REFURBISHMENT
SIKA TECHNOLOGY AND CONCEPTS FOR HYDROPHOBIC IMPREGNATIONS
Architects and designers are more and more creating beautiful structures that are left with the original building material like concrete, brick or stone. However, for these structures water is often a threat as it brings many deleterious elements, such as chlorides and dirt into the porous substrates.

Using a hydrophobic impregnation on these buildings and civil engineering structures can efficiently support the protection of the assets from water damage, even without altering the aesthetics of the original structures.
**WHAT IS A HYDROPHOBIC IMPREGNATION?**

**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 aesthetic appearance of the structure. 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 such as concrete, render and brickwork; this produces a water-repellent surface to keep water and aggressive water soluble salts out, such as chlorides and sulphates.

**HYDROPHOBIC 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.

**STRONG BONDING TO THE 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.

**HOW DOES IT WORK?**

The presence of the hydrophobic impregnation in the pores at the surface of the substrate reduces the 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.

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WHY TO USE A 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 and 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 and/or other aggressive salts ingress to the structure.
- To provide increased protection as a hydrophobic primer underneath a protective coating treatment; because 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 thermal insulation, by effectively drying out the external walls

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 three technologies:

TECHNOLOGIES AND CHARACTERISTICS

<table>
<thead>
<tr>
<th>MATERIAL TECHNOLOGY</th>
<th>Silane</th>
<th>Siloxane</th>
<th>Siliconate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular structure</td>
<td><img src="image" alt="Silane Structure" /></td>
<td><img src="image" alt="Siloxane Structure" /></td>
<td><img src="image" alt="Siliconate Structure" /></td>
</tr>
<tr>
<td>Polarity</td>
<td>Unpolar</td>
<td>Unpolar</td>
<td>Polar</td>
</tr>
<tr>
<td>Penetration</td>
<td>High (due to small molecule size)</td>
<td>Lower (due to larger molecule size)</td>
<td>Very low (the substrates are also polar)</td>
</tr>
<tr>
<td>Type of Material</td>
<td>Water dispersed</td>
<td>Organic solvent based</td>
<td>Pure active chemical</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Alkali resistant</td>
<td>High volatility</td>
<td>High mobility</td>
</tr>
<tr>
<td>Typical Substrates</td>
<td>Concrete &amp; Mortar</td>
<td>Concrete &amp; Mortar</td>
<td>Bricks</td>
</tr>
<tr>
<td></td>
<td>Naturals &amp; Artificial Stones</td>
<td>Naturals &amp; Artificial Stones</td>
<td>Tiles</td>
</tr>
</tbody>
</table>

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 Appropriate Types of Technologies

#### Material Technology

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Silane Concrete</th>
<th>Siloxane Concrete and others</th>
<th>Silicate Other Substrates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For Durability</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration depth</td>
<td>***</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>Increasing freeze/thaw de-icing</td>
<td>***</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>Salt resistance</td>
<td>***</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>Alkali resistance</td>
<td>***</td>
<td>***</td>
<td>-</td>
</tr>
<tr>
<td>Reduction of aggressive agents</td>
<td>***</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>Ingress (chlorides, sulphates, etc.)</td>
<td>***</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>Reduction of steel reinforcement corrosion</td>
<td>***</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td><strong>For Aesthetics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk of darkening the substrate</td>
<td>***</td>
<td>**</td>
<td>***</td>
</tr>
<tr>
<td>Risk of efflorescence</td>
<td>***</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td>Protection against moss and algae growth</td>
<td>**</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>UV Resistance</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Water beading (water repelling effect)</td>
<td>**</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Reduction of dirt pick-up</td>
<td>**</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td><strong>For Application</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility of active substance</td>
<td>**</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>High coverage per coat</td>
<td>**</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td>Sensitivity to early rain</td>
<td>***</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>Sensitivity to damp substrates</td>
<td>***</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>Material cost</td>
<td>-</td>
<td>**</td>
<td>***</td>
</tr>
</tbody>
</table>

Key: *** Best technology for this criteria, ** Good technology for this criteria, * Non-preferred technology for this criteria, – Not to be used.
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.

