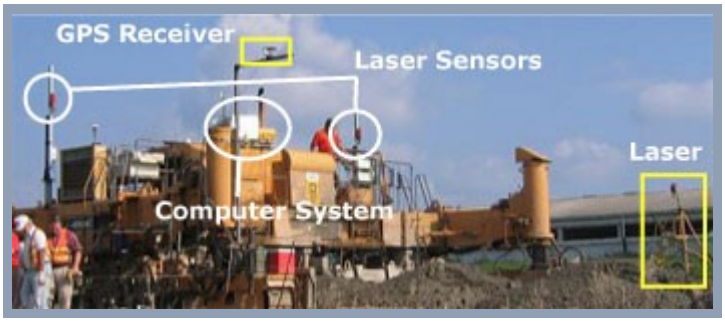
TECH NEWS
TECHNOLOGY NEWS

September-October 2004

Stringless paving: a promising alternative

Today's concrete pavement construction technology uses physical guidance systems in the form of a string or wire line on each side of the paving machine. An ISU research project, sponsored by the Iowa Highway Research Board (TR-490), recently evaluated an innovative stringless concrete paving method on two paving projects in Washington County, Iowa.

Results from the study indicate that stringless guidance systems based on global positioning systems (GPS) are a feasible alternative to traditional string lines.



The on-board guidance system included laser sensors, a GPS receiver, and computer software.

Method

CMI Terex Corporation and GeoLogic Computer Systems are pioneers in GPS-based guidance and control systems for earth-moving and construction equipment. Their GeoSite Manager System uses a combination of GPS and laser technologies. Lasers can improve the elevation accuracy of the GPS control system.

The ISU study in Washington County was the first time this method was used for stringless guidance of concrete paving machines.

For the study, a slip-form paving machine was fitted with a GPS receiver mounted over the front right track. Two laser sensors were mounted on separate masts located on opposite sides of the paving machine.

The on-board, stringless paving computer system combined GPS data with laser data; it ran on a standard Windows operating system.

The research team eventually abandoned the laser technology due to paving speed and rapid changes in terrain. The GPS-only system provided reasonable results in elevation and guidance control.

Requirements

The GPS-based stringless paving technology used in this study requires the following equipment and skills:

- Three-dimensional (3-D), digital project designs must be entered into the paving machine control system.
- Land surveying knowledge is required to convert some data to 3-D GPS coordinates.
- Calibrated monuments along the project way are used as GPS "base stations." Counties without monument systems tied into the state plane coordinates can set temporary monuments.
- GPS receivers mounted on the paver must be modified with additional data to help refine the exact location of the receiver and increase accuracy.

Findings

"James Cable ... believes that stringless guidance systems are the future of concrete pavement construction technology."

The research resulted in a number of interesting findings:

- In general, GPS-based control provided excellent guidance of the slip-form paver.
- Pavement depth and concrete yields were within acceptable design values.
- Elevations at the top edge of the pavement conformed more closely to design values than elevations of control pavement segments (constructed with traditional string line control).
- Pavement surface profiles were acceptable but not smooth enough to provide the contractor with profile incentive payment. Additional software development is needed to improve surface profiles enough to meet Iowa DOT's specification for incentive payments.
- Location of the GPS receiver on the slip-form paver (front, middle, or rear) is critical to proper coordination with the 3-D design program and proper machine control. (The receiver must be mounted above the front track, which controls turning.)
- The stringless control system required frequent adjustment to the location of the paving machine, causing some of the hydraulics (valves) to move up and down more violently than generally observed under stringline control. The hydraulic controls and computer software must be modified to accommodate uniform changes in elevation during stringless paving.

Potential benefits of stringless paving

Stringless paving systems have the potential to offer pavement owner/agencies, contractors, and, ultimately, the public the following benefits:

- savings in labor costs related to setting and removing pins and stringlines (estimated at $10,000 to $16,000 per mile for rural pavements, including setting and leveling pins, calculating cut/fill quantities, writing on wood stakes, and installing and removing the string line)
- easier equipment access to the road, especially where shoulder width is limited
- elimination of challenges related to working around stakes and stringlines
- elimination of stringline sensors on the paving machine (this reduces machine width, making it easier to cross bridges and other tight spots)
- quicker project start-up and finish, resulting in shorter period of traffic disruption

Potential drawbacks

Based on the system studied by ISU, there are some potential disadvantages to stringless paving as well:

- The initial investment for stringless paving systems may be a deterrent to their adoption. (In the long run, the costs should be recouped from savings related to eliminating stringlines.)
- With GPS-based control systems, GPS signals can be temporarily lost in high foliage density areas or under structures.
- Errors in GPS-based control systems may not be as easy to recognize and correct as are stringlines that have gotten out of proper alignment.
- Until stringless control systems are further developed to be more user friendly, paving machine operators will need more technical expertise to work with them.
- Computer experts will likely always have to be on site to eliminate extended breakdowns due to malfunctions of the

computerized stringless control system.

Still, James Cable, ISU professor of civil, construction and environmental engineering and principal investigator of this research project, is enthusiastic about the GPS-based, stringless concrete paving method.

He believes that stringless guidance systems are the future of concrete pavement construction technology.