Evaluation of the Impact of Reduced Conflict Intersections on Truck and Large Agricultural Vehicle Crashes

tech transfer summary

This study examined intersections in several states where reduced conflict intersections (RCIs) have been implemented to determine whether large truck crash frequency had increased and also .

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RESEARCH PROJECT TITLE
Crash Analysis of Restricted Crossing U-Turn Intersections

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Introduction

Within the US, some states have begun to address rural high speed intersection crashes through physically restricting minor road crossing movements (left and through) which simplifies driver decision making in terms of gap acceptance. These treatments are referred to in Minnesota as reduced conflict intersections (RCIs).

In general, RCIs (also referred to as J-turns or RCUTs) have generally been found to decrease crashes. A study by Inman and Haas (2012) compared crashes for nine intersections in Maryland before and after installation of RCIs. Before and after comparisons of traffic crashes were made for each main intersection of the RCI, the sections between the RCI, and the U-turn locations. An empirical Bayes analysis was conducted and a 62% decrease in crashes after the RCI treatments were installed was reported. Additionally, the authors concluded there was a 70% drop in fatal crashes and a 42% reduction in injury crashes between the 3-year periods of installing the RCIs.

Edara et al. (2013) evaluated RCIs in Missouri. Five intersections where RCIs were installed were compared along with a control site, which had two-way stop control. The authors used an empirical Bayes analysis to show a 34.8% reduction in crash frequency for all crashes and a 53.7% reduction for injury and fatal crashes. Minor injury crashes were reduced by 50% and annual disabling crashes by 86%. An overall 80% reduction in right-angle crashes was noted for the five sites.

Within Minnesota's rural corridors, introduction of the RCI design has been successful in preventing severe crashes; however, the unusual design has been met with some apprehension from operators of agricultural equipment and large trucks. This, in combination with a resistance to the unfamiliar, has created a desire for more information regarding RCI intersection configuration safety impacts for these types of vehicles.

Even though RCIs eliminate right-angle crashes, which are the most severe crossing conflicts at rural high-speed intersections, concerns have been raised that as large trucks are required to make the U-turn maneuver, they are occupying the travel lanes for a longer period of time than would be required for a left-turn or through maneuver from the minor road, and consequently are more exposed to on-coming high-speed vehicles.

Project Goal

The goal of this research was to address concerns with increased exposure of large trucks with the RCI design. The study examined intersections in several states where RCIs have been implemented to determine whether there was an increase in crashes with large trucks.

Study Locations

Crash and traffic data were requested for known known RCI locations in six states: Maryland, Minnesota, Mississippi, Missouri, North Carolina, and Wisconsin. Crash data from four of those states (Maryland, Minnesota, Missouri, and Wisconsin) had the necessary data elements to conduct a simplistic before and after analysis.

Crash data from four of those states had the necessary data elements to conduct a simplistic before and after analysis: Maryland, Minnesota, Missouri, and Wisconsin. Crash data included characteristics such as location, type of vehicle, crash type, crash severity, and sequence of events. Crash data were requested for 300 ft around each intersection before installation of the RCI and from the intersection to 300 ft beyond the new U-turns.

Single-vehicle crashes are not typically intersection crashes and were removed from both before and after data. Truck crashes included any crash in which one or more vehicles were a bus, recreational vehicle, farm vehicle, or large truck (defined as any single unit or larger truck).

The RCI design in Maryland is such that the U-turn location is the nearest intersection. As a result, adjacent RCI intersections were combined when they shared a turning location.

Before and After Analysis of Crash Data

Given that data were limited, a simple before and after analysis was conducted for total crashes and truck crashes to evaluate the impact of installation of the RCIs.

The number of years of available crash data depended on what was provided by the corresponding agency. Data were available for 5 years before RCI installation in all cases. When more than 5 years of data were available, only the 5 years immediately before installation of the RCI were utilized, since long-term trends could not be accounted for. After data were available for 4 to 5 years for slightly less than half of the locations with 1 to 2 years of after data available for the rest.

In some cases, annual average daily traffic was provided. As a result, crashes per year was used as opposed to crashes per some unit of volume. Crashes for the before and after period were divided by the number of years of data available to obtain crashes per year.

Table 1 summarizes the changes in crash frequency observed. Positive values indicate an increase in crashes.

Table 1. Comparison of crashes before and after installation of RCI

State	Site	Years of crash data		Total crashes per year		Truck crashes per year		Change in crashes	
		Before	After	Before	After	Before	After	All	Truck
MD	Site 1 (3 adjacent intersections)	5	5	5.4	7.6	0.4	1.4	2.2	1.0
MD	Site 2	5	5	3.2	0.2	0.0	0.0	-3.0	0.0
MD	Site 3 (2 adjacent intersections)	5	5	8.0	5.0	2.0	3.2	-3.0	1.2
MN	Cologne	5	2	4.4	3.0	1.0	0.5	-1.4	-0.5
MN	Cotton	5	2	2.8	2.0	0.2	1.0	-0.8	0.8
MN	Ham Lake	5	2	4.8	0.0	0.2	0.0	-4.8	-0.2
MN	Wilmar	5	4	3.0	0.0	0.2	0.0	-3.0	-0.2
MO	US 63 and Ponderosa	5	1	3.0	3.0	0.4	0.0	0.0	-0.4
MO	US 63 and Deer Park	5	1	11.2	0.0	1.4	0.0	-11.2	-1.4
MO	US 64 and Honey Creek	5	1	1.8	0.0	0.4	0.0	-1.8	-0.4
MO	US 54 and RE e	5	1	1.4	1.0	0.4	0.0	-0.4	-0.4
MO	MO 13 and Old Mo 13	5	4	3.0	2.5	0.4	0.5	-0.5	0.1
MO	RT M and Old Lemay Ferry Road	5	5	3.4	1.4	0.0	0.0	-2.0	0.0
MO	US 65 and Rochester	5	1	3.4	0.0	0.6	0.0	-3.4	-0.6
WI	US 53 and CTH B	5	2	3.4	1.0	1.8	0.5	-2.4	-1.3

