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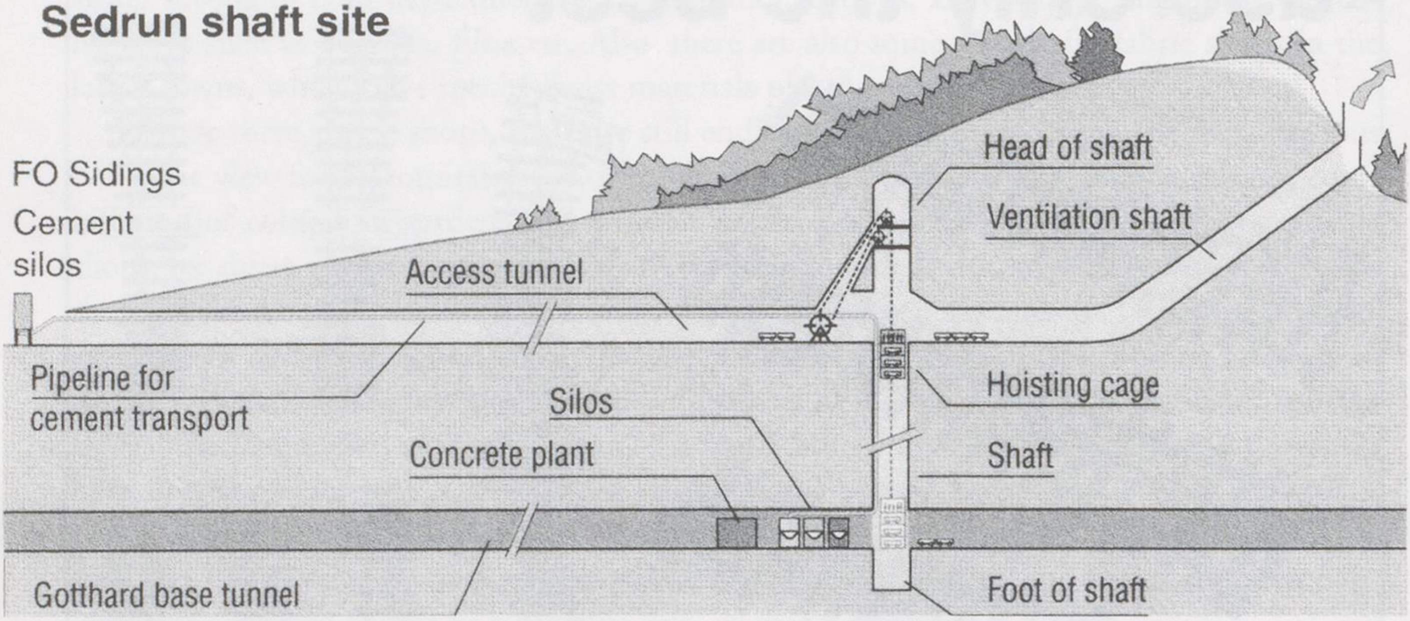
GOTTHARD BASE TUNNEL
Part 2

