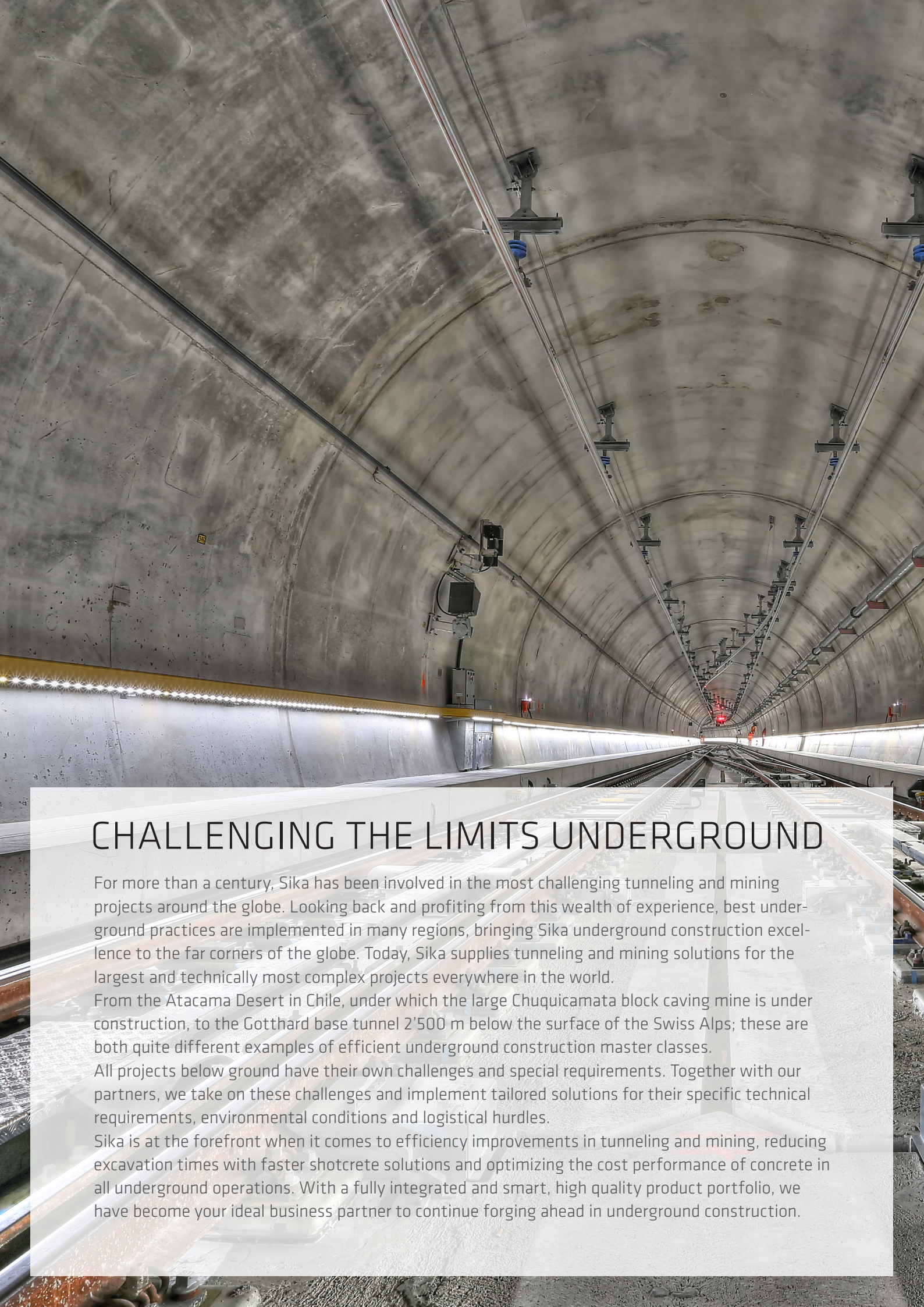




CONCRETE SIKA TECHNOLOGIES FOR TUNNELING & MINING

BUILDING TRUST





CHALLENGING THE LIMITS UNDERGROUND

For more than a century, Sika has been involved in the most challenging tunneling and mining projects around the globe. Looking back and profiting from this wealth of experience, best underground practices are implemented in many regions, bringing Sika underground construction excellence to the far corners of the globe. Today, Sika supplies tunneling and mining solutions for the largest and technically most complex projects everywhere in the world.

From the Atacama Desert in Chile, under which the large Chuquicamata block caving mine is under construction, to the Gotthard base tunnel 2'500 m below the surface of the Swiss Alps; these are both quite different examples of efficient underground construction master classes.

All projects below ground have their own challenges and special requirements. Together with our partners, we take on these challenges and implement tailored solutions for their specific technical requirements, environmental conditions and logistical hurdles.

Sika is at the forefront when it comes to efficiency improvements in tunneling and mining, reducing excavation times with faster shotcrete solutions and optimizing the cost performance of concrete in all underground operations. With a fully integrated and smart, high quality product portfolio, we have become your ideal business partner to continue forging ahead in underground construction.

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SIKA TECHNOLOGIES FOR TUNNELING AND MINING



CONCRETE

Over the past 100 years, Sika has made many notable contributions to the development of concrete as a durable and sustainable construction material.

Sika meets complex concrete production and construction processes with proven and innovative solutions, to accommodate many challenging demands, such as those encountered in tunneling and mining.

Sika® ViscoCrete®
Superplasticizers

Sika® ViscoFlow®
Slump retainers

SikaRapid®
Accelerators

Sika® Stabilizer
Viscosity control agents

SikaPump® Start-1
Lubricant

SikaFume®
Silica fume

SikaFiber®
Micro & macro synthetic

Sika® Intraplast®
Grout admixture for anchoring and grouting



SHOTCRETE

Shotcrete is sprayed concrete and today this combines many aspects of concrete technology with admixture chemistry and modern methods of materials handling and delivery.

Sika has proven expertise and experience mastering all of the technologies to meet the most demanding requirements. This includes the full range of capabilities using both wet and dry sprayed solutions.

Sika® ViscoCrete®
Superplasticizers

SikaTard®
Shotcrete retarders

SikaPump® Start-1
Lubricant

Sika® Sigunit®
Accelerators

SikaFiber®
Micro & macro synthetic

Sikacrete® Gunite
Ready mixed gunite

SikaFume®
Silica fume



WATERPROOFING

Modern tunnel structures are designed for a life span of over 100 years. This puts equally high performance requirements on the waterproofing systems, not only in service, but also during the installation and overall construction phase.

Sikaplan® WT
TPO based sheet waterproofing membrane systems

Sikaplan® WP
PVC based membranes

Sika® WT/WP/Dilatec
Preformed, bonded tapes for waterproof connections and terminations

Sika® Waterbars
Joint waterproofing systems

SikaSwell® P
Hydrophilic swelling profile for joint sealing

SikaFuko®
Injectable hoses for joint sealing and secondary / back-up waterproofing

Sika® Inject
Resins for post-applied waterproofing by injection



INJECTION

Fast cycle times are obviously important for efficient tunneling and mining operations. The Sika® Inject range provides effective and innovative injection solutions including cementitious and resin (polyurethane, silicate, and acrylate) based materials for all possible injection and ground stabilization problems.

Sika® Inject
Fast, reactive injection products that expand with or without contact with water, mainly injected using a two-component pump. The Sika® Inject range is designed for immediate water-stopping under high water flow and hydrostatic pressure conditions.



TBM SOLUTIONS

Sika offers a wide range of TBM products, covering all types of different TBM types.

The products and systems are designed to increase efficiencies throughout the excavation and construction process of fully mechanised tunneling projects.

Sika® Stabilizers

- Complete range of TBM soil conditioning and polymers
- Special main drive and tail sealant grease
- Annulus grout solutions including Bentonite, retarders and accelerators

Sika® Retarders

For retarding and stabilizing backfilling grouts



MINE BACKFILL ADMIXTURES

Sika admixtures for paste backfill operations are designed to optimize and significantly reduce the necessary binder consumption and cost. Additionally, these will also help to ensure the rheology and stability of the paste, thereby reducing the backfill line pressure that is required.

Sika® Stabilizer MBF

A complete range of paste backfill admixtures for the most cost effective solutions with the variations in tailings from all different types of geological deposits and ground conditions.



GROUTING

Heavy machinery such as mills, crushers and hoists are key components of large scale mining operations.

Grouts play an important role in bedding these to successfully transfer vibration and heavy loads into their structural foundations. Sika solutions include the full range of cement and resin based grouting materials (epoxy, acrylic and polyurethane etc.).

SikaGrout®

Complete range of high-performance, cementitious grouting systems

Sikadur®

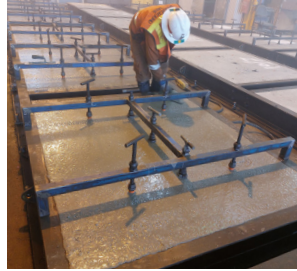
Complete range of epoxy grouting systems

CONCRETE REQUIREMENTS AND APPLICATIONS



CONCRETE LINING

Fast construction of safe and durable concrete structures is no longer a difficult task with Sika admixture technologies. Good pumpability, flow and compaction, followed by high early strength, then low permeability are the key characteristics for a good tunnel lining concrete.



HPC CONCRETE

Sika admixtures for high strength and abrasion resistance are used in tunneling for the associated concrete slabs and structures, plus in mining for the drawpoints, extraction levels, haulage drifts and ore pass linings.



SEGMENTS

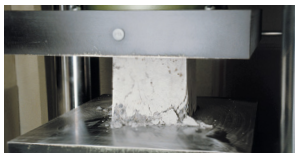
In tunnel segment production, high early strengths for rapid demolding, followed by the highest requirements with regards to performance and durability have to be fulfilled.



SLIKLINE CONCRETE

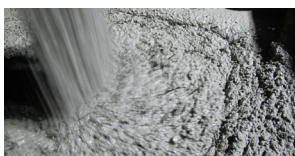
Sliklines are farthest from the concrete pump and immersed in the concrete for a lot of the time, so the mix design needs the right admixtures for the works to continue without segregation and blocking of the lines.

THE MAIN REQUIREMENTS FOR CONCRETE IN TUNNELING AND MINING



High early strengths achieved with Sika® Viscoflow® technology

In order to reduce cycle times in underground operations high early strengths are needed to ensure the elements can be demolded, moved or put under load as quickly as possible.



Extended workability times produced using Sika® ViscoCrete® & Sika® ViscoFlow® technology

In many situations, extending the workability time of the concrete is essential in tunneling and mining applications, especially for pumped concrete, where the transport distances and temperatures can be challenging factors in maintaining the required workability of the concrete.



