Traffic Engineering and Highway Safety Bulletin

You Should Consider a Roundabout!

March 2010

Did You Know?

Traffic circles have been used in the United States for over 100 years, but there have been very few new installations in the last 50 years because traffic circles are not especially safe or efficient. However, the modern circular intersection, hereafter referred to as a "roundabout," was developed in the United Kingdom in the 1960s to address the problems with traffic circles.

Two key characteristics of any roundabout include:

- ✔ Entering traffic must yield to circulating traffic.
- ✔ Each approach has a splitter island designed to slow traffic and to ensure that all vehicles travel in the proper direction around the central island.

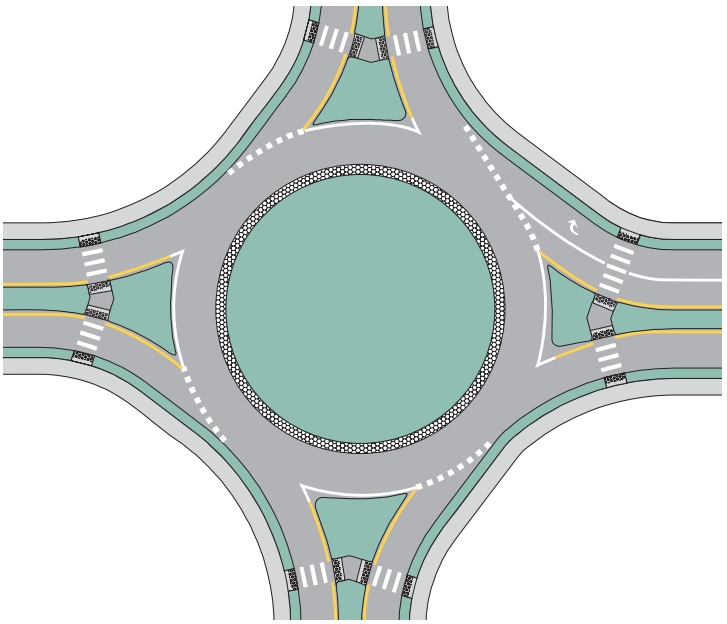
Many studies have shown that roundabouts are safe and effective, and they are now widely used internationally. Perhaps because traffic circles did not work well, in the United States, there has been some reluctance from the public to use roundabouts.

When asked about roundabouts, most unfamiliar drivers in United States say that they do not like them, but after one is constructed locally, the majority of drivers in that area like the roundabout and want more of them.

However, roundabouts are addictive because after an initial installation, local communities typically ask for more. As a result, there are clusters of roundabouts scattered around the United States. It is estimated that there are now over 1,000 roundabouts in the United States, but many smaller countries have a lot more. For example, it is estimated that there are about 20,000 roundabouts in France and 10,000 in the United Kingdom.[1]

[1]Q&As: Roundabouts. Insurance Institute for Highway Safety, Highway Loss Data Institute. Arlington, VA, January 2009.

The purpose of this bulletin is not to inform someone how to design roundabouts, but rather to provide enough information to determine if a roundabout should be considered.



In This Issue...

Did You Know? 1

What's Wrong With This Roundabout? 2

Roundabouts vs. Traffic Circles 2

Advantages of Roundabouts 2

Design Considerations 4

In Conclusion 8

Military Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA)
709 Ward Drive, Building 1990 • Scott Air Force Base, Illinois 62225

David Kirkpatrick • E-mail: david.kirkpatrick@us.army.mil • **Ph:** 618-220-5252 • **DSN:** 770-5252
Tom Mannino • E-mail: thomas.mannino@us.army.mil • **Ph:** 618-220-5249 • **DSN:** 770-5249

Roundabouts can range from a very simplistic single-lane design to complex multilane configurations. Single-lane designs are rather straight forward, but today's multilane configurations are designed so that if drivers enter a roundabout in the correct approach lane they should be able to follow the lane lines to their intended exit roadway without crossing any solid lane lines.

Roundabouts vs. Traffic Circles

Roundabouts are generally smaller than traffic circles and they always have a splitter island to help channelize vehicles and force drivers to travel at a slower speed.

