Long-term Structural Health Monitoring on Grist Mill Bridge

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Introduction

Structural Health Monitoring (SHM) involves the collection, interpretation, and analysis of structural data to ensure the well-being of structures. Fiber optic sensing technology holds great potential for precise strain and temperature measurements. This technology has found wide-ranging applications in various fields, including railways, oil pipelines, and highways. In this poster, we present a novel approach that utilizes the Brillouin optical time-domain analyzer (BOTDA) to create a distributed strain sensing system, which is integrated within a fiber-reinforced polymer (FRP) bridge girder.

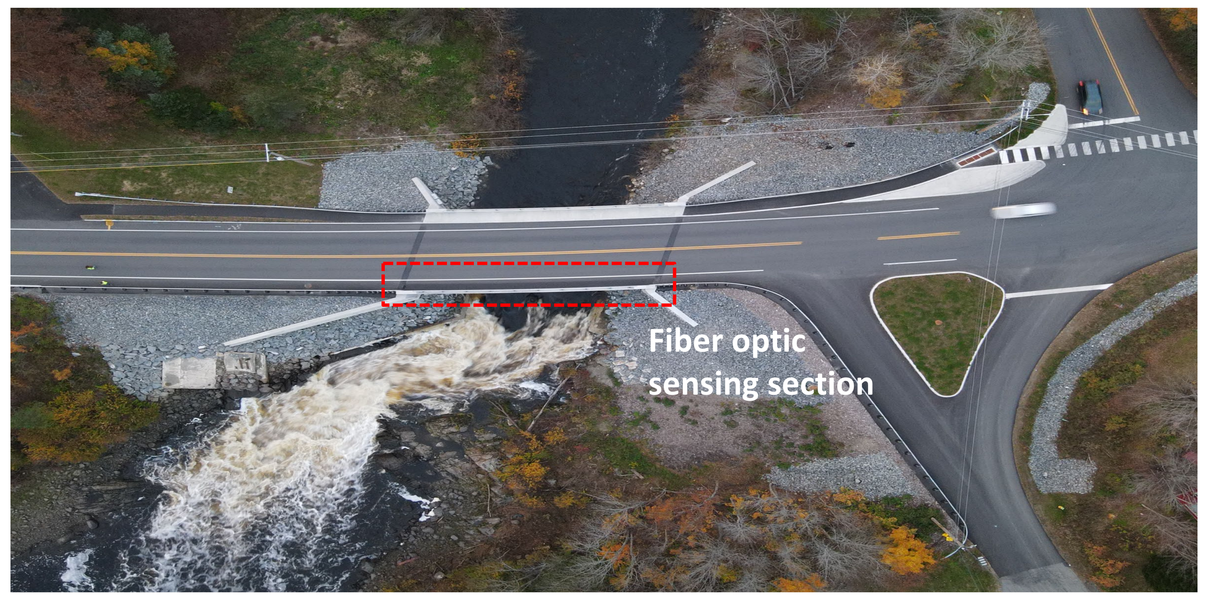

Fig.1 Picture of the Grist Mill bridge and the sensing section.

Sensor Design

The sensing textile design comprised a single-mode fiber (orange) for distributed temperature sensing (DTS) and a U-shaped fiber (blue) for the BOTDA system. Figure 2 illustrates the schematic representation of the textile design. Both sensing sections had a length of 21 meters each. Additionally, a 23.5-meter launching fiber was installed at the start of the textile to establish a connection with the machine positioned above the bridge.

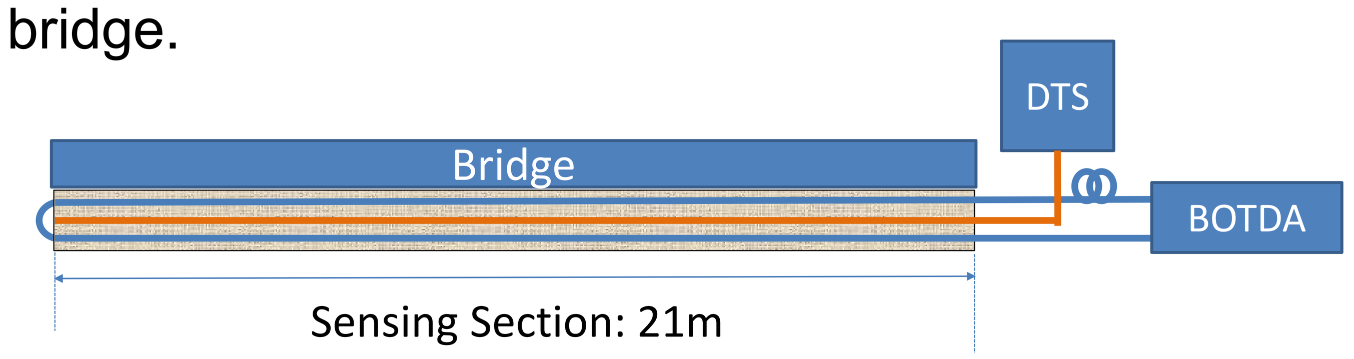

Fig.2 Pattern design of the sensing textile installed in the bridge girder.

