impregnation
3. Sikagard® protective coating

Typical Use

- For severely exposed or weak concrete with a high risk of cracking

Additional Advantages and “Added Value” from Sika

Our clients and their customers not only profit from the performance of the actual Sika products, but also from the numerous ‘Added Values’ provided by the whole of the Sika Group. This means all of the additional advantages, assistance, support and services that Sika can provide for our customers in all areas of a project.

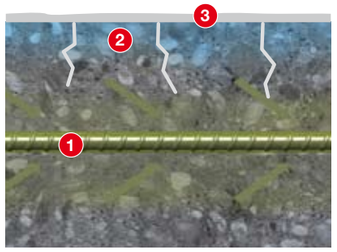
These can include involvement and assistance with the condition survey, its assessment and diagnosis, the design and specification of the most appropriate protective system, producing Method Statements for the contractors with full onsite training, optimised materials consumption and application equipment advice, plus complete procedures for all of the necessary project Quality Control and Quality Assurance, to ensure that the performance requirements of the specifications are actually achieved..

This expert Sika knowledge can therefore make a valuable contribution to minimizing the projects initial cost, together with the maintenance costs over the life-cycle of the structure. Additionally this expertise and our local presence globally, means that our clients and their customers have our practical expertise and support to solve any specific problems on their site, worldwide.

Sika’s long term experience –
since 100 years


Sika’s know-how and competence –
all over ther world


Sika guarantees –
for a reliable partnership



Sika system compatibility –
proven and tested


Sika’s innovative solutions and systems –
for durable structures


Sika’s application engineering –
for efficient application


Sika’s full project support –
for all the project needs


Sika’s complete product range –
full solutions from one supplier


Sika’s hydrophobic engineering –
for overall project cost optimization

Successful Examples of Sika “Added Value”

Complete Durable Protection Systems for Fair Faced Concrete

Landmark or fair faced reinforced concrete structures have to be protected against physical or chemical damage to the concrete and to prevent steel reinforcement corrosion, frequently without changing the aesthetic appearance of the surface. With the widely proven surface applied corrosion inhibitor **Sika® FerroGard®-903***, Sika is able to protect steel reinforcement from further corrosion, even in defined chloride contaminated environments. In combination with an additional **Sikagard®** hydrophobic impregnation, an invisible, unique and long-term protection of the concrete surface and the steel reinforcement is achieved.

System Advantages:

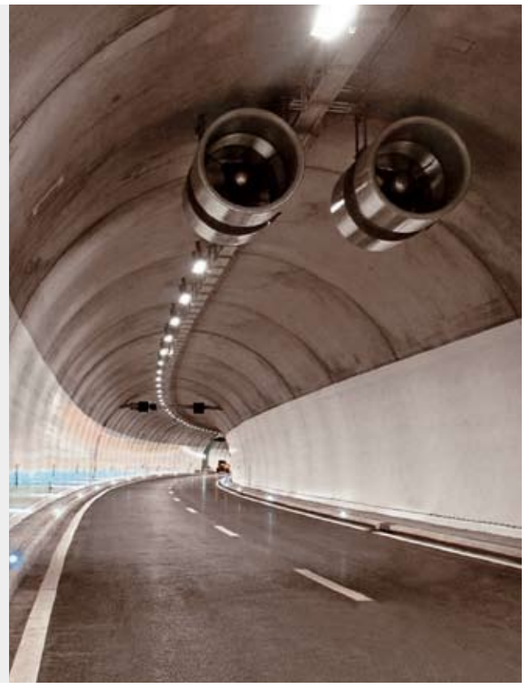
- Long term protection without visual changes to the appearance of the structure
- Cost effective concrete and steel reinforcement protection solutions
- Proven products and systems

Full System Compatibility – Guaranteed

The protective capabilities of rigid coatings for concrete structures will fail when new cracks appear or existing cracks move and open, or if they are applied over surface defects that have not been rectified with appropriate pore sealers before the coatings application.
To prevent damage due to the subsequent ingress of aggressive agents a **Sikagard®** hydrophobic impregnation can be applied as a primer.
Sika has tested and proven the compatibility of all of these combinations of our products, including **Sika® FerroGard®** corrosion inhibitors, **Sikagard®** hydrophobic impregnations and **Sikagard®** protective coatings.