Good pumpability with SikaPump® Start-1

This pumping agent reduces friction and resistance in the pipes, reduces the wear on the pump and the pipes, which therefore increases the volume output. Initially it is also used to produce a lubricant mix to coat the internal walls of the pipe with a high-fines layer and allow easy pumping, right from the start of the concreting operations.



In the hardened concrete, a high resistance to abrasion is achieved by using SikaFiber® in the mix.

For many areas of structural concrete the resistance against percussive or striking impact, plus the toughness and flexural strength of the concrete itself, can be very significantly improved by the use of these Sika structural fibers.



High flow and workability with Sika® ViscoCrete® technology

An efficient way of quickly and easily placing concrete is the use of so-called self-compacting concrete. With the right Sika mix design, this is able to flow under its own weight, completely filling formwork and achieving full compaction without vibration, even around heavily congested reinforcement.



SIKA PRODUCTS

Sika® ViscoCrete®

Superplasticizers with strong water reduction and extended workability times.

Sika® ViscoFlow®

Special designed admixture for extended workability times under demanding conditions.

Sika® Rapid®

Accelerators for precise, high early strength development.

Sika® Stabilizer

Admixtures to improve the cohesion of concrete mixes and compensate for the variations that occur in raw materials (sands and aggregates).

SikaPump® Start-1

A start-up lubricant for the pipes, which also helps to reduce the wear and tear on the pumping equipment and increase the output.

SikaFume®

Fine silica fume, which is added to significantly improve the performance and extend the durability of the concrete.

SikaFiber®

Sika micro and macro fibers can significantly improve the ductility, impact resistance and the tensile strength of concrete.

SPRAYED CONCRETE – SHOTCRETE APPLICATIONS



SLOPE STABILIZATION

Shotcrete is ideal for slope stabilization, especially when dealing with steep slopes and pit wall angles, in order to protect men and machinery in portals, galleries and on ramps.



ROCK SUPPORT

Rapid early strength development of the shotcrete is critical in order to enable short cycle times and ensure efficient rates of progress in both mining galleries and tunneling.



SIKA SERVICE

Sika provides support from pre-testing, right through with continuous on-site support, to the completion of operations, in order to realize ongoing efficiencies.

THE MAIN REQUIREMENTS & SIKA SOLUTIONS FOR SHOTCRETE



High early strengths achieved using Sika® Sigunit® accelerators

Early setting of the shotcrete lining is critical in order to enable rapid underground development with short cycle times.



Extended slump retention achieved with Sika® ViscoCrete® SC technology

Depending on the location and the complexity of the project, long haulage distances can require extended slump life of the concrete and in all manner of environmental conditions.



Laboratory testing

Sika has developed unique testing equipment known as “MiniShot” where local raw materials (e.g. different binders, accelerators, admixtures and additives etc.) can all be quickly and reliably tested locally and in an efficient way to optimize the shotcrete mix designs.



On site testing

After the pre-evaluation and mix selection of the shotcrete-system using the Sika MiniShot, the mix-design is tested under real conditions. The well trained Sika shotcrete teams will then implement the best cost performing solutions.



Trouble-free applications

Safe application, consistent speeds and uninterrupted spraying are critical factors for efficient in cycle shotcreting. This is achieved with Sika support to master the sprayed concrete operations with efficient equipment, mix designs, admixtures and skilled operators.



SIKA PRODUCTS

Sika® Sigunit®

Shotcrete accelerators for high early strength requirements. Sigunit® solutions are available as liquid and powder solutions to suit challenging logistics and different operational requirements.

Sika® ViscoCrete®

Superplasticizers for high water reduction and extended workability times.

SikaTard®

Slump retention admixtures, especially formulated for shotcrete, to control workability times in all different temperature conditions.

SikaFiber®

Sika micro and macro fibers significantly improve the ductility, impact resistance and the tensile strength of shotcrete.

SikaPump®

Special concrete pumping aid to improve pumpability under difficult circumstances such as temperature variations and long transport distances.

FlexoDrain®

An easy to use drainage system to channel water ingress underground.

SikaFume®

Fine silica fume, which is added to significantly improve the performance and extend the durability of shotcrete.

Sikacrete® Gunitite

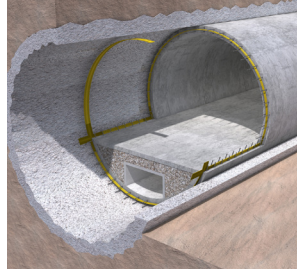
One component, un-accelerated, cementitious silica fume based dry spray mortar. Suitable for use in hot and tropical climatic conditions.

STRUCTURAL WATERPROOFING



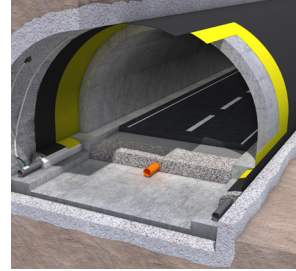
DRAINED

Used in drill and blast tunnels and hard rock TBM excavations where single shell shotcrete or a double shotcrete lining is installed. Liquid applied membranes and Sika FlexoDrain® form the waterproofing system.



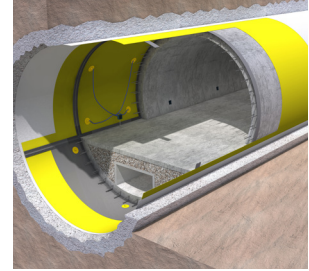
WATERTIGHT CONCRETE

For conventional excavations and Hard Rock TBM's, watertight concrete is used in a "white-box" concept, using engineered joint sealing solutions. For tunnels with limited water pressure resistance requirements.



UMBRELLA SYSTEM

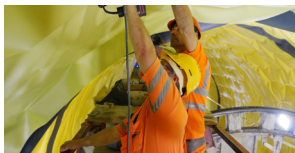
For road and railway tunnels with high overburden. The "umbrella system" provides a cost effective solution, based on a full arch barrier in combination with a drainage system to keep the tunnel and its structure dry.



HYDROSTATIC BARRIER

Loose-laid membrane system, PVC or FPO based, including compartments and integrated injection back-up ports. The membrane is applied as a single or double layer system for the highest watertightness requirements (NEAT system).

SIKA HAS THE WIDEST RANGE OF WATERPROOFING SOLUTIONS



Loose-laid synthetic sheet membranes

For more than 50 years, Sika's loose-laid synthetic membranes have been the below ground waterproofing system of choice where high performance is required. This technology has been continually developed and the service life of Sika membranes remains unchallenged and their leading position is maintained by the most comprehensive materials testing.



Fully bonded sheet membranes

An alternative evolution of Sika's advanced polymeric sheet membranes are these systems designed to form a full surface bond with the structural concrete. These Sika systems also use the FPO materials that fulfil the highest durability as the loose-laid membranes.



Sika 'white box' concept with watertight concrete

The integral waterproofing of concrete structures makes this a very convenient and attractive approach for contractors with Sika concrete admixtures and jointing systems. However durability also depends on the groundwater, especially where this is salt water, or it contains other aggressive influences that can attack the concrete and its steel reinforcement.



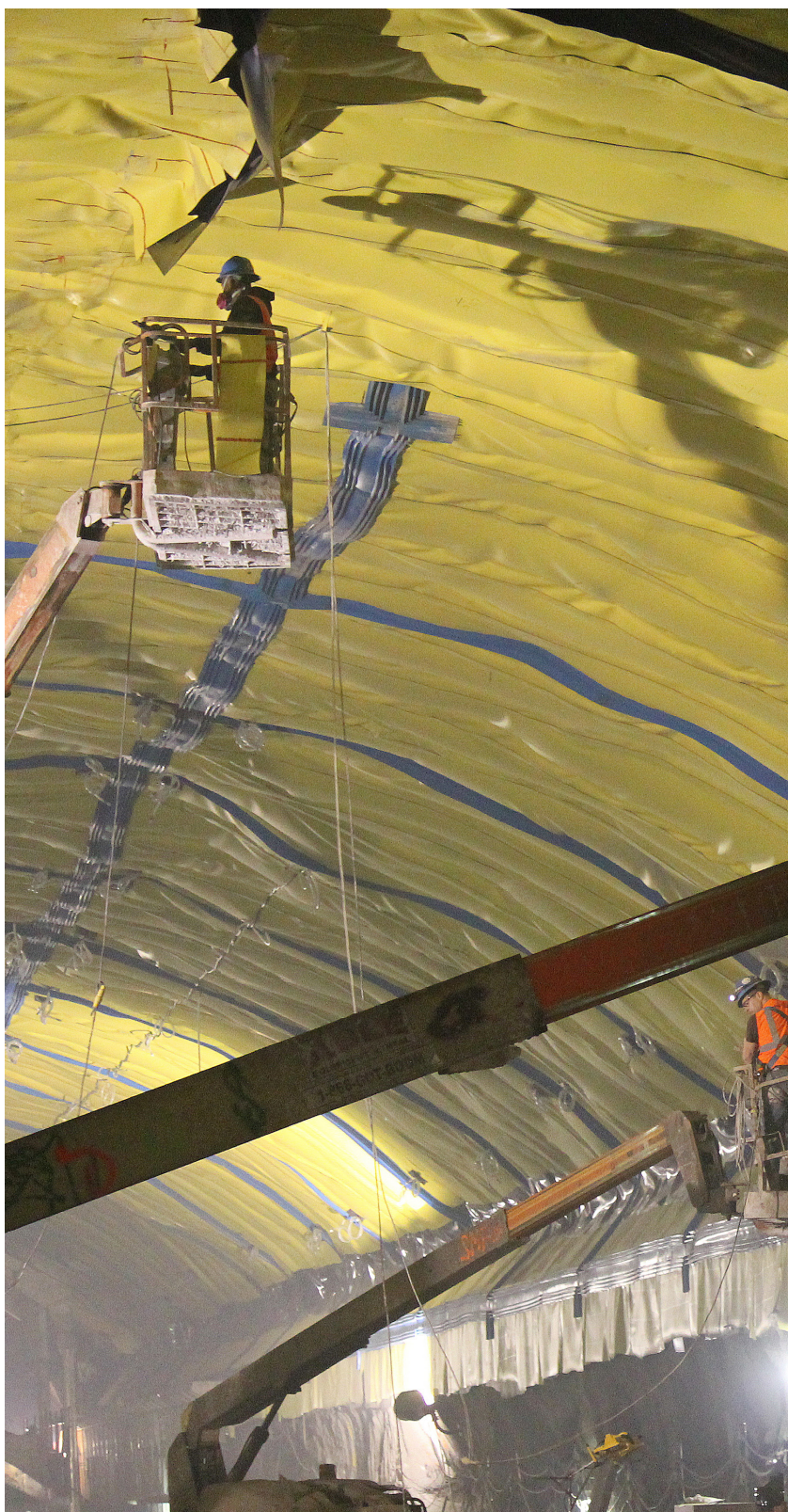
Waterproofing mortars

Sika waterproofing mortars are easy to use to protect both large and small areas of concrete surfaces, and can be applied by hand or spray. These can provide good durability and a long service life in contact with fresh water, however with increasing salt and chemical content this can be reduced and additional protection may be required.



