Abstract

The construction of the more than 27 km twin tube Semmering Base Tunnel requires a sophisticated logistics concept in order to enable optimum conditions for material supply and disposal. Intermediate access points for the three underground construction lots include various shafts with a maximum depth of 420 m and an access tunnel of 1.2 km length. Site installation areas are foreseen at the surface as well as underground located in large temporary or permanent caverns enabling flawless transport and storage solutions. Excavation material transports to the landfill site will be carried out by conveyer belts or via newly built, temporary construction roads.

Keywords: Railway tunnel, twin tube, shafts and caverns, site installation, construction logistics

1 INTRODUCTION

The more than 27 km long Semmering Base Tunnel represents one of the major structures of the Austrian section of the Baltic-Adriatic Railway Corridor connecting the Baltic Sea (Gdansk in Poland) and the Adriatic Sea (Bologna in Italy). The new tunnel system is located 80 km south of the Austrian capital Vienna, connecting the towns of Gloggnitz in the federal state of Lower Austria and Mürzzuschlag in Styria (see Fig. 1.).

The new tunnel system will replace the existing Semmering-Railway line, which is a designated world heritage site due to its engineering excellence when it was built in the mid-19th century. The major benefits of the project are a reduction in travel time for passenger and cargo trains as well as an improvement of the travel quality for passenger crossing the mountainous area. The existing railway line with steep gradients and small radii along numerous tunnels and viaducts does not fulfil the requirements of the Austrian Federal Railways expected in modern rail traffic.

The total investment costs for the project are around 3.3 bi. Euros, with 1.5 bi. Euros related to the civil construction works. Pre-construction works started in 2011, underground excavation works shall be finished by 2022. The installation of the secondary lining, track works, electrical installations and signalling lead to a completion date and start for the final operation in 2026.
The final tunnel system consists of two parallel running single track tubes connected by 56 emergency cross passages. In the centre of the tunnel alignment an emergency station with various caverns and two more than 420 m deep ventilation shafts is located. Due to logistic reasons four additional temporary shafts including cavern systems and a temporary access tunnel are foreseen to approach the main tunnel level.

The excavation works for the underground structures are carried out by means of NATM for a total length of 19 km in the northern and southern parts of the tunnels. At the peak of the excavation works a total of up to 12 NATM headings at various locations in all three construction lots in the main tunnel tubes will be running at the same time. Due to the geological conditions for about 8 km in the central section of the main tunnel tubes, TBM method is applied additionally.

Due to the envisaged completion date and for logistical reasons the main underground works for the tunnels, shafts and caverns of the project are divided into three separate construction lots designated as SBT 1.1, SBT 2.1 and SBT 3.1 (see Fig. 2.).
2 CONSTRUCTION LOGISTICS

2.1 SURFACE SITE INSTALLATIONS

For all three underground construction lots five surface site installation areas are planned in total.

The main site installation area for construction lot SBT 1.1 is located at the Eastern portal of the main tunnel tubes in Gloggnitz. An additional installation area about 15 km away is located at the portal of the intermediate access tunnel in Göstritz. The site installation area in Gloggnitz is divided by the river Schwarza. Therefore, the construction of the permanent rail bridge crossing was already carried out in advance by a preceding contract to enable the use for construction purposes in the current civil works contract (see Fig. 3.). Although access to the road system is easily given by the local main road situated next to the installation area the material supply and disposal is mainly carried out by rail. Thus, the traffic impact on the surrounding neighbourhood is minimized. The transport of the excavated material from the tunnel to the train loading installations is done by conveyor belt, as the existing railway line is located adjacent to the site installation area.

At the temporary access tunnel in Göstritz all transports to and from the site installation area including mucking for four excavation headings have to be carried out by trucks. This leads to a considerable amount of daily truck traffic, which required the construction of a temporary 2.5 km long construction road bypassing the nearby residential areas. The construction road connects the site installation area to a major motorway close by.

The site installation area for the centrally located construction lot SBT 2.1 is situated on both sides along a brook and a local road in a small valley requiring the construction of temporary bridges for pipes, cables and conveyor belts. To provide sufficient space for the construction of the two ventilation shafts as well as for material handling and storage intense slope support measures including anchored bored pile walls, soil nailing and bored piles acting as dowels were carried out. In addition a 15 m high reinforced earth dam was built to increase the size of the horizontal storage and handling area (see Fig. 4.). At the shaft head level sufficient space has to be provided to allow for the material storage of four excavation headings at the same time, including two TBM drives. Especially the storage area for precast concrete segments has to allow for weekends or public holidays when truck traffic is restricted.
The hoisting installations for the 420 m deep shafts include a skip system for mucking and cages for material, equipment and passenger transports. The mucking material is put on conveyor belts for the subsequent transport to the main deposit area, which requires also a crossing of the local road (see Fig. 5.).

