

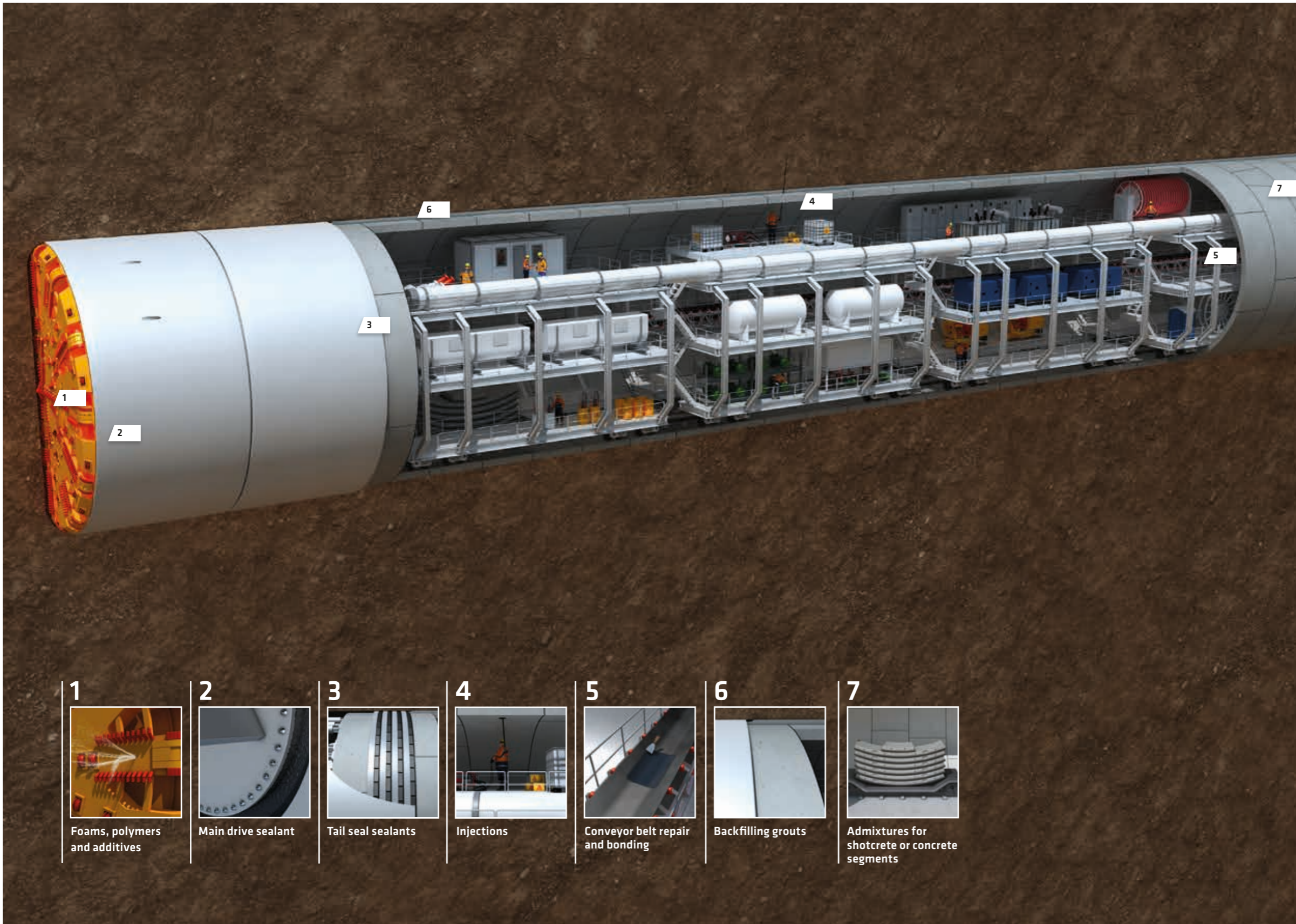


CONCRETE PRODUCTS FOR TBM

BUILDING TRUST



SIKA AND THE PRODUCTS FOR TBM



MECHANIZED TUNNELING has become more and more important with the rapid growth and expansion of underground construction in recent years.

