14 ISSUE BRIEFS

Roundabouts: A Proven Safety Solution that Reduces the Number and Severity of Intersection Crashes

What is a Modern Roundabout?

A modern roundabout is a circular intersection with specific design and traffic control features that distinguish it from other types of circular intersections. These features include a counterclockwise traffic flow around a central island, yield control for entering traffic, channelized approaches, and appropriate geometric curvature and features to induce desirable vehicular speeds. These features have been proven to reduce the number and severity of intersection crashes.[1]

History of Roundabouts

The "modern roundabout" is commonly confused with older-style traffic circles and rotaries. Traffic circles have been around for over a century, with one of the earliest documented being built in 1905 on the southwest corner of Central Park in New York City and named after Christopher Columbus. From the start, traffic circles provided the ability for a city to tie a number of intersecting streets together and make a landscaped central circle that had aesthetic value to the community. Many large circles or rotaries were built in the United States until the 1950s when they fell out of favor. The older-style rotaries enabled high-speed merging and weaving of vehicles that led to a high crash experience.

The modern roundabout evolved from studies in the United Kingdom of various features to rectify problems associated with older traffic circles. In 1966, the United Kingdom adopted a rule requiring entering traffic to "give way," or yield, to circulating traffic at all circular intersections. This rule prevented circular intersections from locking up by not allowing vehicles to enter the intersection until there were sufficient gaps in circulating traffic.

Since the modern roundabout is significantly different from the older-style traffic circles in both design and operation, they have been used successfully around the world. It is estimated that there are tens of thousands worldwide and more than a thousand installations in the United States to date.

What Users Do Roundabouts Serve?

Roundabouts must be designed to meet the needs of all users—drivers, pedestrians, and bicyclists—each of whom may have varying abilities. Proper site selection and the design of appropriate geometric features and traffic control devices are essential to making roundabouts accessible to all users. Roundabouts can also be designed for trucks and larger vehicles and in geographic areas where significant snowfall is the norm during the winter.

The needs of pedestrians with visual disabilities require particular attention in design. Most pedestrians who cross streets at roundabouts use their vision to identify a crossable gap between vehicles or to detect that a driver has yielded to them. Blind pedestrians rely primarily on auditory information to make judgments when crossing a street.

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1. Robinson, B. W., L. Rodegerdts, W. Scarbrough, W. Kittelson, R. Troutbeck, W. Brilon, L. Bondzio, K. Courage, M. Kyte, J. Mason, A. Flannery, E. Myers, J. Bunker, and G. Jacquemart. *Roundabouts: An Informational Guide*. Report FHWA-RD-00-067. FHWA, U.S. Department of Transportation, June 2000. (This document is being updated, with publication likely in 2010.)

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Recent research suggests that some roundabouts can present significant accessibility challenges and risks to the blind user, both in judging acceptable gaps in traffic and in detecting that a driver has yielded. The U.S. Access Board has published a bulletin[2] that describes strategies that may improve the accessibility of roundabouts to blind pedestrians.

Features of Modern Roundabouts

The design and traffic control features of roundabouts, shown in Figure 1, are as follows:

- Yield control is used on all entries.
- Circulating vehicles have the right of way. All vehicles circulate counterclockwise around a central island.
- Pedestrian access is allowed only across the legs of the roundabout, behind the yield line to the circulatory roadway. Pedestrian crossings are typically located at least one vehicle length upstream of the yield point.
- The splitter island is a raised or painted area on an approach used to separate entering from exiting traffic, deflect and slow entering traffic, and provide storage space for pedestrians crossing the road in two stages.
- Landscaping buffers may be provided to improve the aesthetics of the intersection, better separate vehicular and pedestrian traffic, and encourage pedestrians to cross only at the designated crossing locations.
- All intersections that include pedestrian facilities must comply with accessibility standards as required by the Americans with Disabilities Act (ADA). Accessibility features at roundabouts include sidewalks and crosswalks that meet surface, slope, and clearance requirements; ramps connecting sidewalks and crosswalks; and detectable edge treatments at ramp/roadway boundaries. In situations where there are few crossable gaps, or, at crossings with multiple lanes, some form of pedestrian signalization may be appropriate.

2. United States Access Board. "Pedestrian Access to Modern Roundabouts: Design and Operational Issues for Pedestrians who are Blind." http://www.access-board.gov/research/roundabouts/bulletin.htm.

