Sika® Shotcrete Systems
Technology and Concepts for Shotcrete
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.

### Machines

<table>
<thead>
<tr>
<th>Year</th>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920</td>
<td>Spribag BS-12/MS-12</td>
<td>First dry-mix machines (compressed air process) with a spraying capacity of up to 3 m³/hr.</td>
</tr>
<tr>
<td>1940</td>
<td>Sika Aliva-200/285</td>
<td>Rotor spraying machines and systems for dry and wet mixes</td>
</tr>
<tr>
<td>1980</td>
<td>Sika-PM500</td>
<td>Highly-mechanized shotcreting systems for dry or wet mix shotcrete</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Accelerators

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>In 1933 the Sigunite® Brand was born</td>
<td>In powder form, added by hand. Quantity added 3 – 7%</td>
</tr>
<tr>
<td>Naphthalene Sulphonate Melamine Sulphonate</td>
<td>Sikanement®, still a reliable flow control agent in tunnelling. Working time up to 2 hours.</td>
</tr>
<tr>
<td>Alkaline Aluminates</td>
<td>The first liquid setting accelerators for shotcrete, Sigunite®-L Liquid. Quantity added 3 – 6%.</td>
</tr>
<tr>
<td>Aluminium Sulphate</td>
<td>Sigunite®-49 AF Powder, the first alkali-free setting accelerator. Quantity added 4 – 7%.</td>
</tr>
<tr>
<td>Vinyl Copolymers</td>
<td>SikaTard® shotcrete flow control agent. State of the art for decades. Working time up to 4 hours.</td>
</tr>
<tr>
<td>Modified Polycarboxylates</td>
<td>Sika® ViscoCrete®, the latest innovation for shotcreting. Working time over 6 hours.</td>
</tr>
</tbody>
</table>

### Flow Control Agents

- Conforms to the EFCA environmental quality standard
- Konform mit den Umweltrichtlinien der EFCA
- Conforme aux directives écologiques de l’EFCA
- EQ European Federation of Concrete Admixtures Associations
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 13 reduce the human and environmental hazards during handling, storage and use. The spray contains no corrosive semi-solids, 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 mixes are 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.

Parameters influencing the rebound quantity:
- Layer thickness
- Gradation curve
- Substrate condition
- Jet trajectory
- Air volume and pressure
- Adhesion properties
- Early strength
- Fiber type
- Fiber content
- Spraying process

Our commitment to safety, health and environment

pH value

Conventional
alkali-free
pH > 13

Mineral
alkali-free
pH 3-8

With SikaPump: steady feed pressure

Without SikaPump: jerky feed pressure

Pump pressure during concrete delivery

Shotcrete strength development specifications

Compressive strength N/mm²

Effect of W/C ratio on depth of water penetration

Effect of W/C ratio on compressive strength

Compressive strength N/mm²

Shotcrete requirement for a compressive strength of 20 bar

Depth of water penetration in mm

W/C ratio 0.40
W/C ratio 0.46
W/C ratio 0.50

Sulphate resistance of concrete cores

Difference in mean linear deformation between samples stored in sulphate and in water

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 equates 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 correct curing.

Sulphates

Water-soluble sulphates react with the C,A 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 C,A 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 SikaViscoCrete® (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**: 0.3 %
  - 0 – 4 mm with 4 % inherent moisture: 55 % ca. 680 kg
  - 4 – 8 mm with 2 % inherent moisture: 45 % ca. 560 kg
- **Dry mix moist m³**: *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 % 967 kg 358 l
  - 4 – 8 mm with 2 % inherent moisture: 40 % 791 kg 293 l
- **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 set 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 (total aggregate + cement + additional fine aggregates):

- **Aggregate**: 0 – 8 mm 0 – 16 mm
- **Round**: 500 kg/m³ 450 kg/m³
- **Broken**: 525 kg/m³ 475 kg/m³

### 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.

**Examples of Concrete Formulations**

**Quality Control**

**Concrete production**

**Concrete delivery**

**Concrete pumping**

**Early strength testing**

**Spraying**

**Compression testing of core sample**

**Water impermeability**

**Curing**
## Shotcrete Application

### Wet Spraying Process

**Dense flow process**
- Sika® Aliva®-279/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
- Maximum early strength
- Delivery of gravel and sand

