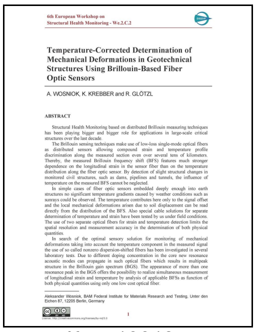

6th European Workshop on
Structural Health Monitoring - We.2.C.2

Temperature-Corrected Determination of Mechanical Deformations in Geotechnical Structures Using Brillouin-Based Fiber Optic Sensors

A. WOSNIOK, K. KREBBER and R. GLÖTZL

ABSTRACT

Structural Health Monitoring based on distributed Brillouin measuring techniques has been playing bigger and bigger role for applications in large-scale critical structures over the last decade.

The Brillouin sensing techniques make use of low-loss single-mode optical fibers as distributed sensors allowing compound strain and temperature profile discrimination along the measured section even over several tens of kilometers. Thereby, the measured Brillouin frequency shift (BFS) features much stronger dependence on the longitudinal strain in the sensor fiber than on the temperature distribution along the fiber optic sensor. By detection of slight structural changes in monitored civil structures, such as dams, pipelines and tunnels, the influence of temperature on the measured BFS cannot be neglected.

In simple cases of fiber optic sensors embedded deeply enough into earth structures no significant temperature gradients caused by weather conditions such as sunrays could be observed. The temperature contributes here only to the signal offset and the local mechanical deformations arisen due to soil displacement can be read directly from the distribution of the BFS. Also special cable solutions for separate determination of temperature and strain have been tested by us under field conditions. The use of two separate optical fibers for strain and temperature detection limits the spatial resolution and measurement accuracy in the determination of both physical quantities.

In search of the optimal sensory solution for monitoring of mechanical deformations taking into account the temperature component in the measured signal the use of so called nonzero dispersion-shifted fibers has been investigated in several laboratory tests. Due to different doping concentration in the core new resonance acoustic modes can propagate in such optical fibers which results in multipeak structure in the Brillouin gain spectrum (BGS). The appearance of more than one resonance peak in the BGS offers the possibility to realize simultaneous measurement of longitudinal strain and temperature by analysis of applicable BFSs as function of both physical quantities using only one low cost optical fiber.

Aleksander Wosniok, BAM Federal Institute for Materials Research and Testing, Unter den Eichen 87, 12205 Berlin, Germany

Licence: http://creativecommons.org/licenses/by-nd/3.0

1

Код: 10918

A. Wosniok, K. Krebber, R. Glotzl

Temperature-Corrected Determination of Mechanical Deformations in Geotechnical Structures Using Brillouin-Based Fiber Optic Sensors

Дрезден, Германия, 2012 год

6 стр; формат: 23,5 x 16 см; библиографический список: 6 единиц

Structural Health Monitoring based on distributed Brillouin measuring techniques has been playing bigger and bigger role for applications in large-scale critical structures over the last decade.

The Brillouin sensing techniques make use of low-loss single-mode optical fibers as distributed sensors allowing compound strain and temperature profile discrimination along the measured section even over several tens of kilometers. Thereby, the measured Brillouin frequency shift (BFS) features much stronger dependence on the longitudinal strain in the sensor fiber than on the temperature distribution along the fiber optic sensor. By detection of slight structural changes in monitored civil structures, such as dams, pipelines and tunnels, the influence of temperature on the measured BFS cannot be neglected.

In simple cases of fiber optic sensors embedded deeply enough into earth structures no significant temperature gradients caused by weather conditions such as sunrays could be observed. The temperature contributes here only to the signal offset and the local mechanical deformations arisen due to soil displacement can be read directly from the distribution of the BFS. Also special cable solutions for separate determination of temperature and strain have been tested by us under field conditions. The use of two separate optical fibers for strain and temperature detection limits the spatial resolution and measurement accuracy in the determination of both physical quantities.

In search of the optimal sensory solution for monitoring of mechanical deformations taking into account the temperature component in the measured signal the use of so called nonzero dispersion-shifted fibers has been investigated in several laboratory tests. Due to different doping concentration in the core new resonance acoustic modes can propagate in such optical fibers which results in multipeak structure in the Brillouin gain spectrum (BGS). The appearance of more than one resonance peak in the BGS offers the possibility to realize simultaneous measurement of longitudinal strain and temperature by analysis of applicable BFSs as function of both physical quantities using only one low cost optical fiber.

Доклад. 6-я Европейская конференция по мониторингу технического состояния сооружений, 2012. Редакция Кристиана Боллера.

Ключевые слова:

Содержание