In addition, roundabouts always require entering vehicles to yield to traffic within the circle, which is similar to merging with traffic at a freeway on-ramp.

Traffic within a traffic circle frequently has to weave across high-speed travel lanes, whereas a properly designed roundabout is more structured to avoid lane changing. The bottom line from a driver's point-of-view is that the design and operation of roundabouts are much more consistent than the design and operation of traffic circles.

Other differences are included in Exhibit 1.

> Roundabouts are generally the safest intersection design available. Remember, a Traffic Circle is NOT a Roundabout.

Advantages of Roundabouts

Roundabouts are designed to meet the needs of all road users – drivers, pedestrians, pedestrians with disabilities, and bicyclists. In contrast to traditional intersections, roundabouts eliminate many of the traffic conflicts, such as left turns and crossing conflicts, both of which are significant contributors to the number and severity of crashes. Because traffic enters and exits only through right turns, the number of severe crashes at roundabouts is substantially reduced. Small-angle collisions that may occur as a result of a right-hand turn are typically less severe than other types of collisions.

A list of advantages and disadvantages of roundabouts is included as Exhibit 2.

In United States, 45 percent of all crashes occur at intersections. However, research shows that converting an existing intersection to a roundabout typically results in a 35 percent reduction in the number of crashes and a 76 percent reduction in the number of injury crashes.[2] In addition, many researchers believe that United States is still on the learning curve because crash rates in United States are higher than in other countries where roundabouts are more common.

As illustrated in Exhibit 3, the number of vehicle-to-vehicle conflict points for a single-lane roundabout is only 25 percent of the number at a conventional intersection. Perhaps even more important, the roundabout does not have any crossing conflicts, the type of conflict that causes the dangerous, side-impact type crashes. Therefore, the safety record for roundabouts is not a fluke.

[2]NCHRP Report 572, Transportation Research Board, 2007, Table 28.

Exhibit 1: Differences between Roundabouts and Traffic Circles

Element	Roundabout	Traffic Circle
Traffic Control	YIELD signs are used on all approach roadways circulating vehicles always have the right of way. Merging is similar to a freeway on-ramp, but at a much slower speed.	Some circles use STOP signs on some approaches and no control on other approaches, and some use STOP or YIELD signs within the circle.
Deflection	A splitter island is used on all approaches to slow traffic and to ensure that traffic goes to the right.	Traffic typically enters the circle at a right angle.
Pedestrians	Pedestrians can only cross the approach legs, at a distance of at least one car length from the circulatory roadway.	Some circles have sidewalks across or on the outer edge of the central island.
Parking	Parking is not allowed within the circulatory roadway or near the splitter islands.	Parking is sometimes allowed within a circle.