In the western construction lot SBT 3.1 the site installation areas are also divided into two separate parts due to the limited space available at the position of the two 120 m deep temporary shafts. The shafts will be equipped with a portal crane, transport and personnel cages. The main installations such as shotcrete and water treatment plant, workshops and storage areas are placed around the shafts. A main gas pipeline crossing the installation area is protected by concrete slabs, which are used as drive way within the site installation area. The second installation area is located approximately 1 km from the shafts and connected by a conveyor belt, which is running parallel to the main local road. All excavated material will be loaded via the shafts by vertical pocket lifts onto conveyor belts and subsequently transported to the second installation area (see Fig. 6.). There all material handling and loading onto trucks is carried out, as truck transports from the main installation area around the shafts are limited in number.
2.2 UNDERGROUND SITE INSTALLATIONS

In addition to the access via the main portal in the eastern construction lot all three underground construction lots provide access to the tunnel level by shafts with depths between 120 m and 420 m. In order to minimize the effect of such transport bottlenecks for the supply and discharge of materials as well as the time consuming entry for personnel sufficient space for site installations has to be provided underground at the shaft bottoms.

In construction lot SBT 1.1, where the shafts are built underground at the end of a 1.2 km long access tunnel, area for site installations has to be provided at the top as well as at the toe of the shafts. Apart from material handling purposes the shaft head caverns are foreseen to house the hoisting and transport installations for the supply and discharge for four excavation headings via the two shafts (see Fig. 7.).
At the toe of the two shafts two approximately 200 m long caverns are located perpendicular to the main tunnel tubes. Site installations for ventilation and electrical supply, pumping chambers, workshops, filling station as well as crew containers and safety installations are placed in these two caverns. The caverns are also connected by additional cross connections running parallel to the main tunnel alignment, which shall enable flawless transport solutions (see Fig. 8.).

Fig. 8: Lot SBT 1.1 – Site installation in caverns at tunnel level (tender design)

In the central construction lot SBT 2.1 at the bottom of the 420 m deep shafts the underground emergency station will be situated. It consists of various caverns, cross connections, passages and adits. In the final configuration these structures provide space for emergency and first aid facilities, ventilation purposes and technical installations. During construction these structures provide space for offices and staff rooms, sanitary installations, warehouses, workshops, a filling station, a concrete laboratory, an explosives magazine, and rescue facilities for all staff underground. In addition, to avoid the shortage of construction materials, depots for cement and concrete aggregates, pea gravel for the annular gap filling or storage areas for various support materials are foreseen. The assembly of the two TBM’s for the northern drives of the main tunnels also takes place in the caverns. Mucking underground will be carried out by conveyor belts (see Fig. 9.).

Fig. 9: Lot SBT 2.1 – Example for conveyor belt arrangement at tunnel level (tender design)

Fig. 10 shows the intersection of the two main caverns in the emergency station during construction.
In the eastern construction lot the temporary main logistics cavern is located perpendicular to the running tunnels at the bottom of the access shafts. In order to optimize the underground transport routes during construction two additional cross connections are provided on both sides of the main cavern.

### 2.3 MATERIAL DISPOSAL AREA

In total a volume of approximately 4.25 Mio. m³ of excavated material will be deposited in the landfill site Longsgraben (see Fig. 11.). Material from all three underground construction lots will be transported to the landfill site, which is situated in a valley about 2.5 km from the site installation area of construction lot SBT 2.1.

For the material transport from the site installation area of construction lot SBT 2.1 to the landfill site a 2.3 km long conveyor belt was constructed. The conveyor belt reaches a height above sea level of about 1.200 m overcoming a total height of 240 m to reach the dropping location.
The excavation material from the eastern and western construction lots SBT 1.1 and SBT 3.1 will be transported by trucks via a newly built access road between the local valley road and the landfill site. Maintenance of this road has to provide such conditions that a permanent, year round, access is guaranteed. Especially in winter times with considerable snowfall height this requires a permanent presence of the maintenance crews. In order to minimize the impact onto the surrounding villages and towns the driving directions from the respective site installation areas to the access road are restricted and specified in detail by the client. A newly built bypass road connecting the adjacent motorway and the local valley road is used to avoid truck traffic in the residential areas. For the access to and from the motorway specially designated temporary entry and exit slip roads were built, which usage is for construction purposes only.

3 CONCLUSIONS

Semmering Base Tunnel with three underground construction lots and a total of five points of attack requires a sophisticated and detailed logistic concept on the surface and underground in order to meet the foreseen time schedule as well as to minimize the impact onto the surrounding neighbourhoods.

Access via deep shafts creates bottlenecks, which could result in reduced advance rates and time delays. Therefore, already during the tender design possible placements of site installations on the surface as well as underground were considered to provide sufficient space during construction. The size of numerous permanent and temporary underground structures such as caverns, passages, galleries and adits was designed under consideration of the space requirements for the various installation structures, material storage and handling areas.

REFERENCES


