Sika Shotcrete Technology
Sika – The Leader by permanent Innovation

The high reputation enjoyed by Sika in tunnelling is so widely known because the Company’s activities always looked towards the future of tunnelling from its beginnings in 1910. The first patent for a spraying machine was registered in the year that Sika was founded, a symbolic coincidence because the history of tunnelling at Sika was always clearly marked by the development of shotcrete technology. To cite just one example from this success story, the decision was made to use Sika products for the waterproofing to all the structures for the electrification of the railway line through the 1st Gotthard Alpine tunnel.

Introduction

For reasons of flexibility, speed and economy, shotcrete has grown continuously in importance over recent decades, especially for heading support in tunnelling. The main basis for this was new developments or improvements in shotcrete and process technology.

New developments in concrete additives and fillers, cements and methods of application are leading to innovative new applications and enabling shotcrete to be produced by the wet spraying process which can meet the highest strength and durability requirements. This potential has yet to be utilized to the full worldwide, as shotcrete is often used as temporary support concrete that only has to meet quite low quality requirements. More recently, however, the fullest possible know-how on wet-mix shotcrete has been developed in a wide variety of projects and for many different applications.

Clients and project designers can rely on the experience gained and can go ahead confidently with creative, innovative ideas and solutions.

1920

In 1933 the Sigunite® Brand was born

- In powder form,
- added by hand
- Quantity added 3 – 7 %

1940

- Spribag BS-12/MS-12
- First dry-mix machines (compressed air process)
- with a spraying capacity of up to 3 m³/hr.

1960

- Sika® Aliva®-200/285
- Rotor spraying machines and systems for dry and wet mixes

1980

- Sika®-PM500
- Highly-mechanized shotcreting systems for dry or wet mix shotcrete

2000

- Aluminium Hydroxide
- Aluminium Sulphate
  - Sika® AF Liquid
  - setting accelerator
  - Quantity added 4 – 7 %

Accelerators

- Alkaline Aluminates
  - The first liquid setting accelerators for shotcrete, Sigunite®-L Liquid
  - Quantity added 3 – 6 %

- Aluminium Sulphate
  - Sika®-49 AF Powder,
  - the first alkali-free setting accelerator
  - Quantity added 4 – 7 %

Flow Control Agents

- Naphthalene Sulphonate
- Melamine Sulphonate
  - Sikament®, still a reliable flow control agent in tunnelling
  - Working time up to 2 hours

- Vinyl Copolymers
  - SikaTard® shotcrete flow control agent
  - State of the art for decades
  - Working time up to 4 hours

- Modified Polycarboxylates
  - Sika® ViscoCrete®, the latest innovation for shotcreting
  - Working time over 6 hours

Machines

- Spribag BS-12/MS-12
- First dry-mix machines (compressed air process)
- with a spraying capacity of up to 3 m³/hr.
Shotcrete Requirements: Ecology and Economy

Sika is committed to the global chemical industry environmental management system "Responsible Care" which defines the principles for safety, health and environmental protection.

Many serious accidents in the past have shown that working conditions on building sites require special attention. Dust generation must be reduced and the hazards created by corrosive and toxic chemicals must be minimized. The market launch of alkali-free setting accelerators such as Sigunite® AF is a milestone in tunnelling. As far as dust pollution is concerned, the wet spraying process creates much less dust than dry-mix spraying. The amount of dust can also be reduced by the best possible nozzle technology. Non-toxic, alkali-free accelerators with a pH value of around 3 reduce the human and environmental hazards during handling, storage and use. The spray contains no corrosive aerosols, so that damage to the skin, mucous membranes and eyes can be avoided.

The spraying capacity is the main factor influencing the economics of the wet spraying process. Depending on the application, up to 30 m³/hour can be achieved. To obtain a high output, it is important to find the best shotcrete formulation, layer thickness and type and quantity of accelerator. A high output cannot be obtained unless the concrete is easily pumpable. If the concrete mix is unsuitable, special additives help to prevent separation and reduce the pump pressure.

The amount of rebound loss is a crucial cost factor. In addition to loading, transporting and disposing of the rebound material, rebound costs also involve the extra shotcrete that has to be produced and applied.

Shotcrete Requirements: Quality and Performance

Clients, project designers, building contractors and health and safety authorities all set different specific standards for the shotcrete.

