Member Nation Report 2008 from Denmark.

The Danish Society for Tunnels and Underground Works has during the year 2008 arranged 6 member meetings including two technical site visits to see the TBM in action at the Hallandsås project in Sweden and to study the PPP project in southern Norway between Grimstad and Kristiansand, where more than 7 mio. cubic meter of rock are to be drilled and blast for the 8 road tunnels under construction with a total length of 12 km.

The 2nd October 2008 the Danish Society for Tunnels and Underground Works celebrated its 25 years anniversary with a one day seminar in Copenhagen. Almost 100 participants from all over Scandinavia including representatives from ITA EXCO made the seminar memorable and a major success.

Members of the society have participated in ITA General Assembly in Agra, India from 21 to 25 September 2008 including meetings in three ITA working groups. Members have also participated in activities within COSUF during 2008.

The Cityringen project has progressed well during 2008. The project consist of 15 km metro lines (30 km tunnels) with 17 underground stations, 5 emergency and ventilation shafts and a 1.5 km branch off tunnel to a new maintenance and service centre. The stations will be constructed by open cuts within a box structure of retaining walls of either secant piles or diaphragm 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. There are strict requirements for not lowering the ground water table during construction and closed face TBM´s of either earth pressure balance or slurry types will be required. For the station construction re-infiltration of ground water will be required for the control of the ground water table during construction, at some sites in combination with pre-grouting or freezing of the soil and rock mass.

The conceptual design and the Environmental Impact Study were approved in 2008 and tender documents are in preparation by the Client Metroselselskabet I/S and its consultants. During 2008 geotechnical and environmental site investigations have been ongoing with the completion of more than 200 geotechnical borings and the campaign continues in 2009.

Prequalification of contractors was initiated in December 2008 by issuing an invitation to tender to build the metro. The civil works have been divided into 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 E&M installations. A separate contract is issued for the transportation system containing signaling, track, and rolling stock for the full circle line. The short listed companies will be announced before the summer of 2009. Tender

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documents will be issued to the shortlisted contractors after the summer 2009 and it is intended to enter into contracts late 2010.

Figure 1: The new Copenhagen Metro.

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. 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 the public and local politicians, because it was designed to remove a very substantial part of the road traffic from the center 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 Rambøll in 2008, and is now included fully or partly in two alternative solutions. In December 2008 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 an Eastern Ring Road.

The proposed approximately 3 km new road link ("Northern Harbour Link") between Nordhavn and Lyngbyvej located north of Copenhagen has during 2008 been developed further. Two alternatives, comprising cut-and-cover and bored tunnels with a length from 0.5 to 2.5 km have been investigated. The project is being developed by the City of Copenhagen and the consultant Rambøll. In January 2009 the Environmental Impact Assessment (EIA) report is expected to be approved by the City of Copenhagen. The project is planned to be tendered for construction works by 2010 and is expected to take 4 - 6 years to complete.

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Figure 2: Northern Harbour Link.

A new tunnel connecting the Motorway system and Ring Road network around Aarhus with Port of Aarhus – containing the largest container terminal in Denmark - is in the design phase. In October 2008 the City Authorities in Aarhus approved the design performed and presented during the Environmental Impact Assessment (EIA) process. The tunnel is a unidirectional cut-and-cover tunnel with two tubes each containing 2 lanes. The total length is 1.8 kilometres with no entrances/exits planned over the distance. On top of the tunnel Marselis Boulevard (a four lane street) will be excavated and reconstructed in a modern layout during the construction phase. In 2010 the construction works are planned to commence and expected completion is late 2015. Prequalification notice is expected to be launched in June 2009. The construction works will be tendered as "Design & Build" divided into two tender packages 1) a 2.0 km 4 lane road with 2 major and 4 minor bridge structures and 2) a 1.8 km cut-and-cover tunnel and reconstruction of Marselis Boulevard. The total budget for the project is approximately 200 million Euros. The Consultant is Ramboll.

The contractor PIHL is conducting 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 work commenced in March 2008 and is expected to be completed during the summer 2010. The contract includes all civil works and technical installations. The automatically parking facilities containing elevator systems to carry the cars to their correct positions and pick them up again will be supplied by the company Westfalia (D). 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 / Ø1200mm) 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 1000mm). 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.

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