Figure 5



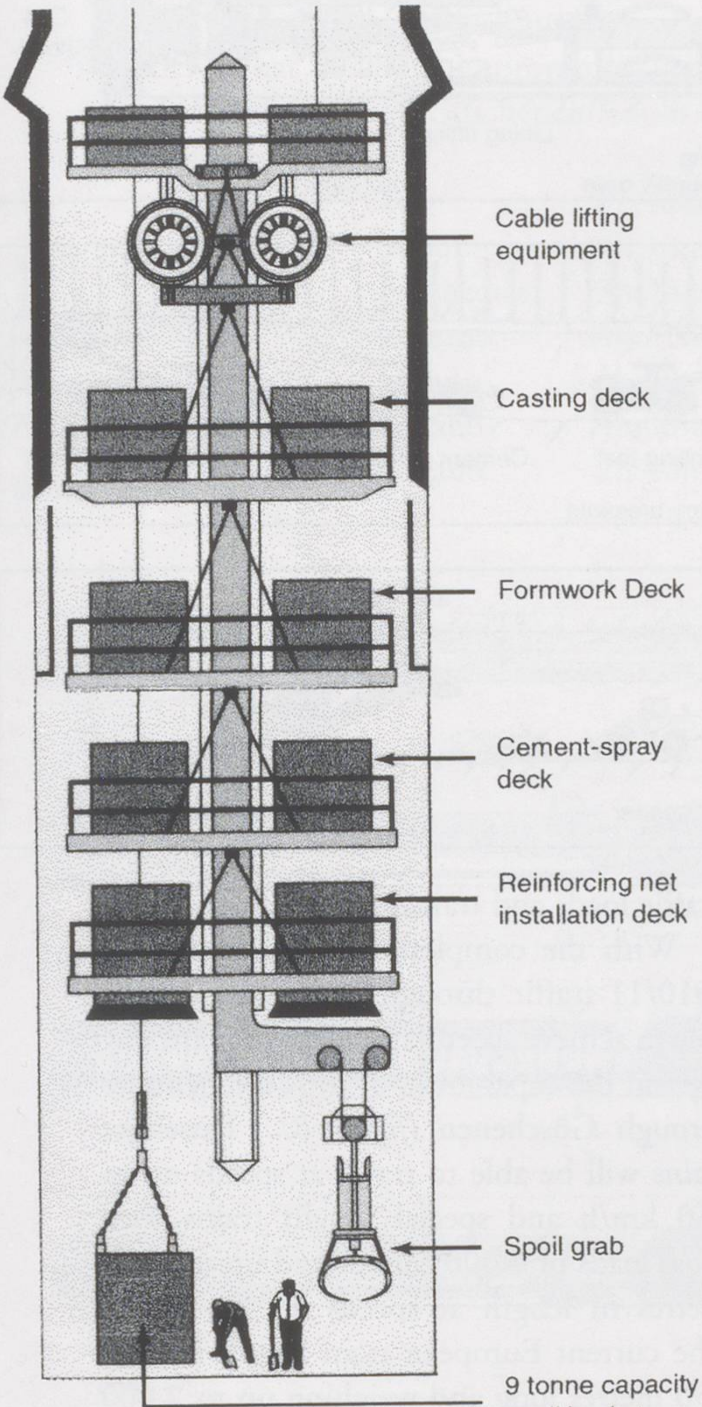
CONTINUED FROM SEPTEMBER 1999

Drilling systems

To decrease the time taken to bore the tunnels work will take place on several faces. Of which the most difficult to start work on is the one located at Sedrun *(figures 5 & 6)*. To help construct the 21 metre wide 800 metre deep access shaft, special engineers from the South African Gold fields were brought in as they had experience of drilling shafts up to 2,500 metres deep. The access tunnel that provides the route for materials for the main shaft is linked to the railway network via a link-line to the Furka Oberalp system on the eastern side of Sedrun.

Cement and material trains will feed the tunnel work-site *(figure 6)* from both the FO at Brig and the RhB at Chur/Disentis. To help drill the Sedrun shaft a special cage weighing 90 tonnes has been constructed, as the shaft is drilled out at the rate of 1.5 metres per day the cage is lowered. At the bottom of the cage is a 9 tonnes bucket system to remove the spoil, just above that is the platform used to re-enforce the shaft walls and above that is the cement spraying unit. Above the spray unit are two decks for form-work and casting. The depth of the cage is controlled from cable control equipment located on the roof of the cage. In the event that the shaft floor requires to be blasted, all personnel are removed from the shaft and the cage is lifted between 80 - 100 metres up the shaft. When construction of the shaft is complete the cage will be converted to a three deck wagon and materials lift. Drilling and construction material will be lowered into the working area, and spoil from the tunnel work faces will be loaded onto wagons and onto the lift for removal to the disposal site. Premixed cement will be fed into the tunnel via a pipe running down

