MOTES ON THE ROCKS: MONITORING ROCKFALL PROTECTION SYSTEMS WITH WIRELESS SENSOR NETWORKS

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Wireless sensor networks (WSNs) are systems composed by spatially distributed autonomous sensors that cooperatively monitor physical or environmental conditions. WSNs are applied in many scenarios, each with unique characteristics in terms of features, displacement and connectivity. Some applications of WSNs are the following: area monitoring, for enemy intrusions detection inside restricted areas; environmental monitoring, for state of permafrost assessment in the Alps; machine health monitoring, for machinery condition-based maintenance in small machinery spaces.

This paper investigates the indicators required by a WSN for defining a condition-based maintenance plan for rockfall protection systems. Ideally condition-based maintenance performed with the support of WSNs allows the maintenance staff to do only the right things, minimizing the level of risk, system failures and time spent on maintenance. This type of maintenance is performed after one or more indicators show that the rockfall protection system is going to fail or that the system performance is deteriorating. The approach proposed is based on the analysis of data acquired using a set of sensors installed on rockfall protection systems to prioritize and optimize maintenance activities. The analysis is performed comparing data coming both from low-cost accelerometers and more expensive load cells used during real-scale impact test performed for certifying the energy absorption of falling rock protection kits (ETAG 027).

Despite its usefulness, there are several challenges to the use of WSNs for monitoring the maintenance status of rockfall protection systems. First of all the introducion of a new technology will invoke a major change in how maintenance is performed, and potentially to the whole maintenance process. For this reason the WSN should be supported by easy to adopt software, enabling the efficiency of distributing and using huge amount of data. Secondly, the cost of a complete system should be comparable with the costs related to periodical inspections performed by humans. Also, the technical side of building a WSN is not always as simple. Even if some types of structures built for rockfall mitigation can easily be observed by measuring simple values as displacement or acceleration, it is not trivial to turn this measured data into actionable knowledge about health of the whole system.

As the rising of performance requirements (e.g. CE marking and ETAG 027) imply rockfall mitigation measures to become more costly, and micro-electro-mechanical instrumentation and software tend to become cheaper and more reliable, WSNs and related information systems become important tools for defining innovative and optimized maintenance

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processes. This paper, on the basis of the indicators defined for assessing the status of a structure subject to impacts, proposes a set of technical standards for establishing uniform engineering criteria, methods, processes and practices for optimizing maintenance activities on rockfall protection systems.