The Application of FBG Sensing in Monitoring Ebian Daduhe River Bridge in Sichuan Province

Dr. Zhi Zhou, et.al., School of Civil Engineering
Harbin Institute of Technology, Harbin, China

1. Project Introduction

The Ebian Daduhe bridge in Sichuan province as shown in Fig.1 was constructed in 1995, spanning 138m. Due to pollution from an up-stream sulfur processing plant, the bridge suffered serious corrosion. From October 2004 to October 2005, the bridge under went extensive maintenance construction and repair. The design on the new suspension cables requires continual health monitoring.

Fig.1. Ebian Daduhe bridge

2. Project Description

The suspension cables are often regarded as the "heart" of the bridge. Due to the common corrosive environments impacting such bridges, various suspension cables often suffer non-uniform deleterious degradation. Cable breakages during maintenance and repair world-wide are often reported. Therefore, how to provide reliable long-term structural health monitoring during maintenance and operation has become an utmost importance, with critical implication for wide-spread applications. Traditional strain gauges are not reliable for long-term monitoring applications. Optical fiber based fiber Bragg grating (FBG) sensing technique offers superior intrinsic characteristics for long-term cable monitoring. Therefore it is especially meaningful to investigate and develop "smart cable" technology incorporating distributed FBG sensors. The current project objectives include: the development of high-performance FBG strain and temperature sensors, method of threading FBG sensors in bridge cables, specifications and installation method for smart cables, the development of smart cable monitoring system, specification and qualification for cable fatigue and lifetime. All these objectives have been successfully accomplished.

3. Engineering Application

Within the smart cable monitoring program, the project team installed 40 FBG sensors (including 30 strain sensors and 10 temperature sensors) on 15 key suspension cables out of a total of 50 suspension cables. Of the 8 cross cables, 4 had 16 FBG-FRP (fiber reinforced polymer) distributed sensor strands installed within. Of the 16 FBG-FRP strands, 12 strands consist of 2 FBG strain sensors each, and 4 strands consist of 1 FBG temperature sensor each. This project has successfully demonstrated the application and monitoring of FBG sensors on Daduhe arch bridge during its repair and operational phases. To the authors' knowledge, this is the first time a successful real-time health monitoring operation using FBG sensing technology that has been applied to the support cables of an arch bridge.

Fig.2. Ebian Daduhe smart suspension cable.

Fig.3. Ebian Daduhe smart cross cable.

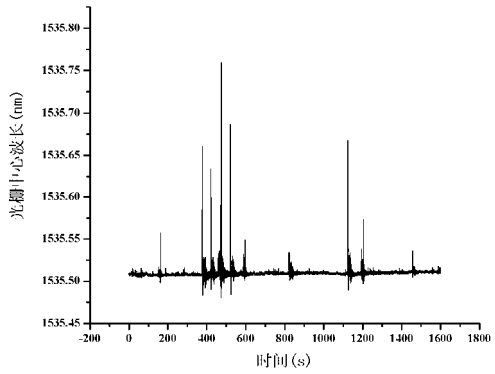

Fig.4. FBG strain sensor response to traffic.

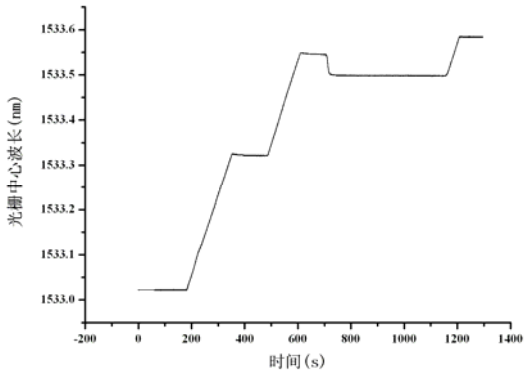

Fig.5. FBG strain sensor response to cable pulling during construction.

4. Main Results and Conclusion

This program has successfully developed high-performance FBG strain and temperature sensors and installation methodology, as well as satisfactorily applied smart cables for structural health monitoring on Daduhe arch bridge during its construction and operational phases. The project outcome has reached international research forefront, and shows significant societal and economic benefits.