



A new tunnel will supplement the existing bridges and ferries in Stavanger

TUNNEL VISION

NORWEGIAN TUNNELLING CREWS USE RUGGED MOBILE TABLETS TO AUTOMATE SURVEYING AND MINIMISE DOWNTIME. SOFIA LÖFBLAD REPORTS

Workers who blast tunnels 290m below the ocean's surface have plenty of 'what ifs' to consider. Technology failures and project budgets shouldn't be among them. So contractors working on Norway's Ryfast tunnel megaproject are using rugged mobile technology to ensure a reliable, safe and efficient excavation process that minimises downtime and reduces personnel costs.

Crews are using the Amberg Navigator from Amberg Technologies, a solution that packages the Amberg Tunnel surveying software with Handheld Group's Algiz 7 rugged tablet PC. Amberg Navigator enables tunnel workers to take precise measurements, generate tunnel profile graphics in real-time, and compile detailed reports, eliminating the need for separate surveying crews. Best of all, workers can perform these tasks with no previous surveying experience and very little computer training time.

A tunnel beneath the sea

Norway's west coast is made up of hundreds of small islands and fjords — areas where seawater reaches into narrow, deep valleys with high cliffs formed by glacial erosion. People travelling to and from the coastal city of Stavanger, the country's fourth-largest metro and the hub of its offshore oil and gas industries, currently use bridges and ferries to access areas separated by water.

The new Ryfast tunnels will connect Stavanger to Norway's Ryfylke region, replacing a ferry between the two areas and cutting travel time by two-thirds. One tunnel segment will link Stavanger's Hundvåg borough to a small island called Hidle, and a second will connect Hidle to the town of Solbakk in Ryfylke.

Upon its completion in 2018, Ryfast will be the world's longest, deepest subsea roadway tunnel, spanning 14.3km and reaching 291m below sea level at its deepest point. Swiss tunnel construction company Marti IAV Solbakk DA won a contract to build the Solbakk segment, which will include the tunnel's deepest point. It will also feature a 7% gradient slope — the maximum tunnel gradient allowed.

For the drill and blast heading, new Sandvik drill rigs with intelligent drilling automation are used. After each advance, the tunnel crew must check the blast from the previous day independently. Immediately after the measurement, the tunnel crew has to mark potential underprofile on the tunnel surface and control the re-excavation to assure profile compliance.

A rugged technology breakthrough

To extend the tunnel through hard rock beneath the sea's surface, workers drill holes through the material in precise locations using enormous semi-automatic drill rigs. Explosives placed in those holes blast the rock away, and conveyor belts remove this material from the site.



Laser scanner measurements with TMS Tunnelscan in front of the tunnel face to determine the complete information of as-built control



The surveyor measures convergence points to analyse the displacement of the tunnel surface

Traditionally, hole placement for the 'drill and blast' method of tunnel construction has been determined by surveying crews, who measure tunnel profiles and use this data to mark hole patterns or georeference drill rigs. But using the Amberg Navigator's automated surveying software has eliminated the need for these extra surveyors; the tunnelling crews themselves can quickly and easily perform surveying tasks with detailed real-time analysis.

"The Amberg Navigator helps avoid unnecessary waiting times because the measurements required can be integrated directly into the work procedures," says Jürgen Wilhelm, a Marti surveyor engineer.

The engineering challenges workers face in the tunnel are amplified by the frigid, wet environment where they perform their work. The tunnel's surfaces can range from muddy and slippery to rough and jagged; temperatures can drop below freezing; and humidity, dust and potential drops all pose threats to ordinary technology. Every piece of equipment at the construction site must be able to withstand very harsh conditions.

With these requirements in mind, Amberg Technologies chose the Algiz 7 rugged tablet. In order to have adequate speed and memory to process profile data, the Algiz 7 has an Intel Atom processor, 128GB storage, 4GB of DDR3 RAM and Windows 7 Ultimate. Despite weighing only 1.1kg, it also meets stringent MIL-STD-810G US military standards for withstanding humidity, vibration, drops and extreme temperatures, and meets IP65 standards for sealing out dust and water.

A one-tablet control center

With the Amberg Navigator, crews can measure tunnel profile data quickly and easily, display visualisations of that data in real time, and save detailed data logs. This solution is extremely simple to use, even without any previous knowledge of surveying. The software automates



Handheld tablet with the Amberg Tunnel software

all measuring tasks, which workers can select and manage with one touch by tapping large, easy-to-interpret icons with illustrations.

"Workers can control and verify an entire tunnel project with a single tablet," says Oliver Schneider, Amberg Technologies product manager.

To take measurements, workers use a total station — an electro-optical scanning tool that measures angles, distances and coordinates. They position the total station on a tripod or console aimed toward the area to be measured. Then the Amberg Navigator communicates with the total station using Bluetooth, automatically adjusts the total station's viewing area, and initiates profile data collection.

The Navigator can automatically profile a tunnel at pre-defined stations; it highlights areas where a blast has taken away too much or too little material; and it evaluates surface-layer thickness and displays the data graphically on the screen. With this information, workers can use the Navigator to set precise blast patterns and control drilling machinery.

"The system makes it possible for personnel from other sectors to carry out simple, routine surveying tasks reliably, efficiently and independently," Marti's Wilhelm says.

THE ENGINEERING CHALLENGES WORKERS FACE IN THE TUNNEL ARE AMPLIFIED BY THE FRIGID, WET ENVIRONMENT WHERE THEY PERFORM THEIR WORK

Sofia Löfblad is marketing director at the Handheld Group (www.handheldgroup.com)



The 'Profiles excavation' measuring task