The MRO-Tunnel in Munich, Germany

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Summary

The construction of the MRO-Tunnel in Munich represents an important infrastructural measure in the eastern part of the state capital of Munich for traffic flow improvement, protection from noise and exhaust pollution as well as for urban development. The main aspects of this paper are the design and the analysis of the MRO-Tunnel. The applied bored pile wall-cover construction method, a top-down method, is of substantial importance to maintain traffic flow and to extensively reduce impairment to adjacent buildings during the construction period.

Keywords: Tunnel; top-down construction method; noise and exhaust protection; tunnel interchange structure.

1. Introduction

Downtown Munich is surrounded by a highly frequented expressway ring road, the so called "Mittlerer Ring", which caters to most of the daily commuters and transit traffic.

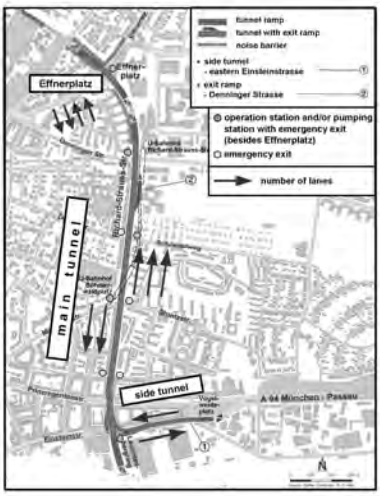

Fig. 1: Overview MRO-Tunnel

This ring road, which has a total length of 30 km, has a traffic volume up to 150,000 cars per day and may therefore be considered to be one of the most frequented highways in Europe.
Massive traffic jams developing especially at the major intersections, strong exhaust pollution and excessive noise emissions may be considered the main problems affecting the urban districts in the close neighbourhood.
To rectify the above mentioned problems three additional tunnels were required and were planned along the ring road.
The eastern one of these tunnels, the so called MRO-Tunnel, has a total length of 2000 m. It is now in construction using the top-down method and will be finished in 2009. The design is governed by high-traffic volumes at the interchanges at Effnerplatz and Denninger Strasse, the crossing of the U4 subway line at Böhmerwaldplatz and the connection to the A 94 motorway at Einsteinstrasse. The necessary road links there require a complicated, grade-separated interchange executed as a tunnel structure with two levels.

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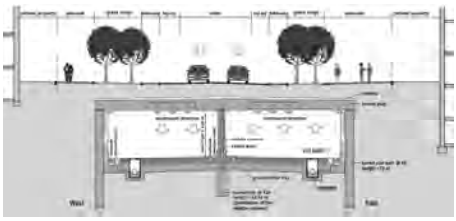
2. Design Concept

Figure 2 shows the standard section of the main tunnel structure.



Traffic flow requirements imposed 2 lanes in the southbound and 3 lanes in the northbound direction. The tunnel section has a clear height of 4.80 m and depending on the number of lanes a clear width of 6.00 m to 11.75 m respectively. In the areas of on- or off-ramps, the tunnel section is widened to accommodate additional lanes.
The construction of the tunnel is executed in its entirety using the bored pile wall-cover method.

Fig. 2: Standard Tunnel Cross Section

A double-bay reinforced concrete frame forms the main structural element of the tunnel. The tunnel ceiling consists of a 1.00 to 1.20 m thick reinforced concrete slab with a pitched profile. Overlapping bored piles with a 88 cm diameter and on-center spacing of 76 cm make up the exterior walls. Basement tanks with 70 cm thick base plates are only used in those tunnel areas where road crust is within ground water levels. During construction, the tunnel ceiling is carried by a middle row of steel piers embedded in bored piles of 120 cm diameter as footings. These are later encased in a 64 cm reinforced concrete median wall.

3. Tunnel Interchange at Einsteinstrasse

The traffic streams at the interchange of Einsteinstrasse with Richard-Strauss-Strasse / Leuchtenbergring require an underground interchange structure. Traffic coming off the A 94 can flow into the tunnel directly, while the southbound tunnel traffic requires a left turn to connect to the motorway A 94. In order to create a grade-separated interchange, a tunnel ramp needs to cross below the main tunnel to join a secondary tunnel leading towards the motorway.

Part of the interchange structure – besides the various tunnel tubes – are an operating and pumping station as well as groundwater conduits and a temporary exhaust channel.

This results in a geometrically very complex multifunctional structure which requires highly charged load transfer elements.

Allowable tunnel wall deflections are limited to 5 mm in the horizontal direction to ensure the safety of surrounding buildings.
This required special care in making the design and its foundations sufficiently stiff which was achieved using a three-dimensional finite element analysis model.

Fig. 3: Tunnel Interchange Structure

4. Conclusion and Vision

The MRO-Tunnel is likely to open in 2009 after a construction phase lasting 6 years.

Overall more than 7,200 piles, 250,000 m^3 of excavations, 182,000 m^3 of concrete and 25,000 tons of reinforcing steel will have been necessary to complete it. A crowning achievement will be the reconfiguration of the square at Effnerplatz. An artwork entitled "Mae West" by American artist Rita McBride is scheduled to become its centerpiece.