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EFFC HEALTH & SAFETY
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City people:

Trevi will work at 21 locations throughout Copenhagen



new system that we are building, which adds to the challenge on this project.”

CSP piling is a new technique for Denmark – it is basically a fully cased CFA pile, but Cavalcoli says it uses no polymer or bentonite so is less messy. “Here all the piles extend to 28m and we are using tools that were specially developed for the scheme and it is a design that we are still tweaking,” he says. “The flint is highly abrasive so we are using a high quality steel to be more productive and adjusting the tooling position to create a more aggressive auger.”

Trevi is working on 12 sites at the moment. Two – Nørrebroparken and Nørrebro Runddell – are already finished and the first TBM was due to be launched from Nørrebroparken as *EF* went to press. Main contractor CMT will eventually have four 6m diameter Kawasaki earth pressure balance TBMs working on the scheme and the second is due to be launched soon from Otto.

Trevi finished at Nørrebroparken in June and work on casting the top slab and excavation of the box has been completed.

“THE FLINTS ARE VERY HARD. WE HAD TO REPLACE 500 TEETH ON THE HYDROMILLS SO FAR”

Giancarlo Zannoni, Trevi

The TBM will travel anticlockwise towards Nørrebro Runddell, which was handed over to CMT on the day of *EF*'s site visit. Nuuks Plaads (see box overleaf) will be the next site to be handed over.

Zannoni says that CMT hopes to achieve 13 to 14m of tunnel construction per day.

Trevi has 200 people working on the scheme and this has gradually ramped up since the company started work on site in late August 2011. “The demand for quality on this scheme is high but safety is also important,” says Trevi HSE manager Stefano Margozzi. “So far we have managed 200,000 hours ➤

WHO?

Trevi is the main subcontractor working on the DKK21.3bn (€2.85bn) scheme for main contracting joint venture CMT (Cityringen Metro Team). Trevi is undertaking all the main foundations work, which mainly involves a mix of diaphragm walling and Trevi's cased auger piling (CAP). The contract may be extended to include compensation grouting work when the tunnel boring machines (TBMs) are

CHALLENGES

Trevi is having to cope with strict noise and environmental limits, as well as overcoming some difficult ground conditions. Dewatering is being carried out by a specialist contractor to carefully control the groundwater around the site in a bid to prevent damage to timber piled buildings in Copenhagen. Layers of flint up to 2m thick in the underlying limestone are being prefractured using sonic drilling.

MORE INFO

More information

www.m.dk

www.metrocityrink.dk

◀ without a lost time accident.”

EF met Margozzi on the Sønder Boulevard site, which is one of Trevi’s most challenging work sites on the project – the actual foundation design is fairly straightforward, but the work is complicated by contaminated soil and restricted working hours.

The new station is being constructed using diaphragm walling and Trevi is using two hydromills and two cranes on the site to construct the station box. But instead of just one desanding plant, Trevi has had to squeeze two onto the constricted site – one to deal with the natural ground and the other to deal with the hydrocarbon contaminated ground.

The station calls for 68 diaphragm wall panels to be installed to 28m to form a 15m wide, 90m long box. “The panels are 2.8m wide and 1.2m thick,” says Sønder Boulevard site manager Francesco Ricci. “The verticality of the panels is checked using on-board systems and selected panels are checked using a koden system.”

Primary and secondary panels are being installed in a careful sequence with at least five days between adjacent panels. “It is taking three to four days per panel – work is slower due to the contamination which lies at between 11 and 20m below ground level,” explains Ricci.



TECHNICAL CHALLENGES

One of the most high profile sites is construction of the station at Marmorkirken where Trevi is working just 100mm from a historic church, which has just undergone restoration work. The station takes its name from the church, which translates as the marble church, but it is also known as Frederik’s Church, which was built between 1749 and 1900, and at 31m span, is the largest domed church in Scandinavia.

