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1320.01 General

Modern roundabouts are near-circular intersections at grade. They are an effective intersection type with fewer conflict points and lower speeds, and they provide for easier decision making than conventional intersections. They also require less maintenance than traffic signals. Well-designed roundabouts have been found to reduce crashes (especially fatal and severe injury collisions), traffic delays, fuel consumption, and air pollution. They also have a traffic-calming effect by reducing vehicle speeds using geometric design rather than relying solely on traffic control devices.

Roundabout design is an iterative process. A well-designed roundabout achieves a balance of safety and efficiency. Good design is a process of creating the smooth curvature, channelization, and deflection required to achieve consistent speeds, well-marked lane paths, and appropriate sight distance.



The guidance in this chapter assumes that a roundabout-type intersection has been determined to be the best intersection design for your particular project based on the process completed in [Chapter 1300](#).

1320.02 References

1320.02(1) Federal/State Laws and Codes

Americans with Disabilities Act of 1990 (ADA)

[Revised Code of Washington \(RCW\) 47.05.021](#), Functional classification of highways

[Washington Administrative Code \(WAC\) 468-58-080](#), Guides for control of access on crossroads and interchange ramps

1320.02(2) Design Guidance

ADA Standards for Accessible Design, U.S. Department of Justice

<http://www.ada.gov/>

Local Agency Guidelines (LAG), M 36-63, WSDOT

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA, as adopted and modified by Chapter [468-95 WAC](#) “Manual on uniform traffic control devices for streets and highways” (MUTCD)

Revised Draft Guidelines for Accessible Public Rights-of-Way (PROWAG), November 23, 2005, U.S. Access Board. The current best practices for evaluation and design of pedestrian facilities in the public right of way per the following FHWA Memoranda:

<http://www.access-board.gov/prowac/draft.htm>

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT

1320.02(3) Supporting Information

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO

“Crash Reductions Following Installation of Roundabouts in the United States,” Insurance Institute for Highway Safety, March 2000

https://www.dot.ny.gov/main/roundabouts/files/insurance_report.pdf

Roundabouts: An Informational Guide, NCHRP Report 672, Transportation Research Board, 2010

Roundabouts in the United States, NCHRP Synthesis 572, Transportation Research Board, 2007

Highway Capacity Manual (HCM), Special Report 209, Transportation Research Board, National Research Council

Modern Roundabout Practice in the United States, NCHRP Synthesis 264, Transportation Research Board, 1998

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_264.pdf

Roundabouts: An Informational Guide, FHWA-RD-00-067, USDOT, FHWA

<http://www.fhwa.dot.gov/publications/research/safety/00067/index.cfm>

Understanding Flexibility in Transportation Design – Washington, WSDOT, 2005

www.wsdot.wa.gov/research/reports/600/638.1.htm

1320.03 Roundabout Types

There are four basic roundabout types: mini, single-lane, multilane, and teardrop.

1320.03(1) *Mini-Roundabouts*

Mini-roundabouts are small single-lane roundabouts generally used in 25 mph or less urban/suburban environments. Because of this, mini-roundabouts are typically not suitable for use on higher-volume (greater than 6,000 AADT) state routes. In retrofit applications, mini-roundabouts are relatively inexpensive because they normally require minimal additional pavement at the intersecting roads. A 2-inch mountable curb for the splitter islands and the central island is desirable because larger vehicles might be required to cross over it.

A common application is to replace a stop-controlled or uncontrolled intersection with a mini-roundabout to reduce delay and increase capacity. With mini roundabouts, the existing curb and sidewalk at the intersection can sometimes be left in place.



1320.03(2) *Single-Lane Roundabouts*

Single-lane roundabouts have single-lane entries at all legs and one circulating lane. They typically have mountable raised splitter islands, a mountable truck apron, and a central island, which is typically landscaped.



1320.03(3) *Multilane Roundabouts*

Multilane roundabouts have at least one entry or exit with two or more lanes and more than one circulating lane. The operational practice for trucks negotiating roundabouts is to encroach on adjacent lanes.



1320.03(4) *Teardrop Roundabout*

Teardrops are usually associated with ramp terminals at interchanges: typically, at diamond interchanges. Teardrop roundabouts allow the “wide node, narrow link” concept. Unlike circular roundabouts, teardrops do not allow for continuous 360° travel. This design offers some advantages at interchanges. Traffic traveling on the crossroad (link) between ramp terminal intersections (nodes) does not encounter a yield as it enters the teardrop intersections. Because this improves traffic throughput on the crossroad between the ramps, it reduces the need for additional lane capacity, thus keeping the cross section between the ramp terminals as narrow as possible.



1320.04 Capacity Analysis

Use the capacity analysis that was completed as part of the Intersection Control Analysis (see [Chapter 1300](#)) to verify the number of lanes required for every individual movement in the design year.

1320.05 Geometric Design

1320.05(1) *Selecting Shape and Location*

Roundabout shape is one of the most important decisions a designer makes, because the shape can affect design elements that affect safety performance and operation of the roundabout. The desirable shape of a roundabout is circular. But sometimes a circular shape is not feasible because of specific needs or constraints; in which case, consider a noncircular shape. Sometimes a circular shape can still be used by slightly offsetting the roundabout. The designer needs to understand the actual constraints and needs.

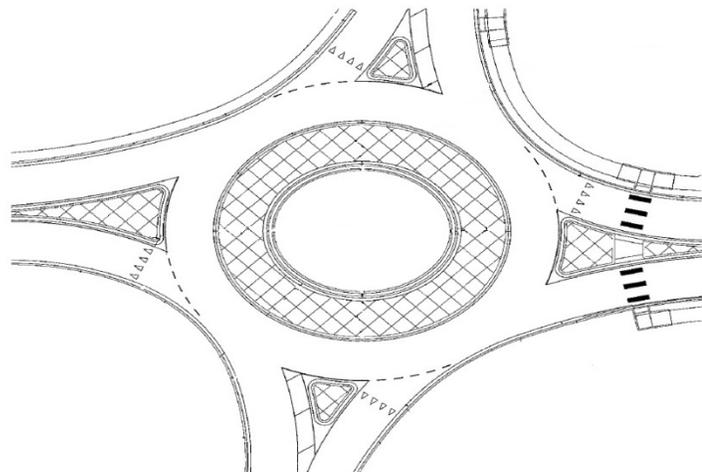


1320.05(1)(a) Circular

The circular shape is the most desirable roundabout shape to be used when constraints allow. If a circular shape is not feasible, contact the region Traffic Office to investigate other shapes.

1320.05(1)(b) Oval (elliptical)

An oval or elliptical roundabout is a good choice when constraints such as right of way, existing roadway alignments, buildings, and/or wetlands influence the shape. The designer should experiment with different roundabout sizes and radii, and use the design vehicle turning software (such as AutoTURN[®]) to refine the oval shape to find the best operation while retaining lower speeds.

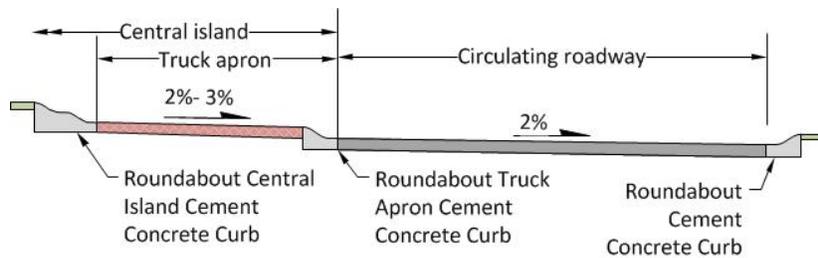


1320.05(1)(c) Racetrack

The racetrack is a successful shape when the main line right of way is very constrained and driveways are attached to the circulating roadway. Special care is needed to design the deflection and travel paths to keep entrance and circulating speeds acceptable for a roundabout.



