



GULF SURVEYORS GROUP INC.

PROFESSIONAL SURVEYORS AND MAPPERS

POBOX 3306, APOLLO BEACH, FL 33572

TEL: (813) 641-1051 FAX: (813) 645-3797

info@gulfsurveyors.com - www.gulfsurveyors.com

GPS and Robotic Machine Control and Increased Efficiency

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There are many types of Machine Control construction. The most common types are construction lasers and sonic units for grading and paving operations. This is proven technology and can be seen on almost any construction site throughout the country.

GPS units in grading operations have made their presence known in the last several years and to a lesser extent, robotic total stations.

GPS and Robotic Technology

Global Positioning System technology was originally developed by the military. It's use in military applications is mind boggling, and that's based on just what the military has allowed us to learn about. We have all seen GPS navigation in our cars and boats. So as technologies go, GPS is actually fairly main stream.

In construction, GPS is used to control the placement of graded material. The benefit of using GPS Machine Control is that it:

1. Reduces and in some cases even eliminates labor cost. How it does this is by reducing the need for stakeout and grade checking. A properly set up machine (typically bull dozers and graders) can do their own grade checking as they move through the job.
2. Increases the speed at which the machines can operate.

There is one other benefit, but this one comes with time and experience using GPS, and that is the confidence of your operators.

3. Your properly trained operators armed with a proper 3d Model and shop drawings of the job won't hesitate when they have high points or ditches on some of these Florida drainage jobs. Parking lot drainage issues will be a thing of the past too.

Construction Robotic Total Stations are 3-5 times more accurate than GPS. It is based on the time tested technology that your stakeout personnel have used forever. There is one major difference compared to how we staked a job years ago and that is Robots track the stakeout rod by locking an invisible laser on the prism.

The only difference between 'stick' or rod stakeout and Robotic Machine Control is that we install the rod on the machine. Since it is so much more accurate the typical application for Robotics is usually graders and surface machines like trimmers and slip form pavers.

The use of Robotics on a slip form paver or curb and gutter machine will do away with string lines completely. And yes, it works and yes I've seen it work.

Machine Technology

Machine Control can be used on almost any machine you have including excavators or back hoes for doing utility trenches. In order to use GPS or Robotics installed on a bull dozer or grader it will be necessary to have the machine set up to use it.

Almost any new bull dozer or grader purchased today will at least have the option to include the necessary valves and wiring required to run Machine Control. On the units we already have, the valves and wiring must be installed.

One very important feature for graders and bull dozers is the cross slope sensor.

A cross slope sensor and on board controller senses the roll of the blade and sets the pitch for the operator. So as we move forward on a roadway lane, the GPS or Robot controls where the unit is and the cross slope of say, 2% is set by the cross slope sensor and controller. This way the entire cutting edge of your blade is where it needs to be.

The operator's job is to steer the machine based on line work files that were delivered with the 3d Model and control the forward motion. The Machine Control does the rest.

The line work files take the place of the field stakes in many ways. Where the operator used to look out in front of the machine and steer based on the stakes, now he will use the monitor in the cab that shows him where the machine is positioned on the job. Once he has cut an edge he can use that to line up on as well.

This technology in the hands of an experienced operator with minimal training and a desire to use it will be more efficient. It's hard to say that he will be 200% or even 300% more efficient because that depends on what you're building, how much you need to cut or fill and what type of material you have to deal with.

GPS and Robotics Compared

GPS positioning is based on a radio signal (a very weak radio signal at that) transmitted from a satellite orbiting the earth.

Robotics is based on the precision of the Total Station and is generally measured in seconds of angular measurement.

Accuracy:

- GPS – The horizontal specification by most manufacturers is usually 0.05'+/- and the vertical specification is usually 0.10'+/-. GPS is often better than this, but the manufacturers need to take into account many conditions such as local interference and space weather.
- Robotics with a 1" instrument can theoretically measure 0.01' at a distance of 2,000' horizontally and vertically to a stationary point. Taking into account the typical factors such as heat waves, radio restrictions and the fact that we are a moving target, I advise my clients that a working distance of about 500' will allow for an accuracy of about 0.02' in grading operations.

Advantages:

- A single GPS base can control several rover units. I've seen as many as 4 and 5 rovers using a single base on jobs.
- GPS can control rovers as far away as a few miles under good conditions.
- Robotic Total Stations are more accurate than GPS.

Disadvantages:

- GPS does not work under trees and has problems around buildings
- Robotic Total Stations can only control one machine or one rod at a time.

Examples of Efficiency

- On a recent project to construct an airport concrete taxiway with 35' paved asphalt shoulders I had an opportunity to conduct a test.

The east paved shoulders on the project consisted of 63,668.59 sq. ft. (35' x 1,800'+/-) or about 7,000 sq. yds. of surface area. Since this project is in Florida, the contractor was required to place geoweb material on the sub-base and 6" of crushed concrete base on top of that.

The contractor had GPS Machine Control installed on a D5 bull dozer and used that to spread the crushed concrete over the geoweb.

We carefully calibrated a grader to ensure that the cross slope sensors were good and we also calibrated the Robot. A new cutting edge was placed on the grader.

After the calibrations we checked the cutting edge of the blade on 3 bench marks. All 3 checked within 0.01' while we were stationary.

It took the grader just under 3 hours to finish the entire crushed concrete base to within 0.02' using robotics! This was checked by stringlines throughout the entire run. According to the operator who has over 25 years of experience the same area might have been 8 or 10 hours of work with traditional stakes if not more. So the difference between 3 hours and 10 hours is over 300% more efficient!

- The contractor also used the grader controlled by robotics to grade the base for the concrete taxiway.

In talking to the regional manager for the construction company I asked him how he liked the Machine Control application.

What he told me is just as important as the any other factor and that was:

'The graded material is so accurate that his future cost estimates could use ½" of excess concrete instead of the 1" he uses now.'

This particular job had 204,276.73 sq. ft. (4.69 ac.) of surface area. One inch over that is 630.5 yards and half of that is 315.25 yards.

Would that help your cost estimate?