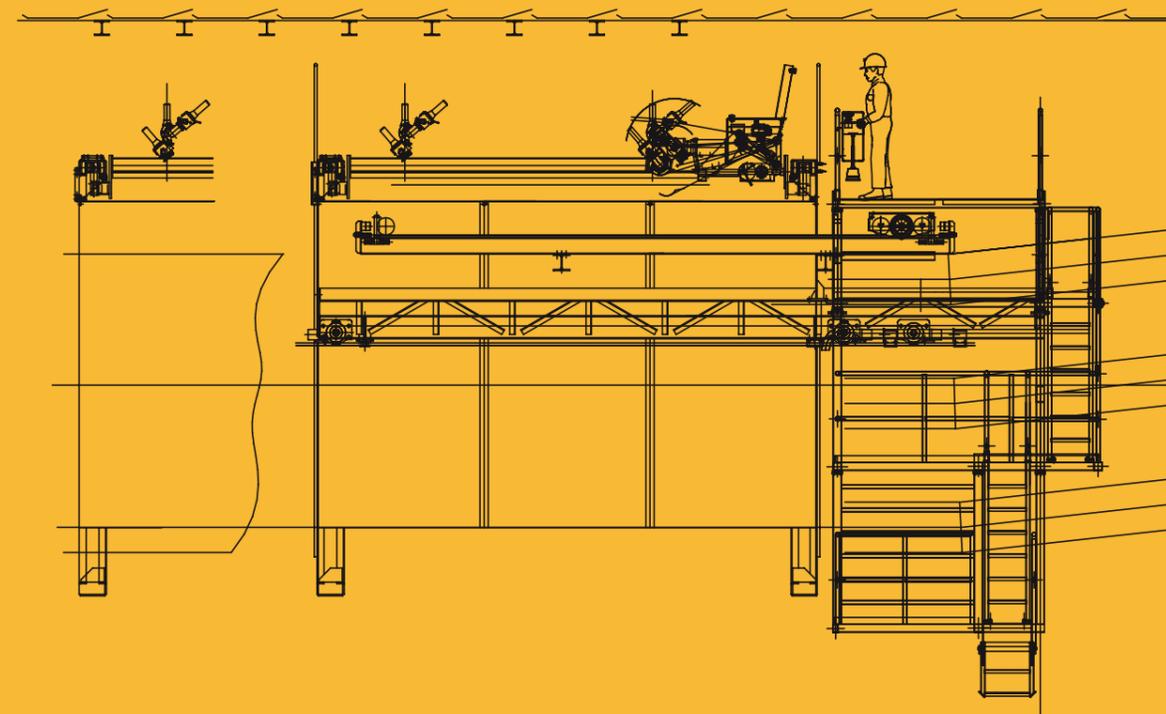




Custom-designed Solutions for Tunnel Excavation by TBM

Comprehensive Product Range for any Customer Need

Equipment, robots and machines shown in the brochure do represent answers to actual problems. They are typical examples of what equipment and device-related solutions for underground work can look like. Each site and each project may require variations on the equipment. Our competent team of designers, civil engineers and mechanical engineers is at your disposal for conceiving any requirement in this regard. Supporting you in your technical challenge with our concepts and by on time delivery of machines and equipment will be our pleasure.



Strategic Alliance

Sika and **Putzmeister** form a global alliance in the field of Tunneling & Mining. The alliance between Putzmeister and Sika guarantees to our customers innovative and consistent development of concrete spraying machines, meeting the highest requirements for highly mechanized sprayed concrete applications. Putzmeister is responsible for the production of the concrete spraying systems and Sika is taking care of their exclusive distribution. Production of the Aliva rotor machines will be continued by Sika.



Concrete transfer station and admixture containers



Pumping station with Sika-PM702

Tunnel construction is nowadays highly mechanized. Securing work in mechanically driven tunnels through rock is mainly carried out with shotcrete. Sprayed concrete technology plays a central role as well for immediate support in the L1 zone as for ulterior support and lining in the L2 zone. Here, the different spraying systems must keep pace with the conditions set by the mechanical driving of the tunnel, i.e.

- High machine efficiency in line with the specified quality requirements, as well as high operational readiness of machines and equipment.
- Minimum labour requirements for spraying, cleaning and servicing.
- Simple maintenance and prompt availability of replacement and wearing parts.

The same applies also to subsequent operations such as backfilling of precast tunnel lining elements with round gravel.

