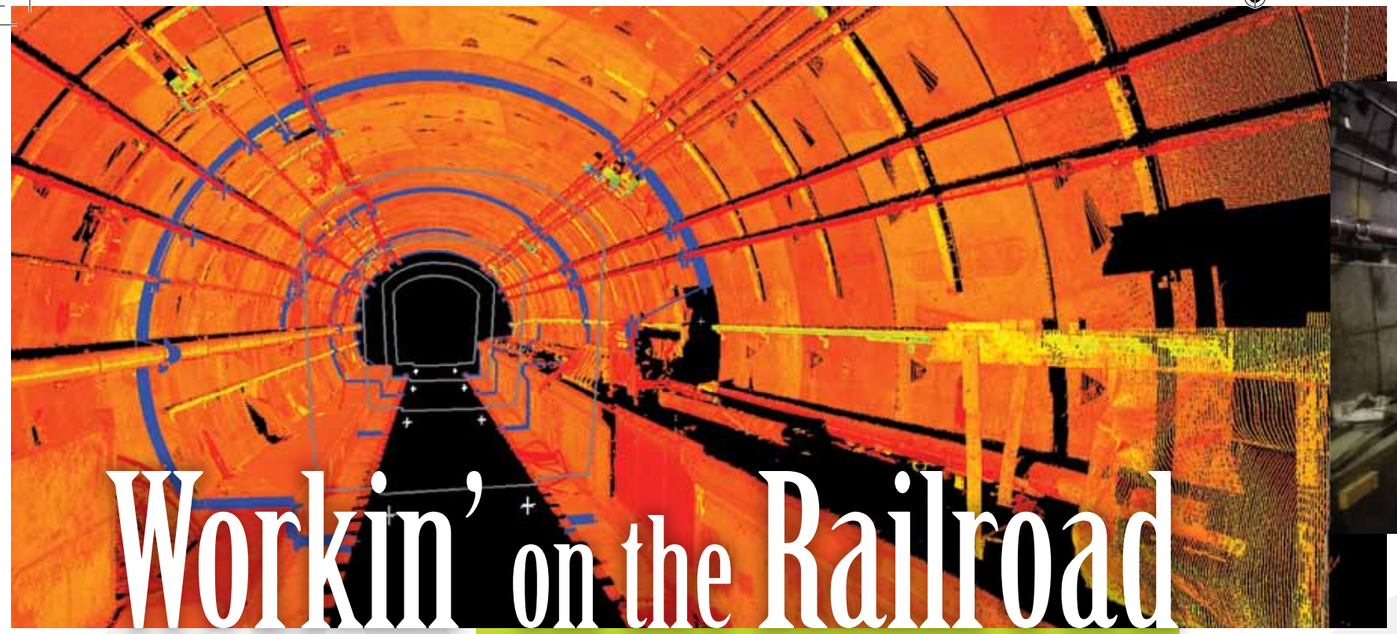


Workin' on the Railroad

By Jonathan Ricablanca

Amberg Technologies' laser scanning trolley systems and software suite make this New York City subway extension project easier.

While there are many technologies and services used to acquire critical data associated with railways and their rights-of-ways, some can be cumbersome and require logistical challenges that can increase risk to track workers. Maser Consulting P.A., a multidisciplined engineering and land surveying firm with offices throughout the East Coast and Mid-Atlantic and with projects located nationally, employs Amberg Technologies, a provider of specialized systems for the georeferenced collection and refinement of civil infrastructure information to alleviate that risk.

Maser Consulting used Amberg's GRP 5000 and GRP 1000 trolley systems with 3D laser scanners mounted on them to acquire LiDAR data of continuous railroad geometry and tunnel appurtenances on the No. 7 subway line in New York City recently.

