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GOMACO WORLD

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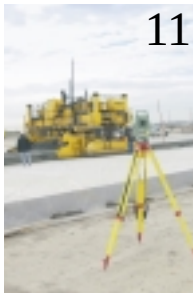

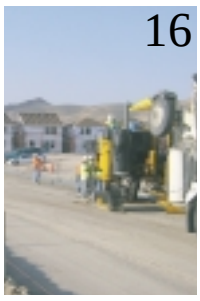

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...Moving Forward While Slipforming in Reverse

Photo by Vinnie Miller CG-110504 #22

General Concrete Construction is not doing a dry run over the steel reinforcing, they're actually slipforming the wall in reverse.

The state of North Carolina is investing millions of dollars into the Highway 17 Bypass by Wilmington. The project includes the construction of a new bridge over the Cape Fear River, which is an inlet to the Atlantic Ocean. The bridge work portion of the contract included slipformed parapet over steel reinforcing. Areas of the bypass are also being reconstructed and the project has a portion of variable barrier wall. At its highest point, the new wall is 83 inches (2108 mm) tall.

General Concrete Construction Inc., working as a subcontractor on the project, is in charge of slipforming the wall on the project and they're using their Commander III four-track for all of it.

They were responsible for every aspect of the wall, including tying the intricate steel reinforcing. The variable height portion of the barrier wall only added to the difficulty of the job.

A photo by Jon Clifford shows the height of the wall at the very beginning of the pour.

Photo by Jon Clifford CG-110515 D4

Variable Barrier –

"We're setting all the steel reinforcing on this project," Jon Clifford, vice president of General Concrete, said. "It has to be perfect and we don't trust anyone else to set it for a wall like this one."

The barrier is a state of North Carolina T2 wall that is 29.5 inches (749 mm) wide at the bottom and eight inches (203 mm) across the top. The height varies from 46 inches (1168 mm) to 83 inches (2108 mm) at the tallest point.

Job-site conditions were less than

Photo by Vinnie Miller CG-110504 #9

The tracks on the Commander III are spun around so the machine is "tricked" into thinking it's moving forward on this portion of the bridge parapet work.

ideal along certain areas of the project. The grade around the wall was rough and rutted, so much so, that General Concrete hand-poured a four foot (1.2 m) wide footing next to the wall for a trackline for their Commander III to run on.

Conditions also added other complications. Obstacles gave General Concrete only one side to work and run their Commander III. They'd be starting their day's pour at the highest point of the variable barrier and the wall would have to be poured with the Commander III slipforming backwards. The trick is to make the Commander III still think it's slipforming forward.

"We don't run the machine in reverse," Clifford said. "We turn the tracks, spin them around, and the machine thinks it's going forward. We just trick it a little bit.

"I was nervous. When you're pouring wall that high, all it takes is one thing to go weird and it's not pretty. This wall, though, everything went off without a hitch."

Their day began with a dry run over the steel reinforcing to make sure it was in place and wouldn't cause any problems. It was also a test for the stringline to make sure it was accurate and followed the variable height of the barrier.

"Our stringline runs underneath the machine, five feet (1.5 m) from the edge of the wall," Clifford explained. "We set it off the high side of the finished pavement, measure from the stringline 46 inches (1168 mm) on this wall, and that gives us our variable height changes on the low side of the pavement."

General Concrete started slipforming the variable barrier at 9 a.m. on a Saturday morning. By 6:30 p.m. that night, they were pulling the Commander III off the finished wall.

"There was 180 feet (54.9 m) of variable height barrier in that section of wall," Clifford said. "We started at 83 inches (2108 mm) and then it just consistently dropped

Photo by Jon Clifford CG-110515 D16

Photo by Jon Clifford CG-110516 D13

The intricate steel reinforcing in the variable barrier was all tied by General Concrete. They did a dry run with the Commander III to make sure everything was exactly where it needed to be.

12 inches (305 mm) every 100 feet (30.5 m) down to 46 inches (1168 mm) high. The pour went well. All the rebar stayed where it was supposed to and everything went really smooth."

The concrete was a North Carolina Department of Transportation required Double-A barrier mix design. Slump averaged one inch (25 mm).

Finishing work behind the Commander III is kept to a minimum. The new wall is straight-edged and broomed. Joints are cut in every 20 feet (6.1 m) with expansion joints every 80 feet (24.4 m).

On the Bridge –

Portions of the Northern Cape Fear bridge parapet were also poured with the Commander III traveling backwards.

The standard parapet had a profile of 32 inches (813 mm) high, 17 inches (432 mm) wide at the bottom and eight inches (203 mm) wide across the top. All of it was slipformed over steel reinforcing.

"On this big bridge, we were averaging 700 to 800 feet (213 to 244 m) of production per day," Clifford said. "The machine leaves a good finish on the wall, so there's not much finishing work that has to be done by hand. We usually hit it once, broom it, and put the joints in."

"On this big bridge, we were averaging 700 to 800 feet (213 to 244 m) of production per day," Clifford said. "The machine leaves a good finish on the wall, so there's not much finishing work that has to be done by hand."

Commander IIIs and GT-3600s –

General Concrete's work radius stretches into both North and South Carolina. They're accomplished slipformers specializing in barrier wall, bridge parapet, sidewalk and curb and gutter. Their slipforming machines of choice are the GOMACO Commander III and the GT-3600.

"We use Commander IIIs for the wall and all of our five foot (1.5 m) wide sidewalk," Clifford said. "The GT-3600 is really good for curb and gutter. It's very maneuverable and pours a tighter radius. We use it to pour as tight as a seven foot (2.1 m) radius."

Jon and his brother David, president of General Concrete Construction, agree that the features on the GT-3600 and Commander III make the machines a great fit for their company. The Hook-and-Go mold mount on the GT-3600 make switching from a 30 inch (762 mm) standard mold to a 30 inch (762 mm) valley curb mold faster and easier on the job site. The side-shifting and vertical lifting trimmerhead and mold allow it to be lifted up or shifted out of the way of job-site obstacles, like fire hydrants and inlets. "Smart" cylinders, with the G21 controller, take less time to dial in the legs for machine set up. And the new, more powerful trimmerhead allowed them to trim through five inches (127 mm) of stone subgrade on a project in Durham, North Carolina.

"GOMACO equipment is all we'll ever own," Clifford said. "The 'smart' cylinders and the G21 really help us out and we can train our tracks to go where we want them to. It's nice to have all the side-shifting features on the equipment, too, with the kind of work that we do. For us, we're just better off owning GOMACO equipment."

General Concrete enjoys the maneuverability of their GT-3600 and it's ability to slipform tighter radii.

Photo by Mark Hankins CG-040516 D20

Photo by Gene Grayson CG-100016 #10A

The GT-3600 with the Hook-and-Go mold mount makes switching molds on the job site faster and easier.

Photo by Ed Lampe CG-080507 D11

The company slipforms five foot (1.5 m) wide sidewalk with their Commander III on a project near Raleigh, North Carolina.

A Paver as Efficient as the Company that Owns It...

Gill Civil Engineering in Kent, England, has carved out a unique niche for their company in the last three years. The country has several prime contractors and most aren't equipped to handle the slipform concrete work on contracts. Gill Civil Engineering saw that need and offer their subcontractor services solely as slipform pavers specializing in mainline paving for highways, and runway and taxiway work at airports.