Custom-designed solutions, customer- and project-specific machines as well as the flexibility of manufacturing them within short delays, considerably contribute towards realization of financially affordable tunnel projects. The development of such machines is based on combining machine technology with concrete technology as well as on highly qualified and experienced designers, engineers and development teams whose long years of broad experience and permanent critical analysis of innovating technologies, constitute the know-how that is necessary to put into practice the concepts presented hereafter.

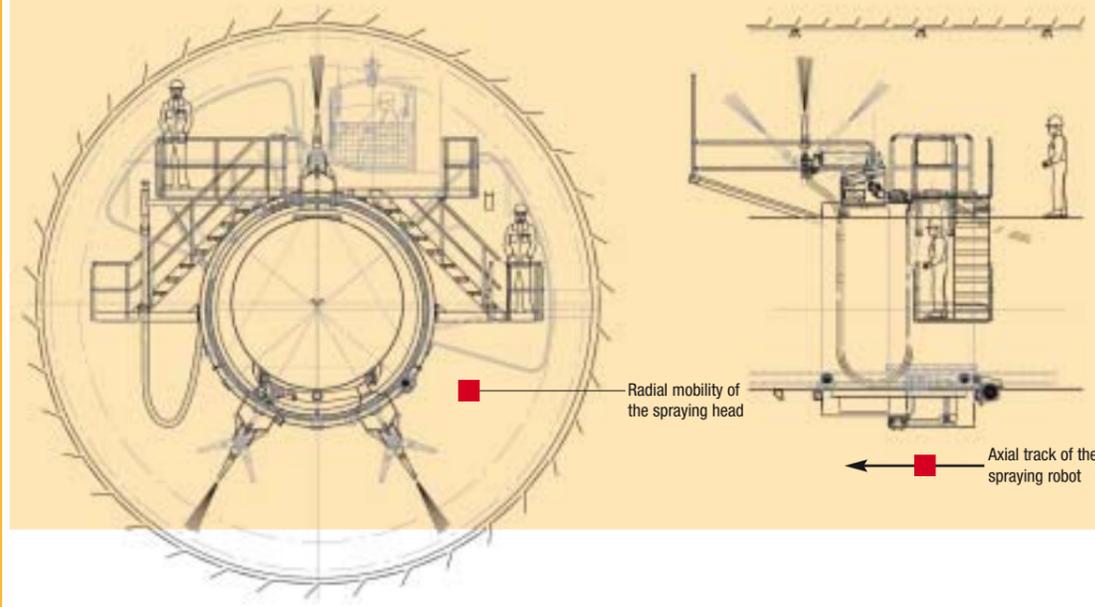
Besides this know-how we have many years of experience in manufacturing machines and equipment designed to meet specific customer needs. The essential in this is that we manufacture the machines ourselves, thus guaranteeing interface-free and reliable production of all equipment. Whether it is spraying robots for large tunnels or robots for galleries, mines or excavation pits, our product range is actually unlimited because we are used to always react, produce and deliver exactly and object-specifically to the customer's need.



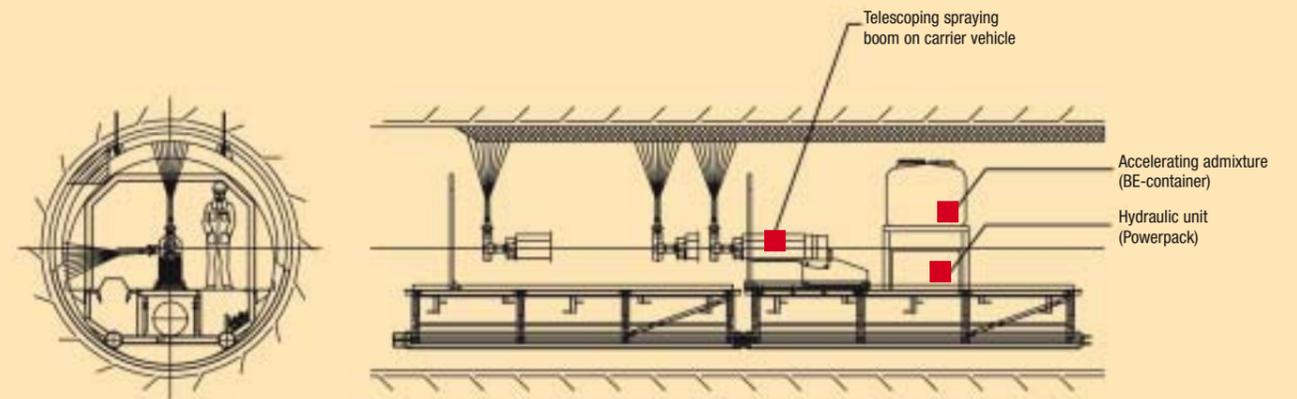
Round Arch Spraying Equipment

Spraying Robot with Telescoping Spraying Boom

Spraying Installation on the Back-up Train with Working Platforms in the L2 Zone



Mount with three-stage Telescoping Spraying Boom



For smaller tunnel cross-sections with diameters of less than 6 m, different worldwide proven solutions with horizontally telescoping booms are available to choose from. The manipulators can be mounted on different existing carrier vehicles or on carrier units built to particular specifications.

