

Project

- Ryfast tunnel project consisting of three tunnels:
 - Solbakk tunnel (14 km)
 - Hundvaag tunnel (5.5 km)
 - Eiganestunnelen (3.7 km)
- Double tube tunnel
- Excavation with drill & blast method
- Contractor: Marti IAV Solbakk DA for the lot EO2 (8 km)
- Costs: 1.3 billions CHF

Duration

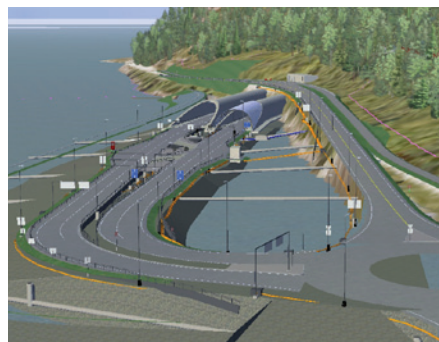
- 2012-2019

Tasks

- Automatic positioning of Sandvik drill rig by the tunnel crew themselves
- "Real-time" as-built analysis and documentation for over/underbreak
- Operation of the system by the tunnel crew
- Daily scans directly in the tunnel heading

Amberg Navigator was chosen to build the world's longest sub-sea road tunnel

The Ryfast tunnel project, the world's longest sub-sea road tunnel, is situated close to Norway's fourth largest city of Stavanger. The project consists of three tunnels: Solbakk tunnel (Ryfast), Hundvaag tunnel (Ryfast) and Eiganes tunnel. The main goals of the project are the establishment of a permanent road link between Ryfylke and Nord-Jaeren (Ryfast) and the reduction of traffic through the northern parts of the city centre (Eiganes tunnel).



The excavation of the Solbakk tunnel started in August 2013. It is the main tunnel of the project with a total tunnel length of 14 km. The two headings are being excavated by drill and blast and will reach a maximum depth of 290 m below sea level (source: Statens vegvesen, 2013). For the first time, a new and innovative software, Amberg Navigator, is in use which allows autonomous tunnel heading guidance operated by the tunnel crew themselves.

Surveying tasks at the Ryfast project

The heading surveying tasks are conducted by Marti IAV Solbakk DA which are responsible for the contractor surveying. For the drill and blast heading, new Sandvik drill rigs with intelligent drilling automation are used. After each advance,



“The use of Amberg Tunnel makes it possible for personnel from other sectors to carry out simple, routine surveying tasks reliably, efficiently and independently.”

This means that on both ends, unnecessary waiting times can be avoided because the measurements required can be integrated directly in the work procedures.”

Jürgen Wilhelm
Surveyor Engineer
Solbakk tunnel project in Norway
Marti IAV Solbakk DA

Challenges

- Two headings at the same time
- Real-time analysis
- 24 hour shifts

Products Used

- FARO Focus 3D I20
- Amberg Navigator Tablet Software
- Leica TS15 Total Station
- TMS Tunnelscan and TMS ProFit Software

Contact

Amberg Technologies AG
Trockenloostrasse 21
8105 Regensdorf-Watt
Switzerland
Phone +41 44 870 92 22
tunnel@amberg.ch
www.amberg.ch/at

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the tunnel crew has to check the blast independently. Immediately after the measurement, the tunnel crew has to mark, if necessary, potential underprofile on the tunnel surface and control the re-excavation to assure profile compliance.

Heading guidance with Sandvik drill rigs

The new Sandvik drill rigs come with a semi-automatic drill functionality. The position and the orientation of the drill rig within the tunnel coordinate system are determined with a total station. The tunnel crew has to install the total station behind the drill rig, then start the “Tripod automatic” positioning method within Amberg Navigator Tablet. This new feature allows the tunnel crew to set up the total station automatically without knowing the point IDs of the control points in the tunnel.

Once the total station is positioned, the two prisms on the drill rig are measured and their coordinates are transferred to the Sandvik iSure system for calculation of the drill rig’s position and orientation. After that, the drill rig starts to drill the new holes into the tunnel face.



Selection of the “Tripod automatic” positioning method



Selection of the “Profiles excavation” measuring task

Excavation control – “real-time” as-built surveying

On the Ryfast project, traditional total station and 3D laser scanning technology were chosen. Total stations are used by the tunnel crew for positioning of the drill rig and profiling. In addition, the surveyor uses 3D laser scanning for a complete and detailed as-built analysis from time to time.

In the past, as-built surveying was done mostly by surveyors. The main reason for this was to control the heading guidance surveying independently. Nowadays, this task is often carried out by the tunnel crew themselves in order to optimize the tunnel heading process and minimize downtimes on the construction site. Jürgen Wilhelm, surveyor engineer also says: “The use of Amberg Tunnel makes it possible for personnel from other sectors to carry out simple, routine surveying tasks reliably, efficiently and independently.”

The results of the profile measurements are displayed to the tunnel crew immediately. Under- and overprofile areas are highlighted in the results. The underprofile can then be marked on the tunnel surface. After the re-profiling, an optional profile measurement step can be done for documentation purposes.



Open for new Amberg Navigator tasks

As the Ryfast project was one of the first projects in which Amberg Navigator was used in Europe, we also maintained very close contact with the surveying team on site. We listened to the needs reported from the site and implemented improvements immediately or generated new Amberg Navigator task for them such as “Drill rig automatic” or “Scanner APM measurement”.

Amberg Navigator helps keep the project costs low

The contractor and site users at the Solbakk tunnel confirm that the surveying tasks in the tunnelling process can be optimized by the use of Amberg Navigator. Jürgen Wilhelm states: “The use of the software helps avoid unnecessary waiting times because the measurements required can be integrated directly in the work procedures”.



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