Tunnel Boring Machines (TBMs) are very advanced equipment used as an alternative to “drilling and blasting” through rock and “conventional mechanical excavation” in soft ground.

TBMs reduce disturbance in the excavation area, which makes them ideal for use in heavily urbanized areas. They will also produce a smooth tunnel wall that reduces the cost of the final lining.

The total excavation time of long tunnels is also significantly reduced with TBMs in comparison to conventional excavation methods.

A variety of TBMs have been introduced during the past decades. These include the Slurry and the Earth Pressure Balance (EPB) for soft ground, the Grippers for hard rock and the Single Shield TBM for tunneling through rock and other stable, non-groundwater-bearing grounds.

Sika provides a wide range of products that are designed specifically for use with all of these different variants of TBM, and throughout the whole of their tunnel excavation and construction process.

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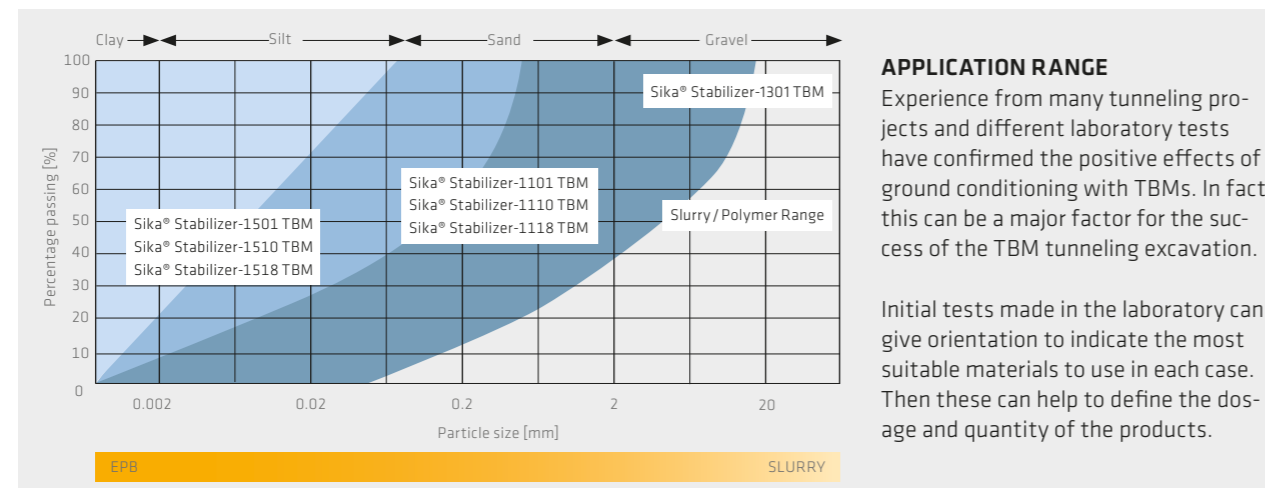
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Admixtures for shotcrete or concrete segments