1320.05(2) Roundabout Elements



1320.05(2)(a) Circulatory Roadway

The selection of the circulation roadway radius is important because it defines the base speed of the roundabout. The design vehicle turning path and width of the entries determine the circulatory roadway.

1320.05(2)(b) Truck Apron

A truck apron will be wider, or narrower, based on the needs of the design vehicle. Using turn simulation software (such as AutoTURN[®]) allows a designer to fine tune the amount of apron needed, so as not to design an apron that won't be used. The apron color should be easily distinguishable from the circulating roadway and pedestrian facilities. Work with the region Landscape Architect (HQ Roadside and Site Development Section for regions without a Landscape Architect) for concrete color and texture.

1320.05(2)(c) Central Island

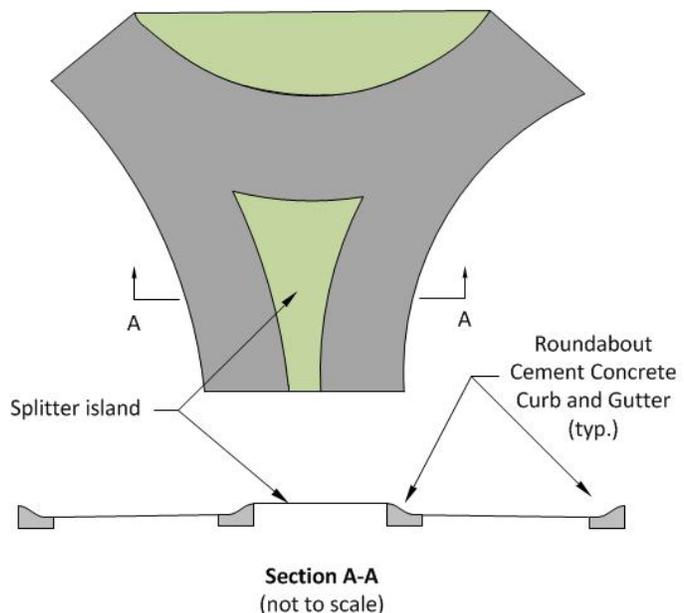
The central island is the portion of the roundabout that is inside of the circulating roadway and typically includes an inside truck apron and a landscaped area. Central island shape is a function of the site-specific needs of a roundabout intersection. It doesn't have to be an identical shape of inscribed circle diameter (ICD) dimensions, but should support the design principles of deflection and low speeds, and the accommodation of the design vehicle.

Roundabouts present opportunities to create community focal points, landscaping, and other gateway features within an intersection form that is also safe and efficient. The central island may include enhancements (such as landscaping, sculptures, or fountains), which serve both an aesthetic purpose and provide conspicuity of the intersection for approaching motorists. These treatments should not attract pedestrians to the central island, as they should never cross the circulating roadway.

1320.05(2)(d) Splitter Island

1. Channelization

Raised channelization, or the appearance of raised curbing, is important, as research shows that drivers will slow down when they perceive that the driving width is narrowing. This is accomplished for a set distance based on approach speeds. The distance will vary based on the site-specific operational speeds and terrain and the desired entry speed, which is usually 20–25 mph. (See [1320.05\(3\)\(a\)](#) for using chicanes on higher-speed roadways.)



1320.05(2)(e) Inscribed Circle Diameter (ICD)

The overall outside diameter of a roundabout is determined by two variables (design vehicle and design speed) and the number of circulatory lanes.

The ranges of ICD in [Exhibit 1320-1](#) are only suggestions to start a roundabout design. The ICD for noncircular shapes should be defined with dimensions along the X and Y axis.

Design Element	Mini ^[1]	Single-Lane	Multilane
Number of Lanes	1	1	2+
Inscribed Circle Diameter ^[2]	45'–80'	80'–150' ^[3]	135'
Circulating Roadway Width	N/A	14'–19'	29'
Entry Widths	N/A	16'–18'	25'
Notes:			
[1] Reserved for urban/suburban intersections with a 25 mph or less posted speed.			
[2] The given diameters assume a circular roundabout; adjust accordingly for other shapes.			
[3] Inscribed circle diameters of less than 100 feet may not be appropriate on a state route.			

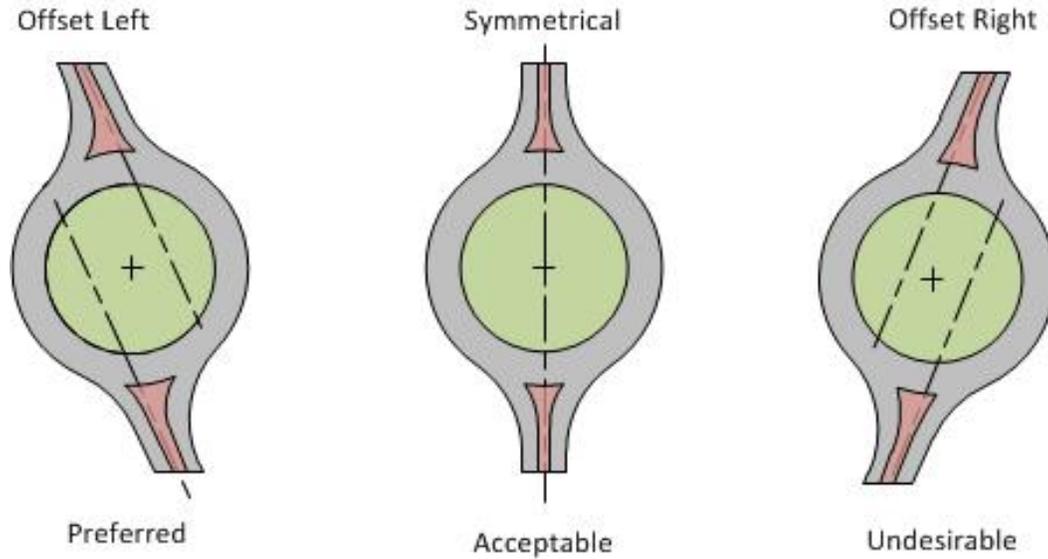
Suggested Initial Design Ranges*Exhibit 1320-1***1320.05(2)(f) Entry****1. Deflection**

Ideal alignment offers an entry design that provides deflection, speed control, and reasonable view angles to drivers while balancing property impacts and costs. While most intersections are at 90° angles and most through movements are straight, deflection contributes to the safety performance of a roundabout. Deflection is primarily achieved by placing a central island and supporting it with splitter islands on both the entries to the roundabout.

2. Alignment Offset

There are three choices for attaching entry legs to the circulatory roadway:

- The offset left alignment constrains the entry, slowing vehicles, and opens up the exit for efficient egress.
- The offset right alignment tends to allow faster entry and constrains the exit.
- The symmetrical alignment (if needed) is acceptable for slower speeds.

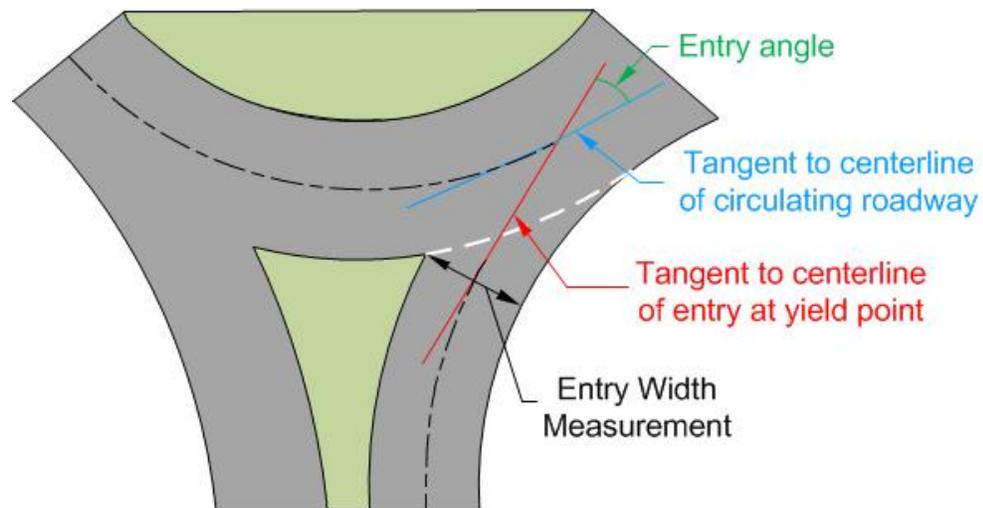


3. Entry Angle

To achieve the proper amount of deflection for each approach to a roundabout, there is a range of angle values that are acceptable. This range is usually between 20 and 40 degrees.

