

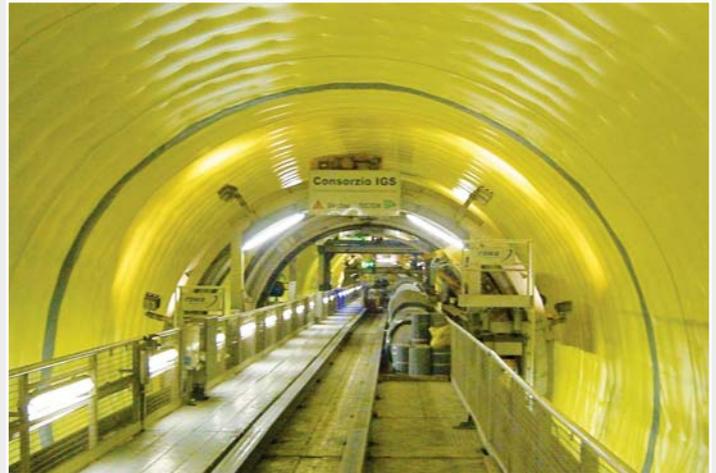
At high speed through the heart of Europe

## Gotthard base tunnel with participation by Leister

Construction of the New Rail Alpine Crossing (NEAT) project represents a further step in regard to Switzerland's integration in the growing European high-speed network. The core is the Gotthard base tunnel, which at 35.4 miles will be the longest rail tunnel in the world. It will comprise two single-track tunnel tubes. Construction is simultaneously in progress on five partial sections of different lengths, so as to optimize the construction time and costs. The costs for this gargantuan project are estimated to be around 9.8 billion Swiss francs (\$ 10.8 billion). The construction time will total 20 years. The historic breakthrough of the tunnel occurred on October 15, 2010 and the grand opening is planned for 2016.

### Future-oriented project

"AlpTransit" passenger trains will one day travel through the tunnel at 124 – 155 mph. Even with the traveling speed of 99 mph that is currently possible, the journey between Milan and Zurich will be reduced by an hour to two hours 40 minutes. Besides the familiar high-speed trains (TGV, ICE), modern tilting trains will be able to travel over the new sections at speeds of over 124 mph. Approximately 20 million people who live in the direct catchment area of the "AlpTransit" line will benefit from the shorter journey time. The entire project



*Finished tunnel seal. The individual sheets are welded in parallel.*

sets new standards in terms of planning, logistics, technology, ecology and financing. Following construction of the flat rail route, fewer locomotives, less personnel and energy will be required for the same amount of transport. This means that rail will once again represent a real alternative to road and air transportation.



*Overhead welding work with the TWINNY S.*

### A coordinated workflow is necessary

The heading is created with a tunnel boring machine or traditionally, with drilling and blasting. Afterwards, an external safeguarding shell is applied with shotcrete. This must fulfil the highest requirements for roughness and flatness. The drainage layer is applied onto the shotcrete. It is fastened onto the concrete with setting bolts. The exact spacing of the fastening points was determined in tests. Discs backed with Velcro are fastened during the same work stage. These will later support the plastic sealing sheeting which is laminated with special felt.

### The «worm» has what it takes

The plastic sealing sheets are welded by a giant, 2 x 273 yard long monster, the so-called “worm.” It works around 79 ft a day through the tunnel. Running through its lower part are the supply lines for electricity, water and fresh air for the tunnel boring machine which is situated further ahead. The entire construction site traffic including excavated material and personnel also runs on rails below it. The “worm” is also the loca-

tion for testing the roughness and flatness of the shotcrete, applying the drainage layer and fastening the Velcro-backed discs. Afterwards, the plastic sealing sheets are unrolled with a special device and pressed onto the Velcro-backed discs.

### Overhead welding made easy

The overlaps of the sheets are then welded tightly and permanently using the TWINNY S welding machines from Leister. This compact combination wedge device has proven its merits once more. Even overhead welding is possible as a result: the TWINNY S presses the two sheets together and thus rises easily and safely during welding. The welding progresses almost by itself. If required, the welding direction can be corrected simply and without interruption. The contact pressure, welding speed and temperature can be adapted to the relevant requirements. Despite its small dimensions, welding speeds of up to 6.5 ft per minute are possible with the TWINNY S, depending on the contact pressure. This is a crucial advantage when you consider the size of this project. The tightness is the most important criterion when evaluating



*The TWINNY S can be easily guided, even in the case of vertical weld seams.*

*Awkward welding work on the base seal is no problem for the lightweight and practical TRIAC DRIVE.*



*“Double” pressure roller and welding nozzle of the TWINNY S.*



the weld quality. To guarantee the greatest possible safety here, a test channel is installed for each overlap weld. This is realised with the pressure roller on the TWINNY S which was specially designed for this purpose. This ensures two parallel weld seams of 0.6 inch each. The resulting test channel between these seams is 0.8 inch wide. The watertightness can be reliably monitored via compressed air using this channel.