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 National Council Highway Research Program 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 BS388 and the Quebec Department of Transport MTQ Standard 3601.
As an example:
In the Alberta Standard BS388 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

SPECIFIC REQUIREMENTS FOR DIFFERENT TYPES OF STRUCTURES

BRIDGES
- Deep penetration of the hydrophobic impregnation
- Reduction of water absorption
- Reduction of chloride ion diffusion
- High freeze-thaw / deicing salt resistance (when required)
- UV resistance
Recommended Technology:
Silane based (liquid or cream type)

SILOS, CHIMNEYS AND COOLING TOWERS
- Deep penetration of the hydrophobic impregnation
- Reduction of water absorption
- High freeze-thaw resistance (when required)
- UV resistance
Recommended Technology:
Silane or Siloxane based (liquid type)

MARINE STRUCTURES
- 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
- Reduction of water absorption
- Reduction of efflorescence
- Reduction of dirt pick-up
- UV resistance
- Improve thermal insulation
Recommended Technology:
Siloxane (liquid or cream type) or Siliconate (liquid type) based
REFURBISHMENT
SIKA TECHNOLOGY AND CONCEPTS FOR HYDROPHOBIC IMPREGNATIONS

THE PROCESS OF ENSURING QUALITY

PRODUCT EVALUATION AND SELECTION
To define the appropriate material, the consumption required and the best application method for different concrete structures in order 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 the 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. This process of evaluation has been applied for the selection of product and consumption required for the maintenance of a bridge in Europe.

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.

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

SYSTEM 2: Durable concrete and reinforcement protection
1. Sikagard® FerroGard® corrosion inhibitor
2. Sikagard® deep penetrating hydrophobic impregnation

SYSTEM 3: High performance protection for extreme conditions
1. Sikagard® FerroGard® corrosion inhibitor
2. Sikagard® deep penetrating hydrophobic impregnation
3. Sikagard® protective coating

TYPICAL USE
- For exposed concrete structures showing no visible concrete defects (crack width <0.3 mm)
- For severely exposed or weak concrete with a high risk of steel corrosion
- For severely exposed or weak concrete with a high risk of cracking
SIKA BRINGS ADDED VALUE

SIKA PROVIDES A DEPTH OF KNOWLEDGE from our ‘state-of-the-art’ technical expertise and global practical experience to produce virtually tailor-made solutions for the protection and repair of buildings and civil engineering structures. This includes fully compatible products and integrated systems to suit almost every project and site requirement. Sika customer advice and support is second to none, from concept, through design and detailing, to practical installation and successful completion on site. This is all based on more than 100 years of experience on large and small projects all over the world.

SIKA – YOUR PARTNER ON SITE
- Global market leader in building and construction chemicals
- Highest technical expertise and practical experience in concrete refurbishment
- Excellent reputation with leading contractors and authorities

SIKA VALUE ENGINEERING AND INNOVATIONS
- High performance integrated products and systems that can boost and improve the efficiency, durability and aesthetics of buildings and other structures – to the benefit of our customers and a more sustainable development
- Sika trained and experienced specialist contractor networks

UNIQUE SIKA SOLUTIONS FOR SPECIAL CONDITIONS
- Solutions for almost all different application requirements and climatic conditions

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PROVEN SIKA SYSTEMS AND APPLICATION TECHNIQUES
- Products and systems with extensive internal and external testing and assessment
- Highest international standards of production and quality control

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

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Sikagard® HYDROPHOBIC IMPREGNATION RANGE

DESCRIPTION | TYPICAL USE
--- | ---
**Sikagard®-705 L**
- Silane based (liquid type)
- Solvent free
- Low VOC content
- Fast absorption
**Sikagard®-706 Thixo**
- Silane based (cream type)
- Water based emulsion
- High coverage per coat
- Low VOC content
- Efficient application

**Sikagard®-704 S**
- Silane/Siloxane blend
- Fast absorption
**Sikagard®-740 W**
- Silane based
- Water based emulsion
- Low VOC content

**Sikagard®-730 Concrete Protect Plus**
- Siloxane based (cream)
- One-single coat
- Efficient application

**Sikagard®-700 S**
- Siloxane based
- Fast absorption

**Sikagard®-703 W**
- Siloxane based
- Water based emulsion
- Low VOC content
**Sikagard®-71 W**
- Silicate based
- Water based solution
- Low VOC content

**Sikagard®-740 W**
- Silane based
- Water based emulsion
- Low VOC content

**Sikagard®-700 S**
- Siloxane based
- Fast absorption

**Sikagard®-703 W**
- Siloxane based
- Water based emulsion
- Low VOC content

**Sikagard®-71 W**
- Silicate based
- Water based solution
- Low VOC content

**DESCRIPTION**

**TYPICAL USE**

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

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

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Sikagard® HYDROPHOBIC IMPREGNATION RANGE

**FOR CONCRETE STRUCTURES**

<table>
<thead>
<tr>
<th>Product</th>
<th>Environmental Issues</th>
<th>Long-term durability</th>
<th>Resistance to freezethaw &amp; deicing salts</th>
<th>Penetration Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sikagard®-705 L</td>
<td>**</td>
<td>***</td>
<td>****</td>
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<tr>
<td>Sikagard®-706 Thixo</td>
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<td>Sikagard®-730 Concrete Protect Plus</td>
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<td>Sikagard®-740 W</td>
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<tr>
<td>Sikagard®-700 S</td>
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</table>

