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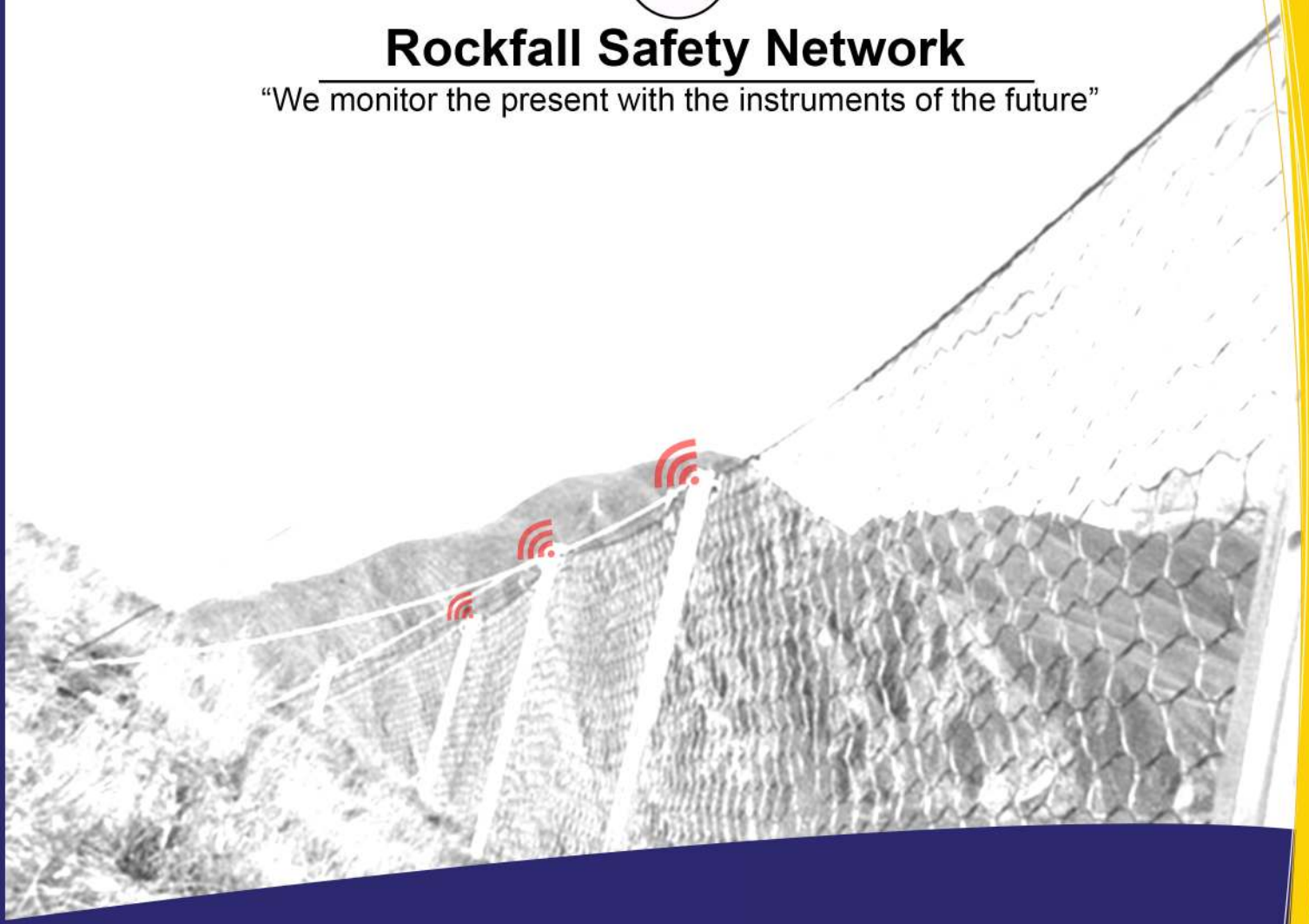
Rockfall Safety Network

"We monitor the present with the instruments of the future"