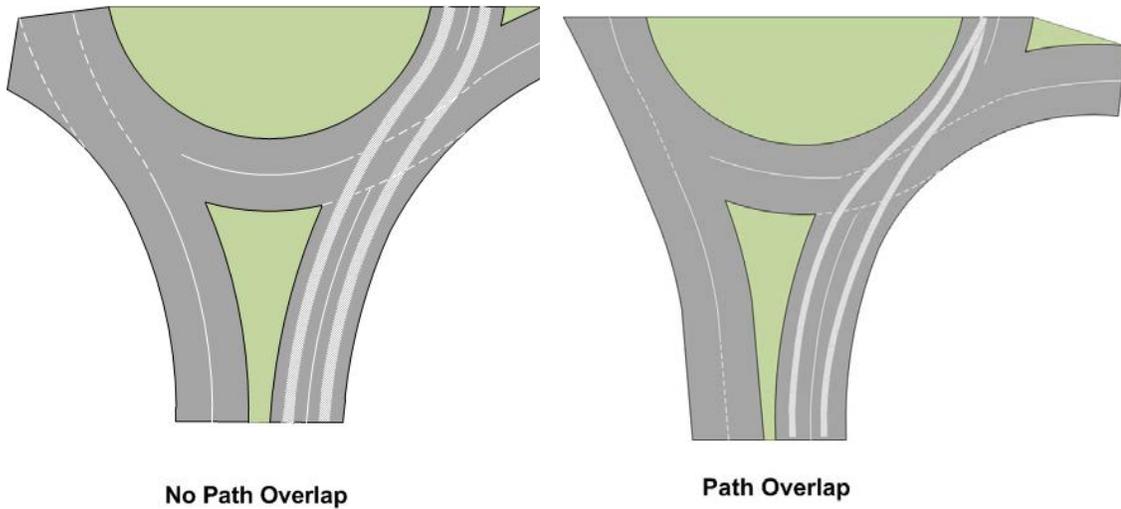
4. Entry Width

Entry width is determined by the turning template of the design vehicle turning through the entry curve of the needed design speed. The ranges of entry widths in [Exhibit 1320-1](#) are only suggestions to start a roundabout design.



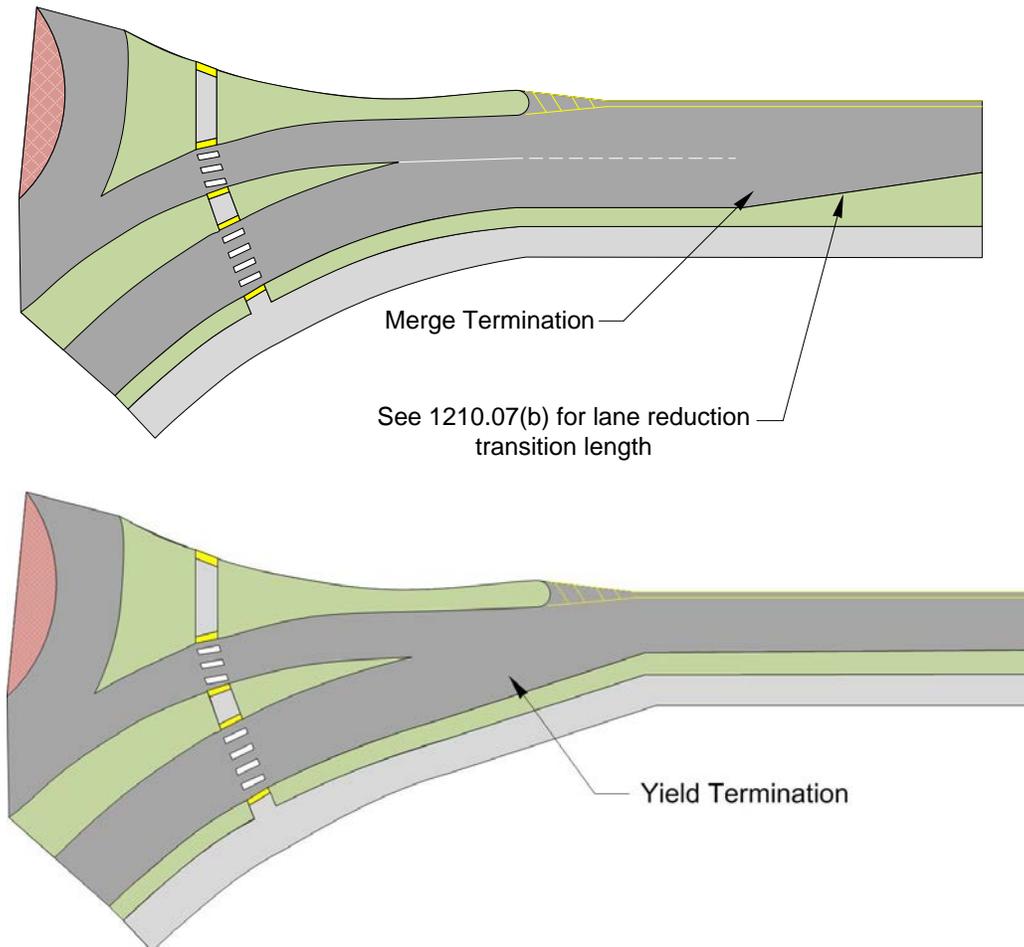
5. Path Overlap

If the vehicles in the entry are aligned toward the central island or the truck apron, the vehicle on the right is pointed toward the inside lane and tends to go in that direction, while the vehicle on the left tends to be squeezed to the right toward the vehicle on the right. Avoid path overlap.



1320.05(2)(g) Right-Turn Slip Lanes

Right-turn slip lanes are a proven way to increase the “life” of an intersection by removing traffic that would otherwise enter the roundabout and lower the available capacity to other movements. If a right-turn movement has a total of 250 vehicles/hour, or if over 40% of the total approach volume is taking right turns, slip lanes should be considered.



1320.05(3) Speed Control

Roundabout operation performance is dependent on low, consistent speeds. Low and consistent operating speeds facilitate driver gap acceptance. Design for travel path operating speeds between 15 mph and 25 mph (see [1320.05\(6\)\(c\)](#)). Design to have low-speed differentials between entering and circulating traffic.

