

The Follo Line Project

LONGEST. URBAN. COMPLEX. FASTER.



2015/1

The project

The Follo Line Project is currently the largest transport project in Norway and will include the longest railway tunnel in the Nordic countries. The new double track rail line forms the core part of the InterCity development southwards from the capital.

The Follo Line tunnel will be Norway's first long twin tube rail tunnel and one of the first to be constructed using tunnel boring machines.

The main construction work will start in 2015, with completion in the end of 2021. Important preparatory work with the alignment of the new line and the construction sites, are soon to be finished.

The project includes:

- ▶ new double track line between Oslo Central Station and the public transport hub at Ski
- ▶ 20 km long twin rail tunnel
- ▶ extensive work at Oslo Central Station
- ▶ construction of a new station at Ski and surface alignment
- ▶ necessary realignment of the existing Østfold Line, both on the approach to Oslo Central Station (with a new tunnel), and between the new Ski Station and the future tunnel for the Follo Line



Overview

Efficient and forward-looking

The Follo Line Project in total will comprise around 64 km of new railway tracks. The new double track line from Oslo to Ski will be 22 km long, and designed for speeds up to 250 km/h. The line will make it possible to reduce the journey time between Oslo and Ski by 50 % (from 22 to 11 minutes). The double track line will be an efficient, safe and environmentally-friendly transport system.

From a railway engineering perspective, constructing new lines in the densely trafficked metropolitan area around Oslo Central Station is a major challenge. Much of the work will be undertaken without disruption to the daily flow of traffic to and from this busy station.

An urban challenge

The Follo Line Project comprises four tracks to Oslo Central Station, which is Norway's largest public transport hub. Trains on the new Follo Line will run directly between Oslo and the public transport hub

at Ski. In tandem with the Østfold Line, which currently runs between Oslo and Ski, the Follo Line will give improved service to passengers.

Growth and the environment

The Østfold Line has reached its capacity limit. Simultaneously, a population growth of at least 30 % is anticipated in this region by 2025. The Follo Line will link residential and working areas together effectively and contribute to development in the region.

A large scale project

The Follo Line Project is comprehensive. Several different operations will be undertaken simultaneously, deadlines will need to be met and the project faces exciting challenges in terms of logistics and management.

During the construction phase, a large scale project of this nature will affect people, nature and the environment. It is required to cause as little impact

as possible. Properties that might be affected are monitored. Groundwater is monitored electronically. Thorough planning is essential in order to restrict the negative impact on the surroundings. Meanwhile progress and costs must be closely monitored.

From road to rail

The Follo Line will provide capacity for more freight trains. Around 80 % of land-based transport of heavy goods in and out of the country passes through the county of Østfold. The bulk of this traffic is currently handled by freight vehicles. One freight train can transport the same volume as around 24 heavy goods vehicles.

Challenges and requirements



The line will be constructed with connections to several platforms.



The Follo Line Project construction areas:

Oslo Central Station:

Between Oslo Central Station and the tunnel, construction of the Follo Line must accommodate other rail traffic in and out of Oslo Central Station. The line will be constructed with connections to several platforms.

In addition restrictions concerning the Medieval Park in Oslo must be taken into account, as this is of great archaeological and historical significance. The Directorate for Cultural Heritage in Norway, Oslo Municipality and the Norwegian National Rail Administration have reached a joint solution for conservation measures regarding both the introduction of the new Follo Line and the new tracks for the Østfold Line through an area known as 'Klypen'. This will provide the opportunity to establish a park area almost twice the current size.

The tunnel:

The bored section of the tunnel represents 19.5 km. The tunnel, which will pass beneath the Ekeberg Hill in Oslo, is about to become the longest railway tunnel to date in the Nordic countries.

