Geophysical Research Abstracts
Vol. 13, EGU2011-13415, 2011
EGU General Assembly 2011

Distributed fiber optic sensor for structural health monitoring of civil infrastructures

Romeo Bernini (1), Aldo Minardo (2), Genni Testa (3), and Luigi Zeni (4)

(1) Institute for Electromagnetic Sensing of the Environment, National Research Council, Naples, Italy, (bernini.r@irea.cnr.it/+390815705734), (2) Department of Information Engineering, Second University of Naples, Aversa, Italy (aldo.minardo@unina2.it/+390815037042), (3) Institute for Electromagnetic Sensing of the Environment, National Research Council, Naples, Italy, (testa.g@irea.cnr.it/+390815705734), (4) Department of Information Engineering, Second University of Naples, Aversa, Italy, (zeni@unina.it/+390815037042)

Structural Health Monitoring (SHM) techniques are opening a new way to assess the performance and life of structures. Normally in civil application the structural performance is a design parameter and uncertainty is managed by using safety factors. Quantitative evaluation of design values are commonly verified by loading experiments upon the completed structure and monitored during the life time by inspection. However, the safety evaluation and the management of the maintenance intervention is difficult for in service structures. The development and use of structural health monitoring systems gives the chance to evaluate on line and in real time the structural performance and their degradation during structure lifetime. As a major result, after implementation of a SHM system the safety will increase due to the measuring and not only guessing damage progression and concurrently the maintenance costs will be decreased due to the optimization of the scheduling of the maintenance actions. While standard SHM systems are based on the use of point sensors (e.g., strain gauges, crackmeters, tiltmeters, etc.), there is an increasing interest towards the use of distributed optical fiber sensors, in which the whole structure is monitored by use of a single optical fiber. Distributed optical fiber strain sensors have attracted increasing attention in research and applications related to civil engineering because no other tools can satisfactorily detect the locations of unpredictable events. For instance, for crack detection, it is necessary to employ a fully distributed sensor because crack locations are a priori unknown. In particular, a great interest have been devoted to distributed optical fiber sensors based on stimulated Brillouin scattering (SBS) that permit to detect the strain in a fully distributed manner, with a spatial resolution in the meter or submeter range, and a sensing length that can reach tens of km. These features, which have no performance equivalent among the traditional electronic sensors, are to be considered extremely valuable. When the sensors are opportunely installed on the most significant structural members, this system can lead to the comprehension of the real static behaviour of the structure rather than merely measuring the punctual strain level on one of its members [1,2].

In this work, we present the results of laboratory and field tests of fiber optic distributed sensors based on stimulated Brillouin scattering for structural health monitoring. In particular, the tests were performed by an SBS-based portable prototype based on Brillouin Optical Time-Domain Analysis (BOTDA). We report a number of laboratory measurements carried out along a 4m-long concrete beam subjected to a variable load. The field test was performed on a concrete road-bridge with a steel load-bearing structure and a span length of 44.40 m. The fiber-optic sensor measurements were carried out in concomitance with the final loading test of the bridge, just before bridge opening to traffic. The loading test was aimed to test the bridge's response to static loadings and to produce an initial database (footprint) of the undamaged structure that can be used for future condition assessment. To perform the static load test, up to five pre-weighed aggregate lorries were placed at pre-determined positions along the length of the bridge. The experiments show a good correlation between the distributed strain measured with the fiber optic sensor and local measurements obtained from conventional one. These results confirm that fiber optic distributed sensors based on stimulated Brillouin scattering area promising tool for SHM of civil infrastructures.

Acknowledgements
The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement n° 225663.

References

[1] R. Bernini, M. Fraldi, A. Minardo, V. Minutolo, F. Carannante, L. Nunziante, L. Zeni, Smart Mater. Struct., vol. 15, pp. 612-622, 2006.
[2] R. Bernini, A. Minardo, and L. Zeni, Smart Mater. Struct., 17, 015006, 2008.