



by Vicki Speed

High above the streets of Manhattan there is a new form of public servant dedicated to serving and protecting the people, property and assets of New York City. This servant works 24/7, never asks for a raise and never takes a break. Its main purpose is to continuously measure and monitor any movement of buildings and structures that might take place while heavy construction continues around the clock throughout the city that never sleeps.

In the last five years, New York City has become one of the most active construction zones in the world – both above and below ground. In addition to the very visible 16-acre World Trade Center rebuild, the city is expanding its subway system with several new lines while public and private developers construct or renovate numerous commercial and residential high-rise projects. Mega construction projects such as these inevitably cause some shift in surrounding structures. It is up to the New York surveying and engineering community to manage and monitor this movement to prevent disaster. Advanced laser-based

monitoring instruments offer a reliable, affordable and continuous solution. In New York City, there are currently over 40 automatic long-term movement monitoring instruments working to provide engineers, project managers, contractors and owners with answers to the question, “Did it move?” and if so, “How much, and when?”

South Ferry Terminal and World Trade Center Rebuild: 24/7 Response

Part of the New York City subway system is the \$490 million South Ferry Terminal project, located underneath Peter Minuit Plaza in Lower Manhattan, adjacent to Battery Park and the Staten Island Ferry Terminal. Once complete in early 2009, this terminal will accommodate 10-car trains and have multiple station entrances, including escalators and elevators. Geomp Corporation, a leader in real-time performance monitoring of constructed facilities, is charged with monitoring the underground and above ground structures including many of the historic buildings that are located throughout this southern portion of Manhattan. The firm installed Leica TCA1800 total stations on several facilities throughout the South Ferry Terminal construction site.





■ Gerard Manley of Leica Geosystems discussing World Trade Project with Geocomp engineer.

According to Allen Marr, President of Geocomp, “We use the tool’s Automatic Target Recognition (ATR) capabilities to measure changes in target positions located on existing structures to an accuracy of 1mm. These instruments are workhorses, built to withstand harsh environments with accuracy and reliability. Some units were placed inside the existing tunnels where they had to operate while heavy construction equipment created dust, dirt, grease and moisture.”

Each instrument can be programmed to automatically search and collect data on as many as 100 targets. On the South Ferry project, ten total stations and hundreds of targets were used for this purpose. The recorded data is collected and transferred in real time via wireless radio to Leica Geosystems GeoMos software at the Geocomp project site. Geocomp interfaces the Leica GeoMos software with its iSite-Central software to provide automated alert messages by email any time a measured value exceeds a preset limit.

Another example is directly in the center of the World Trade Center reconstruction site, where Geocomp is monitoring an active subway tube while the earth above and below is removed to make way for the foundations of the new towers. Gerard Manley, Vice President of Engineered Solutions at Leica Geosystems, says, “It’s an amazing engineering feat to see

a New York subway that was once under ground, now fully exposed and supported only by pillars. We are monitoring this subway suspension as well as several other locations within the World Trade Center site for any sag or subsidence.”

From East to West

Manhattan’s Upper East Side, best known for its high-priced high-rise real estate, internationally-famous museums, and 843-acre Central Park, is also undergoing extensive renovations, including the construction of the new 2nd Avenue subway line to relieve severe congestion on the subway and buses. Wang Engineering is involved in monitoring many of the buildings surrounding the 2nd Ave project. Again Leica TCA1800’s and TCA2003’s are deployed on the sides of buildings. The instruments’ lasers focus on targets located on the sides of buildings up and down 2nd Avenue. Data is collected at a construction site location then transferred to Wang’s headquarters in Princeton, New Jersey for analysis and presentation.

Similarly, Tectonic Engineering and Surveying Consultants P.C., implemented an unmanned geodetic-level monitoring system in Queens to measure possible Metropolitan Transportation Authority (MTA) subway system track shifts caused by the construction of a nearby commercial building and parking garage. Of specific concern to MTA authorities was deep foundation pile driving which causes impact

and vibration to surrounding structures, and thus the potential for movement of nearby train tracks, which could cause derailment.

The commercial building is located about 25 feet from MTA subway tracks, a bridge and a highway. Tectonic Engineering and Surveying Consultants P.C. monitored the movement of the bridge, tunnel walls and retaining walls during the nearby pile driving over the course of 15 months. The structural monitoring network consisted of 32 prisms and a TCPR1201 robotic total station with power search and Pinpoint R300 reflectorless distance measurement with a laptop running the Leica Geosystems GeoMoS automatic monitoring software. The robotic-capable total station and laptop were mounted on a custom built pedestal permanently attached to a concrete abutment of the bridge. A shed was built around it for protection from the weather and security. Michael Lacey, P.L.S., Tectonic's Chief Surveyor says, "The entire network was unmanned 24 hours a day, 7 days a week, with the capability of checking on required readings and managing the "raw" data through our FTP site, from anywhere at anytime. Even if the Internet signal went down, the GeoMoS software continued to gather data from the prisms. The entire monitoring effort was controlled by the GeoMoS software on site using a laptop computer."

On Manhattan's west side along the Hudson River, GZA GeoEnvironmental Inc., a premium geotechnical engineering firm, is conducting structural movement studies of buildings, existing tunnels and bridges in advance of the underground construction that will

become part of the \$2.1 billion expansion of the MTA's No. 7 Line subway extension, one of the larger construction projects in all of Manhattan. These movement studies allow engineers to develop a "baseline" of data that represents existing conditions and alerts all responsible parties in near real time using Web-based data transfer and reporting systems.

The Big Apple and Beyond

"Structural monitoring data is the basis by which industry professionals can ascertain overall structural movement, an integral part of most construction projects throughout New York City and around the world," concludes Leica Geosystems's Manley. "We currently have over 40 automatic total stations operating in New York City. Surveyors and engineers use them for everything from engineering analysis to resolving legal disputes. The technology has gone from 'nice to have' to absolutely required. We've even seen construction completely stopped until our instruments were put in place and collecting data and providing protection."

While the demand for the structural monitoring systems continues to grow, developers continue to advance the technology's capabilities in terms wireless data options, ever-tighter accuracy, speed and size. It's fast become the most reliable way to watch a city on the move. ■

About the author:

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