Semmering Base Tunnel (SBT) - current state of the project

Gerhard Gobiet
ÖBB-Infrastruktur AG, Graz, Austria

Gernot Nipitsch
ÖBB-Infrastruktur AG, Graz, Austria

Oliver Kai Wagner
ÖBB-Infrastruktur AG, Graz, Austria

ABSTRACT: The Semmering Base Tunnel (SBT) is about 27.3 km long and driven from the portal at Gloggnitz and three intermediate construction accesses in Göstritz, Fröschnitzgraben and Grautschenhof. The main components of the tunnel system are two single-track tunnels, cross passages at a maximum distance of 500 m and an emergency station in the middle tunnel section, with two ventilation shafts with a depth of approx. 400 m in case of an incident. For reasons concerning organization, timetable and topography, the tunnel is divided into four construction contracts.

Construction work of the tunnels started in 2014. By autumn 2023 98% of the tunnel excavation is completed. In the landfill site in Longsgraben, where most of the excavated material is deposited, recultivation started.

The presentation highlights the current state of the project, present achievements, and an outlook to further works.

Keywords: Semmering Base Tunnel, general scope, state of project, tunnelling

1 THE SEMMERING BASE TUNNEL - GENERAL SCOPE

History is being written in the Semmering region. The construction of the 27.3 km tunnel in the heart of Austria creates a modern rail link for future generations that also instantly makes rail travel in the south of Austria considerably more appealing. As part of the Baltic-Adriatic Corridor, the Semmering Base Tunnel is also a major section within international rail networks.

Future rail traffic can travel through the mountain at a top speed of 230 km/h after the completion of the tunnel. Freight transport is also much easier and more efficient with the Semmering Base Tunnel, as the steep inclines and narrow curve radii on the historic mountain route are eliminated and long freight trains can also be towed with just one locomotive in the tunnel. However, the historic mountain route will be preserved.

Together with the other upgrades along the new Southern Line between Vienna and Villach, the Semmering Base Tunnel represents an important, sustainable investment for the future. From 2030

onwards, it will be simpler and more appealing to make the switch from cars to railway. In doing so, it will be a useful contribution to climate protection.

1.1 The new Southern Line

The Southern Line between Vienna and Villach is currently the most ambitious construction project of the Austrian Federal Railways (ÖBB). Far-reaching improvements are being implemented for travellers along the entire route. The ambition is also to make this line as competitive as the Western Line between Vienna and Salzburg, which is even now considerably faster than making the trip by car.

For travellers, this means that many destinations can be reached quicker and more conveniently by train in future. As an example, the completion of the Semmering Base Tunnel reduces travel time between Graz and Vienna Main Station by half-an-hour. In specific terms, travel time from Graz to Vienna by train will last about 1h 50.

Around 200 km of railway line is being updated and a further 170 km is being built afresh in total, particularly the 130 km Koralm railway from Graz to Klagenfurt including the Koralm Tunnel. However, the existing railway stations on the line will also be updated to best serve the requirements of modern travellers. Approx. 3.5 million people who live around the Southern Line will find that the railway is more environmentally friendly, more attractive and that it is easier to make the switch from the car.

1.2 The Semmering Base Tunnel is in harmony with the past

Construction of the Semmering Base Tunnel means a new route is being built through the Semmering mountain region that satisfies the requirements of modern rail travel whilst easing the load on the historic Semmering Railway. It was never in doubt that the mountain route would be preserved. The route will still be required for railway operations as well as for tourism, and not just because one of the two tubes must be serviced twice per week for eight hours after the tunnel has been put into service.

This means that the capacity of the mountain route will remain in use. Regardless of these operational necessities, it was clear from the beginning that the Semmering Base Tunnel had to be built and designed in harmony with the Semmering Railway, a UNESCO World Heritage Site. An architectural advisory board was set up with experts who provided support from initial planning to the start of the project and still provides assistance even now.

The necessary renovations at Mürzzuschlag railway station were given particular emphasis. As the western portal of the Semmering Base Tunnel emerges from the mountain near the railway station, large parts of the railway systems had to be restructured. The listed railway building was renovated, and many areas are now much closer to the original historic designs than before starting renovations in 2019.

When designing the northern areas of the railway station, particular attention is paid to ensuring that all new parts are in harmony with the entire railway station and the whole Semmering route. Amongst other things, the Park&Ride facility was rebuilt and extended, and a new maintenance support point was set up. The symbiotic link between historic and modern parts of the building thus have always remained in focus of all considerations in how to ideally combine old and new.

