The use of underground space in Finland
with some remarks around the world

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Rock resources reserved for unclassified future use
Example of 0-land_use: “Katri Vala” park
Rock surface less than 10 m below ground surface
Planned underground spaces and tunnels
Existing underground spaces and tunnels
Extract of the Helsinki underground master plan
Example of 0-land_use:
Katri Vala park

- Storage rooms in the 1950s
- Heat pump station in 2005
- Kruununhaka – Pasila utility tunnel in 1990
- Tunnel for cleaned wastewater in 1986

Space for future projects

Statistics of Underground Helsinki

- Underground space (parking, sports, oil and coal storages, metro, etc.) 10,000,000 m³
  ~ average 1 m² per 100 m² ground surface
- More than 400 premises
- Technical tunnels: 220 km
- Raw water tunnels: 24 km
- Utility tunnels ‘all in one’ (district heating and cooling, electrical and telecommunications cables, water): 60 km

Photo: E. Makkonen
Courtesy Länsimetro Oy
Accesses: Careful consideration is required to locate the overground connections to underground spaces.
Helsinki, Finland
New parking solution
Billboard advertising a new residential area in 2009
No mention of the wastewater treatment plant below!

Your home on the roof of Heaven!

Photo: Ilkka Vähäaho

29.10.2015
Geotechnical Engineering with some remarks around the world

Singapore Mass Rapid Transit (MRT) under construction in 2004

Ilkka Vähäaho’s question: Could the use of anchors instead of internal supports make working easier?
Singapore Little India Station under construction in 2012

Example and principle about how to use temporary anchors instead of internal supports

Anchor
Sheet Pile Wall

Bottom of Excavation

Courtesy: EBS Geostructural
Ilkka Vähäaho’s insight: Cast concrete lining can mean up to 200% extra costs in circumstances of excellent rock materials.

Lyon (France) Tunnel La Croix Rousse
October 2011

Ilkka Vähäaho’s insight: Cast concrete lining means extra costs. In this case, it is required for aesthetic and cultural reasons.

www.tunnelcroixrousse.fr
A bare uncovered rock surface ‘window’ in the Kluuvi underground parking hall in Helsinki

Temppeliaukio Church built into solid rock
Helsinki would like to buy my forest.

My opinion is: nothing to beggars!

Non-geotechnical Engineering for Underground Space Development

Price of land is rising and the city centre is expanding
The new 400,000 m$^3$ coal stock silos of the Salmisaari power plant were built (2002-2004) into the bedrock with piles of coal and quarried rock (Left). The photo on the right shows the same area with the headquarters of some of Finland's major companies.

The coal storage silos in the bedrock were built with the money that Helsinki got by selling the former coal heap area to private companies.

Salmisaari underground coal storage

Photo: J. Vilkman

Courtesy: Finnish Tunnelling Association

Courtesy: City of Helsinki

Courtesy: Google Earth

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Recent examples

Helsinki region, Tampere and Oulu

District cooling in Helsinki

Cold water reservoir for district cooling in city centre was built between 50-90 meters from ground level because of the lack of free space
Tampere, Finland
Tunnel project on Highway 12 (VT 12)

Tunnel project

2.3 km tunnel under the city centre

Bedrock surface
Tampere, Finland
Gateways every 150 meters

Tampere, Finland
New parking solution

- Parking cave for 950 cars underneath Tampere city center
- 600 m long, 30 m wide, 12 m high
- Two (two-way) entrances for cars
- 14 elevators at 7 different locations

Future extensions
Tampere, Finland
New parking solution

Oulu, the capital city of northern Finland

Courtesy: City of Oulu
Kivisydän (Stoneheart) parking in Oulu

Parking in Oulu
Parking in Oulu

• Kivisydän parking in the heart of Oulu
• Construction started in June 2012
• Completed by autumn 2015

http://youtu.be/Mbe5oZ9u4n4

Geofantti-2015 Award was given to Underground Space Solutions of the Ring Rail Line

architect Arttu Suomalainen
PES-Architects
Main drivers for the underground development in Finland

- Favorable characteristics of the bedrock
- Need to have open spaces even in the city centers
- Excellent and long-lasting cooperation between governmental technical departments and commercial enterprises
- Real estate owners may restrict the use of underground space only if the space is harmful or it causes some loss

www.geotechnics.fi