MD=Maryland, MN=Minnesota, MO=Missouri, and WI=Wisconsin

The majority of sites (13 of 15) experienced a decrease in total crashes per year with only one site experiencing an increase in crashes after installation of the RCI (Maryland Site 1, which includes 3 adjacent locations, had an increase of 2.2 crashes per year). US 63 and Ponderosa in Missouri had no change in total crashes. The other locations had decreases ranging from 0.4 to 11.2 crashes per year.

Similarly, the majority of sites experienced a decrease in truck crashes (9 of the 15) with 2 sites having no change and 4 sites having a small increase. Increases of 1.0 and 1.2 crashes per year were noted at the Maryland Site 1 and 3 locations, respectively. One site in Minnesota (Cotton) had an increase of 0.8 crashes. Three additional locations had minor increases or no change. US 53 and CTH B (Wisconsin) had an decrease of 1.3, and US 53 and Deer Park (Missouri) had a decrease of 1.4 truck crashes per year. US 65 and Rochester (Missouri) had a decrease of almost 1 crash per year. Six locations had minor decreases from 0.2 to 0.4 crashes per year.

It should be reiterated that crash data for the after period contains a larger segment of roadway than the before segment. Agencies provided after data for the intersection of interest plus roadway sections extending to the upstream and downstream U-turn locations. Although the team attempted to account for this, the after data may have included crashes that were not intersection crashes.

Analysis of Truck Crash Patterns

One of the main goals of the research was to determine whether the frequency of truck crashes may have increased due to the added exposure of trucks in the oncoming lanes as they complete the U-turn. Truck crash patterns were evaluated for the periods before and after installation of the RCIs. The intent was to identify whether crashes were occurring that may have been a result of increased exposure of trucks in the on-coming travel lane. Several characteristics were explored, including the following:

- Crash type
- Vehicle maneuver
- Contributing circumstance

In a few cases, crash diagrams were available and were examined to determine whether the crash may have been due to a conflict between the turning truck and another vehicle. Any truck crash in the after period where a U-turn or left turn was indicated was flagged because these crashes were the most likely to have been this type of conflict. Unfortunately, the same crash variables were not available for all states, so each state is reported separately.

Maryland

Truck crash patterns for Maryland were examined using collision type, first harmful event, primary cause, vehicle movement, direction, and contributing circumstance. Before installation of RCIs, truck crashes were as follows:

- Primarily right-angle or left-turn
- Commonly attributed to failure to pay attention, failure to yield right of way, or too fast for conditions
- Several same direction sideswipe crashes occurred
- One rear-end crash occurred

After installation of RCIs, truck crashes were as follows:

- Rear-end crashes were the predominant truck crash type
- Same direction sideswipes were also common
- No crashes were coded as having involved a U-turn

Overall, right angle truck crashes were reduced, while rear-end and same-direction-sideswipe crashes were the most common. Both rear-end and sideswipe could be a result of large trucks turning into adjacent lanes; however, in most cases “straight” rather than some type of turn was the primary movement before the crash.

Minnesota

Truck crash patterns in Minnesota were evaluated using crash type, vehicle action, vehicle factor, sequence of events, most harmful events, and primary contributing factor. Before installation of RCIs, truck crashes were as follows:

- Primarily same-direction-sideswipe or right-angle

After installation of RCIs, truck crashes were as follows:

- Same-direction-sideswipe was the predominant truck crash type
- No crashes were coded as having involved a U-turn

Overall, no obvious change in truck crash type was apparent.

Missouri

Missouri truck crash patterns were examined using accident type and sequence of events from the crash data and crash diagrams since individual crash forms were also provided. Before installation of RCIs, truck crashes were as follows:

- Left turn, right angle, rear-end, and passing crashes

After installation of RCIs, truck crashes were as follows:

- Passing crashes were the most common truck crash type
- No crashes were coded as having involved a U-turn

Overall, no obvious change in truck crash type was apparent.

Wisconsin

Wisconsin truck crash patterns were evaluated using crash type, vehicle direction, vehicle movement, vehicle action and driver action. Before installation of RCIs, truck crashes were as follows:

- Angle crashes, head-on or rear-end

After installation of RCIs, truck crashes were as follows:

- Only one truck crash was noted in the after period (rear-end)
- No crashes were coded as having involved a U-turn

Overall, no obvious change in truck crash type was apparent.

Summary

Based on the limited data available, this analysis did not show that the frequency of truck crashes increased after the installation of an RCI. In addition, the installation of the RCI appears to have shifted crash patterns from the more severe right-angle crashes to the less severe rear-end and side-swipe crashes.

Evaluation of truck crash patterns before and after installation of RCIs did not suggest increases in the type of crashes that would have appeared to result from increased truck exposure in the on-coming lanes as trucks completed a U-turn.

The most significant limitation of the results is that only a limited after period (1 to 2 years) was available for a number of the sites. As a result, regression to the mean and short-term crash trends could not be accounted for in the analysis.

Another major limitation is that crashes for a different area of intersection influence exist before and after installation of RCIs. As a result, a larger area of influence was included for the after period and this could lead to an overestimate of the number of crashes in the after period.

References

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Acknowledgments

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