Figure 6



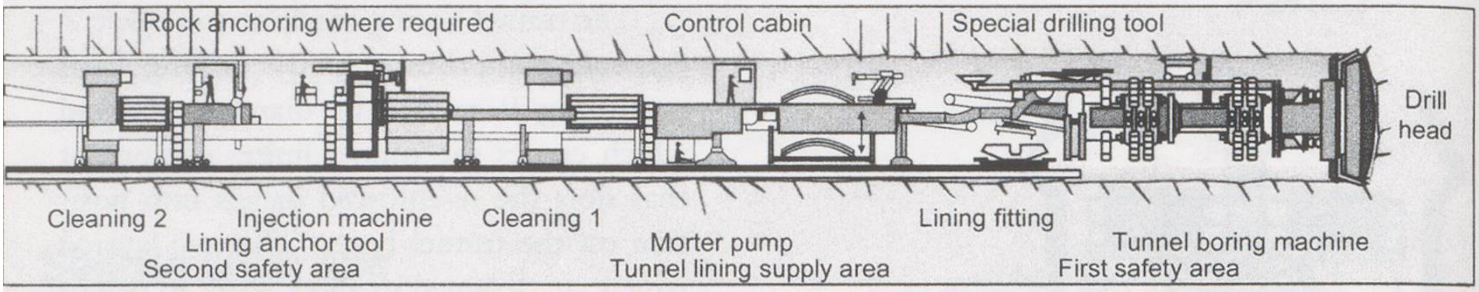
one side of the shaft into silos in the tunnel area.

The tunnel boring machine *(see figure 7 overleaf)* comprises a rotary drilling head measuring 9 metres in diameter, behind which comes the tunnel lining equipment that slots the re-enforced panels into position on the tunnel bore. The two-layered panels are designed to allow water to percolate through the outer panel and for it to be guided by the inner layer into the drain at the base of the tunnel floor.

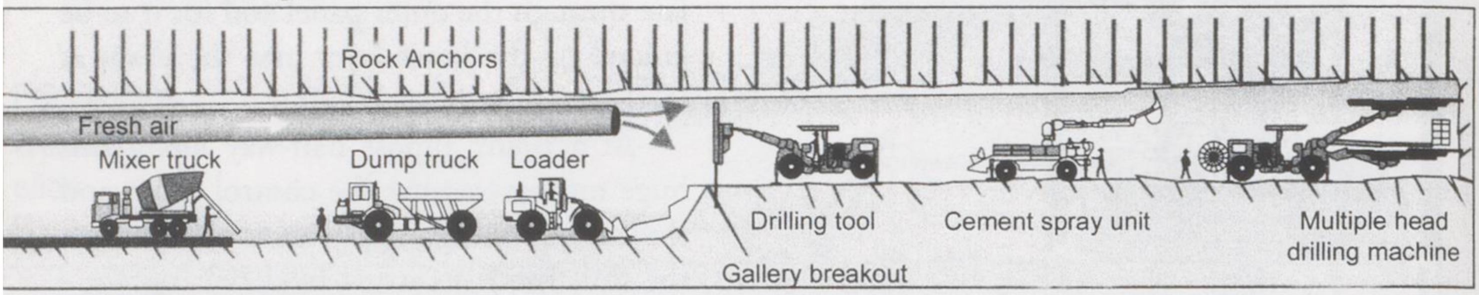
At a point almost half-way along this huge machine comes the control cabin and the tunnel lining supply area. Spoil from the drill head is carried by a belt system - laid into the centre of the machine - to the rear of the system where it is loaded into wagons for disposal as required. To the rear of the control cabin is located the drilling and injection unit that will carry out any anchoring work and sealing that may be required in the roof area. The length of this machine is approximately 300 metres.

