Zurich to Thalwil

An Example of Modern Tunneling Technique

Michael Bahr

Swiss Railways have started laying a parallel double-track line between Zurich and Thalwil to relieve the heavy traffic load on the lakeside section of this route. The new line, due to be opened for passenger and goods trains in 2003, will pass for 9.4 kilometres of its total 10,7 length through a tunnel under the Allmend Brunau region. The geological structure through which the tunnel will be driven presents a stiff challenge in which compressed air will play a major role.

The tunnel boring machine that will carry out this task weighs in at 900 tons and will drive a 12.36 metres diameter tunnel through earth, shale and solid rock for which the boring head is equipped with 74 rolling chisels. To pass through the section of water-saturated shale, the machine must be fitted with a so-called hydraulic shield. This involves introducing a special liquid mud called Bentolit into the boring head under pressure to prevent collapse of the cutting face.

Compressed air - of vital importance for shale tunneling

Saturated shale has a tendency to flow like water and if allowed to do so the cutting face would collapse into the boring head. It must be held back by liquid mud at a specific pressure produced by compressed air in a double chamber system. The chamber immediately behind and around the boring head is filled with the mud kept under pressure by air in another chamber to which it is connected. The pressure of the air is carefully regulated at all times and the cutting face is prevented from collapse, allowing tunneling to progress smoothly.

“Compressed air has a prime function with us,” comments engineer and tunnel expert Ernst Hägi.

Tunnel expert Ernst Hägi in conversation with Peter Häni, technical consultant from Kaeser Kompressoren AG, Regensdorf

The Bentonite has another function as it conveys the spoil out of the tunnel to settling tanks where it is separated and pumped back to the cutting face for re-use.

In the section of the boring machine behind the cutting head, steel-reinforced concrete ring sections known as “tubbings” are moved into position and sealed with mortar to form the tunnel lining.

Rear view showing the pre-formed, steel-reinforced tubbings that will form the tunnel lining

Forming a ring of tubbings

The machine drives its way through shale at an average rate of about eight metres a day.

Absolute reliability is demanded of the compressed air generating plant

As nothing moves without it the supply of compressed air is vital and so absolutely reliable generating plant and emergency backup has highest priority. Two KAESER model DSD 241 screw compressors, featuring the energy-efficient 1:1 drive system

Screw compressor packages installed underground to supply the base load

are installed underground to supply the base load. Each can deliver 24 m³ of compressed air per minute at 7.5 bar pressure. In support, is a 20.9 m³ per minute model DSD 201 compressor installed in a transport container positioned above ground. Beside it, a second container carries all the necessary air treatment equipment including refrigeration dryer, combination microfilter and condensate treatment plant, which ensure the specified air quality is maintained.

Diesel-driven backup compressors

To ensure continuity of supply, even in the event of a power failure, four diesel-driven Mobilair 260 compressors are provided above ground. These are the type of rugged machines normally used on construction sites.

Four Kaeser diesel-driven portable compressors of the type Mobilair 260 provide emergency backup. In the background can be seen the two containers (with air receivers) that house the Kaeser DSD 201 peak load compressor, the master controller and the air treatment components.

A Kaeser MVS 8000 master controller sequences and regulates the delivery of the electric-powered DSD compressors to exactly match the demand. In the event of a power failure an emergency generator provides the controller with power so that it can automatically start the diesel-driven backup compressors to maintain air pressure under ground. The generator also powers the air treatment plant and auxiliary systems.

“Air pressure is regulated by a pressure sensor in the cutting heat itself,” explains Ernst Hägi. “If the pressure sinks, indicating a power failure, the sensor sends a signal to the master controller to start the diesel compressors and bring the pressure up again.”

“Kaeser was chosen to supply the compressed air plant,” Ernst continues, “Because we saw them as a most competent business partner, offering the product, the control system and the know-how at the right price. We were even impressed by their team commitment during negotiations.” is his parting shot.

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