Primer on FOX-TEK FT Sensor System

The FOX-TEK FT sensor system is an advanced fiber optic system with a long gauge length, compared to traditional sensors. Gauge lengths can vary from as small as 10cm to over 100m. The FT sensor measures the average displacement over the sensing length, using FOX-TEK's FTI-3300 instrument. The system is suitable for static or low frequency monitoring applications such as continuous in-situ structural health monitoring.

As an all-fiber optic sensor, the FT sensor possesses some unique advantages, compared to conventional electrical sensors. It is immune to electromagnetic interference, and being light powered, it is intrinsically safe, making it ideal for deployment in hazardous or flammable environments. The sensor itself is made from conventional single-mode optical fiber, with a diameter of 250 microns. This small diameter allows the sensor to be embedded inside the structure being monitored with minimal intrusive effect. The sensor is also available in various ruggedized packaged configurations, for easy installations. Being a flexible fiber, allows the sensor to be configured into almost any shape, thus making it ideal for targeting a specific location or defect.

The dynamic range of the sensor is 40mm of total displacement (regardless of gauge length), with an accuracy of ±20 microns. As the sensor measures displacement (and not strain) with a fixed displacement error, it can be seen that the sensitivity of the sensor to strain (change in length/gauge length) increases with gauge length. For example, a 1m sensor has an error of ±20 microstrain, whereas a 20m sensor has an error of ±1 microstrain. The dynamic range of the sensor is governed by the instrumentation and not the sensor, as the fiber itself can withstand elongations greater than 2% (i.e. 400mm for a 20m sensor).

The fundamental principle behind the FT sensor is the interference of light. The sensor system can be modeled as being comprised of two optical paths combined with a light source and a detector. Each of the optical paths has a reflective mirror at the end, so that any light traveling down that path is reflected back. One path length is a reference length internal to the instrument, and the other path length is the FT sensor itself. When the system is at 'zero', with no load on the sensor, the two optical path lengths are exactly equal. In this instance, the light signals - which are sent to both path lengths (and reflected back) - arrive at the detector at the same time, in phase. This results in constructive interference, and there is a peak in the magnitude of the signal at the detector.

When the sensor is under strain, the fiber is elongated (or compressed), resulting in a change in the optical path length. This change means that the two signals at the detector are no longer in phase, resulting in a drop in the magnitude of the signal. When this occurs, the FTI-3300 instrument changes the length of the reference path length until the two signals are in phase again. The system looks for a peak in the signal intensity, signifying this effect. When the path lengths are matched again, the change in length of the sensor can be determined by determining the change in length of the reference path. Since an interference peak only occurs within a very small distance (related to the wavelength of the light signal), the resolution of such an interferometric system is very high.

As mentioned before, the FT sensor measures the *average displacement* over the gauge length, using an interferometric technique, and is not a distributed strain sensor, giving the user a strain profile over the sensing length. As such, the gauge length has to be selected with the sensing length and required sensitivity in mind.

Please contact FOX-TEK for more information:

Fiber Optic Systems Technology (FOX-TEK) Inc.
4580 Dufferin Street, Suite 402, Toronto, ON M3H 5Y2 Canada.
Phone: (416) 665-2288, Fax: (416) 665-0494, Web: www.fox-tek.com