2 PROJECT HISTORY

2.1 Extensive preliminary investigations

Comprehensive geological and hydrogeological preliminary surveys had to be carried out years before starting construction to excavate a tunnel system of this length. Around 280 core drillings with a total boring length of around 41 kilometres were made in the Semmering area. As a result,

setting out an ideal alignment of the tunnel has been successful. Construction started after completion of the extensive testing and approval procedures (Vanek & Fasching 2013, Wagner et al 2015).

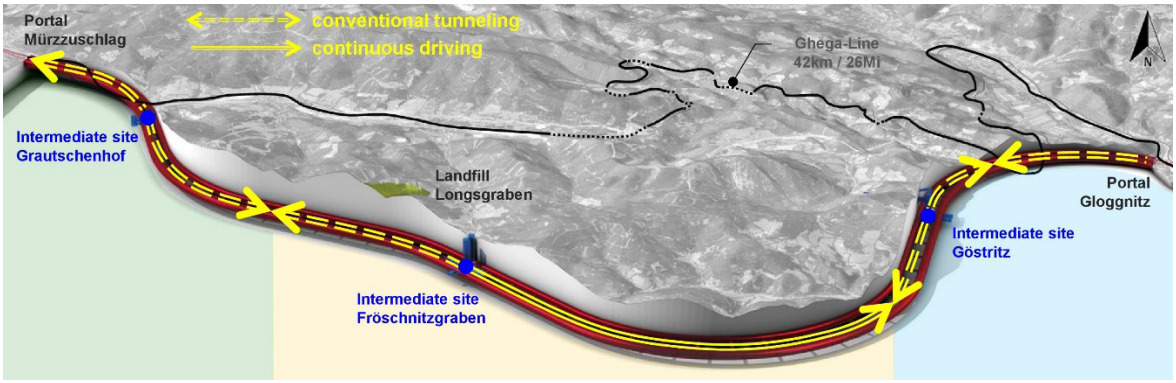

Figure 1. Semmering Base Tunnel - Project overview (ÖBB/3D-Schmiede).

It was decided to work on several construction sites due to the immense length of the tunnel. Alongside the portal locations in Mürzzuschlag and Gloggnitz, three further intermediate construction accesses were set up in three additional sites at Göstritz, Fröschnitzgraben and Grautschenhof (Gobiet & Wagner 2013). Shafts up to 400 m deep were dug into the mountain to build the tunnel within its depths. This means a total of 14 drives took place at the same time, starting in 4 locations (see Figure 1). Two of the tunnel drives in Fröschnitzgraben are excavated with tunnel boring machines. All other tunnel sections are excavated following the principals of the NATM (drill and blast).

2.2 2023: around 98% of tunnels completed

After construction started on the overall project in 2012 (tunnelling in 2014, Gobiet et al. 2017, Wagner et al. 2017), the first drive was completed in the Fröschnitzgraben section in February 2021. The first breakthrough between two tunnels drives happened in June 2022 between Göstritz and Fröschnitzgraben. By autumn 2023, 10 of the 14 drives have already been completed. In these sections inner lining is work in progress (see Figure 2 and 3).

Figure 2. End of continuous driving and associated inner lining. (ÖBB/Wagner/Ebner).

Figure 3. Concrete work for inner lining in emergency station. (ÖBB/Ebner).

Due to all in all expected heterogenous geological and geotechnical conditions some circumstances led to substantial delays and cost increase during driving works. West of Grautschenhof unexpected weak ground conditions required a modification of the excavation concept (almost circular profile, increased support, exceed existing profiles, see Figure 4).

Figure 4. Temporary backup for lining and modified excavation concept. (ÖBB/Wagner/Ebner).

Between Fröschnitzgraben and Grautschenhof an aggregation of rock containing sulphate called for a massive reinforced inner lining to be all set for potential swelling behaviour up to 2,0 MPa.

And finally, the already predicted fault zones east of Göstritz posed the major challenge for the project (see chapter 3.1).

2.3 Building in harmony with nature

A major project such as the Semmering Base Tunnel also heralds changes for the region in which it is built. Extensive notification conditions and verification of construction by external experts ensure that the impact on nature and the environment during the construction phase is reduced to a minimum, unavoidable level. In the case of the Semmering Base Tunnel, a landfill site was established in Longsgraben next to the construction site in Fröschnitzgraben, which was filled with around 4.25 million cubic metres of material excavated from the tunnel (which is roughly twice the volume of the Great Pyramid of Giza). Instead of using lorries, most of this huge quantity of material was directly transported on conveyor belts to the landfill site from the Fröschnitzgraben section. Reforestation of the whole landfill site has already started (see Figure 5). A mixed forest is planted that is adapted to the challenges posed by climate change.