Liquid applied membranes (LAM) based on reactive resins (PUR/PUA)

Sika provides a complete range of liquid applied membranes, primarily designed for spray application, but they can also be hand applied, which is useful for complex detailing solutions. Sika LAM are therefore ideal for waterproofing surfaces with a lot of penetrations and/or difficult access for the application works.



SIKA PRODUCTS

Sikaplan® WP

Homogeneous, plasticized PVC sheet membranes for waterproofing tunnels, plus cut and cover structures.

Sikaplan® WT

Glass fabric reinforced, FPO sheet membranes for waterproofing tunnels and other structures, particularly against salt water and aggressive ground conditions.

Sika Waterbar WP/WT

External waterstops, heat welded to the installed Sikaplan® membranes to form compartment systems.

Sikaplan® WP/WT Tapes & Sika Dilatec ER/E Tapes

Adhesive sealing tapes based on PVC or FPO, bonded with Sikadur®-31 CF or other adhesives for sealing details and perimeter terminations.

SikaProof®

A fully bonded, highly durable and chemical resistant FPO/TPO membrane is the common denominator of all SikaProof® systems. In addition, SikaProof® for tunnel systems are pre- and postaplicable and overlap joints are sealed by thermal jointing.

Sikalastic® LAM

Highly flexible, fast curing, two component (PUR / PUA) spray applied, membranes for concrete surfaces.

Sika® WT 100/200

Pore blocking and active crystalline concrete admixtures for producing watertight concrete. The utmost in waterproofing technology for concrete mix design.

GROUND INJECTION AND ROCK CONSOLIDATION



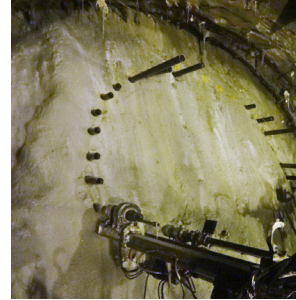
STOPPING WATER

Uncontrolled water intrusions in tunnels and mines represent major hazards often responsible for long downtimes and expensive pumping campaigns. The Sika® Inject injection range includes powerful solutions to stop and then block this water, to regain hydrological control.



VOID FILLING

Cavity and void filling is used as and when necessary to consolidate fractured strata and to stabilize the ground, therefore ensuring a faster and safer excavation process.



GROUND STABILIZATION

An efficient way to stabilize unconsolidated geological perimeters, fractured rock-strata or permeable soils is by injecting them with specially formulated grouts (normally cementitious).



INJECTIONS FOR TBM'S

Water bearing fault and shear zones can represent a major risk for TBM's. These risks can be managed by using Sika pre-injection systems to consolidate and stabilize the ground ahead of the TBM.



Sika Injection expertise

Site inspection for selection of the appropriate concept, as well as the correct material and application method, is critical for a successful injection approach. Sika experts provide assistance on site and in the laboratory to select the most suitable and cost-effective materials and methods. We also provide the necessary detailed documentation and training for successful product application.

Injection Material	Clay	Silt	Sand			Gravel	Pre-injections	Water stopping	Ground consolidation
			fine	medium	coarse				
Cement						days	X		X
Sikalnject®-865					hours		X		X
Sikalnject®-155				45 seconds			X	X	
Sikalnject®-275				10 seconds				X	X
Sikalnject®-668				15 seconds			X	X	X
Sikalnject®-567				40 seconds			X		X
Sikalnject®-301 ID				2 - 15 minutes			X	X	X
Sikalnject®-633				2 - 15 minutes			X		X
Grain size (in mm)	0.001	0.01	0.1	1	1.5	10			
Permeability K (m/s)	10 ⁻⁷	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³				

This table: Different Sika injection technologies for use based on substrate permeability and reaction times required.



SIKA PRODUCTS

Sika® Inject®-155

Polyurethane foam injection resin designed to foam with or without water.

Sika® Inject®-275

Rigid polyurethane injection resin hardens to form a tough material that is used to seal high water inrushes.

Sika® Inject®-301 ID

Acrylate resin based with low viscosity – similar to water – but hardens to form a rigid, hydrophilic and water repelling compound. Ideal for injection to low permeability soils.

Sika® Inject®-567

Silicate resin based, designed to expand to a rigid material by foaming. Its high foam expansion factor makes it ideal for filling large voids.

Sika® Inject®-668

Silicate resin based, non-foaming, rigid injection material that has excellent adhesion to damp surfaces. It is used for demanding rock consolidation to stabilize damp and wet geological fault zones.

Sika® Inject®-865 ID

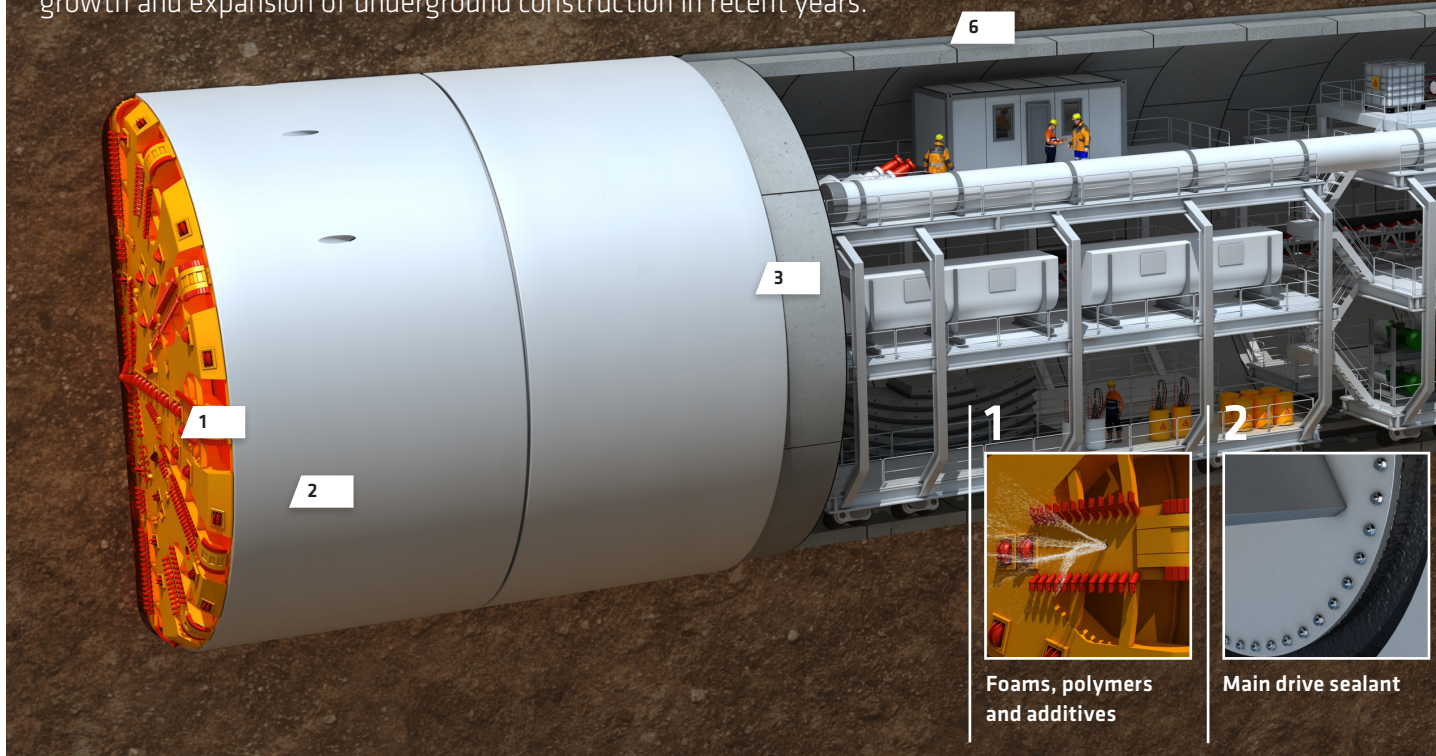
Cementitious grout range, modified using organic polymers. During hydration of the cement, the grouts will harden to a rigid material as required.

Sika® Inject®-633

A solvent-free, non-foaming, hydrophilic, onecomponent injection system, based on a nanometric colloidal silica suspension of primary, discrete particles.

SIKA SOLUTIONS 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.

Soil conditioners (EPB TBMs)

Basic foaming agents	Foaming agents with lubrication polymers	Foaming agents with anti-day polymers
Premium	Premium	Premium
SS-1118 TBM	SS-1111 TBM	SS-1514 TBM
Standard	Standard	Standard
SS-1113 TBM	SS-1112 TBM	SS-1518 TBM