The company is constantly on the move handling a variety of different projects and specifications. They needed a concrete paver that was easy to transport and could change widths quickly and easily. The GOMACO GHP-2800 four-track slipform paver fit the company criteria perfectly.

"I've been slipforming for 15 years all together now and I've always worked with GOMACO," Simon Renker, paving contract manager for Gill Civil Engineering, said. "We chose the GHP-2800 because it's so versatile and user-friendly. Everything is made simple to change from transport mode to paving mode and back again. It's all made so simple, even changing the width of the frame is easy and that's really one of the best selling points on the machine."

"I've been slipforming for 15 years all together now and I've always worked with GOMACO," Simon Renker said. "We chose the GHP-2800 because it's so versatile and user-friendly."

They just recently finished up a taxiway and runway project at the Leeds and Bradford Airport in Leeds, England. The airport called for 16,744 square yards (14,000 m^2) of concrete and, according to Renker, was one of the company's smallest projects.

"Basically, it was a taxiway that blended into a runway and it was a small job for us," Simon Renker said. "We bid it because of our versatile GHP-2800 and our ability to change widths with it very quickly and move it from site to site."

The new taxiway/runway was built over the existing one that had been planed down. When the old structure was planed though, it was planed at variable depths. Gill's paving runs would have to accommodate the inconsistency over the 79 foot (24 m) wide concrete paving.

"The variable depth was the tricky part," Simon Renker explained. "It was the reason the airport authorities wouldn't let us go very wide with our paver."

HW-110505 D10

Photos by John Bowden HW-110505 D13

The new taxiway/runway was built over the existing one that had been planed down. Paving passes could only be 15.75 feet (4.8 m) wide and depth varied between 12.2 to 18.1 inches (310 to 460 mm) thick.

Paving was accomplished in five passes, 15.75 feet (4.8 m) wide. Slab depth varied between 12.2 to 18.1 inches (310 to 460 mm) thick. Each pass was approximately 1722 feet (525 m) long.

Concrete on the project was supplied by Gill's own batch plant. The company currently owns two plants purchased from GOMACO International Ltd.

"Obviously, if you understand slipform paving, you want to get your concrete just right and having control of your batch plant allows you that," Simon Renker said. "We really are self efficient with our own batchers on site, our own transport and then we slipform it, as well."

The batch plant has the capacity to produce an average of 157 cubic yards (120 m^3) per hour. On this project, production averaged 1236 cubic yards (945 m^3) per day.

The Pavement Quality Concrete (PQC) is a C-40 mix design with 641 pounds per cubic yard (380 kg/m^3) of cement. Slump averages 1.5 inches (38 mm).

Three articulated dump trucks capable of carrying an 11.8 cubic yard (9 m^3) load delivered concrete to the site. An excavator was used to level out the concrete in front of the GHP-2800 paver.

"Our paver is a nice machine," Simon Renker said. "The lower engine and shroud gives a better view around it and it definitely is a lot quieter now. The G21 controller combined with the steering makes the paver more responsive."

Behind the paver, the new slab has a bull-float finish followed by a brush-texture finish. Joints are wet saw cut 18 hours after the mainline paving during the winter months. Summer temperatures shorten that time down to six hours. Joints are cut every 16.4 feet (5 m) with crews cutting up to 105 joints per day in the new runway/taxiway.

In addition to their GHP-2800 paver, they also own a GOMACO four-track GT-6300. They certainly have the work for it with projects on several airports in England including the Birmingham Airport, the East Midlands Airport and the Manchester Airport.

HW-110506 D15

A batch plant sold by GOMACO International Ltd. produces up to 157 cubic yards (120 m^3) per hour of concrete.

HW-110505 D9

The airport project, with only 16,744 square yards (14,000 m^2) of concrete paving, was a small one for Gill Civil Engineering.

HW-110505 D16

Joints had to be wet saw cut every 16.4 feet (5 m) and crews were cutting up to 105 joints per day into the new concrete.

HW-110506 D3

Gill Civil Engineering's next projects will be on the Birmingham, East Midlands and Manchester airports in England.

Round and Round Goes the GT-3600...

It must be quite a sight to see when Cameron Contracting Inc. in Airway Heights, Washington, is working on a project.

Photo courtesy of Cameron Contracting, Inc. CG-110514 D2

HW-050514 D7

An aerial view from Cameron Contracting best shows the radius work they performed on this round-about in the state of Washington.

The company, never afraid of tackling the most challenging projects, also believes in enjoying their work to the fullest. They have a truck on the project with a 700 watt stereo system mounted to it pumping out music.

Then there's the "flaming" GOMACO GT-3600 curb and gutter machine slipforming anything from curb and gutter to sidewalk. The GT-3600 is hand-painted with bright red flames... the result of a pin-striping job gone to the extreme...

"You've got to have fun and when we're rolling down the road, we put on quite the little show," Jim Cameron, president of Cameron Contracting, said.

The company specializes in curb and gutter and sidewalk work, and has owned GOMACO curb and gutter machines since 1990. In fact, they were one of the first companies to introduce slipformed concrete sidewalk to the state of Washington, according to Cameron.

"We like to try new things, and more than anything else, a new challenge is fun," Cameron said. "There weren't too many people trying to slipform sidewalk when we started and it was a challenge. Setting the stringline and the mold right was a little bit of a learning curve. Plus, since this was a new thing, we were really under the microscope and had engineers and inspectors watching our every move.

"We learned that a quality subgrade and properly set stringline are essential to any slipforming project. We like to have 'banjo tight' stringline, nice and tight, because whatever is in the stringline is going to come out in the curb or sidewalk."

They conquered the challenge of sidewalk, so much so, that it's now one of Cameron's favorite applications to slipform. It's also an application that adds to the versatility of his company and the work they can perform for clients.

> "The GT-3600 is the perfect machine for what we do," Cameron said. "It's a good fit, all the way around."

"We do a lot of subdivisions and road work," Cameron explained. "We looked at the 2005 GT-3600 and liked the new features and decided to add one to our company."

Those new features include new two-speed track motors that provide a smooth, uninterrupted crawl while slipforming and a travel speed up to 125 fpm (38.1 mpm) for moving around the job site.

"It's a huge benefit for moving around the job site and saves us a ton of time," Cameron said. "The track system is so much smoother. Any curb machine I've been around is constantly compensating for itself by adjusting up and down and going left and right. The tracks are so smooth on this new GT-3600. That's the only way to describe it. It's just smooth and you don't feel any movement on it."

The 36 inch (914 mm) stroke legs are 15 percent larger in diameter than the older style and have the same quality and durability as the Commander III legs. "Smart" cylinders on the legs eliminate the sprocket, chain and potentiometer at the top of each leg and simplifies steering control and setup.

Cameron's GT-3600 has the trimmerhead with the new,

Photos courtesy of CONAGGBIT, Inc. CG-070517 D4

The GT-3600 does some tight-clearance paving to get by a fire hydrant on the project.

more efficient, direct-drive, radial piston motor. The new system provides a 15 percent increase in torque for more power and a faster tooth-tip rotational speed which moves the trimmed material out of the trimmer box at a higher rate.

"The new trimmer is just amazing and works really well," Cameron said. "We've trimmed gravel up to eight inches (203 mm) deep while slipforming curb and gutter at 12 to 14 feet (3.7 to 4.3 m) per minute. It powers through a ton of stuff and it's very impressive."

