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Chapter 5 - Roundabout Safety

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5.1 Roundabout Safety

Typical crash patterns at roundabouts

Exhibits 5-1 and 5-2 identify the most common types of crashes that occur at roundabouts. These crash types are based on data collected outside the United States (principally France but also the United Kingdom and Australia) but are generally transferable to the United States.

Exhibit 5-1 presents a diagram of typical crash types at roundabouts. Exhibit 5-2 presents a summary of the percentage of crashes by collision type as reported in France, Australia, and the United Kingdom to provide guidance on the reported frequencies of each type of crash. The numbered items in the list correspond to the numbers indicated on the diagrams given in Exhibit 5-2 as reported in France. The French data illustrate collision types for a sample of 202 injury crashes from 179 urban and suburban roundabouts in France for the period 1984 to 1988 (CETUR 1992). For comparison purposes, data from Queensland, Australia (Arndt 1998) and the United Kingdom (Maycock and Hall 1984) have been superimposed onto the same classification system.

Exhibit 5-1
Diagram of Crash Types at Roundabouts

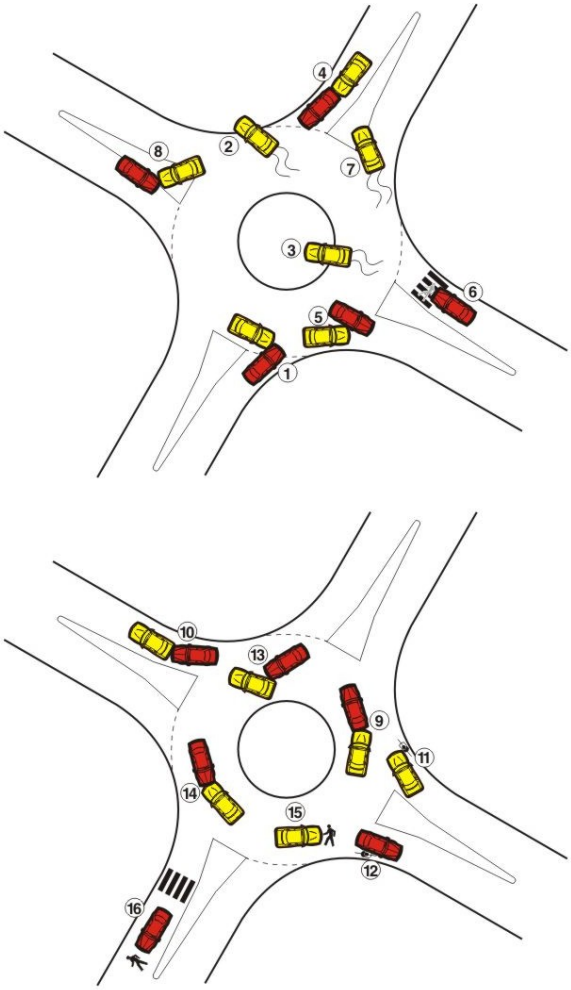

Exhibit 5-2
Comparison of Collision Types at Roundabouts

Collision type	France	Queensland (Australia)	United Kingdom[1]
1. Failure to yield at entry (entering-circulating)	36.6%	50.8%	71.1%
2. Single-vehicle run off the circulatory roadway	16.3%	10.4%	8.2%[2]
3. Single vehicle loss of control at entry	11.4%	5.2%	[2]
4. Rear-end at entry	7.4%	16.9%	7.0%[3]
5. Circulating-exiting	5.9%	6.5%	
6. Pedestrian on crosswalk	5.9%		3.5%[4]
7. Single vehicle loss of control at exit	2.5%	2.6%	[2]
8. Exiting-entering	2.5%		
9. Rear-end in circulatory roadway	0.5%	1.2%	
10. Rear-end at exit	1.0%	0.2%	
11. Passing a bicycle at entry	1.0%		
12. Passing a bicycle at exit	1.0%		
13. Weaving in circulatory roadway	2.5%	2.0%	
14. Wrong direction in circulatory roadway	1.0%		
15. Pedestrian on circulatory roadway	3.5%		[4]
16. Pedestrian at approach outside crosswalk	1.0%		[4]
Other collision types		2.4%	10.2%
Other sideswipe crashes		1.6%	

Notes:

1. Data are for "small" roundabouts (curbed central islands > 4 m [13 ft] diameter, relatively large ratio of inscribed circle diameter to central island size)
2. Reported findings do not distinguish among single-vehicle crashes.
3. Reported findings do not distinguish among approaching crashes.
4. Reported findings do not distinguish among pedestrian crashes.

Sources: France (CETUR 1992), Australia (Arndt 1998), United Kingdom (Maycock and Hall 1984)

Recent Studies

A number of safety studies have been conducted to evaluate the crash experience and safety performance of U.S. roundabouts since the publication of the FHWA Roundabout Guide. These include a study completed by the Insurance Institute for Highway Safety (IIHS) and another by the Maryland State Highway Administration.

