WISCONSIN TRAFFIC OPERATIONS
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Safety Evaluation of Wisconsin Roundabouts: Phase 2

Executive Summary

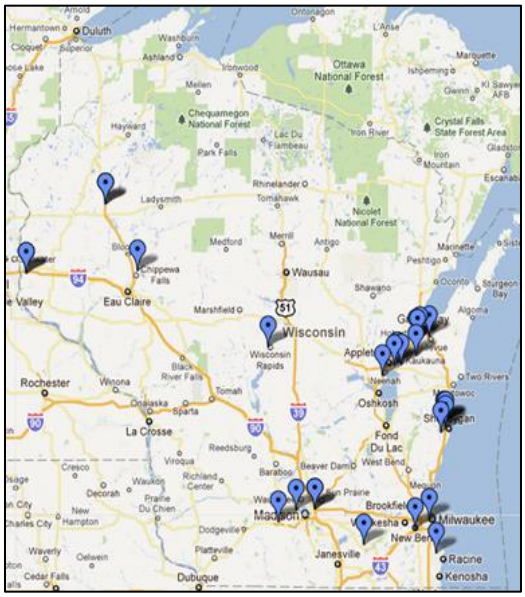
Roundabouts (RABs) are being installed throughout the U.S. at an aggressive pace. The primary reasons for the rapid installation of RABs are the simultaneous operations and safety benefits. Wisconsin is no exception to this national trend, with approximately 150 currently installed on the state system and approximately another 300 installed by the end of the 2015 construction season.

While roundabouts have significant safety benefits, they also can provide significant operational benefits in terms of continuous traffic flow when used under the right conditions. Although roundabouts have been shown to generally reduce both frequency and severity of crashes, in some cases, roundabouts may offer safety tradeoffs similar to other traffic control strategies, i.e., reduce severity of crashes while property damage only (PDO) crashes increase. Such cases are not dissimilar to increases in rear-end crashes after installation of a traffic signal or increase in PDO crashes after installation of a cable median barrier. Therefore, it is important to view safety evaluation of roundabouts in this respect as well.

This document provides an Executive Summary of the key findings from a safety study of existing Wisconsin RABs. A safety study was performed using a 'with and without treatment' analysis methodology to determine the safety benefits gained with Wisconsin RABs. The key findings indicate that RABs continue to provide the intended objective of significantly reducing severe (fatal and injury) crashes at intersections. An important next step is further investigation of the increase in low severity (PDO) crashes to identify potential design improvements and assess the need for additional public outreach on navigational information.

Study Design

- 40 RABs were built with WisDOT oversight in 2008 or before. 30 of the 40 RABs were selected for this analysis.
- 10 RABs were omitted due to either a lack of post-construction data or unique geometry, specifically:
  - 7 RABs were new intersections
  - 2 RABs combined several closely spaced intersections
  - 1 RAB was under construction until 2009
- Crash data were collected for 3 years before and either 3 or 4 years after the RAB installation



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- Traffic volume data were collected before and after the RAB installation
- Crash data obtained during the construction year were omitted
- Statistical methods were applied to make inferences about the safety data, namely the Empirical Bayes and Simple Before/After Crash Analysis methods

Empirical Bayes Crash Analysis

- Crash severity
  - Significant decrease in crash severity
    - 21 of 30 locations had decrease in all injury crashes
    - 0 of 30 locations had fatal crashes after RAB installation
    - 9 of 30 locations had increase in injury crashes. For the 9 RABs, the average annual crash increase was 0.4 crashes per year.
  - Wisconsin RABs had a decrease of 38% for fatal and injury crashes. RABs nationwide have also experienced a significant decrease in severe crashes
- Total crash frequency
  - 13 locations (43%) observed a decrease or no change in total crashes
  - 17 locations (57%) observed an increase in total crashes
    - 5 of the 17 RABs observed increases of 1 to 3 total crashes, or less than 1 per year
    - 3 of 17 RABs contributed to approx. 50% of the total increase in crashes
  - Overall, Wisconsin experienced a 12% increase in crashes across all 30 RABs
- Crash characteristics
  - For total crashes, single lane RABs showed a 4% reduction in crashes while dual lane RABS saw an increase of 27%. For fatal and injury crashes, all types of RABs showed a decrease in crashes.

