Fiber Optic Sensor Structural Deformation



Overview

To this end, this paper proposes a method to estimate the continuous deformation of concrete beams by utilizing the distributed optical fiber monitoring technology.

Key Takeaways

Fiber optic deformation sensors measure strain or structural deformation by detecting changes in light properties within optical fibers, offering high sensitivity, immunity to electromagnetic interference, and suitability for harsh environments.

Working Principles

Fiber optic deformation sensors operate by detecting changes in light caused by mechanical deformation of the fiber. There are several key mechanisms: Phase-based sensing: Deformation alters the optical path length and refractive index along the fiber, producing measurable phase changes in transmitted light. This principle underlies distributed acoustic sensing (DAS), which can detect strain along the entire length of a fiber, enabling applications in seismic monitoring, pipeline surveillance, and structural health monitoring.

Phase changes are related to the integral of strain along the fiber and are sensitive to fiber curvature and local refractive index variations. Path unbalance sensing: Sensors like the SOFO Standard Deformation Sensor use two optical fibers—one reference and one measurement fiber. Deformation changes the path difference between the fibers, which is read by a dedicated unit.

© 2026 AK OPTICAL SYSTEMS - All rights reserved

These sensors can be surface-mounted or embedded in concrete, providing long-term structural monitoring with high reliability. Curvature or bending sensors: In Fiber Optic Curvature Sensors (FOCS), bending causes light to leak from the fiber core into the cladding, reducing transmitted light intensity. Structural modifications, such as trenches or teeth on the fiber surface, enhance sensitivity.

Positive or negative bending changes the light intensity in predictable ways, allowing precise measurement of fiber curvature.

Advantages

Fiber optic deformation sensors offer several benefits over conventional strain gauges: Electromagnetic immunity: They are unaffected by EMI/RFI or lightning, making them ideal for aerospace, defense, and industrial environments. Long-distance sensing: Optical fibers can transmit signals over kilometers without loss of accuracy. Intrinsic safety: No electrical current is required at the sensing point, suitable for hazardous environments.

High spatial resolution: Distributed sensing allows dense measurement points along a single fiber, useful for seismic or structural monitoring. Durability: Many sensors are designed for harsh conditions and long-term deployment, with some products offering decades of operational reliability.

Applications

Fiber optic deformation sensors are widely used in: Structural health monitoring: Bridges, buildings, and tunnels. Geotechnical monitoring: Landslides, slopes, and embankments. Seismology: Using DAS to detect seismic waves along pre-installed telecom fibers.

Aerospace and defense: Monitoring strain in aircraft or military structures. Industrial pipelines and perimeter security: Detecting vibrations or deformations over long distances.

Commercial Examples

Opsens OSP-A sensors: Compact, EMI-resistant, suitable for harsh environments, and capable of precise deformation measurement.

SOF

O Standard Deformation Sensors: Long-term structural monitoring with embedded or surface-mounted installation. Fiber Optic Curvature Sensors (FOCS): Sensitive to bending, used in experimental or specialized applications. Fiber optic deformation sensors combine high sensitivity, robustness, and versatility, making them a preferred choice for modern monitoring systems across civil, industrial, and scientific domains.

© 2026 AK OPTICAL SYSTEMS - All rights reserved

Article Content

Improved deformation reconstruction of composite

In this study, structural deformation reconstruction algorithms have been investigated by improving the slope recursion algorithm and the Ko

All-Fiber Optic Sensing for Multiparameter Monitoring

This study introduces an all-fiber optic sensing network based on fiber Bragg grating (FBG) technology for structural health monitoring (SHM) of

Structural Deformation Sensing Based on Distributed Optical Fiber ...

To this end, this paper proposes a method to estimate the continuous deformation of concrete beams by utilizing the distributed optical fiber monitoring technology. In this method, optical

Recent Advances and Tendencies Regarding Fiber Optic Sensors for ...

Electrical-based sensors have been widely used for structural deformation monitoring. However, they are difficult to achieve accurate measurements in some harsh environments, such as

Structural Health Monitoring by Fiber Optic Sensors

Since then, many large-scale structural tests and in-service strain and load measurements have been performed using fiber optic sensors, which

Structural Deformation Monitoring of Flight Vehicles Based on Optical ...

Structural deformation monitoring of flight vehicles based on optical fiber sensing (OFS) technology has been a focus of research in the field of aerospace.

Learning to sense three-dimensional shape deformation of a single ...

We demonstrate proof-of-concept 3D multi-point deformation sensing via a single multimode fiber by using k -nearest neighbor (KNN) machine learning algorithm, and achieve a

Fiber optic sensor & transducer for structural health monitoring

Fiber optic sensor enables in-situ detection of structural strain, enable timely preventive action to reduce structure life cycle cost, improve safety and reliability, and extend operational life cycle.

Lightweight Fiber Optic Sensors for Real-Time Monitoring of Structural ...

© 2026 AK OPTICAL SYSTEMS - All rights reserved

For the first time ever, real-time strain measurements can be used to determine the shape of an aircraft''s wing, monitor the structural integrity of bridges and pipelines, or ensure precise placement of the

Optical Fiber-Based Structural Health Monitoring:

Structural health monitoring (SHM) plays a vital role in ensuring the safety, durability, and performance of civil infrastructure. This review delves into

Recent Advances and Tendencies Regarding Fiber Optic Sensors for ...

In this review, fiber optic deformation sensors (FODSs) are divided into contact and non-contact types according to the spatial location relationship between them and the objects being

Fiber optic Bragg grating sensors for high-precision structural ...

This study shows an interesting application potential for FBG sensors in structural deformation control for various fields such as optics or high-precision machine tools.

Structural deformation monitoring of flight vehicles based on optical ...

Abstract Structural deformation monitoring of flight vehicles based on optical fiber sensing network is a hotspot in the field of aeronautics and astronautics.

Flexible Optical Fiber Sensing: Materials, Methodologies, and ...

For flexible optical fiber sensors based on deformation loss, when a fiber undergoes deformation, the light that usually propagates through total internal reflection tends to escape from the deformed region.

Fiber Optic Sensors in Structural Health Monitoring

Structural Health Monitoring (SHM) can be understood as the integration of sensing and intelligence to enable the structure loading and damage-provoking conditions to be recorded,

Review of Optical Fiber Sensors for Deformation Measurement

The characters of optical fiber sensors are analyzed and the research status of different types of optical fiber sensors for curvature measurement is introduced and discussed in details.

Fiber-optic sensor

A fiber-optic sensor is a sensor that uses optical fiber either as the sensing element ("intrinsic sensors"), or as a means of relaying signals from a remote sensor to the electronics that process the signals

Fiber-Optic Sensing Technologies for Structural

© 2026 AK OPTICAL SYSTEMS - All rights reserved

Topics of interest include, but are not limited to: • Fiber-optic sensing for structural health monitoring: Applications of FBG, interferometric, and distributed fiber-optic

Related Video Reference

This video was associated with the source search result. Verify technical details against current product documentation and project requirements.

Contact Us

Continue your research online:

Website: https://aboutkitchens.biz
Technical inquiry: https://aboutkitchens.biz/project-desk.html
North American project location: Research Triangle Park, North Carolina, United States

This document is for preliminary research. Verify specifications against current standards, product documentation and project requirements.

© 2026 AK OPTICAL SYSTEMS - All rights reserved