Special Topic

Remote Monitoring of flexible protective Structures against natural Hazards – Increasing Safety and Reducing Costs

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Geobrugg AG in Romanshorn, Switzerland, has developed a remote monitoring system for flexible protective structures against natural hazards. It can be used for protection systems of different manufacturers. Monitoring is simplified and maintenance can be better planned.

Geotechnics • Slope stabilisation • Monitoring • Automation • Safety • Cost efficiency

Fig. 1: Rockfall barrier with sensor device

The melting of permafrost and frequent heavy rainfall events are leading to a requirement for protection against rockfall and debris-flow in more and more places. In the last 30 years, rockfall barriers made of steel wire nets have established themselves worldwide as a protective solution. During this time, the maximum energy-absorption capacity of these flexible barriers has multiplied [1]: from about 1,500 kJ in the mid-1990s to 10,000 kJ in 2018. Since 2008, thanks to a standardised test method (ETAG 027, now EAD 340059-00-0106 [2]), rockfall barriers can be certified according to their performance. In parallel with these flexible rockfall barriers, flexible debris-flow barriers were developed and installed worldwide.

Protective structures are mainly built in the mountains, or on sea coasts. The systems are usually located in rough terrain. They are therefore often difficult to reach and cannot be visually monitored. In recent decades, the inspection and maintenance of such facilities has in many places been neglected. The Swiss company Geobrugg AG has therefore developed a new type of sensor device, the Geobrugg Guard: It simplifies monitoring and makes maintenance plannable (**Fig. 1**).

Maintenance of Barriers depending on Event and Location

In practice, those responsible usually define intervals for the on-site inspection of the barriers. This can take place once to several times a year. But even with frequent inspections, an event can remain undetected for a long time. If an event, for example a major rockfall, then reduces the protective capacity, there will be a safety risk until the next inspection.

Apart from gravitational natural events, corrosion is the most important factor for a reduced service life of installations. Nowadays, the corrosiveness of the envi-

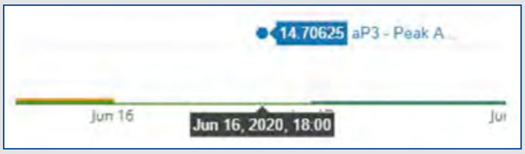
Service-life Prediction of Wire Zinc Coatings according to EN ISO 12944-2 [3]

The predicted service life of a protective structure, for example, can be between 30 and 90 years depending on the defined climate and standard. Without ongoing measurements, the lowest value must be assumed, and this can cause unnecessary costs; it is also not convincing in terms of sustainability. With ongoing measurement, the infrastructure operator knows the real corrosion situation and can act accordingly.

Fig. 2: Sensors on different components of rockfall barriers

Fig. 3: Automated transmission of external monitoring results via GSM network to a dashboard

Rockfall Report from Heiligenberg



On 16 June 2020, a rockfall occurred above state road 201 near Heiligenberg in the state of Baden-Württemberg, Germany. It was a boulder with a size of 100 cm x 100 cm x 40 cm and a mass of around 1,000 kg. The boulder was successfully restrained by a ring net rockfall protection system after a deflection of about 2.5 m.

A Geobrugg Guard installed in the field adjacent to the impact recorded the rockfall event: Acceleration 14.7 g, date 16.06.2020, time 18:00:32. The event triggered a report of this data via Dashboard. This enabled those responsible for maintenance to take appropriate action.

ronment is defined according to ISO 12944-2 [3]. This environment definition leaves a great deal of scope for interpretation. According to ISO 12944-2 [3], the service-life prediction of, for example, wire zinc coatings according to DIN EN 10244-2 [4] is always inaccurate by a factor of at least two (see **Box**).

In corrosive environments, for example near the sea or when salt is spread on roads in winter, the service life of barriers decreases. Other factors, such as salt ingress, wind, north or south exposure, have a significant influence on corrosion. It is therefore important to have exact information on the microclimate in which the barrier is located.

Measure and Report – independently and continuously

To document events and corrosion in-situ at the barrier, the Geobrugg Guard sensor device monitors protective structures around the clock. The sensor devices can be installed in a short time on different components of barrier systems from different manufacturers (**Fig. 2**). Thanks to their independent energy supply, they operate for up to ten years without on-site checks.

Acceleration sensors, position sensors and force sensors measure events. Environmental and physical data are transmitted via GSM network and the message appears on the online dashboard (**Fig. 3** and **Box** on the rockfall report from Heiligenberg). Those responsible thus know the condition of their barrier not only directly after an on-site inspection, but on an ongoing basis.

In addition to the sensors mentioned above, a corrosion sensor permanently determines corrosion-relevant environmental influences. The measurements allow an accurate prediction of the service life of the installed components at the respective location and a safer, more efficient operation and maintenance of the installations.

Conclusion and Outlook

Geobrugg Gard is now in operation in more than ten countries, using automated monitoring to increase the operating safety of barriers against natural hazards and to reduce the cost of their maintenance. Further developments in sensor technology and increasing digitalisation are making positive contributions to these effects. Automated monitoring offers considerable potential for reducing the impact of natural hazards in future.

References

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