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Table 1 Roundabout Safety Performance by Number of Lanes

		Single-lane	Multi-lane
	Number of RABs	15	15
Total Crashes	RABs with Increased Crashes	8	9
	RABs with Decreased Crashes	7	6
	Total Expected Crashes	168	344
	Total Observed Crashes	161	411
	% of Changes	4%	-19%
KABC Crashes	RABs with Increased Crashes	7	3
	RABs with Decreased Crashes	8	12
	Total Expected Crashes	55	120
	Total Observed Crashes	37	71
	% of Changes	33%	41%

- For total crashes, a conversion from a two-way stop controlled traffic control to a RAB showed a crash reduction of 5%. While RABs compared to the other traffic control alternatives showed an increase. For fatal and injury crashes, RABs demonstrated a decrease in crashes over all the traffic control alternatives.

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Table 2 Roundabout Safety Performance by Traffic Control Type

		No Control/ Yield	TWSC	AWSC	Signalized
	Number of RABs	2	15	6	7
Total Crashes	**RABs with Increased Crashes**	2	8	4	3
	RABs with Decreased Crashes	0	7	2	4
	Total Expected Crashes	9	196	83	225
	Total Observed Crashes	16	187	118	251
	% of Changes	-75%	5%	-43%	-12%
KABC Crashes	**RABs with Increased Crashes**	0	4	4	2
	RABs with Decreased Crashes	2	11	2	6
	Total Expected Crashes	4	69	30	72
	Total Observed Crashes	1	40	22	45
	% of Changes	76%	42%	26%	37%

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- When examining by region, please note that NC and NW have limited roundabouts so the sample size is small and should not be used to for comparisons.

Table 3 Roundabout Safety Performance by Region

		NC	NE	NW	SE	SW
	Number of RABs	1	16	3	5	5
Total Crashes	RABs with Increased Crashes	1	8	1	4	3
	RABs with Decreased Crashes	0	8	2	1	2
	Total Expected Crashes	16	319	37	51	89
	Total Observed Crashes	27	332	24	66	123
	% of Changes	-64%	-4%	35%	-29%	-38%
KABC Crashes	RABs with Increased Crashes	0	6	1	2	1
	RABs with Decreased Crashes	1	10	2	4	4
	Total Expected Crashes	7	106	12	15	34
	Total Observed Crashes	3	68	7	10	20
	% of Changes	59%	36%	43%	34%	42%

- For total crashes, RABs in rural locations showed a crash reduction of 26%, while urban locations showed an increase of 36% total crashes. For fatal and injury crashes, both urban and rural locations displayed a decrease in crashes.

Table 4 Roundabout Safety Performance by Urban/Rural Location

		Rural	Urban
	Number of RABs	12	18
Total Crashes	RABs with Increased Crashes	4	13
	RABs with Decreased Crashes	8	5
	Total Expected Crashes	201	312
	Total Observed Crashes	149	423
	% of Changes	26%	-36%
KABC Crashes	RABs with Increased Crashes	2	8
	RABs with Decreased Crashes	10	11
	Total Expected Crashes	55	120
	Total Observed Crashes	37	71
	% of Changes	33%	41%

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Simple Before and After Analysis

The crash frequency is classified by crash outcome (K, A, B, C, and PDO). Using a simple before-and-after crash analysis, researchers found that two sites in which fatal crashes were found in the before condition experienced no fatal crashes after the installation of a roundabout. No sites experienced a fatal crash after a roundabout was installed. For all injury (A, B, and C) crashes, the number of locations with a reduction in these crash types was greater than the number of locations with increases in these crash types. Similarly, the magnitude of decrease in injury crashes is higher than the magnitude of increase.