The conventional drilling system *(see figure 7 overleaf)* comprises a multi-headed drilling machine similar to that used in the road tunnel from Göschenen to Airolo. Spoil that has been drilled or blasted out is carried away by dumper wagons to the disposal site. The floor is drilled out by another unit to complete the breakout of the gallery created by the first machine. A loader will lift any spoils from the drill units onto dumper wagons for disposal, when a sufficient area has been cleared to the correct profile a cement wagon will supply concrete for the laying of the floor foundations. Cement is sprayed onto the tunnel walls and roof to stabilise the area. Rock grinding equipment will be used in those areas that do not require blasting etc. or where the

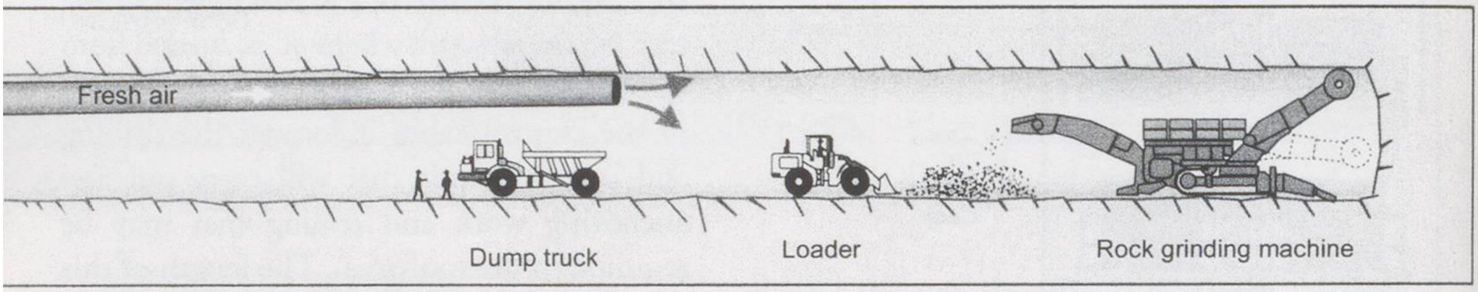
Tunnel boring machine



Conventional drilling machine



Rock grinding machine



rotary drilling unit is likely to get stuck in soft rock or damaged by cave-ins.

A problem that will confront the miners in this low level tunnel, as it did in the case of the original railway and road tunnels, will be the temperature in the tunnel bore. The temperature that the miners of the Göschenen/Airolo rail and road tunnels tolerated was 32°C at its peak, but the temperature expected in the main bores will be of the order of 45° C although it is hoped to keep this down to 30° C by forced-air ventilation. In winter this level of heat will subject the miners to a temperature difference of up to 60° C between the tunnel and the surface, and because of this high differential all staff changing shifts will be treated in much the same way as divers are when coming to the surface.