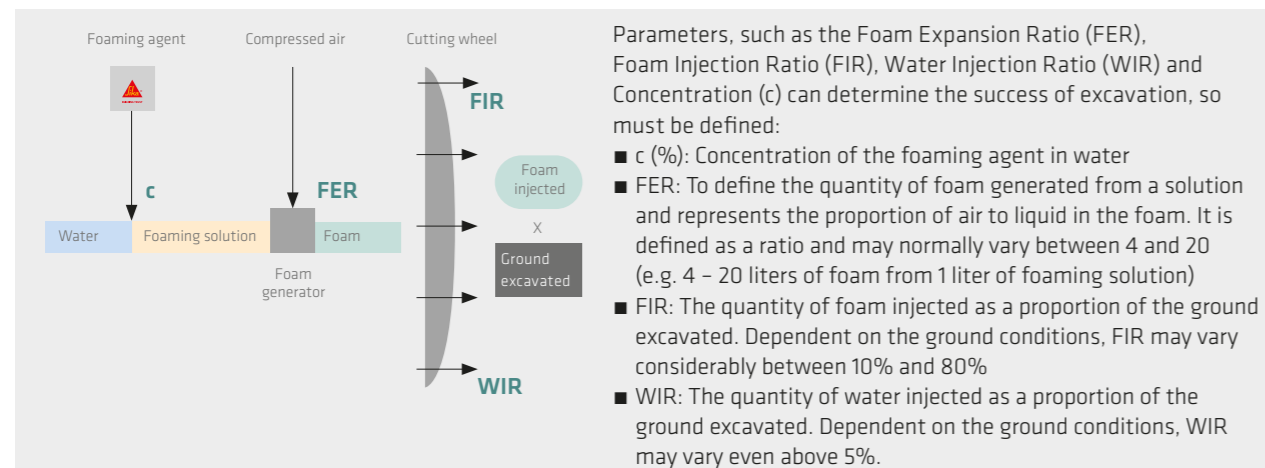
FOAMS, POLYMERS AND ADDITIVES

THE INJECTION OF FOAMS, POLYMERS AND OTHER ADDITIVES into the tunnel face can significantly modify the characteristics of soft ground, including its plasticity, texture and permeability, in order to make the work and progress of the TBM easier and faster. The selection of the best type and quantity of material for this ground conditioning is dependent on the specific geology and the equipment available with the TBM.

APPLICATION RANGE OF EPB-TBM / USE OF FOAM



FOAM PARAMETERS



ADVANTAGES OF CONDITIONING

Soft Ground

- Reduction of friction angle
- Short term cohesion
- Lower wear and lower torque
- Short term face stabilization
- Less clogging
- Lower permeability

Hard Rock

- Reduction of dust
- Reduction of disc cutter choking
- Cleaner and faster changing of disc cutters
- Lower wear and lower torque
- Reduced abrasion and wear



FOAMS

As not all ground is ideal for excavation by TBMs, the use of ground conditioning foams can allow EPB TBMs to achieve better advance rates, even in heterogeneous grounds containing gravel, sand and water or under other critical geological conditions.

Foaming agents from the range Sika® Stabilizer TBM are liquid conditioning foaming agents which have been formulated to be used with earth pressure balance machines (EPB) for modifying the properties of the excavated soil.

To fulfill specific increasing environmental expectations and try to reduce the ecological impact of soil conditioned and excavated by the TBM after its disposal, Sika is promoting an alternative range of foaming agents from the Sika® Stabilizer TBM family, which has an adapted formulation without glycol. Considering the tunnel geology and job site conditions, the use of these products may reflect a more positive environmental impact of foaming agents.

POLYMERS

Typical Sika polymer applications in the TBM excavation process are for:

- Reduction of “stickiness”
- Reduction of adhesion to metal surfaces
- Reduced segregation in the mixing chamber
- Drying out the ground

Water absorbing polymers, viscosity modifiers or stabilizers for foams from the range Sika® Stabilizer TBM are specially formulated for the use in TBM tunneling.

ADDITIVES

Although foams are the most widely used materials, they are not the only type of products that can be considered. Additional products may be used to achieve different results during TBM excavation and progress.

The range Sika® Stabilizer TBM also counts with special liquid products such as cutter cleaners, defoaming agents or friction reducers.

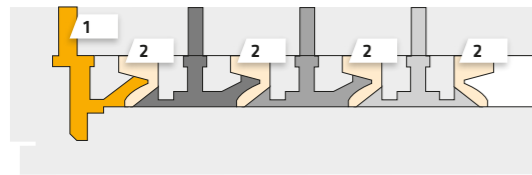
MAIN DRIVE AND TAIL SEAL SEALANTS

SIKA SEALANTS HAVE BEEN SPECIFICALLY DESIGNED to fulfil specific application requirements. At the front of the machine, the main drive sealants avoid any residual spoil contamination. At the back of the shield, the tail seal sealants protect against water, ground and grout ingress.

MAIN DRIVE SEALANT

One of the most important and expensive components of the TBM is probably the main bearing. In order to keep this in good condition, it has to be properly sealed and lubricated. Experience has shown that most failures of TBM main bearings are related to a loss of lubricant, or to the entry of contaminants from outside. For this reason it is absolutely essential to have the system working with reliable products. Sika® Stabilizer TBM H protects the main bearing preventing it from contact with water, mud, dust and foam contamination.