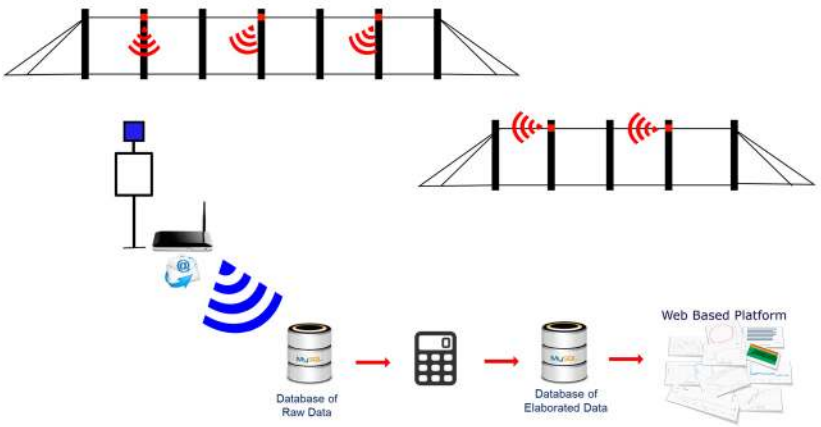


MUMS
modular underground monitoring system

Rockfall Safety Network

ASE s.r.l. produces and commercializes innovative instrumentations designed for geotechnical and environmental monitoring. Our systems are fully automated, while the data management involves the acquisition, storage, elaboration of data along with their representation through a web-based platform. We have introduced the Internet of Things principles in the geotechnical field, what we define the Internet of Natural Hazards.

Rockfall Safety Network is the system designed by ASE S.r.l. for the monitoring activity of rockfall barriers after their installation on-site. Moreover, the innovative approach followed by the system aims to exploit these structures as control elements, in order to evaluate the stability conditions of slopes where the monitored barriers are installed. The proposed technology allows to identify from remote the presence of material on the barrier, providing also an indication regarding the work rate of the structure. At the same time, the system is able to detect impacts on the barrier with a near-real time approach, allowing to disseminate alert messages to authorities responsible of the monitoring activities. In case of Early Warning operations, the systems is able to send SMS and e-mails, and permits the control and activation of several tools including traffic lights, variable message signs and acoustic alarms.



The RSN system is composed of a series of different sensors, allowing to integrate automatic procedures for the sampling and monitoring of several parameters of interest. The placement of multiple devices along the same barrier allows for a comprehensive control of the structure behaviour.
Each single module installed on the barrier includes the following sensors:

- **MEMS (Micro Electro-Mechanical System)**
- **Electrolytic tilt sensor**
- **Strain gauge load cell (OPTIONAL)**
- **Trigger element**

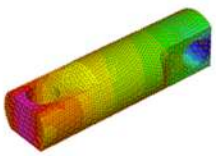
MEMS and electrolytic sensors are encased within an IP68-certified metallic box, defined BPM module, and specifically designed to withstand high-intensity vibrations. Its installation on the barrier steel post is performed thanks to a dedicated connector, which can be adapted to several models of rockfall barriers and allows for a rapid removal at the end of the monitoring activity. The presence of two independent tilt sensors provides redundant information about the steel post inclination,with an accuracy up to 0.003°. The strain gauge load cell is designed to monitor the forces acting on the upstream steel wire ropes, providing a measure of the stress state related to a single steel post. The module operativity is guaranteed for a duration of 2 years by the presence of 2 Lithium batteries.
The multi-parametric approach permits to identify both high-intensity events, represented by a rotation of the steel post and/or a brake elongation, and low-intensity events that have no influence on the brake elements, but can be detected by the increasing load measured on the upstream steel wire ropes.
The system comprehends also an electro-mechanical Trigger device, able to indetify automatically an impact on the barrier. Thanks to the implementation of this tool in the monitoring instrumentation, the Rockfall Safety Network can be considered an Early Warning System (EWS). In fact, when a specific impact activates the Trigger component, the system automatically queries every sensor placed on the barrier and sends acquired data to the elaboration centre. Then, a dedicated software identifies the critical event and enables the dissemination of alert messages (SMS and/or e-mail) to predefined users and the activation of different alarm devices (traffic lights, variable message signs and acoustic alarms).

