

STEP BY STEP THROUGH THE MOUNTAIN



The lining segments in the north tunnel are constructed as a single-skin finish. Source: Harry Schiffer

IN PROGRESS
AUSTRIA/2013-22

Koralm Tunnel, Construction section 3

Text: Sebastian Dietrich

Since November 2013, PORR has been boring through the layers of the Koralpe Massif bedrock, drilling the Koralm Tunnel project into reality.

The contract covers the construction of 2 tunnels with 21km total length. In the south tube, an existing exploratory tunnel has been extended in riverbed/soil advance, while a tunnel boring machine named “KORA” is pushing its way through the north tunnel.

Background

The Koralm Tunnel (KAT), scheduled to open in 2025, will establish a link between two Austrian state capitals: Graz and Klagenfurt. The project can be listed alongside the Brenner Base Tunnel and Vienna Central Station as a key element of the Baltic-Adriatic corridor, which links Danzig in Poland with Ravenna, Italy. The Koralm Tunnel has two tunnel tubes lying 25m to 50m apart and connected by cross passages every 500m. In 2013, Austrian railway company ÖBB Infrastruktur AG awarded the contract for the third and final construction section, KAT3, to PORR Bau GmbH. This major project involves construction of the two tunnel tubes with a total bore length of 21km. With an overall order volume of 297 million euros, KAT3 currently represents PORR’s largest construction site.



FOR THE SOUTH TUNNEL, THE EXISTING EXPLORATORY TUNNEL WAS WIDENED TO THE FULL PROFILE OVER A LENGTH OF MORE THAN 7 KM.

Sebastian Dietrich
Project head, PORR Bau GmbH

Complex, challenging logistics

Right at the beginning of the work, once the full face had been driven through, a dismantling cavern had to be built at the end of the construction section, where the TBM from the neighbouring construction section would be dismantled. A crusher and conveyor system were installed during the advance to tunnel metre (TM) 7,000, in order to be able to

Project data

Employer	ÖBB Infrastruktur AG
Contractor	PORR Bau GmbH
Order type	Baumeisterarbeiten
Project type	Civil engineering/infrastructure, Tunnelling
Project scope	Creation of a 2 tunnels with a total length of 21km
Order volume	297 million euros
Construction start	11/2013
Construction end	08/2022

Three geological zones

From a geological point of view, the construction section can be divided into three distinct zones. For the first 4km or so, the PORR miners bored through sedimentary rock from the Neogene period, alternating between clay, silt and gravel. This was followed by a 400m stretch through the main Lavanttal fault before reaching a crystalline section of fine-grained gneiss, mica schist and marble that extended to the end of the construction section.

Varied advance techniques

Work has been ongoing on both tunnels since November 2013. The team began in the Lavanttal in Carinthia and is boring through the Koralpe Massif towards Styria. The north tunnel is being bored throughout its 10,474m length by the “KORA” tunnel boring machine (TBM). The conventional drilling & blasting and excavating technique was used for the south tunnel. There was an existing exploratory tunnel around 7,000m long here; this has been extended downwards, so that the exploratory tunnel forms the upper two-thirds of the final cross-section, i.e. the tunnel dome. The bottom third, the side walls and tunnel floor, are the result of this widening process. For the remaining 2,700m to reach the edge of the construction section, the full cross-section was bored. The cross passages between the north and south tunnels are being created at 500m intervals via cyclic advance: excavation/drilling & blasting.

complete the drill & blast advance all the way to the boundary of the construction section.

A crusher and conveyor belt system up to the construction section boundary had to be maintained from TM 7,100 up to TM 9,826 and the dismantling cavern, even once the full-face excavation had been completed. This meant that the various machine modifications became very costly and the

cyclic drill & blast and excavation advance was more challenging – after all, normally the tunnel would be driven from the portal to the end of the construction section or breakthrough point in a single pass.

The PORR team was challenged by the ambient conditions, as well as by the complex logistics. The high overburden of up to 1,200m in this section meant that at times the temperature reached 31 degrees. The fresh air supply, provided by an airtight pipe, was therefore supplemented with a cooling system.



The excavated material from the drilling & blasting was processed on-site by a crusher and transported away via a conveyor system. Source: Toni Rappersberger



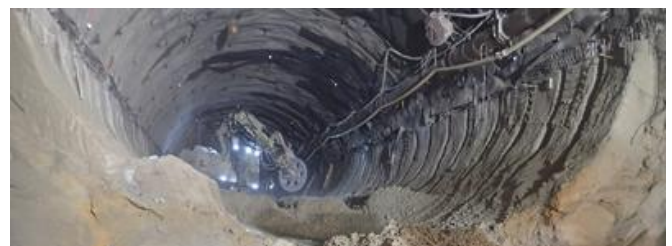
Dismantling cavern in the south tunnel, with a full-face cross-section of 170m², looking towards Klagenfurt in the direction of the rail tunnel advance. Source: Toni Rappersberger

Widening in the crystalline and Neogene zones

In the next section of advance, the existing exploratory tunnel running from TM 4,400 to TM 7,098 was widened, once again using drilling & blasting. The excavated material was then transported out via the crusher and conveyor belt system.

The side wall and tunnel floor advance then continued from the portal to TM 4,400. Due to the challenging geology, preliminary drainage measures were necessary in some sections: boreholes in the existing dome cross-section were extended in advance and placed under a vacuum. In some areas, up to 570,000l was shifted within 24 hours.