The new GT-3600 also has the G21 digital control system with push-button steering setup. The controller allows the operator to teach the "smart" cylinders to set a desired degree of leg rotation, so the tracks won't strike any objects while tight-clearance paving.

"I'm intimately aware of the GT-3600 and how it operates," Cameron said. "One of our operators quit this summer and I was actually out running the new machine for a couple of months. The G21 is very nice, easy to learn and easy to operate. It works very well."

So far, Cameron Contracting has had the opportunity to slipform barrier wall, sidewalk and curb and gutter with their new machine. A new kind of project is gaining popularity in the state of Washington - roundabouts. Cameron and his crew had the opportunity to slipform the first one in the state.

"The state is trying to get away from traffic signals and all that expense by going to roundabouts," Cameron explained. "We had to slipform this one in live traffic with a constant barrage of cars and trucks. We had a lot of traffic control, a lot of flaggers and we really had to be aware of everything going on around us."

The roundabout called for an 18 inch (457 mm) tall curb with a 24 inch (610 mm) wide gutter. The engineers designed it that size to create a visual impact for drivers who would be approaching the roundabout at 50 miles per hour (80.5 km/hour).

"It was challenging," Cameron said. "We had to get ready-mix trucks through the traffic and to the machine all the time. With curb and gutter that size, we were only getting nine feet per cubic yard (3.6 m/m^3) of concrete and one truck didn't go very far."

The concrete mix design was a six-sack mix with a three-quarter inch (19 mm) aggregate. Slump averaged 1.5 inches (38 mm).

Finishing work was kept to a minimum with a broom finish applied to the top. Joints were tooled in every 10 feet (3 m).

"We figure we're running about 20 percent faster with this new GT-3600," Cameron said. "That's a huge difference and we have to be careful not to tire out our finishers too much."

The GT-3600's faster production, more powerful trimmer and the versatility of the G21 controller is the perfect fit for Cameron Contracting, a company that's not afraid to put the versatility of their new curb and gutter machine to the test.

"The GT-3600 is the perfect machine for what we do," Cameron said. "It's a good fit, all the way around." GOMACO

CG-070517 D9

The company figures they're running 20 percent faster with their new GT-3600 and have to be careful not to tire out their finishers.

CG-070517 D7

Higher speed track motors on Cameron's GT-3600 make it faster to move around the job site.

If You Don't Change with the Times, You're Left Behind...

Photos by Gayle Harrison HW-100520 D9

Berns Construction Company has been in the concrete paving business since 1928. The family-owned concrete company specializes in highway and airport work. The majority of their work has been on the interstate transportation system and, during the last 15 years, the rehabilitation of that system.

The progressive-thinking company has never shied away from new technology. They've been following the progress of stringless technology and have even implemented a GPS system on their bulldozers and motor graders. The next step was a stringless system for their concrete paving work.

Berns Construction knew they had a large project coming up at the Indianapolis International Airport in Indianapolis, Indiana. They did some research into GOMACO pavers equipped with the Leica 3D stringless guidance system.

"I really think this stringless system in concrete paving is the wave of the future," Dan Keys, president of Berns Construction, said. "That was our reason for getting involved, particularly here at the Indianapolis Airport. We thought it lent itself to a good application to the apron paving that we're doing here."

The project is a complete new terminal and apron at the airport. It's a one billion dollar project that includes a new apron to connect to existing runways. It also includes entrance roads into the airport. All total, they'll be slipforming 500,000 square yards (418,064 m^2) of 16 inch (406 mm) thick apron paving, as well as 100,000 square yards (83,613 m^2) of roadways coming into the new terminal.

Berns had the choice of putting down one of three subbases on the project: cement-stabilized base, asphalt or econocrete. Berns Construction, being concrete pavers and having all the necessary equipment, chose the econocrete option. It would also be a chance for the company to learn the 3D stringless system before starting the apron paving.

"The econocrete is a lean mix design of concrete," Tim Hartgrove, project manager for Berns Construction, said. "There's minimum and maximum specifications on it, for example, it can't be over 1200 psi (8.3 MPa)."

All of the econocrete on the project is paved with the GHP-2800 and is six inches (152 mm) thick. D1 dowel baskets are placed on the grade 20 feet (6.1 m) apart to form the transverse joint. Project designers were concerned about the concrete sticking to the econocrete, so eight hours before a lane is paved, Berns uses their GOMACO T/C-600 texture/cure machine to spray the econocrete and baskets with a wax-based curing compound.

With the econocrete subbase down, baskets in place and the bond-breaker sprayed, concrete paving can begin. Hartgrove and his crew head out an hour before paving is scheduled to begin to set up the 3D system.

"We show up and get our three total stations set up. We use three because two are always on the paver guiding it, and the third we use to leap frog ahead and for as-built checks behind the paver," Hartgrove explained. "There are a total of five different prisms that come with the system and two of those are on the paver. The other three prisms are set up on reference points located on the project.

"We hook the Leica computer up to the GOMACO G21 controller and turn it on. Then you go back to the total stations and sight them in so they're ready to go. You go back to your Leica computer, pick the reference line for the day that you're going to pave off. It's just like stringline. You pick the line and you give it an offset. For instance, we're paving 20 feet (6.1 m) wide so we offset 10 feet (3 m) to the center of the machine. That's all you do. It's just like you have invisible stringline out there."

The project is being slipformed in 20 foot (6.1 m) wide lanes that are 16 inches (406 mm) thick. They slipform a pilot lane, skip a lane and then do another pilot lane, eventually going back and filling in all of the gaps. All of the joints on the apron, both longitudinal and transverse, are 20 feet (6.1 m) apart.

HW-100521 D3

A *T/C-600 texture/cure machine follows behind the paver.*

HW-100519 D9

T*he econocrete subbase has to be sprayed with a bond-breaker bef*

HW-100521 D22

E*dge slump on the airport paving project is very important, and according to Keys, the GHP-2800 is doing very well with it.*

"Edge slump on the apron is very important and we're pouring the concrete pretty dry," Keys said. "The GHP-2800 two-track is doing a great job and the edge takes very little attention."

The concrete mix design was modified to accommodate the cooler temperatures in Indianapolis at the time. They're running 100 percent cement in the mix and eliminated the fly ash. Slump averages one inch (25 mm).

The T/C-600 follows behind the paver applying a burlap-drag finish. The new concrete also has to be covered with plastic when the temperatures approach the freezing point.

GOMACO had the opportunity to visit Berns' job site, in person, just four weeks into their stringless paving venture. Their reactions to the new system were interesting and it was surprising to hear them describe the new system as "boring."

"When you undertake any new process, you're going to be apprehensive and we were worried if we were going to be able to grasp the idea," Hartgrove explained. "The 3D system turned out to be simpler than what we thought. It can't be too complicated. Basically, you've got northings, eastings and elevations. Everything is controlled by those points. You're simply moving from one point to another point on each side of the paver."

The biggest fear for a contractor making the move to the stringless 3D system has to be the fear of paving in the wrong place or out of tolerance. Without stringline, there's no visual confirmation. The 3D system has checks and safeguards built into the system to make sure that doesn't happen.