Exhibit 2: Roundabouts vs. Other Types of Intersections

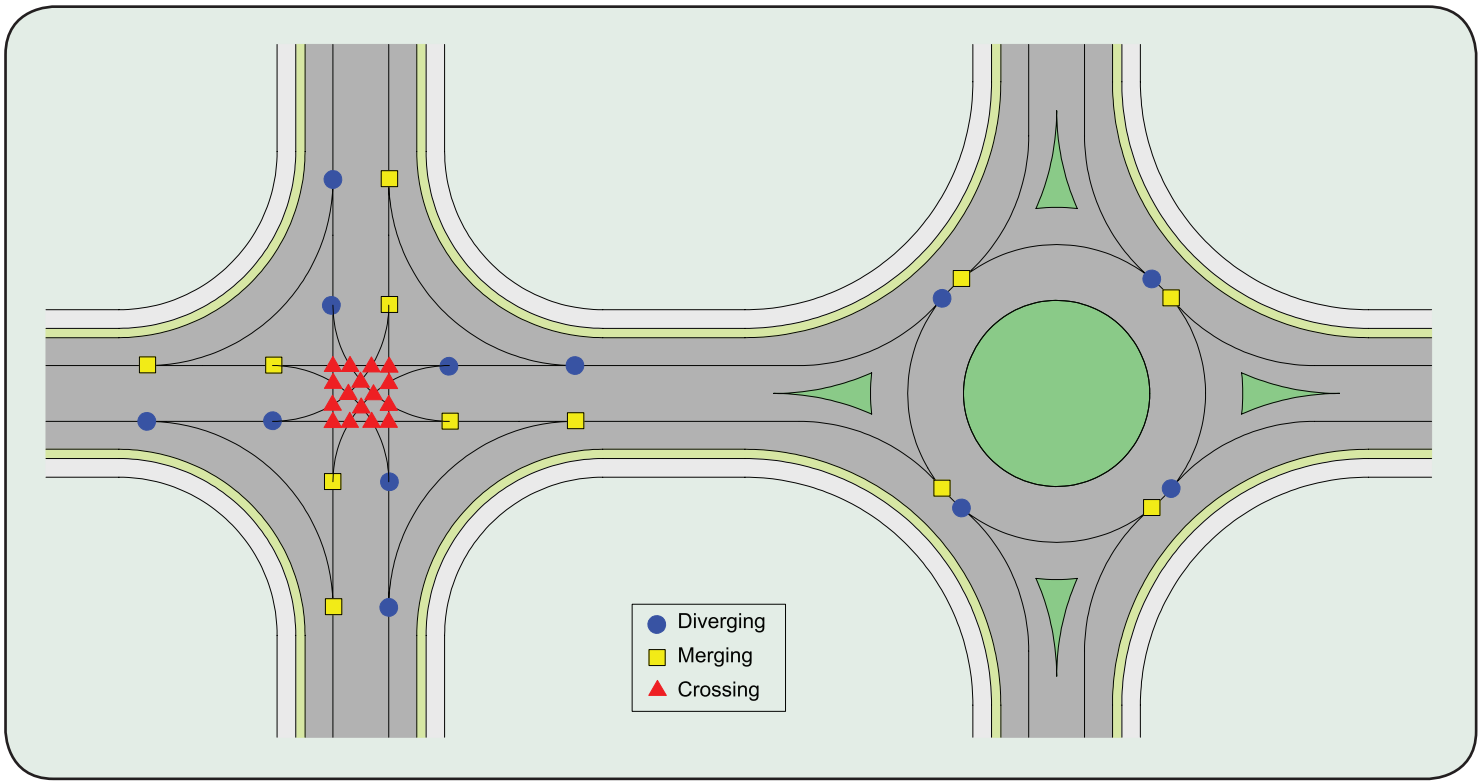
Advantages:

- ✔ Fewer and less serious crashes.
- ✔ Improves safety for pedestrians – the splitter island provides a refuge for pedestrians to allow a two-stage crossing, with each stage crossing a one-way roadway.
- ✔ Can be used for speed control, especially speed mitigation at Entry Control Facilities.
- ✔ Improves traffic flow with fewer stops.
- ✔ Accommodates U-turns, even for larger trucks.
- ✔ Safely operates during power outages.
- ✔ No overhead traffic signals to hinder over-height loads.
- ✔ Facilitates the junction of more than four roadway approaches.
- ✔ Can easily be designed to prohibit exiting at an intersection leg with turn prohibitions.
- ✔ Unlike signalized intersections, storage lanes are not required.
- ✔ Simplifies the driver decisions when entering an intersection because all traffic is coming from the left (this is especially helpful for older drivers).
- ✔ From an environmental standpoint – improves air quality, reduces energy consumption, requires fewer travel lanes, and provides more landscaping opportunities.

Disadvantages:

- ✔ May require a larger intersection footprint.
- ✔ May require pedestrians to walk a greater distance.
- ✔ Cannot assign a priority to a specific roadway – roundabouts treat all approaches equally.
- ✔ Unfamiliar drivers may find roundabouts confusing.
- ✔ It may cost more to convert a stop-controlled intersection to a roundabout than to a signalized intersection, unless a signalized intersection requires a lot of widening for turning and storage lanes.

Exhibit 3: Comparison of Conflict Points



The number of conflict points for pedestrians is also reduced by at least 50 percent, and pedestrians only need to cross one direction of traffic at a time. Therefore, safety benefits are not just for vehicles, but also for pedestrians.