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Sikagard® HYDROPHOBIC IMPREGNATION RANGE

**FOR OTHER TYPES OF STRUCTURES**

<table>
<thead>
<tr>
<th>Product</th>
<th>Environmental Issues</th>
<th>Durability</th>
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<tbody>
<tr>
<td></td>
<td>Brick</td>
<td>Natural and Artificial Stone</td>
</tr>
<tr>
<td>Sikagard®-730 Concrete Protect Plus</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Sikagard®-705 S</td>
<td>***</td>
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</tr>
<tr>
<td>Sikagard®-71 W</td>
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<td>**</td>
</tr>
</tbody>
</table>

**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 where there is the presence of existing aggressive salts in an old structure, in these cases the negative effects (salt dissolved in the pore solution will crystallize as the substrate dries out. This crystalization inside the porous structure induce expansive forces in the substrate than can lead to cracking and damage)

**Note 3:** Efficiency of hydrophobic impregnations will be reduced on pure limestone. Preliminary trial is recommended.
## 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 the possible application methods etc. Therefore, a detailed condition survey must always be carried out to optimize the application details and reduce the overall costs. The table below explains the influence of different conditions during application and shows their implications.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Influence</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substrate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very dense concrete</td>
<td>Reduced penetration</td>
<td>Preferred technology: Silane based materials</td>
</tr>
<tr>
<td>Very porous concrete</td>
<td>Deeper penetration</td>
<td>Use cream type for longer penetration time</td>
</tr>
<tr>
<td>Damp concrete</td>
<td>Higher absorption rate</td>
<td>Higher consumption to achieve the required penetration depth</td>
</tr>
<tr>
<td>Substrates other beside concrete</td>
<td>Lower penetration</td>
<td>Long waiting time between applications</td>
</tr>
<tr>
<td><strong>Weather</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High temperatures and/or windy applications</td>
<td>Increase of loss and wastage</td>
<td>Use cream type products to reduce wastage</td>
</tr>
<tr>
<td>Rain</td>
<td>Risk of wash out</td>
<td>Re-application might be required</td>
</tr>
<tr>
<td><strong>Application Method:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spray application</td>
<td>Fast application</td>
<td>Faster application but with higher consumption</td>
</tr>
<tr>
<td>Hand application</td>
<td>Slow application</td>
<td>Lower wastage but with higher application costs</td>
</tr>
<tr>
<td><strong>Type of Materials:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid type</td>
<td>Lower quantity per application step possible</td>
<td>More application steps to reach the defined consumption rate</td>
</tr>
<tr>
<td>Cream type</td>
<td>Longer contact time</td>
<td>Deeper penetration</td>
</tr>
<tr>
<td><strong>Health and Safety:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solvent based products</td>
<td>More restrictions</td>
<td>Ventilation required during application, plus appropriate protective clothing</td>
</tr>
<tr>
<td>Water based products</td>
<td>Less restrictions</td>
<td>Less protection required and lower costs</td>
</tr>
</tbody>
</table>

## 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. The data below shall be considered as a recommendation. More detailed information is available in the Method Statement.

### Cream Type

- Sikagard®-706 Thixo
- Sikagard®-710 Concrete Protect Plus

### Liquid Type

- Sikagard®-705 L, Sikagard®-704 S
- Sikagard®-740 W, Sikagard®-700 S
- Sikagard®-703 W, Sikagard®-72 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 and Auto-feed Long-Haired Roller
- Low Pressure Spray or Airless Spray

### Tools for small-scale application

- Professional Paint Brush or Long-Haired Roller
- Long-Haired Roller or Low Pressure Spray

**Applications**

- Cream Type: 1 – 2 applications*
- Liquid Type: 2 – 3 applications**

*Dependent on the project requirements, weather conditions and targeted consumption defined to achieve the required penetration depth and performance.
GLOBAL BUT LOCAL PARTNERSHIP

FOR MORE INFORMATION:

WE ARE SIKA

Sika is a specialty chemicals company with a leading position in the development and production of systems and products for bonding, sealing, damping, reinforcing and protecting in the building sector and the motor vehicle industry. Sika’s product lines feature concrete admixtures, mortars, sealants and adhesives, structural strengthening systems, flooring as well as roofing and waterproofing systems.

Our most current General Sales Conditions shall apply. Please consult the most current local Product Data Sheet prior to any use.