Main drive sealants from the range **Sika® Stabilizer TBM** are bearing sealants for TBMs with a strong grab and adhesion to metal surfaces, with extremely high wash-off resistance. They also have good lubrication and pumping properties.



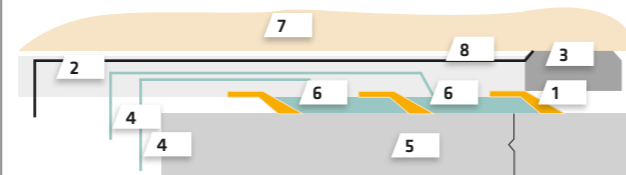
1 Main drive sealant | 2 Seals



TAIL SEAL SEALANTS

Tail seal sealants are injected between the rows of brushes in the gap between the tailskin and the lining segments to prevent water, soil and the backfill grout from entering the TBM.

Sika® Stabilizers TBM are specifically designed to be safe for use in urban areas and elsewhere that ground water could be in contact with TBM excavations.



1 Wire brush	2 Tailskin	3 Backfill	4 Grease lines
5 Concrete segment	6 Tail Seal Sealant	7 Ground	8 Grout lines



INJECTIONS

SIKA PROVIDES A WIDE RANGE of injection products which are used with TBMs for different applications including soil consolidation, rock stabilization, stopping water ingress, permanent sealing and waterproofing, plus the filling of voids and cavities.



Water ingress and wash-out with the development of uncontrolled cavities present a security risk and potentially major costs for hard rock and gripper TBMs. SikaFix® injection technologies are highly efficient in solving such problems.

SikaFix® 301

This is an acrylate based, 3-component injection resin, specially developed to penetrate and consolidate low permeability structures. SikaFix®-301 has almost water-like consistency and therefore penetrates rock and sand filled structures quickly and very efficiently. Reaction time of the resin can be adjusted from 2 - 15 minutes depending on the application and penetration distances required.



SikaFix® 501

SikaFix®-501 is a 2-component, silicate resin with a high foaming factor of around 30 times (reaction time is around 15 sec.). The product foams with- or without the presence of water. Another important advantage for TBMs with this product is the cuttable nature of the cured foam, as a PU-foam would adhere to the cutter-head of the TBM.

SikaFix®-501 also shows excellent cost performance in comparison to other TBM pre-injection products, and is widely used for to stabilize fractured geology with a high void or cavity content.

SikaFix® 601

SikaFix®-601 is a 2-component, silicate resin with a short reaction time (around 40 sec.), which cures to a high strength solid resin, without the development of any foam. It also has excellent adhesion, even on damp surfaces, therefore SikaFix®-601 is frequently used for demanding rock consolidation and for controlling over-blasting in the tunnels. The product is also available as a thixotropic grade for use in overhead applications and self-drilling bolt injection.



Tunnel Boring Machines (TBMs) are very advanced equipment that reduce disturbance in the excavation area and shorten the construction time in long tunnels. They also produce a smooth tunnel wall and are ideal for use in heavily urbanized areas.

Sika provides a wide range of products required throughout the whole tunnel excavation and construction process.

CONVEYOR BELT REPAIR AND BONDING

TUNNELING AND THE MINING INDUSTRY are amongst the largest industrial sectors in the world where rubber conveyor belt systems are widely used. Sika's expertise can provide superior cost-performance options for the bonding and repair of rubber belts and components for many applications.

BELT REPAIR

Sika's 2-component, high-performance elastomeric, synthetic resin based system is specially designed for the repair of textile and steel reinforced rubber conveyor belts. The material is primarily used to fix the commonly occurring, non-structural damage such as holes, cuts and ripped edges caused by the rocks. This significantly extends the service-life of the conveyor belt.

When applied it cures and develops outstanding mechanical properties on a well prepared substrate. This product is ideal for fast repairs with a rapid return to service of the conveyor belts.