**Working in a confined space**

The structural sealing acts as a shield protecting against penetration by mountain water. Drainage pipes collect the diverted moisture on both sides. This is held in the large, central collecting pipe and routed to the tunnel exits. Waterstop profiles set in concrete on both sides in the kicker area (concrete base) complete the “rain shield.” The rain shield seal is joined to the back of the waterstop here. This awkward work in a very confined space and on hard substrate is performed with the lightweight and practical semi-

automatic welding machine TRIAC DRIVE from Leister. Where necessary, a protection rail is mounted afterwards and finally a reinforcement installed. As a final step, the concrete inner shell of the tunnel is installed.

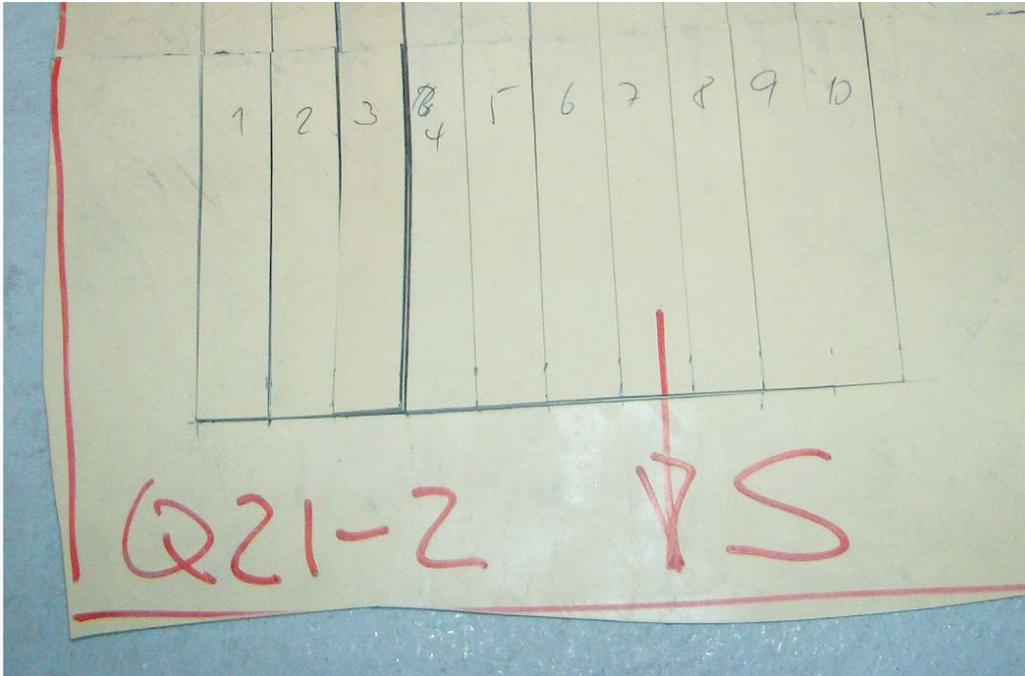
**621 miles weld seams**

The plastic sealing sheets for the south side and center of NEAT are produced in the Sika plant in Duedingen, Switzerland with a width of 2.40 yards. Two overlapping sheets are prefabricated here. As a result, a circumferential weld seam of 26 yards is only necessary approximately every 14 ft for processing in the tunnel. This includes the two-sided weld seams on the base seal and the weld seams for the countless cross connections of the two tunnel tubes. In total, this corresponds to a weld seam length of around 621 miles for the entire, 35.4 mile long Gotthard tunnel! The sheet fabrication, cutting to length and delivery of the plastic sealing sheets are each adapted to the construction section.

### Quality is crucial

On account of the permanent shift operation and the special parameters, a high level of dust, heat and air humidity arises in the tunnel. Only the best quality of material, processing and machine enables fault-free and hence efficient work. With a planned service life of over 100 years, there are different requirements in play than those typical of standard structures. All products used for the sealing system therefore had to prove their suitability for this extraordinary project during long tests. The selection of the materials was also accompanied by regular monitoring, thereby ensuring that the quality and processing remain within a defined tolerance range. The

specialists at the accredited test institute, Tecnotest AG in Rueschlikon, Switzerland are relied on for this process. Control inspections concerning the drainage and sealing are conducted in the laboratory. In addition, the company inspects the quality of the weld seam and the substrate on site. Regular peel tests to check the weld quality are carried out directly in the tunnel using the EXAMO test device from Leister, a device highly suitable for construction sites. The plastic sealing sheets and the drainage layer undergo further tests in the laboratory in order to test the various material properties.