STEEL POST ROTATION

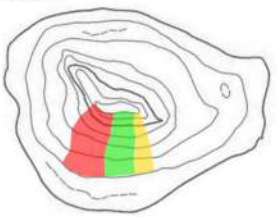
Each module is equipped with a MEMS sensor and an electrolytic tilt sensor, allowing the monitoring of steel post rotations with an acuracy of 0.003°.

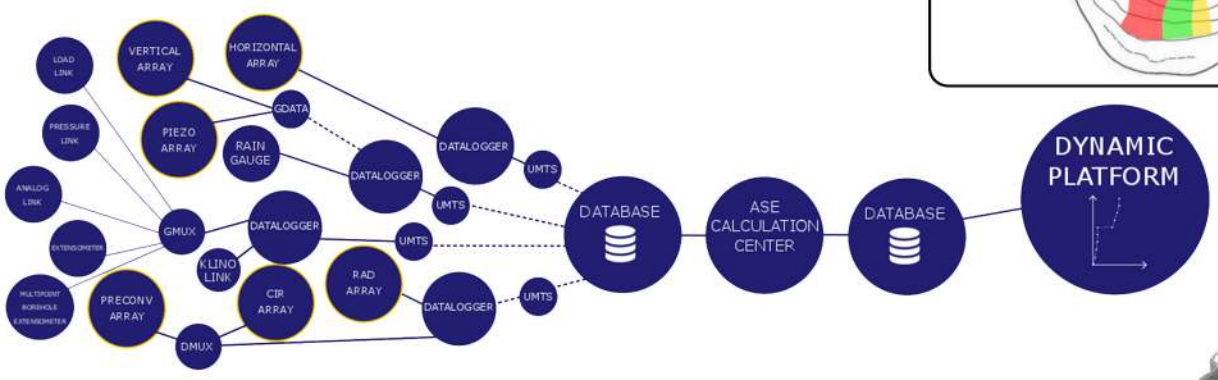
LOAD ON UPSTREAM STEEL WIRE ROPES

The Rockfall Safety Network system allows the measurement of the forces acting on the structural steel wire ropes, thanks to a dedicated strain gauge load cell located on the upstream steel wire rope.



The Rockall Safety Network system is designed with a triple function:
1. Evaluate the barrier working level;
2. Provide an Early Warning System for rockfall-related phenomena;
3. Identify the location of any rockfall event impacting the barrier.
Information derived from several installations within the same area will allow the development of active GIS hazard maps at slope scale.





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ASE801 Control Unit queries all the instrumentations provided by ASE s.r.l. with a frequency defined by the customer that can be easily changed during the monitoring. For each single reading of every sensor, control unit collects 64 data and saves their average value. This operation is a first check of the raw data collected, reducing the influence of outliers.

The procedure requires about one second for each sensor. Data are memorized on a volatile memory and once a day sent to the mainframe server at the elaboration centre through a UMTS router and 4G, 3G GPRS or LAN line.
ASE801 data logger, in addition to our systems, can also read every type of sensors available on the market (4-20 mA, mV/V, 0-5 V etc.) enabling integration of third part sensors withint the proprietary data management platform.

The power supply of the control unit is provided by a **solar panel**, which must be sized according to the site, the solar radiation, the orientation and the sampling time of the instrumentation. The standard version has a power of 10 W.
In the reserved area of the website, it is possible to control the battery level variation along time.

Once the mainframe server receives a new dataset, it stores them inside a dynamic MySQL database with daily multilevels backup. Raw data (electrical digital or analogic signals) are always available for a back-analysis or a re-elaboration with new algorithms.

If a predefined threshold is overcome, the software automatically sends alert messages (SMS and/or email) and activate any specific alarm device (traffic lights, variable message signs, acoustic alarms).