In mechanical tunnel driving, sprayed concrete support work is often carried out by means of arch-shaped spraying installations, centrally mounted on the back-up train mainly in the L2 zone (at 40 to 65 m from the excavation face). This configuration allows continuation of additional logistic operations and assures, by means of a protective shield, free passage also while concrete spraying work is carried out. Thanks to the installed working platforms tunnel workers can carry out other securing work at the tunnel roof such as laying drainages.

The transverse moving gear, the trolley and all nozzle manipulations can be remote controlled by the nozzle man. Continuous accelerator dosage and control of shotcrete output is also done by remote control.

On request, a second identical manipulator can be mounted between the round arches. Both shotcreting systems can be operated independently by remote control, the two transverse moving gears being protected from colliding.



Spraying robot with two transverse moving gears



Spraying robot with one-stage spraying boom

Technical Data
Number of spraying heads: 1
Mobility range of spraying head: 140° / 90° incl. rotatory brush movements
Telescoping range of mount: 2000 mm incl. automatic mount
Travel distance arch unit: 2500 mm / 240°

Spraying Robot with one-stage Telescoping Spraying Boom

The problem created by the laser navigation system of an existing back-up train has been solved by the one-stage telescoping boom with offset-mounted spraying head. The manipulator is guided by two elliptic half arches, thus allowing interference-free laser positioning of the TBM, also during shotcreting.

The complete arch-shaped spraying unit can be moved along the tunnel axis on two lateral rails, which in this case are fixed to the back-up train. The two big arches carry the transverse moving gear. Between the guide rails of the transverse moving gear, the manipulator or nozzle head for spraying is mounted on the lengthways back and forth moving trolley.

Technical Data Manipulator
Working range on TBM: for instance 240° radius of arch rail 4 metres along tunnel axis
Number of nozzle heads: 1 (optional 2)
Mobility of spraying head: 3 movements (90°/90°/rotatory brush movement)



