The Use of Infrastructure through Tunneling over Time in Stockholm, Sweden

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Introduction
This presentation highlights the use of infrastructure through tunnelling over time in Stockholm. The Stockholm region is growing. Despite the business cycle there is a growth in population of approximately 20,000 new inhabitants per year. The main infrastructure in the Stockholm region was built decades ago. Most of the infrastructure does not serve its purpose and is in great need of maintenance. The Stockholm region needs both infrastructure for public transport as well as new capacity for road transportation. A large investment programme has now been launched and has started to be implemented. Major projects under construction are a new railroad for commuter trains (Citybanan), new tramways and a new highway as part of the inner ring (Norra Länken). One major project currently being planned is the new western bypass (Förbifart Stockholm).

Planning history
In the early sixties a ring road (fig 1) around Stockholm was planned. The plan was to construct the new motorways as surface roads with bridges over water and land. Essingeleden, which was opened for traffic 1967, was constructed this way as an elevated highway (fig 2). Essingeleden has only one tunnel, a short tunnel which is 220 m long. This tunnel has no ventilation or safety equipment.

Figure 1: The Stockholm Ring Road
Figure 2: Essingeleden
Essingeleden is 7 km long. In the beginning of the nineties the road was extended by one kilometre. The road had six lanes but just before the opening of the Södra Länken, which we will talk about later, the traffic lanes were rearranged to eight lanes by narrowing the lanes. The traffic volume today is about 175 000 vehicles per day. At the same time that Essingeleden was designed and constructed a bypass west of Stockholm was being discussed, also as a surface road with bridges. The ring road plans from the sixties were not carried out. In the beginning of the nineties the plans for the ring road and the bypass were again taken up in discussion. Everyone then realised that it would be impossible to build these new roads in the same manner as Essingeleden. Studies were carried out taking into consideration the environment, noise, pollution, barrier effects, aesthetics and development of the city along the roads. Different solutions with long and short tunnels were studied. Solutions with intersections underground were also studied. These studies resulted in a proposal that comprised roads with 3 – 5 km long tunnels with underground intersections. For many reasons we thought at that time that 4-5 km was the maximum length of a tunnel.

Södra Länken – the southern link
The first underground motorway constructed this way was the Södra Länken 1997 – 2004.

Figure 3: Södra Länken
Södra Länken (fig 3) is a new road traffic system that links Essingeleden, Huddingevägen, Nynäsvägen and Värmdöleden. It is approximately 6 km long, of which 4,5 km run through tunnels immediately south of Stockholm´s inner city under suburbs with many buildings. Most of the tunnels are blasted rock tunnels with shorter concrete tunnels where the tunnels reach the ground. Södra Länken is today Sweden’s largest road tunnel ever constructed and the most extensive road project undertaken in the Stockholm region since Essingeleden was built in the 1960s. This highly sophisticated road system also includes interchanges at Åbyvägen, Ärsta, Johanneshov, Nynäsvägen, Hammarby, Sickla and Värmdöleden. Södra Länken is designed as an urban motorway with three lanes in each direction: two lanes for through traffic and one lane for traffic entering or exiting the road. The speed limit is 70 km/h except for some ramps which are designed for 50 km/h.
Interior design
In shorter tunnels that were previously constructed in Stockholm there had not been a great effort put into the interior design (fig 4) of the tunnels. When the tunnels became longer and carried more vehicles it became important to be much more observant of the of the interior design. In order to find it attractive to drive down underground into these long tunnels the tunnel environment must seem like part of the city above. We have therefore put greater effort into the interior design of the tunnels. The tunnels are bright and rather wide, with different artistic designs together with ordinary traffic signs making exits easy to recognise. In addition the air in the tunnel is kept fresh through constant circulation. There are also many safety considerations (fig 5 ) in the design such as emergency exits every 100 – 150 meters.

Effects
Södra Länken helps reduce through traffic in the inner city areas by offering a smooth and easy alternative. It also creates better traffic flow. Traffic below ground improves the local environment, and conditions are created for building residential and business developments such as Hammarby Sjöstad and Sickla. Södra Länken entails better road safety for all categories of road users. Pedestrians and cyclists can move around more safely on local roads in the southern suburbs when the through traffic has been redirected through the tunnels. In addition driving is safer in the tunnels where traffic lanes run through parallel tubes without on-coming traffic. The traffic volume in Södra Länken is about 100 000 vehicles per day.

Norra Länken – the northern link
The next step in the Stockholm Ring Road is the Norra Länken (fig 6) now under construction since 2007.
Norra Länken runs between Karlberg and Värtan with a connection to Roslagsvägen at the university. Norra Länken will be about 5 km long. One kilometre of this is already built and opened for traffic as a surface road. The City of Stockholm now plans to put this part of the road into a tunnel because they want to develop a new district of the town with residential and office buildings above the traffic tunnel. Most of the new parts of Norra Länken will be housed in tunnels, with the longest single stretch of tunnel being about 3 km long. Eighty percent of the tunnels are blasted rock tunnels the remainder are concrete tunnels. The major part of Norra Länken passes underneath the City National Park.

The interior design for Norra Länken will similar to Södra Länken. But the idea is to use coloured light to a greater extent, rather than artistic installations. Architects and artists are now working on this.

Norra Länken solves traffic problems while opening new opportunities in the Stockholm region. Together with Södra Länken and Essingeleden, Norra Länken comprises a centrally located, inter-linking system. This northern link is vital to the economic growth and competitive ability of the entire region and is of national importance through its connection to the ports at Värtan. Norra Länken will also benefit local residents and road users in the area by directing cars and heavy transport vehicles into the tunnels. Ninety to ninety-five percent of the heavy lorries at Valhallavägen and Lidingövägen is expected to disappear. Access and mobility will improve while at the same time enabling the construction of new housing and business developments in north-eastern Stockholm. Norra Länken is also necessary for safer inner city streets for pedestrians and cyclists.

Norra Länken has essentially the same design as Södra Länken. It is designed as an urban motorway with six lanes in each direction: two lanes for through traffic and one lane for traffic entering or exiting the road. The speed limit will be 70 km/h except for some ramps which are designed for 50 km/h. When it opens for traffic in 2015 the volume is estimated to 100 000 vehicles per day.

The Western Bypass

The next step in the development of the road infrastructure in Stockholm is the Western Bypass which is now under design. Construction is planned to start 2012. It consists of a 17 km long tunnel in spite of the fact that it is it situated under partly undeveloped areas. The western bypass
is designed with three lanes in each direction and intersections underground. The speed limit will be 90 km/h and the traffic volume is estimated to 140 000 vehicles per day. The western bypass has been discussed for decades. The first idea for a western bypass was launched in 1960s. In this plan the entire length was suggested to be a highway with two lanes in each direction with only a short tunnel. This idea was discussed in the regional plans but never came to construction. The next part of the history for the western bypass started in 1980 when a new plan was launched. This time the suggestion was to have more of the road in tunnels (fig 7). Approximately one third of the total project was suggested to be placed in tunnels. This plan was never constructed and the planning of western bypass started once again in 2001.

Figure 7: The change over time of the western bypass in Stockholm

The planning of the western bypass (fig 8) has been very controversial. The road passes under an area that has high cultural and environmental value. The road passes within the buffer zone of Drottningholm which is a world heritage site. The planning has resulted in a long tunnel. Today most of the road is suggested to be in a tunnel. Out of a total of 21 km road length, the length of tunnels will be approximately 17 km.
The main reason for building the western bypass is to connect the southern and northern parts of the region, to create one market for housing and workplaces and last but not least to reduce the vulnerability in the region’s traffic system.