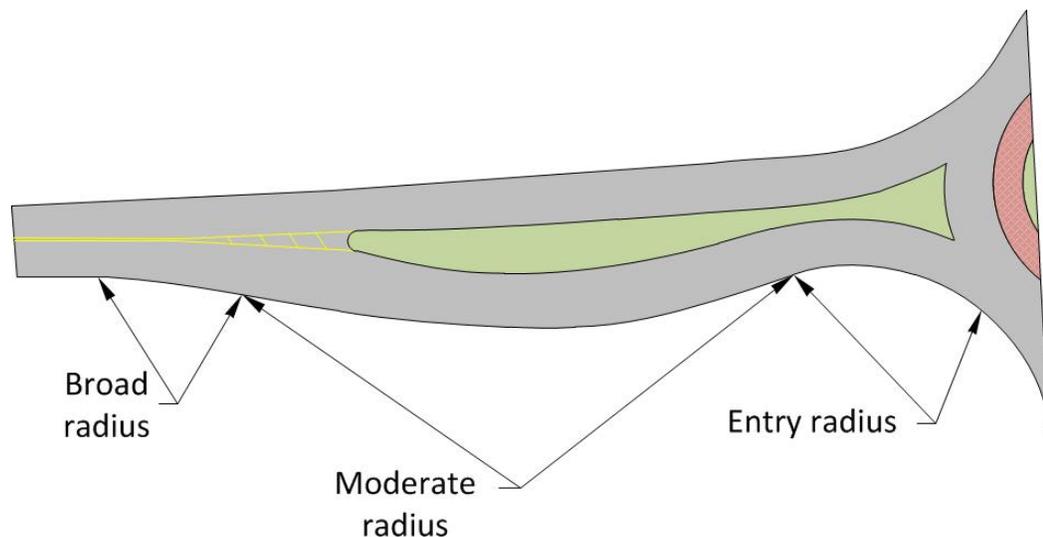
The optimal design speed mechanism is when the design speeds of the entry legs, based on their deflection alignment, are the same or slightly slower than the design speed of the circulation lane(s), so that the vehicle enters the roundabout at that slower speed.

The vehicle then moves into and through the circulation lane, being controlled all along by the design speed of the circulating lane. The circulating design speed controls the exit speed; therefore, the exit design speed is not as critical

Designing this type of speed mechanism encourages lower speeds and lower-speed differentials at conflict points, which reduces the potential for collisions.

1320.05(3)a Chicanes

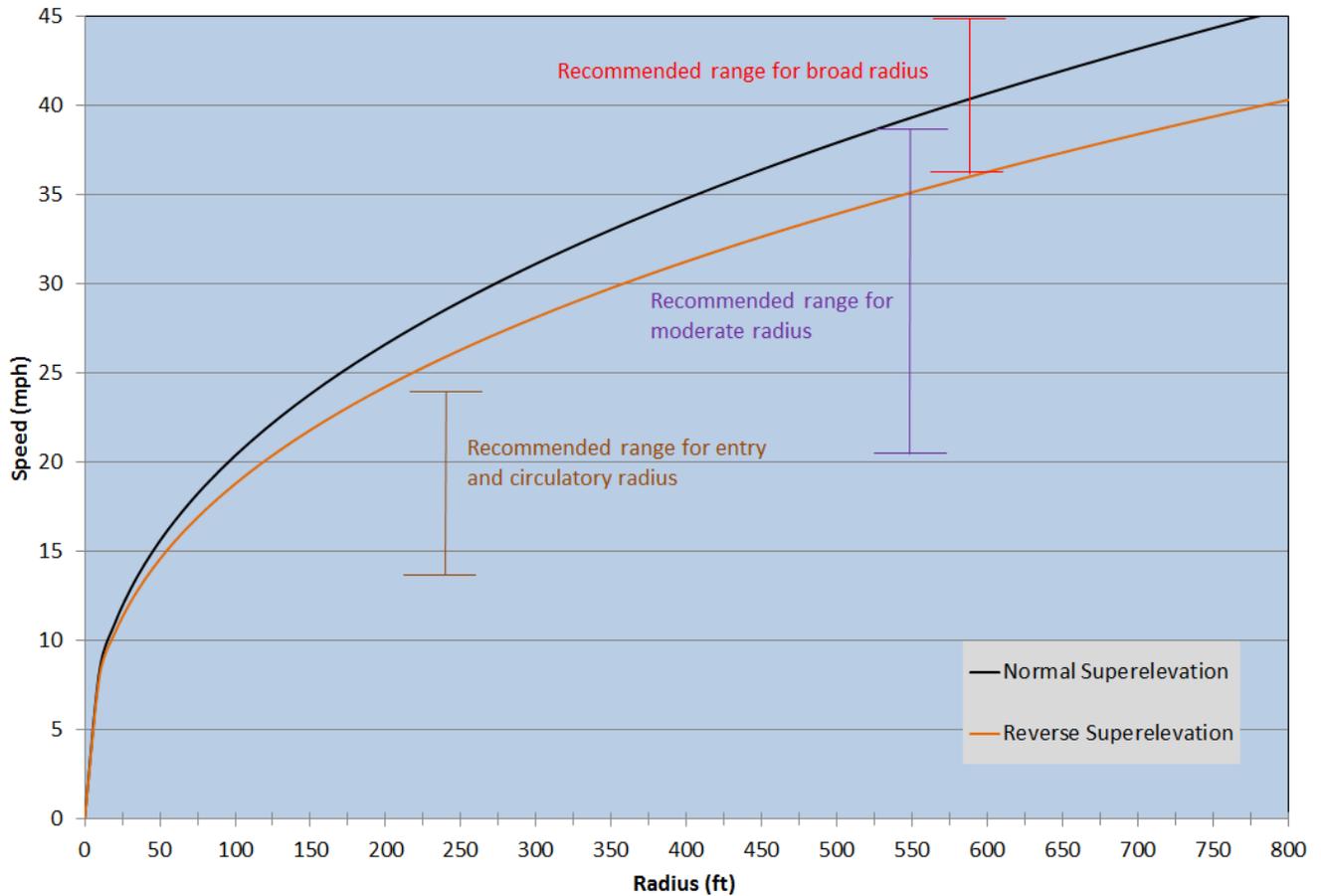
Chicanes are a type of horizontal deflection used in traffic calming to reduce the speed of vehicles. Research has shown that chicanes have value in slowing down higher approach speeds. **Note:** Use of this component should be documented as a design decision in the DDP.



Consider chicanes at approaches of 45 mph or higher. Design chicane curves with successively smaller radii in order to reduce the design speed approaching the roundabout entry; use [Exhibit 1320-2](#) to determine the radii-speed relationship (the radii are measured from the midpoint of the travel lane for single-lane roundabouts). For multilane roundabouts, the radii measurement is from the center of the total pavement width of the entry travel lanes.

All three curves of a chicane are designed to, one by one, successively reduce vehicle speed from the speed of the main line to the speed of the entry curve.

Also, consider the grade of the roadways that enter the roundabout, because a vehicle can more easily slow down on an upgrade than on a downgrade. Adjust the length of the deceleration based on the “Adjustment Factors for Grades Greater Than 3%” in *Design Manual* [Exhibit 1360-10](#).



Radii-Speed Relationship
Exhibit 1320-2

1320.05(4) Grades

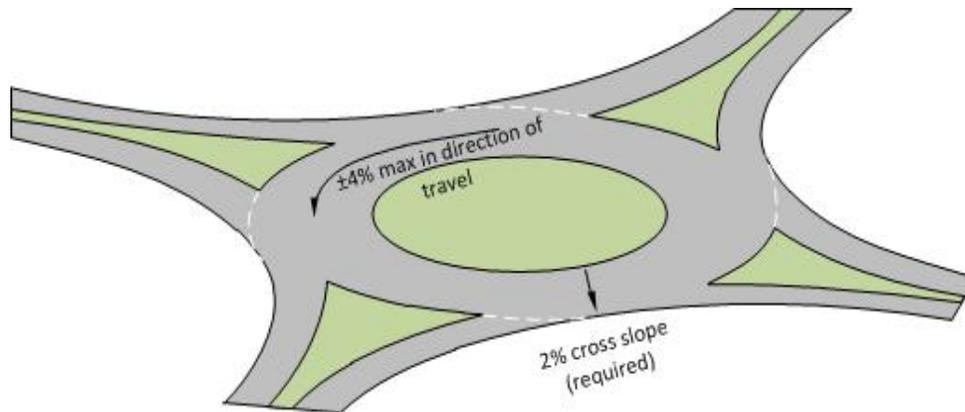
Do not use grades as a constraint during scoping to rule on a roundabout, because typical 90° and other specific-angle intersections work with grade ranges, so there are no limitations to grades at a roundabout. Be aware however of how the profiles mesh with sight distances and ADA pedestrian requirements.