System Advantages:

- Full system supply: All from one supplier
- Security from the full system compatibility: No negative surprises on site
- Cost effective e.g. in areas where the application of pore sealers is difficult or too costly, the combination of a Sikagard® hydrophobic impregnation and protective coating is a very cost effective solution



The Sikagard® Hydrophobic Impregnation Range

Description | Typical Use

Sikagard®-705 L

- Silane based (liquid type)
- Solvent free
- Low VOC content
- Fast absorption

- Concrete structures
- New and repair works
- Application is possible on green concrete
- Also used as a primer for coatings

Sikagard®-706 Thixo

- Silane based (cream type)
- Water based emulsion
- High coverage per coat
- Low VOC content
- Efficient application

- Concrete structures
- New and repair works
- Easy overhead application
- Application is possible on “green” concrete
- Also used as a primer for coatings

Sikagard®-704 S

- Silane/Siloxane blend
- Fast absorption

- Concrete structures
- New and repair works
- Also used as a primer for coatings

Sikagard®-740 W

- Silane based
- Water based emulsion
- Low VOC content

- Concrete structures
- New and repair works
- Also used as a primer for coatings

Description | Typical Use

Sikagard®-700 S

- Siloxane based
- Fast absorption

- Multi purpose hydrophobic impregnation
- Suitable for wide variety of substrates and structures (concrete, render, natural stone, brickwork, etc.)
- Also used as a primer for coatings

Sikagard®-703 W

- Siloxane based
- Water based emulsion
- Low VOC content

- Multi purpose hydrophobic impregnation
- Suitable for wide variety of substrates (render natural stone, brickwork, etc.)
- Also used as a primer for coatings

Sikagard®-71 W

- Siliconate based
- Water based solution
- Low VOC content

- Hydrophobic impregnation designed for non alkaline mineral substrates (bricks, terracotta, natural stone, etc.)

Selection Guide

For Concrete Structures

Product	Environmental issues	Long term durability	Resistance to freeze/thaw & de-icing salts	Penetration Depth	
				Class II (≥10mm)	Class I (<10mm)
Sikagard®-705 L	**	****	****	****	****
Sikagard®-706 Thixo	***	****	****	****	****
Sikagard®-704 S	-	***	***	-	***
Sikagard®-740 W	****	**	-	-	**
Sikagard®-700 S	-	*	-	-	*

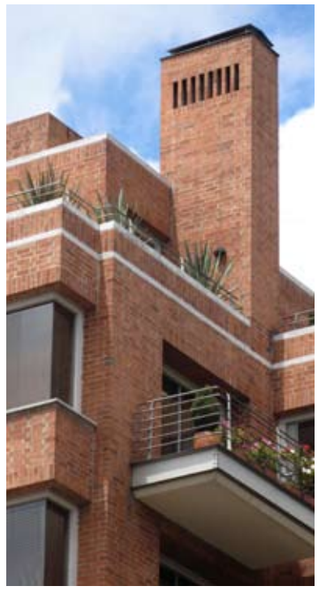
For Other Types of Structures

Product	Environmental issues	Durability		
		Brick	Natural and Artificial Stone	Cement Render
Sikagard®-700 S	-	****	****	****
Sikagard®-703 W	****	****	**	****
Sikagard®-71 W	***	*	*	*

Note 1: For structures made of brick or natural stone, preliminary testing is always recommended to ascertain the suitability of a hydrophobic impregnation

Note 2: Caution should be taken when there is the presence of existing aggressive salts in an old structure, as these can have negative effects (Salt dissolved in the pore solution will crystallize as the substrate dries out. This crystallization inside the porous structures induces expensive forces in the substrate that can lead to damage and cracking)

Key:
**** Best technology for this criteria
** Good technology for this criteria
– Non-preferred technology for this criteria



