Structural Health Monitoring of Concrete Arcs using Multi-axial Stress Sensors

Mohammad Abbasi Gavarti[1, 2], Francesco Braghin[1], Daniele Caltabiano[2], Agatino Pennisi[2], Angelo Caratelli[3], Gabriele Bertagnoli[4], Marzia Malavisi[4]

[1]*Dipartimento di Ingegneria Meccanica, Politecnico di Milano, Milan, Italy*
E-mail: mohammad.abbasi@polimi.it, francesco.braghin@polimi.it

[2]*Advanced System Technology, STMicroelectronics, Agrate, Italy*
E-mail: daniele.caltabiano@st.com, agatino.pennisi@st.com

[3]*Dipartimento di Ingegneria Civile, Università Tor Vergata, Rome, Italy*
E-mail: caratelli@ing.uniroma2.it,

[4]*Dipartimento di Ingegneria Strutturale, Politecnico di Torino, Turin, Italy*
E-mail: gabriele.bertagnoli@polito.it, marzia.malavisi@polito.it

Keywords: keywords list (Internal Stress, Concrete Structure, Health Monitoring).

In recent years the monitoring and damage evaluation/identification of concrete structures has become of major importance due to the ageing and the occurrence of some accidents [1]. For existing structures, the only possibility of doing structural health monitoring (SHM) is by applying (magnetic, piezoelectric and/or optical) sensors on the surface of the structure itself. However, if a new concrete structure is to be built, one could think of inserting these sensors directly into the structure. Using "external" sensors usually leads to more complicated algorithms for the identification of structural ageing/faults and, eventually, to the impossibility of identifying defects in certain critical positions [2]. Thus, "internal" sensors would be of great use for thorough SHM algorithms.

For large-scale applications in civil structures an innovative low-cost stress sensor has been developed that provides high accuracy, robustness and simplicity of operation. The sensor directly measures the internal stress of the structure both normal and tangential to the sensor surface [3], exploiting the piezo-resistivity of thick inks based on ruthenium oxide [4]. Moreover, the sensor can easily be calibrated, temperature compensated and is inherently hermetic, ensuring a protection of the sensitive elements from the external environment. Pads and cables are waterproof and suitable for a reliable operation in harsh environments.

An array of these sensors was installed in tunnel concrete arcs and used to assess the behaviour of these beams under static and cyclic loading under laboratory conditions. The obtained results confirm the targets of the design: the sensors were capable of identifying internal loads of the structure as well as of local imperfections.

References

[1] *Cusatis, G., Alnaggar, M., D'Ambrosia, M. and Qu, J., "Aging and Deterioration of Concrete Structures" CONCREEP-10, Vienna, Austria, September 2015.*
[2] *Nagayama, T., Spencer, B.F, SHM Using Smart Sensors, NSEL, Urbana (2007).*
[3] *Guidetti, E., Abbasi Gavarti, M., Caltabiano, D. and Bertagnoli, G., "Stress Sensor for SHM", Italian Patent 102017000044301 (2017).*
[4] *Tamborin, M., Piccinini, S., Prudenziati, M. and Morten, B., "Piezoresistive properties of RuO_2-based thick-film resistors" Sensors & Actuators A. 58 (1997) 159-164.*