

***BEITRAGSREIHE
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***ROSENSTEINTUNNEL
STUTT GART***



*Rosenstein-Tunnel Stuttgart: A new road tunnel project under challenging urban conditions
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Rosenstein-Tunnel Stuttgart: A new road tunnel project under challenging urban conditions

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ABSTRACT: In Stuttgart, the Rosenstein-Tunnel is currently under construction in combination with the third Leuze-Tunnel, which is also under work. This will improve the traffic conditions in the highly populated city areas, located north of downtown Stuttgart.

The owner, the City of Stuttgart, had to face challenging conditions when setting up the project. This includes the impact of urban environment at both tunnel portals and within the open cut sections. Intensive actions were required concerning cable and pipe routing and various traffic phases with local detours, which have to manage the traffic and to enable the construction works at the same time.

The ground conditions with the presence of mineral water have a major impact on the tunnel construction works. As the project is partly located in an area, in which dewatering of groundwater is not allowed, restrictions of the tunneling sequence and the provision of injections became necessary.

1 INTRODUCTION TO THE PROJECT

Stuttgart, as the capitol of the south German federal state of Baden-Württemberg, has an important meaning for economy and politics and has become one of the most prospering zones in southern Germany. The improvement of the traffic infrastructures for the major federal roads as well as for the German railway is the dominating actual topic in Stuttgart and this will continue at least for the next 5 years.

At the south bank of the river Neckar in the district of Bad Cannstatt, the junction of the two federal main roads B 10 and B 14 shall be released by a new third tunnel near the thermal bath Leuze.

Following the river downstream, the B 10 circumnavigates the Wilhelma zoo by a road “knee”. This edge will be shortened by the new Rosenstein-Tunnel with a length of totally 1.3 km, from which approx. 750 m are realized by underground excavation of two separate tunnel tubes, which are connected by four cross-cuts. Additionally, in the center of the tunnel length there is a section with an extended cross-section for emergency stops, which is a major safety issue of the tunnel. Figure 1 displays the general project layout for the Rosenstein-Tunnel.

The major urban challenges in this project area can be introduced such as follows:

- Maintenance of the road traffic and the commuter railway system, about 60,000 cars per day must be able to pass the construction site
- Maintenance of the supply of water, electricity, lighting, gas, long-distance heating and waste water by redirecting the lines and pipes prior to the construction works
- Management of the interfaces during the construction period with construction works for the major project “Stuttgart 21” of the German railways
- A special focus in this area is the ground water situation. As the ground water consists of thermal water, which feeds the thermal baths Leuze and Berg, restrictive conditions were defined by environmental authorities relating to construction works, which will come in contact with these thermal ground water tables.
- Another special topic in German cities generally is still the possibility of running across warfare material such as bombs and ammunition from the last world war.

Extensive measures had to be carried out, before the working panels for the different sites could be handed over to the construction companies.

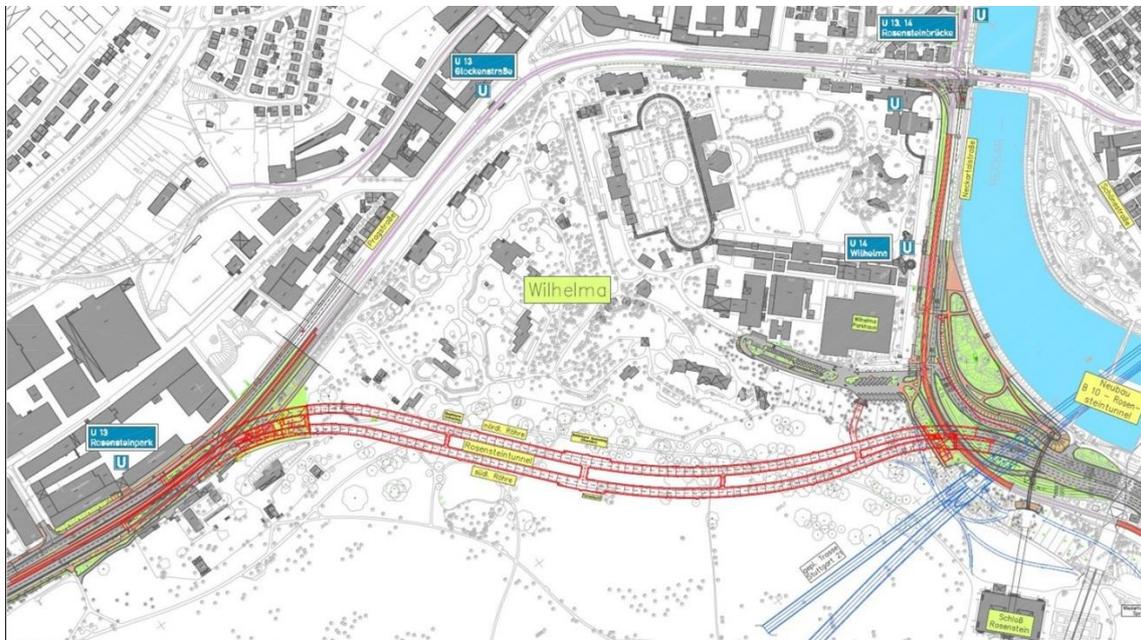


Figure 1. Overview to the project layout of the Rosenstein-Tunnel near the river Neckar in the district of Bad Cannstatt.