To the project designer, the most important factor is meeting the specifications, while the contractor places the emphasis mainly on the most economic production and installation method that guarantees the required minimum quality at minimum cost. Health and safety authorities demand maximum hygiene and safety on site during the spraying operations (maximum early strength of the shotcrete applied for heading support, low dust pollution and minimum hazards from toxic or alkaline substances).

Early Strength

This is the prerequisite for overhead spraying, particularly for high outputs, when applying thick layers or when spraying onto water penetration points. The curve of strength development in the first few minutes has a strong influence on dust generation and rebound. The strength development is normally plotted for the period between 6 and 60 minutes. The strength is also measured at hourly intervals.

Final Strength

The less water in the concrete mix, the lower the porosity of the hardened cement. This has an advantageous effect on most of the concrete properties, especially compressive strength. The amount of water necessary for cement hydration equals to a W/C ratio of about 0.40. Excess water evaporates after application and leaves voids in the hardened cement.

Durability, Watertightness

Durability means high watertightness. Low capillary porosity is essential for high watertightness and is obtained by correctly applied shotcrete with a low W/C ratio and vascular human tissue.

Sulphates

Water-soluble sulphates react with the C3A in the cement to form ettringite. The ettringite crystals first propagate into the pores. When the pores are filled, ettringite develops explosive pressure that can destroy the concrete structure. If sulphate-resistant shotcrete is required, sulphate-resistant cement grades must be used, e.g. composite cements with slag, pozzolana or cement with a low C3A content and added silicafume.
Shotcrete Formulations

Formulations for shotcrete must always be adapted to the specifications of the aggregate components and cement available so that the required early strength and workability can be obtained. Preliminary tests in the concrete laboratory make the site operations easier.

The cement grade has a strong influence on both strength development in the early stages and the final strength and properties of the hardened concrete. SikaFume® is used for much higher watertightness (durability) and reduced rebound. SikaTard® (retarder) is used for long-time retarded shotcrete and SikaTard® or ViscoCrete® (flow control agents) for better workability at a reduced water content. Steel fiber increase the load-bearing capacity and ductile bearing properties of the shotcrete. Polypropylene fiber is used for improved early shrinkage properties and higher fire resistance of the shotcrete. The air void content of the fresh shotcrete is increased, which improves the workability and spraying result.

The maximum aggregate particle size depends on the layer thickness and the surface finish required for the shotcrete layer. Approximately 95% of the aggregate surface is supplied by the 0 – 4 mm sand fraction and variations in the sand component have a massive effect on the fresh concrete properties, the W/C ratio and therefore the properties of the hardened concrete. The sand fraction must be analyzed with extreme care during the quality control process. We distinguish between round and broken aggregate. The best particle form is cubic/spherical: it is very important for workability. The aggregate must be hard, clean and not weathered.

Examples of Concrete Formulations

**Dry-mix shotcrete 0 – 8 mm**

- Cement 280 kg
- SikaFume®-HR/-TU 20 kg
- Retarder SikaTard®-930
  - 0 – 4 mm with 4% inherent moisture 0.3 %
  - 4 – 8 mm with 2% inherent moisture 45 %

Dry mix moist

- *ca. 1540 kg

*Must be checked by a yield test

**Cement content**

- For 1000 litres dry mix, 280 kg cement is added to 800 litres aggregate
- For 1250 litres dry mix, 350 kg cement is added to 1000 litres aggregate

**Shotcrete from 1 m³ dry mix gives on the wall**

- Accelerated with Sigunite® AF Powder (rebound 16 – 20 %) 0.58 – 0.61 m³
- Accelerated with Sigunite® AF Liquid (rebound 20 – 25 %) 0.55 – 0.58 m³

**Cement content in the shotcrete ca. 450 – 460 kg/m³**

**Wet-mix shotcrete 0 – 8 mm**

- Cement 425 kg 135 l
- SikaFume®-HR/TU 20 kg 9 l
- Flow control SikaTard®/Sika® ViscoCrete® 1.2 %
- Retarder SikaTard®-930 0.3 %

**Aggregate**

- 0 – 4 mm with 4% inherent moisture 60 %
- 4 – 8 mm with 2% inherent moisture 40 %