The only intersection traffic control that is approximately as safe as a roundabout is a multiway stop intersection. However, multiway stop intersections have less capacity, more delay, many negative environmental consequences, and create disrespect for STOP signs.

In addition to safety, efficiency is another major benefit of roundabouts. Many studies have documented reductions in delay, unnecessary stops, fuel consumption, emissions, and energy usage.

Design Considerations

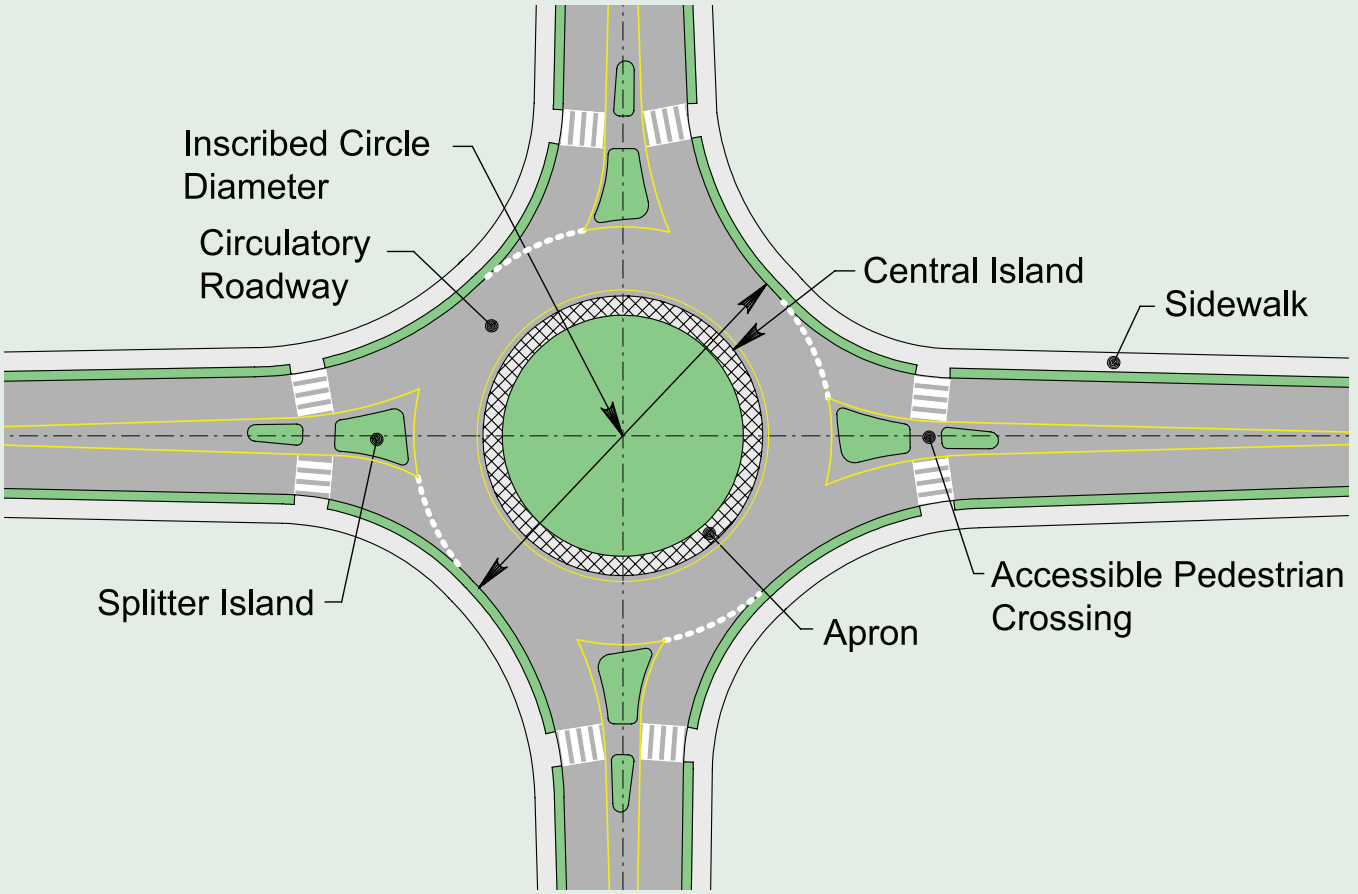
The design of a roundabout is essentially a reiterate process that should only be done by a professional with a thorough knowledge of roundabouts. Among other references, the designer should consult FHWA's book entitled Roundabouts: An Information Guide (Publication FHWA-RD-00-067), June 2007.