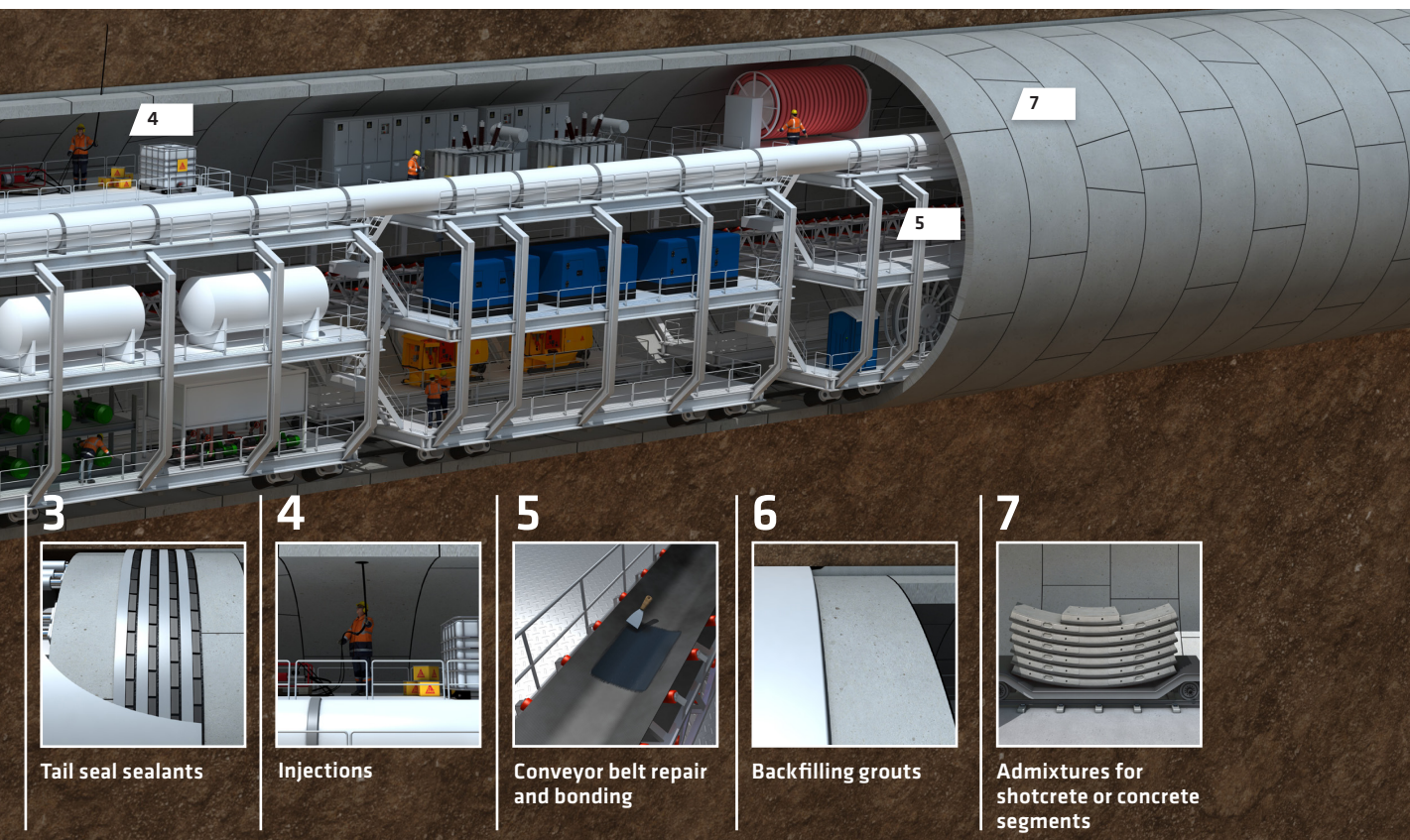
New Gen
SS-1215 TBM
New Gen
SS-1219 TBM

Granular Soil

Cohesive Soil

Any Soil

Rock & Abrasive Soil



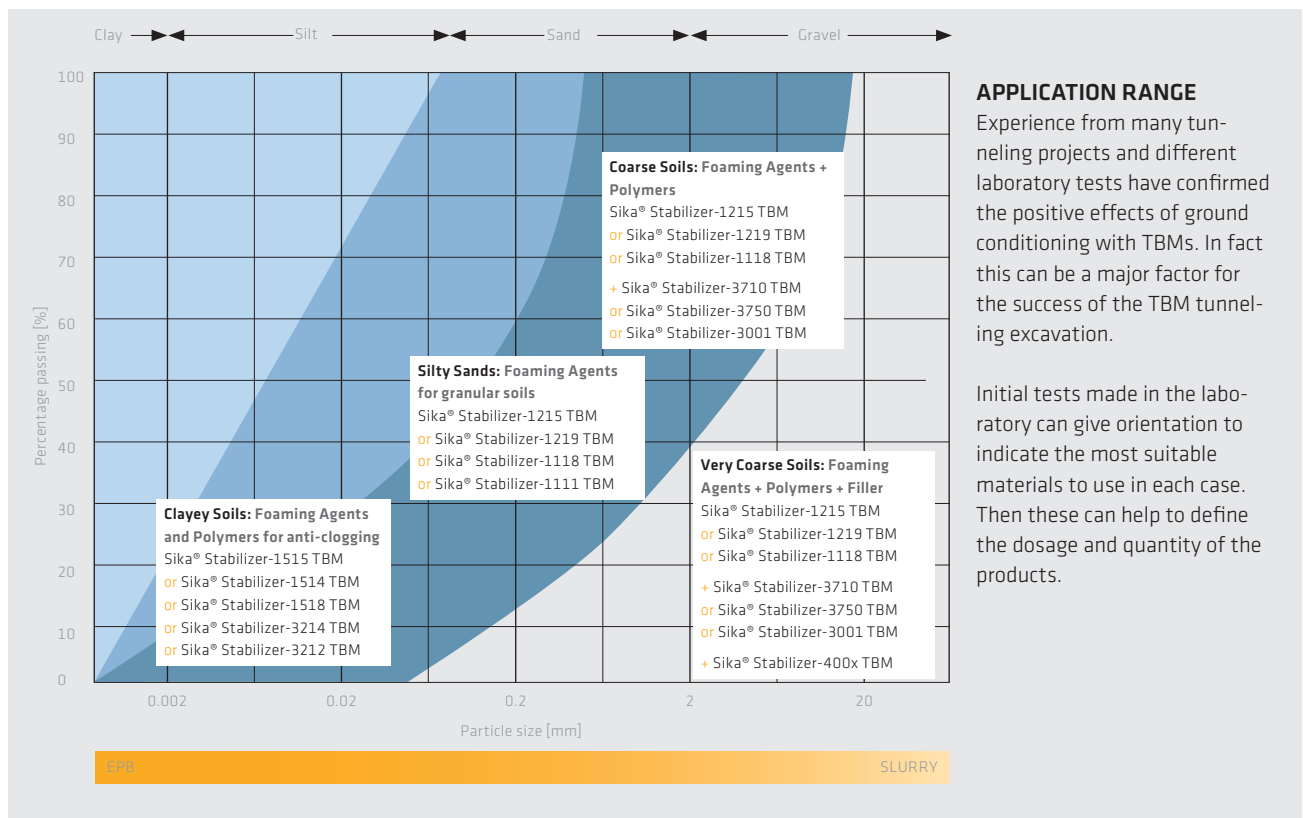
		Rock TBM	Shield TBM	Any TBM	Slurry TBM	Shield TBM
Pure anty-day polymers	Super water absorber polymers	Anti abrasion foaming agents	Tail sealant greases	Main bearing greases and lubricants	Slurry	Backfill grouts (2k)
Premium	Premium	Premium	New Gen PG	MD – Syn	Betonite	Retarder
SS-3214 TBM	SS-3710 TBM	SS-1513 TBM	SS-2231 TBM	SS-2031 TBM	SS-4001 TBM	SS-5010 TBM
Standard	Standard	Standard	New Gen FF	L-Syn	Extender	Accelerator
SS-3212 TBM	SS-3001 TBM	SS-1516 TBM	SS-2131 TBM	SS-2032 TBM	SS-4601 TBM	SS-6018 TBM
	Saline water		Old Gen PG		Extender	Low CO ₂
	SS-3750 TBM		SS-2232 TBM		SS-4602 TBM	SS-7100 TBM
			Old Gen FF		Thinner	
			SS-2132 TBM		SS-4501 TBM	
					Flocculant	
					SS-4141 TBM	

PG: Pumping grade
FF: First filling

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



APPLICATION RANGE

Experience from many tunneling projects and different laboratory tests have confirmed the positive effects of ground conditioning with TBMs. In fact this can be a major factor for the success of the TBM tunneling excavation.

Initial tests made in the laboratory can give orientation to indicate the most suitable materials to use in each case. Then these can help to define the dosage and quantity of the products.

Contact your Sika Tunneling support team for a proper choice of the most suitable soil conditioning solution. We will provide you with supporting pre-investigations in our local, regional and global labs.

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 producing a variety of conditioning solutions from the Sika® Stabilizer 1000 TBM range, with environmentally friendly composition and fast biodegradability profile.

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.

BACKFILLING GROUTS

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

TWO COMPONENT BACKFILLING GROUT

The two-component backfilling grout is created by combining a mixture of water/cement, bentonite, and retarder (component A) with an accelerator (component B). This blending of the two components occurs just before injection through the tailskin, where the mixture undergoes a rapid transformation from a creamy liquid to a gel in approximately 10-20 seconds. The final grout has long term compressive strength comparable to the surrounding ground and has the ability to fill every gap and void before setting and hardening.

Various Sika admixtures and stabilizers, such as Sika® Stabilizer 5000 TBM range, SikaTard® and Plastiment®, can be employed to achieve the desired flow and retarded set effects. Additionally, Sika® Stabilizer 6000 TBM range of products or Sigunit® accelerators are used to control gel, set and hardening time of the grout.

ONE COMPONENT BACKFILLING MORTAR

Excavation with shield Tunnel Boring Machines (TBMs) involves the installation of precast concrete segments to create the tunnel lining, leaving an annular gap between these segments and the surrounding ground. Properly filling this annulus is crucial as it ensures a uniform contact with the ground, facilitates load transfer from the TBM back-up, and contributes to waterproofing the tunnel.

Various types of filling materials have been developed for this purpose, including hydraulically setting mortar and two-component grout. Sika provides a comprehensive range of stabilizers and admixtures for batching backfilling mortars, including Sika® Stabilizer 5000 TBM Range and Sika Tard®, Sika® Visco-Crete®, SikaFume®, and Plastiment®.

PEA-GRAVEL

Pea-gravel backfilling is commonly employed method in hard rock TBM projects to fill the annular gap between the excavated tunnel lining and the surrounding rock. It consists of a mixture of pea-sized gravel and grout. The stabilization of the grout flow allows a good filling in secondary injections. This can be achieved with Sika® Stabilizer 5000 TBM range of retarders. In case of water flow the grout can as well be accelerated with Sika® Stabilizer 6000 TBM range of accelerators.



LOW CO₂ GROUT SOLUTIONS

INTRODUCING LOW CO₂ FOOTPRINT Backfilling grouts – Revolutionizing Tunneling with Sustainable Grouting. Our cutting-edge technologies in backfilling grouts applications for Tunnel Boring Machines (TBMs) redefine industry standards by prioritizing environmental responsibility.

Engineered with alternative binders, our formulations minimize carbon footprint without compromising on performance. Sika® Stabilizer 7100 TBM ensures load transfer, volume integrity but also excellent pumpability while optimizing efficiency.

Embrace a sustainable future with our innovative solutions, meeting the demands of both construction and environmental stewardship. With Sika sustainability meets performance, ensuring a seamless tunneling experience leaving at the same time a positive impact on the planet. Join the movement towards responsible construction practices with Sika® Stabilizer TBM solutions.



TAIL SEALANT GREASES

Metal brushes in the TBM tail shield require proper maintenance and sealing against water, soil, and backfill grout ingress. Our tail sealant greases are designed to ensure:

- Reliable pressure-proof sealing between the tail shield and external ground conditions
- Anti Wash-Out properties
- Pumpability, adhesion to metal parts, and consistency
- Fire-resistant performance

Modern tail shield greases must be technically performant, easy to pump, and cost-efficient to align with high TBM production rates, avoiding unplanned stoppages and extra costs.

Sika tail shield greases prevent ground water, soil, and backfill grout from entering the TBM, offering inert and eco-friendly options without negative effects on the concrete lining and EPDM gaskets.

