

Leica Geosystems **TruStory** Monitoring above and below ground in London's heart



The exponential growth in cities has an impact in transportation infrastructure – tunnels, railways and bridges are used more extensively than ever before. With this increased demand and an aging infrastructure, smarter traffic management and maintenance regimes to minimise transport disruption and manage safety risks is critical. It is important to monitor the impact of any maintenance or construction works to ensure any movement remains within expected and acceptable limits.

The required monitoring output information can come from a wide range of manual and automated survey and sensor methodologies. This is where a professional full-service surveying and monitoring company, like Murphy Surveys, comes into play. As one of the leading surveying and monitoring firms in the United Kingdom and Ireland, the

company offers a wide range of services – from aerial LiDAR survey to underground radar and monitoring of structures using geodetic, wireless geotechnical and structural sensors.

Murphy Surveys created a resilient sensor network using Leica Geosystems solutions to provide reliable processed data to monitor any changes and deformations affecting underground tunnels, assets and buildings inside the zone of influence surrounding a major development project in London's inner city.

Creating a sensor network

The Regent's Park Development project in the heart of London involves the demolishing of a series of buildings, and the excavation and construction of new of new buildings. The zone of influence for the unloading – due to excavation and later loading when constructing the new buildings – extends over a radius of approximately 80 metres. The

encompassed area includes Grade 1 and 2 listed historical buildings, London Underground tunnels, and electrical supply substations assets.

Murphy Surveys' dedicated monitoring department uses a mix of optical and sensor monitoring equipment including robotic total stations, MultiStations and GeoMos Monitoring Solution, among other sensors, to monitor any changes impacting the zone of influence building area. The monitoring configuration provides continuous automatic monitoring of above and underground structures to generate two types of reports:

1. A report analysing the above ground movement of buildings and other technical assets, such as a power supply transformer station or medical equipment in a nearby surgery, and;

2. A ground movement report monitoring the tunnel of the Jubilee Line North and Southbound tunnels as well as the Metropolitan Line tunnel that passes underneath the demolishing site.

The two monitoring processes ran continuously and, more importantly, prevented people from being sent to a hazardous area, reducing cost, risk and increasing safety.

The power of combined technologies

Murphey Surveys combined multiple geotechnical and optical monitoring technologies in a sensor network in the overall scheme:

1. Leica MS60 MultiStations for laser monitoring of facades;
2. Wireless tilt metres for stable deformation, convergence and longitudinal settlement monitoring in London Underground tunnels;
3. Automatic vibration, noise and dust monitoring;
4. Alarm features using Leica GeoMos monitoring solution, allowing all project stakeholders to have access to the monitoring data base with different set permission levels to view or modify reports and receive alarm messages;
5. The integration of all data into Leica GeoMos, an off-the-shelf software to provide the client with all the monitoring data within one software and web interface.

To monitor multiple buildings on this London inner city project, Murphey Surveys



uses three MS60 MultiStations geometrically connected over common control points and wired up to Leica ComBox5 to broadcast the monitoring data via internet broadband to the GeoMos servers.

The Metropolitan Line double track brick tunnel is being monitored by an automatically controlled MS60 MultiStation reading in track reflector and laser scan data. The two Jubilee Line tunnels are fitted with 250 Senceive wireless tilt sensors connected through a fibre optic cable to broadcast the data to the internet and GeoMos.

This innovative approach awarded Murphey Surveys in March 2015 to win the competitive tender process to monitor the above and below ground assets, as well as the environmental monitoring, for London's Regent's Park project.

An inclusive monitoring system

GeoMos software is the platform where all data are collected, validated, processed and delivered.

"GeoMos allows us to observe and record parameters of building and ground movement, deformation of railway track and London Underground tunnel segments. GeoMos recorded all monitoring data from a variety of sensor sources, such as 3D reflector data, manual levelling and inclinometre data, Senceive's wireless tilt sensors data, and laser scan data," said Andrew Masters, technical manager at Murphey Surveys.

Leica GeoMos 6.0 automatically analyses laser scan point clouds for deformation analysis. The output is a colour coded point cloud where the colour indicates the size of the deformation on a colour scale, making it easier to find deformation areas across a monitored surface.





"We suggested certain refinements on the software to Leica Geosystems' development team, which now allow us to separate longitudinal, lateral and height deviations, as well as single data points to automatically calculate the longitudinal settlement and ovalisation deformation of the tunnel lining," said Masters.

Beyond the geometrical monitoring, the team of surveyors also collects data from various environmental sensors on site, such as dust, vibration and noise sensors that run their own alarming routines but accumulate in the weekly data report within the GeoMos web interface.

The use of GeomosNow provides an integrated data interface to the client's engineers. The software narrows down the real-time data flow running through thousands of sensor channels to a simplified clear report.

"The new technology streams laser scan data from the ATS to the GeoMos software in real time. The new algorithm processes automatically the monitoring surfaces and compares them to a baseline survey," Unitalicise said Masters. "Movement exceeding the set parameters triggers automatically laser scan monitoring. This continuous live communication and data exchange from site to office, provided by our reliable equipment, eliminates delays and costly site revisits."

Choosing partners strategically

Murphy Surveys has carried out thousands of surveying and monitoring projects over three decades using Leica Geosystems solutions. Although needs vary considerably by project, detailed, precise and timely data is always required. For the monitoring of the Regent's Park Development project, the challenge was to provide the right mix of laser scanning techniques, topographic surveying and monitoring solutions to deliver precise and reliable data in a timely manner while minimising any disruptions and increasing safety.

"We concentrate on the quality of our staff and innovation. For this reason, we choose suppliers and partners that match the requirements for quality, innovation and cost effectiveness over the short, medium and long term. Collaboration with Leica Geosystems and sensor specialists like Senceive enables us to provide an innovative and flexible service for our clients," explained Kai Duebbert, managing director of Murphy Surveys.

"For a large global manufacturer, Leica Geosystems has shown great flexibility, for example in reacting rapidly to our ideas on how to customise software routines and to solve new local challenges on site. This kind of support is critical to deliver the most suitable solution and give the client the comfort to only deal with one service partner for all his survey, BIM and monitoring requirements," concluded Masters.

Leica Geosystems AG

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- when it has to be **right**

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