Figure 1 shows the alignment of the new B 10 tunnel, at the right margin in blue colour the new railway bridge crossing the river Neckar for the Stuttgart 21 project is displayed. In the area of the two future tunnel portals, the installation areas for the construction companies are located. Both portal zones, in Neckartalstraße and in Pragstraße, will be carried out as cut and cover constructions. Therefore partly deep construction pits are necessary, which require extensive deviations of traffic routes (road and rail).

Figure 2 displays the standard cross-section of one road tunnel tube and the construction elements of the tunnel. The clear diameter of the tunnel tubes will reach more than 10 m. The maximum overburden above the tunnels will reach approx. 23 m.

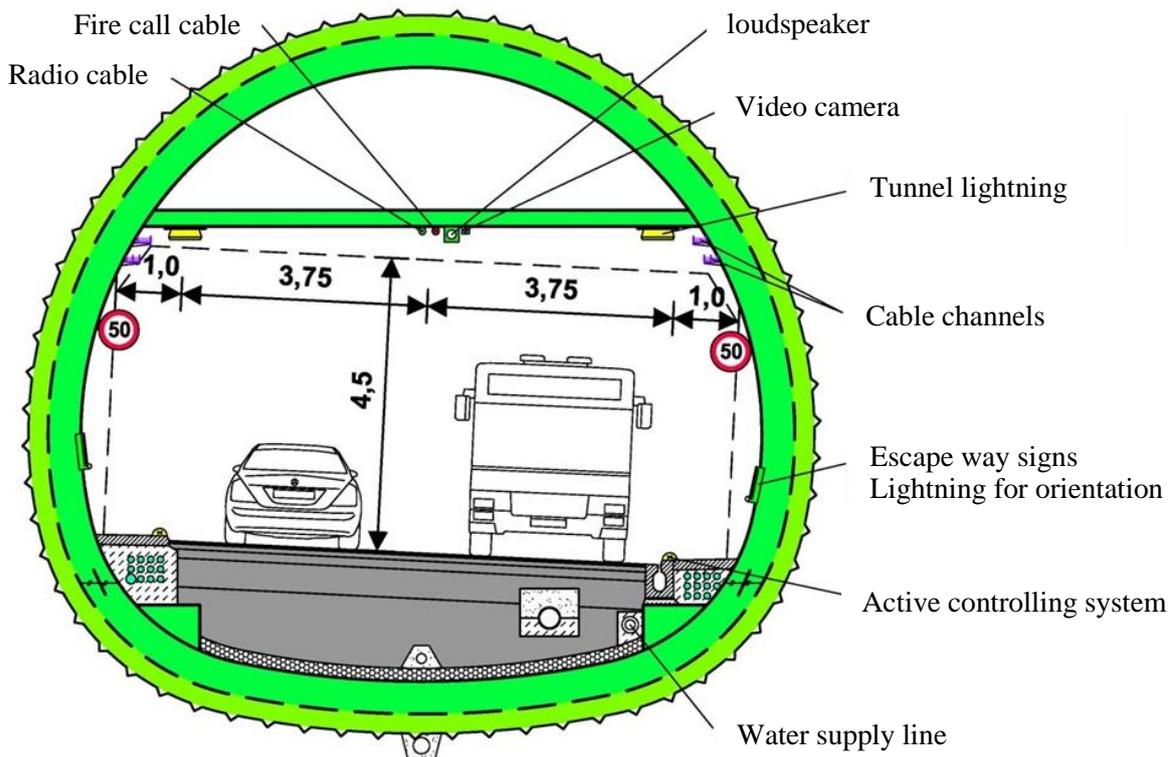


Figure 2. Standard cross-section of the Rosenstein road tunnel.

2 GEOLOGY

Figure 3 shows a longitudinal section along the south tube. The geological situation in the area of the Rosenstein-Tunnel can be described as follows:

Under the surface quaternary soils/fill with predominantly cohesive character have to be expected followed by several layers of the gypsum Keuper, which is a typical geological formation within the city of Stuttgart. In the project area the gypsum Keuper consists predominantly of silt stone in a leached status. It can be described as weak to very weak rock.