The work at this site involves construction of a T-shaped diaphragm wall for a new station and what was previously the church gardens, which will be restored at the end of the project. As well as working close to the church, the area is surrounded by buildings on all sites and Trevi is using a smaller Soletanche Bachy hydromill at this site to help overcome the restrictions.

Margozzi adds: “The benzene pollution is believed to have been caused by use of this area by an oil refinery in the 1920s. Because we are working close to residential properties, we have had to take special precautions. The desanding plant has been covered to protect the area from pollution rather than noise and dust and a Crown monitoring system has been installed in the covered plant to warn if pollution levels reach a critical level.

“We have 10-minute toolbox talks every day to remind staff about the specific risks on this site.”

NOISE RESTRICTIONS

Noise is also a concern. “The site is in a very quiet area of Copenhagen and there are strict noise limits placed on our work,” says Margozzi. “Between 7am and 6pm we are limited to 70dB(A) but between 6pm and 7am and all day on weekends, we are limited to just 40dB(A). Normally on this kind of scheme we would work 24 hours a day but these limits make this impossible – most sites are operating 10-hour shifts – and we have had to look at our equipment to make sure we meet demands during the daytime too.”

Part of the solution has been to use sound-

In total, 116 diaphragm wall panels will be installed at the site, again to 28m below ground level.

The limited space here is helping Soilmec to test out its latest desanding plant. The SDM 35 has a much smaller footprint than other models and is mounted vertically over several storeys to save room and features an automated truck loading system.

“The system features centrifuges in line, rather than in parallel to try and match the centrifuge capability with the 300m³/hour bentonite output from the hydromill,” says Trevi geotechnical engineer Paulo Cavalcoli. “There is no room to store the used bentonite at Marmorkirken and we can’t run the centrifuges overnight to process the stored material anyway.”

“NORMALLY ON THIS KIND OF SCHEME WE WOULD WORK 24 HOURS A DAY BUT THESE LIMITS MAKE THIS IMPOSSIBLE”

Stefano Margozzi, Trevi

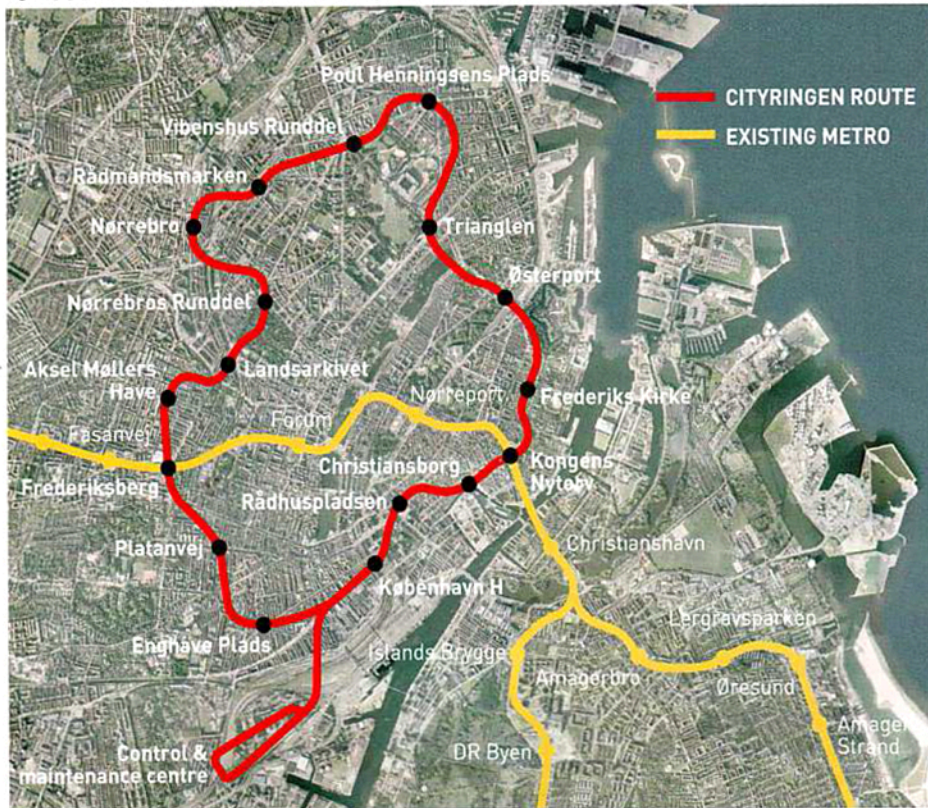
reducing fencing around the sites and efforts have also been made to insulate the Soilmec machines being used on the project and mobile sound barriers are also being used to further reduce noise levels. “We are monitored 24 hours a day by the client for noise and vibration levels,” says Margozzi.