#### Disadvantages
- Complex start-up and cleaning process
- 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

### Typical requirement

<table>
<thead>
<tr>
<th>Use</th>
<th>Typical requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heading Stabilization in tunnelling</td>
<td>High early strength, Low final strength, High spraying capacity</td>
</tr>
<tr>
<td>Tunnel lining with shotcrete</td>
<td>High early strength, High final strength, High water tightness, High durability</td>
</tr>
<tr>
<td>Mining</td>
<td>High early strength, Sealing of excavation faces, Low to medium final strength</td>
</tr>
<tr>
<td>High or increased fire resistance</td>
<td>Protective layer (no load-bearing function), High adhesion, Resistant to temperatures of over 1200°C</td>
</tr>
<tr>
<td>Slope stabilization, Excavation stabilization</td>
<td>Rapid strength development, Flexible use, Flexibility of use for spraying small concrete volumes</td>
</tr>
<tr>
<td>Tunnel repair</td>
<td>Long-term resistance, Good adhesion, Chemical resistance, Suitable elastic modulus</td>
</tr>
<tr>
<td>Repair of concrete dams</td>
<td>High durability in thin layers, Low elastic modulus, Low rebound</td>
</tr>
<tr>
<td>Repair of harbour walls</td>
<td>High mechanical resistance, High resistance to chemical effects, Low elastic modulus</td>
</tr>
<tr>
<td>Bridge reconstruction</td>
<td>New concrete not susceptible to vibration from traffic, Frost and freeze/thaw resistance</td>
</tr>
</tbody>
</table>
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) High-performance flow agent</td>
<td>SikaTard®</td>
<td>High water reduction&lt;br&gt;Better workability&lt;br&gt;Time controlled workability&lt;br&gt;Rapid increase in strength&lt;br&gt;Better shrinkage and creep properties&lt;br&gt;Higher water tightness</td>
<td>Optimum effect when added after the mix water&lt;br&gt;Optimum dosage depends on cement type&lt;br&gt;For specific properties, preliminary tests with the cement and aggregates to be used are essential</td>
</tr>
<tr>
<td>Retarder (VZ)</td>
<td>SikaTard®-930</td>
<td>Adjustable workability&lt;br&gt;No cleaning of pumps and hoes necessary during the retarding phase</td>
<td></td>
</tr>
<tr>
<td>Silicate slurries</td>
<td>SikaCem®-L, SikaFume®</td>
<td>Improved fresh concrete homogeneity&lt;br&gt;Much higher water tightness&lt;br&gt;Improved adhesion between aggregate and hardened cement&lt;br&gt;High frost and freeze/thaw resistance&lt;br&gt;Lower rebound</td>
<td>Added at the batching plant&lt;br&gt;Optimum curing is necessary because silicate concrete dries out very quickly on the surface</td>
</tr>
<tr>
<td>Silicate powder</td>
<td>SikaCem®-PP1</td>
<td>As for SikaFume®&lt;sup&gt;+&lt;/sup&gt; plus: Significant water reduction For very high quality specifications</td>
<td>As for SikaFume®&lt;sup&gt;+&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pumping agents and stabilizers</td>
<td>SikaPump®, SikaStabilizer</td>
<td>Improvement in homogeneity and internal cohesion for unsuitable concrete mixes Increase in spraying output with lower energy consumption, even for mixes with broken aggregate</td>
<td>Addition increases the power input of the mixer and the concrete consistency – do not adjust by adding water</td>
</tr>
</tbody>
</table>

Table of the various Accelerator Types and their main Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Alkaline &lt;br&gt;Aluminate-based</th>
<th>Alkaline &lt;br&gt;Silicate-based</th>
<th>Alkali-free</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dosing range</td>
<td>3 – 6 %</td>
<td>7 – 10 %</td>
<td>4 – 7 %</td>
<td></td>
</tr>
<tr>
<td>pH value</td>
<td>12 – 14</td>
<td>11 – 13</td>
<td>12 – 13</td>
<td></td>
</tr>
<tr>
<td>Na₂O equivalent</td>
<td>20 %</td>
<td>12 %</td>
<td>&lt;1 %</td>
<td></td>
</tr>
<tr>
<td>Very early strength of set time (h)</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>Cracking 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>

**SikaTard® AF Liquid**
- Heading stabilization in tunnelling
- Rock and slope stabilization
- High quality lining shotcrete
- Very high early strength
- Increased water tightness
- 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

**SikaTard® AF 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
- Final strength reduction compared with the non-accelerated original concrete

<table>
<thead>
<tr>
<th>Product</th>
<th>Use/effect</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calcium hydroxide Ca(OH)₂</strong></td>
<td>Elutability of the Calcium Hydroxide Ca(OH)₂</td>
<td>Gels and cements for mortar production&lt;br&gt;Building materials&lt;br&gt;Concrete admixtures&lt;br&gt;Concrete admixtures</td>
</tr>
</tbody>
</table>
## Dry and Wet Mix Spray Mortars

### Machines for Shotcreting

#### Concrete Spraying Systems

<table>
<thead>
<tr>
<th>Sika®-PM500</th>
<th>Highly mechanized concrete spraying systems for large and small tunnels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High flexibility due to modular design</td>
</tr>
<tr>
<td></td>
<td>Ideal for high slopes</td>
</tr>
</tbody>
</table>