*Welding samples taken directly in the tunnel.*



*Peel tests are conducted in the laboratory, but also on site with the EXAMO test device from Leister.*



*Mechanical application of the prefabricated, 14 ft wide plastic sealing sheets onto the Velcro-backed discs located below. Welding is then carried out.*

### Long-term project

The flat rail route opens up new dimensions in passenger and goods transportation. Economic centers on both sides of the Alps will be brought closer together. The railway will become a modern and powerful instrument of transportation on the North-South axis thanks to "AlpTransit." It will be able to provide greater transport capacity with shorter traveling times. Furthermore, it will guarantee an environmentally-friendly, sustainable solution for issues of mobility and the continually growing volume of traffic. An incredible amount of work has gone into this project for the future. The quality of this construction of the century is therefore extremely important. Not only is the processing and the material crucial, but also the machinery used. Leister shares the responsibility for this thanks to the use of its welding machines and hot-air hand tools. Even under these exceptional conditions in the tunnel, the equipment of the long-established Swiss company is once again proving its merit. After all, the sealing system must continue to fulfil its purpose for 100 years' time!



*The finished welded sealing layer before concreting the inner shell of the tunnel.*

Questions about the NEAT construction site directed to the project manager responsible at Sika Bau AG, Urs Streuli

**The NEAT construction site is dominated by difficult climatic conditions. – What does this mean for the machinery and equipment used?**

Temperatures of up to 82 °F and an air humidity of over 90 percent predominate in the tunnel. A clean weld seam preparation is therefore essential. It is also important to store all machinery cleanly after use in order to prevent unnecessary corrosion.

**What are the most important measures for complying with the processing quality?**

Clean work in general, as well as clean weld seam preparation. What is more, the welding must not be too fast and must never be performed in water.

**How do you monitor the processing quality?**

Every weld seam is subject to a visual inspection with the screwdriver; dual seams with a test channel are "inflated." Peel tensile tests are also carried out regularly. The latter, either in the Sika laboratory or by Tecnotest AG. A control weld is also conducted when starting work.

**What are the most important advantages of Leister devices from your point of view?**

We work exclusively with Leister devices and depend on their reliability. They correspond exactly to our requirements. We have been working with Leister equipment for as long as I can remember...

**Sometimes the spaces are very confined on a tunnel construction site like the one here with NEAT. How effective does the Leister machinery prove to be?**

