

# DRILLING HAS BEGUN ON THE SAN GOTTARDO TUNNEL

**When the going gets tough, the tough get going.**

*Text by the UTT - Mapei Underground Technology Team*

**T**he breakthrough of the final diaphragm between the Canna di Bodio and the rock tunnel through the West Tube on the Alp-Transit San Gottardo SA building site in Bodio-Pollegio marked the beginning of "drilling" operations on the San Gottardo Tunnel.

Carried out by the Consorzio Matro (Pizzarotti S.p.A., Muttoni SA, Ferrari SA, Fondazioni Speciali s.r.l.), work on the technically tricky approximately 400-metre-long "loose material section" began in September 2000."

This press release from 25.11.2002, which also appeared on the web site [www.alptransit.ch](http://www.alptransit.ch), was how the contracting company Alptransit S.A. announced the news that drilling had begun on the opening section of the San Gottardo railway tunnel.

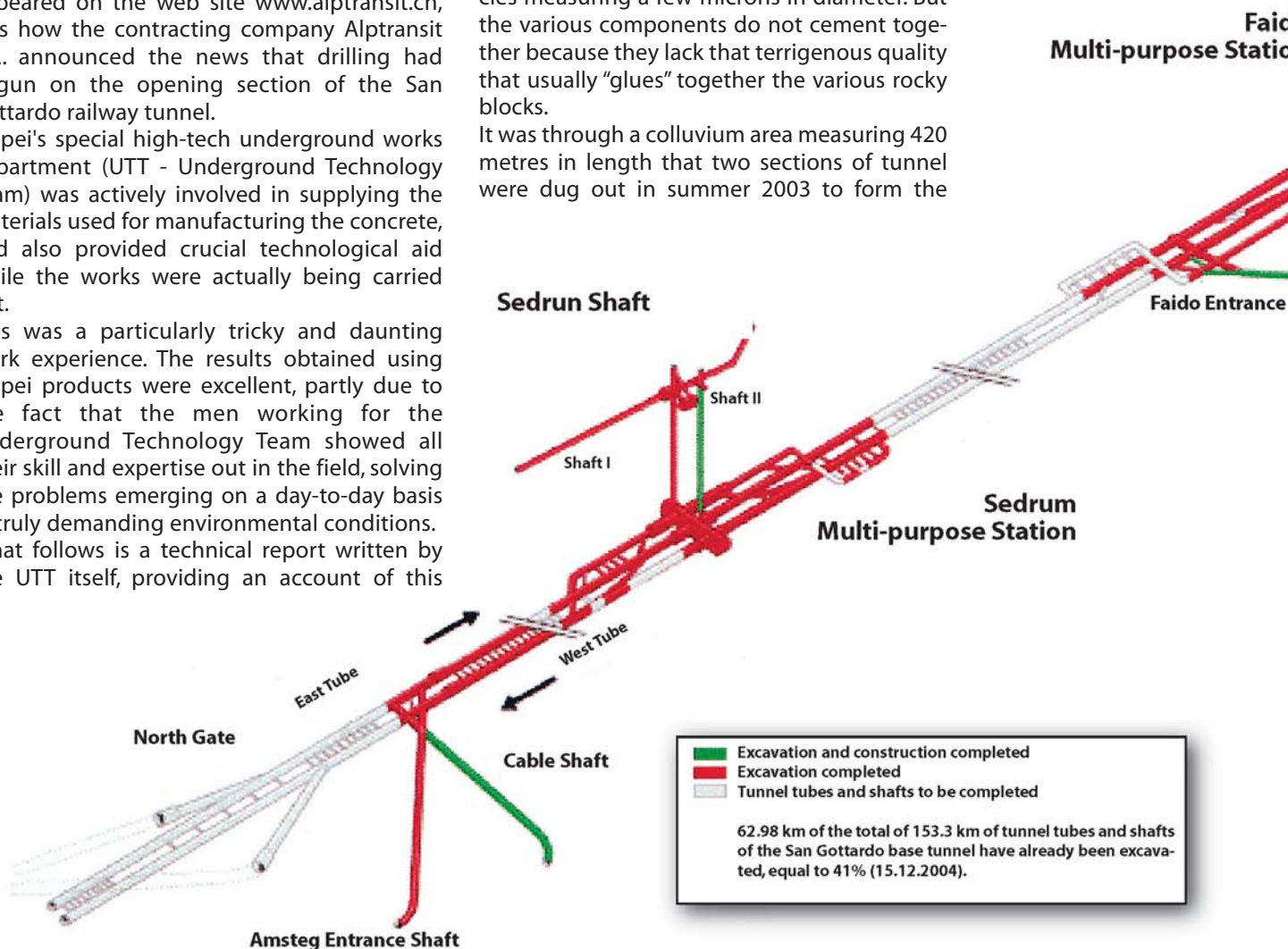
Mapei's special high-tech underground works department (UTT - Underground Technology Team) was actively involved in supplying the materials used for manufacturing the concrete, and also provided crucial technological aid while the works were actually being carried out.