Insurance Institute for Highway Safety Study
"Crash Reductions Following Installation of Roundabouts in the United States"

The IIHS study, completed in March 2000, evaluated the changes in motor vehicle crashes following conversion of 24 intersections from stop sign and traffic signal control to modern roundabouts. The settings, located in 8 states, were a mix of urban, suburban, and rural environments. The study categorized the sites into the following categories based on the type of control prior to conversion. The study employed the empirical Bayes methodology to estimate two measures of safety effects of the proposed roundabouts. The first is "index of safety

effectiveness", which is approximately equal to the ratio of the number of crashes occurring after conversion to the number expected had conversion not taken place. The second is the more conventional percent reduction in crashes. The results of the analysis are summarized in Exhibit 5-3.

Exhibit 5-3
Estimates of Safety Effect for Groups of Conversions

Group Characteristic Before Conversion/Jurisdiction	Count of Crashes During Period After Conversion		Crashes Expected During After Period Without Conversion (Standard Deviation)		Index of Effectiveness (Standard Deviation)		Percent Reduction in Crashes	
	All	Injury	All	Injury	All	Injury	All	Injury
Single-lane, Urban, Stop Controlled								
9 Intersections	44	4	112.6 (10.2)	16.6 (2.6)	0.39 (0.07)	0.23 (0.12)	61	77
Single-lane, Rural, Stop Controlled								
5 Intersections	44	5	105.2 (8.4)	26.9 (3.4)	0.42 (0.07)	0.18 (0.09)	58	82
Multilane, Urban, Stop Controlled								
7 Intersections	131	*	153.8 (12.4)	(n/a)*	0.85 (0.10)	(n/a)*	15	(n/a)*
Urban, Signalized								
3 Intersections	73	4	106.7 (10.0)	12.0 (2.5)	0.68 (0.10)	0.32 (0.17)	32	68
All conversions	292	14	478.2 (20.7)	57.8 (5.1)	0.61 (0.04)	0.24 (0.07)	39	76

* Injury data unavailable.

Overall, the empirical Bayes procedure estimated a highly significant 39 percent reduction for all crash severities combined for the 24 converted intersections. Because injury data were not available for the period before construction of the 4 roundabouts in Vail, Colorado, overall estimates for changes in injury crashes are based on the other 20 intersections. The empirical Bayes procedure estimated a highly significant 76 percent reduction for injury crashes for these 20 intersections.

Exhibit 5-3 breaks down the crash results according to the above categories. As expected, the crash reductions are greater for the single-lane roundabouts. This can be attributed to fewer conflict points and easier decision-making process for single-lane roundabouts compared to multilane roundabouts.

Two ongoing projects are expected to significantly expand the information presented in the IIHS study, and both involve research team members common to the IIHS study. First, a study is currently nearing completion for the New York State DOT that increases the number of sites documented in the IIHS work by approximately 40 percent. Additionally, further crash

information will be investigated under the National Cooperative Highway Research Program (NCHRP) project 3-65 (Applying Roundabouts in the U.S.). Essentially, both studies will use the same methodology to update the crash database initiated with the IIHS study.

Maryland State Highway Administration study
"Maryland's Roundabout Accident Experience and Economic Evaluation"

This study looked at the crash experience at all roundabouts constructed by the Maryland State Highway Administration (SHA) prior to September 2002. As of this date, SHA had in operation more than 30 modern roundabouts. Out of this total, 15 single-lane roundabouts had sufficient post-construction data available for analysis, from which the following conclusions were made:

- The average annual crashes fell from an average of 4.05 crashes per year in the before period, to an average of 1.11 crashes per year in the after period, a 73 percent reduction.
- Crash severity also decreased, as injury crashes have shown a reduction from an annual average of 2.31 injury crashes per year in the before period, to an average of 0.35 injury crashes per year in the after period, a reduction of 85 percent.
- The mean total crash rate for the roundabout in the *before* period was 1.36 reported crashes per million vehicles entering (MVE). The mean total crash rate in the *after* period was 0.27 crashes per MVE.
- The mean injury crash rate in the *before* period was 0.79 crashes per MVE. The mean injury crash rate in the *after* period was 0.09 crashes per MVE.

A benefit/cost analysis was conducted for the fifteen single-lane roundabouts. The findings of this analysis are:

- At locations where roundabouts have been installed there has been a 60-percent decrease in the total crash rate and a 100-percent decrease in the fatal crash rate.
- There was an 82-percent reduction in the injury crash rate and a 27-percent reduction in the property damage only crash rate.
- The benefit/cost effectiveness analysis indicated that for every dollar spent on these projects there is a return of approximately eight dollars to be realized through crash reduction.

5.2 References

1. Maycock G., and Hall R.D. *Crashes at four-arm roundabouts.* TRRL Laboratory Report LR 1120. Crowthorne, England: Transport and Road Research Laboratory, 1984.

2. Centre d'Etude des Transports Urbains (CETUR). "Safety of Roundabouts in Urban and Suburban Areas," Paris, 1992.

3. Arndt, O., "Road Design Incorporating Three Fundamental Safety Parameters", Technology Transfer Forum 5 & 6, Transport Technology Division, Main Roads Department, Queensland, Australia, August 1998.

4. Persaud, B.N., R.A. Retting, P.E. Gardner, and D. Lord. "Crash Reductions Following Installation of Roundabouts in the United States". Arlington, VA: Insurance Institute for Highway Safety. March 2000.

5. Maryland State Highway Administration, Office of Traffic and Safety, Traffic Safety Analysis Division. "Maryland's Roundabout Accident Experience and Economic Evaluation". Maryland, December 2002.