

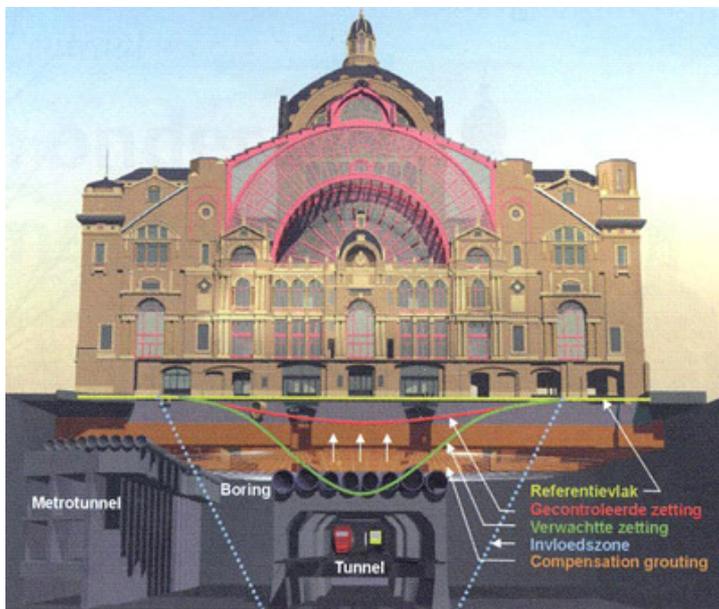


Client: NMBS
Main Contractor: TV ACS Tunnel
Execution: 2000
Machine: CBC
Pipes: reinforced concrete pipes
ID-OD: 2.500 - 2960 mm and 2.000 - 2.370 mm
Length: 8 x 80 m

The under-tunnelling of the terminus station (Central Station Antwerp) is one of the critical phases in the development of the high-speed train link under Antwerp town centre. With a length of 80 metres, the undertunnelling of the terminus station is the shortest part of the North-South railway link. Despite the short length, different construction techniques are being applied and risks are not insignificant, not the least because of the proximity of the historical terminus station. In the preliminary design phase, three different construction methods were assessed. In the end, it was decided to construct a horizontal tubular roof and to use compensation grouting. Under the protection of this shield, the final station was built completely underground. Finally, following techniques were applied : lowering of the groundwater level to app. 26 metres, compensation grouting linked to a fully automated measuring system, pipe jackings Ø2000 and Ø2500 under the terminus station, building of supported trenches starting from the outermost jacking pipes and excavation and concreting of the roof structure with specially designed movable formwork.



concrete pipes. The design of the special jacking pipes takes into account the considerable upper load of the monumental terminus station and the loads, caused by the overlying compensation grouting. In order to meet the strict quality and planning requirements, Smet-Tunnelling has used two TBM's. Both TBM's are app. 7.00 metres long and weigh respectively 64 tons (Ø2500) and 57 tons (Ø2000). In the jacking shaft and aboveground, there is a universal control unit, removable jacking frame, desanding plant for treatment of the excavated sands and a gantry crane for the manipulation of the jacking pipes.



Pipe jackings

Starting from a jacking shaft on the Astridplein, eight pipe jackings have been executed, each with a length of 80 metres. The jacking pipes with an internal diameter of 2500 mm consist partly of armed concrete and partly of a steel construction; starting from these jacking pipes, the supported trenches – the final walls of the station – are being executed. The four middlemost jackings have an internal diameter of 2000 mm, and are armoured





Settlement tolerances and results

To reduce the settlement caused by the pipe jacking to a minimum, different measures are imposed. I.e. the execution period has to be held as short as possible, and all jackings are executed in continuous regime (day and night) until the primary injection of the ring space has ended. Later, a second (contact) injection, starting from the jacking pipes, was executed. Though the groundwater level was lowered drastically, a full-face-TBM was opted for: the soil release with such a TBM type is considerably smaller than with an openshield pipe jacking. Furthermore, the oversize of the TBM compared to the jacking pipes is limited to maximum 0.5% of the diameter. Finally, detailed planning and follow-up of the works has to see to it that the supported trenches and the pipe jacking are concreted before a neighbouring pipe jacking is executed. Thanks to these measures, the settlement before the compensation grouting has been restricted to maximum 2 mm; after each jacking, the settlement is fully compensated within 5 working days after ending the jacking.

Conclusion: a fully-fledged alternative

In addition to the important impact of the historical building on the execution method, numerous environmental factors have influenced the activities. The available space on the Astridplein forced the contractor to stack the drilling equipment on top of one another, and to build an adapted jacking frame in order to perform very quickly the transfer to the next jacking. The arrival shaft, from where the two large TBM's had to be hauled up and transported, was located in the middle of the existing and operational station hall. All unusual crane operations were executed out of office hours by a specialised crane company. Considering the described specific conditions, the proposed solution turned out to be a suitable solution for the undertunnelling of the terminus station. The allowed budget was not exceeded, and the settlement tolerances – estimated at 5 mm – were amply observed.