This was a particularly tricky and daunting work experience. The results obtained using Mapei products were excellent, partly due to the fact that the men working for the Underground Technology Team showed all their skill and expertise out in the field, solving the problems emerging on a day-to-day basis in truly demanding environmental conditions. What follows is a technical report written by the UTT itself, providing an account of this

important work experience, a challenge that Mapei people met with great success.

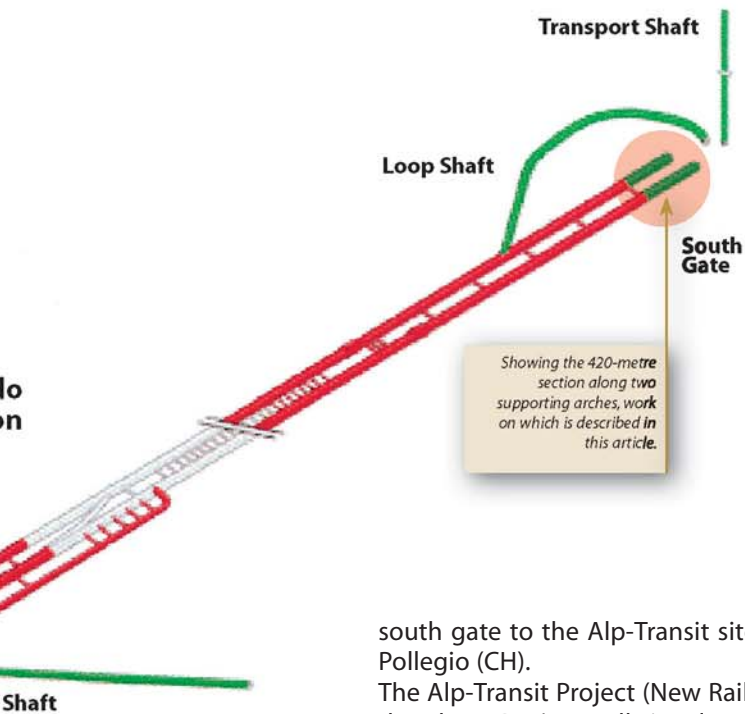
Colluvium is the trickiest thing to handle when tunnelling. Geologically speaking, it comes from a build-up of material tumbling down the mountainside, that breaks away due to the effects of atmospheric agents like frost and rain and then falls due to the force of gravity and the flow of rain water until it forms a sort of pile of material of highly varied particle size. This forms a pile that sediments over time, filling several cubic metres with clay-like particles measuring a few microns in diameter. But the various components do not cement together because they lack that terrigenous quality that usually "glues" together the various rocky blocks.

It was through a colluvium area measuring 420 metres in length that two sections of tunnel were dug out in summer 2003 to form the





## Buzza di Biasca



south gate to the Alp-Transit site, near Bodio-Pollegio (CH).

The Alp-Transit Project (New Rail Link through the Alps, NRLA) actually involves one long tunnel, which, when it is completed, will allow trains to cover the 57 kilometres from Bodio to Erstfeld along one single underground section. This is known as the San Gottardo base railway tunnel, the project for which was divided into five different length parts in order to complete the works as quickly and economically as possible by digging in several places at the same time.

The south gate, the so-called Bodio section, is the longest part of the base tunnel and, considering the tricky geological situation involved, the two 420-metre-long entrance ways were really a challenge within a challenge for the Alp-Transit project. A tender was even organised for them, that was then awarded to the Matro Consortium (Muttoni SA, Pizzarotti S.p.A., Ferrari SA, Fondazioni Speciali s.r.l.). The company ended up tackling the first section by conventional method of excavation, followed by mechanized tunnelling (for which ano-

ther tender was arranged), once the solid rock section was reached.

Usually, work progresses by digging out a section of tunnel whose length is set in relation to the quality of the material being worked (small distances in the case of low-quality material). Steel arches and anchorings are then set in place, followed by sprayed concrete serving support and safety purposes.

Since in this case the ground crossed was highly unstable, face injections had to be made first using fiber glass tubes with cement-based grouts and 15-metre forepoling constructed with 3-metre overlaps. High-quality sprayed concrete with very high mechanical compressive strength development also had to be used to support the tunnel.