Figure 5. Landfill site Fröschnitzgraben. (ÖBB/Ebner).

3 PROJECT PROSPECTS

3.1 Last kilometre of excavation

Preliminary geological investigations made clear that the area south-west of Gloggnitz around the so-called Northern Grasberg Boundary Fault and the Schlagl Fault Zone provided demanding conditions for tunnelling (Wagner et al. 2015). This analysis before starting excavation has proven to be accurate. Extensive special measures must be carried out in this area to make safe tunnelling possible. On the one hand, cement and chemical injections are necessary to stabilize the rock and reduce the water inflow, at which point it becomes possible to build the tunnel via excavation and blasting. On the other hand, weak ground conditions and an overburden of up to 500 m demand for a pilot tunnel and massive use of lining stress controllers (see Figure 6).

Figure 6. Injections in Grasberg and pilot tunnel and lining stress controllers in Schlagl. (ÖBB/Ebner).

The final meters of tunnel will be excavated in about 1 ½ years. Afterwards, the concrete lining in the tunnel can be completed before the technical tunnel equipment can be installed as the final step before being put into service in 2029/30.

3.2 Tunnel equipment - the last construction phase

A modern tunnel has a large range of installations that are necessary for digitalised and internationally networked railway operations. Signalling, radio, illuminated handrail and telecommunication systems must therefore be installed in the tunnel.

Innovative systems (conductor rail) instead of the traditional catenary systema are used to provide the traction unit with electricity. Specially designed reinforced concrete slab elements are used in the tunnel. These slabs are particularly durable and stable - known as a “slab track”. To reduce vibration and sound transmissions, sections that are relatively close to the surface and residential areas have a light mass-spring system.

The tender documents for the first tunnel equipment contract were published in June 2023.

3.3 Safety in railway operations

Due to safety standards, long tunnels in Austria are now only built with two independent tubes and cross passages every 500m. In case of emergency these cross passages lead to the safe area. An emergency stop is also located approximately in the middle of the Semmering Base Tunnel if a train must be stopped inside the tunnel in the event of an incident.

Evacuation then readily takes place in the other tube and travellers are taken away by rescue trains. As it is the case on all main railway routes, the European Train Control System (ETCS) is used in the Semmering Base Tunnel. Amongst other things, it controls the speed and travel direction of trains via a continual radio network. If the speed limit is exceeded, the system can automatically slow the train down and bring it to a stop before a danger point.

4 SEMMERING BASE TUNNEL INFO HUB

Info boxes and info towers at the most important points near the Semmering Base Tunnel construction sites allows spectators public access. The accessible info box at the tunnel portal Gloggnitz provides a full overview of the entire Semmering Base Tunnel project. From planning to construction, you can follow all measures that were taken to professionally prepare this project and ensure its sustainability. The info box and info tower in Mürzzuschlag near the second tunnel portal provide, above all, insight into those parts of the project focusing on the railway station and the western portal in Mürzzuschlag. The three info towers in Göstritz, Fröschnitzgraben and Grautschenhof are accessible whilst also providing a direct view of the 3 construction areas.

REFERENCES

Gobiet, G., Wagner, O.K. 2013. The New Semmering Base Tunnel – Project overview. Geomechanics and Tunnelling 6 (5), pp. 551–558. Ernst & Sohn: Berlin.

Vanek, R., Fasching, A. 2013. Geological and geotechnical ground investigation for new Semmering Base Tunnel in Austria. Tunnel 22 (2), pp. 18–24.

Wagner, O.K., Haas, D., Druckfeuchter, H., Schachinger, T. 2015. The challenges of contract SBT1.1 „Tunnel Gloggnitz“. Geomechanics and Tunnelling 8 (6), pp. 554–567. Ernst & Sohn: Berlin.

Wagner, O.K., Fasching, A., Stadlmann, T., Vanek, R. 2017. Semmering Base Tunnel – Ground characterisation for tendering and construction. Geomechanics and Tunnelling 10 (5), pp. 574–583. Ernst & Sohn: Berlin.

Gobiet, G., Nipitsch, G., Wagner, O.K. 2017. The Semmering Base Tunnel – Special challenges in construction. Geomechanics and Tunnelling 10 (3): pp. 291–297. Ernst & Sohn: Berlin.