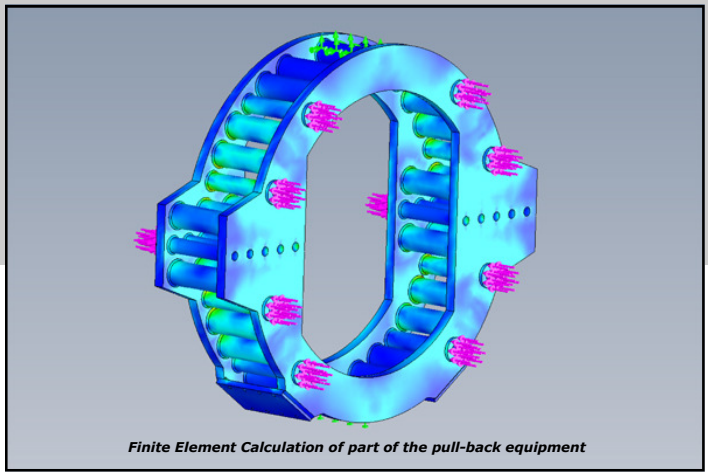
Smet Group

Project microtunnelling
Copenhagen (DK)
Heating tunnel

Client: HOFOR A/S
Main contractor JV NCC / Smet Group
Machine: AVND 2500
ID-OD: 3.000 - 3.600 mm
Length: 320 m
Execution: 04/2015 - 01/2016



Finite Element Calculation of part of the pull-back equipment

Smet Group constructs city heating tunnel in the center of Copenhagen.

The construction of a tunnel, which will soon play an important role in Copenhagen's city heating distribution, is a project for which Smet-Tunnelling tendered some time ago. With success, the Belgian company from Dessel teamed up with a Danish contractor called NCC and was awarded with the assignment. In the beginning of February 2016, the part of the work of the Belgian contractor was finished. Smet proved flexibility by acting accurately in what was stated as being a major challenge.

The client for the project, named HOFOR, is Copenhagen's main energy and water supplier, also responsible for heat distribution throughout the city of Copenhagen. He wanted to construct a tunnel from Islandsbrygge to Kalvebodsbrygge in the very center of Copenhagen suited for the installation of city heating pipes and also some other utilities, in this way serving as an integrated utility tunnel.

Smet Group got engaged into the project after having a good experience in Scandinavia before. In 2011 the company built a tunnel (with an internal diameter of 2.500mm and a length of 1.100 m) underneath the city of Helsinge, in this way creating a rain water buffer with a volume of about 6.000 m³ by means of trenchless technology.

"By means of this project in Copenhagen, we can maintain our position on the Scandinavian market", Wouter Roels explains. Being one of the Area Managers of Smet, he was intensively involved in the engineering and the follow up of this achievement. "In Denmark, a client considers it very important that the contractor throughout the construction process suggests all kinds of solutions, not only on technical aspects, but also with regards to quality and safety aspects, in order to comply with the rather stringent demands on these issues."

Method Statement
Also in Copenhagen, Smet Group relies on their so-called microtunnelling techniques, consisting of a full face tunnelling unit based on the hydroshield principle. It allows pipe jacking activities both in non-accessible and accessible diameters (internal diameter range from 400mm up to 3.500mm) and is very suitable for crossing rivers, roads, environmental areas and other infrastructure.
"Starting from a departure shaft, the reinforced concrete jacking pipes one by one proceed through the soil. This is achieved by means of a set of hydraulic jacks, whilst at the same time the Tunnel Boring Machine's (TBM) cutting wheel is excavating and removing the soil up front. The tunnelling system is guidable and is able to work well underneath the ground water level."