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Table 5 Before and After Crash Data for Wisconsin Roundabouts Built in 2008 or Before

Roundabout	WisDOT Region	Before (three years)						After (four years)					
		K	A	B	C	PDO	Total	K	A	B	C	PDO	Total
STH 54/Gaynor St/17th St	NC			2	6	8	16			2	1	24	27
CTH F/S. Ninth St.	NE			1			1			1	2	4	7
CTH F/Suburban Dr.	NE					2	2				2	1	3
STH 32/57 and STH 96	NE			1		4	5			1	2	9	12
STH 141 / Allouez Ave	NE			1	2	6	9			2	2	17	21
STH 32/STH 57 Broadway	NE		1	2	10	38	51		2	7	19	127	155
STH 55/CTH KK	NE		1	4	4	9	18			1		4	5
Lake Park/Plank Rd (CTH LP/CTH P)	NE					1	1			1		5	6
CTH N / Emons Road	NE			1	3	1	5			5	3	21	29
STH 28/32 (high speed)	NE				1	4	5				1	14	15
STH 42/ I-43, Interchange Ramps (West)*	NE			1	2	7	10			1	4	11	16
STH 42/ I-43, Interchange Ramps (East)*	NE				2	7	9		1	1	1	10	13
STH 42/Vanguard, Wal-Mart entrance	NE				1	1	2			1	1	9	11
Breezewood ln/Tullar Rd	NE				1	2	3			1		10	11
US 53 ramps and CTH O (West)*	NW				1	7	8			1	1	5	7
US 53 ramps and CTH O (East)*	NW					4	4			1	3	5	9
STH 124/CTH S	NW		1	3	7	5	16				1	7	8
Canal St/25th Ave	SE					1	1				2	13	15
STH 38/CTH K	SE			4	5	21	30		2	1	2	23	28
Elkhorn Rd (Bus 12)/Bluff Rd/Clay St	SE		1			1	2					5	5
STH 78/STH 92, 8th St, Springdale, CTH ID	SW			2		15	17				3	28	31
Thompson and Commercial (North)	SW	1	1	3	7	6	18		1		10	45	56
Thompson and STH 30 (South)	SW			1	4	8	13				1	11	12
Old STH 12/Parmenter	SW			1		3	4			1	1	13	15
Roundabout	WisDOT Region	Before (three years)						After (three years)					
		K	A	B	C	PDO	Total	K	A	B	C	PDO	Total
STH EE (Grant St.) & Lawrence Dr.	NE			1	1	5	7			2	1	5	8
USH 10 & CTH N	NE	2	2	8	3	8	23			1		10	11
CTH A (N. Lynndale Dr.) & CTH JJ	NE				1	2	3		1		1	7	9
STH 16 (Wisconsin Ave.) & Walnut. St	SE				4	16	20				2	14	16
STH 74(Main St.)/McLaughlin Rd. & CTH V	SE						0				1	1	2
USH 18 & Bennett Rd.	SW			3	3	2	8			1	2	6	9
Grand Total		3	7	39	68	194	311	0	7	32	69	464	572

Future Research

This research study has shown that the majority of roundabouts installations have led to improvements in traffic safety, especially in terms of crash severity. Although the results show an overall increase in the total number of crashes based on the 30 roundabouts studied in this research, additional research is required to ascertain the exact cause behind this increase. Detailed review of the crashes at some of

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the locations that show a substantial increase in the total number of crashes could reveal further insight into the crash trends and safety issues at such locations, an example of which is presented in Appendix E of the full report. The two trends that were shown in this analysis were: failure to yield to both circulating lanes and wrong lane choice.

Another recommendation is the ability to conduct a study of driver behavior at roundabout locations using incident and near-miss data using video data collection. This method can be used to understand potential safety issues, especially in the immediate period after construction; identify safety concerns; and/or evaluate countermeasures. It is also recommended that this research be continued in the future, with the addition of more locations, to increase the sample size of roundabouts studied in Wisconsin.