Case Study - Geotechnical

Long term monitoring of seismic changes of a key fault

Chih-Shan, Tai-Dong County, Taiwan

August 2005

Long-term monitoring of seismic changes of a key fault

Aim	To determine the underground plate movements at the Chih-Shan fault.
Location	Chih-Shan, Tai-Dong County, Taiwain
System Integrator	Prime Optical Fiber Corporation (POFC), www.pofc.com
Customer	Taiwan Government
Date	August 2005
Instrumentation	(1) Micron Optics sm125-500 Optical Sensing Interrogator
Sensors	(14) Prime Optical Fiber Corp, FBG Bending Gauges
Software	Customer designed. ADSL data link.
FBG Technology Benefit	FBG sensors to provide real-time quantitative information.

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- Background

Taiwan is geographically located in an area of where the Philippines sea plate and the Eurasia plate meets. Historically speaking, the Philippines sea plate has had the tendency to move northwesterly, and has periodically collided with the Eurasia plate for more than five million years. All the mountainous ranges of Taiwan basically are formed as a direct result of this phenomenon, Orogeny, including Taiwan's Central Mountain Range which lies on the Eurasia plate and Taiwan's Coastal Mountain Range which lies on the Philippines sea plate. The colliding force has lifted the earth layer from thousand meters below sea level to three thousand meters above sea level. The lifting rate is rather exceptional and is comparable with that of the Himalayas Mountains. In horizontal terms, the visible fault at the surface of the earth varies in shortening of about 7 cm per year and is accompanied by frequent earthquakes.

The Tai-Dong Valley, with width of about 2~5 km and length of approximately 150 km, covers the Hua-Lian and Tai-Dong counties and is situated at the border of these two plates. The Central Mountain Range sits at the western side of the valley with the Coast Mountain Range at the eastern side. The Philippines sea plate still moves at a pace of 70 km per million years, and forms the surface fault in Tai-Dong Valley. The fault is a spectacular occurrence and has received much attention from researchers and academics alike, with substantially knowledge to be gained on Plate Movement Theory.

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- Application

Lots of attention has been placed on the surface fault variation at Chih-Shan, for example, the monitoring sensors of epeirogeny shown in the above figure, has been in progress for over 10 years. The observed shortening of the fault in the last ten year is about 25mm per year, and all plate movements were properly documented and well kept. However, the information gathered thus far was all from surface measurements, and the research community would appreciate further information on underground movements. Dr. Chung-Yu Wang, chief of the Center of Bridge Engineering Research (CBER) and professor at the National Central University (NCU), has proposed and won support from the government on this particular topic. Dr. Wang currently leads his team of engineers and scientists in this project for determining underground movement at the Chi-Shan fault.

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- Solution

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 had decided to use the FBG Bending Gauge as a long-term monitoring tool to record and document the variation below the surface fault. A 30-meter deep borehole into the rock layer was prepared for this purpose and a casing tube has been put in for the further installation of FBG Bending Gauges. A total of14 FBG Bending Gauges were used in this project and each sensing unit is 2 meters in length and equipped with one pair of spring leg plates that guide and help the sensor to be inserted into borehole casing tube. To installation the FBG Bending Gauges, a sensor installation cart was also used. The cart can be easily assembled at site and it helps to increase the installation efficiency of FBG Bending Gauges (see photo below).

The 14 FBG Bending Gauges were inter-connected in parallel and series which resulted in 4 signal fiber lines by design. The 4 signal fiber/cables were connected to 1 unit of Micron Optics sm125-500 interrogator which scans at a speed of 1Hz.

