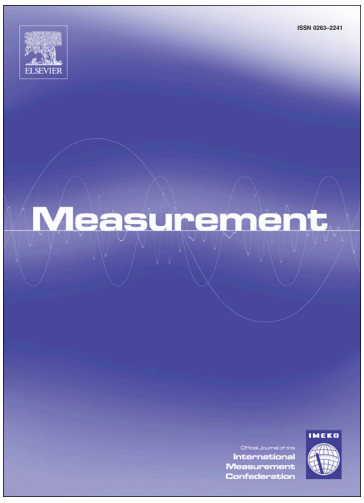

In Situ Monitoring of Prestressed Concrete Using Embedded Fiber Loop Ring-down Strain Sensor

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In Situ Monitoring of Prestressed Concrete Using Embedded Fiber Loop Ringdown Strain Sensor

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Abstract

We report near real-time in situ monitoring of prestressed concrete beams using a new fiber loop ringdown (FLRD) strain sensor. The strain sensor was fabricated by integrating a micro air-gap in the sensor head and had a strain detection limit of tens of nanostrain ($n\varepsilon$). Two unbounded prestressed concrete beams were constructed with two strain sensors embedded in each concrete beam; one sensor was attached to the post-tensioned (PT) rod, while the second sensor was embedded in the concrete beam. A tensioning stress of up to 351 MPa was produced on the PT rod in steps of 39 MPa, and during a 3-point loading test of the concrete beams, a force of up to 8 kN was applied in steps of 1 kN. Results demonstrated the ability of the FLRD strain sensor for sensing the stress on the PT rod as well as on the concrete far before the crack initiation.

Keywords: Fiber loop ringdown, fiber optic sensor, prestressed concrete, strain sensor, structural health monitoring

1. INTRODUCTION

Concrete is one of the main building materials in civil structures, such as buildings, bridges, tunnels, dams, and some critical facilities [1]. In order to improve the ultimate strength, durability, and reliability of the modern concrete structures, the prestressing technique is widely practiced [2]. Prestressing is the technique of reinforcing concrete, in which high strength tendons (steel strands or rods) are positioned inside a concrete structure and tensioned to a specification before the service load is applied to the concrete. However, over the period of time, several changes occur in the concrete, for example, prestress loss over the time, damage due to overloading conditions, deterioration induced by environmental degradation, or damage due to natural disasters, such as an earthquake, large storms, etc. Failure to mitigate these damages may result in adverse effect on the health of the concrete structures. Therefore, near real-time, in situ, continuous monitoring of structural health is crucial to mitigate any catastrophic disasters that can result from the aforementioned damages. Hence it is highly desirable to have smart sensors deployed along with prestressed concrete and tendons.

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