1320.05(4)(a) Circulatory Roadway

The circulatory roadway grade value should not exceed 4%.

1320.05(4)(b) Grade Transitions for Roadway Entry and Exit to the Circulatory Roadway

Consider the grade transitions and make them as long as feasible.



1320.05(5) Cross Section Circulatory Roadway

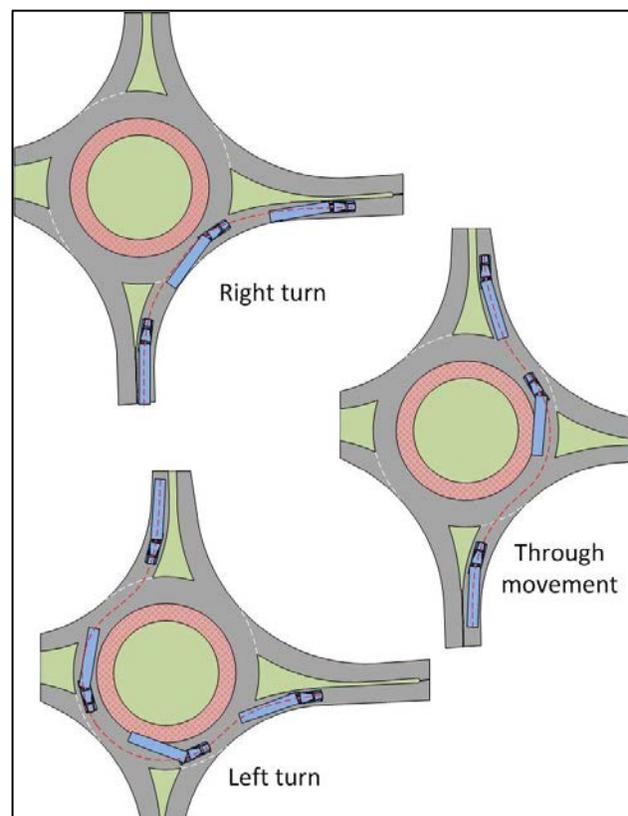
Designers should use a cross slope of 2% away from the central island to promote lower circulating speeds, improve central island visibility, minimize breaks in cross slope of entry and exit lanes, and facilitate drainage of water to the outside of the roundabout.

1320.05(6) Design Tools

During scoping, do not use truck turning paths alone as a constraint to rule out a roundabout. There are several design tools available to aid in the design of a roundabout. It is important to understand how the software works and impacts designs, default settings, and so on.

1320.05(6)(a) The Importance of Design Vehicle Assumptions and Wheel Base (WB) Measurements

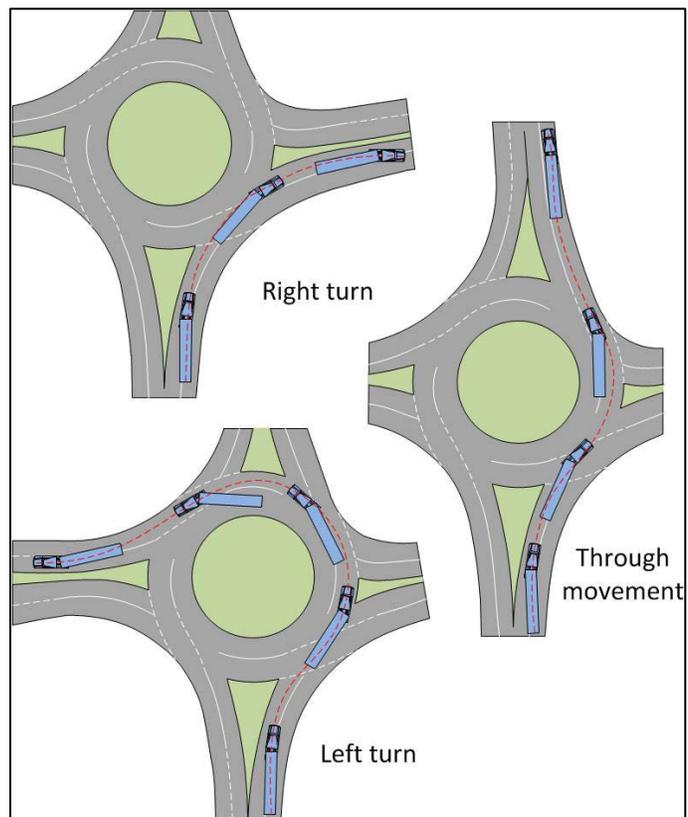
While all highway-to-highway movements require accommodating a WB-67, there are certain assumptions that must be made with software programs that replicate truck swept paths. Designers should discuss defaults and recognize that on some highway segments, truck percentages are 20%, and on others, they are 2%. Designers should also recognize that among that percentage, WB-67s may only represent a small sample of the entire truck volume on any given day.



1320.05(6)(b) Truck Swept Path

In some cases, roundabouts of the perfect circular variety with symmetrical roadway attachments require less specific knowledge of truck-turning software and its applications. This knowledge curve, however, climbs quickly when looking at shaped roundabouts where a combination of the speed of the truck, its turning angle settings, its rear axle locations, and set up requires a mastery of this software.

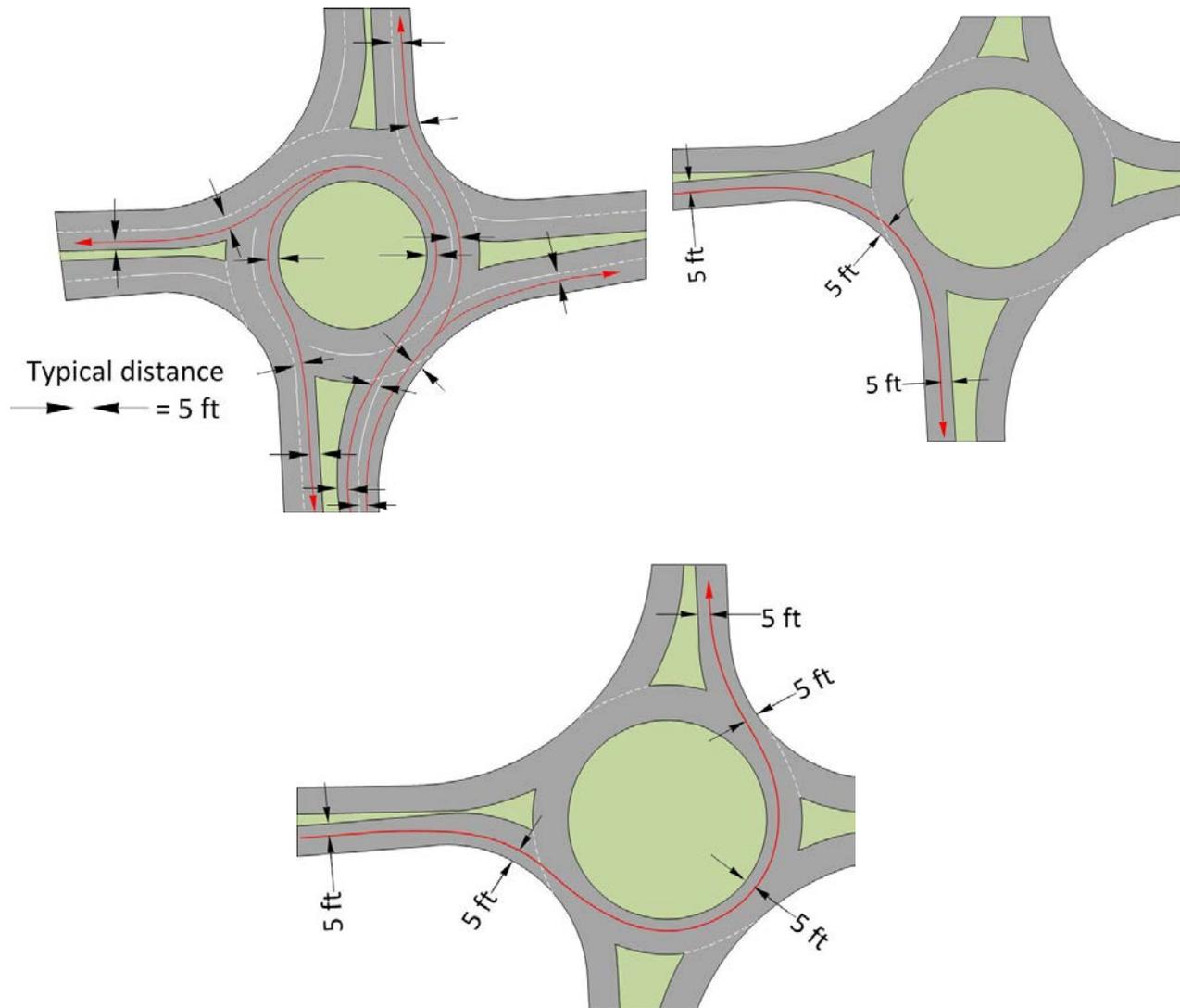
Design to slow the speed of the truck, and make good engineering judgment about how fast a truck might use a roundabout (for example, for AutoTURN[®] use 5 mph). Design tool default settings don't necessarily allow the maximization of the tool and can prohibit the designer in getting a good, balanced design between passenger car speeds and truck accommodation.



