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Stringless Concrete Slip Form Paving Using GPS Controlled Spreaders

Construction stakeout is a major cost item in concrete construction. If we rely on subcontractors to do the stakeout that often adds scheduling issues.

Traditional string line controlled paving adds the inconvenience and cost of the string lines. The string lines become obstacles for the trucks delivering the concrete and finishing crews. If direct access to the upstream concrete is needed by machinery such as skid steers the strings must be lowered and reset. Any delay caused by the string lines adds time to the process and reduces profit. When we add the potential for error in the stakeout, the stress level can be enormous.

This economy demands that we reduce our cost, but produce as much, or more than we did in the past. None of us have any choice in the matter.

Project Description

The following is based on a project in North Carolina. The paving machinery is produced by GOMACO Corporation and the controlling instrumentation is produced by Leica Geosystems. The machinery configuration included 2 GOMACO PS 2600 spreaders controlled by RTK (Real Time Kinematic) GPS. The role of the spreaders was to receive and pre-shape the concrete for the GOMACO GHP 2800 slip form paver which is controlled by robotic total stations.

Figure 1

Figure 1 shows the lead spreader; note the GPS antenna at the left of the machine. Each spreader has 2 GPS antennas, one on the left and another on the right.

In this configuration, the lead spreader receives single truck loads of green concrete and spreads the material to create a mass of material for the second spreader.

Figure No.2 shows the second spreader working in front of the slip form paver.

Note the GPS antenna on the left side of the spreader and the robotic prism on the left of the slip form paver to the rear of the spreader.

The role of the second spreader is to receive more green concrete and to place that material to the approximate dimensions of the final product.

Ideally, the second spreader will have placed just enough green concrete that the slip form can mold it into the final paved lane.


Figure 2


Figure 3

Figure No. 3 shows the GOMACO GHP 2800 slip form paver. The robotic prisms are located on the left and the right of the machine.

In front of the paver you can see the results of the 2 spreaders and how the material is placed almost perfectly for the paver.

Since there are no stringlines, if more material is needed, it can be placed very easily by a skid steer or front end loader without the paver needing to stop production.

On the other hand, any excess material can be removed and placed in front of the first or second spreader without having to lower the strings, stop the forward progress of the paver and reset and adjust the strings.

Figure No. 4 shows all 3 machines in action.

Figure 4

Cost Savings and the Construction Model/Stakeout Point File

In this application the cost savings on just the stringlines is about $10,000 per production mile. If you are using subcontractors they can produce about 1,500 LF/day per single stringline. The cost of stakeout is about $1,200.00/day. Since 2 stringlines are required for a slip form paver we will have about $10,000 of savings per production mile!

The model we create for construction is named a Digital Terrain Model. Most contractors that use stringless technology will also use models and GPS to do the site grading.

A proper model is created as a single entity. In other words, the sub-base, base, pavement, curb, sidewalks, embankments are all part of the same model, not 5 or 6 different pieces. If you have 5 or 6 different pieces, then whoever built the model better check one against the other or you will have a mess and the cost benefit will be lost. The term we will use for unchecked modeling data is disconnected data. So, if the 5 or 6 parts don't work together, they are disconnected.

A DTM is generally thought of as a single entity, but it can have thousands of sub elements. It is created with the data provided by your designer. This data can be typical sections and profiles or in the case of concrete paving it is usually design elevations on the joints. In the case of joint elevations you might have thousands of points. There will be DTM points for all of your surface elements (asphalt, concrete, curb and gutter, (etc.)). These points are defined with just the position and elevation. When you look at a DTM point list the data doesn't indicate what the point represents.

In order for your stakeout to be performed, you need an additional file where the points have been described. In other words the point list needs to define if the point is a joint elevation or an edge of asphalt. If you don't have this data the best case scenario is that your stakeout will take longer, the worst case is that you will have errors in the stakeout.

Regardless of how advanced the technology may be there will always be objects that need to be staked in the field.

Errors are not something we want to discover with the concrete ordered, the trucks coming and the finishing crew waiting for concrete to finish. If your model or stakeout isn't right, you may find out the answer to this one the hard way.

One last word of advice, use a surface model for everything and have your operators 'dial down' to the sub-base and the base. It's the best way almost all of the time.

Questions and Answers

While on site I had the opportunity to talk to some of the operators, foremen and the superintendant. Here are some responses I received:

Q. – How do you like the stringless technology?
A. – Now that we've used it, we won't go back to the old ways.

Q. – On a stringline run, the ground man or the foreman might make adjustments for things like depth of material by dialing the machine up and down. How is this different?
A. – The difference is that we have a screen that shows us where we are. If we need to raise the machine up a hundredth we make the adjustment on the screen.

Q. – What do you base your adjustments on?
A. – We have a grade checker that stays with the paver. He will check things like the elevation of the base material or the top of the concrete. We make adjustments on the information he gives us.

Q. – How about other adjustments like the form width?
A. – It's the same.

Q. – Is anything different for the paver operator?
A. – No, the operator's job is the same.

Q. – What are the advantages?
A. – There aren't any strings to get in the way. If we need to run a skid steer to add or remove material we don't need to stop production to drop the strings then put them back up and make adjustments. The concrete trucks and finishers don't have the strings in the way either.

Q. – How about the decision to use the technology and what kind of learning curve did you have?
A. – The decision to use the technology was a big one because we didn't have any experience with it. We did have a learning curve and had a few issues at first, but they got worked out.

Q. – Anything else?
A. – We make more money and have more control of the operation with this equipment.

The Leica PaveSmart 3D System

The only manufacturer that has a successful stringless application today is Leica. The real advantage to the PaveSmart 3D system is that it can control curb and gutter machines and can be applied to slip form pavers, milling machines, trimmers and asphalt pavers as well.

There are 3 controlling configurations for a curb machine which includes robotic total stations front and rear, GPS on the front and a robot on the back or a single robot for tangent sections. For machines like slip forms the system can be run with up to 3 robots for continuous uninterrupted runs. The slip form paver has 2 robots controlling the machine at any time and a 3rd that is in place up station and ready for the machine when it comes into range. When the system transitions from the back pair of robots to the front pair, the back robot is moved into a convenient position up station, is positioned and waiting to go. In the case of machines that don't require accuracies to the hundredth of a foot, RTK GPS can be used in place of the robots.

I've used robots for over 5 years in one man applications; in fact, you might say I'm a pioneer of robotic processes. I've never had a robot complain about wanting a raise or that it was too hot or

tired to keep going. Robots happily work on Saturday and Sunday too, this might impress the foremen, superintendants and owners amongst us.

Adapt and Conquer

The way we used to do business is changing whether we like it or not. I've been at this for over 33 years now and in the surveying world we've gone from transits and chains with 3 man crews to GPS and robotics and 1 man crews.

Not only do we have the opportunity to significantly increase our production levels and quality, but if we are competing with firms that use Machine Control we're going to struggle if we don't use it ourselves.

Investments in technology in these days might be a hard pill to swallow, but if we take the leap, we'll be here in 10 years to talk about how bad things were. What about the guys that didn't take the leap?