

0-6896: Developing a Surface Drainage Rating for Inclusion in TxDOT's Asset Management System

Background

The ability to collect infrastructure-related data through automated means continues to expand rapidly. The use of mobile light detection and ranging (LiDAR) scanning (MLS) gives highway agencies the opportunity to collect vast amounts of surface geometric data at highway speeds. The conversion of geometric data into information assists the Texas Department of Transportation (TxDOT) in understanding the nature of the built environment. For roadways and roadsides, this type of information provides details on paved surface design compliance, paved surface drainage, and roadside drainage.

The primary purpose of the project was the creation of a surface drainage rating that evolved into an overall surface rating accounting for design compliance and drainage. Design standards represent a safety-first mentality while trying to balance other roadway needs, such as drainage. Therefore, the project developed a surface drainage rating that consists of evaluating geometric elements against design standards and focusing on specific surface drainage features.

What the Researchers Did

Researchers used a single-laser MLS device to collect geometric data on various highway section types. MLS techniques captured vast amounts of data that researchers processed into a gridded format. The use of a gridded format facilitated the analysis of surface water flow and evaluation of other surface features. Researchers decided upon a 1-ft by 1-ft grid for the paved

surface analysis and a 3-ft by 3-ft grid for the roadside analysis. Researchers chose to develop the rating for the data collection lane and adjacent roadside only. The rating includes the following geometric elements:

- Traveled way width.
- Travel lane cross slope.
- Hydroplaning potential.
- Front slope steepness.
- Ditch depth.
- Ditch flowline steepness.

The first three elements are roadway attributes, while the final three are roadside attributes. The requirement of both roadway and roadside features limits the network-level application to rural sections. This does not exclude the use of MLS to analyze urban and metro sections; however, researchers recommend treating these types of sections as project-level analyses.

In the final rating, the three paved surface attributes were equally weighted to create a paved surface rating. Similarly, the three roadside attributes were equally weighted to create a roadside rating. The paved surface and roadside ratings were then equally combined to

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form the overall drainage rating. Applying this rating effectively to a large network required that researchers develop proof-of-concept code to process data on 0.1-mile data collection sections with minimal intervention. The rating was successfully applied to 73.5 miles in four districts.

What They Found

The work performed in this project shows how a single-laser MLS can be used to collect geometric information through automated means. Proof-of-concept code further showed that data processing can occur with little manual intervention. Researchers discovered that LiDAR data can be effectively used to generate visualizations, but converting visualizations into useful information can be challenging especially when limiting manual processing efforts.

When applying the actual rating, many sections were plagued with out-of-shapeness. Once a section's alignment is established, the highpoint on the surface should fall within a predicted location, but this often did not occur. Sections classified as out of shape received a zero rating for cross slope. High hydroplaning potential also led to low paved surface ratings. These sections were typically found on roadways with a posted speed limit of 70 mph or 75 mph. The hydroplaning speed calculation was often above 50 mph, but the difference of more than 20 mph between the hydroplaning speed and the posted speed limit drove the rating lower.

On the roadside, front slope steepness typically received high ratings. When the deductions occurred on the roadside, they were typically a

result of shallow or flat ditches. As a whole, the roadside ratings were higher than the paved surface ratings.

The use of MLS proved highly effective in several project-level analyses. MLS data were used to help create a detailed design of an underdrain system accompanying improvements in roadside drainage. MLS data were also used to suggest pavement profile changes and roadside improvements along a 2-mile stretch of highway. Finally, detailed rut maps were produced that TxDOT staff used to perform maintenance work.

What This Means

The elements within the surface drainage rating provide roadway managers with insight into roadway performance. For example, the creation of a hydroplaning potential metric allows managers to identify potential safety issues. Researchers believe expanding the study to compare hydroplaning potential with wet weather crashes can be implemented immediately.

A review of distressed pavement sections with roadside drainage ratings provided no definite conclusions. Researchers hypothesize that including additional information about soil conditions might assist in finding a correlation. Researchers suggest continuing this work with a temporal analysis of pavement distress history combined with soil data to further investigate the link between surface drainage and pavement performance.

Finally, the use of MLS data for project-level analyses and support should be expanded.

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