



South Carolina  
Department of Transportation



U.S. Department  
of Transportation

**Federal Highway  
Administration**

## PROJECT SUMMARY

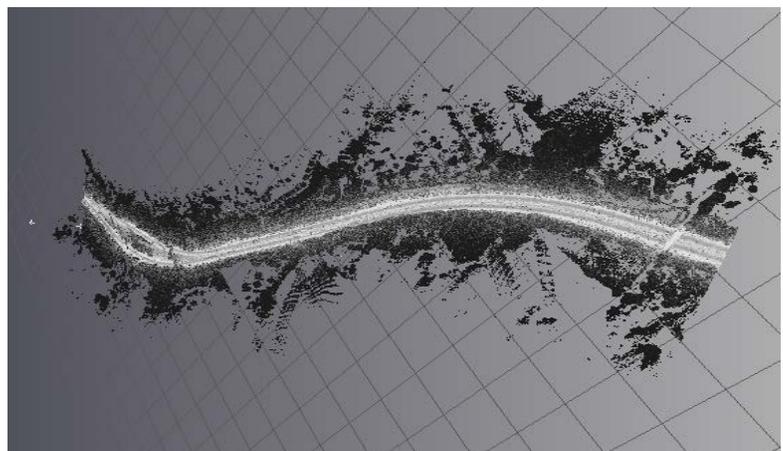
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## CROSS SLOPE VERIFICATION USING MOBILE SCANNING ON SCDOT HIGHWAYS

### Overview

Mobile Terrestrial Laser Scanning (MTLS) provides a cost-effective method of scanning roads for pavement cross slope data, and other roadway measurements. Conventional approaches for planimetric and topographic roadway surveys are labor intensive, expensive, and time consuming. Traditional survey methods often require personnel to work in close proximity to traffic, necessitate short term lane closures, expose personnel to safety concerns, and disrupt traffic flow potentially resulting in congestion. Surveying data collection difficulties are especially prevalent when obtaining measurements to determine an accurate depiction of pavement surfaces. MTLS provides an efficient means to collect 3D imagery quickly, safely, and cost effectively. This technology-based approach can potentially accelerate pre-construction tasks required to prepare design and contract documents for successful repaving and rehabilitation projects. MTLS data can provide additional maintenance, asset management, and operational benefits further fulfilling South Carolina Department of Transportation (SCDOT) data needs. The research covered a variety of data elements including detailed profile, alignment and cross section comparisons, and ground proofing using conventional survey methods. Results of this research support the feasibility of MTLS in comparison to manual data collection methods to obtain cross slope and estimate pavement material quantities. Establishing standardized MTLS test procedures to verify data collected by private companies for state procurement contracts was an important issue addressed through this research project.



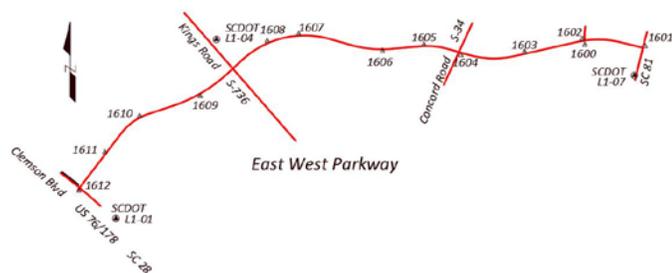
**Figure 1: Lidar Point Cloud of the Corridor (digital file in ASPRS LAS format) showing Test Section 3, Business 85 in Spartanburg, SC, limited access freeway.**

## Key Findings

A technical and economic evaluation of MTLs was conducted focusing on accuracy and precision of collected cross slope data and procedures to calibrate, collect, and process data. Findings were based on data provided by vendors who participated in an MTLs rodeo collecting data from three test section locations in Anderson, SC and Spartanburg, SC. Findings are summarized as follows:

**MTLS Cross Slope Verification:** Research results indicate that MTLs can measure cross slope to within  $\pm 0.14\%$  grade for a single lane and to within  $\pm 0.2\%$  if 2 lanes are measured in one pass. These values are based on post-process survey adjustments using ground control points. Analysis of data collected on US 123 indicated that MTLs can measure cross slope to within  $\pm 0.18\%$  based on an unadjusted point cloud.

**MTLS Validation Guidelines:** Test section 2 (East West Parkway in Anderson, SC) was chosen as an ideal pre-qualification site because of relatively new pavement and varying geometric characteristics and roadway design elements. In-place survey ground control points (primary, secondary, and cross sectional at 100-ft. station intervals) will help facilitate evaluation of data collection capabilities and quality of any potential MTLs vendor.



**Figure 2: Control Points along 2.9 mi. East West Parkway in Anderson, SC (Test Section 2)**

**MTLS Benefits:** MTLs provides a cost-effective method for continuously measuring roadway cross slope and researchers recommend MTLs be used for SCDOT's cross slope verification program. An even greater return on investment could be achieved by using MTLs data to meet additional asset management needs.

## Additional Results

Research emphasis was focused on technical and economic comparisons for MTLs with conventional survey methods for cross slope verification. Recommendations are summarized as follows:

**Construction:** When using MTLs to determine construction adherence, average slope should be measured from generated breaklines along longitudinal pavement markings at 100-ft stations in tangents, and 50-ft stations in curves. These average slopes should meet Level 1 or Level 2 tolerances as per SCDOT cross slope specifications.

**Safety:** To minimize possibility of hydroplaning, mean MTLs cross slope measurements should average greater than 1.84% for a single pass for each lane and 1.99% for a single pass for two lanes to ensure that minimum slopes will meet or exceed 1.5% at a 95% confidence level.

**Cost:** MTLs provides a cost-effective method for continuously measuring roadway cross slope and MTLs is recommend as standard for SCDOT's cross slope verification program. An even greater return on investment could be achieved by using MTLs data to meet additional asset management needs.

## Conclusion

Based on findings from the research, a series of proposed changes and procedures are recommended for cross slope verification using MTLs. Most of the standards identified in the current ARMS are still valid. This study included an examination of current and historical data collection methods, specifications, and standard practices used by other transportation agencies with regard to cross slopes. Research results show that MTLs is safer than conventional surveying because it does not require personnel to be located in or near the travel lanes, and it also increases productivity by significantly reducing the time need to collect the data. MTLs data uses are many and can be beneficial to virtually all state highway agency employees who work with spatial data for asset collection, design, planning, estimating, and many other applications.