Designed for direct contact with the tracks, Amberg's trolley and software solutions provide comprehensive track geometry and corridor mapping, including gauge, super-elevation, curvature, middle ordinate, clearance and asset inventory. Designed like a three-wheel trolley and weighing 45 pounds, a single operator can exit the tracks with the Amberg GRP 5000 system in seconds. This mobile system increases safety and reduce the duration of track outages and the need for lengthy mobilization times.

"When time is of the essence, the Amberg method is a … profound tool that gives us the ability to provide our clients (with) a comprehensive and accurate solution in an efficient and cost-effective manner," says Ryan Leonard, a Maser Consulting rail and tunnel consultant.

The trolley at its core is a geometric measuring sensor. Positional information is established by a robotic total station located by resection to the local control monuments, which is continuously tracking a prism mounted on the trolley. With the inclusion of a phase-based 3D laser scanner, the Amberg trolley captures continuous LiDAR data perpendicularly about the tracks, reaching as far as 79 meters. The complete dataset is then geographically referenced to the local control using the Amberg Rail software suite.

Utilizing a Leica TS30 for position, a Z+F 5006i laser scanner and a Panasonic Toughbook to run the Amberg software, Maser Consulting's crews can capture comprehensive track geometry and LiDAR information at more than 600 feet per hour. Within tunnel environments, data is gathered at an average speed of 0.5 miles per hour.

One problem that must be overcome is the position of the laser scanner. Due to its position mounted on the trolley, features inside the rails cannot be collected. Static or stationary laser scanning methods can be implemented to gather this information. This technique has been successfully and extensively used on New York City and Washington, D.C., area rail and tunnel projects.

"Different projects require different tools. The same scanner can't be used on every project," said John Ott, Maser Consulting's crew chief. "Due to the level of detail that the client required, especially in subway tunnel construction, accurate track measurements (were) obtained using the Amberg trolley system, not only because of its ability to collect precise rail data in real time, but how quickly we can collect it. … If you want dynamic clearance and track data, Amberg's the one you want. The true benefit is realized when the data we collected is processed using the Amberg Rail suite in the office. Time savings in that aspect is substantial."

Opposite: Three-dimensional Autodesk AutoCAD drawing exchange format files of tunnel wall cross-sections with Metro Transit Authority car-body data overlaid onto laser scan data for the No. 7 subway extension project in New York City. Left: The Amberg GRP 5000 trolley system takes track as-built scans prior to the pouring of concrete on the No. 7 rail extension project in New York City. Images courtesy of Maser Consulting

Under construction since 2006, the No. 7 subway line, which had terminated at Times Square, is being extended approximately one mile to a new station at 34th Street and 11th Avenue. Upon completion, the $2.4 billion extension will provide access to the entire Hudson Yards Redevelopment area and is vital to the growth of businesses and to residents on the Far West Side of Manhattan.

Hudson Yard currently serves as the Metro Transit Authority's 20-acre western rail yard, where the MTA has leased the rights to developers to create New York City's largest development project in recent years. Proposed development includes a 14-acre park and 16 skyscrapers, containing approximately 13 million square feet of commercial, retail and residential space.

In February 2013, as part of the track and signal contract issued to RailWorks Transit, a division of New York City-based RailWorks Corp., Maser Consulting performed as-builts of approximately 12,000 linear feet of track, including two tangential crossovers and a station platform at 34th Street. RailWorks chose Maser Consulting due to its ability to generate clearance as-builts without the need for a geometry car or plywood cutouts of train body cross-sections.

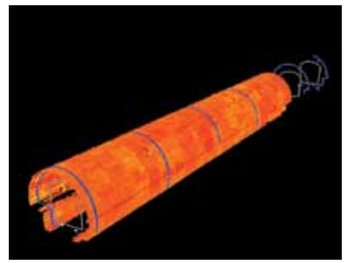
For existing tracks, resections using a minimum of four points were used to establish the position of the Leica TS30. Once resections were completed, the stationing position of the Amberg trolley was locked in with the prism mounted on top of the Z+F 5006i laser scanner. Scan positions were re-established every 150 to 350 feet, depending on the location within the tunnel and other variables.

