# The Application of FBG Sensors in Monitoring the Binzhou Yellow River Bridge of Shandong Province

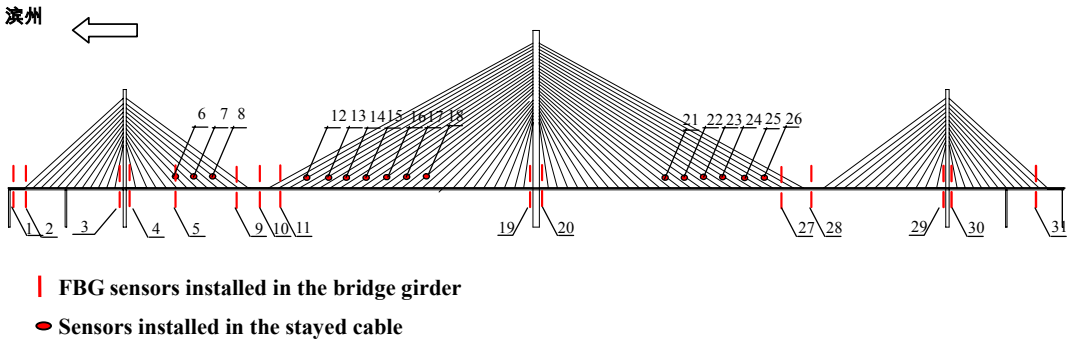
## I. Overview of this project

The Binzhou Yellow River Highway Bridge is an important cable-stayed bridge across the Yellow River along the new 205 State highway. The bridge is 1,698 meters long and 32.8 meters wide; the main bridge is made up of spans of 42+42+300+300+42+42 meters. The main towers and side towers use double poles and double cables style. The middle tower is 125.28 meters high and the side tower is 75.778 meters high. Its design is innovative, and its structure is complex. So much new technique is used. Total investment is about RMB 735 millions. The construction period was from 2001 to 2004.

Figure 1 Binzhou Yellow River Highway Bridge

## II . Engineering Application

Because the bridge structure was obviously degraded in its operation period, badly affecting security of the bridge, the Highway Bureau of Shandong Province Transportation Ministry entrusted Harbin Technology of University (HIT) for the design and implementation of the bridge health monitoring system. The monitoring system used FBG strain and temperature sensors developed by HIT and a FBG interrogator supplied by Micron Optics Inc. (MOI). Through the bridge structure analysis created by the finite element model, the monitored locations were determined in accordance with the principle of hot stress. 96 effective FBG sensors were installed. Based on a programmable optical expansion switch and FBG interrogator, the FBG sensing network was achieved which could monitor the strain and temperature of the bridge girder and the stayed cables. The installation positions of some of the sensors, part of the monitoring system and some measured results are shown in figure 2~5.



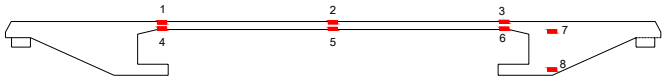



Figure 2 Position of installed FBG sensors


Figure 3 photographs of installing sensors

Figure 4 FBG sensor monitoring system

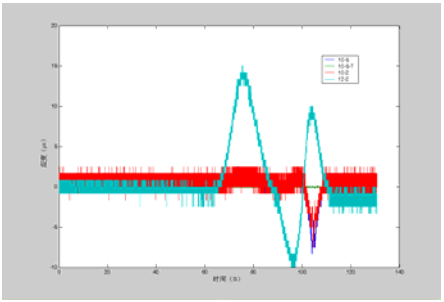


Figure 5 Testing response of FBG sensor under dynamic load

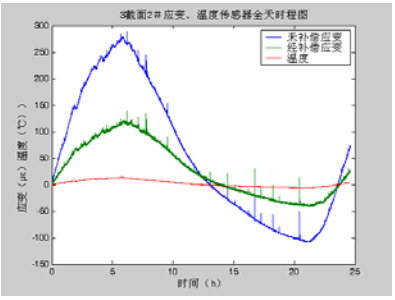



Figure 6 Response of strains and temperatures from daily traffic

Figure 5 shows the response of the FBG sensor to the strain when one heavy vehicle was passing the closure section of the bridge at the speed of 60km/h. The tested result is consistent with the actual situation. Figure 6 shows the response of the strain and temperature at a point during 24 hours, including one strain curve without temperature compensation and another corresponding strain curve with temperature compensation.

## III. The Main Conclusion

After installation, testing and operation for more than two years, it is proved FBG strain and temperature sensors have good durability, high precision, etc. The strain and temperature of the bridge can be effectively monitored. In addition, the FBG sensors need temperature compensation for long-term monitoring. For civil engineering and related structure health monitoring, it is significant to popularize this kind of new technology.