

Geotechnical monitoring of gravitational natural hazards

Huggenberger AG was commissioned in 2018 and 2019 to install and operate systems for monitoring gravitational natural hazards. A selection of these projects and the system components used are described below. In all these projects, radio sensor networks were used, which are characterized by large radio ranges, even in difficult terrain and long autonomy in battery operation. In addition, the customer and the responsible organizations have access to the Huggenberger-Monitor web platform, on which the measurement results, the status regarding limit violations and alarm, information about the object to be monitored and the measuring system are available.

Rock wall Kitzmaiss, Ovella: On the border between Austria and Switzerland, in the Lower Engadine, construction is underway for the Inn power plant, the Ovella weir and the inlet structure for the 23.4km long pressure gallery under a massive rock wall up to approx. 650mm high. A Huggenberger system monitors the rock displacement at 36 measuring points and alerts the responsible people and organizations in the event of an incident. The measuring points each consist of Huggenberger Telejointmeters. Each of them is combined with a WRLog mini-node and installed in the rock wall to detect precisely displacements between individual blocks rock gaps. They transmit the measured values to the gateway by radio. The measured values are continuously transferred from the gateway to the Huggenberger-Monitor internet data platform to display the data measured and to trigger an alarm by SMS to the responsible organizations and persons in the event of an exceeding of limit values.



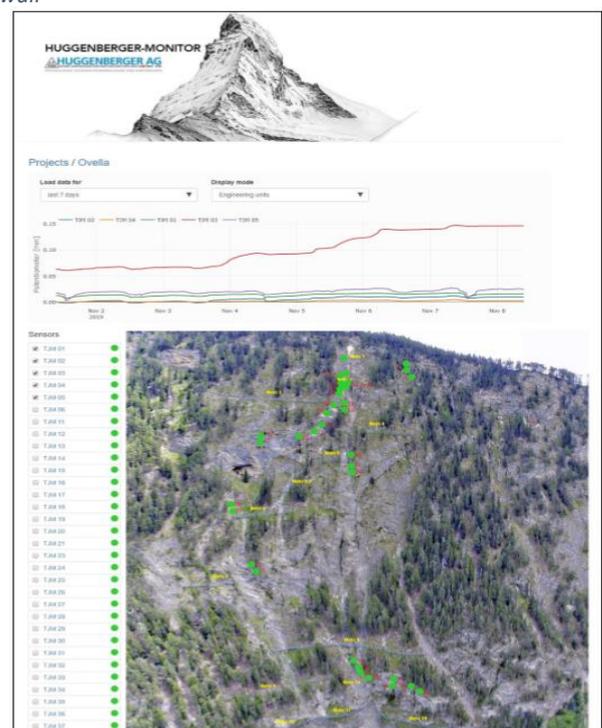
Telejointmeter with Node



Sensor mounted in a rock wall



Rock cliff Kitzmaiss (in the ground of the valley the Ovella weir)



Internet- Data Platform

Weggis, Spare rock wall: The Spare Nagelfluh rock wall is located above the busy connecting road between Weggis and Vitznau, which runs along Lake Lucerne in Switzerland. In front of the wall stand individual large blocks, some of them detached from the wall, which are monitored by Huggenberger-measurement technology. Rock displacements are monitored using 20 Telejointmeters and a laser distance meter. In addition, 3 air temperature sensors are installed to determine the effects of temperature to the rock displacement.

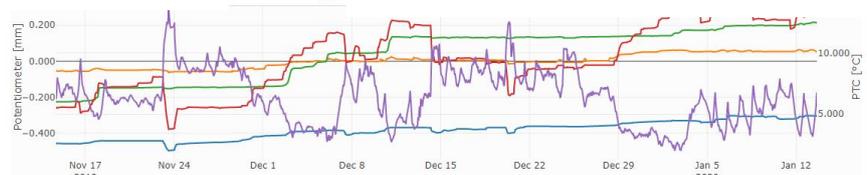
Also here the WRLog system is also used. The Telejointmeters are connected in groups to 4-channel radio modules. The nodes continuously send their measured values to the gateway via radio data transmission. These measured values are immediately transferred to the Huggenberger monitor data platform and are available as tables or in diagrams on an overview photo.