Multilane roundabouts assume truck straddling behavior, so printing out numerous copies of the same path throughout isn't necessarily using the tool. It is okay to say the tool doesn't apply except to specific movements; for example, gas station tankers using a driveway, or a super load that needs to make a specific movement with a wind blade or generator.

1320.05(6)(c) Travel Paths

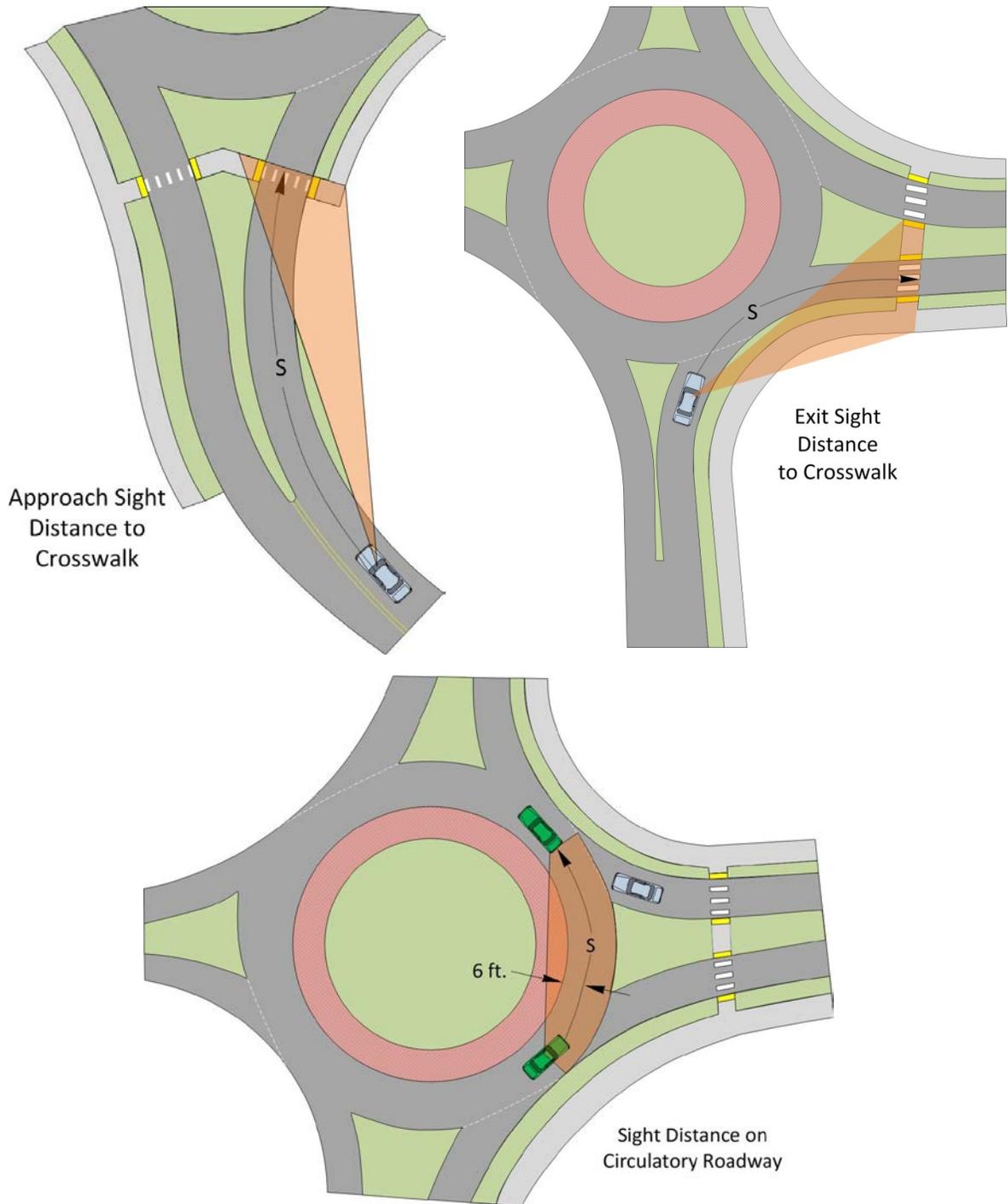
Travel path calculations can be used on multilane designs to get an understanding of speeds for different paths throughout the roundabout. A travel path is the shortest path through the roundabout, no closer than 5 feet from any curb face or lane line (see section 1320.05(3) for speed control).

**1320.05(7) Sight Distance**

Sight distance is an important consideration at roundabouts. Restricting sight distance across the central island with strategic landscaping may enhance the intersection by making the intersection a focal point and encouraging lower speeds. Work with the region Traffic Engineer and Landscape Architect (HQ if there is no region contact) to determine this balance. Provide sight triangle plan sheets for consideration of landscape design.

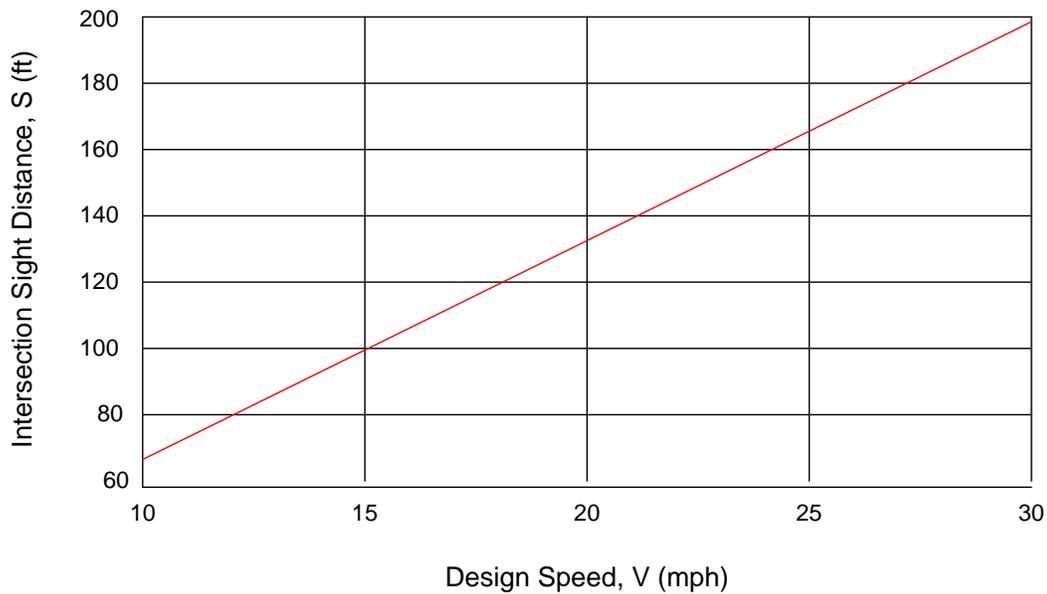
1320.05(7)(a) Stopping

Use the design stopping sight distance guidance in [Chapter 1260](#). Anticipated speeds throughout the roundabout can be calculated using [Exhibit 1320-2](#), based on the radius and direction of the particular curve. These distances are assumed to follow the curvature of the roadway, thus are not measured as straight lines but as distances along the vehicular path.