In areas where track had not yet been laid, especially around the 34th Street Station platform, at tangential crossovers and entrances to the tunnel shaft, the Amberg TMS positioning method was used. Resections were still needed to establish the position of the total station within the tunnel alignment, but instead of having the Z+F on a trolley, it was mounted onto a tripod and scan positions were re-established every 30 to 40 feet.

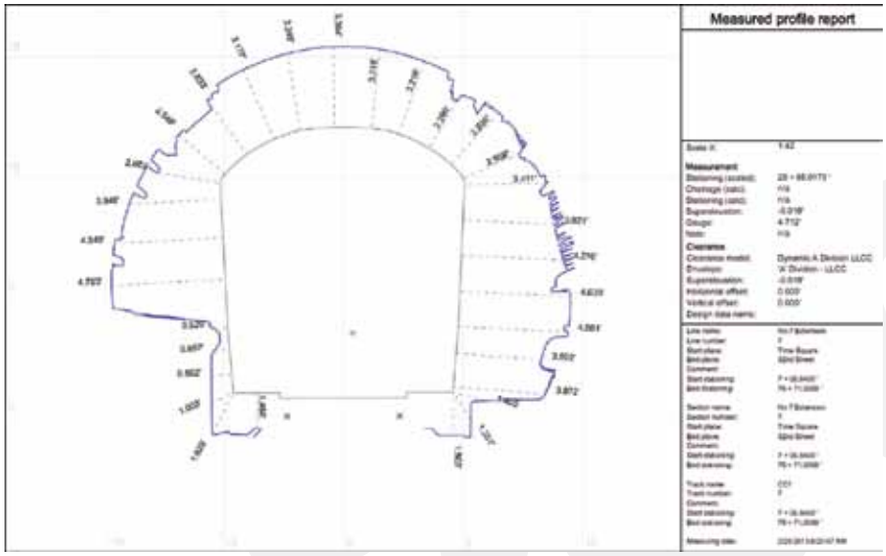
RailWorks was pleased with the results. "By deploying Maser Consulting and their expertise with their Amberg Rail trolley, we were able to dramatically improve our response to any clearance issues well in advance of our client's inspection," says Jeffrey Nalbone, project manager for RailWorks Transit. "Coupling Maser's work with our own Amberg trolley work with track alignment just made the whole process that much more seamless."

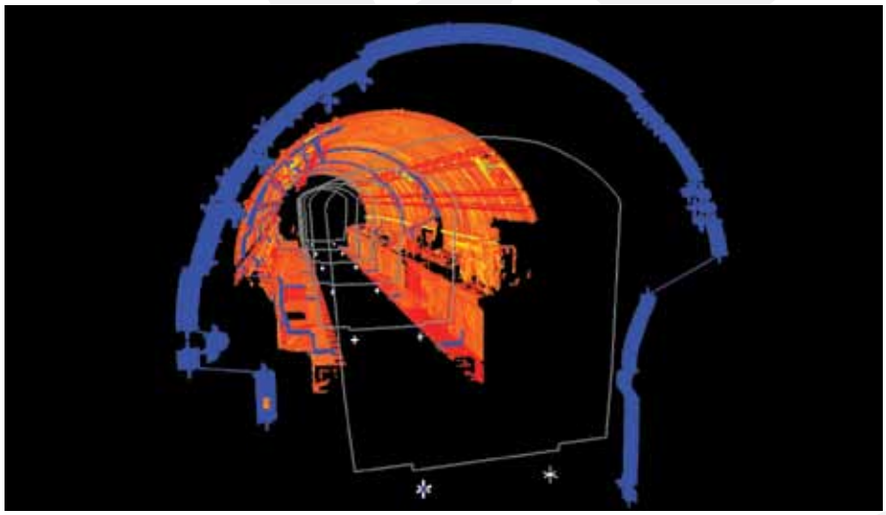
Instead of traditional railroad timber ties, the No. 7 extension utilizes a low vibration track (LVT) system. Due to tight deadlines and the precision required to maintain vertical and horizontal clearances within the tunnel, Maser Consulting performed additional scans for as-built track alignment and geometry prior to setting the LVT blocks to concrete. This was done to ensure that the top of the rail was set at a certain distance below the proposed top of the rail elevation, to accommodate the rise of the LVT's as the concrete slab cures. Particular focus was made on the alignment, super-elevations and gauge. Dynamic clearance cross-sections were then developed, providing added assurance that MTA clearance specifications were met.