RUBBER BONDING

The vulcanization of rubber is time-consuming and can also be an expensive business with a lot of hardware and special know-how involved. Sika is one of the companies with patented knowledge in this field, plus a global reach to supply outstanding rubber-bonding adhesives.

Sika's fast curing and flexible adhesive systems have been designed to replace mechanical fixings or fastenings, such as rivets, screws or welding as well as hot vulcanizing itself. They are also suitable for bonding to and/or between many other materials such as rubber, metals, hard plastics, glass and wood.



BACKFILLING GROUTS

SIKA IS ACTIVELY INVOLVED AROUND THE WORLD in different tunneling projects, providing a wide range of products for TBM backfilling according to each project's specific requirements.

BACKFILLING MORTAR

Excavation with shield TBMs means that precast concrete segments are installed to form the tunnel lining, and an annular gap remains between these segments and the ground. The filling of this annulus is a very important requirement as this ensures homogeneous contact with the ground, transfers load from the TBM back-up and also can help to waterproof the tunnel.

Different types of filling materials have been developed: hydraulically setting mortar and two component grout. Sika offers a complete range of stabilizers and retarders to prepare the backfilling grout: SikaTard®, Sika® ViscoCrete®, SikaFume® and Plastiment®.

TWO COMPONENT GROUT

Two component injection grout is prepared by mixing a blend of water/cement, bentonite and retarder (component A) with an accelerator (component B). The two components get mixed just before being injected through the tailskin where the mixture finally transforms from a creamy liquid to a gel in around 10 - 20 seconds. The final mix has comparable compressive strength to that of the surrounding ground and can fill every gap and void before it sets and hardens.

Different Sika admixtures and stabilizers may be used for the required flow and retarded set effects, such as SikaTard® and Plastiment® products. SikaSet® or Sigunit® accelerators are then used to control the set and hardening time and process.



ADMIXTURES FOR SHOTCRETE

SPRAYED CONCRETE UNITS use modern materials handling technology as well as concrete technologies such as admixture chemistry. Increasing demands on cost-effectiveness, the protection of health and the environment have meant that sprayed concrete has been in continuous flux for recent years.

Sika® ViscoCrete®

Products used to reduce the water demand of the concrete, control the workability and increase the durability of sprayed concrete. Strength development is positively influenced by the dual actions of the superplasticizer and the acceleration effect.