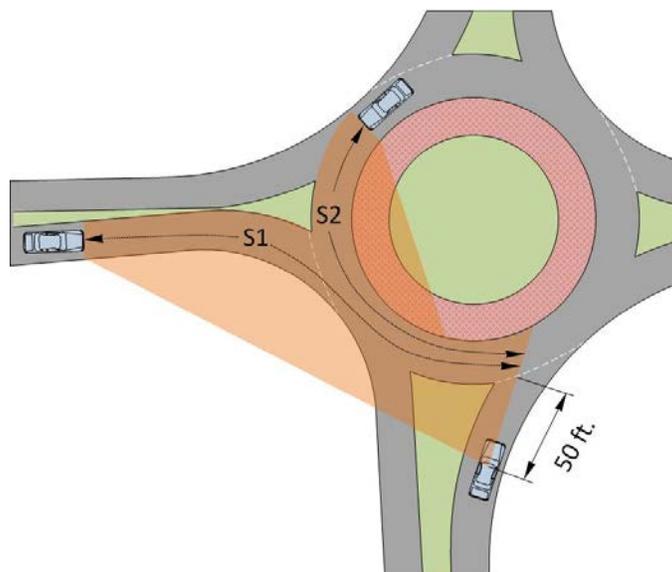


1320.05(7)(b) Intersection

There is an advantage to providing minimum intersection sight distance. Longer sight distances can lead to higher vehicle speeds that reduce the safety for all road users. For intersection sight distance at roundabouts, provide entering vehicles a clear view of traffic on the circulating roadway and on the immediate upstream approach in order to judge an acceptable gap. The intersection sight distance at roundabouts is given in [Exhibit 1320-3](#). The S_1 intersection sight distance is based on the average of the entering and circulating speeds, and the S_2 intersection sight distance is based on the left-turning speed. The sight distance may also be calculated using the intersection sight distance equation given in [Chapter 1310](#) using a time gap (tg) of 4.5 seconds.



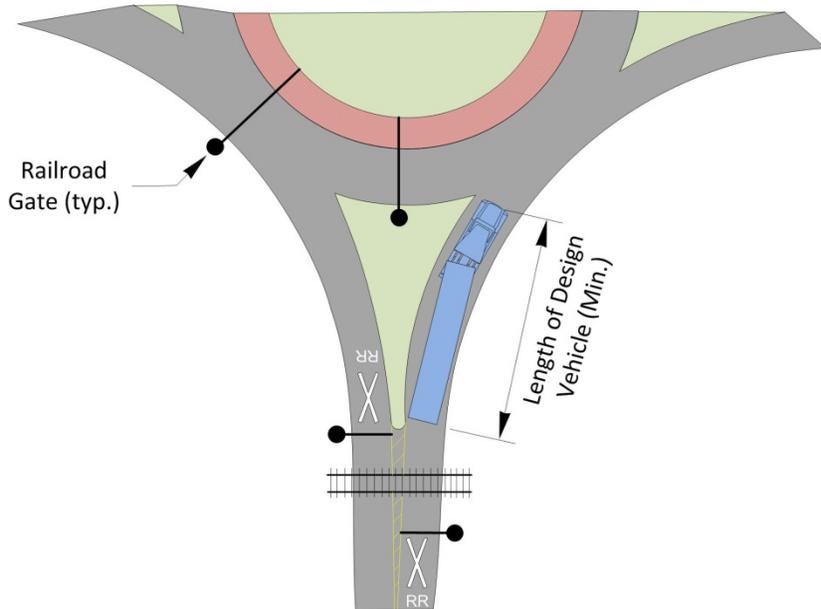
Intersection Sight Distance
Exhibit 1320-3



1320.05(8) Railroad Crossings

Although it is undesirable to locate intersections near an at-grade railroad crossing, a crossing is acceptable near a roundabout as long as the crossing design does not force vehicles to stop on the tracks. The distance between the yield point and the tracks is sized to at least accommodate the design vehicle length, unless there is a gate on the circulating roadway that allows the roundabout entry to clear prior to the train's arrival.

Intersection analyses and site-specific conditions help determine the need for, and optimum placement of, a gate on the circulating roadway. Two example locations for railroad gates on the circulating roadway are shown; however, only one would be used. While a roundabout has a tendency to lock up as soon as the gates come down on the circulating roadway, the leg with the train is very efficient at returning to normal operation.



1320.06 Pedestrians

As part of the approved Intersection Control Analysis (ICA), it has already been determined whether pedestrians will use the roundabout and, if so, which legs (see [Chapter 1300](#)).

With the knowledge of where pedestrian facilities are needed, design the roundabout while keeping in mind the ADA requirements for crossings, sidewalks, paths, and other pedestrian facilities.

Wherever feasible, sidewalks at roundabouts should be set back from the edge of the circulatory roadway by a buffer. The buffer discourages pedestrians from crossing to the central island or cutting across the circulatory roadway of the roundabout, and it helps guide pedestrians with vision impairments to the designated crosswalks. A buffer between the sidewalk and curb is recommended. Consider a buffer wide enough for low shrubs or grass in the area between the sidewalk and curb to maintain sight distance needs.

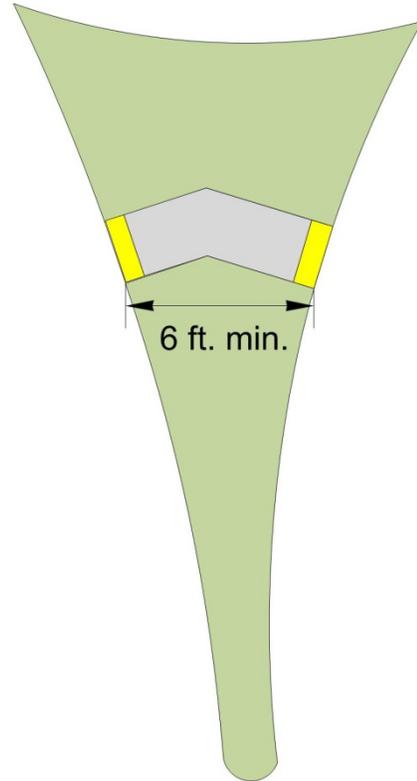
1320.06(1) Crossing Location

The crossing located on the entry side of a roundabout leg should be at least 20 feet from the yield line so that a pedestrian can walk behind a vehicle that is waiting at the yield line. If there is an extremely large truck percentage, consider moving the crossing to accommodate the most common truck.

The crossing located in the exit side of the roundabout leg can be closer to the roundabout, because as the vehicles leave the roundabout, they accelerate and make it harder to find a break in traffic. As speed increases, drivers are less likely and less able to stop.

1320.06(2) Splitter Island Pass Through

Design splitter island pass through widths 10 feet, or the width of the sidewalk if the sidewalk is greater than 10 feet wide. Design the length (measured back of curb to back of curb) at least 6 feet long measured along the shortest section of the pedestrian path. Consider a “V” shape pass through as shown.



1320.06(3) Buffers

It is preferable to have buffers between the sidewalk and the circulatory roadway.

Buffers allow room for curb ramp transition sections and, depending on the width, room for curb ramps out of the pedestrian access route.

