Design and construction of the Schuman Multimodal Point tunnel under the centre of the European district in Brussels

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Summary

This article details the civil works for the redevelopment and extension of the Brussels-Schuman station. These works were limited by boundary conditions imposed by its location in the centre of the Brussels European district. The project had to comply with several existing structures and its execution should minimize the disruption of existing traffic flows, for both road and rail traffic.

Keywords: railway tunnel, city centre, listed buildings, limited construction time

1. Introduction

The railway link «Schuman Josaphat» is a new link on the Belgian railway network and will connect the European Quarter to Brussels Airport in just 12 minutes instead of 32 minutes today. The new link includes a 350 meters long section in the station Brussels-Schuman and a new 1250 meters long tunnel, branching off the existing tunnel under a block of houses.

The construction and installation of all necessary equipment of the new Brussels-Schuman station and the Schuman-Josaphat tunnel started in June 2008 and will be accomplished in 2015.

2. Residence Palace Building A

The new tunnel crosses building A of the Residence Palace at the level of the existing cellars. During the first stage, new foundations piles were made from inside the existing basements. Therefore, jet-grout piles were chosen as it was possible to enter the machine inside the existing cellars. Two walls were made alongside the future tunnel. Each wall consists of 3 lines of piles forming a continuous 2m thick wall that is able to withstand both the lateral earth pressure and the weight of the building. Once the foundations were complete a dividing beam was cast on top of the piles.

Simultaneous with the tunnel construction, a large renovation of building A is taking place. At the same time, four large steel trusses were created within the existing part of the building to span across the new tunnel. At ground level all bearing walls were suspended by these trusses. Once this was done the excavation of the tunnel started.

The deformations and settlements of the building were monitored during every construction stage. The moment that the ground floor was suspended by the trusses is clearly visible in the graphs by a raise up to 2,5mm of several measuring points in the suspended zone. As the deformation occurred during the stage in which the building's weight was transferred to the new foundation, we assume that the weight of the building was less than expected. This caused the jacking system to raise the building slightly. During excavation, the deformation increased on the south side of the new tunnel up 5 mm maximum. This was caused by a further reduction of the building's weight due to the removal of the three basement levels.

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3. Building C

The new tunnel crosses building C – unlike building A – only at one corner. This resulted in far smaller adaptions of the building and the building could remain in use during the works.

The main bearing structure of the building remained unchanged. Only one wall and 4 columns had to transfer their load to a new constructed roof. The new roof was cast around the columns and temporary supports of the wall. After this, the structures inside the future tunnel were demolished. By using flat jacks, the deformations of the roof under the buildings loads could be compensated.

All of these works were monitored equally to the measurements of Residence Palace building A. Due to the far smaller impact on the bearing structure of the building no deformations occurred.

4. The Wetstraat

The Wetstraat consists of a central, 3 lane wide, tunnel exit, flanked on both sides by 2 lanes of local traffic. One of Brussels subways is located below the street. The new railway tunnel passes between the existing subway and the street. The existing structure didn't allow for this. Therefore the longitudinal profile of the road tunnel was lifted by 40 cm, meanwhile adapting the structure to reduce its height to a minimum. Four post-tensioned beams were made with a span across the future train tunnel. Each beam was modeled between the existing structure of the side lanes and the free clearance gauge of the future railway line.

As the central tunnel forms a vital access road to Brussels, it could only be closed once during a 3 month period in the summer. During this time, the entire existing structure was replaced. To respond to the stringent planning for the demolition and reconstruction of the tunnel (3 months), prefabrication of structures was required. The new structures are built up by prefabricated beams with an in situ cast plate on top of them. There are four zones, each with its own design adapted to fit the local circumstances. Some of the crossbeams were isostatic prestressed beams, others were hyperstatic post-tensioned beams.

During the summer of 2012 road traffic was deviated through parallel roads but train and subway traffic in the station had to remain fully operational. To make the deadline possible the first few weeks, work continued 24 hours a day. Good preparation combined with good planning allowed the Wetstraat to reopen one week ahead of schedule, despite 2 days of European Summit in June and simultaneous important works for the new headquarters of the European Union.

5. Conclusion

Due to its location in the centre of the European district, between existing high buildings, this project required several tailor made solutions. For the buildings A and C of the Residence Palace, this consisted of building a new support structure within the existing building. This made it possible to demolish cellars and foundations to allow the new tunnel to pass through the buildings. During all this, deformations and settlements of the buildings were monitored. In both cases, the tunnel was constructed without any damage to the remaining structures.

To allow the new tunnel to fit between the existing subway and the Wetstraat, the longitudinal profile of the Wetstraat was adapted. The closure of the road was reduced to a minimum by preparing the substructure within existing underground spaces without interrupting traffic. This was followed by a period of 12 weeks during which the entire superstructure was replaced and a new road surface was applied. Everything went as planned and this even allowed the road to open 1 week earlier.

These construction works required very detailed planning and adaption of the execution methods to make everything fit within the limits of the existing structures. But the main construction works went according to plan and are currently finishing. The equipment works have started and the tunnel is on schedule to open in 2015. At that point the Brussels-Schuman station will be transformed from an outdated station with narrow underground passages into an open space with natural daylight in which the traveler has a clear overview of all the platforms, train and subway, while increasing its capacity and adding a new direct railway connection to the airport.