Laser distance measurement sensor



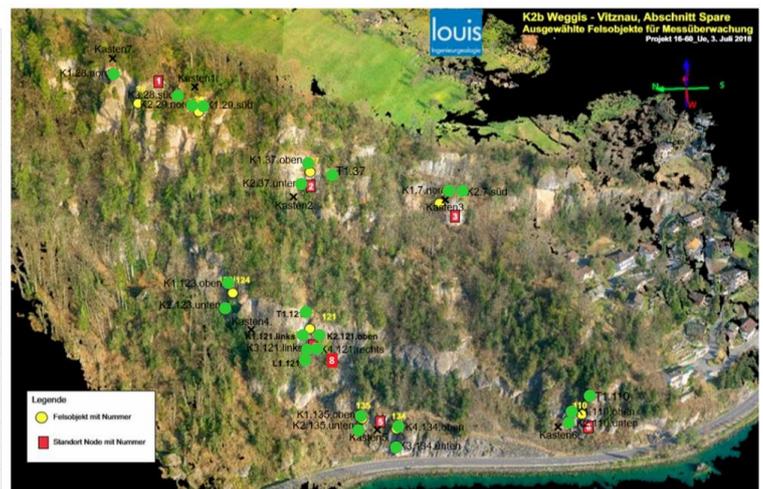
Telejointmeter sensor



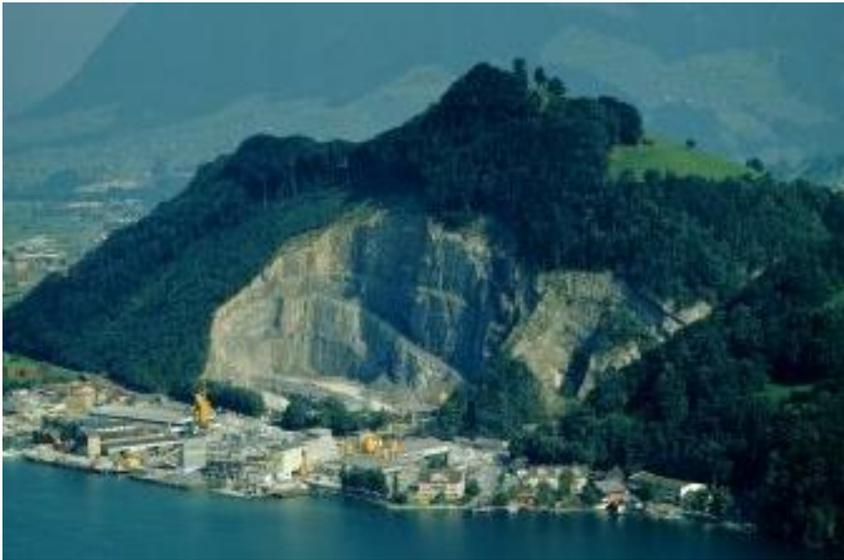
Sensors

- K1.135 oben
- K2.135 unten
- K3.134 unten
- K4.134 oben
- K1.110 oben
- K2.110 unten
- K2.123 unten
- K1.123 oben
- K3.121 links
- K4.121 rechts
- K1.28 nord
- K1.37 oben
- K2.37 unten
- K1.7 nord
- K2.7 süd
- K1.29 süd
- K2.29 nord
- K3.28 süd
- T1.110
- T1.37

Spare Internet-Data platform



Rotzloch quarry, Stansstad: The displacements of individual critical blocks against the rock face have been measured and monitored at a total of 7 measuring points using manually measured telejoint meters for several years. In order not to endanger the persons entrusted with this work, these measurements were only carried out in good weather conditions. On the one hand, this led to long measurement intervals and periodically to long measurement interruptions of several months. In addition, individual cables that reached the access point at the top of the quarry were damaged by rock fall. In order to optimize the effort for measurement and maintenance as well as the frequency of measurements, the customer, Steinag AG, decided to install and operate, an automatic system with Telejointmeters and a temperature sensor that is operated with the WRLog radio data transmission network.



Telejointmeter sensor

Quarry Rotzloch,

Huggenberger wireless sensor networks

The system essentially consists of the sensors, the nodes, the gateway and the Huggenberger-Monitor data platform.

Different tasks require different sensors:



Borehole extensometer, anchor load cell, clinometer

- Telejointmeter for displacement measurement over individual fissures, convergence extensometer for distances over 1m to approx. 4m and over large distances between widely spaced boulders using laser distance meters
- Water pressure sensors for measuring pore water pressures groundwater levels, which often have a significant impact on rock and ground movements
- Inclinometers are used to detect tilt of rock structures and supporting structures (retaining walls, nail walls, etc.) with high precision.
- Borehole extensometers record shifts in soil and rock over one or more sections in the rock and ground
- Load cells allow monitoring of soil anchors and rock nails.
- Inclinator measuring chains record and monitor deep sliding movements in vertical and horizontal boreholes.

The **WRLog system** mainly consists of the following components:

- The nodes are data loggers which transmit the measured values to the gateway using LORA radio. We can assume transmission distances of several kilometers and a battery operating time of several years. This eliminates the need for complex cabling work and the otherwise necessary surge protection.
- The gateway connected to the power supply is the receiver for the nodes and sends the data to an FTP server on the Internet. The data can also be queried via API.



WRLog-Node and Gateway

The **Huggenberger-Monitor** web platform is prepared as a project website and provides the measured values graphically and numerically, can trigger alarms (as SMS or email) and summarizes the entire monitoring information on a password-protected website.

Links:

[Gemeinschaftskraftwerk Inn GmbH](#)

[WRLog-System](#)

[Telejointmeter](#)

[Huggenberger-Monitor](#)