"The first time with the system was scary," Hartgrove said. "We were out there in the middle of nowhere and trying to pick our reference line for the day. We had some idea where the pavement was going, so we pulled our paver up, picked our reference line and the computer with the Leica system on the paver said, 'You're off two hundred feet (61 m) pal. You're on the wrong reference line.' And you have the chance to adjust the paver and get it in position before any concrete is on site."

fore paving.

HW-100522 D7

One of the three Leica total stations on the project tracks the GHP-2800 paver as it slipforms the new apron.

The third total station on the project plays a crucial part in monitoring accuracy also. Berns uses a sixth prism, a mini-prism, that they can sit right on the concrete coming out the back of the paver. The third total station takes shots at that prism and then relays the information to the Leica computer. The computer instantly displays that information and stores it for future reference. All of it can be downloaded off the computer and used for reports.

"You can program the computer to tell you whatever information you want about the project," Hartgrove said. "At the end of the day, I can download that information and take it with me. That data tells your tolerances, your as-built checks, where the total stations were setup, your elevations, what the design was, how much we paved that day and whatever else you've programmed into the computer."

All of this information can be viewed on the Leica computer during paving as well. If a question arises, the computer is designed to be able to toggle through different screens of information and not disrupt the paving process.

"There's a series of computer screens that you can toggle through and you can learn anything you want to about what's going on with the paver," Hartgrove said. "You can see where the paver is, the front and the rear of the paver in relationship to the actual design, cross slope, feet per minute, stationing, how far away you are from the total stations and all those things. The guys can come around there and look and see what exactly is happening with the paver at any time."

The 3D system is also more accurate than the traditional stringline method. It eliminates the human error involved with the setting of stringline and issues that can happen during the paving process with the stringline getting bumped or even cut.

"This system is definitely more accurate than stringline," Hartgrove said. "What we've always done with stringline is have a survey crew go out, put a hub with a tack in it for line and elevations every 25 feet (7.6 m). Another crew drives the pins for the stringline and measures up from the tack. When you're on a road job, you have two stringlines, with a high and a low stringline that controls each edge of the paver. Then the day of paving, you have a crew that goes along and eyeballs the stringline tapping the stake down a little bit or raising it up. All that room for human error is eliminated with the 3D system.

"We've taken the opportunity here to get involved with the stringless system," Keys said. "I believe that if you don't change with the times, you're left behind."

"Plus, you don't have to worry about stringline, people messing with your stringline, buying the stringline, or messing with all of the parts that go along with stringline."

The system has been designed to be understandable and user-friendly in every way. As Hartgrove likes to point out, you don't have to be a rocket scientist to understand it.

"I was probably one of those people who said that I'd never pull a concrete paver up to an open area without stringline and just start paving," he said. "When you first look at something like this, you're going to say you have to be a rocket scientist to be able to figure this thing out. Actually, the system can't be too much simpler than what it is. It's just a series of points and you're going from one point to another, just like you'd put up stringline.

"We've been doing it for four weeks now, and to tell you the truth, it's kind of boring."

Berns Construction recently won another contract at the Indianapolis Airport to slipform a new north apron that they'll start on in the spring. A majority of their time through 2007 will be spent working on the airport. They also have plans of taking their stringless system out on interstate paving projects.

"Our people have adjusted very well, adapted to the Leica system and have found it user friendly," Keys said. "We've taken the opportunity here to get involved with the stringless system. I believe that if you don't change with the times, you're left behind."

It's obviously a successful philosophy for Berns Construction. They'll celebrate their 78th anniversary in the concrete paving business this year.

HW-100502 D13

A worker uses a prism to conduct an as-built check behind the paver and ensures correct concrete placement on the project.

HW-100525 D7

Paving passes with the two-track GHP-2800 are 20 feet (6.1 m) wide and 16 inches (406 mm) thick.

Breaking Their Own Record... Again and Again

Photos courtesy of Q & D Construction CG-090522 D4

CG-090522 D3

Q & D Construction has broken their own company record twice in the last few months. The first time they used their Commander III and GT-3600 to slipform 14,000 feet (4267 m) of curb and gutter on one project in a single day. The company set a second new benchmark with a single machine, slipforming 8000 feet (2438 m) of curb and gutter in a single day with their Commander III.

Q & D Construction is a general contractor in Sparks, Nevada. When their company starts a subdivision project, they have the capabilities to complete the entire project, from the underground work– to dirt work– to curb and gutter and paving– to building the cabinets in their own cabinet shop for the new houses. The company prides itself on the quality of their construction and their impressive turn-around time once their crews are on-site.

It was their drive for quality that led them to buy their first GOMACO GT-3600 curb and gutter machine in 2000. In 2005, they expanded their inventory to include a three-track Commander III. The new machine would allow them to pour more curb and gutter, as well as tackle larger barrier wall and monolithic curb and gutter and sidewalk.

"Last year we were constantly chasing projects, trying to get one done so we could move onto the next one. We had to work a lot of hours, a lot of weekends and overtime to get everything done," Johnny Glantz, concrete superintendent for Q & D, said. "This year it's nice to have two curb and gutter machines. It's less stress on one operator and the rest of the crew. Plus, the new Commander III gives us more versatility and more production.

"The GT-3600 is super efficient for building parking lots because it has a shorter turning radius and makes curves easier. The larger Commander III is great for mainline pouring, which is a huge portion of our subdivision work."

In the past few months, Q & D has broken their top two company curb and gutter production records. The first new company record happened on Vista Boulevard in Spanish Springs, Nevada.

Timing on the project was tight and the curb and gutter and street paving had to be done before cold temperatures moved in. If all the dirt work, utilities and project preparation could be completed in time to slipform all the curb and gutter on the project in one day, it would be a record-setting 14,000 feet (4267 m) of curb and gutter for the company.

"Down one side of Vista Boulevard is 3500 feet (1067 m) and then back again another 3500 feet (1067 m)," Glantz explained. "We could have easily done

CG-090522 D1

The race was on during Q & D's record-setting day in Nevada.

that in a single day with one machine, but with everything ready to go on the project and time a consideration, we decided to bring in our other curb machine and pour the median island. We did them both at the same time for a 14,000 foot (4267 m) total."

The GT-3600 and its crew was in charge of slipforming the median curb while the Commander III slipformed the larger L-curb and gutter. Work started at six a.m. and the race between the two crews started almost immediately.

"Each of the crews and machines had their own foreman and each was trying to grab the ready-mix trucks for their machine," Glantz said. "Of course, the median curb goes twice as fast and far because it's a smaller curb. We were getting 35 feet per cubic yard (14 m / m^3) with the median curb and only 20 feet per cubic yard (8 m / m^3) with the L-curb. It was a challenging scenario."

Coordinating the effort both before and during the pour was a huge task. Working space was tight and getting concrete trucks to the curb machines required careful timing.

"We always had one concrete truck on each machine, two trucks stacked up in front of them and there wasn't a whole lot of room to drive in between," Glantz said. "We had to coordinate the trucks coming in and out, coordinate the slump and make sure it was always right, the stringline had to be sighted and everything just had to be right where it was supposed to be. There was no room for error."

"It takes a tremendous effort for everyone involved in a project like this to end up with a record-setting day," Glantz said.

Sixteen ready-mix trucks kept the two curb and gutter machines supplied throughout the pour. The concrete mix was a 4000 psi (30 MPa) city mix with fiber added. Slump averaged one inch (25 mm).