After track adjustments were made during the concrete pour, the Amberg GRP 1000 configuration (without the laser scanner) was used to align the left and right rails of the track to its proper position. The Amberg GRP 1000 closely follows the hopper as it is moved into position. As the concrete is poured, the system is rolled 6 to 10 feet, where track adjustments are made. At each stop, the trolley operator tells laborers the exact alignment of each rail by utilizing Amberg Slab Track software.



Three-dimensional Autodesk AutoCAD drawing exchange format files of tunnel wall cross-sections with car-body data overlaid onto laser scan data. Image courtesy of Maser Consulting





Left: A sample dynamic clearance cross-section in Amberg Rail software. Below left: Three-dimensional Autodesk AutoCAD drawing exchange format files of tunnel wall cross-sections with Metro Transit Authority car-body data overlaid onto laser scan data for the No. 7 subway extension project in New York City. Above: A screen capture of Amberg Slab Track software showing track adjustment criteria. Images courtesy of Maser Consulting

"The No. 7 extension tunnel is a prime example of a project where fusion of point-cloud data and track measurements were collected simultaneously with one specific tool, where multiple technologies were incorporated to perform routine tasks common to rail construction," Leonard says. "Tunnel or no tunnel, the Amberg method, combined with a fundamental and technological approach to precise land surveying techniques, creates value on any rail project in terms of the time and speed in which data is collected, its precision and with the various types of deliverables we can generate for project owners."

Through Amberg Rail software, dynamic clearance analysis was developed using the MTA's A Division car-body clearance specifications. The car body was created in Autodesk AutoCAD and imported into Amberg Rail. Cross-sections were developed at 10-foot intervals along tangent track and at 5-foot intervals along curves. That information was provided to RailWorks Transit, so that it could identify potential obstructions along the tunnel wall and ledges, such as conduits, signals or the wall itself. In addition, a spreadsheet of all pertinent track geometry was developed, including alignment, top of rail, gauge and super-elevations, as well as an ASCII point file of critical tunnel asset locations.

These cross-sections were created with and without "bandwidth" (forward scanning and back scanning of the actual measures profile location at a defined distance). Users can extract the sections at any possible interval. These cross-sections depict distances from the selected shape (as defined by the created MTA clearance model) to the surrounding actual features as measured by the scanner. The cross-sections can be exported in a variety of formats, including Adobe PDF and Autodesk DXF.

The Amberg project was then processed for 3D deliverables, including point-cloud data in .PTS format, which is then converted to an .LAS format using third-party software. Scans performed using the Amberg TMS position method were processed with Amberg TMS Office, the same as the deliverables generated from Amberg Rail.

"The Amberg Rail suite is a fantastic tool when it comes to processing accurate track data and performing clearance analysis," says CJ Ruch, Maser Consulting's project surveyor. "Raw data processing times can be quicker, but no other software can provide the end result like Amberg Rail can, in terms of providing track detail and dynamic clearance analysis. ... When there's 12,000 feet of track and tunnel to process, that's a lot cross-sections. Who's got time for that? I know we don't."

Jonathan Ricablanca is a survey project manager with Maser Consulting. He has 15 years of experience in land surveying, civil engineering and construction management. He has a bachelor's degree in civil engineering from the New Jersey Institute of Technology. For a demonstration of the Amberg GRP 5000 trolley system, access http://tinyurl.com/o4dxfx8.