Within the gypsum Keuper the Bochsinger horizon and the Bleiglanzbank-layer are known as groundwater bearing aquifers, while the layers of middle gypsum, dark red marl and gypsum base layer are less permeable. On more than 50% of the tunnel length the tunnel excavation will be below the groundwater level within the Bochsinger horizon.

The mineral water aquifer is the karstic Upper Muschelkalk, which is situated below the gypsum Keuper and was not reached with the exploratory borings in this project. The pressure level of the mineral water aquifer reaches several meters above ground surface (confined groundwater conditions).

Both tunnel tubes and the access tunnel are situated within the inner zone of the groundwater protection zone of Stuttgart. The conditions determined by the environmental authorities of the City of Stuttgart do not allow to install dewatering or drainage systems in this area.

The following measures are planned to handle these restrictions:

- Pre-grouting of the area which are potentially groundwater-bearing.
- Installation of wells to monitor the groundwater-conditions and the efficiency of the pre-grouting.
- Tunnel support using a low permeable shotcrete lining and rapid ring closure.

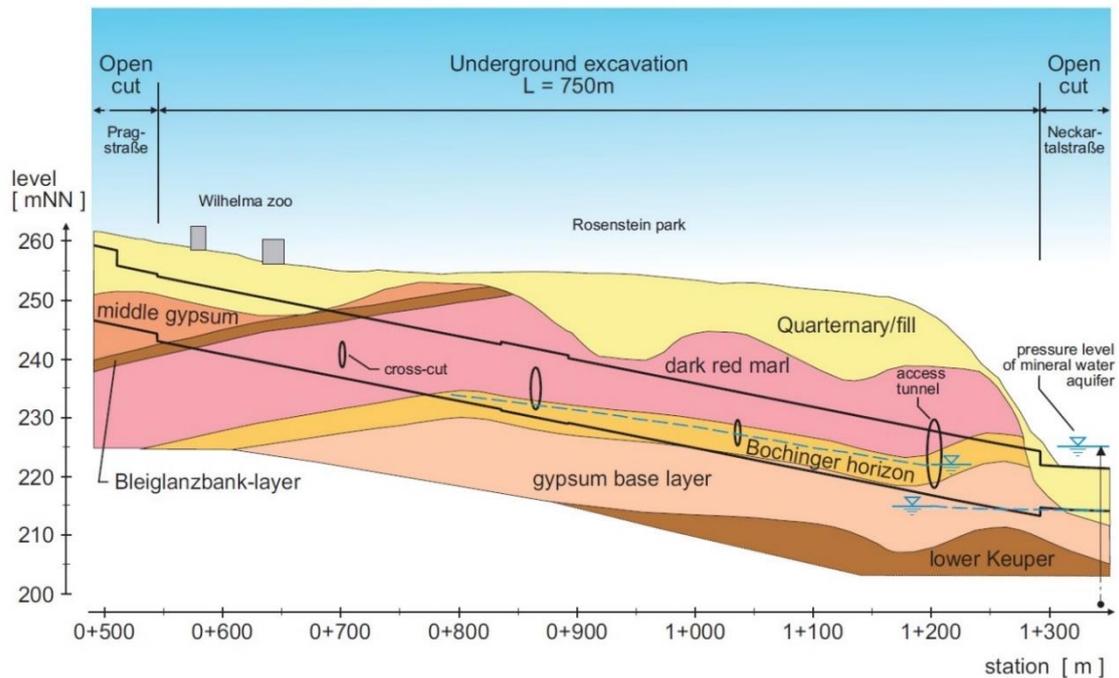


Figure 3. Longitudinal geological section along the axis of the south tube.

3 STATE OF WORKS

The construction works for the Rosenstein-Tunnel started in March 2014. When the site facilities were installed, cable and pipe redirecting works had been performed first. Then the open cut tunnel section at the western end of the Rosenstein-Tunnel in Pragstraße was started including the up to 17 m deep construction pit for the cut-and-cover tunnel portal.

Actually, the excavation works for the access tunnel have been started in the beginning of March 2015. In tunnel sections with low overburden, tunnel excavation will be carried out under the protection of a pipe umbrella (see Figure 4).

It is expected to reach the sensitive water-bearing rock horizons in summer 2015. Then excavation works have to be interrupted, until extensive grouting measures are carried out to provide intrusion of mineral water into the tunneling zone.

The examination works for searching warfare materials are almost finished. No significant findings had to be noticed up to now.

In autumn 2015 the start of the construction works for the railway project Stuttgart 21 in the vicinity of the Rosenstein-Tunnel site is expected. This will have further impact on the site organization in the working panel in Neckartalstraße, where then two huge projects have to share the rare installation space.