**Air voids (4.5 %) 45 l

**Steel fiber 40 kg 5 l

**Shotcrete Density per m³ 2398 kg 1000 l

**1 m³ of applied shotcrete gives on the wall**

- Accelerated with Sigunite® AF Liquid (rebound 6 – 10 %) 0.90 – 0.94 m³

**Cement content in shotcrete 420 – 470 kg/m³

**Steel fiber content in shotcrete 30 – 36 kg/m³

**Sufficient fines ≤ 0.125 mm are important for pumpability. Recommended fines content**

<table>
<thead>
<tr>
<th>Total aggregate + cement + additional fine aggregates:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate 0 – 8 mm 0 – 16 mm</td>
</tr>
<tr>
<td>Round 500 kg/m³ 450 kg/m³</td>
</tr>
<tr>
<td>Broken 525 kg/m³ 475 kg/m³</td>
</tr>
</tbody>
</table>

Quality Control

During the prequalification procedure the client or project designer normally requires suitability tests to be carried out to verify that the quality specifications are met. These tests have to be done at the start of construction and the locally available raw materials (cement and aggregate) and the plant and equipment planned for the works must be used.

During construction the quality of the shotcrete must be controlled in accordance with current standards or the tender documents.
## Shotcrete Application

### Wet Spraying Process

**Dense flow process**

- **Sika® Aliva® 278/Sigunite® AF Liquid**
  - The shotcrete (wet mix) is loaded into the piston pump funnel tube.
  - Delivery to the nozzle is by the dense flow process.
  - Just before the nozzle (distance depending on whether the accelerator is alkali-free or alkaline) the dense flow is broken up in the current transformer by high air pressure.

- **The Sigunite® accelerator is added to the shotcrete with air.**

#### Advantages
- Easy to handle
- The concrete does not have to be pumpable
- Start-up and pause without prelubrication or cleaning
- Dry-mix spraying without change of machine
- Spraying with steel fiber

#### Disadvantages
- Problems with fine aggregate (caking)

### Fine flow process

- **Sika® Aliva® 263/Sigunite® AF Liquid**
  - The shotcrete (wet mix) is loaded into the rotor machine funnel tube.
  - Delivery to the nozzle is by the fine flow process.
  - Just before the nozzle (distance depending on whether the accelerator is alkali-free or alkaline) the Sigunite® accelerator is added to the shotcrete with air.

#### Advantages
- Easy to handle
- The concrete does not have to be pumpable
- Maximum early strength
- Delivery of gravel and sand

#### Disadvantages
- Very high dust generation
- Wear costs
- Higher rebound

### Dry Spraying Process

**Fine flow process**

- **Sika® Aliva® 263/Sigunite® AF Powder**
  - The shotcrete (dry mix) is loaded into the rotor machine funnel tube.
  - Delivery to the nozzle is by the fine flow process.
  - Just before the nozzle (distance depending on whether the accelerator is alkali-free or alkaline) the Sigunite® accelerator is added to the shotcrete with water.

#### Advantages
- Easy to handle
- Does not need pumpable concrete
- Maximum early strength
- Delivery of gravel and sand

#### Disadvantages
- Very high dust generation
- Wear costs
- Higher rebound

---

### Use and Typical requirements

<table>
<thead>
<tr>
<th>Use</th>
<th>Typical requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heading Stabilisation in tunnelling</strong></td>
<td>High early strength, High final strength, High spraying capacity</td>
</tr>
<tr>
<td><strong>Tunnel lining with shotcrete</strong></td>
<td>High early strength, High final strength, High watertightness, High durability</td>
</tr>
<tr>
<td><strong>Mining</strong></td>
<td>High early strength, Sealing of excavation faces, Low to medium final strength</td>
</tr>
<tr>
<td><strong>High or increased fire resistance</strong></td>
<td>Protective layer (no load-bearing function), High adhesion, Resistant to temperatures of over 1200°C</td>
</tr>
<tr>
<td><strong>Slope stabilization</strong></td>
<td>Rapid strength development, Flexibility of use for spraying small concrete volumes</td>
</tr>
<tr>
<td><strong>Tunnel repair</strong></td>
<td>Long-term resistance, Good adhesion, Chemical resistance, Suitable elastic modulus</td>
</tr>
<tr>
<td><strong>Repair of concrete dams</strong></td>
<td>High durability in thin layers, Low elastic modulus, Low rebound</td>
</tr>
<tr>
<td><strong>Repair of harbour walls</strong></td>
<td>High mechanical resistance, High resistance to chemical effects, Low elastic modulus</td>
</tr>
<tr>
<td><strong>Bridge reconstruction</strong></td>
<td>New concrete not susceptible to vibration from traffic, Frost and freeze/thaw resistance</td>
</tr>
</tbody>
</table>