EARLY WARNING SYSTEM

TECHNOLOGY

The technologies that ASE is proposing are at the base of the development of a completely new monitoring concept and innovative system in the fields of geotechnical engineering, rock mechanics and rock engineering, tunnelling and landslide control and prevention, environmental monitoring. The main feature of these systems relates to their complete automation and remote managing and control.

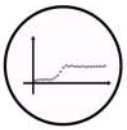
HISTORY

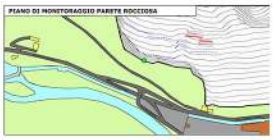
Advanced Slope Engineering s.r.l. (ASE) is a Spin Off company of the University of Parma, Italy. The partners, Andrea, Corrado and Luca, founded the firm with the aim of develop, build and distribute a new monitoring system named MUMS, based on innovative micro-technologies, which is a patent of ASE s.r.l. Most of ASE activities are about research and development in the fields of new technologies and data recover, management and analysis. All the members and employees have Ph.D or Master's degrees in engineering (Civil, Environmental or Electronic) and some are academics. In the framework of the 4th industrial revolution, ASE idea is to provide automation, big data application and internet of things approach in the management of the environment and, in particular, in the decisional support for critical conditions related to hydrogeological hazards or to the construction and operational phases of new and large infrastructures in sensitive contexts or difficult area.

Upon arrival on central server, raw data (electric signals) are automatically elaborated and transformed in physical units. This is done with a proprietary **software** routine, which couples raw data with the transformation coefficients through a specific numerical process that differs for each application. The elaborated data are stored in a "parallel" database from which they can be accessed, analysed and recovered through a controlled access website.

During the data elaboration, the mainframe server analyses the results and, where requested, controls the eventual overcoming of predefined thresholds. Some automated algorithms are applied, to control the quality and the variation of the data samples, and a preliminar validation is provided.

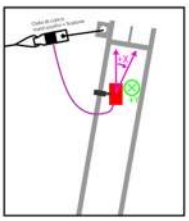
Results are available in a few minutes on a **web platform** with private access. If the customers wish to use their own platform or have a copy of the elaborated data, it is possible to configure an automated FTP transfer that will occur every time a new set of data reaches the elaboration centre.
The platform can also represent third-party sensors outputs.





Data are graphed on a dedicated web based platform with private access and can be checked from anywhere and using multiple devices (PC, Smartphone, etc.). The platform displays the monitoring data relating to the desired period using graphs and tools.

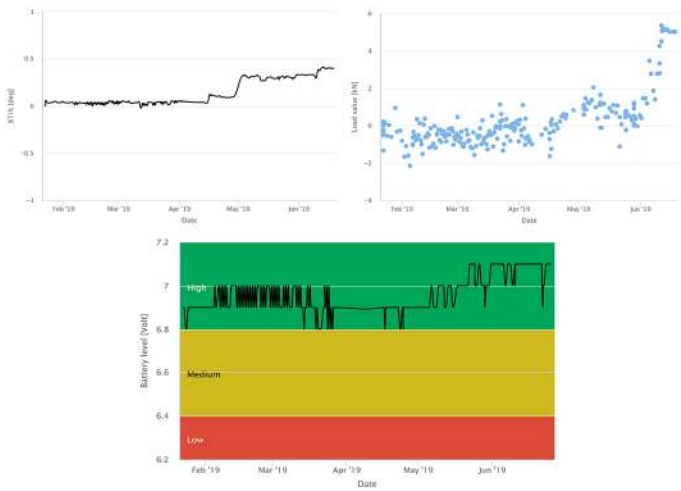
The perception of the occurring events is therefore immediate and the system allows for an instantaneous correlation of the data coming from different instruments. Data can be exported from the platform in common formatsa (.csv, .xls) and the graphics can be saved as images (.jpg, .png, .pdf, .svg) with a simple and straightforward procedure.



Battery Level [Volt]: 13.2

Date: 2017-09-26 12:08:05

The data provided by the system allow the creation of a database of measurements, which constitute an extremely useful statistical sample when dealing with long term and near-real time monitoring.
In such type of monitoring, the determination of reliable thresholds concerning posts rotation and load is extremely important in order to activate alert levels or alarms.



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