

JOINT TRANSPORTATION RESEARCH PROGRAM

Principal Investigator: Andrew P. Tarko, Purdue University, tarko@purdue.edu, 765.494.5027

Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp

Sponsor: Indiana Department of Transportation, 765.463.1521

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Analysis and Methods of Improvement of Safety at High-Speed Rural Intersections

Introduction

Since 2006, INDOT has been preparing an annual five-percent report that identifies intersections and segments on Indiana state roads that require attention due to the excessive number and severity of crashes. Many of the identified intersections are two-way, stop-controlled intersections located on high-speed, multi-lane, rural roads. Some contributing design and human factors have been identified, while other factors still await investigation.

Multivariate ordered probit models have been developed to help identify additional factors of the frequency and severity of crashes. These models can estimate how much different factors increase the frequency of crashes at several levels of injury severity (fatal/incapacitating, non-incapacitating/possible, and property-damage-only). They have a unique ability to account for unobserved but common conditions that affect all of the crash severity levels. Recommendations for safety countermeasures are made based on both of these research results and our study of published reports of other authors.

Findings

The statistical analysis was performed on 553 existing intersections in Indiana and 72 existing intersections in Michigan using crash data reported during a four-year period. The identified safety factors include the following: presence of horizontal curves within the intersection vicinity, traffic volume on the major road, land use, population of the area surrounding the intersection, the minor road functional class (traffic volume on minor road unknown), nearby at-grade railroad crossings, intersection conspicuity to drivers on the major road, acceleration lanes for both left and right turns, median width, intersection angle, and number of intersection legs. These results are in line with other research results as documented in the literature review.

Based on the results of this and other studies, recommendations are made to improve safety at new intersections

as well as at existing intersections. For new intersections, construction of medians wider than 80 feet is suggested. Where this is not possible and a narrower median needs to be constructed, adding a parallel acceleration lane for vehicles turning left from the minor road is suggested. Intersections should be placed at a sufficient distance from horizontal curves and from at-grade railroad crossings. Solutions with indirect left-turn lanes (Michigan U-turns, J-turns) are recommended.

At existing intersections experiencing excessive numbers of crashes involving vehicles from the minor road, median closure should be considered or a median opening should be restricted to certain maneuvers. Median acceleration lanes can be added in order to allow a two-stage maneuver for left turns from the minor road. Enhanced guide and warning signage can be used to improve intersection conspicuity; adding road illumination can especially help at night. The practice of adding left- and right-turn bays should be continued as this is a proven intersection safety improvement practice. Applying these countermeasures may help improve safety and avoid the construction of expensive grade separations.

Finally, advanced intersection collision avoidance systems, such as road-side dynamic signs warning drivers on the minor road about a short gap on the major road, should be the subject of pilot studies in Indiana. Experiments in other states have indicated that these systems help drivers choose safe gaps.

Implementation Recommendations

The recommendations for new intersections should be reflected in the Indiana Design Manual to help designers select solutions that may promote safety at high-speed rural intersections. The recommendations for existing intersections can be implemented as a part of the Hazard Elimination Program. The guidelines and tools for safety audits and supporting computer tools (such as RoadHAT) should include these countermeasures among its alternative improvements together with crash reduction factors

and other inputs needed for an economic analysis of the benefits and costs. The below listed countermeasures need before-and-after studies to confirm their effectiveness in increasing safety and to estimate the crash reduction factors to facilitate economic analysis, which is a necessary step in the implementation of these countermeasures:

- Median acceleration lanes
- Indirect left turns (U-turns and J-turns)
- Enhanced intersection approach signage
- Intersection collision avoidance system

References

Tarko, A. P., S. Leckrone, and P. Anastasopoulos. *Analysis and Methods of Improvement of Safety at High-Speed Rural Intersections*. Publication FHWA/IN/JTRP-2012/01. Joint Transportation Research Program, Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2012. DOI: 10.5703/1288284314648

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