With reference to Exhibit 4 and the definitions, the splitter island must be of sufficient length to accommodate pedestrians, curved to slow and deflect approaching traffic, and aligned with the central island. The width of the splitter island should not be so wide that it encourages high speeds. Moreover, traffic signs and pavement markings must act in concert to ensure safety.

Size – The basic term used to reflect the size of a roundabout is the inscribed circle diameter, which is the measurement between opposite outer edges of the circulatory roadway. This diameter is based on the design speed and the number of lanes in the circulatory roadway – as the design speed or the number of circulatory lanes increase, the inscribed circle diameter should also increase.

The recommended design speed within the circulatory roadway is a function of the speed of approaching vehicles when they are 300 or 350 feet from the center of the roundabout. For vehicles approaching at about 45 mph, the design speed should be about 50 percent of the approach speed (or 22.5 mph) and for vehicles approaching at 25 mph the design speed should be about 62 percent of the approach speed (or about 15.5 mph). If the approach roadways have different approach speeds, the roundabout should be designed for the higher speed. Design speeds for the merge point and at the exit point may be slightly higher than the design speed on the circulatory roadway.

Exhibit 4: Key Roundabout Features



Definitions

Apron – When used, it is the outer portion of the central island that is designed for off-tracking of the rear wheels of trucks, buses and tractor trailers. This portion of the central island must be able to physically accommodate these large vehicles, but it should be raised above the roadway and have a rough texture to discourage other vehicles from using it.

Central Island – The raised area in the center of the roundabout, around which traffic circulates.

Circulatory Roadway – The curved path available for use by vehicles to travel in a counter-clockwise direction around the central island.

Inscribed Circle Diameter – The basic term used to describe the size of a roundabout. It is the minimum measurement between opposite outer edges of the circulatory roadway.

Splitter Island – The raised island on an approach to the circulatory roadway that separates entering traffic from exiting traffic, deflects and slows entering traffic, and provides a refuge for pedestrians.

The capacity of a one-lane roundabout is approximately 20,000 vehicles per day; therefore, if the volumes are greater than that, additional lanes generally will be required. However, the capacity is highly depended upon the traffic volumes during the peak hours, specifically the distribution of the volumes across the approaches and whether vehicles are making left-turns, right-turns, U-turns, or straight-through movements.

In an urban environment, the inscribed circle diameter typically would be about 100 to 130 feet for a single-lane roundabout, and 150 to 180 feet for a double-lane roundabout. Additional area is also needed outside of the inscribed circle for sidewalks.

The capacity of a roundabout is directly related to the turning movements. The highest capacity would occur if all approaches had the same volume and everyone wanted to make a right turn. On the other hand, the worst scenario would be if everyone wanted to make a U-turn.

Alignment – Ideally, the centerline of each roadway leg should pass through the center of the inscribed circle so that entry and exiting speeds are balanced and the central island is conspicuous to approaching drivers.

Central Island Shape – Although most central islands are round, other shapes include:

- ✔ Elliptical.
- ✔ Tear-shaped, especially if one-way roads are involved.
- ✔ Turbo-shaped with push outs to emphasize the beginning of left-turn lanes.

For example, the central island in Exhibit 5 could be expanded outward to include the yellow crosshatched areas on the bottom and right sides of the central island to force drivers to spiral outward so that they are not accidentally trapped in an added left-turn lane.

Things that may affect the shape of the central island include: the number and alignment of the approach roadways; the number of lanes on each approach; the presence of exclusive left-turn or right-turn lanes; and the presence of one-way roads.