---

### Use

- **Typical requirements**
  - **Heading Stabilisation in tunnelling**: High early strength, High final strength, High spraying capacity
  - **Tunnel lining with shotcrete**: High early strength, High final strength, High watertightness, High durability
  - **Mining**: High early strength, Sealing of excavation faces, Low to medium final strength
  - **High or increased fire resistance**: Protective layer (no load-bearing function), High adhesion, Resistant to temperatures of over 1200°C
  - **Slope stabilization**: Rapid strength development, Flexibility of use for spraying small concrete volumes
  - **Tunnel repair**: Long-term resistance, Good adhesion, Chemical resistance, Suitable elastic modulus
  - **Repair of concrete dams**: High durability in thin layers, Low elastic modulus, Low rebound
  - **Repair of harbour walls**: High mechanical resistance, High resistance to chemical effects, Low elastic modulus
  - **Bridge reconstruction**: New concrete not susceptible to vibration from traffic, Frost and freeze/thaw resistance

---

### Diagrams

1. **Wet Spraying Process**
   - **Dense flow process**
     - Sika® Aliva® 278/Sigunite® AF Liquid
     - Delivery to the nozzle is by the dense flow process.
     - Just before the nozzle (distance depending on whether the accelerator is alkali-free or alkaline) the dense flow is broken up in the current transformer by high air pressure.
   - **Fine flow process**
     - Sika® Aliva® 263/Sigunite® AF Liquid
     - Delivery to the nozzle is by the fine flow process.
     - Just before the nozzle (distance depending on whether the accelerator is alkali-free or alkaline) the Sigunite® accelerator is added to the shotcrete with air.

2. **Dry Spraying Process**
   - **Fine flow process**
     - Sika® Aliva® 263/Sigunite® AF Powder
     - Delivery to the nozzle is by the fine flow process.
     - Just before the nozzle (distance depending on whether the accelerator is alkali-free or alkaline) the Sigunite® accelerator is added to the shotcrete with water.
Shotcrete Additives

Workability Time of wet Shotcrete Mixes

Table of Additives and Fillers for Shotcrete

<table>
<thead>
<tr>
<th>Type</th>
<th>Product</th>
<th>Use/effect</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow control agent (FM)</td>
<td>SikaTard®</td>
<td>High water reduction</td>
<td>Optimum effect when added after the mix water</td>
</tr>
<tr>
<td></td>
<td>Sika’ViscoCrete®</td>
<td>Better workability</td>
<td>Optimum dosage depends on cement type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time controlled workability</td>
<td>For specific properties, preliminary tests with the cement and aggregates to be used are essential</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rapid increase in strength</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Better shrinkage and creep properties</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher water tightness</td>
<td></td>
</tr>
<tr>
<td>Retarder (V2)</td>
<td>SikaTard®-930</td>
<td>Adjustable workability</td>
<td>No cleaning of pumps and hoses necessary during the retarding phase</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silica fume slurries</td>
<td>Sikacrete®-L</td>
<td>Improved fresh concrete homogeneity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SikaFume®</td>
<td>Much higher water tightness</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved adhesion between aggregate and hardened cement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>High frost and freeze/thaw resistance</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower rebound</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polymer-modified silica fume powder</td>
<td>Sikacrete®PP1</td>
<td>As for SikaFume® plus:</td>
<td>As for SikaFume®</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Significant water reduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For very high quality specifications</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumping agents and stabilizers</td>
<td>SikaPump®</td>
<td>Improvement in homogeneity and internal cohesion for unsuitable concrete mixes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sika’Stabilizer</td>
<td>Increase in spraying output with lower energy consumption, even for mixes with broken aggregate</td>
<td></td>
</tr>
</tbody>
</table>

