

Leica Geosystems **TruStory**

Monitoring of the Central-Wanchai Bypass During Construction



■ Objective

Deformation monitoring of bridge construction works

■ Customer/Institution

Chun Wo Construction and Engineering Company Limited

■ Challenge

Planning and installation of a temporary monitoring system within a daySmooth transition from a temporary into a permanent monitoring system Real-time deformation monitoring throughout the construction

■ Date

Since February 2011

■ Location



■ Project Summary

Instruments

Leica TM30

Leica Geosystems Monitoring prisms

Software

GeoMoS Monitor / Analyzer

Web viewer for displaying data and reports

Communication

Cables

Uninterrupted Power Supply (UPS)

■ Benefits

- Continuous and remote monitoring
- The safety of the bridge can be ensured round the clock during operation

The Island Eastern Corridor is a major expressway connecting Causeway Bay to Chai Wan, which was completed in the 1980's. In February 2011, a bridge abutment supporting the slip road was found to have unusual structural movements, causing the temporary suspension of underground works and soil stabilization and measurements to be taken immediately. As further settlement is still possible and construction work needs to continue, which could potentially threaten the safety of road users, further monitoring of the bridge structure is required to provide real time deformation information to the engineers, so that they can make a correct decision to ensure the highest degree of safety. The automated deformation monitoring system

(ADMS) was initially set up temporarily to automatically operate round the clock, providing precise deformation measurements. However, in March 2011, the system was turned into a permanent system.

The temporary monitoring system was originally set up on a rental basis with a Leica TCA 2003 total station, but after one month, the customer purchased a new permanent monitoring system with a Leica TM30 total station, which was specially designed for monitoring use. The TM30 can operate 24 hours, 7 days a week even under severe environments. It also performs well throughout a wide temperature range and is protected against wind driven rain, sand and dust, which is omnipresent in this monitoring site as it is an open-air area with cars



travelling around. Incorporating all these features, measurements could be taken round the clock and the system remains stable and precise at all times. Measuring over a hundred monitoring prisms mounted on bridge abutments and other surfaces, monitoring data were measured in a one-hour cycle. For the monitoring of such a critical road bridge, with cars frequently passing by, outliers or data gaps cannot be tolerated. With the Leica TM30 total station, the system provides high accuracy angular measurements of 0.5" and precise distance measurements with 0.6 mm + 1 ppm. With the direct drives and the SmartEye vision the total station can perform the measurements to all the monitoring prisms in a short cycle.

Monitoring System Setup

The monitoring consists of a TM30 total station, a computer and more than one hundred Leica prisms. The total station is mounted on a platform next to a bridge abutment and protected by a fixed metal stand, once the system became a permanent set-up. The prisms are mounted on various surfaces, which are distributed around the concerned slip road in the construction site. Reference prisms are installed in stable areas to provide a control network for the Leica TM30 total station. The computer, with Leica GeoMoS for the total station control and data acquisition, is located just next to the total station in a heavy transportable box. In addition, an uninterrupted power supply (UPS) is installed so that the complete

system is still operational during any short-term power outages. A backup database is used to store backup data, as past data plays an important role in future analysis and comparison. To enable monitoring users to access the monitoring data anywhere, the computer is connected to a web server in a data centre and all the data is uploaded in real time to the Internet. To ensure the monitoring system operates smoothly, reliably and accurately in spite of all the construction work nearby, regular system maintenance checks and cleaning of optical prisms is done to prevent coverage by sand and dust or movements caused by vibration.

Temporary to Permanent

After the initial structural movements in February 2011, the customer demanded a fully automatic monitoring system from Leica Geosystems Hong Kong with only a half-days' notice. The monitoring system planning, with the position of the total station, prisms and setup, had to be done within hours. The Leica monitoring system components were set up very easy with plug & play for a one month temporary installation. To reach the highest standards of a monitoring system, it was turned into a permanent setup one month later. During the installation period of the permanent set-up, the temporary set-up continued operating until it had worked for two whole months, so that surveyors could compare the data between the two set-ups and adjust them accordingly.



the reasons behind the notification and confirm whether the message was due to faulty equipment (displaced prism), human error or construction activities. They decide what kind of actions need to be taken, e.g. increasing monitoring frequency or even a temporary suspension of all nearby works.

Conclusion

The implementation of the automatic deformation monitoring system after the initial structural movements has been highly beneficial, as with the help of the monitoring system, the Central-Wanchai Bypass project could be resumed safely and the public can be constantly kept informed about the situation. The monitoring system has allowed the progress of construction projects to continue, in addition to ensuring public safety.



Data Visualization

All the measured monitoring data is first processed by the computer with GeoMoS Monitor. The responsible surveyors can then view the data directly with GeoMoS Analyzer on the computer located on the construction site or via a web interface, as the data is immediately uploaded to the Internet. After logging into the web page the users can display the data with numerical or graphical reports, their associated limit levels and download raw data. The actual monitoring data can be displayed with reference to the initial values measured at the start of the monitoring or as trends.

Messaging System

As the name of automatic deformation monitoring system suggests, every process should work without human intervention. Therefore, instead of employing a person to watch the data 24 hours a day, computers notify surveyors and engineers immediately when any deformation beyond tolerance occurs with the system. After the monitoring positions of the prisms are measured, they are compared with the set limit levels. If any monitoring data reaches or exceeds one of the three limit levels, the messaging system is immediately activated. The designated personnel are notified through various media and by e-mail. The surveyors in charge then investigate