PRODUCT DESIGN AND PERFORMANCE

Sika® Stabilizer greases consist of high-molecular polymers, natural fillers, and fibers. Key properties include consistency, pumpability, adhesion, and sealing capacity above 34 bar (Matsumura sealing test).

Sika® Stabilizer greases have been successfully used on various TBMs worldwide, sealing diameters up to 17.47 meters to date.



NEW GENERATIONS OF TAIL SEALANT GREASES

Pumping grade: Sika® Stabilizer-2231 TBM

First fill: Sika® Stabilizer-2131 TBM

Fire-resistant, with higher performance and reduced density, ensuring excellent adhesion to metal and concrete surfaces. Adaptable to any TBM pumping system and chemically compatible with similar products.

WORLD CLASS QUALITY TAIL SEALANT GREASES

Pumping grade: Sika® Stabilizer-2232 TBM

First fill: Sika® Stabilizer-2132 TBM

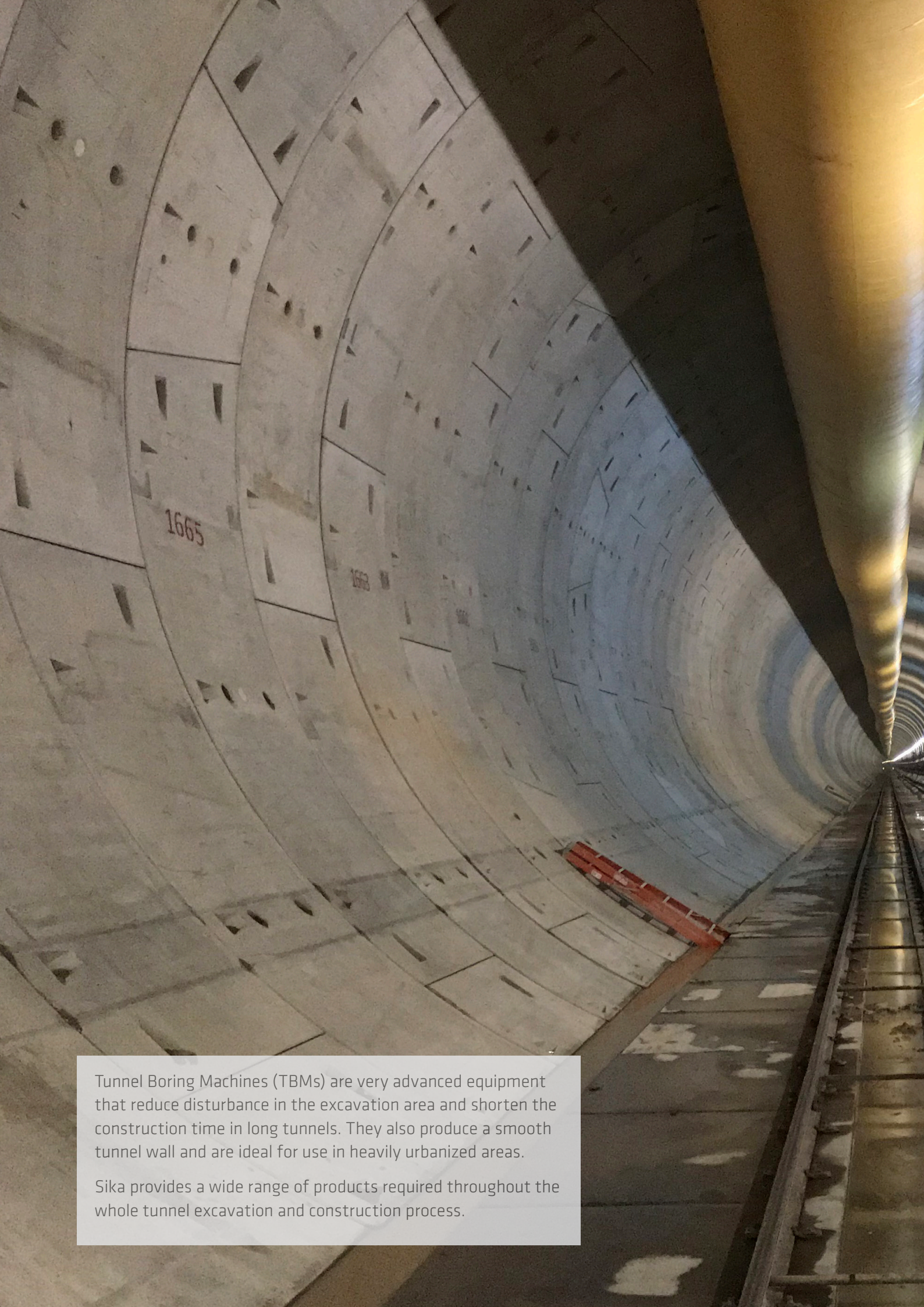
High-density greases for enhanced performance in critical geologies with high groundwater pressure. Adaptable to any TBM pumping system and chemically compatible with similar products.

FACTORS INFLUENCING GREASE CONSUMPTION

TBM and tunnel conditions impact grease performance. Examples include:

- Brush conditions
- Air trapped in the TBM grease pumping system
- Quality of installed tunnel lining
- Roughness of external tunnel lining surface
- Backfill grout pressure
- Number of strokes and waiting times at PLC





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.



SLURRY TBM

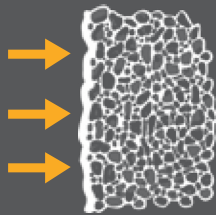
SLURRY TBM PORTFOLIO

Slurry TBMs remove the excavated material by using a bentonite-based suspension, also called slurry or mud. The excavated soil is pumped out along with the slurry to a Separation Treatment Plant (STP) situated outside the tunnel where the slurry is separated from the muck for recirculation. The support pressure in the excavation chamber is precisely managed using an automatically controlled air cushion. Face stability is the major issue to keep under control during mining, and pressurised bentonite with the help of our additives provide the adequate face support for tunnelling in safety.

In its function as a support medium, the task of the drilling fluid is to form a zone of low permeability at the front of the excavation. While the counteraction against the ground water pressure is principally secured, the excess slurry pressure must be transferred to the soil skeleton to counteract the earth pressure. The pressure transfer can be achieved in two ways:

1

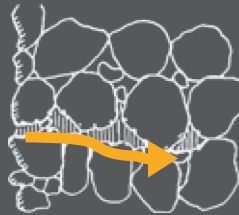
With a membrane



The **FILTER CAKE** membrane forms a thin impermeable layer directly on the wall, transforming excess slurry pressure into effective support stress in low permeability grounds. The slurry creates only a surface impermeabilization, typically several millimeters thick.

2

or, with a penetration zone



In **PENETRATION ZONE FORMATION**, excess slurry pressure transfers to the soil skeleton

along the entire penetration depth through shear stresses between suspension and soil grains in moderately to highly permeable grounds. The slurry penetrates ground pores before stopping and setting, constituting the impermeable interface. This zone varies from several tens of centimeters to a few meters in thickness.



BENTONITE – Sika® Stabilizer-4000 TBM RANGE

Sika provides a diverse range of sodium bentonites, spanning low to high plasticity, suitable as binders and viscosity improvers with varying swelling properties. All Sika bentonites are guaranteed through an ISO 9001:2000 certified quality management system.

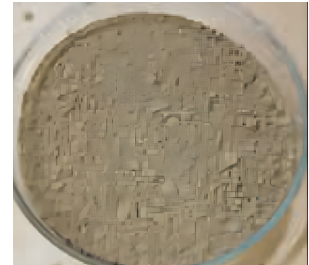
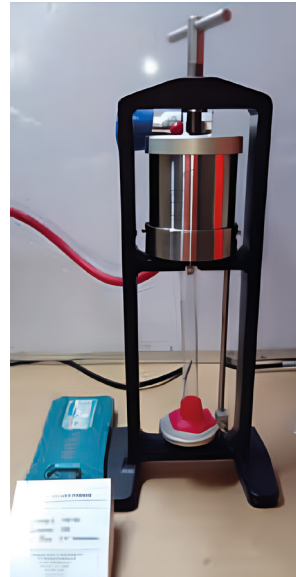
VISCOSITY MODIFIER ADMIXTURES

BENTONITE EXTENDER – Sika® Stabilizer-4601 TBM (FRESH WATER) / Sika® Stabilizer-4602 TBM (SALINE WATER)

Water-soluble polymers, ensure filter cake formation and reducing filtrate losses. These polymers restructure soils with poor grading and low fines content, enhancing mud rheological properties. They increase soil plasticity and cohesion, improving pressure balance in the working chamber for better ground stability and slurry extraction.

BENTONITE THINNER – Sika® Stabilizer-4501 TBM

A water-soluble polymer acting as a powerful thinner agent. It adsorbs onto clay platelet surfaces, preventing bentonite and heavy clays from gelation, addressing clogging and adhesion issues. It eliminates the risk of TBM blockage under high pressure and temperature conditions, both at the cutterhead and in pumping lines.



FLOCCULANT FOR SOLID/WATER SEPARATION – Sika® Stabilizer-4141 TBM

A very high molecular weight polyacrylamide-based low-anionic flocculant powder. It efficiently facilitates solid-liquid separation with a high to very high precipitation rate. Predominantly used for effective and fast solid-liquid separation, it can be applied separately or in combination with a cationic flocculant.



MAIN DRIVE SEALANTS

MAIN BEARING GREASES AND LUBRICANTS

The main bearing, being the most costly component of the TBM, requires effective protection and lubrication. Our renewable raw material version of main bearing sealants and lubrication greases sets a benchmark for the industry's environmental standards.