Shotcrete Accelerators

Table of the various Accelerator Types and their main Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Accelerator type</th>
<th>Alkaline</th>
<th>Alkaline</th>
<th>Alkali-free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dosage range</td>
<td></td>
<td>3 – 6 %</td>
<td>12 – 15 %</td>
<td>4 – 7 %</td>
</tr>
<tr>
<td>pH value</td>
<td></td>
<td>13 – 14</td>
<td>11 – 13</td>
<td>3</td>
</tr>
<tr>
<td>Na2O equivalent</td>
<td></td>
<td>26 %</td>
<td>12 %</td>
<td>&lt;1 %</td>
</tr>
<tr>
<td>Very early strength</td>
<td></td>
<td>++ + +</td>
<td>++ + +</td>
<td>++ + +</td>
</tr>
<tr>
<td>Incremental water tightness</td>
<td></td>
<td>+ + + +</td>
<td>+ + + +</td>
<td>+ + + +</td>
</tr>
<tr>
<td>Final strength</td>
<td></td>
<td>++ + +</td>
<td>++ + +</td>
<td>++ + +</td>
</tr>
<tr>
<td>Water tightness</td>
<td></td>
<td>+ +</td>
<td>+ +</td>
<td>+ +</td>
</tr>
<tr>
<td>Leaching behavior</td>
<td></td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Occupational health</td>
<td></td>
<td>+ +</td>
<td>+ +</td>
<td>++</td>
</tr>
<tr>
<td>Occupational and transport safety</td>
<td></td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
</tbody>
</table>

Elutability of the Calcium Hydroxide Ca(OH),

<table>
<thead>
<tr>
<th>Property</th>
<th>Alkaline Alkali-free</th>
<th>Alkaline Alkali-free</th>
<th>Alkali-free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium hydroxide content</td>
<td>10</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

Legend:
- Shotcrete with SikaFume®: Non-corrosive
- Shotcrete with SikaFume®: Non-corrosive
- Shotcrete with conventional alkaline setting accelerator: Not compatible with alkaline accelerators
- Metal parts in contact with this accelerator must be of stainless steel

- Shotcrete with Sigunite® AF: Liquid
- Shotcrete with Sigunite® AF: Powder

- Heading stabilization in tunnelling
- Rock and slope stabilization
- High-quality lining shotcrete
- Very high early strength
- Increased watertightness
- Reduced eluate quantity
- Better health and safety
- For the dry or wet spraying process
- Non-corrosive
- Low final strength reduction compared with the non-accelerated original concrete
- Not compatible with alkaline accelerators
- Metal parts in contact with this accelerator must be of stainless steel

- Shotcrete with SikaFume®: Liquid
- Shotcrete with SikaFume®: Powder

- Heading stabilization in tunnelling
- Rock and slope stabilization
- Very high early strength
- Reduced rebound
- Can be sprayed on a wet substrate
- For the dry or wet spraying process
- Corrosive
- Low final strength reduction compared with the non-accelerated original concrete

Workability Time of wet Shotcrete Mixes

<table>
<thead>
<tr>
<th>Consistency, flow</th>
<th>Property</th>
<th>Accelerator type</th>
<th>Alkaline</th>
<th>Alkaline</th>
<th>Alkali-free</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 – 6 %</td>
<td>12 – 15 %</td>
<td>4 – 7 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pH value</td>
<td>13 – 14</td>
<td>11 – 13</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Na2O equivalent</td>
<td>26 %</td>
<td>12 %</td>
<td>&lt;1 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very early strength</td>
<td>++ + +</td>
<td>++ + +</td>
<td>++ + +</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incremental water tightness</td>
<td>+ + + +</td>
<td>+ + + +</td>
<td>+ + + +</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Final strength</td>
<td>++ + +</td>
<td>++ + +</td>
<td>++ + +</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water tightness</td>
<td>+ +</td>
<td>+ +</td>
<td>+ +</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaching behavior</td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Occupational health</td>
<td>+ +</td>
<td>+ +</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Occupational and transport safety</td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
</tbody>
</table>

Calcium hydroxide content

<table>
<thead>
<tr>
<th>Property</th>
<th>Alkaline</th>
<th>Alkaline</th>
<th>Alkali-free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium hydroxide content</td>
<td>10</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

Legend:
- Shotcrete with SikaFume®: Liquid
- Shotcrete with SikaFume®: Powder

- Heading stabilization in tunnelling
- Rock and slope stabilization
- High-quality lining shotcrete
- Very high early strength
- Increased watertightness
- Reduced eluate quantity
- Better health and safety
- For the dry or wet spraying process
- Non-corrosive
- Low final strength reduction compared with the non-accelerated original concrete
- Not compatible with alkaline accelerators
- Metal parts in contact with this accelerator must be of stainless steel