#### Concrete Spraying Machines

<table>
<thead>
<tr>
<th>Aliva®-246/Aliva®-252/Aliva®-263/Aliva®-285</th>
<th>Concrete spraying machines for dry and wet spraying</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low to medium outputs</td>
</tr>
<tr>
<td></td>
<td>Mobile and multi-purpose</td>
</tr>
<tr>
<td></td>
<td>For spray mortar and shotcrete</td>
</tr>
</tbody>
</table>

#### Spraying Robots for TBM Heading

<table>
<thead>
<tr>
<th>Aliva®-TBM Spraying Robots</th>
<th>Shotcreting robot for immediate stabilization and lining by shotcreting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium to high outputs</td>
</tr>
</tbody>
</table>

#### Spray Arms/Metering Units

<table>
<thead>
<tr>
<th>Telescopic spraying arm</th>
<th>Sika®-PM Spraying Booms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wide radius of operation</td>
</tr>
<tr>
<td></td>
<td>Maximum mobility</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liquid metering unit</th>
<th>Aliva®-403.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High efficiency</td>
</tr>
<tr>
<td></td>
<td>Synchronized metering control</td>
</tr>
</tbody>
</table>

#### Concrete Spraying Pump

<table>
<thead>
<tr>
<th>Sika®-PM702</th>
<th>Compact easy-to-operate concrete spraying pump</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Synchronized accelerator dosage</td>
</tr>
<tr>
<td></td>
<td>Powered by electric or diesel engine</td>
</tr>
</tbody>
</table>

### Sika® Shot

For significant water presence
- Maximum early strength
- High watertightness
- Good adhesion to substrate
- Dry spraying process
- usable with rotor machines
- 1-component ready-mix gunite, highly accelerated

### Sika®-Crete® Gunite

- High durability
- High frost and freeze/thaw resistance
- Sulphate-resistant
- Good adhesion to substrate
- Dry spraying process

### Sika®-Cem® Gunite

- Can be applied in thin layers
- High frost and freeze/thaw resistance
- Sulphate-resistant
- Good adhesion to substrate
- Dry spraying process

### Sika® MonoTop

- 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

### SikaCrete®-Gunite®

- Silicafume-modified
- High durability
- High frost and freeze/thaw resistance
- Sulphate-resistant
- Good adhesion to substrate
- Dry spraying process

### SikaCem®-Gunite®

- Polymer-modified
- Can be applied in thin layers
- High frost and freeze/thaw resistance
- Sulphate-resistant
- Good adhesion to substrate
- Dry spraying process

### Cold-injecting robots

- Can be used in thin layers
- High frost and freeze/thaw resistance
- Sulphate-resistant
- Good adhesion to substrate
- Dry spraying process

### Liquid metering unit

- Aliva®-403.5
- High efficiency
- Synchronized metering control

### Gunite

- SikaCrete®-Gunite
- High durability
- High frost and freeze/thaw resistance
- Sulphate-resistant
- Good adhesion to substrate
- Dry spraying process

### Sealing gunite

- Sika®-Cem®-Gunite
- Can be applied in thin layers
- High frost and freeze/thaw resistance
- Sulphate-resistant
- Good adhesion to substrate
- Dry spraying process

### Repair mortar

- Sika®-MonoTop
- 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

### Stabilization and sealing gunite

- Sika®-Shot
- For significant water presence
- Maximum early strength
- High watertightness
- Good adhesion to substrate
- Dry spraying process
- Usable with rotor machines
- 1-component ready-mix gunite, highly accelerated

### Sika®-Crete® Gunite

- Silicafume-modified
- High durability
- High frost and freeze/thaw resistance
- Sulphate-resistant
- Good adhesion to substrate
- Dry spraying process

### Sika®-Cem® Gunite

- Polymer-modified
- Can be applied in thin layers
- High frost and freeze/thaw resistance
- Sulphate-resistant
- Good adhesion to substrate
- Dry spraying process

### Sika® MonoTop

- 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®-PM500

- Highly mechanized concrete spraying systems for large and small tunnels
- High flexibility due to modular design
- Ideal for high slopes

### 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

### Aliva®-TBM Spraying Robots

- Shotcreting robot for immediate stabilization and lining by shotcreting
- Medium to high outputs

### Telescopic spraying arm

- Sika®-PM Spraying Booms
- Wide radius of operation
- Maximum mobility

### Liquid metering unit

- Aliva®-403.5
- High efficiency
- Synchronized metering control

### 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: Signum® AF Liquid, second generation
- Shotcreting systems: Sika®-PM500/Aliva®-503

**Shotcrete Stabilization in TBM Heading**

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

**Excavation Slope Stabilization with Wet or Dry Mix Shotcrete**

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

**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

Sika®-PM500 shotcreting system for large sections
Aliva®-503 shotcreting system for small sections
Slope stabilization
Excavation stabilization
Slope stabilization
Excavation stabilization
Shotcrete stabilization in TBM heading
Shotcrete stabilization in TBM heading
Bridge repair
Bridge repair
Tunnel repair
Concrete System Documentation

Sika® Shotcrete Systems
Technology and Concepts for Shotcrete

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