Geophysical Research Abstracts
Vol. 16, EGU2014-6830-1, 2014
EGU General Assembly 2014

Distributed Fiber Optic Sensor for Early Detection of Rocky Slopes Movements

Aldo Minardo (1), Luciano Picarelli (2), Agnese Coscetta (1), Giovanni Zeni (3), Giuseppe Esposito (4), Marco Sacchi (4), Fabio Matano (4), Mauro Caccavale (4), Zeni Luigi (1,3)

(1) Second University of Naples - DIII, Aversa, Italy, (2) Second University of Naples - DICDEA, Aversa, Italy, (3) Institute for Electromagnetic Sensing of the Environment (IREA) - CNR, Napoli, Italy, (4) Institute for Coastal Marine Environment (IAMC) - CNR, Napoli, Italy

Distributed optical fiber sensors have in recent years gained considerable attention in structural and environmental monitoring due to specific advantages that, apart from the classical advantages common to all optical fiber sensors such as immunity to electromagnetic interferences, high sensitivity, small size and possibility to be embedded into the structures, multiplexing and remote interrogation capabilities [1], offer the unique feature of allowing the exploitation of a telecommunication grade optical fiber cable as the sensing element to measure deformation and temperature profiles over very long distances. In particular, distributed optical fiber sensors based on stimulated Brillouin scattering (SBS) through the so-called Brillouin Optical Time Domain Analysis (BOTDA), allow to measure strain and temperature profiles up to tens of kilometers with a strain accuracy of $\pm 10\mu\varepsilon$ and a temperature accuracy of $\pm 1°$C [2]. They have already been successfully employed in the monitoring of large civil and geotechnical structures such as bridges, tunnels, dams, pipelines allowing to identify and localize any kind of failures that can occur during their construction and operation [3,4].

In this paper we present the application of BOTDA to the monitoring of movements in a rocky slope, showing how the sensing optical fiber cable is able to detect the formation and follow the growth of fractures, and to identify their location along the slope, as well. The experimental results have been achieved on a test field located in the area of Naples (Italy), where a single mode optical fiber sensing cable has been deployed along a yellow tuffs slope, by spot gluing the cable with epoxy adhesive. In order to assess the validity of the proposed approach, a few existing cracks have been artificially enlarged and the magnitude and location of the induced strain peaks have been clearly identified by the sensing device. It should be emphasized that, due to the distributed nature of the sensor, no preliminary information about the possible displacement locations of rocks are required in advance. The sensing cable can be simply deployed in a zig-zag pattern path along the slope, for hundreds of meters, and the system will remotely detect and locate any displacements wherever they occur along the fiber cable path, so representing a powerful tool for early warning against possible rock slides.

[1] J. M. López-Higuera, L. R. Cobo, A. Q. Incera, A. Cobo, " Fiber Optic Sensors in Structural Health Monitoring", Journal of Lightwave Technology, Vol. 29, pp.586-608, 2011.
[2] A. Minardo, R. Bernini, L. Zeni, “Numerical analysis of single pulse and differential pulse-width pair BOTDA systems in the high spatial resolution regime”, Optics Express, vol. 19, pp. 19233-19244, 2011.
[3] A. Minardo, R. Bernini, L. Amato, L. Zeni, “Bridge monitoring using Brillouin fiber-optic sensors”, IEEE Sensor Journal, Vol. 12 (1), pp. 145-150, 2012.
[4] R. Bernini, A. Minardo, S. Ciaramella, V. Minutolo, L. Zeni, “Distributed strain measurement along a concrete beam via stimulated Brillouin scattering in optical fibers”, International Journal of Geophysics, Vol. 2011, pp. 1-5, doi:10.1155/2011/710941, 2011.