Monitoring the stability of a rock cliff on a Swiss road and rail route

Country

Switzerland

Project type:

Geophysical monitoring

Sector:

Rail/road

Main product:

Monitoring Solution

Challenge

The Swiss trans-alpine Gotthard railway is a key part of the rail network linking north and south Europe. Carrying passengers through the Gotthard Base Tunnel, which opened in 2016 and is the world's longest and deepest rail tunnel, the line carries more than 10,000 people and 67,000 tonnes of freight a day.

Near the small town of Sisikon, on the banks of Lake Lucerne, the rail line and a nearby road both pass underneath a 120-meter overhang. The feature is impressive—and potentially dangerous should rocks fall onto the tracks below. With some sections having proved to be unstable, it was vital to secure the cliff and monitor it for possible movements.

Solution

The rock face was stabilized with nets secured by rock bolts. A part of the rock cliff has been reinforced with an anchored concrete support structure. During the stabilization work, four boreholes to a depth of 20 meters were drilled to fit three-point borehole extensometers. Four ground anchor load cells were also fitted into the rock face monitoring system. The issue was how to collect the data from these sensors placed across the rock cliff. The only way to take manual readings would be to send professional maintenance climbers to do so; a rather dangerous and expensive undertaking. Automatic monitoring could have been achieved also by installing cables for data transmission from the extensometers and load cells to a data logger, however one can imagine the difficulties in installing cables and cable ducts on a vertical 120m high rock cliff.

Because of the difficulty in accessing the site, the Swiss engineering structure monitoring specialist Huggenberger, part of the advanced geotechnical instrumentation leader Sisgeo, opted to install a wireless data collection solution from Worldsensing. Each extensometer is fitted with an analog four-channel node and every anchor load cell is connected to a Worldsensing Piconode, a one channel "mini node". The nodes send data to a solar-powered, wireless gateway located beyond line of sight on a tunnel entrance wall.

The entire monitoring network and devices are monitored and managed through CMT Edge, an on-premise network management tool, capable of showing the status and health of all devices across the Worldsensing network and in turn is connected to the Huggenberger-Monitor analysis system via API.

"In the past, we did this with cables, but of course it's an effort. For the construction company it would have been a lot of work. It's not really competitive anymore to use cable systems in such projects."

Daniel Naterop
Project manager
Huggenberger

Benefits

The wireless monitoring solution entered operation in October 2021 and feeds data every two hours to a Huggenberger-Monitor analysis system that can be accessed by the Swiss Federal Roads Office. Using Worldsensing technology for wireless data collection offers many advantages. Installation is easier and more cost effective without cables, for example. And there is no risk that sensor data could be lost because of damaged cables, which could happen due to rock falls or animals.

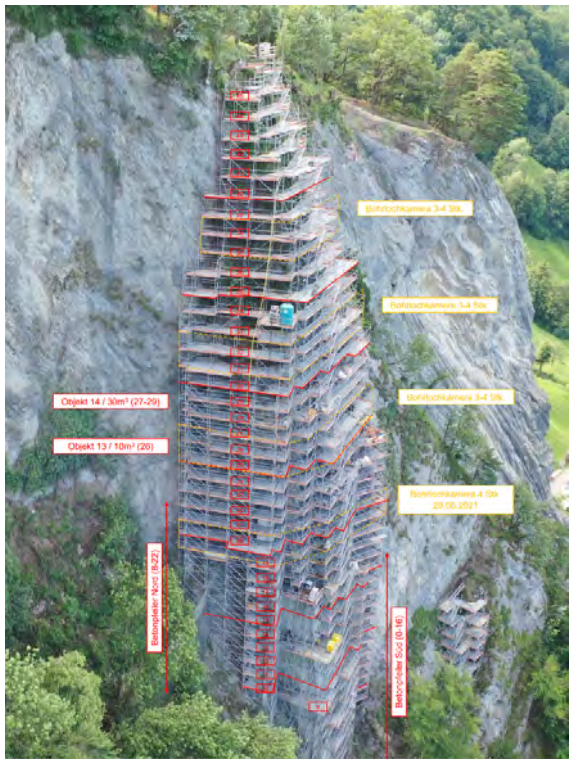
The risk of damage from animals is particularly acute in this region, which is why Piconodes were used instead of four-channel nodes to connect the load cells even though the sensors were only 20 meters apart. Although the reliance on solar power can hamper communications in winter, Worldsensing's use of low-power, wide-area (LPWAN), long-range (LoRa) technology means there is practically no loss of data at other times, providing reassurance that all is well on the pass.

About Huggenberger

Within the Sisgeo Group, Huggenberger AG is a small, independent Swiss company specializing in the development and production of high-precision physical measuring systems. Founded in 1900, the company was able to establish itself as a specialist for the instrumentation of dams with the instrumentation of the Schräh dam in Wägi Valley, Switzerland, once the world's highest hydro dam at that time. Since then, over 450 civil engineering works, mainly concrete dams, have been equipped with Huggenberger measuring instruments.

Advantages

- Improved safety during the course of a major infrastructure construction project
- Low-cost thanks to the wireless nature of the monitoring system
- Real-time alerts delivered via SMS and email



Dornisporn rock cliff monitored by Huggenberger with borehole extensometers and anchor load cells.