Spraying robot in the L2 zone



Spraying robot with three-stage spraying boom

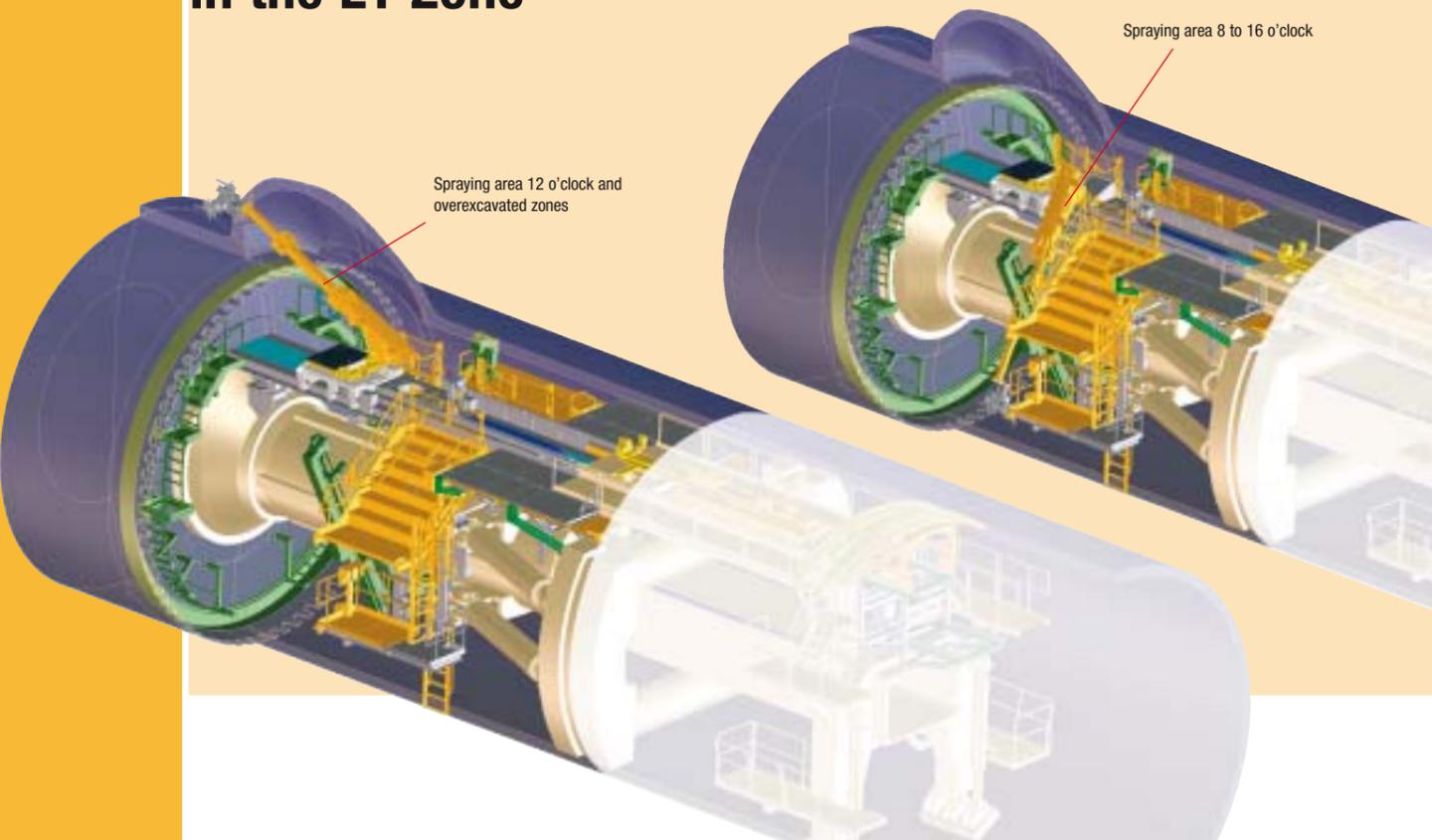
Technical Data
Working range on TBM: depending on carrier vehicle
Number of spraying heads: 1
Mobility range of spraying head: 240° / 360° incl. rotatory brush movements
Telescoping range of mount: 3000 mm incl. automatic mount
Travel distance spraying unit: 1000 mm transversally to both sides

Spraying Robot with three-stage Telescoping Spraying Boom and Carrier Vehicle Advance

The spraying robot is assembled using standard product system components. The three-stage telescoping boom and its spraying head are mounted on a sturdy carrier vehicle, able to travel 1000 mm in the tunnel axis. The spraying nozzle remains always operating centred in the tunnel axis.



Spraying Robot for temporary Use in the L1 Zone



Mounted on a Tracked Carrier

The compactness of this shotcreting robot opens a wide range of utilizability. It can for instance be mounted on a tracked carrier, thus representing a handy spraying unit utilizable in mines and small galleries and as a self-propelled machine on TBM back-up trains. Depending on requirements regarding site environment conditions, the carrier vehicle can be powered by compressed air or diesel engine.

Technical Data Aliva®-503	
Number of spraying heads:	1
Mobility range of spraying head:	240° / 360° / rotatory brush movements
Telescoping range of mount:	3000 mm
Spraying range:	depending on travel distance of carrier vehicle



Spraying robot on a tracked carrier

Feeding gravel into the rotor machine

When tunnels are excavated by TBM and subsequently lined with precast tunnel lining elements, the space between tunnel wall and lining element must be completely filled. The round gravel is injected through pre-manufactured openings in the lining elements.

Injection is done by type **Aliva®** rotor machines. The round gravel is fed from a silo into the rotor machine and blown through a hose fitted with a special connector into the gap behind the ring elements. When the gap is filled, the feed-

ing is stopped by remote control. The hose is connected to the next injection opening and the feeding machine is started again by remote control.

Spraying Robot in the L1 Zone

If required, these spraying robots can be installed in any place on an existing working platform in the L1 or L2 zone. The manipulator is fitted with a spraying head, which in addition to executing all rotary nozzle movements is also telescopically extendable. The robot and the concrete line are remote-controlled by one operator. The compactness of this spraying unit opens a wide variety of application fields.



