

Research Spotlight

Project Information

REPORT NAME: Safety Performance Functions for Rural Road Segments and Rural Intersections in Michigan

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Site-specific data will improve safety decisions for Michigan rural roads

Nationwide, the fatal crash rate on rural roads is higher than on urban roads - 2.6 times higher in 2015. Rural road safety continues to be a top MDOT concern, but national models developed for safety assessment do not provide sufficiently accurate results when applied to Michigan's rural roads. Researchers developed new, more accurate models for estimating safety using data from a broad range of rural trunklines and county roadways across Michigan. Using these models will allow MDOT and local agencies to make more informed safety-related decisions to save lives and reduce serious injuries.

Problem

The 2010 [Highway Safety Manual](#) (HSM), published by the American Association of State Highway and Transportation Officials (AASHTO), is an important resource used by state agencies to improve highway safety. Among the HSM tools are safety performance functions (SPFs) – predictive models that can estimate average crash frequency at individual sites based on a site's traffic volume and road characteristics of the site.

Because the HSM models were developed based on data from select states nationwide, individual state agencies are encouraged to evaluate, calibrate or recalculate SPFs using local data to improve the accuracy. Many states have adopted this practice, and frequently the calibrated or locally specified models vary greatly from the calibrated HSM models. MDOT's examination of the HSM's average crash frequency models showed that their



This newly paved segment of state trunkline highway M-88 in Antrim County is representative of two-lane trunklines examined for this project.

direct application to Michigan's rural roads generally did not provide sufficiently accurate results. Consequently, MDOT sought to develop a series of Michigan-specific models for estimation of roadway safety performance using data from a broad range of rural roadways across the state.

“This project comprehensively assessed Michigan’s rural roadways and developed tools that will allow us to choose cost-effective safety treatments that are most likely to save lives.”

Dean Kanitz, P.E.
Project Manager

Research

Researchers developed Michigan-specific rural roadway models to estimate the safety performance of four-lane trunklines (divided and undivided), paved and unpaved two-lane roadways, signalized intersections and minor-road stop-controlled intersections. They compiled data from thousands of rural trunkline and county road segments and intersections statewide, including traffic crashes and traffic volumes, from 2011 to 2015. Researchers also gathered roadway classifications, geometry, cross-sectional features and other site characteristics from satellite and street-level imagery and from databases maintained by MDOT, Michigan State Police, and the Michigan Geographic Data Library.

Because a very high proportion of rural roadway crashes involved deer, researchers found that those crashes skewed HSM models when applied to Michigan roadways. Consequently, deer–auto crashes were removed from the road segment models to improve the predictive capability. Then, using Michigan-specific data to calibrate the HSM’s base SPFs, researchers developed more detailed local models that incorporated features such as shoulder width, driveway density, horizontal curvature, road surface, and intersection skew. Methods for prediction of crash frequency by collision type and injury severity also were established.

Results

Comparing the Michigan-specific SPFs across a range of traffic volumes and rural roadway types, researchers discovered several interesting findings. For example, four-lane divided trunklines had greater midblock crash rates for single vehicles than did four-lane undivided and two-lane trunklines. There was little difference for multivehicle midblock crashes across all road types. Two-lane paved county road segments had approximately double the midblock crash rates of trunklines, and gravel county roads had higher crash rates than paved roads of equivalent classification. Notably, data for gravel county roads had not been investigated extensively in previous safety performance modeling research. Generally, three-leg intersections contributed to fewer crashes than four-leg intersections for both stop-controlled and signalized intersections.

Researchers also developed Michigan-specific crash modification factors to adjust crash estimates when site characteristics deviate from the base SPF conditions. For example, wide paved shoulders were associated with fewer crashes across all road types, while lane width did not affect crash occurrence within the typical range of values (10 to 12 feet). An increase in the amount of horizontal curvature on the segment was associated with increases in crash occurrence and crash severity across all rural segment types. Greater driveway density was associated with greater crash occurrence for segments and intersections, although this effect was most pronounced on trunkline segments. Finally, considering four-leg intersections with minor-road stop control, skew angles of greater than 10 degrees were found to increase crash occurrence.

Value

The tools developed in this project will allow MDOT and local agencies to conduct effective safety activities such as network screening and identification of high-risk sites for rural roadways. Combined with

the results from an [earlier study](#) addressing SPFs for intersections and segments on urban trunklines, the tools can be applied either at the state level or within any of MDOT’s seven geographic regions. The project report includes procedures for maintaining and updating Michigan-specific SPFs over time. Through this research and its tools, MDOT and other agencies will better understand the impacts of safety performance and decision-making throughout the state, which will aid in MDOT’s [Toward Zero Deaths](#) highway safety campaign.

Research Administration

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This final report is available online at

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