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APPLICATION OF BRAGGIAN SENSORS IN MECHANICS

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Abstract. The measured wavelengths were calculated to compensate for deformation measurements of the thermal effect on the Bragg wavelength, and the convergence was estimated using the algorithm method.
Key words: Fiber Bragg Grating, optical fiber, sensors

Almost every type of public infrastructure, including bridges, pipelines, tunnels, foundations, roads, dams, etc. is susceptible to factors that may worsen it or cause it to malfunction. These structural problems can be the result of wear and tear, improper construction methods, seismic activity, nearby construction activities, etc. Although electrical strain gauges have long been used to monitor structural changes, they sometimes lack the strength and integrity required to provide accurate, reliable information over extended periods.

Fiber Bragg Grating (FBG) optical strain gauges operate on completely different principles than traditional electrical strain gauges. Simply put, a fiber Bragg grating is a microstructure (usually a few millimeters long) created by modifying a standard germanium-doped single-mode telecommunication fiber with an ultraviolet laser. This microstructure creates a periodic change in the refractive index of this optical fiber.

As light travels along the fiber, the Bragg grating reflects a very narrow range of wavelengths; all other wavelengths are transmitted through the grating. The center of this band of reflected wavelengths is known as the Bragg wavelength (Figure 1).

Optical fiber sensing systems offer engineers fatigue limits that are more in line with the fatigue characteristics of today's materials of construction. For example, lightweight carbon fiber sheets have higher fatigue and deformation limits than traditional structural materials. Even commonly used materials such as steel, concrete and wood are increasingly modified to optimize their fatigue performance, so they also require inspection systems designed with higher fatigue limits.

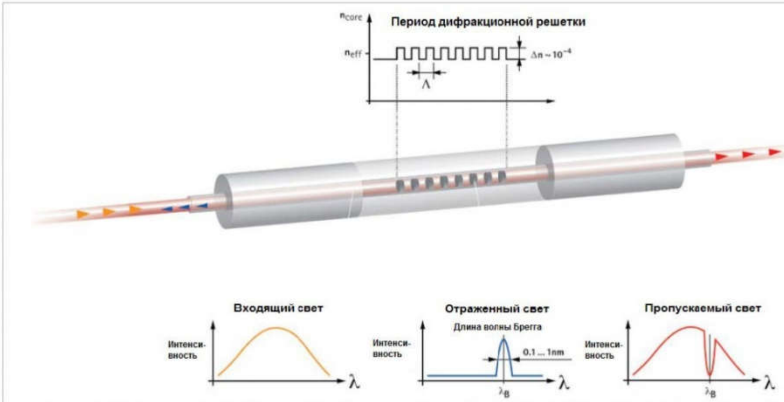

Figure 1. The principle behind the operation of fiber Bragg grating (FBG) strain gauges.

Figure 2 shows a recent example of the use of optical fiber for infrastructure monitoring. HBM Fiber Sensihg helped design a system to monitor real-time deformations and convergence of a tunnel in an active metro line in São Paulo, Brazil, while a skyscraper was under construction. The tunnel monitoring system was essential during the excavation and construction of the skyscraper's retaining wall to ensure uninterrupted operation of the metro line and guarantee the safety of passengers. The extensometric tunnel convergence method used for this project uses Bragg grating (FBG) sensors to measure deformations at various points along the tunnel contour and converts them to tunnel support displacement. It also allows you to quantify convergence and its geometric evolution over time.

Figure 2. Installing the measuring section for tunnel monitoring

Conclusion. For the section of the tunnel, seven measuring points were monitored with one strain sensor and one temperature sensor at each measurement point. To interrogate all sensors, a rack interrogator Braqq METER FS22 with four optical channels was used, data was collected once a minute, then processed and stored in the database. A 19-inch rack was installed nearby to protect the metering unit, server PC, UPS and Internet connection. The measured wavelengths were calculated to compensate for deformation measurements of the thermal effect on the Bragg wavelength, and the convergence was estimated using the algorithm method.

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