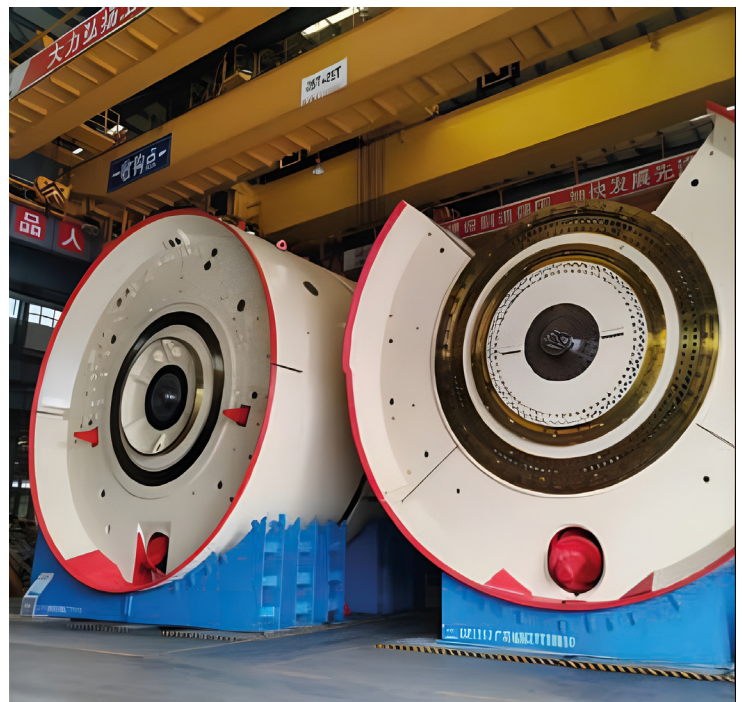
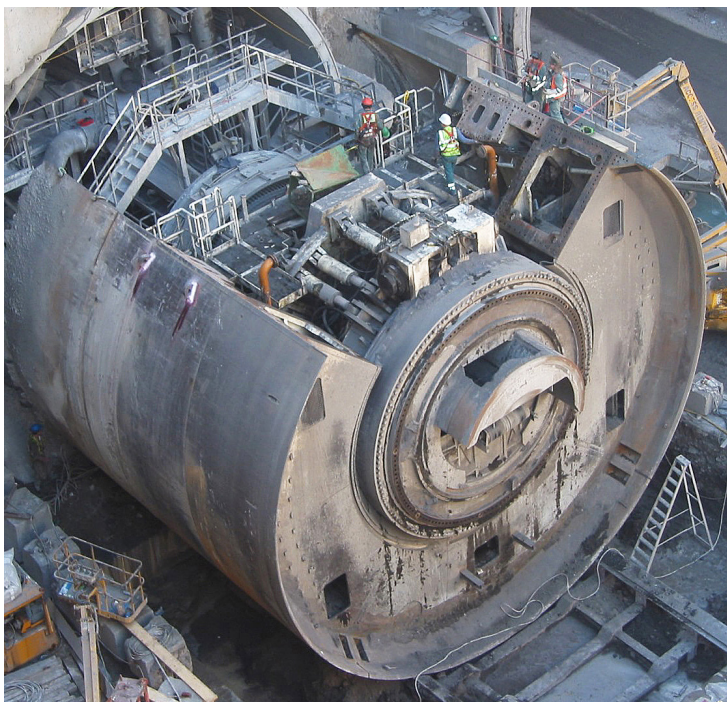
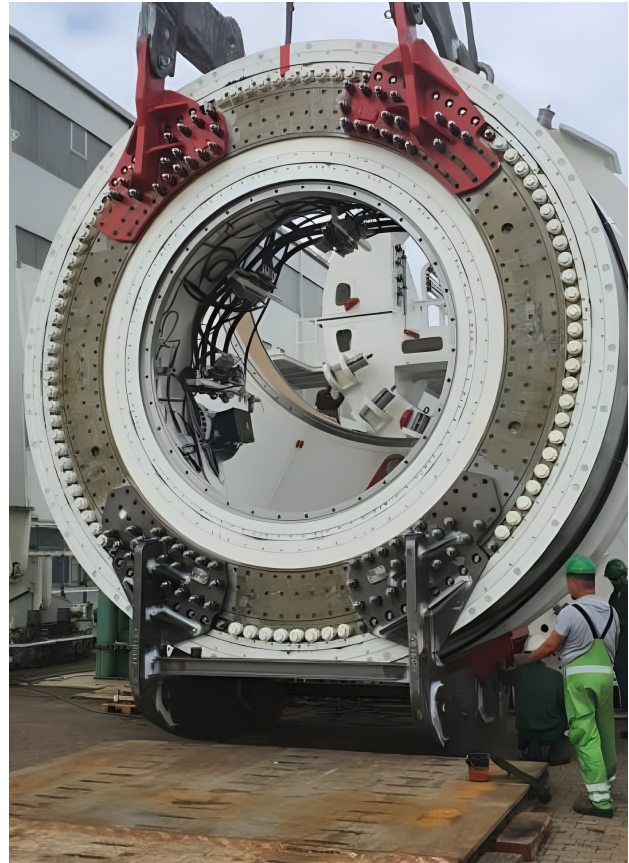
To uphold the highest quality, we produce our sealant greases at selected global sites with a continuous supply of premium raw materials. All Sika greases and lubricants are non-hazardous, ensuring worker safety and environmental friendliness. They hold Merkel certification, meeting the 85 NBR B248 standard.

MAIN BEARING SEALING – Sika® Stabilizer-2031 TBM

Our excluder grease shields the main bearing by preventing water and soil from entering the TBM sealing system. Formulated to resist high water and ground pressure, it exhibits excellent lubrication and pumping properties with superior adhesion. Key properties include a 4-ball wear (DIN 51350:5) <0.9mm and water spray off (ASTM D 4049 @ 25°C) <4%.

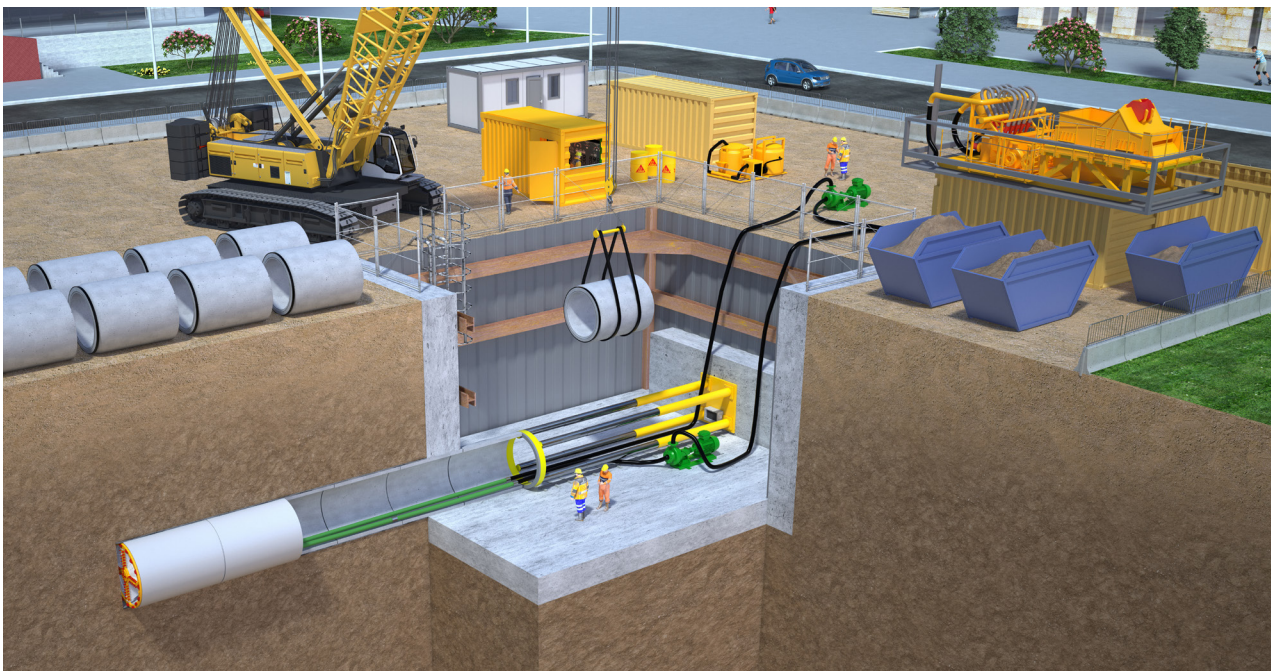
MAIN BEARING LUBRICATION – Sika® Stabilizer-2032 TBM

Our lubricant incorporates antioxidants, corrosion inhibitors, and EP/AW additives. It offers exceptional mechanical stability, load-carrying capacity, and corrosion protection, making it suitable for heavy-loaded bearings and wet environments. Key properties include a 4-ball wear (DIN 51350:5) 0.5mm and biodegradation >80%.



SIKA AND THE MICROTUNNELING WORLD

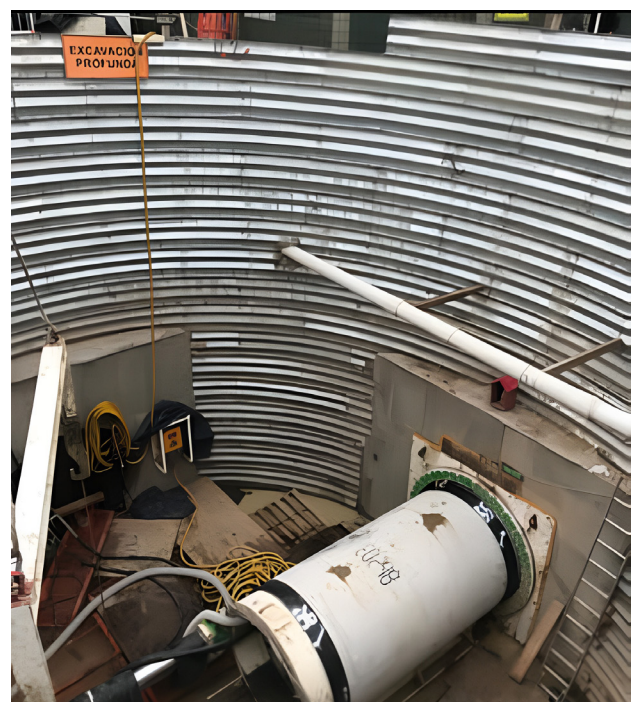
TUNNEL BORING MACHINES (TBMs) are commonly found with diameters from 5 to 17 meters and increasing. There are also the micro TBMs which are smaller, have an excavation diameter up to 4 meters and are extensively used today to construct kilometres of underground infrastructure worldwide.



Microtunneling is a fast alternative to conventional pipe installation systems. It is a fully automated method of boring and pipe installation without the need for disturbing the surface. Micro TBMs start at diameters from a few centimetres and increase up to 4 meters. They are typically used for excavation of many of the vital utility facilities such as fresh water, wastewater, oil, gas, communications and electricity.

Projects with micro TBMs do not require trench excavation work. It is a technique especially suited for minimising disruption in densely populated areas, crossing difficult geological zones, penetrating through ground with high water levels, under rivers or generally overcoming obstacles where room for construction is restricted. The use of micro TBM is increasing more and more and has the advantage of limiting the environmental impact compared to traditional excavation methods. It is a fast method of continuous excavation with minimal interruptions.

Sika is offering a wide range of products for the micro tunnelling excavation.