Fig. 3 Pictures of installation. (a) UML team working on the girders. (b) Side view of the bridge girder. (c) Installing fiber connectors. (d) Picture of the bridge and the location of fiber sensing textile.

Sensor Installation

The sensing textile was installed at Grist Mill Bridge in Hampden. The accompanying pictures depict the dedicated team working on the lengthy, narrow girders, measuring 59*27cm.

A modified slider was utilized as an invaluable installation tool to optimize efficiency within the limited space. This slider facilitated the smooth unrolling of the sensing textile while the epoxy was applied for secure bonding.

Scrapers and brushes were employed to eliminate any trapped bubbles beneath the sensing textile, ensuring a flawless installation. The precise location of the sensing textile is clearly depicted in Fig. 3 (d).

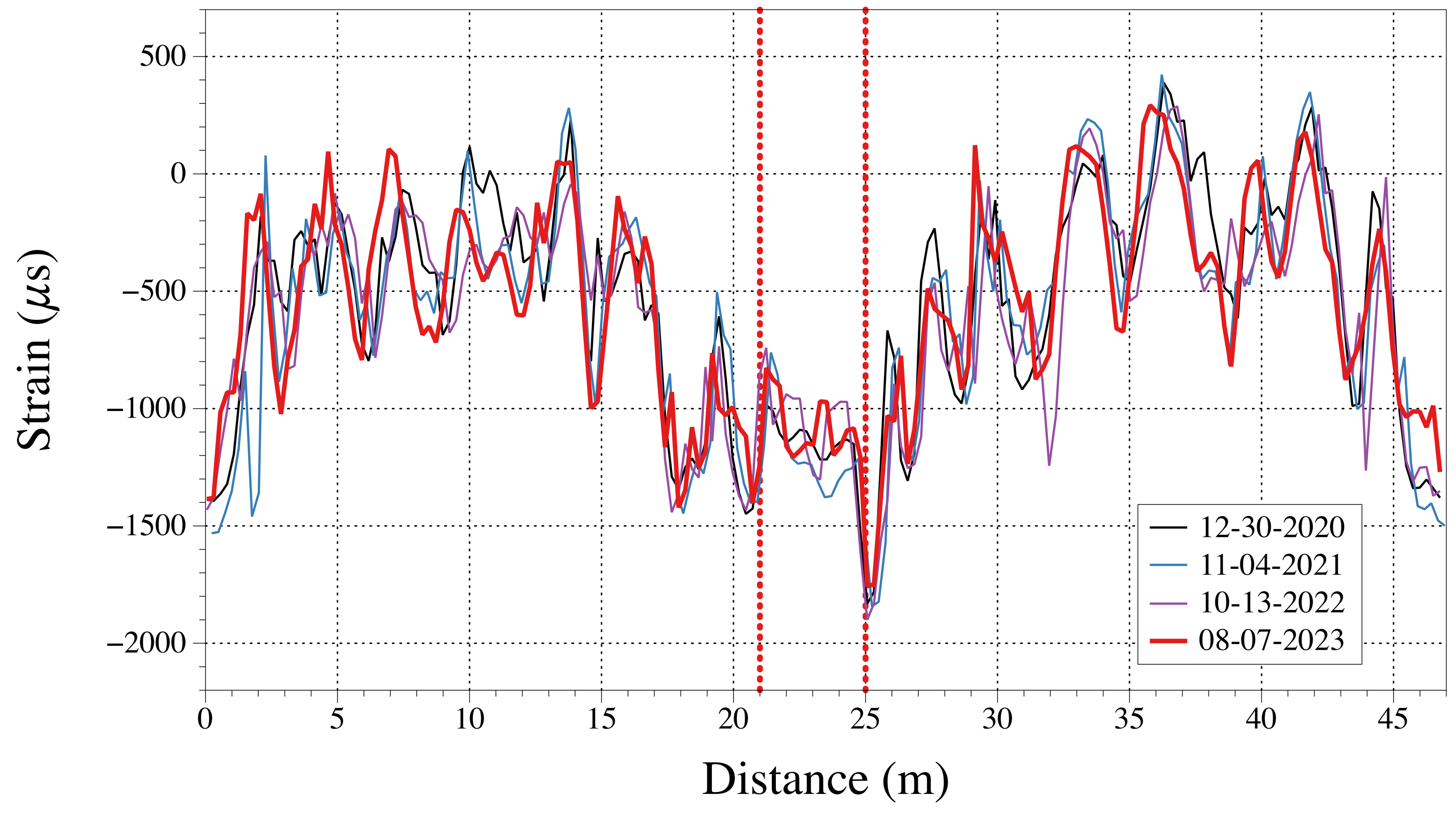

Fig.4 Long term monitoring results of Grist Mill Bridge.

Four Years Test Results

The strain distribution of the bridge without traffic was recorded annually over a four-year period. Fig. 4 illustrates the configuration of the sensing textile, where the initial 21-meter segment represented the first section of the U-shape, while the subsequent 25 to 46-meter section constituted the remaining part of the U-shape.

Considering that temperature fluctuations can impact the Brillouin frequency; the temperature compensations were implemented for all the strain data collected. Upon analyzing the strain distribution baselines over the three-year period, it was observed that no significant changes occurred. This finding indicates that the bridge did not experience any noticeable structural alterations.

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