Work began at six a.m. that day and the crews were poured out by 3:30 p.m. that afternoon. Each machine averaged 40 cubic yards (30.6 m^3) per hour of production or an 80 cubic yards (61 m^3) per hour combined total.

"It takes a tremendous effort for everyone involved in a project like this to end up with a record-setting day," Glantz said. "That whole road was done in two weeks from the time we got on the project. That's a tremendous effort from the dirt end, from our engineering department, mechanics and everyone involved. We had a six-man line crew and they worked three days to get the stringline up. Then it took 26 people and two curb machine operators 9.5 hours to pour 550 cubic yards (421 m^3) of curb and gutter."

Q & D Construction wasn't content with just one new company record. Just a few months after setting the new benchmark for two machines, they took their new Commander III out and broke their record for a single machine's one day production.

The second record pour took place at a subdivision called Mount Rose Estates. Glantz and his Q & D concrete crew slipformed 8000 feet (2438 m) of curb and gutter in a ten-hour day.

"We set a new benchmark thanks to our new GOMACO machine, a perfect grade set by our dirt crew foreman and great coordination from our concrete team," Glantz said. "The team slipformed 380 cubic yards (291 m^3) of concrete and did a superb job."

Editor's Note: Congratulations to everyone at Q & D Construction for your record-breaking pours. The ability to break not one but two company records is a great testament to your slipforming skills. GOMACO is proud to have played a part in your quality production.

CG-090522 D5

Two curb machines with operators, 16 ready-mix trucks and 26 workers slipformed 550 cubic yards (421 m^3) of curb and gutter in 9.5 hours.

Stringless Is Here!

Editor's Note: The first *GOMACO World* technical article on 3D stringless paving appeared in the magazine in December 1999, in Volume 27, Number 4. It announced the cooperation between GOMACO and Leica Geosystems, in Heerbrugg, Switzerland, to develop a stringless guidance system. The key advantage to making 3D stringless paving work on GOMACO machines was the CAN (controller area network)-based G21 controller.

"We feel we have an advantage over any of the other industry players because of our CAN-based G21 controller," Kevin Klein, GOMACO Research and Development Manager, said in 1997. "It's one of the key reasons the Leica system works with GOMACO equipment."

Today, it's still the magic of the G21's CAN-Bus network that allows GOMACO equipment to work so seamlessly with the stringless technology. A recent interview with Karl Soar, Product Manager for Paving Systems for Leica Geosystems, reveals some insight into the plug and play technology of the system, advances in the stringless system, and other issues. Here's what he had to say...

Why does your system work so well with the GOMACO G21 controller?

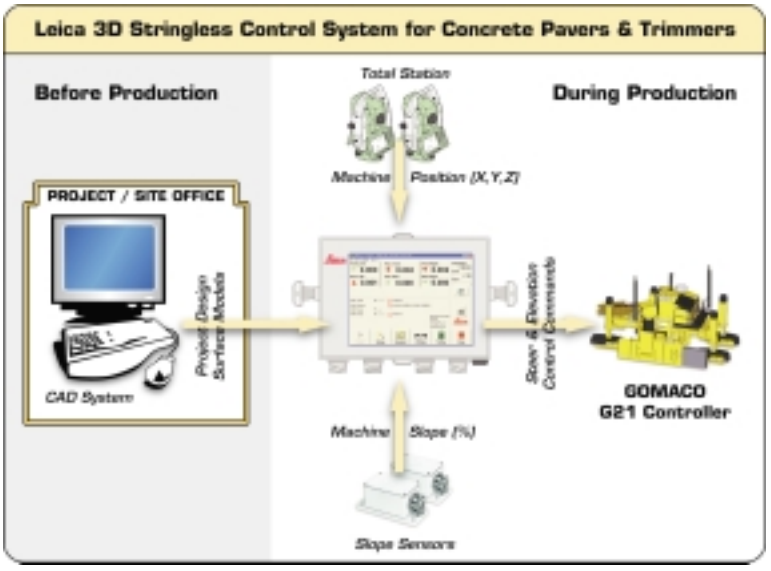
The G21 controller works on a technology called CAN-Bus. The way I like to describe CAN-Bus to customers is that it's like "internet for machines." It's a communications method that allows all the different sensors on the machine, plus engine components and circuits, to communicate with each other over one common cable network. Much like PCs in an office can share printers and exchange information with each other, CAN-Bus allows a machine to do that. The information that can be exchanged on CAN-Bus is anything from engine and oil temperature and pressure to 3D position data and hydraulic control signals.

Our 3D control system for stringless paving is built around CAN-Bus technology and we've been working on this together with GOMACO since 1999. We defined a message system which allows our machine computer and software to share the CAN-Bus network on GOMACO machines and send out our steering and grade commands to the G21 controller, which then talks to the valves in a similar way as it would to a stringline sensor.

What are the advantages of a CAN-Bus working with your system?

The advantage of a CAN-Bus is that it is extremely fault tolerant. For example, if there is any electrical interference on or around the machine, CAN-Bus itself is not affected by that. It's a voltage differential system and if there are any changes in the background voltage of the machine, such as when operators crank the starter or adjust engine revs, the CAN-Bus messages are not affected by that.

It's also extremely fast. The CAN-Bus messaging system that we use together with GOMACO runs at 125 kilobits– very fast compared to older serial communication methods which also aren't as flexible or reconfigurable as CAN-Bus. The key advantages are robustness and speed.



Is it safe? What keeps contractors from trimming or paving out of tolerances?

The CAN-Bus allows us to take advantage of safety features that are built into the G21 controller. For example, if an error is detected with our system because the machine is not in the position it needs to be, we send out a stop command and the machine will stop. We only need to send one small message across to the G21 and it takes care of shutting down the travel circuits, the vibrators, augers and tampers and locks the hydraulics on the legs.

That's a huge advantage for us, because we only have to define one message standard that allows us to set the GOMACO machine into standby. Once it's in standby, the G21 controller will not let the machine move again until the error condition has been cleared or the Leica system detects that the fault has been fixed. It's a very safe technology in that respect. Correctly set up, it simply won't let the customer put concrete in the wrong place on line or level. We can set limits in our system that as soon as we see the machine is more than a pre-defined amount away from where it should be, a stop command is instantly sent to the machine.

For example, imagine the operator has forgotten to put the grade control loops into automatic and he tries to start paving. Our system will immediately detect that the machine is not within a couple of millimeters of where it should be and it will send a stop command instantly onto the CAN-Bus. That stop command is picked up by the G21 controller which does all the rest of the work. We just need to say, here's the message, do something with it and the G21 takes care of the rest.

What's the latest development with the system?

Another advantage of the G21 controller is the large program space it has available. It's allowed GOMACO and Leica to develop a new feature which we call mixed-mode paving configuration. It's particularly useful on airport projects where contractors have to pave pilot lanes.

Let's imagine that the contractor has to pave five lanes total, all adjacent to each other. Typically on an airport you would pave lane #1, then #3, then #5, and come back and do

the fill-in lanes #2 and #4. Where they have to connect to an existing slab, obviously, they need a smooth joint with no step elevation changes between the two slabs. In that situation, our mixed-mode paving allows us, with the 3D system, to steer the machine so the contractor doesn't have to put up any temporary stringlines. They can then lock-to-grade with the track legs to perfectly match the grade of the adjacent slabs.