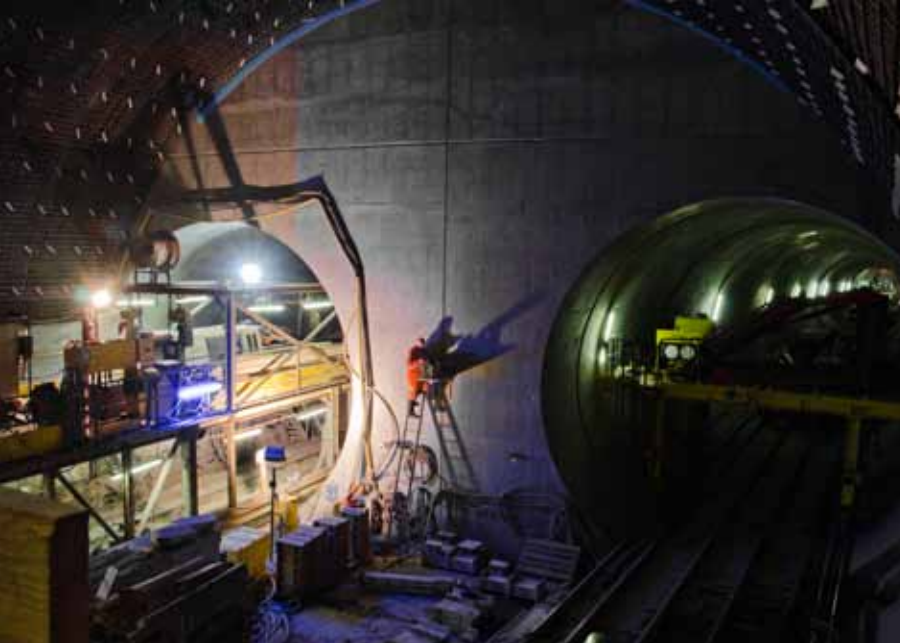


Excavation shall be performed by means of four hard rock shielded tunnel boring machines (TBM). This will be one of the first railway tunnels in Norway to be excavated by TBM, a technology that is otherwise common in the excavation of long tunnels in Europe. In addition, drill & blast techniques will be utilised for some of the tunnel work on the Follo Line Project.

Important criteria for the long tunnel:

- ▶ impermeable and safe
- ▶ long service life
- ▶ minimum maintenance requirements
- ▶ maximum "up-time" (to ensure reliable traffic)
- ▶ minimum impact on the local environment during the construction and in operation
- ▶ willingness to embrace technological solutions, skills upgrading and development

The tunnel will comply with inter-European safety requirements for long tunnels with cross passages approx. every 500 metres to be used as escape routes. The life expectancy of the tunnel will be at least 100 years. ▶▶



TBMs are well suited for the construction of this tunnel due to:

- ▶ the tunnel's length
- ▶ the rock characteristics
- ▶ generally adequate cover/overburden
- ▶ access to a large rigging area suitably located in relation to the tunnel and to the main road system
- ▶ limits the number of cross cut tunnels in populated areas

The tunnel will become the first long rail tunnel in Norway with twin tubes to facilitate:

- ▶ access to future operation and maintenance
- ▶ optimum train/traffic handling
- ▶ safety-evacuation

TBM technology

Drill & blast is the most common method used in tunnel construction in Norway. In the 70s and 80s, tunnel boring machines were also utilized although these were less complex and mainly used to excavate hydro-electric power tunnels.

The decision to use TBM paves the way for alliance-building, skills upgrading and innovation as both national and international participation is most likely in this project.

Quality and rock conditions

Tunnel boring is a system comprising precast impermeable concrete elements installed in a closed ring to ensure protection from rock fall, as well as water and frost. The space behind the concrete elements is filled with cement grout to seal the gap between the rock face and the ring.

Production and installation of concrete elements will form part of an industrialised process. This will help ensure a high and consistent quality of components, as well as the actual installation process. From a life cycle perspective, precast concrete elements in a closed ring will require less maintenance than the more traditional form of rock support using bolts and shotcrete.

Choosing machinery that is suited to the ground conditions and a crew experienced in operating under similar rock conditions, is essential. Extensive knowledge of ground conditions is an important prerequisite to success.

One major construction site

The rig area at Åsland, a rural site on the outskirts of Oslo, will include facilities for production of precast concrete segments. From the rig area two TBMs ▶▶

The decision to use TBMs paves the way for alliance-building, skills upgrading and innovation.

