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Distributed Fiber Optic Sensors For The Monitoring Of A Tunnel Crossing A Landslide

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Optical fiber distributed sensors have recently gained great attention in structural and environmental monitoring due to specific advantages because they share all 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], but also 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 long distances, without any added devices. In particular, distributed optical fiber sensors based on stimulated Brillouin scattering 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. These sensors have already been employed in static and dynamic monitoring of a variety of structures resulting able to identify and localize many kind of failures [2,3,4].
This paper deals with the application of BOTDA to the monitoring of the deformations of a railway tunnel (200 m long) constructed in the accumulation of Varco d'Izzo earthflow, Potenza city, in the Southern Italian Apennine.
The earthflow, which occurs in the tectonized clay shale formation called Varicoloured Clays, although very slow, causes continuous damage to buildings and infrastructures built upon or across it. The railway tunnel itself had to be re-constructed in 1992. Since then, the Italian National Railway monitored the structure by means of localized fissure-meters. Recently, thanks to a collaboration with the rail Infrastructure Manager (RFI), monitoring of various zones of the landslide including the tunnel is based on advanced systems, among which the optical fiber distributed sensors.
First results show how the sensing optical fiber cable is able to detect the formation of localized strains and cracks, following the evolution of their width and identifying their location along the tunnel walls. It is worth noticing that the distributed nature of the sensor makes it possible to perform the monitoring with no preliminary information about the possible location of concentrated deformation. The sensing cable is simply glued to the tunnel walls and the system will remotely detect and locate any deformation and fracture wherever they occur along the fiber path, so representing a powerful early warning system.

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