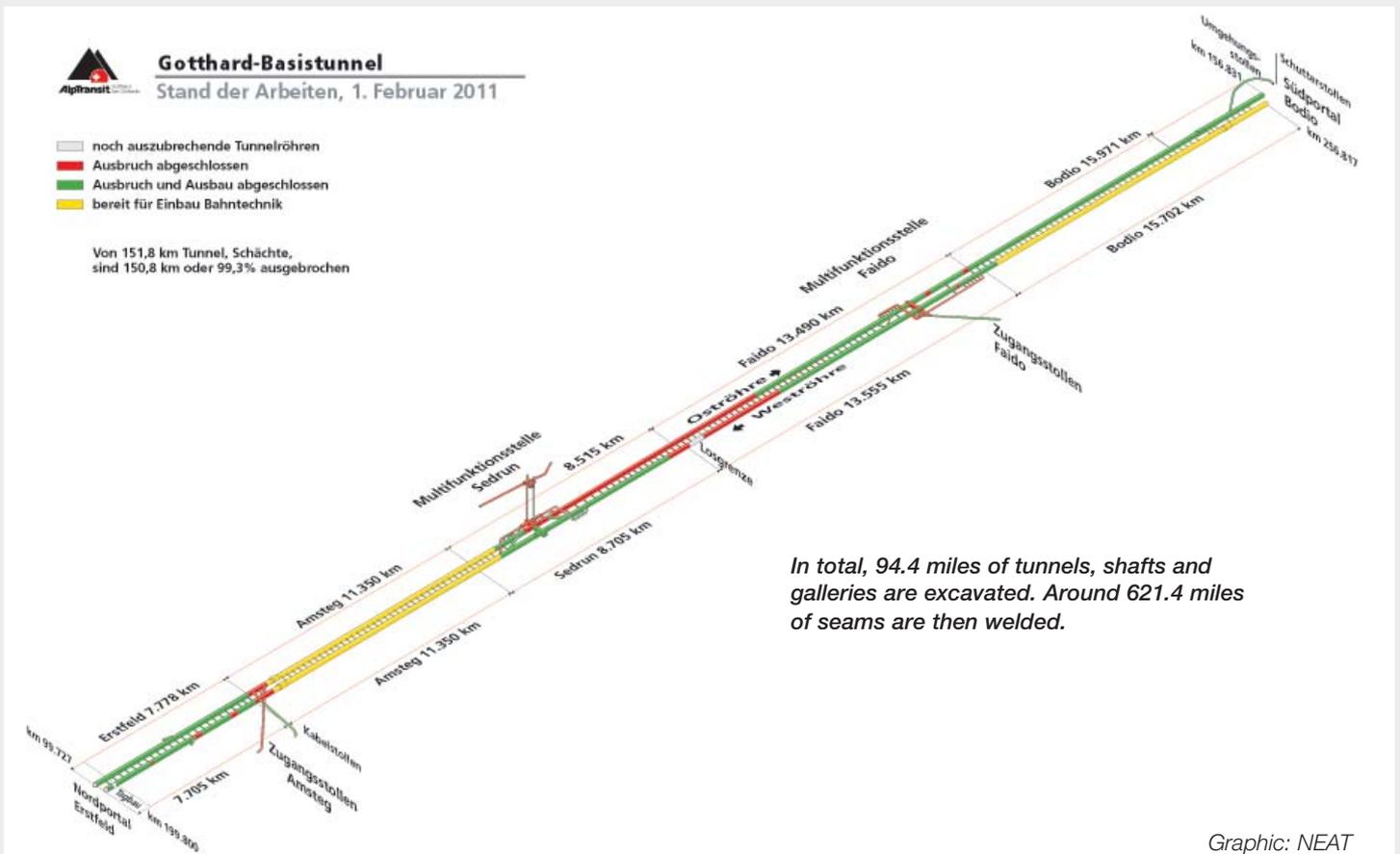
TRIAC Drive and TWINNY S are practical and lightweight welding machines. That makes them ideally suited for use even in very confined spaces like here. Even overhead welding work does not pose any problems.

**Are you happy with the support provided by the Leister Sales and Service Center?**

Yes, we are satisfied with the service of the Leister partner responsible. If one of the devices needs a service, it is soon ready for use again afterwards.

**Does Sika Bau AG also work with Leister equipment for other major projects? – If yes, which ones?**

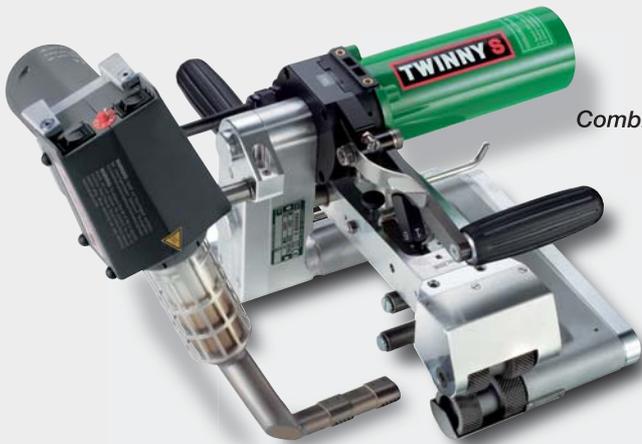
We only work in Switzerland. Sika Bau AG uses Leister devices exclusively in all tunnel projects here, for example on the bypass tunnels in Zurich, Lungern and Olten, and in the Ceneri base tunnel (part of the new flat rail route through the Alps).



In total, 94.4 miles of tunnels, shafts and galleries are excavated. Around 621.4 miles of seams are then welded.

Graphic: NEAT

Leister equipment used on the NEAT construction site:



