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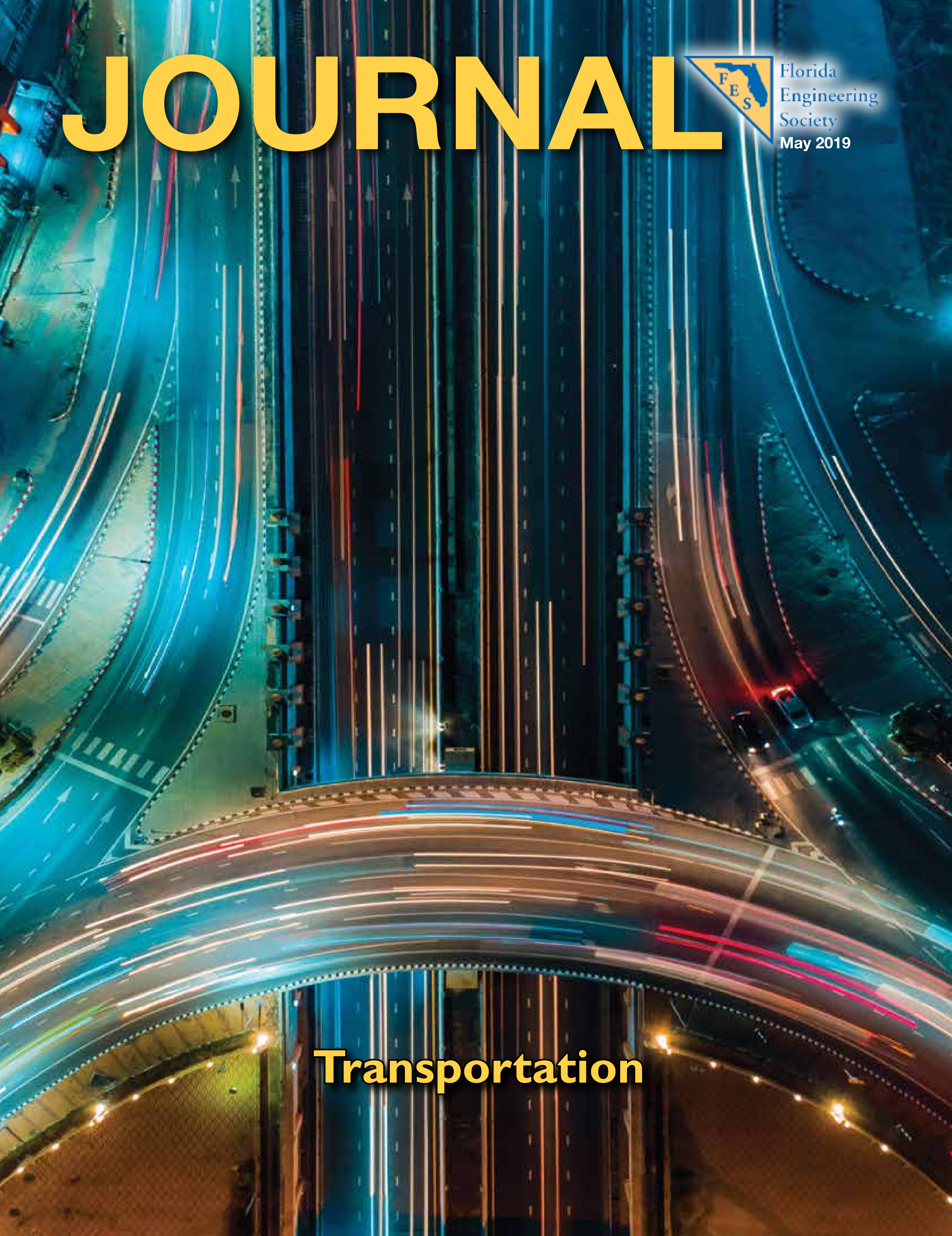

Transportation

Curve Advisory Speed Analysis Using Mobile LiDAR

For many years, the evaluation of the safe travel speed for highway curves has been a subjective practice. Based on the curvature geometry and superelevation, this safe speed limit historically has been determined using conventional, boots-on-the ground survey methods.