- Shotcrete with SikaFume®: Liquid
- Shotcrete with SikaFume®: Powder

- Heading stabilization in tunnelling
- Rock and slope stabilization
- Very high early strength
- Lower rebound
- Can be sprayed on a wet substrate
- For the dry or wet spraying process
- Corrosive
- Low final strength reduction compared with the non-accelerated original concrete

Calcium hydroxide content

<table>
<thead>
<tr>
<th>Property</th>
<th>Alkaline</th>
<th>Alkaline</th>
<th>Alkali-free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium hydroxide content</td>
<td>10</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>
**Dry and Wet Mix Spray Mortars**

**Machines for Shotcreting**

### SikaShot®
- Stabilization and sealing gunite
  - For significant water presence
  - Maximum early strength
  - High water tightness
  - Good adhesion to substrate
  - Dry spraying process
  - Usable with rotor machines
  - 1-component ready-mix gunite, highly accelerated

### SikaCrete® Gunite®
- Sealing gunite
  - Silicafume-modified
    - High durability
    - High frost and freeze/thaw resistance
    - Sulphate-resistant
    - Good adhesion to substrate
    - Dry spraying process
- Sealing gunite
  - Polymer-modified
    - Can be applied in thin layers
    - High frost and freeze/thaw resistance
    - Sulphate-resistant
    - Good adhesion to substrate
    - Dry spraying process

### SikaCem® Gunite®
- Repair mortar
  - Silicafume and polymer-modified
    - Repair of concrete structures
    - High frost and freeze/thaw resistance
    - Good adhesion to substrate
    - Ideal surface workability
    - Wet spraying process
    - 1-component ready-mix mortar

### Sika® MonoTop®
- Repair mortar
  - Silicafume and polymer-modified
    - Repair of concrete structures
    - High frost and freeze/thaw resistance
    - Good adhesion to substrate
    - Ideal surface workability
    - Wet spraying process

### Concrete Spraying Systems
- **Sika®-PM500**
  - Highly mechanized concrete spraying systems for large and small tunnels
  - High flexibility due to modular design
  - Ideal for high slopes

### Concrete Spraying Machines
- **Aliva®-246/Aliva®-252/Aliva®-263/Aliva®-285**
  - Concrete spraying machines for dry and wet spraying
  - Low to medium outputs
  - Mobile and multi-purpose
  - For spray mortar and shotcrete

### Spraying Robots for TBM Heading
- **Aliva®-TBM Spraying Robots**
  - Shotcreting robots for immediate stabilization and lining by shotcreting
  - Medium to high outputs

### Spray Arms/Metering Units
- **Sika®-PM Spraying Booms**
  - Telescopic spraying arm
    - Wide radius of operation
    - Maximum mobility
  - Liquid metering unit
    - **Aliva®-403.5**
      - High efficiency
      - Synchronized metering control

### Concrete Spraying Pump
- **Sika®-PM702**
  - Compact easy-to-operate concrete spraying pump
  - Synchronized accelerator dosage
  - Powered by electric or diesel engine
Uses of Shotcrete

Shotcrete Stabilization in conventional Heading

**Sika Solution**
Flow control agent *SikaTard®/Sika'ViscoCrete®*
Retarder *SikaTard®-930*
Setting accelerator *Sigunite® AF Liquid*, second generation
Shotcreting systems *Sika®-PM500/Aliva®-503*

Excavation Slope Stabilization with Wet or Dry Mix Shotcrete

**Sika Solution**
Flow control agent *SikaTard®*
Setting accelerator *Sigunite® AF Liquid*, first generation
Concrete spraying machines *Aliva®-263/Aliva®-285*

Shotcrete Stabilization in TBM Heading

**Sika Solution**
Flow control agent *SikaTard®/Sika'ViscoCrete®*
Retarder *SikaTard®-930*
Setting accelerator *Sigunite® AF Liquid*, second generation
Robot sprayer *Aliva®-303 L1/Aliva®-303 L2*

Concrete Repair with Dry Mix Spray Mortars

**Sika Solution**
Bonding coat *Sika® MonoTop®*
Patching mortar *Sika® MonoTop®*
Concrete spraying machine *Aliva®-246*

**Sika Solution**
Seal *SikaShot®*
Patching mortar *SikaCem®-Gunite®*
Concrete spraying machine *Aliva®-252*
Your local Sika Company

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