

The design and the construction of a public utility tunnel in the Zuidas, Amsterdam

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The municipality of Amsterdam has built a 500-meter long public utility tunnel in the hart of the new international city centre Zuidas. This tunnel accommodates the majority of the underground public utilities necessary to supply this city centre with energy, water, sewerage and data communication. As a result future road works for public utility networks are avoided and the use of the available underground space is optimised. This paper describes the design and the construction process that has led to the first and largest public utility tunnel in The Netherlands.

New international city centre.

The Zuidas in Amsterdam will be a new, multi purpose city centre which will be developed with a high building density. This building intensity can be expressed by a Floor Space Index (FSI), which is the index of square meter of gross floor space per square meter of project area. In the Zuidas project this FSI will be average 4, whereas up to now in The Netherlands a FSI of 1,5 was the highest. This high building density requires special attention to accessibility of the city centre and at the same time of the sufficient capacity of all public utilities. On the other hand the municipality and its private investors strive to reach a very high quality of the public space and a sustainable development.

The Mahlerlaan is one of the first main roads within the project area, which had to be constructed. During the very first analysis it became clear that the underground space under the road was too tight to accommodate all public utility infrastructures in a traditional way. The municipality had to look for alternative methods to accommodate all utilities. The public utility tunnel was the result.

Design

The leading principle for the design of the utility tunnel was that all utilities had to be accommodated in the tunnel. Therefore an assessment had to be made of the space needed for all future public utilities. On the basis of this assessment an optimum arrangement of cables and pipelines was established which led to a kind of principle profile (a "Profile of Free Space") around which a civil construction was designed.

The tunnel consists of two galleries in which the cables and pipelines are vertically stacked and mounted along the walls. Each gallery has an alley through which the cable and pipeline infrastructure remains accessible for maintenance and new connections. The tunnel itself consists of two sheet pile walls with a concrete roof. The roof is supported by concrete piles in the middle. The roof is covered by a 1,20 meter thick layer of soil. This soil layer is thick enough for the freatic groundwater to flow over the tunnel and for trees to grow above the tunnel.

In order to be able to connect all the buildings in the Mahlerlaan to the utilities in the tunnel, steel ducts are applied. The steel ducts are oversized and connect the underground parking garages of the building straight to the utility tunnel. During the exploitation of the tunnel public utility infrastructure can be brought through the ducts from the tunnel into the building without interference of the surface traffic or damaging the pavement (no dig policy).

At both ends of the 500 meter long tunnel, the public utilities have to be connected to the networks outside the tunnel. The networks leading to and from the Mahlerlaan are traditionally laid in the subsoil. In order to make the connection the cable and pipeline infrastructure in the tunnel has to be transformed from its vertical stacking along the walls into a traditional position next to each other in a horizontal plane. To do so the tunnel profile had to widen at its outer ends, the so called "hamerheads".

A majority of the pipeline infrastructure in the tunnel could be mounted during the construction phase of the tunnel itself. However the design should be such that all utility cables and pipes can be replaced during the exploitation of the tunnel. Therefore the tunnel has special access facilities for large pipeline pieces. For regular inspection access a separate access is made through a technical compartment, where also the tunnel installations are controlled.

Risk assessment

In the design stage an extensive risk assessment is made for all utilities in the exploitation phase of the tunnel. Initial investigations made by the branch organisations of utility owners, showed that, under the right conditions, the utility

infrastructure in a tunnel is more safe compared to the traditional situation in the subsoil. This is mainly due to smaller chance of damage through third party interference, mainly due to earthworks.

On the other hand the utility tunnel introduces new risks which have been identified during the risk assessment and which have led to additional measures. The main risks are explosion, fire, heating, molest and working conditions for employers. A proper quantification of these risks in the given circumstances appeared to be very difficult, due to a lack of data. The assessment is mainly done on the bases of an expert-judgement.

For each, unacceptable, risk, measures are taken in order to reduce the chance of occurrence and/or to minimise the effect of an occurrence. For this reason the gas and electricity infrastructure is positioned in the two different galleries of the tunnel. Also no special applications in the gas pipelines, like shutters etc. are allowed inside the tunnel, and all pipelines are carried out in steel with full X-ray controls during construction. In order to minimize the risk of heating of the drinking water, the heat generating utilities like electricity and city heating are placed in the one gallery, whereas the drinking water is placed in the other gallery. To prevent the chance of damage through molest or vandalism the access of the tunnel is secured by 24-hours surveillance. On top of all these measures the tunnel is equipped with detection systems, which will allow quick interferences in case of a calamity.

Construction and finance

The civil construction of the utility tunnel took almost one year. Complications were met mainly due to interference with other construction works and design alternatives. After completion, five months were needed by public utility parties to install the cable and pipeline infrastructure. Since March 2005 the tunnel is in operation.

The construction costs, all inclusive, were ca. 8 million euro. About 1,5 million euro thereof was needed for special development of knowhow and capacity building. The tunnel was developed as a pilot project, of which the municipality has paid for the construction costs. The exploitation costs will be (partly) covered by the utility company. The exploitation costs are estimated to be ca. 100 keuros per year.

Exploitation

The exploitation of the tunnel is done by the tunnelling department of the municipality of the city of Amsterdam. A 24-hour surveillance is guaranteed by the control room. The utility companies will be able to check their infrastructure periodically. A detailed user manual which prescribes the necessary safety measures to be taken in case works are carried out in the tunnel. Works can only be carried out with a so called hot work permit.

The municipality, the utility owners and the real estate investors recognise that in certain fields more knowledge and experience is to be gained. The Centre of Underground Construction (COB) has already executed several research projects, initiated from this projects. Parties have also experienced that existing laws and regulation in some areas hinder the new developments like this public utility tunnel. The project has proven that a serious investment in the underground is needed to obtain a high quality city environment above ground.