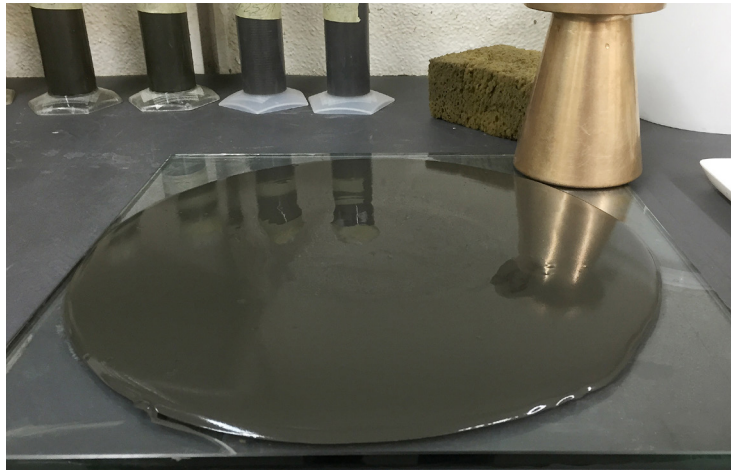


MINE BACKFILLING

PASTE WITH NO ADMIXTURE



THE SAME MIX WITH Sika® Stabilizer MBF



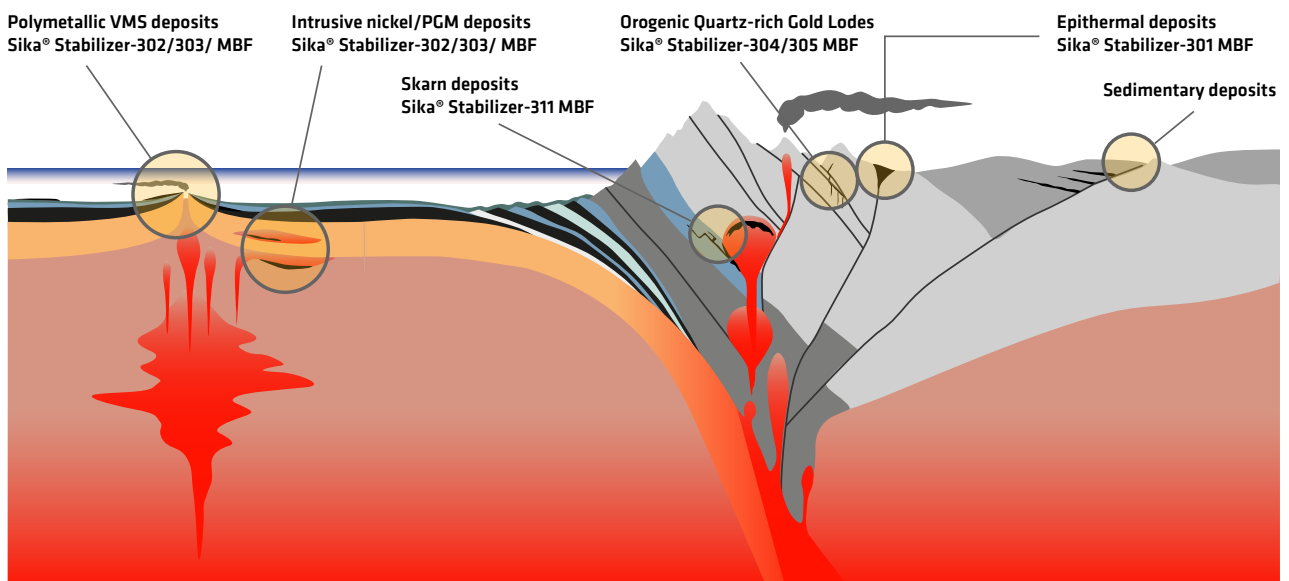
Paste-mix design without admixtures (left side), and with Sika® Stabilizer MBF admixture (right side), note the very significant increase in slump.

Using backfill admixtures allows engineers to adjust and modify the many variables of backfilling materials. The following parameters can all be modified in order to obtain the required properties and cost performance from the backfill:

- Reducing the binder content
- Increasing the strengths
- Increasing the solids content of the paste mix and hence increase fill efficiencies
- Improving the rheological properties of the cement based fill during the mixing, pumping and backfilling process
- Reducing yield stress whilst enhancing workability

- Reducing pumping pressures
- Reducing wear and tear on machinery and equipment
- Minimizing segregation and bleed
- Improving consistency of fill rates and compressive strengths
- Reducing the risk of line blockages
- Preventing liquefaction

Sika has developed a powerful range of mine backfilling admixtures to modify the paste mixes from all of the main ore deposit types. The most suitable admixtures can be selected on each individual project for maximum cost efficiency.



Sika backfill admixture range for different deposit types.



SIKA PRODUCTS

Sika® Stabilizer-301 MBF

Paste backfill admixture for Epithermal, polymetallic deposits.

Sika® Stabilizer-302 /-303 MBF

Paste backfill admixture for polymetallic volcanic hosted massive sulphide deposits (VMS).

Sika® Stabilizer-303 /-302 MBF

Paste backfill admixture for intrusive hosted nickel/PGM deposits.

Sika® Stabilizer-304 /-305 MBF

Paste backfill admixture for orogenic, greenstone hosted quartz-gold lodes.

Sika® Stabilizer-311 MBF

Paste backfill admixture for intrusion related skarn deposits.

Sika® Stabilizer-306 /-311 MBF

Admixture for limestone replacement deposits, carlin-style or skarn deposits.

Sika® Stabilizer-401 MBF

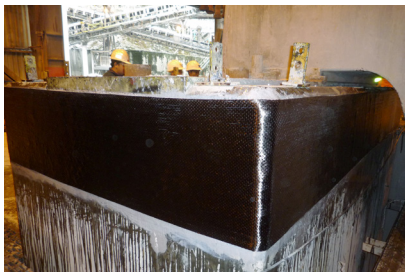
A special admixture to prevent high water bleeding.

GROUTING



Sikadur® EPOXY BASED GROUTS

Sika's epoxy resin based grouts are widely used for load bearing plate and direct equipment fixing, especially those under dynamic load and subject to vibration, such as generators, crushers, rolling mills and other special machinery. The correct application of these products is critical to ensure a durable outcome. Sika provides extensive guidance and assistance, including onsite support for complex grouting procedures.



Sikadur®-42 Range

Pre-batched, epoxy resin based, chemically resistant, high flow grouts for precision grouting of structural components and machinery.

SikaTop® Armatex® EpoCem®

For use in highly corrosive environments in combination with all Sika repair systems.

SikaWrap®/ Sika Carbodur®

Carbon based, structural strengthening material for concrete.



SikaGrout® CEMENTITIOUS BASED GROUTS

Sika is a market leader in high quality cement based grouts. These cementitious SikaGrout's are available all over the globe and widely used within the tunneling and mining industry for many different applications and requirements. From high strength concrete repairs through to grouting structural columns, base plates and heavy equipment – The SikaGrout® range covers it all.



SikaGrout®-200 series

The standard cement based, multi-purpose grouting products for many different applications. These grouts are pourable and self-leveling. They are compensated against shrinkage and quickly develop high compressive strengths of 50 – 60 MPa.

SikaGrout®-280 series

The advanced, cement based, multi-purpose grouting products for grouting applications that require large thicknesses. These grouts are all pourable and self-leveling, compensated against shrinkage and rapidly develop compressive strengths up to 80 MPa.

SikaGrout®-880

Cementitious high strength, non-shrink, iron reinforced precision grout



Sika® REPAIR MORTARS

Refurbishing deteriorated or damaged concrete structures and upgrading them for the future is one of Sika's core competencies. Our extensive product range provides a system or product as the ideal solution for every concrete repair job you will ever encounter anywhere in the world!



Sika MonoTop® Range

Pre-bagged, one component, polymer modified, cement based, concrete repair mortars for many applications.

Sika Gunitex®

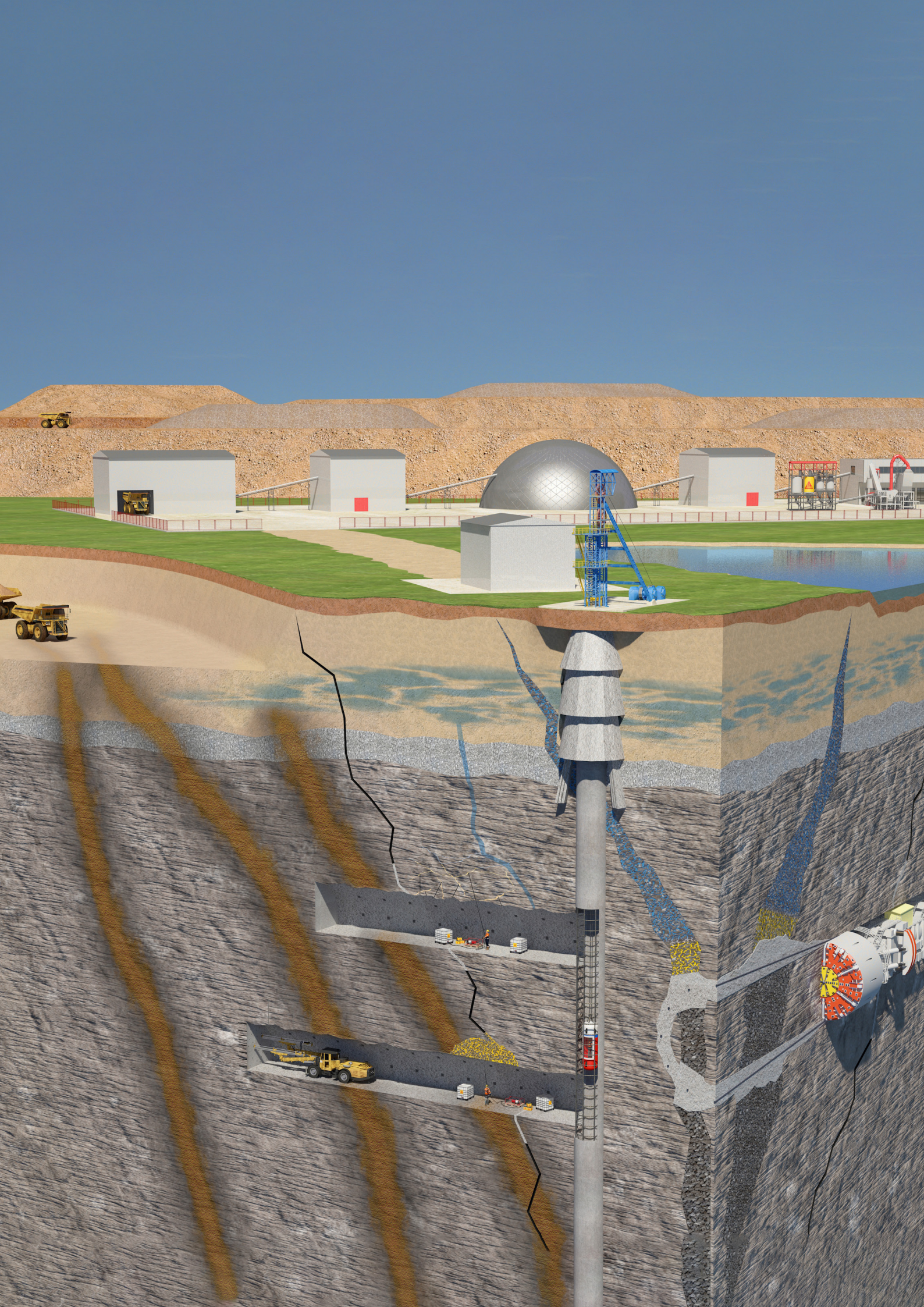
Dry spray mortar for large volume repairs using Aliva® spray equipment.

