

Project identification

North/South Line Amsterdam Running tunnel City Centre

Type of project

Bored Tunnel



Client

Municipality of Amsterdam

In co-operation with

Project assignment

Feasibility study, preliminary design, final design, tender design, tender documentation and evaluation, detailed design and contract management & supervision

Country

The Netherlands

Location

Amsterdam

Project duration

1994-2012

Project phase

all project phases

Construction cost

€ 350.000.000,=
(excl. VAT)

Consultancy fee

more than € 200.000.000,-
(excl. VAT)

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Bored Tunnel

For the running tunnels, a twin bored tunnel is applied that follows the street pattern as closely as possible and is lowered to a great depth to minimise the construction effects (since high water tables and soft soils had to be dealt with). The total length of the bored tunnel part is approx. 3.2 km; the outer diameter is approx. 7 m. Since the streets are very narrow the tunnels are bored with only 0,5 x diameter clearance. On some sections in the South the tunnels even had to be bored above each other because positioning the tunnels next to each other was not possible.

It is obvious that the assessment of possible construction risks in this urban environment is of high importance. Therefore a combination of the principles of 3D value engineering and design by testing is adopted. 3D value engineering is used to optimise the design by means of parametric studies thereby applying advanced 4D FE models to predict the impact due to tunnelling and for which the advanced tunnel boring machine (TBM) is considered. Since the interaction between the ground and structure plays an important role, the FE models are not always considered to be reliable up to the level that is required. In these cases, full scale tests are carried out for verification reasons meaning that the design is confirmed by way of testing. Furthermore, advanced TBM techniques are developed to limit damage to historic buildings. It includes:

- a compact shield system (Vario) that can be adjusted during boring depending on the varying ground conditions;
- a TBM process control system that will be supported by means of the GIS Settlement Risk Management tool
- an innovative concept of the tail of the TBM with an injection principle that was tested on a scale of 1:5. The tests proved that assessment of the settlements improved significantly.

This information was provided to the contractor during the tender phase. The selected contractor decided to implement all techniques in the TBM that eventually was used. On a number of locations, along the metro line, there was support available to several buildings by means of the compensational grouting technique, while the TBM was passing.

The lining design consists of 0.35 m thick segments and includes a special joint design that is accommodating an optimised structural interaction between the ring sections.

The consultancy services included:

- Feasibility study in which a single large diameter bored tunnel was compared against twin smaller diameter bored tunnels in terms of costs and impact on the historic structures
- Pre-design, final design, tender design and detailed design
- Tender documentation and consultation
- Contract management and supervision