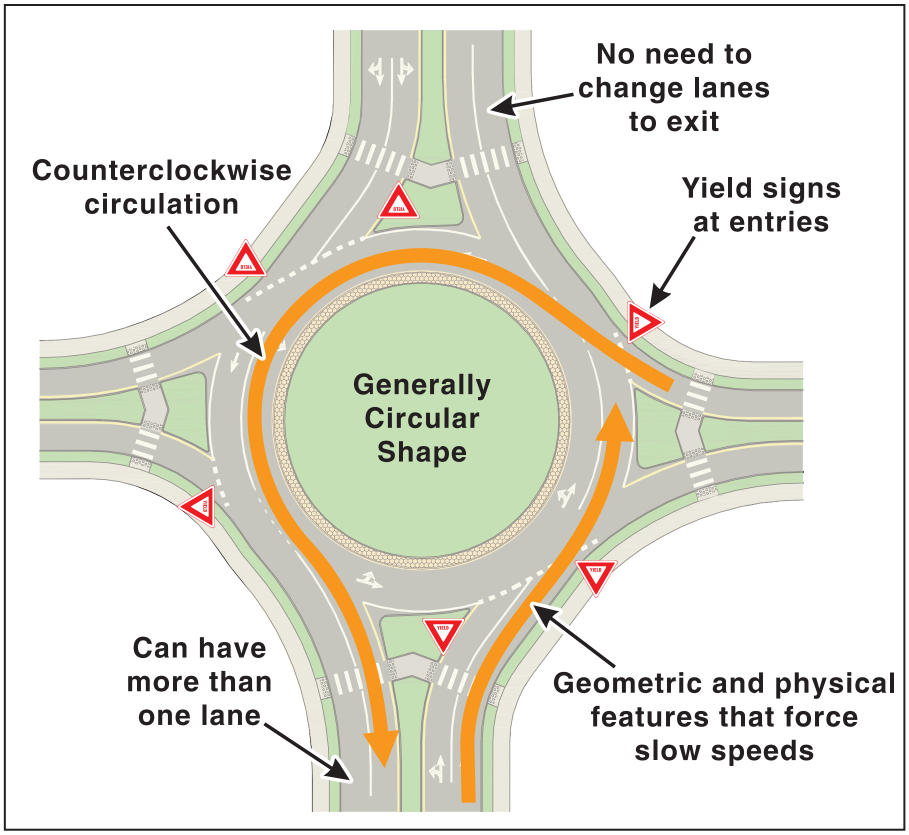

Figure 1. Features of Roundabouts

Roundabout Safety

NCHRP Report 572 examined crash data at 55 sites and reported the estimated change in performance when converting to a roundabout from a variety of intersection types.[3] Table 1 summarizes these findings and presents crash reduction factors (CRFs) and standard errors for each type of control in the before condition. Each CRF is associated with a certain standard error, which is a measure of the accuracy of estimate of the true value of the CRF. A relatively small standard error indicates that a CRF is relatively accurately known. A relatively large standard error indicates that a CRF is not accurately known. The standard error may be used to estimate a confidence interval of the true value of the CRF.

The results shown in Table 1 demonstrate that roundabouts produce a statistically significant reduction in all types of crashes and particularly injury crashes for a variety of conditions. The notable exceptions are the findings for all-way stop-controlled intersections, which demonstrated no statistically significant difference between the safety performance of all-way stop-controlled intersections and that of roundabouts (standard error exceeded the magnitude of the estimate). NCHRP Report 572 also found very few reported crashes involving pedestrians or bicycles, although it did identify conditions that may make crossings more chal-

3. Rodegerdts, L. A., M. Blogg, E. Wemple, E. Myers, M. Kyte, M. Dixon, G. List, A. Flannery, R. Troutbeck, W. Brilon, N. Wu, B. Persaud, C. Lyon, D. Harkey, and E.C. Carter. NCHRP Report 572: *Roundabouts in the United States*. Washington, DC, Transportation Research Board of the National Academies, 2007.

Table 1. Safety Performance Estimates for Intersection Conversions to Roundabouts

Control Before	Crash Severity	Point Estimate of the Percentage Reduction in Crashes (Standard Error)
All Sites (all environments, all number of lanes)	All	35 (3)
	Fatal/Injury	76 (3)
Signalized (all environments, all number of lanes)	All	48 (5)
	Fatal/Injury	78 (6)
All-Way Stop (all environ-ments)	All	No statistically significant change
	Fatal/Injury	No statistically significant change
Two-Way Stop (all environ-ments)	All	44 (4)
	Fatal/Injury	82 (3)
Two-Way Stop (rural only)	All	72 (4)
	Fatal/Injury	87 (3)

lenging, particularly for pedestrians with visual impairments. Further information, including a more detailed breakdown of results by factors such as environment, number of lanes, and so on, can be found in the report.