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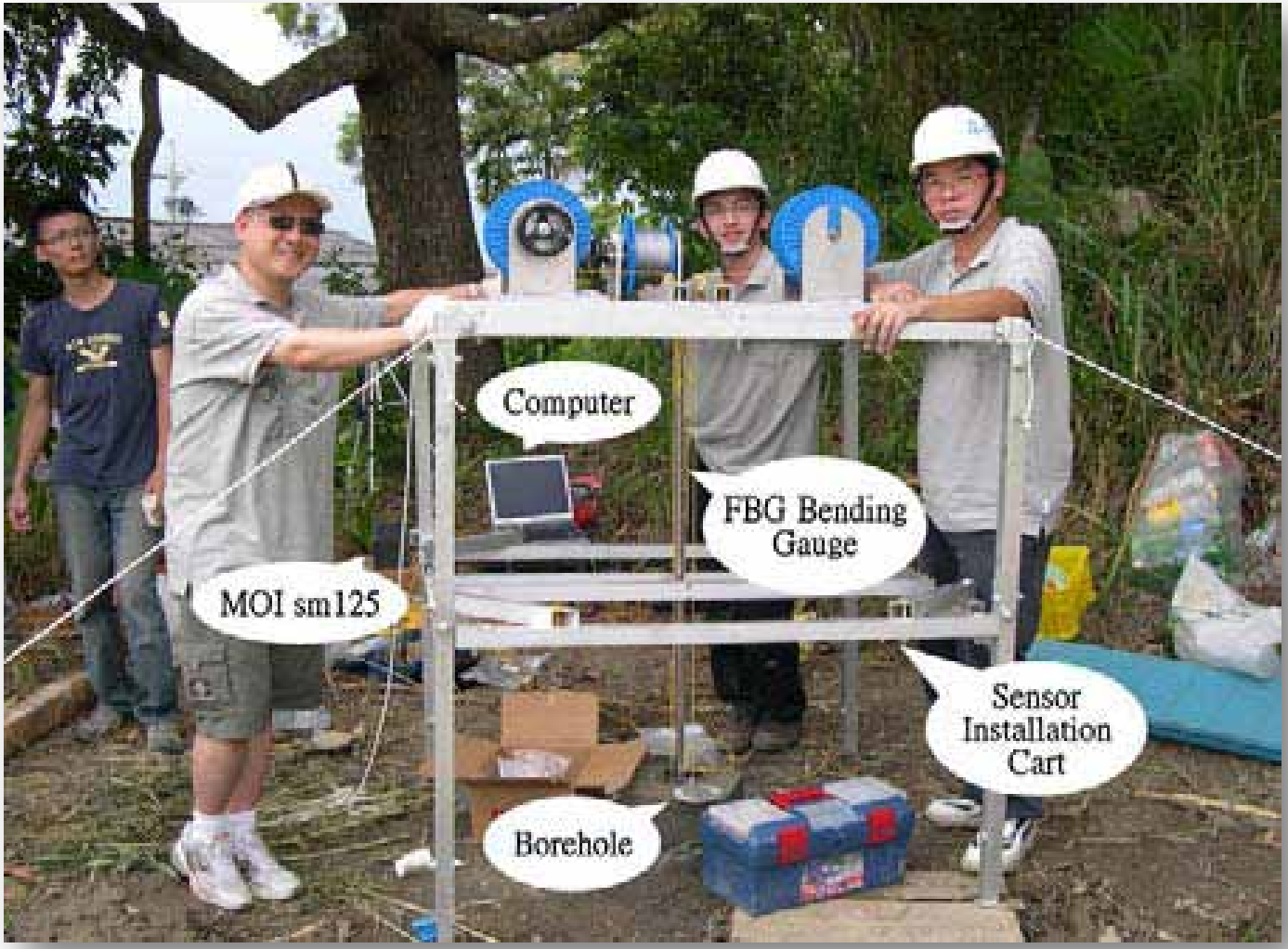