SikaTard®

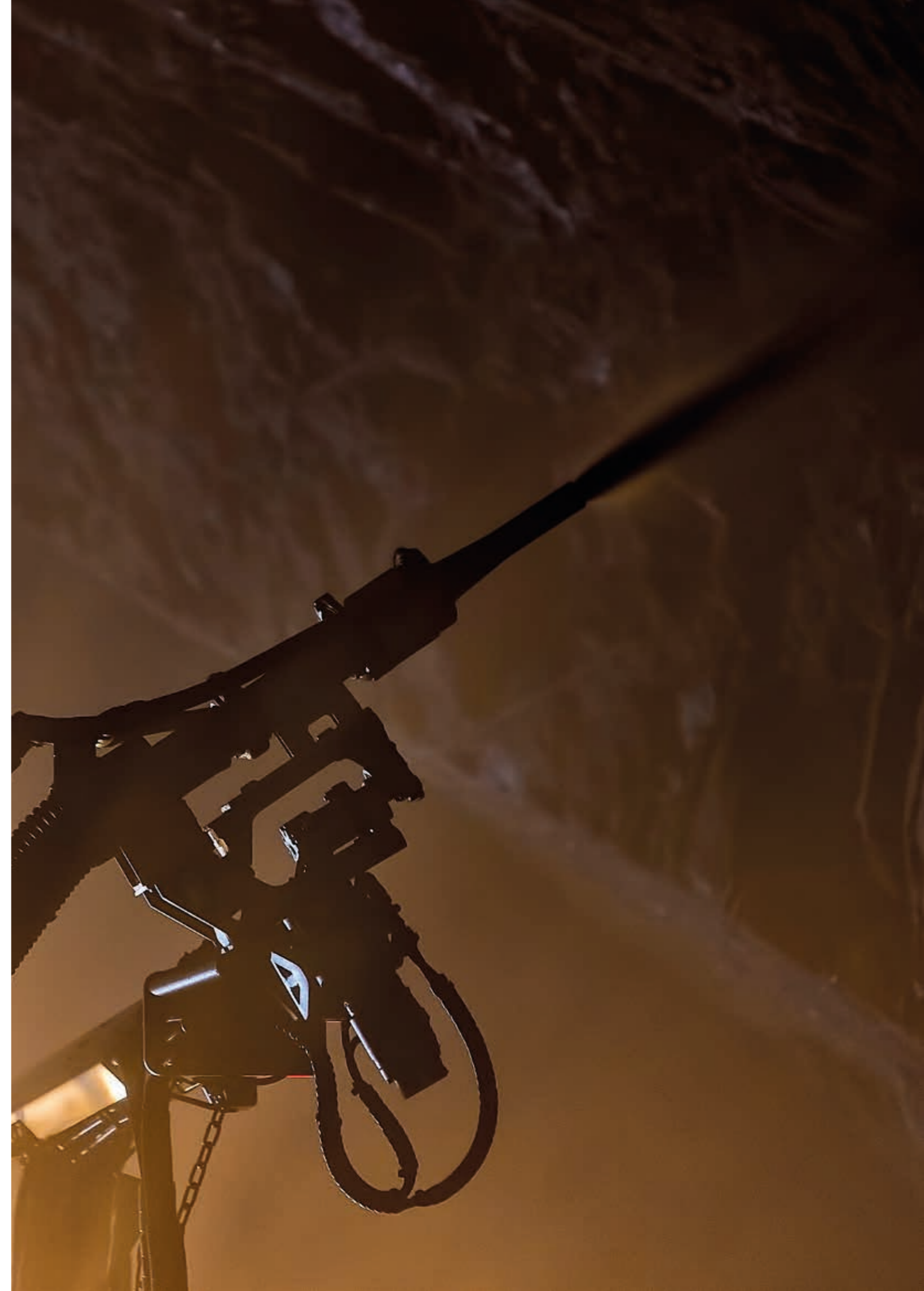
Admixtures developed to regulate the hydration of sprayed concrete which enable an extended workability time, so that continuous spraying with fresh mixes can continue without difficulty for defined periods of time as required.

Sika® Shot

High performance, quick setting repair mortars for dry-spray application to concrete, stone and mortar substrates. Specially designed for application as ready-mixed gunite mortar for stopping severe water ingress and securing operations in the prevention of rock-falls during underground structure construction.

Sika® Sigunit®

A complete range of alkali-free and alkaline accelerators for shotcrete providing fast strength development according to the required J1, J2 and J3 curves.



ADMIXTURES FOR CONCRETE SEGMENTS

IN MODERN TBM CONSTRUCTION the permanent tunnel lining is produced with precast concrete segments. This type of concrete often requires innovative solutions for the mix design.

CONCRETE SEGMENTS

During the production of concrete segments for tunnels, it is important that the concrete can be placed without the formation of hollows or voids. The mix must also have a high early strength to reduce the curing time and de-mold the segments as fast as possible. With a high plasticizing effect, a low water/cement ratio can be achieved that will result in increased early strengths and increased durability.

After just a few hours the concrete should have sufficient strength. To meet these requirements, special admixtures have been developed using Sika® ViscoCrete® technology. Sika® Separol® release agents are used to ensure easy de-molding and improved concrete surfaces.