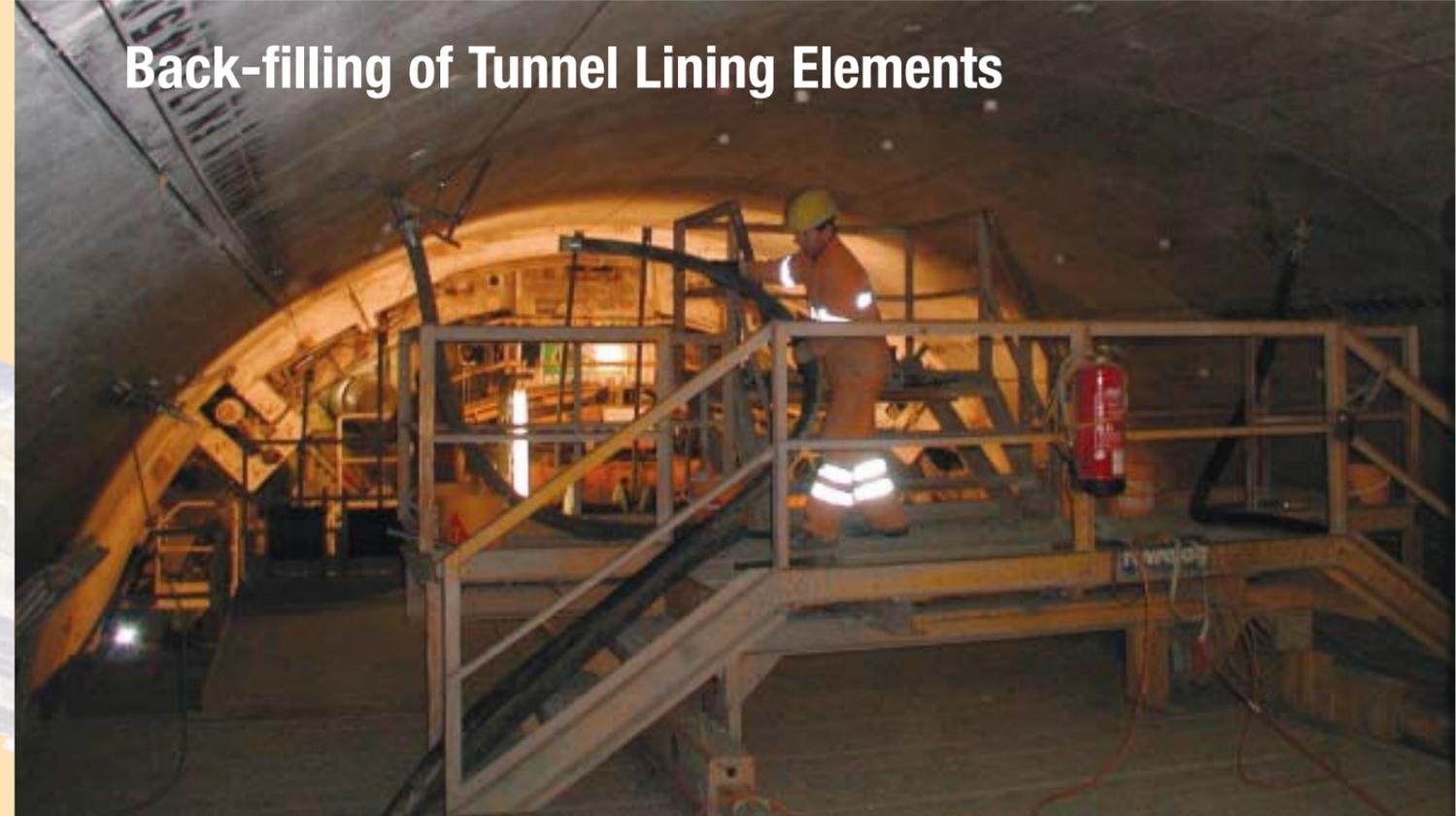
Temporary spraying robot with 800 mm telescoping range, mounted on the live ring of a drilling mount

Conveying of gravel with Aliva-263 rotor machine

Technical Data Rotor Machine Aliva®-263	
Rotor volume:	16 / 25 litres
Conveyor hoses:	\ 65/85 mm
Conveying distance:	20 to 300 m
Theoretical output:	10/15 m³/h
Round gravel:	8/16 mm

Technical Data Rotor Machine Aliva®-252	
Rotor volume:	16 litres
Conveyor hoses:	\ 60/80 mm
Conveying distance:	20 to 300 m
Theoretical output:	up to 8 m³/h
Round gravel:	8/16 mm

Back-filling of Tunnel Lining Elements



Custom-designed Solutions for Tunnel Excavation by TBM

System Documentation Concrete



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Engineering and design is subject to change. All technical data is based on theoretical and standard conditions. For correct operation and maintenance please consult the current machine operating manual.