It also allows scab-on paving. When a contractor is scabbing-on to the side of an existing slab, they can run lock-to-grade on that side of the paver and 3D control on the opposite side so they're able to smoothly connect to the existing concrete. It's a neat little feature.

What troubleshooting capabilities does the operator have?

The G21 has diagnostics screens that allow the operator to troubleshoot very quickly if there are any communication problems with the CAN Bus. If for some unfortunate reason the Leica computer gets damaged or the power supply to our computer fails, the G21 will instantly detect that the Leica computer is no longer on the network and put the machine into standby. This prevents any risk of concrete going in the wrong place or the wrong grade. There are a lot of safety features, time-outs and cut-outs in the system that prevent any risk of incorrect paving. That's extremely important. Safety is the key. We've put a lot of engineering into our system to make sure it is as bullet-proof as possible.

What is the biggest objection you hear from contractors when you talk to them about stringless paving?

Surprising as it might sound, we've been meeting customers and selling this technology in Europe since 1999. Believe me, we've heard every objection in the book! To be honest, since we launched stringless with GOMACO in the United States, we're hearing more positive comments than objections! One of the biggest objections we still hear is, "I can't see my strings. I can't see if there are design errors in there. How can I trust the stringless system will keep the machine in the right place?" Of course, with stringless technology, the most common errors – i.e, the human errors in hub-setting, pin-driving, clamp setting, line-levelling and tensioning, plus the dreaded "catenary-effect" of slack stringlines that often leads to poor ride quality are completely eliminated. The machine is running from a "perfect" computer model of the finished project. Mistakes can happen. The data model itself just might have some errors in it, and contractors need to have the confidence that they can still check the model. That's where we can help.

We actually handle a lot of that ourselves in the 3D system. We have the graphic capability to actually look at the design, which we like to call "virtual stringlines" and see that the elevations and slopes are correct on each piece of the model. Just clicking on a piece of the model tells you all the information you need to know about it.

Even prior to putting the model on the machine to pave, you can load that model into any CAD system in a 3D view mode and you can literally "fly-through" your project. It takes just a couple of mouse clicks to exaggerate the vertical scale of an electronic drawing, or even generate a full contour map so you can look for any high or low spots in your "virtual stringlines." It's the same process of somebody getting down on their hands and knees and looking down a physical stringline for any low spots.

The beauty of the "software version" of virtual stringlines is that you can be sitting in a nice, warm office with a cup of coffee just clicking through a CAD program and you can spot any design errors before you even take that model out to the machine. You can overlay existing features and compare the model to your subgrade.

Imagine a contractor paving an airport runway... the subgrade has been put in and it's an inch or so high. They have to go in and trim that to spec with their trimmer. One thing the contractor can do first is a grid-level survey where they take spot heights and form a rectangular pattern to build up a surface model of their existing subgrade. From that, they can work out the amount of material and know how it relates to the theoretical design level for the subgrade.

They can instantly work out how much volume of material they're going to take off with their trimmer. The contractor can use that very same model that they've used for trimming, dial in the thickness of the slab they want to pave, put it into the computer on the paver and go pave it. They don't need to generate another model, assuming that their concrete is a constant thickness slab design. They might have an 18 inch (457 mm) slab, so just dial in 18 inch (457 mm) offset, upwards from subgrade level, and there's your finished concrete level to go pave with.

The preferred alternative is even better, but does require owners, designers and contractors to cooperate. It's now 2006,

CG-070512 D16

A *Commander III slipforms curb and gutter with the 3D system on a project in Calgary, Alberta, Canada.*

FT-090402 D13

A *total station tracks the progress of a 9500 trimmer as it works on a project in St. Louis, Missouri.*

and pretty much everything is designed in CAD, so why not use it as it is? Where's the benefit in taking a good electronic design, plotting it onto paper, reading or scaling-off the design, manually surveying and staking it out and introduce all those possibilities for errors?

Just get the top-of-concrete levels and slab positions from the designers directly in an electronic file. Double-check it first, of course, but then put it straight into the Leica system. Dial in that 18 inch (457 mm) offset as a negative number (i.e. a "cut") and go trim the subgrade perfect relative to top-of-concrete. Move the Leica system onto the paver, reset the offset to zero, and off you go! Imagine how much time, money, effort and material that can save you over a sizeable project!

Where has my stringline gone?

Another big objection is... "Where has my stringline gone? I've got nothing to check against." As time progresses, contractors are going to realize that's not something they need to worry about anymore.

The fear that the machine is going to go in the wrong place is taken care of by our system in connection with the G21. The secret to all that apparently complex communication is the CAN-Bus. We use our robotic total stations for position, and slope sensors for orientation of the machine, to figure out how much height, steer and crossfall adjustment it needs, plus how much draft, and mainfall to provide.

We just hook the slope sensors up to the GOMACO machine installing them on the GOMACO mounting brackets, connect one cable allowing the G21, our Leica system and our slope sensors to all talk on the same network. It's a fast and super-reliable technology.

The fear the customer has that the Leica system doesn't somehow integrate with their processes and doesn't integrate well with the machine, that it's some kind of bolt-on effort, is really not the case at all.

Is this system plug and play technology between the Leica stringless system and GOMACO's G21 controller?

It's pure plug and play technology. In fact, we call it "Plug & Pave!" That's exactly what it is, because as soon as we fire up our computer and are on the CAN-Bus, we recognize the G21, the G21 recognizes us, and you're ready to go pave.

If the contractor needs to go to one of the mixed-mode paving options, paving left or right grade, it's just a case of them selecting the appropriate mode on the G21, restarting the G21, running that new mode and away they go. It's really just press a button and flip a switch.

What about the average machine operator? Are they going to be able to operate this system?

It's complete rubbish for anyone to say the average operator won't be able to handle this system, that it's too complicated for them. Why would GOMACO be the market leader if their products were too complicated for people to use? And why would Leica be the world's leading surveying equipment manufacturer if no one could switch on our total stations? You just have to have a team of guys that are willing to go through the learning curve, because there is a learning curve involved.

As far as training the machine operator... it takes us no more than 10 to 15 minutes to get the operator up to speed on what needs to be done. It's really just a case of you used to pave in dual-grade left or dual-grade right, now press that button one more time and the Leica mode comes up.

On our Leica system, there's only three or four buttons the operator really needs to know. Those are start, stop and offsets so he can change the position and attitude of the machine on the fly if he needs to adjust for concrete variances.

Once our system is up, measuring, and sending steer and grade commands to the G21, the operator just has to remember to put the G21 into the Leica mode before he goes to pave and everything is the same as it would be on string. All he has to do is occasionally glance an eye over the Leica computer to see that everything looks sensible.

Remember, if there's an issue, a red warning light flashes on our system and the machine stops. The operator has to take a quick look at the diagnostics on the G21 and it displays something like "Leica stopped tracking, reset Leica." It won't let him start paving again until the diagnosis is dealt with.

It is a new way to pave, but our customers get comfortable with it very quickly. Once they've gone through that learning curve, the world is their oyster and they never want to go back to stringline. It's so frustrating when some people see this technology and just attack it and say it doesn't work. All we ask is for people to just give it a fair hearing, then call us or GOMACO and arrange to try it for themselves. We know they'll be impressed!