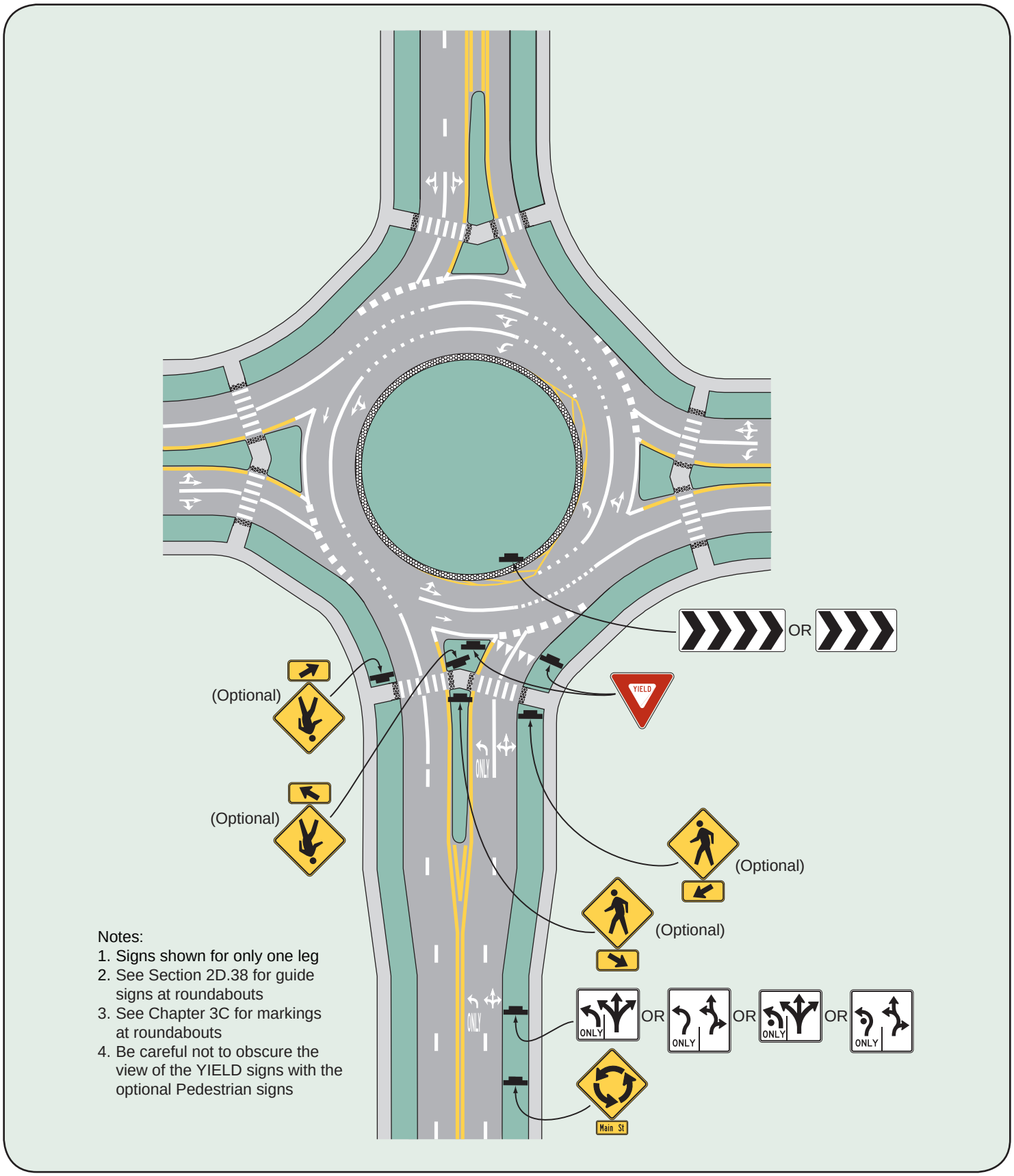
Pedestrians – Pedestrians should be accommodated on the outside of the circulatory roadway and across the splitter island. The most common crossing is a bent crosswalk to make the crossing as short as possible (see Exhibit 5). The *MUTCD* states that crosswalks should be located a minimum of 20 feet from the edge of the circulatory roadway, but we recommend a minimum of 25 feet in advance of any yield line.