Strict preliminary tests were carried out before starting tunnelling, in order to assess the effectiveness of the systems planned to be used. At the end of the trial tests it was found that the Mapei-UTT system, outlined below, was the best of all:

Cement Type I 42,5	420 kg
W/C ratio	0,45
Crushed sand 0/4	70%
Crushed gravel 4/8	30%
DYNAMON SX* superplasticiser	1%

The mix design prepared by the Mapei Underground Technology team resulted in a S5 class consistency concrete with no bleeding, with slump retention of over 2 hours and excellent rheological properties, guaranteeing mix pumpability and as well accelerator dispersion during the spaying phase.

Two different types of alkali-free accelerators were used: MAPEQUICK AF 1000\* for "ordinary" working conditions and MAPEQUICK AF 2000\* when having heavy in-flows of water in the tunnel. MAPEQUICK AF 1000\* ensures fast setting time and, at the same time, good compressive strength development (at 24 hours





$R_{ck}=15-20 \text{ N/mm}^2$ ); MAPEQUICK AF 2000\*, thanks to its even quicker setting time, guarantees self-bearing capacity of shotcrete, even in presence of flowing water on the surface.

The amount of accelerator used was set by a special computerised dosing unit, according to the production rate (approximately  $22 \text{ m}^3/\text{hour}$  using a CSS - 2 spritz system CIFA pump), which is exactly 7% on weight of the cement (approximately 29 kg of accelerator per cubic metre of concrete) for MAPEQUICK AF 1000\* and 6% in weight of the actual weight of the cement for MAPEQUICK AF 2000\* (25 kg of accelerator per cubic metre of concrete).

The lining of sprayed concrete was made in thicknesses of between 20-80 cm, with a gradual increase in thickness every 12 metre close to the overlaps between the different forepoling sets (where the thickness was at least one metre) and was shoued in one single uninterrupted spraying phase.

Using such high-performance sprayed concrete

(at 28 days  $R_{ck}=40-50 \text{ N/mm}^2$ ), convergence in the tunnel cavity could be controlled even in the presence of unstable and heterogeneous materials. Such a high quality shotcrete allowed as well to have a waterproofing lining. Similar results were also favoured by the high-tech properties of products like the DYNAMON\* acrylic superplasticiser, which confer fluidity to concrete with low water/cement ratios and, most particularly, MAPEQUICK AF\* alkali-free setting accelerator, which already meet European directives (soon to be enforced) for sprayed concrete.

We are proud to announce that an all-Italian team (firm, suppliers of materials and machinery), working to Swiss rules and regulations, managed to successfully complete a highly complex project up to the expected standards. This testifies to the high technological standards and know-how of Italian industry in this sector, which now seems to have a bright future, as well as a great past to constantly draw on.







## TECHNICAL DATA

**Alp-Transit San Gottardo Railway Tunnel**, Bodio-Pollegio (CH)

**Years:** 2001-2003

**Customer:** Alp-Transit Gotthard AG, Bodio-Pollegio

**Contractor:** Consorzio Matro (Pizzarotti - Muttoni - Ferrari - Fondazioni Speciali)

**Project and Works Management:** Ingenieurgesellschaft Gotthard-Basistunnel Süd (Lombardi AG - Jaakko Pöyry Infra - Amberg Engineering)

**Mapei Co-ordinator:** Mapei Underground Technology Team, Mapei Spa

**\*Mapei Products:** the products referred to in this article belong to the "Admixtures for Concrete" and "UTT" ranges. The technical data sheets are available on the "Mapei Global Infonet" CD/DVD and at the web site: [www.mapei.com](http://www.mapei.com).

**Dynamon SX:** superplasticizer based on modified acrylic polymer for concrete with low water/ cement ratio for traditional and self-compacting concrete.

**Mapequick AF 1000:** liquid accelerator based on alkali-free, organic salts developed for shotcrete with very rapid setting time.

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The Underground Technology Team (UTT), Mapei's superprofessional squad for handling underground works, will soon have its own web site at: [www.utt-mapei.com](http://www.utt-mapei.com). The aim is to meet all its clients' technical needs in real-time as far as underground constructions are concerned. In addition to an updated presentation of the full range of Mapei products for every need and situation, the site will basically provide the chance to get directly in touch with everybody working in this field, that look likely to expand in the near future.

An international renowned organisation like the UTT could not afford to overlook such an important means of communication, as the team is set to take on truly global status.

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UNDERGROUND TECHNOLOGY TEAM