LASER-GUIDED EQUIPMENT

BY RODNEY GARRETT
CONTRIBUTING AUTHOR

Ground traffic control

PennDOT dives into laser-guided equipment at airport job

The Pennsylvania Department of Transportation (PennDOT) is in the middle of preparing specifications for using GPS technology that includes automated precision grading with bulldozers and motor graders. One of the PennDOT team members responsible for bringing the specifications to fruition is Thaddeus R. Mikolajczyk Jr., P.L.S., and chief of surveys. Mikolajczyk has been working closely with PennDOT Project Manager Brian Steffy, P.E., who is in charge of the DuBois-Jefferson County Regional Airport Access Road, a construction project where the use of Global Positioning Systems (GPS) technology is under scrutiny by PennDOT.

When this access road project is completed, it will link the airport to I-80 four miles to the south. I-80 is the main northern tier interstate highway running from New Jersey to California. Since I-80 is an important freight transport route, the new access road will not only enable many of the yearly 47,000 air passengers to have easier access to the airport, but should attract businesses and light industry to establish warehouses and light-manufacturing facilities here. Hoping to entice businesses, there is an industrial park under construction next to the airport and designated a Keystone Opportunity Zone, which carries tax-free privileges for the businesses. The park also is a Foreign Trade Zone 254, enabling businesses to delay paying import taxes until the product is sold.

A stakeless claim

From both PennDOT's and the project contractor's perspective, there is yet more significance to this road project than its link between the airport, the industrial park and I-80. This is a major PennDOT construction project where some of the latest GPS technologies for grading are being evaluated and documented. The results will assist PennDOT engineers and construction project managers to draw up final specifications on using GPS technology on future construction projects requiring precision grading.

Francis J. Palo Inc. of Clarion, Pa., is the project contractor and has been instrumental in pioneering the use of GPS technology in the state. Palo recently made a substantial financial investment to purchase GPS equipment that was fitted on two of the company's bulldozers and two motor graders. Palo also has been influential with PennDOT by introducing some of the latest GPS technology to the department for their consideration when writing the new specifications.

Michael Palo, CEO of Palo Inc., has been a strong advocate for new technology. "You must be willing to take some risks if you are to move your company forward, and I find this new GPS technology is good not only for the contractor but good for Pennsylvania," he said.

The technology Palo is talking about is known as stakeless grading. This stakeless approach includes both rough grading and precision grading on all phases of road construction. PennDOT not only approved the use of this technology for the airport access road project, but its project manager, Steffy, has embraced it by working very closely with the contractor in all phases of the project.

The stakeless grading method used on this project is benefiting both parties. Palo's winning bid for the project was $16.7 million. The contractor started the project in October 2005. According to Palo Project Manager Sam Denison, the project should be completed weeks earlier than the designated July 2007 completion date. Denison attributes the shorter completion date, in part, to the faster grading operation made possible by the GPS technology.

The new two-lane road will be 5.2 miles long; its alignment is like that of a French curve, where there is a multitude of irregular curves making up an overall arc form. This alignment was deemed the most economical and practical design for constructing the road. Much of the terrain in and around the alignment consists of rolling hills and low mountains, and despite building the road on this curved alignment to avoid the hills, there are still multiple high and low areas to deal with for reaching the wanted grades.

One-million cu yd of ground is being excavated, including overburden and intact rock (approximately 200,000 cu yd) that is drilled and blasted to fragment sizes 36-in. minus. Cuts along the alignment are up to 60 ft deep and fills go to 60 ft

high. About 700,000 cu yd of the excavated materials is used for the fills. The extra 300,000 cu yd of materials is exported from the project site. Slopes left on either side of the cuts and made by the fills are graded 2 to 1 by the two bulldozers fitted with GPS systems.

Connecting the wireless

At the top of the list for this trial are various Topcon GPS systems. "We carefully evaluated another GPS system and even had it demonstrated on this project but it did not measure up to the performance we have been experiencing with the Topcon 3D-MC system. (Circle 914) As far as we [Palo] can see, the technology is precise and the most reliable to operate," said Denison.

Here is a rundown of the different GPS components Palo is using to perform all rough and fine grading at this project. First, there is a HiPer+ wireless (Circle 915), integrated GPS receiver system, which is stationed on a pole at the airport. Since the project is located in the middle of mountains, Palo bought two Topcon Radio Repeaters in case they were needed to overcome signal interferences. It was later found that the repeaters are not necessary for this project. Denison hypothesizes since the road is being constructed in an arc (rather than a straight line) and the wireless unit at the airport is relatively close to all points along the alignment, the radio repeaters were not needed. Actually, the farthest distance from the road to the wireless unit is less than four miles.