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According to the U.S. Department of Transportation Federal Highway Administration (http://www.fhwa.dot.gov/), public agencies have invested $1.75 trillion in transportation assets (https://www.fhwa.dot.gov/asset/if08008/amo_02.cfm). Over the past decade, Transportation agencies have experienced an increased need for a better means of inventorying asset condition due to high risk failures. The calculation of the safe speed by which to travel around roadway curves is one such asset. And time is ticking to complete the reevaluation of these designated speeds and corresponding signage.

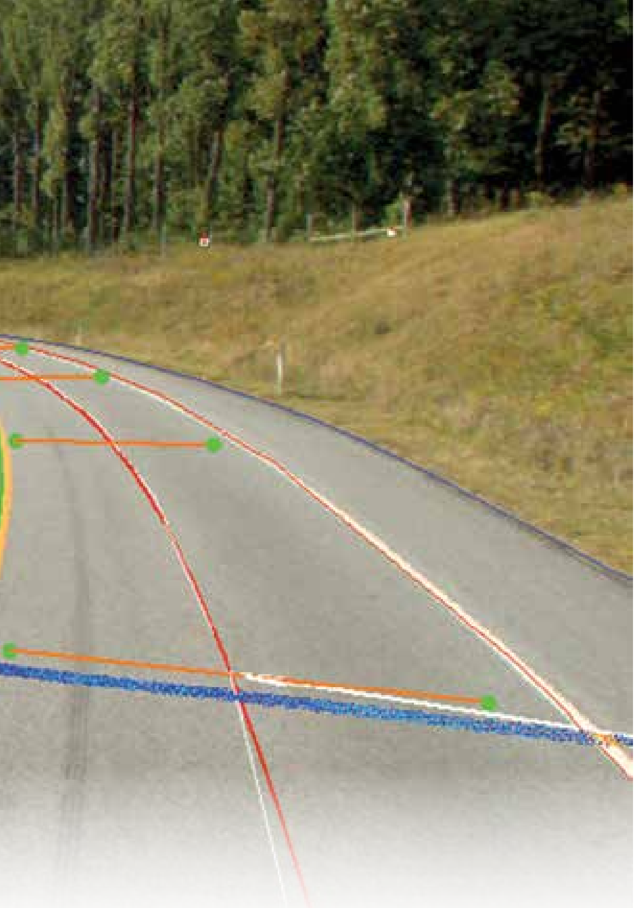
Deadline Looming

The 2009 MUTCD (*Manual on Uniform Traffic Control Devices*) presented explicit requirements for signing curves and gave us a 10-year grace period to get this job done. Well, time is almost up, because that compliance deadline is December 31, 2019! And if you're not in compliance you will be in violation of a federal code.

History

For many years, the evaluation of the safe travel speed for highway curves has been a subjective practice. Based on the curvature geometry and superelevation, this safe speed limit historically has been determined using conventional, boots-on-the ground survey methods. In many states, the reliance on "ball bank" tools and hand measurements in the field has made this a somewhat inefficient and inexact science. For instance, the Ball Bank Indicator method requires multiple speed test runs for each curve in both directions in 5 MPH speed increments.

According to a white paper approved by the Transportation



Research Board (TRB) entitled *The Effective Use of Mobile LiDAR Data for Curve Advisory Speed Analysis*, (2017) by Patel, DiGiacobbe, Knaak, Kharva:

"This approach typically encounters inconsistencies in advisory speeds due to variation in test vehicles classification, equipment calibration, steering corrections (driving style) and ability to maintain constant speed while traversing the entire curve. It may also require an additional person to document the results and, more often, conservative speeds are being posted which results in increased non-compliance by drivers."

This method takes time and even slight inaccuracies can lead to potential danger to the traveling public if "reduced speed" signs may be posted with higher speeds than what is actually advisable.

The Good News

While no one could have predicted the breadth of the technological advancements we've made over the past 10 years following the MUTCD mandate, the time is here to use these very viable tools. The modern use of mobile LiDAR has evolved to provide a much more exact evaluation of these highway curves from establishing the curve radii to the superelevation along the curve. Equipped with the availability of mobile LiDAR scanning technology to collect this data using TopoDOT software, we can help Highway authorities evaluate the advisory speed curves with a higher rate of accuracy than ever before. Transportation officials can determine precisely where the curve is underperforming for a given travel speed as well as to choose to either repair any deficiencies to the roadway or lower the advisory speed sign.

