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An introduction to the development for urban underground space in Helsinki

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ABSTRACT

Helsinki has developed a dedicated Underground Master Plan for its whole municipal area, not only for certain parts of the city. This work began in the 1980s and from then the City of Helsinki has maintained an underground space allocation plan. On average, under each 100 m^2 of surface area in Helsinki there is 1 m^2 of underground space. Consequently, there are still many underground resources for future needs existing within the whole city area. The Underground Master Plan of Helsinki shows both existing and future underground spaces and tunnels, as well as existing vital access links to the underground. It also includes rock resources reserved for the construction of as yet unnamed underground facilities. The development of the master plan has resulted from a long-term commitment of many public and private stakeholders to the planning process, the creation of a suitable legal framework and the collection and management of the data on geotechnical conditions and underground facilities.

1. Introduction

Finland has 317 independent municipalities as of 2015. Helsinki, the capital, is by far the biggest city in Finland. The surface area of Helsinki is only 214 km^2 including a number of bays, peninsulas and islands. The inner city area occupies a southern peninsula where the population density in certain parts can be as high as 16,500 inhabitants per km^2. The Greater Helsinki area is the world's northernmost urban area among those with a population of over one million. Altogether, 1.3 million people – or approximately one in four Finns – live in the area.

Helsinki has a humid continental climate and Helsinki's landscape is quite flat – the highest natural point is only 60 m above sea level. One third of Helsinki's ground is clay with an average thickness of three metres. The average depth of soil material upon bedrock is seven metres, but varies from 0 to almost 70 m. The bedrock quality in Finland is for the most part ideal for tunnelling and for building underground spaces since the bedrock mainly consists of old Precambrian rocks (Finnish Tunnelling Association, 1997) with only few places where younger sedimentary rocks exist. There are several fracture zones formed by rock block movements that cross the bedrock in the city centre (Saraste, 1978). It is important to identify the locations and properties of these zones in the planning and excavation of rock constructions.

The average price per cubic metre of tunnels and underground spaces in Finland in 2014 is EUR 100/m^3 (including excavation, rock reinforcement, grouting and underdrainage). To date, only the Drill and Blast (D&B) method has been used for rock excavations – the use of Tunnel Boring Machines (TBMs) has not been competitive in Finland so far. The reason for the low cost of tunnelling in Finland is due to the practice of not using cast concrete lining in hard rock conditions, effective D&B technology and extensive experience of working in urban areas.

2. The history of the Underground Master Plan of Helsinki

The process of drawing up the Underground Master Plan was prepared by the City Planning Department. A decision making history is provided in documents by Helsinki City Council (2010) and Narvi (2012). This work began in the 1980s and from then the City of Helsinki has maintained an underground space allocation plan. The City Council approved the Underground Master Plan of Helsinki on 8 December 2010 except for one reservation against which

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an appeal was made to the Administrative Court. This appeal was rejected on 18 November 2011.

While some aspects of the Master Plan are not fixed and legal consequences are not defined, the Master Plan does, in fact, have legal effect. Results and developments arising from the Master Plan include:

- Connected to the Master Plan is an underground space allocation plan, which supports the City's underground facilities management system and the exchange of information. The Master Plan includes space allocations for various facilities: transport, civil defence, sports, various installations and establishments, water and energy supply, parking, storage, waste management and similar. The aim is to achieve joint use of facilities (e.g. use of civil defence facilities in normal circumstances; multipurpose tunnel network; shared parking).
- Current functions could be studied to see if they can be located underground if this would release land above ground or otherwise improve matters.
- Underground spaces are to be located mainly in bedrock. Bedrock resources are to be investigated in sufficient detail.
- Bedrock resources are to be reserved mainly for uses that are for the common good.
- Bedrock resources below recreational areas may be used if this does not present problems for such recreation or for valued natural environments.
- Planning will support arrangements for underground parking in new residential areas with due consideration of the potential for its implementation.

In the author's view, the close cooperation that the City of Helsinki has established with the numerous 'partners' involved in planning, financing and designing as well as the actual construction and maintenance of tunnels and underground spaces has perhaps been the most important issue for sustainable underground property development. As much of this work is also carried out unofficially, trust between the parties is central, particularly when developing processes and sharing risks.

3. Key aspects for the use of underground space in Helsinki

There are 10,000,000 m^3 underground spaces in Helsinki (parking, sports, oil and coal storages, the metro, etc.), more than 400 premises, 220 km of technical tunnels, 24 km of raw water tunnels and 60 km of 'all-in-one' utility tunnels district heating and cooling, electrical and telecommunications cables, and water. On average, under each 100 m^2 of surface area there is 1 m^2 of underground space. Consequently, there are still many underground resources for future needs existing within the whole city area (Vähäaho, 2012).

In Finland, property owners must include civil defence shelters in buildings of at least 1200 m^2. Such spaces are now designed to meet the needs of normal times with 'just' strengthening for 'exceptional times'. This enables property owners to transform the swimming pool, for example, into a defence shelter quickly and economically should the need arise. The underground swimming pool in Itäkeskus (Fig. 1) has facilities on two floors and can accommodate some 1000 customers at a time. The hall attracts some 400,000 customers a year. Quarried out of solid rock, the hall can be converted into an emergency shelter for 3800 people if necessary.

As the city structure becomes denser, more facilities suited for different purposes are being placed underground. There is also a growing demand to connect underground premises to each other to form coherent and interrelated complexes. The growth in underground construction and planning, and the demand to coordinate different projects have led to a requirement to prepare an Underground Master Plan for Helsinki. Having legal status, the plan also reinforces the systematic nature and quality of underground construction and the exchange of information related to it. The Underground Master Plan is a general plan that allows the control of the locations and space allocations of new, large significant underground rock facilities and traffic tunnels, and their interconnections (Helsinki City, 2009).

Underground planning enhances the overall economy efficiency of facilities located underground and boosts the safety of these facilities and their use. "In simple terms, underground facilities can be thought of as providing the ultimate 'green roof'. Facilities placed fully underground (once constructed) do not impact the surface aesthetic and can provide natural ground surfaces and flora that maintain the natural ecological exchanges of thermal radiation, convection and moisture exchange" (Sterling et al., 2012).

Helsinki has developed a dedicated Underground Master Plan for its whole municipal area, not only for certain parts of the city. While the favourable characteristics of the bedrock and the very severe winter climate conditions are contributors to the reasons for the extensive underground developments in Helsinki, there are others maybe even more important – such as the Finnish need to have open spaces even in the city centre, the excellent and long-lasting cooperation between technical departments and commercial enterprises as well as the small size and high population of Helsinki.

Space allocations for long-term projects, such as traffic tunnels, must be maintained for future construction. The same applies to

Fig. 1. Underground swimming pool in Itäkeskus, which can accommodate 1000 customers at a time and can be converted into an emergency shelter for 3800 people if necessary. Photo: Erkki Makkonen.

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