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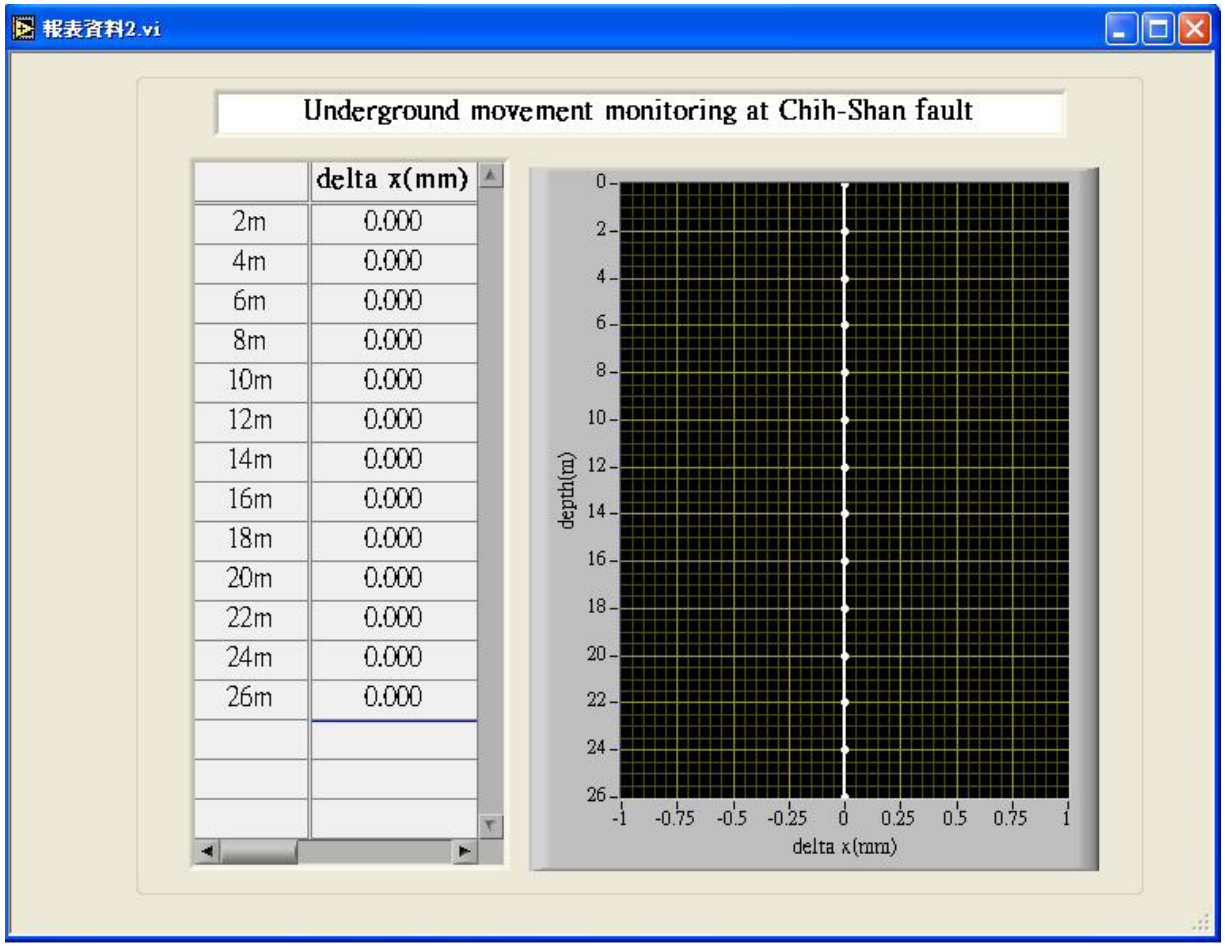
GUI of monitoring program



Results and Acknowledgements

- Results
  - The installation progressed smoothly and took about 4 hours. After the installation is completed, a monitoring station is soon to be put in.
  - The station will house a computer, the sm125-500 interrogator and an ADSL data link.
  - This long-term monitoring will continue for one and half year, results will be collected and frequent reports will be submitted to the authority and may be shared among various research organizations.
  - Further, if worthy results are obtained, the project duration will be extended.

- Acknowledgements
  - Dr. Chung-Yu Wang, chief of the Center of Bridge Engineering Research (CBER) at National Central University
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