Sikacrete® SCC

Pre-bagged, silica-fume enhanced, self-compacting concrete mix.

Sikadur® 31

Two-component Epoxy adhesive thixotropic for bonding repairing, sealing, filling and reprofiling



TUNNELING AND MINING

Project references



THE GOTTHARD BASE TUNNEL, SWITZERLAND

At the heart of the new transalpine rail route in Switzerland is the Gotthard Base Tunnel and with a length of 57 km it is the world's longest and also the deepest rail tunnel. It opened to traffic and became operational at the end of 2016 after more than 15 years of design and construction works.

Sika was involved in this project from the beginning, providing assistance to the project team from their global expertise and experience, including many previous tunneling projects in the Alpine regions of Europe. Sika's support was particularly valuable in developing all of the concrete and sprayed concrete systems, as well as for the complete waterproofing concept.

Sika Solutions:

Sika® ViscoCrete®	Superplasticizers
Sigunit®	Shotcrete accelerators
SikaTard®	Set retarders
Sikaplan®	Tunnel waterproofing system

THE KIRUNA MINE

Since 2008 Sika has been the main supplier of concrete admixtures and underground concrete construction technologies at Kiruna. Located in Swedish Lapland, north of the Arctic Circle, the challenges in terms of concrete production and logistics are manifold. Sika, together with its partner LKAB took on these challenges and today the LKAB operations are a showcase of 'Mining Best Practice' for other large, block cave mining projects around the world.

Kiruna is also now one of the world's largest underground sub-level block cave operations. Fast mining-cycle times are the key to maintain high productivity and ore throughput rates. Hence, an efficient in-cycle shotcrete set-up is required, providing fast re-entry times into the blasted areas once their perimeters are secured.

Sika Solutions:

Sikament®	Superplasticizers (HRWR)	Sika® Sigunit®	Shotcrete accelerator	Sika Control®-50	Shrinkage reducer
SikaTard®	Consistency stabilizers	Sika FastMix	HRWR (powder)	Sika Crackstop	12 mm Fibers w
Sika Aer®	Air entrainers	Sika Intrapast-A	Expansion aid	Sika® Inject®	2-comp. injections
Sika Retarder	Retarders	Sika Antifreeze S	Antifreeze		
SikaRapid®	Concrete accelerators	Sika NeatCrete	Concrete remover		

THE EMISOR ORIENTE TUNNEL, MEXICO

Mexico City, and its metropolitan area has developed and expanded over the years in an area that was once an area of swamp and lakes. As the city grew, more and more construction took place on the ancient swampland, the city was faced with increased risk of flooding. At present, a 62 km drainage tunnel is under construction, with 24 shafts and an output capacity of 150 cubic meters of water per second, making this a landmark in the Latin America infrastructure landscape. Sika has been involved with the project design and construction since the beginning, providing concrete admixture technologies for the precast segments to build the tunnel by TBM techniques. Sika also supplies many other materials to support the TBM's progress.

Sika Solutions:

Sika® ViscoFlow®	Superplasticizers
SikaFoam TBM	Foaming agent for EPB – TBM excavation
Sika® Sigunit®	Shotcrete accelerators
Sika® Separol®	Mould release agents

TUNNELING AND MINING

Project references



THE GRASBERG MINE, INDONESIA

The Grasberg mine, operated by Freeport McMoRan and jointly owned by Freeport and Rio Tinto, is one of the largest mining clusters on the globe. The mine is located in the very remote highlands of the Sudirman mountain range in the province of Papua, Indonesia. Freeport McMoRan and its main contractors are long standing partners of Sika.

Sika supplies large quantities of materials to the Grasberg operation including concrete admixtures for self-compacting, shaft lining concrete and shotcrete, plus shotcrete accelerators, injection resins and additional concrete refurbishment products. For example, to ensure rapid underground progress, the high performing Sika Sigunit® AF shotcrete accelerators are used to achieve high early strength of the shotcrete that allows cost efficient, short cycle times.

Sika Solutions:

Sika® ViscoCrete® Superplasticizers

Sika® ViscoFlow® Slump retainers

Sika® Sigunit® Shotcrete accelerators

SikaTard® Consistency stabilizers

Sikacrete® High performance, dry sprayed gunite

Sikafloor® Industrial floors

Sika® Inject® 2-comp. injections

THE METRO IN DOHA, QATAR

An extensive metro system is under construction in Doha, Qatar, with a total length of 358 km. The Doha Metro system will be one of the most extensive metro systems in the region. Phase 1, to be completed in 2018, comprises tunnels with a total length of 49 km, excavated using EPB-TBM machines. Elevated and at grade sections feature for approximately 30 km of this length.

Sika is the main supplier of concrete admixtures to produce the fire resistant precast concrete segments with a design life of at least 120 years. Sika is also supplying Sika membrane waterproofing solutions for all of the cross passages, plus concrete hardening accelerators and synthetic macrofibers, as well as Aliva wet spray machines, for the sprayed concrete lining. Elevated sections are assembled using the same SikaDur® structural adhesive as originally developed for the equally demanding requirements of segmental bridge construction.

Sika Solutions:

Sika® ViscoCrete® Superplasticizers

Sika® Stabilizer TBM Foaming agent for EPB – TBM excavation

Sikaplan® Waterproofing membranes

Sigunit® Shotcrete accelerators

SikaFiber® Synthetic macrofibers for shotcrete

Sika® Separol Mould release agents

SikaFiber® Synthetic microfibers for concrete

Sikadur®-31 SBA Segmental bridge adhesive

THE ESCOBAL MINE, GUATEMALA

Since the Escobal project in Guatemala broke ground, Sika has been involved as the main supplier for concrete admixtures and many other specialty chemicals. In order to achieve the ore throughput levels of 4'500 tons per day, of which half will be put back underground in the form of cemented paste backfill, the mine needs an efficient in-cycle support installation for rapid development rates. From the very beginning, one of the main challenges was to provide enough underground production headings in order to source enough ore feed for the mill on surface. Hence, multiple ore development headings are driven simultaneously, in sometimes difficult ground conditions, which require expert shotcrete support in mix design and spray application that is all fully integrated into the mining cycle.

Sika Solutions:

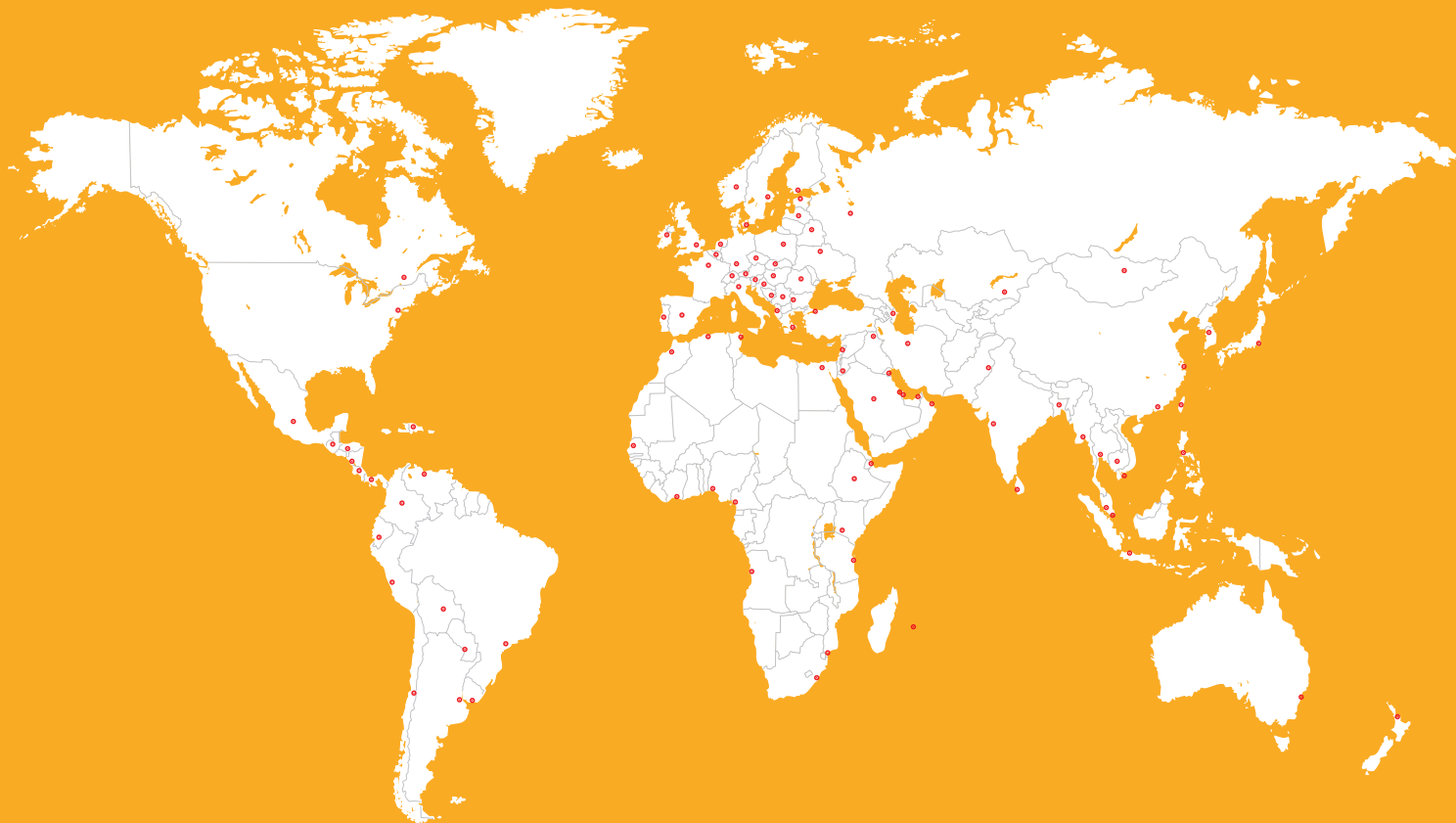
Sika® ViscoCrete® Superplasticizers

Sika® ViscoFlow® Slump retainers

SikaTard® Consistency stabilizers

Sika® Sigunit® Alkali-free High performance shotcrete accelerators

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.



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BUILDING TRUST