4 SITE IMPRESSIONS

In the following, significant stages of the construction works are shown exemplarily. Figure 4 gives an impression about the use of pipe umbrellas in areas of low overburden. Tunneling works have been started at the access tunnel (Figure 5), while the up to 17 m deep construction pit for the cut-and-cover tunnel portal is under construction in the Pragstraße area (Figure 6).

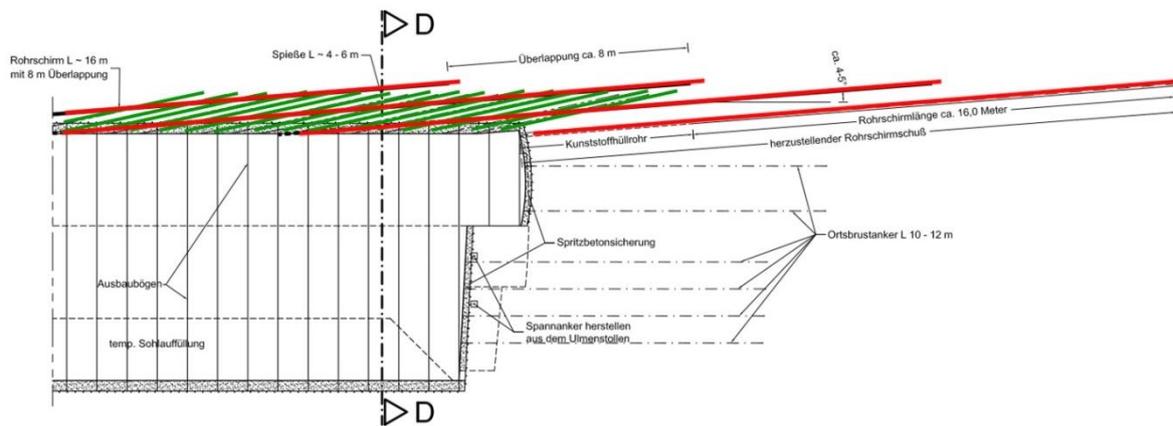


Figure 4. Principle of the excavation method by drilling pipe umbrellas in the roof in tunnel sections with low overburden.



Figure 5. Start of excavation works for access tunnel.

5 SUMMARIZING OUTVIEW

A brief project introduction could be given. The construction works for the Rosenstein-Tunnel have entered now a decisive phase with the start of the underground excavation works for the two tunnel tubes. All involved parties are looking forward to a successful continuation of all construction works on the Rosenstein-Tunnel project. The 3D-visualization in Figure 7 gives an idea about the expected final state of the project.



Figure 6. Deep construction pit at portal zone Pragstraße.

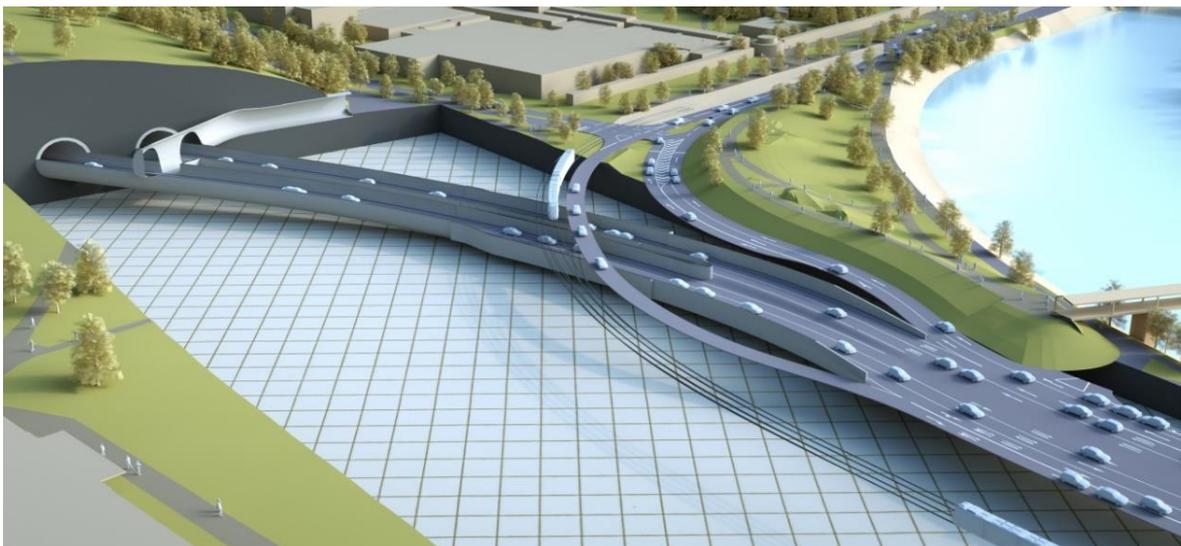


Figure 7. 3D-visualization of the new traffic situation at the southern tunnel portal in Neckartalstraße.

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