Here's How to do it

Affixed to the top of a vehicle, Mobile LiDAR scanners provide high-accuracy 3D data acquisition at a rate of over 1 million points per second while the unit is in motion. This allows the technicians to collect data, covering large distances in minutes rather than days or hours. Plus, the very nature of the process takes the surveyors physically out of the perils of the roadway and into the protection of a vehicle driving at posted highway speeds as well as reducing disruptions to the travelling public.

Since mobile LiDAR scans record virtually everything in its path, it can detect every possible deviation in the pavement and other details that could affect the recommended speed limit—or further confirm it. In the case of advisory curve analysis, mobile LiDAR data is used with the industry standard software to accurately measure key components of AASHTO's Geometric Design Method for determining speed advisory, including establishing the curve radii and the superelevation along the curved roadway. This data, along with the appropriate friction factor, is then input to calculate the safe running speed. The results from the computations enable transportation officials to precisely determine where the curve is underperforming for a given travel speed. Equipped

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New signage requirements are loud and clear.

with this precise data output, officials can now choose to repair any deficiencies to the roadway or lower the advisory speed sign.

The beauty of LiDAR is that its data can be stored in a point cloud in virtually unlimited amounts. This data is so rich in detail about all available assets, that any of them can be extracted from the file for individual use, drawn upon at a later date and repurposed for use in other projects. Information about assets like ADA ramps, bridge clearances, guide rails, and pavement markings can all be isolated and used for any number of other design or planning projects without having to perform subsequent scanning or surveying.

The precise geometric characteristics of the data also allow for an interactive and automated workflow at the desktop. Secure and accurate data can be transferred in real-time from field to office rather than in an uncontrolled, and possibly unsafe, field environment. The results can be visually depicted in a typical Computer Aided Design (CAD) session and output into tabular form to a spreadsheet file format. The net effects of this new capability are safer road conditions, a modern and more accurate analysis method and potential reduction in liability for a public agency.

Just like any other transportation asset, advisory speed curve signage needs to remain accurate when roadway design or conditions change. Instead of being located "somewhere between mile marker 12.3 and 12.4," integrating geospatial technologies like GPS, GIS and Mobile LiDAR technology, every asset can be accurately located, mapped, inventoried, assigned details about their condition assessment, maintenance and scheduled into a workflow—all of which can be accessed in real-time from a desktop or other hand-held device.

Conclusion

Every organization has some program for managing their assets in place, whether it's a traditional manual system or mix of manual and technological. But today, utilizing mobile LiDAR is quickly becoming the tool of choice for analyzing roadway curve to determine the advisory speed. This versatile tool increases safety while reducing time in the field and the need for traffic protection. It should be noted that the overall effort has an efficiency gain of 20 to 1 over conventional advisory curve survey methods.

New signage requirements are loud and clear. And according to MUTCD, you don't have much time to comply! Have your curve signage re-evaluated and updated now!

Resources

Chapter 2c. *Warning Signs and Object Markers - Manual on Uniform Traffic Control Devices (MUTCD)* published by the Federal Highway Administration (FHWA). https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part2c.pdf

FWHA new criteria for compliance regarding safe speed curve signage that agencies need to comply with by December 31, 2019. http://safehighwayengineering.com/FHWA Requirement - Safe Speed Curve Sinage.pdf

Effective Use of Mobile Lidar for Advisory Speed Curve Analysis for TRB by Patel, DiGiacobbe, Knaak, Kharva: http://amonline.trb.org/2017trb-1.3983622/t023-1.3996143/722-1.3996337/18-00371-1.3991096/18-00371-1.3996400?qr=1

About the Author:

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is the Director of the Geospatial Department for Maser Consulting PA and has over 31 years of experience in the field of civil engineering and related technologies. His responsibilities include the management and advancement of LiDAR technologies for the firm. Mr. DiGiacobbe is a registered professional engineer in the states of Florida and Pennsylvania and a registered design-build professional. He received his BS in Civil Engineering from Villanova University.