HW-050408 D7

A *stringless GP-4000 slipformed a 24 inch (610mm) thick slab at the Atlanta Hartsfield Airport in Atlanta, Georgia.*

CG-110506 D21

B*arrier wall on Highway E411 in Belgium was slipformed with the Leica 3D stringless guidance system.*

Order GOMACO Items Online

GOMACO has made it easier for you to order our wearables and gift items. A new online store, www.gomaco.com/store, features all of our items, from jackets and hats to sunglasses. All available sizes and colors are listed along with the prices of each.

Simply click on the items you wish to purchase and they're added to your shopping cart. The shopping cart gives you the chance to change the number of items you'd like to purchase or to clear the cart out entirely and start over shopping again.

Once you've finalized the items in your shopping cart, you continue to the check-out page where you're required to enter your shipping and billing information. It's also where you'll choose your payment method. Both Visa and Mastercard are accepted.

With that information entered, you continue onto a page that will ask you to review your order to make sure the correct items and quantities will be charged and shipped to your account. Once everything is correct, you proceed onto the final page where your order is placed and sent to GOMACO to be filled and shipped out.

Several new items have joined the GOMACO line. Check them out at www.gomaco.com/store.

Goodbye to Our Friend...

Gene Grayson, 67, a member of the GOMACO family for over 22 years, passed away December 27, 2005, from a massive stroke. Gene worked as a field service representative in the Service Department.

He traveled the world for GOMACO and helped set-up new equipment or troubleshoot on older equipment. He helped out in the shop sessions at GOMACO University each winter and was a seasoned show veteran helping set up many World of Concrete and CONEXPO-CONAGG shows.

"I think with his death, Gene took a little bit of all of us with him. Gene's ability to work with people was his greatest asset," Dennis Ernst, Service Department Supervisor, said. "Gene would travel anywhere, anytime and do a job that made GOMACO proud, and the customer completely satisfied. Gene's reputation and ability to get the job done right, both overseas and domestically, spoke the loudest and will always be a tribute to him. Gene will be missed by everyone that ever met him and he will always be known as the 'Gentle Giant' to me."

From the GOMACO Service Department – Servo Valve Rebuilding Program Now Available

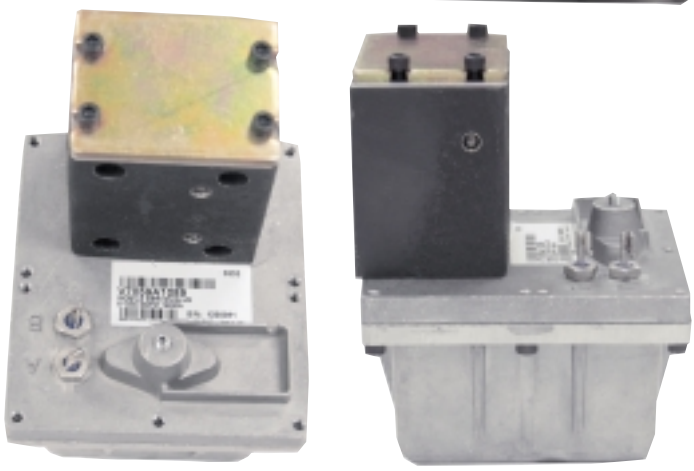
GOMACO Corporation now has the ability to repair certain types of grade and steering servo valves to OEM rebuilt standards. The GOMACO part numbers along with the OEM part number is listed below:

GOMACO PART NUMBER	GPM	OEM PART NUMBER
R-125-10A09	2 gpm	V7059A-1089
R-125-10C96	4 gpm	V7059A-1105
R-125-10D63	7 gpm	V7059A-1139

These servo valves were used on the early model GOMACO curb and gutter machines and early model GOMACO pavers and trimmers. The rebuilt servos are available for the two, four and seven gallon models.

If you, the dealer or customer, have any equipment with this type of servo valve control, please contact GOMACO for information on our rebuilt exchange program. If you have any of these valves that are now defective and would like to return them for credits without purchasing replacements, we have a list and will authorize the return as our inventory requires.

If you have any questions regarding this type of valve, please contact GOMACO at 800-831-2320 and ask for the Service Department. Please have your machine serial number ready when you call.



Tips for Setting Up and Paving with 3D Stringless Controls

by Dennis Clausen, Director of Training

How many times during paving operations has your stringline broken, or you have had to take it down to allow trucks or other equipment to pass? How accurate is your stringline? How much does it cost to set the stringline and constantly monitor it? Have you ever wondered if there was an easier way to control your paver rather than setting stringline?

There is a better way. It's through the use of the Leica stringless control system. The system controls the paver through the use of laser beams and radio signals.

When surveyors plot a project, they often do it using a total station and a measurement prism. After they have established reference points on the project, the information is inserted into a design program and the final project is developed, including horizontal and vertical alignments. Now, instead of using this information to place stakes on the job, the information can be loaded into the Leica computer and then used to control the machine.

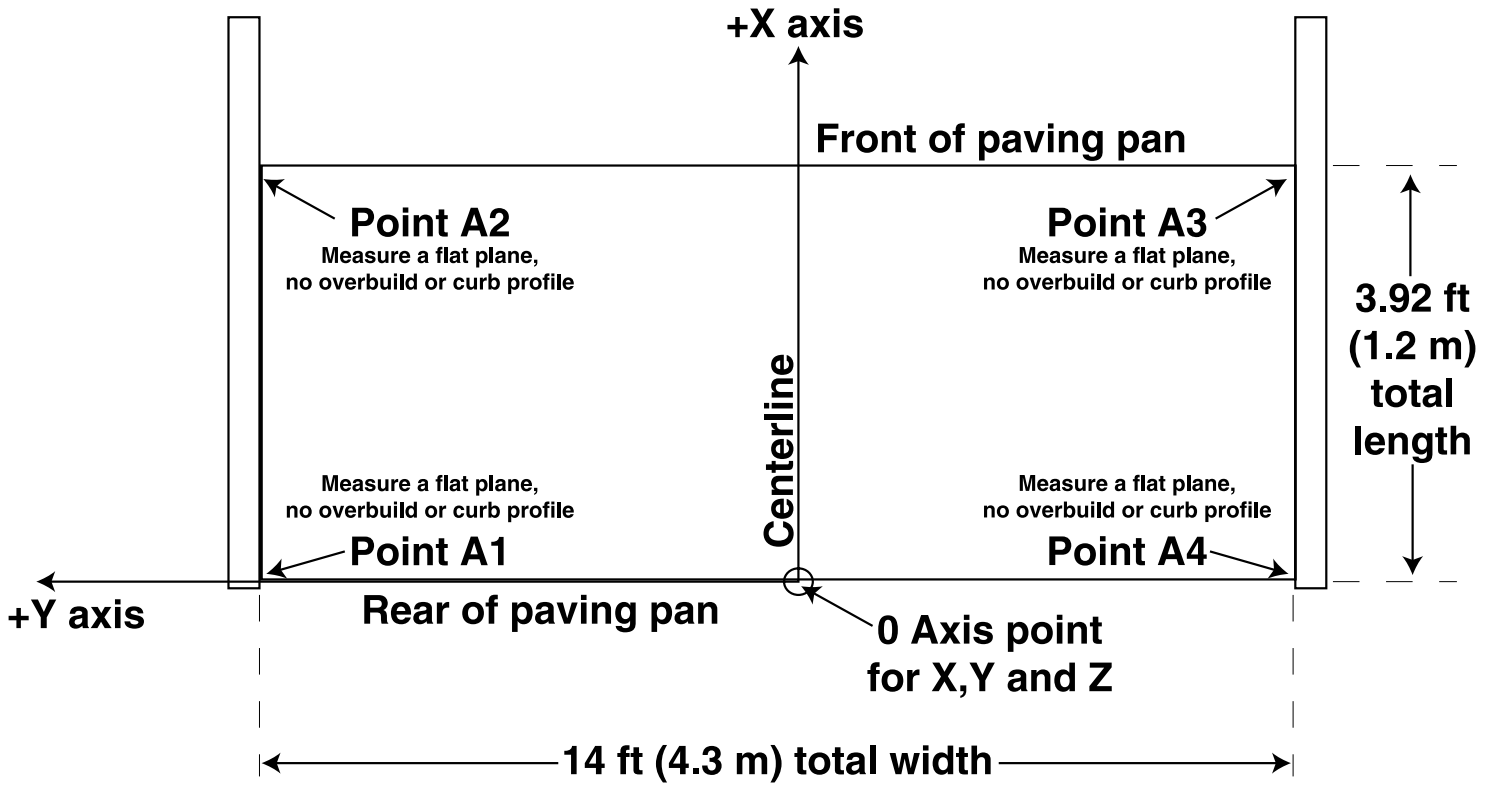
For machine setup, the Leica MPC4 machine controller is mounted on the GOMACO machine. Power is supplied to the controller from the machine electrical system. The CAN-Bus cable between the G21 controller and the switch box on the machine is replaced with a "Y" CAN cable which allows the controller to be connected into the machine control system. Two prism mounting poles are attached to the machine with a 360 degree prism attached to the top of each one. One pole is attached to the left rear of the machine and the other is attached to the right rear. A "dual axis" slope sensor which measures cross slope (side to side) and long slope (front to rear) is mounted to each of the prism poles and connected to the Leica controller. The prisms basically locate the elevation of the rear of the machine, while the dual axis sensors control the front elevation.