What's Wrong With This Roundabout?

- ✔ The splitter islands are too wide, which encourages higher speeds.
- ✔ Sidewalks should be continuous and crosswalks should cross each splitter island.
- ✔ Ideally, pavement markings should define the islands and the merge point.
- ✔ Missing signs include an advance Circular Intersection (W2-6) symbol sign, and the new black-and-white Roundabout Directional Arrow within the central island as included in the 2009 *MUTCD* (see Exhibit 5).
- ✔ A Keep Right (R4-7) sign is also desirable at the beginning of the splitter island because there are no center line pavement markings.

continued on page 7

Exhibit 5: Sample Design for a Multilane Roundabout



Source: Figure 2B-23 of the 2009 MUTCD*, with modifications*

Bicyclists – Cycling through a roundabout should be safer than through a conventional intersection because:

- ✔ Travel speeds are generally lower, and
- ✔ Cyclists can normally merge with other traffic without stopping.

Trucks and Other Large Vehicles – It is important to design roundabouts to accommodate the largest trucks, buses and tractor-trailers that will be using the intersection. These vehicles can be accommodated by using an apron on the outer portion of the central island. To help prevent smaller vehicles from driving on this part of the central island, the surface of the apron can be raised.

Multilane Roundabouts – The design of multilane roundabouts is more critical than the design of single-lane roundabouts. Specifically, it is essential that the roundabout be designed so that if drivers enter the roundabout in the correct approach lane they will be able to follow the lane lines to their exit roadway without crossing any solid lane lines.

Exhibit 5 illustrates a multilane roundabout with several different lane assignments. Lane assignments should be custom designed for each intersection, based on the design-hour traffic volumes. The lanes on each approach should always line up with the lanes in the circulatory roadway.

Signs and Markings – Signs and pavement markings on the approaches and on the circulatory roadway should be compatible with each other to provide a consistent message. See Sections 2B.43, 2B.44, 2B.45 and 2D.38, and Chapter 3C of the 2009 *MUTCD* for additional design details. In additions, review the various examples of roundabouts in Chapter 2C.

In Conclusion

Studies show that roundabouts:

- ✔ Are safe and efficient.
- ✔ Are environmentally friendly.
- ✔ Reduce travel speeds.
- ✔ Provide for landscaping and beautification.
- ✔ Are contagious.

Therefore, everyone will be seeing more of them in the future, so why not consider them at your military installation?

Please contact SDDCTEA for more information. SDDCTEA is available to assist in traffic engineering studies such as roundabout concepts and design, SMART-design of entry gate alternatives, and crash location enhancement studies. We can also help with your sign maintenance program.

Contact Us

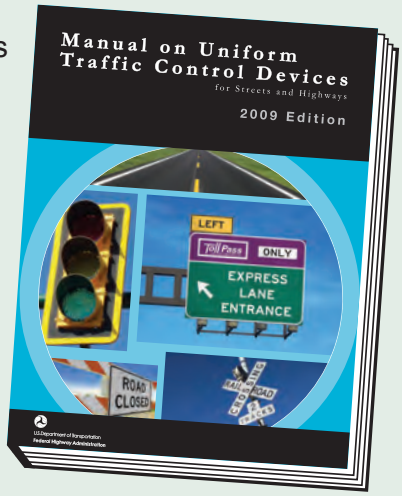
David Kirkpatrick
E-mail: david.kirkpatrick@us.army.mil
Phone: 618-220-5252

Tom Mannino, P.E., PTOE
E-mail: thomas.mannino@us.army.mil
Phone: 618-220-5249

Military Surface Deployment and Distribution Command
Transportation Engineering Agency
709 Ward Drive, Building 1990
Scott Air Force Base, Illinois 62225
DSN: 770-5252
Fax: 618-220-5125
E-mail: sddc.safb.traffic@us.army.mil

Web Site: www.tea.army.mil for pamphlets, bulletins and studies

Check it Out!



Military installations are required to follow the Federal Highway Administration's (FHWA's) *Manual on Uniform Traffic Control Devices* (*MUTCD*). The 2009 *MUTCD* was published in December 2009 and is available at www.mutcd.fhwa.dot.gov.

