



## Member Nation Report 2009 from Denmark.

The Danish Society for Tunnels and Underground Works has during the year 2009 arranged 6 member meetings including two technical site visits. The first technical site visit covered design and construction of 3 fully automatic underground facilities for Copenhagen Municipality in the City Centre. The second visit and study tour covered a four day visit to the 57 km long railway tunnel, Gotthard Base Tunnel in Switzerland, including a visit to the 800 m deep Sedrun shaft and the Testing Gallery in Hagerbach.

Members of the society have participated in the ITA General Assembly in Budapest, Hungary from 23<sup>rd</sup> to 28<sup>th</sup> May 2009 including meetings in three ITA working groups. Members have also participated in activities within COSUF during 2009. One member is active member of PIARC's tunnel Committee including two working groups on safety and operation of tunnels bringing back news for the Danish tunnel industry.

The Metro-Cityring project, consisting of an extension of the existing metro with 15 km metro circle line (30 km tunnels) with 17 underground stations and 5 emergency and ventilation shafts, has progressed well during 2009. The extension will be operated independently of the existing system and will have its own maintenance and service centre. There will be 5 interchange stations to existing railway and metro.



Figure 1: The two new Metro lines, M3 and M4, to be constructed as circle lines in the historical city center of Copenhagen including 17 new underground stations.

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Tender documents for the project have been issued to a group of pre-qualified contractors. The project is being tendered under design and builds contracts. Bids will be received in April 2009 with the aim of signing a contract with the successful contractors in the autumn of 2010.

The civil works is being tendered in two lots, a northern contract covering construction of 7.2 km twin tube tunnels and 8 underground stations and a southern contract covering construction of 7.9 km twin tube tunnels and 9 underground stations plus the 1.1 km branch off twin tube tunnels. The civil works contracts include M&E installations but exclude the architectural and finishes works. A separate contract is issued for the transportation system containing signaling, track, and rolling stock and a 5 year operation and maintenance period for the full circle line including the operation and maintenance centre.

The tender documents define the performance specifications and the geometrical requirements and constrains. The stations will be constructed by open cuts within a box structure of retaining walls; the platform will generally be 19 m below ground, with some stations only 15 m deep and one station 25 m deep. The tunnels will be constructed in limestone of 2/3 of the alignment, whereas in the northern part of the alignment the tunnels will have to be constructed in glacial water bearing deposits of sand, gravel and clay till. The utilization of closed face TBM's are required. Clients consultant: COWI.



*Figure 2: The existing and brand new Copenhagen Metro in operation.*

In September 2005 a proposal was published outlining a 12 km immersed road tunnel with 6 lanes linking the motorway system at the north with the motorway system at the south of Copenhagen (Eastern Bypass). The alignment followed the Copenhagen Harbour Canal throughout and included an underwater parking facility. The cost was estimated to be close to 3 billion Euros. The proposal was very well received by public as well as by local politicians, because it was designed



to remove a very substantial part of the road traffic from the centre of Copenhagen as well as providing better access to development areas east of Copenhagen Harbour. The scheme has been developed further by the City of Copenhagen together with the consultant Ramboll in 2008, and is now included fully or partly in two alternative solutions. In February 2009 The Danish Government presented their plan for the Danish Transport Policy until 2020. The plan states that the government will initiate a strategy analysis for the Eastern By-Pass. This work has begun and it is expected that the strategy analyse will be ready in 2011.

The proposed approximately 3 km new road link ("Northern Harbour Link") between Nordhavn and Lyngbyvej located north of Copenhagen has during 2009 been developed further. The two proposals comprise cut-and-cover and bored tunnels with a length from 0.5 to 2.5 km. In January 2009 the Environmental Impact Assessment (EIA) report was approved by the City of Copenhagen. A preliminary design has been prepared for two proposals in autumn 2009. The project is being developed by the City of Copenhagen and the consultant Ramboll. The project is planned to be tendered for construction works by the end of 2010 and is expected to take 4-6 years to complete.

The tender documents for a new road tunnel in Aarhus - connecting the Motorway system and Ring Road network with the Port of Aarhus that contains the largest container terminal in Denmark - is about to be completed. The construction works are to be tendered as "Design & Build" divided into two packages. Now, tender documents have been issued for one package whereas the package containing construction works of the tunnel itself has been delayed waiting some financial funding. By introducing another way of interfere into the existing traffic flow during the construction phase, the deadline for the completion of the construction works for the tunnel by late 2015 are still expected to be met. Apart from all structures, mechanical and electrical installations in connection with the tunnel-project itself, the tender has been extended to include operation and maintenance works of all installations with a concession period of 5 years after the inauguration day. In general the tunnel-package consists of a unidirectional cut-and-cover tunnel with two tubes each containing 2 lanes. The length of the tunnel including ramp structures is 2 km in total. The existing four lane Marselis Boulevard on top will be excavated and reconstructed in a modern layout during the construction phase. The client is the Municipality of Aarhus and consulting engineers are Ramboll. In the process of preparing the tender documents a new way of reducing pollution from traffic at the western exit zone of the tunnel has been introduced. The system will use recycling of polluted air from the west to the east whereas the harbor area in east has less strict demands for the limits of pollution.

The contractor PIHL is about to finalize a turnkey contract for construction of 3 fully automatic underground parking facilities with room for in total 840 cars for the client, Copenhagen Municipality. The 3 parking facilities are located at Nørrebro, Amagerbro and Islands Brygge. The facilities at Nørrebro and Islands Brygge are handed over to the Client, and the facility at Amagerbro will be handed over during the summer 2010. The contract includes all civil works and

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technical installations. The underground structures are constructed by reinforced concrete bottom slab and top deck. The walls are made by either reinforced bored piles (length approx. 19 m / Ø1200 mm) with a inner reinforced wall or sheet pile wall (HZ /AZ) without inner wall. Uplift anchors are installed and during construction the ground water is lowered by means of filter borings. The method of bored piles is used due to limit environmental impact from noise/vibration and geological reasons. In the depth of 10 - 12 m below ground level the Copenhagen limestone starts and the hardness varies from H1 to H5 (flint stone of layers 100 to 1000 mm). In spite of construction sites located in dense populated areas and the actual geological conditions, the contractor PIHL has been able to conduct the work without disturbances due to unacceptable noise or vibrations. The Copenhagen Municipality plans to establish another 3 facilities (total 375 parking spaces) in 2012-2013.



*Figure 3 and 4: Construction of fully automatic underground parking facilities in the city center of Copenhagen.*

Close to Copenhagen Central Railway Station a new single track railway tunnel with a length of 120 m is undergoing detailed design. The tunnel will be build as cut-and-cover with a high degree of complexity due to a construction site next to existing main tracks in operation. The project goes out in tender by mid 2010 and the appointed contractor will start the construction works late 2010. The Client is the Danish State Railway using a JV of COWI and Grontmij - Carl Bro as consulting engineers.

Environmental Impact Assessment (EIA) of a new immersed tunnel under Roskilde Fjord is very close to be completed ready for the public hearing phase including political decisions. Two solutions for a southern alignment of approximately 700 m and 1.600 m IMT are a part of the



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investigations. Both solutions have been prepared by COWI as conceptual design covering two bores with two lanes each including interchanges and highways on both sides of the Roskilde Fjord. The Client is the Danish Road Directorate under the Ministry of Transport and Energy.

Latest news and status for the planning of the combined new 20 km road and railway link crossing the Baltic Sea between Rodby (Denmark) and Puttgarden (Germany) refer to: <http://www.femern.com/>

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