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Lab-on-sensor concept, calibration and application in evaluation of structural behaviors under environmental and loading conditions

Statement of the Problem: Civil infrastructures are exposed to open environment and subjected to multiple hazards. They are designed for multiple structural limits or behaviors, such as fatigue, fracture, yielding, buckling, cracking, corrosion, scour and deflection in bridge designs. Each structural behavior is determined by a combination of environmental, loading and material factors. Unless completely known, the causative factors monitored in part with commercial measurement devices are insufficient to offer a practical solution for the evaluation of consistent and conclusive structural behavior. This study aims to describe our experience of exploring lab-on-sensor concepts for direct monitoring and assessment of three structural behaviors (cracking, corrosion and scour) without knowing intermediate factors.

Methodology & Theoretical Orientation: In lab-on-sensor designs, a structural behavior will be extended from a structural member to a custom-made sensor that directly relates a physical measurement to the evaluation of the behavior. The structural behaviors of the sensor and the structure are correlated experimentally.

Findings: The lab-on-sensor concept has been realized for the monitoring and assessment of cracking, corrosion and scour in bridge applications. The unique concept allows the physical measurement to be memorized on the sensor so that the measured data can be retrieved later. The dual measurements in real time and later ensure the reliability of the physical measurement that is required in long-term monitoring of structural behaviors. As an example, nano iron particles are coated on a long period fiber grating sensor and once immersed in corrosive environment; the resonant wavelength shift can be consistently related to the corrosion process of iron particles.

Conclusion & Significance: Lab-on-sensor concept can offer the measurement of critical data that are directly related to structural conditions without requiring sophisticated data analysis. It would be easy for adoption by practical engineers and potentially provide a unique tool for aging infrastructure maintenance.

Biography

Genda Chen is a Professor and Abbett Distinguished Chair in Civil Engineering and Director of System and Process Assessment Research Laboratory. He has received his PhD degree from SUNY at Buffalo in 1992 and joined Missouri S&T in 1996 after three years of bridge consulting practices. He has authored over 350 publications in structural health monitoring, structural control, interface mechanics and deterioration and multi-hazard engineering. He has received the 1998 NSF CAREER Award, the 2004 Academy of Civil Engineers Faculty Achievement Award and the 2009/2011/2013 Missouri S&T Faculty Research Awards. He is an Associate Editor of the *Journal of Civil Structural Health Monitoring*. He was a Member of post-disaster reconnaissance teams after the 2005 Category III Atlantic Hurricane, 2008 M7.9 China Earthquake, 2010 M8.8 Chile Earthquake and 2011 M9.0 Great East Japan Earthquake. He was elected to be ASCE Fellow in 2007 and Structural Engineering Institute (SEI) Fellow in 2013.

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