4D Survey and Geotechnical Monitoring Achieving Enhanced Project Outcomes for Construction

Lee HELLEN, Australia

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SUMMARY

The Southpoint Development project in Brisbane's Southbank precinct located Queensland State, Australia, is a working example of how Land Solution Australia has effectively used consulting surveying knowledge and the latest advancement in technology to solve a complicated construction challenge.

The 4D monitoring system, developed in conjunction with a major Australian Building and Civil construction company, uses multiple robotic instruments and geotechnical sensors to feed real time survey and geotechnical data to a host of engineers, builders and public stakeholders. Alarming capability is also a by product of the system which can alert key stakeholders of movement and change in the construction environment in a shorter timeframe than traditional methods.

This has allowed the builder to demonstrate greater corporate responsibility in terms of managing the risk of damage or deformation of neighbouring assets and maximise their efficiency by having minimal interruptions to their construction program.

The combination of both survey and geotechnical instrumentation including vibration, tilt and displacement was expertly installed and managed by Land Solution Australia so that it could work with minimal human intervention for a period of 18 months. The system serves up nearly 2500 precise measurements per day which are delivered in near real time via a remote server login to 40 project managers and engineers. The complete 'geospatial' ecosystem devised is also remotely scalable with the ability to increase or decrease observation frequency automatically.

The 4D automated monitoring solution devised by Land Solution Australia has resulted in enhanced efficiency and collaboration when dealing with a complex construction and public safety challenge. This system has now been duplicated on other sites and is delivering a enhanced outcome for stakeholders for medium to high risk impact asseessable development.

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1. SCOPE

4D (XYZ and Time) survey and Geotechnical Monitoring is a near real time monitoring system that incorporates precise automated robotic total station observations from multiple locations with vibration, joint-meters, in place inclinometers and other geotechnical sensor data. All data is transmitted to a central server for integration into customised monitoring software. The monitoring software, Trimble® 4D Control™ (T4D), is capable of collecting, managing, and transmitting alarm triggers via SMS or email to an unlimited number of stakeholders. The system can be accessed remotely by a number of stakeholders via an internet URL and secure username and password.

The system is ideally suited to monitor horizontal vertical settlement, and vibration movements over short or long term construction timeframes. It is highly efficient for applications in areas of difficult, restricted or unsafe access. Once installed, the monitoring system can be easily programmed to observe at an increased frequency or for longer durations if required without significant cost.

2.0 EQUIPMENT

- Trimble® S8 and S9 (1") total stations
- Monitoring reflective prisms
- Ground Vibration Monitoring Geophones
- In-place Inclinometers (MEMS) sensors
- Shape Accel Arrays (SAA)
- Vibrating Wire (VW) crackmeters
- Campbell CR800 geotechnical data loggers
- Temperature sensors for Total stations
- Cellular routers
- Scaleable 'Cloud' server
- Trimble® 4D Control™ (T4D) Software

2.1 DEVISING AND INSTALLING THE SYSTEM

Land Solution Australia Pty. Ltd., a private consulting surveying firm, developed a 'complete geospatial solution' that included Trimble® total stations, various geo-technical sensors and a combination of different communications to control and transmit the data to Land Solution Australia's Trimble® 4D Control™ (T4D) software platform.

To deliver this system, Land Solution Australia relied heavily upon the equipment and expertise of various technology partners, geotechnical consultants, and IT specialists.

Expectations for accuracy and sensor type were agreed upon by consulting engineers prior to the design of the system. Detailed monitoring implementation plans were then prepared by Land Solution Australia and distributed amongst project engineers, contractors and asset owners for approval prior to commencement. The expertise of the consulting surveyor in managing accuracy constraints and relating the components spatially (sensor correlation) was critical to the design and maintenance of the system.

Installation for robotics and sensors ranged in duration form 24 hours to up to 5 days for complex installations in tunnels for individual components. Integrity of communication and stability was given the highest importance in areas where access was highly restricted and difficult to obtain. Communications were designed to provide the data to the customer in near real-time, reliably, and constantly for a 12-24 month timeframe.

2.2 DATA MANAGEMENT AND AUTOMATED NOTIFICATION

Data collected in the field is sent automatically to a cloud server by networking static Internet Protocol (IP) communication tunnels. By managing all sensor data at a central server, the system is capable of supplying a simplified single portal for presentation and alarming for all monitoring data.

One of the real challenges of any project is the way in which the data is served or presented to the client. The 4D monitoring system solution accomplished this with ease by means of a consistent Web user interface, desktop software, SMS and e-mail messages. The Trimble® 4D Control™ (T4D) user interface allowed engineers to chart, map, analyse and integrate data of different type, accuracy and frequency, to look at trends and data for periods of their choice, and to plot various data types against each other.

A consistency in automated notification (alarming) and data visualisation and presentation across multiple sensor types (survey, environmental and geo-technical observations) was also possible so that 24-hour automated alarms were sent to stakeholders whenever realistic tolerances were exceeded. Separate alarms for no data can alert the user where maintenance of the system is required, ensuring the continuity of the entire system.

3.0 THE VALUE OF THE INNOVATION

The Southpoint Development project and others since, have combined data from several different mature technologies. The innovation these systems deliver has to do with the way construction deals with challenges and constraints. Managing the constraints of a live project, (busy public transport utilities and an evolving construction sequence) meant an opportunity to innovate in a way that builds simplification, enhanced communication, transparency, and trust to what traditionally can be a complex and difficult task.

The project was innovative because it brought the geotechnical sensors into a single monitoring platform; as well as reporting the geospatial information that surveyors conventionally deal with, in a harmonious way.

4D monitoring solutions enhance safety both the workers on- site, and of the public who use the public transport corridors. It also serves as a powerful risk management tool for construction and infrastructure, providing it the data required to limit the potential risk of deformation of adjoining assets during the construction. In the words of a client of the system, "the 4D control monitoring project has been quite a learning experience. It has been very good at managing risk for the builder and the variety of stakeholders on site."

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BIOGRAPHICAL NOTES

Lee is the founding Director of Land Solution Australia and Registered Consulting and Cadastral Surveyor with the Surveyors Board of Queensland and Northern Territory. He is a past chair of the Spatial Queensland Pty Ltd, which is an industry collective that represents over 80 surveying and spatial information businesses across Queensland. Lee's experience in the spatial industry spans over the past eighteen years as a consulting surveyor conducting engineering, boundary and aerial surveys in Queensland, The Northern Territory, New South Wales and the United Kingdom.

Lee studied a Bachelor of Applied Science (Surveying) at QUT and holds a post graduate diploma in Geomatic Studies at the University of Southern Queensland.

Lee has worked on many iconic construction and infrastructre projects in Australia and The United Kingdom in a capacity as Lead Surveyor and Survey Project Manager. He is currently championing robotics and automation to support precise 4D Survey and Geotechnical Monitoring requirements for infrastructure and construction.

CONTACTS

Mr Lee Hellen
Land Solution Australia Pty Ltd
20/240 Waterworks Road
Ashgrove, Brisbane
AUSTRALIA
Tel. +61 7 3366 3525
Fax +
Email: lee.hellen@landsolution.com.au
Web site: www.landsolution.com.au