Traffic loads and transit times

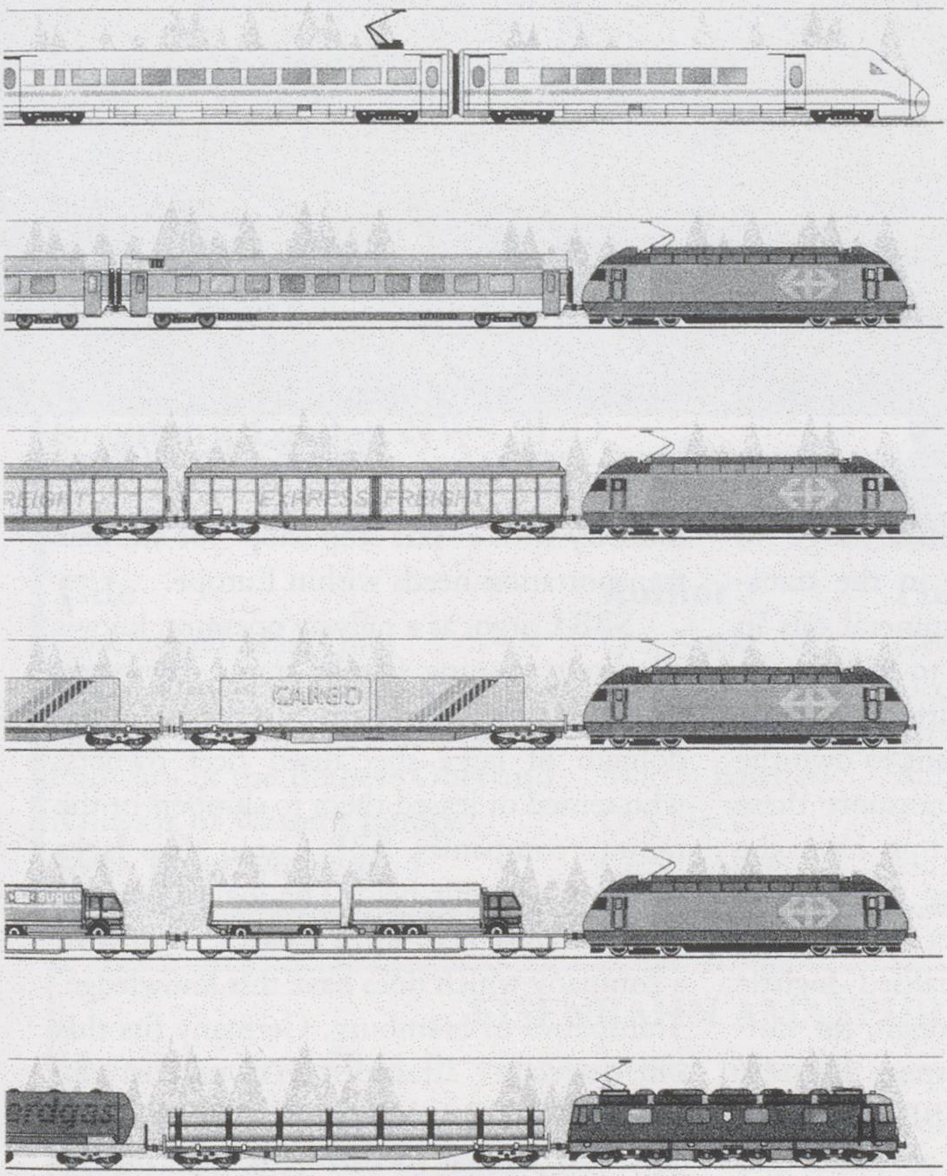
With the completion of the tunnel in 2010/11 traffic through the tunnel will be able to achieve speeds and loads that are way beyond the capabilities of the current route through Göschenen *(figure 8)*. Passenger trains will be able to travel at speeds up to 250 km/h and special freight trains with gross loads of 4,000 tonnes and up to 1500 metres in length at speeds of 120 km/h. The current European train length limit is 750 metres long and weighing up to 2,000 tonnes. The number of freight trains will increase to 325 per day from the present level of 190. The motive power and train sets - such as ICE, TGV, Pendolino and IC2000 along with Re460 and Re6/6 locomotives - needed to operate this service are either already available or currently under construction.

When the tunnel through the Ceneris - due to start construction in 2005 - is completed in 2016 the transit times through the Gotthard will fall to almost half their current level. To complement all the tunnelling are projects started earlier as part of the Bahn 2000 scheme that will provide much improved access to the Gotthard. Many of these schemes are already complete or well under way with completion due before the tunnel opens for traffic. What this huge improvement in route capacity and transit time will mean for the present route through Göschenen/Airolo is still not clear.

Transit times

From	**To**	**Present**	**2010AD**
Zürich	Milan	4h:10m	2h:10m
Aarau	Bellinzona	3h:00m	2h:00m
Biel	Locarno	4h:35m	3h:15m
Basel	Milano	5h:20m	3h:45m
St Gallen	Lugano	4h:00m	2h:50m
Luzern	Lugano	2h:40m	1h:30m

Figure 8



Future Passenger Trains

Eurocity. [TGV, ICE & Tilting trains]

Maximum speed. km/h	250
Seats	800
Maximum length. Metres.	400

Current Passenger Traffic

Maximum speed. km/h	200
Seats	1000
Maximum length. Metres.	400

Future and Block Freight Traffic

Maximum speed. km/h	160
Maximum load. Tonnes.	1200
Maximum length. Metres.	450

Unaccompanied Container Traffic

Maximum speed. km/h	120
Maximum load. Tonnes.	4000
Maximum length. Metres.	1500

Rolling Road Traffic

Maximum speed. km/h	120
Maximum load. Tonnes	4000
Maximum length. Metres.	1500

Wagon load Freight Traffic

Maximum speed. km/h	120
Maximum load. Tonnes	3200
Maximum length. Metres.	750