Combi-wedge welder TWINNY S



Semiautomatic welding machine TRIAC Drive



Hot-air hand tool TRIAC PID



Hot-air hand tool TRIAC S



Test device EXAMO

<b>Construction customer:</b>	AlpTransit Gotthard AG, 6003 Lucerne, Switzerland, <a href="http://www.alptransit.ch">www.alptransit.ch</a>
<b>Sealing system for the south side and center:</b>	Sika, 8048 Zurich, Switzerland, <a href="http://www.sika.com">www.sika.com</a>
<b>Sealing sheets for the south side and center:</b>	PVC-P from Sikaplan, thickness 2.0 mm
<b>Laying company for the south side:</b>	Consortio IGS (SikaBau AG and Tecton AG)
<b>Laying company for the center:</b>	Sika Bau AG, 8952 Schlieren, Switzerland, <a href="http://www.sikabau.ch">www.sikabau.ch</a>
<b>Sealing system for the north side:</b>	Sarnafil AG, 6060 Sarnen, Switzerland, <a href="http://www.sarnafil.ch">www.sarnafil.ch</a>
<b>Sealing sheets for the north side:</b>	PE-Copolymer from Sarnafil, thickness 2.2 mm
<b>Laying company for the north side:</b>	Gunimperm SA, 6532 Castione, Switzerland
<b>Laboratory and tunnel inspection tests:</b>	Tecnotest AG, 8803 Rüschlikon, Switzerland, <a href="http://www.tecnotest.ch">www.tecnotest.ch</a>
<b>Equipment supplier for sealing work:</b>	Leister Process Technologies, 6056 Kägiswil, Switzerland, <a href="http://www.leister.com">www.leister.com</a>

**Text:** Norbert Tholl, Tecnotest AG / Christophe von Arx, Leister / NEAT  
**Photos:** Norbert Tholl, Tecnotest AG

**Headquarters:**

Leister Process Technologies  
Galileo-Strasse 10  
CH-6056 Kaegiswil/Switzerland  
phone:+41 41 662 74 74  
fax: +41 41 662 74 16  
leister@leister.com

**Leister Technologis KK**

Shinyokohama Bousei Bldg 1F  
3-12-20, Shinyokohama, Kohokuku  
Yokohama 222-0033 / Japan  
phone:+81 45 477 36 37  
fax: +81 45 477 36 38  
info@leister.co.jp

**Leister Technologies LLC**

1253 Hamilton Parkway  
Itasca, IL 60143/USA  
phone:+1 630 760 1000  
fax: +1 630 760 1001  
info@leisterusa.com

**Leister Technologies Ltd.**

Building A, 1588 Zhuanxing Road  
Shanghai 201 108 PRC  
phone:+86 21 6442 2398  
fax: +86 21 6442 2338  
leister@leister.cn



**Our close worldwide network of more than 120 Sales and Service Centres in more than 90 countries.**

- |                |               |             |                 |                |                     |                      |                 |
|----------------|---------------|-------------|-----------------|----------------|---------------------|----------------------|-----------------|
| <b>Europe:</b> | Great Britain | Russia      | <b>America:</b> | <b>Africa:</b> | <b>Middle East:</b> | <b>Asia Pacific:</b> | <b>Oceania:</b> |
| Austria        | Greece        | Serbia      | Canada          | Algeria        | U.A.E.              | P.R.China            | Australia       |
| Belarus        | Hungary       | Slovakia    | Mexico          | Egypt          | Saudi Arabia        | Hong Kong            | New Zealand     |
| Belgium        | Ireland       | Slovenia    | USA             | Kenya          | Qatar               | India                |                 |
| Bulgaria       | Iceland       | Spain       | Argentina       | Morocco        | Iran                | Indonesia            |                 |
| Croatia        | Italy         | Sweden      | Brazil          | South Africa   |                     | Japan                |                 |
| Cyprus         | Latvia        | Switzerland | Chile           | Tunisia        |                     | Korea                |                 |
| Czech Republic | Lithuania     | Turkey      | Columbia        |                |                     | Malaysia             |                 |
| Estonia        | Netherlands   | Ukraine     | Costa Rica      |                |                     | Philippines          |                 |
| Denmark        | Norway        |             | Ecuador         |                |                     | Singapore            |                 |
| Finland        | Poland        |             | Venezuela       |                |                     | Taiwan               |                 |
| France         | Portugal      |             | Peru            |                |                     | Thailand             |                 |
| Germany        | Romania       |             |                 |                |                     | Vietnam              |                 |

**Distributor Addresses:**

**Western Process Heat Inc.**  
92029 Escondido, CA  
Toll free number: 800 694 1472  
www.hotairtools.com

**Leister USA Geosynthetics Division:**  
17 Frost Drive  
Durham NH 03824/USA  
Toll free number: 855 534 7837  
geosynthetics@leisterusa.com

**Industrial Heat Sources LLC**  
44134 Cleveland, OH  
Toll free number: 800 635 0384  
www.industrialheatsources.com



**Canada: STANMECH Technologies Inc.**  
944 Burlington, Ontario  
Toll free number: 888 438 6324  
www.stanmech.com

**Malcom Company Inc.**  
02878 Tiverton, RI  
Toll free number: 888 807 4030  
www.malcom.com

**Heely-Brown Company**  
30318 Atlanta, GA  
Toll free number: 800 241 4628  
www.heely-brown.com

**Swiss Made Quality.**

Leister Process Technologies is an ISO 9001 certified enterprise.