The working method is applicable in various geological conditions : sand, clay, loam and even very soft peat layers are possible to cross. By adapting the cutting wheel, pipe jacking activities can also take place in soft and hard rock conditions. In general, the technique can be used for the construction of main sewer pipes, sewer branches, (drinking) water pipes, utility tunnels, ecoducts, pedestrian and bicycle tunnels, draining pipes, tubular roofs, outfall pipes for off-shore connections, and so on. "With certainty we can state that microtunnelling provides a fast,

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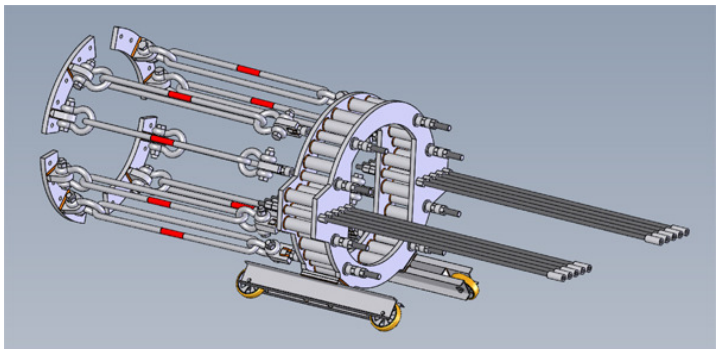
reliable, safe, efficient, precise, watertight and multifunctional method of working", Wouter Roels explains.

Challenges

The Copenhagen project posed some strong challenges upon Smet 's tunnelling teams. The pipe jacking activities took place at a depth of about 25m below the surface. "The soil characteristics were not so evident : a rather soft lime stone combined with very hard and abrasive flint stone, required for high performance demands on the cutting wheel and cutting tools. In addition to that, we had to cope with a ground water pressure of 2.5 bars."
In the summer of 2014 the engineering and preparatory works could start. After that, Smet Group's Danish partner NCC, also charged with the project's main supervision, started with the site preparations and the deep shaft construction, in order for Smet to initiate the tunnelling process in the beginning of april 2015. "For these kinds of projects we need about three weeks to install the tunnelling equipment. After this the TBM is lowered down into the starting shaft. In this case we were dealing with an almost 1000 kN weighing TBM with an outer diameter of 3.6m. Being a well-known habit in the (micro)tunnelling world, the TBM is baptized before it enters into the soil. 'Gertrude' was the name the client proposed; a "spear of strength", derived from the Germanic elements *ger* "spear" and *thrud* "strength...".



Rupture

"Nevertheless we encountered huge water flows in the soil, untill the mid of May, the tunnelling process went according to schedule", Wouter Roels continues. But the 'spear of strength came to a stop. "Suddenly, when we arrived at about 60m, one of the jacking pipes showed several cracks. This was causing water intrusion into the tunnel, leaving us no other option but to stop the tunnelling activities."
A team of experts arrived at the job site in order to determine the cause of the pipe rupture. After thorough investigation and analysis, an obstacle in the so-called overcut (the gap between the pipes outer wall and the excavated bore hole which is necessary to overcome large friction forces on the pipe wall) most likely caused the cracks. "Since it was no longer an option to continue the process with the cracked pipe in the pipe string, together with the client and the insurance company, it was decided to retract the already constructed part of the tunnel, in this way removing the broken pipe."
A retraction operation of this kind is a huge job. As far as known, it had never been done on such a large diameter of microtunnel and at such depth! "We had to engineer and develop a completely new system consisting of pulling anchors and force distributors, in order to make it possible to retract the TBM and the already installed pipes."

Injections

After having pulled back a length of 12m, the broken pipe returned into the jacking shaft. "In mean while, we engineered an injection plan, allowing us to remove the obstacles around the pipe by cutting through the tunnel (pipe) wall. The injections were needed to seal off the water flow from the surroundings in order to guarantee safe conditions for the obstacle recovery. After having removed the obstacles, the tunnel (pipe) wall was again closed off by means of concrete. Also this pipe was removed from the tunnel by retracting it.

After the pull back operation, the tunnelling teams had to remove the complete retraction system from the tunnel and reinstall the normal tunneling system in order to restart the pipe jacking activities. "The event, for which Smet could not be kept responsible, resulted in a down period of more than six months! It was only in the month of December 2015 we could restart tunnelling works. In order to maintain the projects completion date, Smet decided to work throughout the whole Christmas holiday in a 24/7 working schedule."

In the beginning of February 2016, the tunnelling job was completed without any further problems. Even after such a very long stand still, after restart, the jacking forces were reduced to extremely low values of less than 1 kN/m²!
"Both departing and arrival shaft are finished by means of concrete works through our Danish partner, after which the client will still have about three months in order to install the city heating pipes into the tunnel. By the end of September 2016, the job will be completely done."

(Bart Vancauwenberghe, Riorama 03-2016)

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