Structural Health Monitoring—A novel system for real-time structural health monitoring in infrastructure

TLB
Technologie-Lizenz-Büro
der Baden-Württembergischen
Hochschulen GmbH

This system enables online real-time monitoring of structures with local data analysis and wireless data transmission to the central station. With innovative technology, the system keeps you informed about the condition of your structures.

- Fully autonomous evaluation in real-time
- High reliability, reducing the number of false alarms
- Significantly shortened response time to genuine alerts
- Enables monitoring of older structures (hidden concrete cracks)
- Applicable to other measurement tasks (e.g., temperature or tilt) as long as the sensors overlap

Fields of application

This system is helpful in all areas of building monitoring, especially for evaluating structural damage.

Contact
Dipl.-Ing. Julia Mündel
TLB GmbH
Ettlinger Straße 25
76137 Karlsruhe | Germany
Phone +49 721-79004-0
muendel@tlb.de | www.tlb.de

Development Status
TRL4

Patent Situation
EP 4075114 A1 pending

Reference ID
21/002TLB

Service
Technologie-Lizenz-Büro GmbH has been entrusted with exploiting this technology and assisting companies in obtaining licenses.

Background

Structures frequently experience localized deterioration, including cracks or fractures within the cement and reinforcement materials. This degradation primarily results from shrinkage, corrosion, or incomplete hydration, especially in newly constructed facilities. Conventionally, such damages are recognized once they surpass certain predefined thresholds established by industry standards. However, more sophisticated monitoring systems adopt a dynamic approach by incorporating additional parameters. These systems continuously refine these predefined limits to account for environmental variables, such as temperature fluctuations, thereby enhancing the precision of structural health assessments.

Problem

Quality assessment and structural monitoring rely on direct on-site investigation, sampling, and analytical analyses performed through manual intervention. This data is meticulously reviewed and interpreted against established standards at regular intervals. Consequently, it necessitates the constant presence of engineers and technicians on-site to conduct visual inspections. In instances where visual inspections are impractical, the challenges only escalate. Additionally, manual inspections are prone to generating false alarms, leading to unnecessary expenses and the consumption of significant resources. Moreover, these initial investigations may occasionally require further material analysis to comprehensively address the issue, often resorting to destructive testing methods. These analytical investigations are not only time-intensive but also demand the expertise of highly qualified personnel within laboratory settings. However, continuous monitoring of these structures is imperative to guarantee user safety.

Solution

Researchers at the University of Stuttgart have implemented a comprehensive fiber-optic sensor system across the entirety of a bridge to facilitate structural monitoring. This system is strategically designed with sensor nodes that overlap at the peripheries, ensuring comprehensive coverage. Each sensor, extending approximately 2 meters in length, is capable of delivering up to 200 strain measurements per minute from various nodes throughout the testing phase. To efficiently process this influx of data, a sophisticated data evaluation method has been developed. This method distinguishes critical and non-critical structural changes, such as those resulting from varying traffic densities. It is based on the algorithm defined by three specific variables.

- If the correlation of the measured values between two adjacent sensors differs.
- If a maximum allowable limit for the peak-to-peak amplitudes of a sensor (measured, for example, by load tests) exceeds.
- If variation occurs in each sensor's current statistical modes data compared to the last values determined over time.

Only when these variables align with predefined conditions will a notification be wirelessly dispatched to the system's designated overseer.

Figure: The monitoring system uses sensors to measure various parameters on bridges. The collected data is transmitted via radio to a central unit to enable effective monitoring and early detection of potential problems. (F-Lehmann, Materials Testing Institute (MPA) - Department of Civil Engineering, University of Stuttgart)