The new Ski Station will be built with six tracks and three central platforms, a new pedestrian underpass, a new road bridge, bus terminal and enlarged car park.

will be working towards Oslo Central Station to be connected to conventionally blasted tunnels in the Ekeberg Hill. A further two TBMs will be working in a southerly direction toward Ski to be connected to a future cut and cover section.

The entire TBM tunnel constructions will be accessed and supplied via two access tunnels at the rig area. All four TBMs will be launched from assembly caverns constructed at the bottom of these access tunnels.

Together, the access tunnels will cater for traffic to and from the main tunnel, as well as removal of excavated material by belt conveyors to the rig area. The tunnels are also important to secure air supply to the main tunnel. The assembly chambers for the TBMs will be reused as future rescue and evacuation facilities.

The TBM assembly chambers and the access tunnels will be constructed utilizing drill & blast techniques. The tunnel sub-project comprises all conventional made tunnels in the Follo Line Project, i.e. the relocation of the inbound Østfold Line, inner part of the twin tunnel, a number of crossings with existing tunnels and roads and a three-track tunnel at the

interface with the work to be made at the Oslo Central Station.

Open section and the new Ski Station:

The Follo Line will run along a 1.5 km open section south of the tunnel before reaching the public transport hub at Ski. Retaining walls and culverts (concrete tunnels) will be built along this section, and it will be necessary to realign the Østfold Line in order to achieve efficient train operation.

Within the station area itself, the new Ski Station will be built with six tracks and three central platforms, a new pedestrian underpass, a new road bridge, bus terminal and enlarged car park. Accessibility, efficient transport and integration into the urban landscape are important factors to the Norwegian National Rail Administration.





Excavated materials – a resource

During construction of the Follo Line, around 10-11 million tons of rock spoil will be removed within a period of around 3-3.5 years.

Contractors are required to reuse excavated material. This will include the use of suitable excavated materials for segment production.

From an environmental and social perspective, it is important to achieve the most effective utilisation of resources. A minimum of transport and safe transport of excavated material is necessary in order to minimize the impact on the local environment.

From an environmental perspective, it is advantageous if excavated materials can be of use at Åsland, or be transported from this rig area, which has direct access to the E6 European highway.

Contractors will be required to maximise the reuse of excavated material wherever possible.

More sustainable transport

Trains are the most environmentally friendly mode of transport we have, if we disregard cycling and walking. However, the construction of rail lines burdens the environment. Therefore the Follo Line Project imposes environmental requirements, in accordance to Norwegian laws, regulations and the corporate goals of the Norwegian National Rail Administration.

The main requirements are aimed at transport of the excavated material, noise protection during the construction phase and considerations regarding vulnerable species and the groundwater.

The best contractors

The Follo Line Project has invited to tender for four EPC contracts, both nationally and internationally, in addition to the Signal contract (frame agreement). EPC is an acronym for engineering, procurement and construction. This is a recognized contracting arrangement within the construction industry, adapted for the Norwegian National Rail Administration by the Follo Line Project.