The 2009 *MUTCD* has more information and detail than the previous versions. Some of the changes include:

1. The sheer volume of the manual was greatly increased with many new signs, symbols and figures. FHWA attempted to incorporate many localized practices used across United States.
2. Paragraph numbers were added to assist users when referencing the *MUTCD*.
3. Only English units of measurement were used to help eliminate some of the previous redundancy.
4. Over 20 new figures for roundabouts were added, including a new Chapter 3C that addresses pavement markings at roundabouts.

5. Provisions for area-wide speed limits such as citywide and neighborhood speed limits. This provision has application on military installations, and when used it should reduce the total number of speed limit signs.
6. A new symbol Turning Vehicles Must Yield to Pedestrians sign was added to help improve pedestrian safety.
7. Barricades and gates are regulatory devices and were placed in Chapter 2B with regulatory signs (Sections 2B.67 and 2B.68, respectively). The stripes on all barricades and gates must now be vertical instead of diagonal when used outside of areas with temporary traffic control (i.e., work zone). Obviously, this has ramifications at all military installations. This new vertical orientation also applies for gates at highway-rail grade crossings.
8. The minimum size of warning signs on multilane roads was increased to 36"x36".
9. A requirement to use the combination of lower-case letters with an initial capital letter for the names of all places, streets and roads when used on guide signs. For destination signs, it is now recommended that horizontal lines be used between places with different directions (see the illustration).
10. Community Wayfinding signs were added as Section 2D.50, and this could have application on military installations (see the illustration).

11. Toll Road signs were added as Chapter 2F, including signs with new purple backgrounds that have application for entry control facilities (ECFs) with electronic card readers.
12. Addition of U-turn traffic signal arrow indications, and flashing red traffic signal arrows, including the red U-turn arrow.
13. To enhance the visibility of traffic signals, 12-inch signal indications are now required for new signals on roads with a speed limit greater than 30 mph, and backplates are recommended on roads with a speed of 45 mph or greater. Yellow retroreflective strips may be used to outline the backplates.

Mr. Curt Zargani
Acting Director, SDDCTEA

DEPARTMENT OF THE ARMY
Military Surface Deployment and
Distribution Command Transportation
Engineering Agency
709 Ward Drive
Building 1990
Scott Air Force Base, Illinois 62225

OFFICIAL BUSINESS

Reference List

- ✔ U.S. Department of Transportation, Federal Highway Administration. Roundabouts: An Informational Guide, FHWA-RD-00-067. Washington, D.C., June 2000 (www.tfhrc.gov/safety/00068.htm).
- ✔ Transportation Research Board. Roundabouts in the United States, NCHRP Report 572. Washington, D.C., 2007 (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_572.pdf).
- ✔ Insurance Institute for Highway Safety. Q&As: Roundabouts, January 2009 (www.iihs.org/research/qanda/roundabouts.html).
- ✔ U.S. Department of Transportation, Federal Highway Administration. Manual on Uniform Traffic Control Devices. Washington, D.C., 2009 Edition (www.mutcd.fhwa.dot.gov).
- ✔ Institute of Transportation Engineers. Traffic Engineering Handbook. Washington D.C., 2009.
- ✔ www.fhwa.dot.gov
- ✔ www.tea.army.mil
- ✔ www.ite.org

Training

Continuing Education	Phone	Web Site
Pennsylvania State University;		
The Pennsylvania Transportation Institute	(814) 865-4700	www.pti.psu.edu
University of Maryland;		
Md. Transportation Technology Transfer Center	(301) 403-4623	www.ence.umd.edu/tttc
Georgia Institute of Technology	(404) 385-3501	www.gatech.edu
Northwestern University Center for Public Safety	(800) 323-4011	www.northwestern.edu/nucps/index.htm
Texas A&M University	(979) 845-3211	www.tamu.edu
University of Washington; College of Engineering	(206) 543-2100	www.engr.washington.edu/epp

Prepared with the assistance of Gannett Fleming
Your Trusted Advisor Since 1915