Sika Application Engineering for Cost Performance Optimization

The Influence of Job Site Conditions

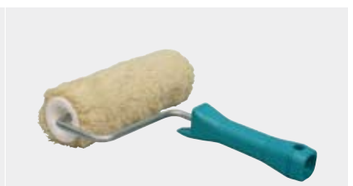
The quality of existing concrete structures varies according to their age and exposure, the original construction methods and quality of the concrete, plus their location. The costs for materials and application depend on the specific project, including the substrate condition, the technical requirements, weather conditions and possible application methods etc.. Therefore, a detailed condition survey must always be carried out to optimize the application and reduce the overall costs.
The table below explains the influence of different conditions during application and shows their implications.

Condition	Influence	Implication
Substrate:		
■ Very dense concrete	■ Reduced penetration	■ Preferred technology: Silane based materials ■ Use cream type for longer penetration time ■ Higher consumption to achieve the required penetration depth
■ Very porous concrete	■ Deeper penetration ■ High absorption rate	■ Faster application speed ■ Preferred technology: Silane based materials
■ Damp concrete	■ Lower penetration	■ Higher consumption to achieve the required penetration depth ■ Long waiting time between applications layers
■ Substrates other than concrete	■ Aesthetic Issues ■ Water beading effect	■ Preferred technologies: Siloxane or Siliconate based material
Weather:		
■ High temperatures and/or windy applications	■ Increase of loss and wastage ■ Fast evaporation	■ Use cream type products to reduce wastage
■ Rain	■ Risk of wash out	■ Re-application might be required
Application Method:		
■ Spray application	■ Fast application	■ Faster application but with higher consumption
■ Hand application	■ Slow application	■ Lower wastage but with higher application costs
Type of Materials:		
■ Liquid type	■ Lower quantity per application step possible	■ More application steps to reach the defined consumption rate
■ Cream type	■ Longer contact time	■ Deeper penetration ■ Less application steps and faster working ■ Better application control
Health and Safety:		
■ Solvent based products	■ More restrictions	■ Ventilation required during application, plus appropriate protective clothing
■ Water based products	■ Less restrictions	■ Less protection required and lower costs

Sika Product Application Guide

Efficient application reduces the total cost. To be efficient, wastage has to be limited and the right application tools should be used according to the structure, the site conditions and type of material.

Sika supports our customers by providing detailed information regarding all relevant application techniques and application tools to help save time and money on every site.

	Cream Type	Liquid Type
Product	 Sikagard®-706 Thixo	 Sikagard®-705 L, Sikagard®-704 S Sikagard®-740 W, Sikagard®-700 S Sikagard®-703 W, Sikagard®-71 W
Substrate preparation	 Cleaning with Low Pressure Water-jetting <18 MPa (<180 bars)	 Cleaning with Low Pressure Water-jetting <18 MPa (<180 bars)
Tools for large-scale application	 Airless Spray	 Low PressureSpray or Airless Spray
Tools for small-scale application	 Professional Paint Brushes	 Long Haired Rollers
Applications	1 – 2* applications	2 – 3* applications

*dependent on the project requirements, weather conditions and targeted consumption defined to achieve the required penetration depth and performance.

Sika Full Range Solutions for Construction

Concrete Production

Sika® ViscoCrete®
Sika® Retarder®
Sika® SikaAer®

Waterproofing

Sikaplan®, Sikalastic®
Sika® & Tricosal® Waterstops
Sika® Injection Systems

Flooring

Sikafloor®
SikaBond®

Corrosion and Fire Protection

SikaCor®
Sika® Unitherm®

Concrete Repair and Protection

Sika® MonoTop®
Sikagard®
Sikadur®

Structural Strengthening

Sika® CarboDur®
SikaWrap®
Sikadur®

Joint Sealing

Sikaflex®
Sikasil®

Grouting

Sikadur®
SikaGrout®

Roofing

Sarnafil®
Sikaplan®
SikaRoof® MTC®

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Please consult the Product Data Sheet prior to any use and processing.

Certified Quality System ISO 9001/EN 29001 since 1986
Certified Management System ISO 14001 since 1997

Innovation & Consistency | since 1910