Monitor Optics Systems

Optical Sensing Solutions for Structural Monitoring

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AUSTRALASIA

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CASE STUDY

Monitoring Mining-Induced Strain in a Rod Using Fibre Bragg Grating Sensors

The control of landslides is a critical issue in mountain areas. Often the only way to protect towns and roads is by the use of retaining walls.

Engineers constantly research new designs and materials to achieve higher levels of protection with lighter and more environmentally friendly structures.

A long term monitoring system using Monitor Optics embedded Fibre Bragg Gratings (FBG) based sensors was employed to monitor the performances of an element of a retaining wall characterised by an innovative design and concrete mix. The monitoring system is expected to provide information on the structural performances of the prototype element for a period of 3 to 5 years. While the element is being monitored with other conventional techniques, only the FBG sensors can provide information on what happens inside the structure.

Why Fibre Bragg Grating Sensors

Thanks to their survivability in harsh environment and their totally passive operation, fibre optics sensors are one of the very few technologies that can be employed to perform measurements inside a concrete structure. As a high number of FBG sensors can be multiplexed on a single channel, this technology allows a high number of measurement points with limited intrusion by foreign elements in the structure, a factor extremely important in embedded sensors. Monitor Optics embeddable strain sensor is specifically designed to survive the environment of setting concrete and provide reliable long term measurements.

Sensor Network

A total of 7 sensors were embedded into one of the concrete elements of the retaining wall. The sensors were located in selected measurement points within the proximity of the tensioning wires. Part of the sensors was located on the outer side of the structure and part on the ground side. Each sensor was provided with temperature compensation to prevent the pollution of the acquisition of strain measurements by any temperature effects on the Bragg Gratings.

Data Acquisition and Processing

Demodulation of the FBG signal is provided by a Micron Optics Si125 interrogator controlled by custom designed software. During the tensioning phase the system was employed to acquire continuous real time strain measurements with a frequency of 1 Hz. During the normal operation of the system data is acquired at hourly intervals and then sent daily to a remote server with secure access for the customer.

Results

The sensors were embedded into the structure during the manufacturing process in September 2007. All the sensors survived the manufacturing process and the storage period leading to the installation of the structure. During the storage period the sensors were periodically checked and provided information on the setting of the concrete.

During the initial tensioning phase, strain measurement acquired using the FBG sensors were compared to measurements acquired using vibrating wire sensors located on the structure surface, with full-field optical measurements and with Finite Element analysis predictions. These comparisons proved again the accuracy and reliability of the FBG based sensors.

The monitoring system has been active since October 2007 in an environment characterised by normal temperatures below zero and has since provided continuous and reliable information on the strain field inside the concrete element.

Conclusions

A monitoring system has been developed, designed and installed that employs FBG based sensors embedded into the concrete of a structural element. The sensors have proved their capability to survive the concrete element manufacturing process and are providing information that cannot be acquired by any other type of sensor.