In the Neogene zone, a Jetcrete dome invert had been installed along the full length of the exploratory tunnel. This invert was removed using an extra tunnel excavator with a cutting wheel, an innovative solution which represented a significant optimisation for the tunnel boring process, as it meant that cutting could be largely carried out independently of the time-critical path.



The existing dome invert was cut out in advance using a tunnel excavator with a built-in cutting wheel. Source: PORR

The cross passages

The passages linking the two tunnels were constructed in parallel with the cyclic advance through the south tunnel. The lining segments through the Neogene zone were shored up with steel reinforcement. In order to take the forces until the in-situ concrete inner lining had been installed, the upper and lower reinforcement traverses were pre-tensioned using presses over the supports; these were retained until the solid reinforced lining block had reached the required strength. The steel reinforcement was then removed, transported to the next cross passage, and

reassembled.



Before breaking through for the cross sections, the lining segments in the Neogene zone were shored up with steel reinforcement. Source: PORR AG



The tunnel invert and roof were concreted after installation of the membrane seal. Source: PORR

The north tunnel

The north tunnel was mainly bored with the “KORA” tunnel boring machine. The cyclic method was only used for the (568m) approach tunnel and (70m) start tunnel. “KORA” was assembled in the Mitterpichling construction pit; the trailing support was assembled at the west portal and pushed through the approach tunnel.

Once the TBM had been assembled, the advance began from the end of the start tunnel. The Neogene section was bored with the TBM, using earth pressure balance shielding, or EPB. This is a system where the excavated material is broken down and conditioned to act as a plastic support medium. The excavated material is transported with an auger to the subsequent conveyor belt. The team confronted significant obstacles during the advance through the Neogene zone. The greatest delay resulted from extensive maintenance works to the cutting wheel carried out during summer 2016. Successful completion of the first section, the Neogene zone, was marked by the breakthrough to the Paierdorf intersection. Next, in between the Neogene and crystalline zones, the main Lavanttal flow had to be pierced – this covered a length of almost 430m. This section

consisted of fault rock and extremely high strength blocks that affected the performance of the TBM to such an extent that it was decided to use a cyclic advance technique for part of the main Lavanttal flow, with a counter-approach from the south tube: this would save on construction time.

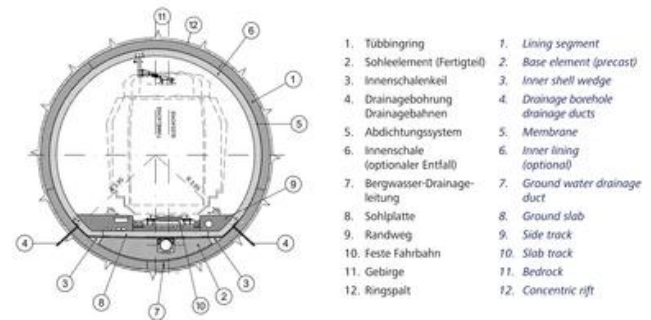


The “KORA” TBM was assembled in the Mitterpichling construction pit. The drill bears the Carinthian state colours. Source: Toni Rappersberger

After the breakthrough, the TBM was converted underground into hard rock mode. The drill head was adapted for the crystalline section and the conveyor system for the excavated material was replaced with a Muckring conveyor and belt removal system. The crystalline zone represents the hardest bedrock in the Koralm Massif. Apart from a few individual fault zones, where strengthening measures were carried out starting from the south tunnel, the advance is currently progressing through hard rock.

Inner lining and finish

Once the advance is complete, work can begin in both tunnels on installing a drainage system, membrane and inner lining. The lining segments in the north tunnel are being constructed as a single-skin finish. An additional inner lining is therefore only being installed in certain sections, such as fault zones. The carcass will be complete after the crack-limited ground slabs, side tracks and shoulders are installed.



A highlight of every tunnel construction project: the breakthrough – here at the Paierdorf intersection. Source: Harry Schiffer



View looking towards the TBM trailing support in the north tunnel with single-shell lining. The logistics are implemented by rail. The supply and removal pipes, the conveyor belt and fresh air pipe have been installed in the tunnels. Source: Harry Schiffer



A highlight of every tunnel construction project: the breakthrough – here at the Paierdorf intersection. Source: Harry Schiffer

Technical data

7,4t

Weight of segment stone

48t

Weight of complete ring

14t

Weight of base element

Machine name	S-857 – „KORA“
Nominal diameter	9.940mm
Shield length	10,760m
Installed power/drive power	7.200kW / 4.200kW
Length of TBM + trailing support	250m
Weight of TBM + trailing support	2.475t
TBM advance length	10.474m
Number of segments	5.500
Segment system	Universal ring, sealed
Segment thickness	35cm
Segment width	1.90m
External ring diameter	9.500mm
Internal ring diameter	8.800mm
Machine type	Multi-mode TBM



THE KORA TUNNEL BORING MACHINE WAS CONVERTED UNDERGROUND FROM EARTH PRESSURE BALANCE SHIELD MODE TO HARD ROCK MODE.

Sebastian Dietrich

Project head, PORR Bau GmbH

Historic milestone

In August 2018, the breakthrough of the south tunnel marked one of the most important milestones for the Koralm centenary project. At that time, there were less than six kilometres to go before the second breakthrough to the north tunnel. KORA will execute the complete breakthrough of the Koralm Tunnel after these remaining kilometres.



The north tunnel is mainly being bored using the “KORA tunnel boring machine”. Source: Harry Schiffer