Fatal crashes at roundabouts are extremely rare events and thus were not a specific focus of the report study. A March 2007 report by the Maryland Highway Administration indicates that 19 single-lane roundabouts with at least 2 years of history since construction (and an average of 6.4 years of history since construction) have experienced a 100 percent reduction in fatal crashes.[4]

These analyses suggest that well designed roundabouts can be safer and more efficient than conventional intersections. Safety considerations and benefits of roundabouts include the following:

- Roundabouts have fewer conflict points in comparison to conventional intersections. The potential for hazardous conflicts, such as high-speed right-angle, left-turn, and head-on crashes, is virtually eliminated by the geometry of a roundabout. Low absolute speeds associated with roundabouts allow users more time to react to one another, thus contributing to fewer and less severe crashes.
- Roundabouts with single-lane approaches produce greater safety benefits than roundabouts with multilane approaches because of fewer potential conflicts between road users. However, roundabouts with multilane approaches show similar improvements in reducing injury crashes.
- Roundabouts in a range of settings (urban, suburban, and rural) result in reduced total and injury crashes when compared to signalized and two-way stop intersections. Safety benefits for installation of roundabouts in rural settings have been found to be particularly significant.
- Recent research has not found substantial safety problems for non-motorists at roundabouts. However, roundabouts have demonstrated challenges related to the accessibility and usability of roundabout crosswalks for pedestrians with visual impairments. Research is being conducted on the effectiveness of a variety of treatments to address this problem. The United States Access Board has issued draft accessibility guidelines stating that, at roundabouts with multilane crossings, a pedestrian-activated signal shall be provided for each segment of each crosswalk, including the splitter island.[5]

Safety Problems Susceptible to Correction by Roundabouts

The decision to install a roundabout as a safety improvement should be based on a demonstrated safety problem of the type susceptible to correction by a roundabout. A review of crash reports and the type of crashes occurring is essential. Some types of crashes, including rear-end crashes and fixed-object crashes, may not improve or

4. Cunningham, R. B. *Maryland's Roundabouts: Accident Experience and Economic Evaluation*. Traffic Development and Support Division, Office of Traffic and Safety, Maryland State Highway Administration, Maryland Department of Transportation, March 2007.

5. United States Access Board. "Revised Draft Guidelines for Accessible Public Rights-of-Way." November 23, 2005. http://www.access-board.gov/prowac/draft.htm (accessed July 2009).

may actually increase with the installation of a roundabout.

Examples of safety problems susceptible to correction by roundabouts include high frequencies of right-angle, head-on, and left-turn/U-turn crashes and high severity that could be reduced by the slower speeds associated with roundabouts.

Issues to Review When Considering Roundabout Alternatives

Roundabouts are an intersection form that is proving to be useful in a variety of settings and circumstances. Roundabouts are not always the most appropriate choice, as other intersection forms may prove to be better options on a case-by-case basis. A common constraint in retrofit situations is right-of-way needs, which may be larger for a roundabout at the intersection corners than for other alternatives. In addition, some higher-volume installations may require larger designs (e.g., 3-lane entries and 3-lane circulatory roadways) that have had limited experience in the United States to date and might be more appropriately addressed with other intersection forms. However, they should at least be considered as an alternative and judged with other alternatives based on objective evaluation criteria (e.g., safety, operational performance, accessibility, environmental impacts, costs, and so forth).

The following issues should be considered during the planning and design of a roundabout:[6]

- **Context.** Is the roundabout the first in a community? Is it being located in a new roadway system, or is it replacing an existing intersection?
- **Space feasibility.** Is there enough right-of-way to build the roundabout? Is right-of-way acquisition required?
- **Physical or geometric complications.** Are there existing buildings, utility conflicts, drainage problems, and/or unfavorable topography that may limit visibility or complicate construction?
- **Significant traffic generators.** Are there generators of significant traffic nearby that could significantly affect the operation of the intersection, including high volumes of oversized trucks, heavy pedestrian traffic, or high bicycle use?
- **Operational considerations.** Is there traffic congestion that would cause routine backups into the roundabout, such as nearby traffic signals? This could include conditions that may require changes in traffic priority rules, such as queue clearance for an at-grade railroad crossing. Note that roundabouts may offer better operational performance than other intersection types, even if there is no significant safety improvement (e.g., comparisons with all-way stop-controlled intersections).
- **Delay to the major street.** Is the subject intersection one between a major arterial and a minor arterial or local road where an unacceptable delay to the major road could be created? Roundabouts introduce some delay to all traffic entering the intersection, including traffic on the major arterial that would not be present if the intersection were operated with two-way stop-control. Likewise, intersections located on arterial streets within a well-coordinated signal network may operate more efficiently as signalized intersections than as roundabouts due to the ability to promote progression of through movements.

Each of these conditions poses challenges for all types of intersections, not just roundabouts. Roundabouts have, in fact, been built at locations that exhibit nearly all of the conditions listed above. Each condition can be typically resolved through careful analysis and design, coordination with and support from other agencies, and potential implementation of specific mitigation actions. An objective comparison of alternatives is essential in aiding good decision making.

6. Robinson, B. W., L. Rodegerdts, W. Scarbrough, W. Kittelson, R. Troutbeck, W. Brilon, L. Bondzio, K. Courage, M. Kyte, J. Mason, A. Flannery, E. Myers, J. Bunker, and G. Jacquemart. *Roundabouts: An Informational Guide*. Report FHWA-RD-00-067. FHWA, U.S. Department of Transportation, June 2000. (This document is being updated, with publication likely in 2010.)