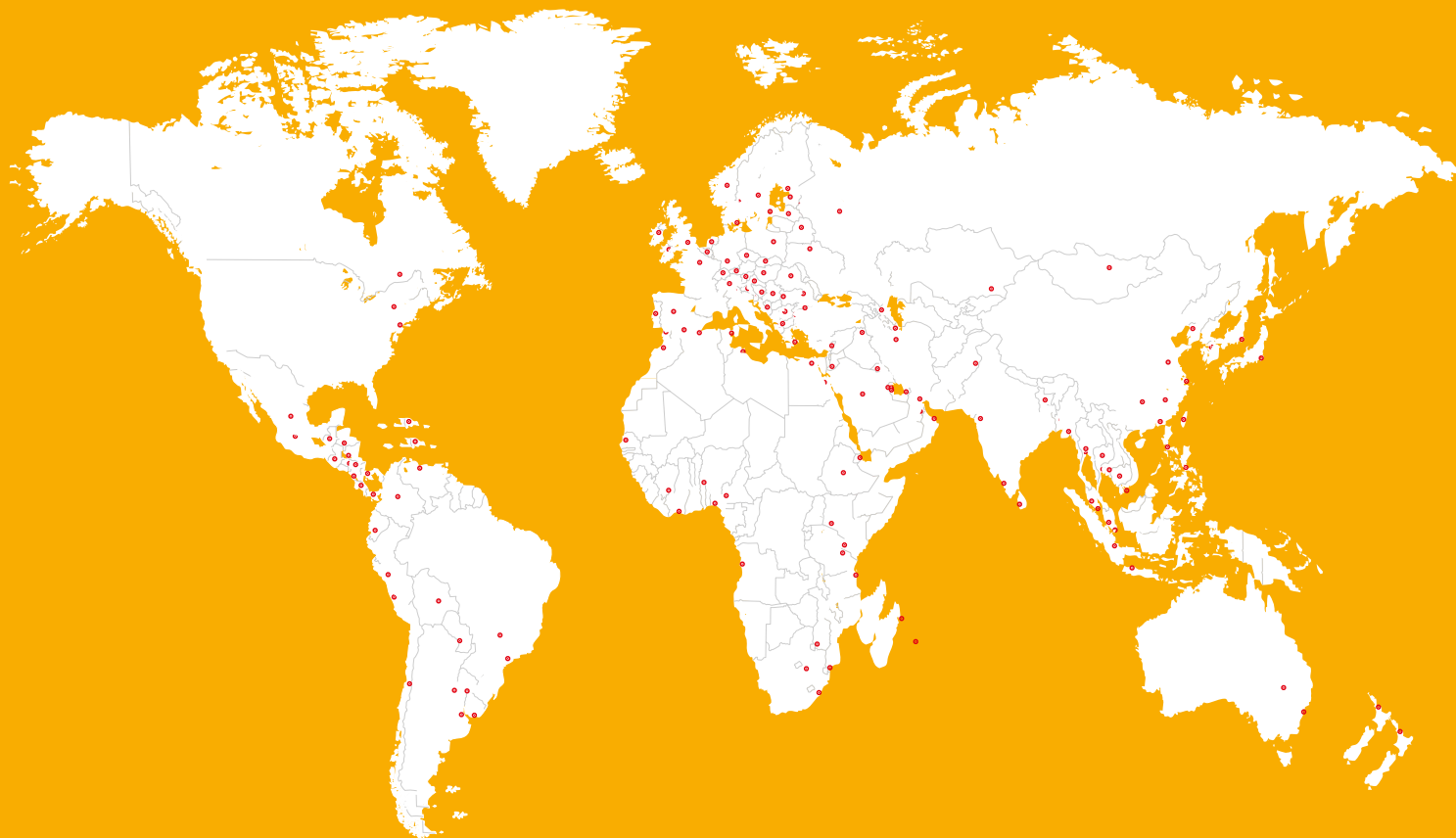
In some conditions, the segments forming the permanent lining can be exposed to aggressive influences in the ground. In such cases, Sikagard® products are used to provide a high level of protection.

CONCRETE FOR INNER LININGS

The concrete volume that is required for the inner lining of tunnels is very large. Cost effectiveness is therefore a significant aspect. The concrete must flow easily so that it can be cast in the molds, it must not bleed or segregate and in order to ensure rapid production and mold turnaround, it must provide high early strength. The requirements of consistence, stability and early strength are controlled by the use of Sika® ViscoCrete® technology. Additional Sika admixtures such as Sikament®, SikaTard® and SikaPlast® are also used to meet specific demands.



GLOBAL BUT LOCAL PARTNERSHIP



FOR MORE INFORMATION:



www.sika.com/tbm

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, industrial 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.



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