

Fiber-Optics Sensing Applications

Characterizing aged bridge response by loading test



Key Topics:

- Surface mounted FBG Bending Gauges
- Health diagnosis by measuring deflection of an aged, single-span bridge
- Including static and dynamic testing
- Application of FBG interrogation system

Application

The residents of tribe in the mountain area of Fu-Sing township, Tao-Yuan County, Taiwan have long feared the safety of the aged, single-span Hsin-Han bridge. The residents constantly worry about the sudden collapse of the bridge while passing through it.

This bridge was designed and constructed in 1966, when traffic loading was light and scarce at the time, but now more and more heavy-duty truck go through this bridge with recent prosperity of this tribeship.

The township head had urged health diagnosis of the bridge this past year, the case became a project under study. Dr. Chung-Yu Wang, chief of the Center of Bridge Engineering Research (CBER) at National Central University (NCU), leads his team in running the project. The aim of this project is not only to validate the usability but also to determine the critical loading factor of this bridge.

Solution

This aged bridge is 60m in length and 5m in width. It was constructed based on a cantilever model without any pier support to avoid impact due to potential mudflow or landslide. The bridge has been in operation for about 40 years and the original structural design drawing are no longer available, and only the exterior and cosmetic data of this bridge is available. To evaluate the health of this bridge accurately, it presented serious challenge without any historical data.

The FBG Bending Gauges of Prime Optical Fiber Corporation (POFC) is capable of measuring overall deflection curve for the object of interest in the multi-linking mode. Dr. Wang proposed using that as a diagnosing tool to record the response of the bridge under static and dynamic loading. With the response data, further data manipulation will be processed to evaluate if any damage exists in the bridge that the residents had long feared.

26 FBG Bending Gauges in total are used in this project. For comparison purpose, a newly developed laser displacement measurement system is also tested to compare with fiber optical sensor system. Four electric velocity- meters included to evaluate the stability of the bridge while loading test. Each FBG Bending Gauge is applied with tunable stage fixture which was mounted onto the bridge surface directly for the zero operation. Half of them were inter-connected in series and feed into channel 1 & 2 of MOI's si425-500, while the other half were inter-connected and plugged into channel 3 & 4.

In static loading test, a heavily loaded truck was parked at specified locations on the bridge for data recording.

While in dynamic load testing, the same truck was driven across the bridge at 30km/hr speed and the FBG interrogator si425-500 recorded all the data at full speed of 250Hz. (see photo below)

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Results

Results of this test are still being processed and calculated to yield a final report to the township authority. Qualitative results had already shown feasibility of this method in determining bridge safety. Further improvements and modifications will be made on stage fixtures for the FBG Bending Gauge for several project of CBER in the near future. After this case study, team members of CBER praise the advantage of optical fiber sensor, especially for its immunity to EMI and multiplexibility that greatly reduce the loathsome line processing. (see photo above for the strong comparison) Now, the CBER is keeping its direction to make use of this technology and POFC optical sensing products as their main tool for bridge health diagnosis.

Project Details

Project Date:	Jan. 2005
Publication Date:	Apr. 2005
Contributors:	Team of the CBER of National Central University supplied the information for this note.
Instruments:	Micron Optics si425-500 Optical Sensor Interrogator
Sensors:	POFC FBG Bending Gauges
Location:	Tao Yuan County, Taiwan