HW-100406 D20

A *Leica total station tracks the progress of the GOMACO GP-4000 paver on a highway project in the Czech Republic.*

After all of the hardware is mounted on the machine, it will be necessary to calibrate the system. To calibrate the system, it will be necessary to establish the paving pan coordinates. A total station is used, along with a measuring prism to measure four points on the bottom of the paving pan, one at each corner. The first step is to enter the width and length of the paving form into the controller. Once the mold information is entered, an elevation measurement is "shot" for the front and rear of the bottom side of the paving form on each side. This information is automatically stored in the controller. The next step is to "shoot" each of the 360 degree prisms. This allows the system to calculate the distance from the paving pan to the prisms in a very accurate manner. The system now knows where the paving pan is in relation to the prisms as the machine moves about the project. After these measurements are recorded, it will not be necessary to retake them unless the width of the paving form changes or the location of the prisms is changed.

Once the measurements are all stored in the controller, it is time to set the machine up on the job site. The machine is moved to a location that is relatively close to the proper paving position. The total stations (one for the left and one for the right) are positioned in a location that will be clear of all construction traffic. It is also suggested to have them set on an elevation that is high enough to allow the laser tracking beam to be above all construction traffic. Once the total stations are positioned, they are then used to locate at least three reference locations on the job site. After each total station "knows" its location on the job site, one is targeted at the prism on the left side of the machine and the other one is targeted at the right prism. As the paving operation commences, it is possible to make adjustments to the elevation and alignment by simply changing the vertical



It's necessary to establish the paving pan coordinates to calibrate the system and this drawing illustrates that technique.

or horizontal offsets in the computer.

Normally during paving operations, three total stations are used. The paver only requires two for control. The third can be used to check the slab elevation, or it can also be used for "leap frogging" the stations.

For example, the station controlling the left side of the paver may be set 250 feet (76 m) from the machine and the one controlling the right side may be 500 feet (152 m) from the machine. When the machine begins to get out of range of the left total station, that side can be switched to the third total station. The total station that is not being used can then be moved to a new position to take over control of the right side of the machine when it gets out of range of the station controlling it. That station is then moved forward to control the left side when it again gets out of range. This procedure continues until the project is completed.

With the Leica system, several different projects can be "loaded" into the controller and the corresponding one selected as necessary. This allows moving from one location to another without the need to stop to download the required program. No more stringline in the way!

GOMACO University: Registrations are now being accepted for all of the 2006 GOMACO University classes. Contact Shari Simmons at GOMACO University to register at 1-800-831-2320, or visit the University's website at http://www.gomaco.com/university to view the list of classes available or to register online.

A *GHP-2800 paver slipforms an econocrete subbase on this project at the Indianapolis International Airport.*

The *Leica MPC4 computer is mounted on the GOMACO machine and supplies the operator with system information.*

GOMACO around the world

CG-010604 D16

Machang Construction Equipment slipformed barrier wall with their new Commander III on a project in Korea.

CV-110501 D4

A GT-3600 was the main attraction in the GOMACO distributor's booth at Bices, a trade show in Beijing, China.

CV-010601 D5

GOMACO attended the Australian Small Bridges Conference in Sydney, Australia, and featured the C-450 bridge deck finisher.

HW-070506 D18

Jiangcheng Highway and Bridge Company use their new four-track GHP-2800 with In-the-Pan Dowel Bar Inserter (IDBI) to slipform a new highway in the Yanbian Autonomous Region, China.

CV-010602 D4

Dutch Concrete Day in Rotterdam, Netherlands, attracted several interested slipformers into the GOMACO distributor's booth at the show.

CG-110505 D22

Liam Maher uses a Commander III to slipform curb around a new car dealership in Cashel in County Tipperary, Eire, Ireland.

CG-080541 D6

Kosmos slipforms stand up curb with their Commander III in Perm, Russia.

Slipping a Slope on the Inside of a Breakwater in Japan

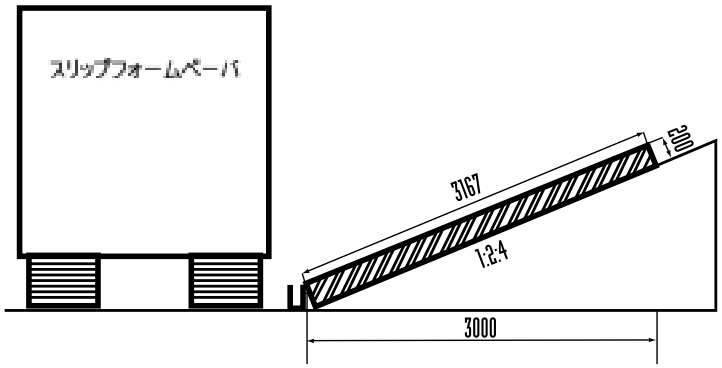
Maeda Road Construction Company in Tokyo, Japan, recently completed a slope project with their four-track Commander III. The project required them to slipform a 9.8 foot (3 m) wide slab at a 1:2.4 slope. Concrete slump was two inches (50 mm).

The project was part of building a slope on the inside of a breakwater. At the top of the slope is a barrier and on the ocean-side are specially made concrete structures designed to dissipate water wave energy coming off the ocean and keep the water from flowing over the barrier.

Photos courtesy of Maeda Road Construction Company CG-120502 D2

CG-120502 D1

A *structure was built over the Commander III to pivot the mold at the bottom of the slope and to support the mold at the top of the slope.*



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