As Zannoni has already mentioned, the ground conditions across Copenhagen also present some challenges – the geology is mainly limestone with a flint layer that can be up to 2m thick. Trevi is overcoming the problem by predrilling using a sonic drill to “pre-fracture” the flints to try to reduce wear on the piling auger and damage to the hydromill.

Ricci says: “The sonic drill is being used to



→ CITYRINGEN ROUTE



predrill at all locations at Sønder Boulevard with five, 120mm diameter bores being drilled to 14m at every panel location.”

In a city where the canals are a major tourist attraction, it is hardly a surprise that the water levels are high – generally 1 to 2m below ground level. Protection of water quality is therefore a challenge too.

“Any water extracted to dewater the work has to be treated before it can be discharged,” says Cavalcoli. “A lot of the buildings in Copenhagen have wooden piled foundations, so we are only allowed to drop water levels outside the sites by 50mm to prevent damage to the foundations.”

Dewatering is being managed by specialist contractor Hoelscher from Germany.

ENVIRONMENTAL ISSUES

But there are also environmental concerns associated with the work and Trevi has had to specially prepare machines for this project. “We are using vegetable oil in our machines and all of them are equipped with spill kits should there be a hydraulic oil leak,” says Margozzi.

All the machines on the project are new and fitted with Soilmecc’s Drill Monitoring System (DMS) which is being monitored from the

main office Trevi shares with CMT. The rigs have also been fitted with additional particulate filters to reduce engine emissions. “The rigs all meet EU requirements but the client has decided to set a higher standard,” says Margozzi. “Each filter costs €40,000.”

If all this wasn’t enough to deal with, winters in Copenhagen are also cold which has an impact on the bentonite, concrete and PPE needed. “The days are also very short,” adds Margozzi.

While the piling and diaphragm walling work is getting into a good rhythm, there are still some further challenges for Trevi – CMT is still considering the use of grouting in some areas to manage settlement from the TBM and other techniques are also being called for on some stations.

“At Gamestrande we are going to use micropiling techniques for the temporary works to construct a slab over the canal from which we can install the diaphragm wall,” explains Zannoni. “The station calls for us to work in the middle of the canal channel but we have to ensure boats can continue to use the canal throughout the work.”

Trevi’s work is scheduled to finish in mid-2014. “We will complete the piling work by the end of 2013 though,” says Zannoni.

GROUND ISSUES

The next site Trevi is due to hand over to CMT is Nuuks Plaad, where work started in early February this year. At the time of EF’s visit work was 70% complete, but getting to this stage was far from straightforward.

The work involves construction of an 18.6m wide, 72.45m long station box, plus another 13m square box for the stair shaft using 300 1m diameter cased secant piles (CSP) that are being drilled to 28m below ground level for the main box and to 14m for the stair shaft.

The main challenge is the proximity to one of the main roads through Copenhagen, a historical archive building and residential properties. “We are using two 120t rigs here so safety is essential,” says Curreli.

The ground conditions at Nuuks Plads have proved to be more challenging than other areas – granite boulders and olivine in the limestone have been encountered. “The original plan was to only use the sonic drill when we came across a hard layer of flint, but we have ended up pre-drilling all of the pile locations,” says Curreli. “It is a balance on time and rig wear – it was taking 10 hours to form each pile without sonic drill but five-to-six hours with it.”