All contracts are scheduled to be signed in 2015. The

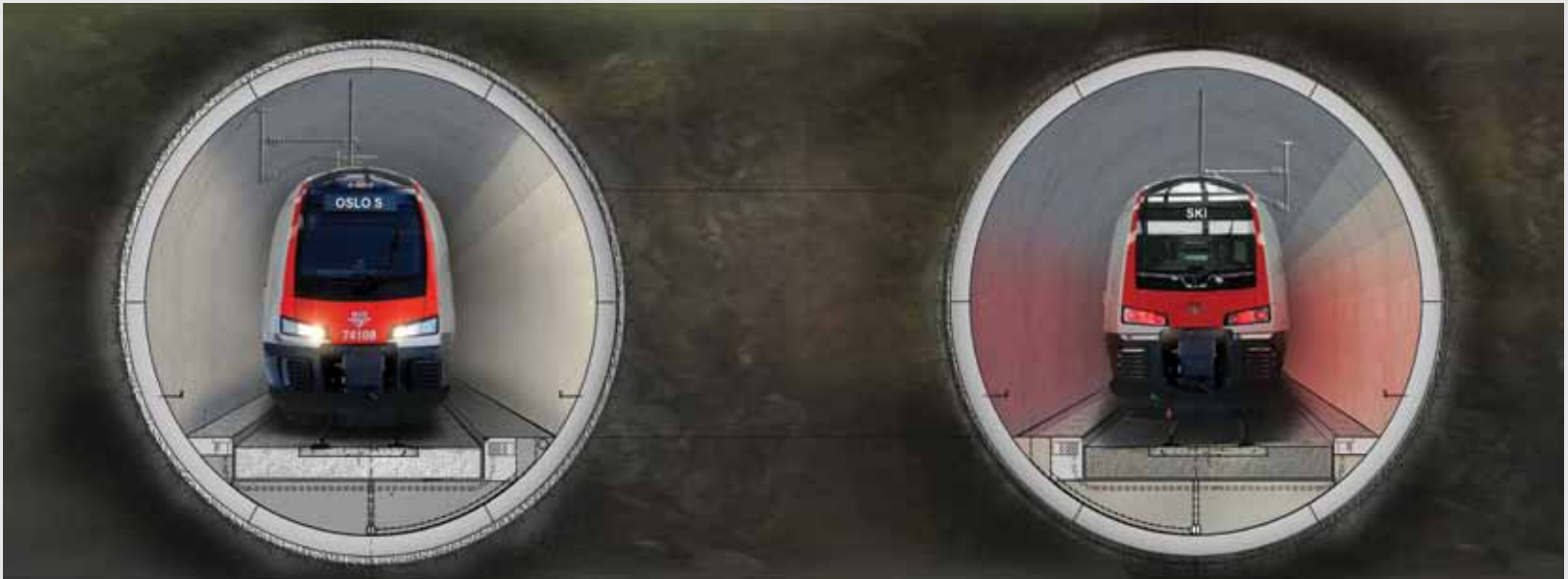
project is split into the following EPC contracts: Oslo Central Station, conventional blasting of rail tunnels in the Ekeberg Hill, TBM excavation of the twin tube rail tunnel, Ski station/open section and Signal.

Important preparatory work with the alignment of the new line and the construction sites will be completed in summer 2015.

Based on the size of the project, a suitably adapted contract strategy has been formulated. General contractors will be used as much as possible. Simultaneously the Norwegian National Rail Administration's expertise will be leveraged and the role as developer will be cultivated.

The Norwegian National Rail Administration would like to encourage cooperation and competence building that may benefit the further construction of rail lines in the InterCity triangle and further strengthen Norwegian tunnel-building expertise on the international stage.

The Follo Line Project is developed by the Norwegian National Rail Administration under commission from the Ministry of Transport and Communications.



The Follo Line Project: Five EPC contracts

Oslo S	Tunnel		Langhus-Ski
	D&B	TBM	
EPC contract no. 1	EPC contract no. 2	EPC contract no. 3	EPC contract no. 4
Civil work	Civil work	Civil work	Civil work
+ Railway systems	+ Railway systems		+ Railway systems
Signal (Frame-agreement)			

Facts about the Follo Line Project

- ▶ currently Norway's largest transport project
- ▶ 22 km new double track line from Norway's capital to the Ski public transport center
- ▶ will comprise a 20 km long tunnel; Norway's longest railway tunnel to date and the first long railway tunnel to have separate tubes
- ▶ one of the first railway tunnel in Norway to be excavated with tunnel boring machines (TBM)
- ▶ the project includes extensive works at Oslo Central Station and the construction of a new station at Ski
- ▶ includes the necessary realignment of tracks for the existing Østfold Line on the approach to Oslo Central Station and between the tunnel and the new Ski Station
- ▶ will comprise the construction of around 64 km new railway tracks
- ▶ provides increased traffic capacity to/from Oslo
- ▶ will enable a 50 % reduction in journey time Oslo-Ski
- ▶ designed for speed up to 250 km/h
- ▶ important preparatory work started in 2013
- ▶ main construction phase commence in 2015
- ▶ scheduled for completion in 2021
- ▶ forms the core part of the InterCity development southwards from Oslo
- ▶ may be combined with a possible high-speed line to the continent



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The Swedish Transport Administration / Herrenknecht AG /
Ostra / Metropolitan Transportation Authority /
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www.jernbaneverket.no/follobanen