If there is a heart to the GPS system it is the unit at the airport. It is the first system with a wireless, integrated GPS receiver and radio. The unit is compact and lightweight for easy handling and simple to install at a fixed station. Important is its dual-constellation satellite tracking. The dual-constellation tracking will provide 40% more satellite coverage than the more conventional GPS-only tracking systems. This superior tracking, in turn, greatly improves operation time even when in challenging environments where the GPS-only systems go down.

Notable also is the center-mounted RTK UHF antenna for boosting its RTK performance and distance without compromising the strength of its GPS signals. Additionally, the integrated 40-channel dual-frequency receiver features the integrated Bluetooth technology; it also features co-op tracking technology for exceptional under-canopy performance.

With dual-constellation tracking capabilities, satellite-tracking integrity is maintained when the bulldozer or motor grader is grading near or under canopies such as trees.

There are two different types of control systems mounted on the bulldozers and motor graders. The Caterpillar D8T bulldozer has the 3Di-GPS+ Indicate Control System (Circle 916). This system is suitable for rough grade applications, especially where substantial in situ ground is to be excavated making shallow to deep cuts. Likewise, this system lends itself well for bulk filling and backfilling activities. It does not have automated control so the operator is completely in charge of operating the bulldozer just as he is when operating the machine without the GPS indicate control. However, guesswork associated with traditional grading and backfilling and the constant need of a grade foreman are eliminated, thus reducing grading time while achieving superior grading results.

Mounted on the Caterpillar D5N bulldozer and the 120H motor grader, as well as a John Deere model 770 motor grader, are Topcon 3D-GPS+ automated-control systems. The D5N bulldozer also is used for rough grading, but its grading procedure is automatically controlled, and with the base station in place, the grading tolerances are within 0.1 ft or less. Precise location points are achieved by triangulation. This system tracks all available satellite signals, thus assuring greater solution quality and integrity.

With dual-constellation tracking capabilities, satellite-tracking integrity is maintained (locked) when the bulldozer or motor grader is grading near or under canopies such as trees. To illustrate, if 30% or more of the sky is blocked from the receiving system by a canopy (trees, etc.), the value of tracking is locked (if all satellite signals are temporarily blocked), thus ensuring uninterrupted grading activities.

Added to the systems installed on the two motor graders is the optional Millimeter GPS System (Circle 917) for an even more precise grading-control system. It enables the motor graders to automatically perform fine grading (measurable in millimeters) not readily reachable by using traditional staking or standard GPS methods. Only one PZL-1 transmitter (Circle 918) with its Lazer Zone technology is required for operating multiples of the PZS-MC-equipped (Circle 919) machines and the PZS-1 Positioning Zone Sensors (Circle 920) that are mounted on GPS range poles.

Palo is using two PZL-1 transmitters that are placed about 500 ft apart because of the height variations and grades found along the road alignment. Stakes also are placed at these 500-ft intervals so PennDOT can verify the preciseness of the GPS system using traditional survey methods. On PennDOT projects, stakes are specified to be installed at 25- to 50-ft in-

tervals along the complete length of a road alignment. This project called for 25-ft intervals for subgrade and 50 ft for the cuts and fills. Essentially, 10 to 20 stakes were avoided per 500 ft and all the survey work that goes with it.

Palo constantly verifies all grading activities by monitoring the grades at random points with Topcon Pocket-3D FC-100 field controllers **(Circle 921)** running its software in concert with PZS-1 mounted on the range poles. Troy Wolfgang, survey technician, is in charge of this activity and Dale Zimmerman supervises it. Palo has four FC-100 units, which includes field controller sofware.

PennDOT pluses

There are significant benefits to be reaped from using a GPS system or its use on PennDOT road projects would be a no-go. "We do not specify what brand GPS equipment a contractor uses as long as he gets the grading results we specify," Mikolajczyk explained. "The equipment either performs or it doesn't."

Here is a short list of benefits that PennDOT associates with using GPS technology, according to Mikolajczyk. These benefits are significant enough for PennDOT to justify making an addendum covering GPS technology use, which will be inserted into the *PennDOT Publication 408*; Section 210 Specifications.

- A superior highway ride quality is probable;
- Faster completion dates for the road projects can be expected; and
- As more contractors use this cost-effective technology, bid pricing will be lowered.

Mikolajczyk projects there will be additional benefits realized once the practice of this technology comes into fruition on various PennDOT projects.

There are benefits to also be enjoyed by the contractor. Steffy has his own short list of benefits that he says can be realized by the contractor using the GPS technology:

- At this project, direct labor costs for doing the grading and grading-monitoring work are reduced by more than 60%. This is because the grading crews are reduced in numbers of participants per crew; this holds true for rough and fine grading activities, albeit the number of members per rough-grade and fine-grade crews differ, respectively;
- Grading production has doubled. Simply, the dozers and graders are that much more productive; and
- The improved bottom line on the profit and loss sheet is where the above listed benefits lead to.

Garrett is a freelance writer based in Bernville, Pa.