1320.06(4) Curb Ramps

Roundabouts with buffers typically have combination-type curb ramps; otherwise, parallel curb ramps are normally used. (See [Chapter 1510](#) and the *Standard Plans* for curb ramp information.)

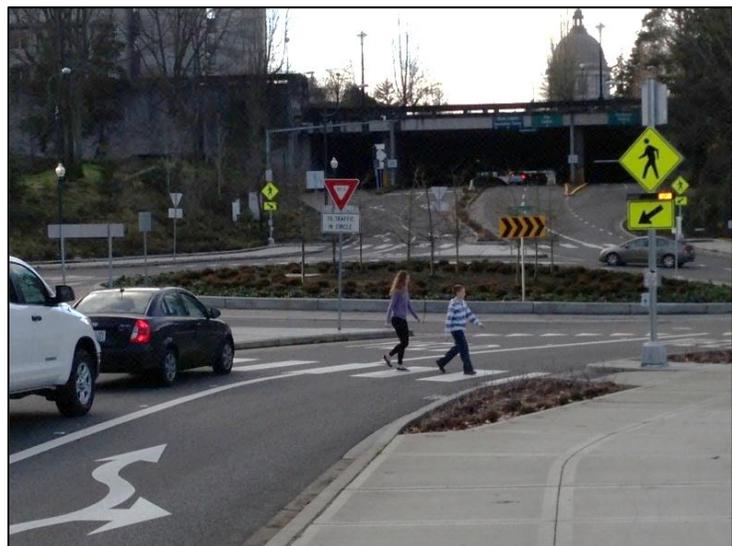
1320.06(5) Sight Triangles

Vehicle sight triangles specific to pedestrians (see [1320.05\(7\)](#)) need to be able to see the whole curb ramp, including the landing, where pedestrians are likely to wait to cross.

It is also important that pedestrians are also able to see approaching vehicles.

1320.06(6) Pedestrian Beacons

On multilane roundabouts, consider installing pedestrian beacons to warn vehicles that a pedestrian wants to cross the roadway. Work with the region Traffic Engineer on types and locations of pedestrian beacons.



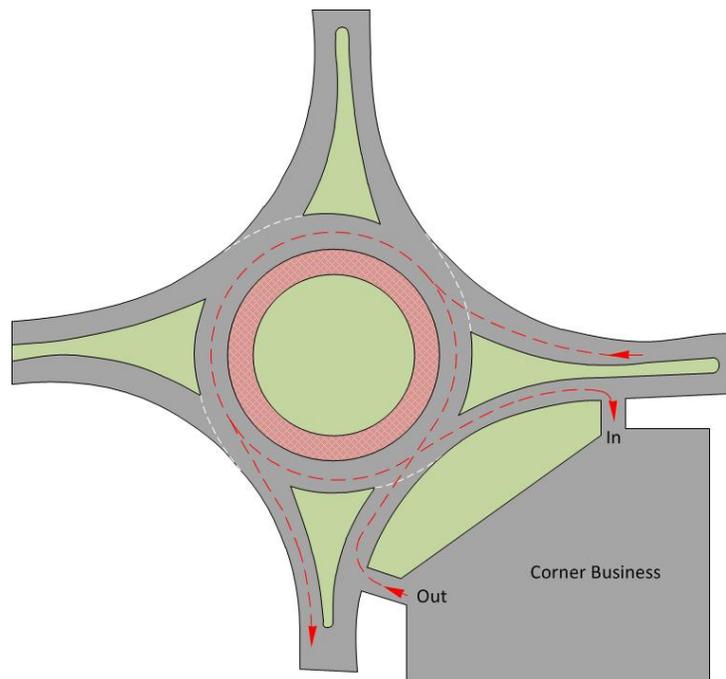
1320.09 Illumination

Provide illumination for each of the conflict points between circulating and entering traffic in the roundabout and at the beginning of the raised splitter islands. Illuminate raised channelization or curbing. Position the luminaires on the upstream side of each crosswalk to improve the visibility of pedestrians. Light the roundabout from the outside in toward the center. This improves the visibility of the central island and circulating vehicles to motorists approaching the roundabout. Ground-level lighting within the central island that shines upward toward objects in the central island can also improve their visibility. (See [Chapter 1040](#) for additional information on illumination.) On higher-speed approaches, you may consider internally illuminated bollards (IIB) in lieu of other illumination.

1320.10 Road Approach, Parking, and Transit Facilities

No road approach (road or driveway) connections to the circulating roadway are allowed at roundabouts unless they are designed as legs to the roundabout. It is desirable that road approaches not be located on the approach or departure legs within the length of the splitter island. The minimum distance from the circulating roadway to a road approach is controlled by corner clearance using the outside edge of the circulating roadway as the crossroad (see [Chapter 540](#)). If minimum corner clearance cannot be met, provide justification. For additional information on limited access highways, see [Chapter 530](#).

If the parcel adjoins two legs of the roundabout, it is acceptable to provide a right-in/right-out driveway within the length of the splitter islands on both legs. This provides for all movements; design both driveways to accommodate their design vehicles.



Roadways between roundabouts may have restrictive medians with left-turn access provided with U-turns at the roundabouts.

Parking is not allowed in the circulating roadway or on the entry or exit roadway within the length of the splitter island.

Transit stops are not allowed in the circulating roadway, in the approach lanes, or in the exit lanes prior to the crosswalk. Locate transit stops on the roadway before or after the roundabout, in a pullout, or where the pavement is wide enough that a stopped bus does not block the through movement of traffic or impede sight distance.

1320.11 Approvals

1320.11(1) Preliminary Geometric Design

Coordination between the design team, region Traffic and Project Development offices, and HQ Traffic and Design offices is essential for a roundabout design layout.

Conduct an early meeting with the region Traffic Office, the region Project Development Engineer or Engineering Manager, and the HQ Traffic and Design offices. The intent of this meeting is to review, discuss, and evaluate initial layouts for a roundabout before too much time and resources have been expended. The outcome of the meeting will provide sufficient information that a designer can proceed with finalizing the geometric design.

As a minimum, consider, discuss, and document the following items for the meeting.

1320.11(1)(a) Project Overview

1. Summary of the Approved Intersection Control Analysis (ICA)

Some items to include:

- Preliminary layout
- Design vehicle
- Sight distances
- Vehicle turn simulation software (such as AutoTURN[®])

2. Other Topics for Discussion

Additional items to discuss and consider in the design of the roundabout may include:

- Travel path speeds
- Splitter island design: Provide a smooth entry alignment into the roundabout
- Other roundabout shapes
- Bike and pedestrian design, including ADA requirements and rapid flash beacons
- Central island design
- Curbing details
- Signing, illumination, and delineation considerations
- Staging and traffic control during construction
- Vertical grade
- Adjacent posted speeds
- Existing and future corridor congestion



The iterative nature of roundabout design requires a high level of communication in determining design details, construction sequencing, and so on. Additional meetings are recommended as necessary to review and discuss the progress of the design. A peer review may also be beneficial on more complex designs.

1320.11(2) Final Geometric Design

The Roundabout Geometric Design Package is the documentation of the final roundabout design and decisions. This package should be approved prior to PS&E work.

As a minimum, include the following items in the Roundabout Geometric Design Package:

- (a) Intersection Control Analysis (ICA).
- (b) Intersection plan showing the roundabout channelization.
- (c) Summary of the design documentation that pertains to the roundabout.
- (d) Roundabout geometric data, including the following:
 - Provide detailed drawings showing the travel paths and speeds for each movement.
 - Provide a table summarizing stopping and intersection sight distance on each leg.
 - Provide turn paths showing design vehicle, WB-67, and largest oversize vehicle movements using turn simulation software (such as AutoTURN[®]).
- (e) Detailed drawings of the splitter islands on each leg.
- (f) Preliminary signing, delineation, and illumination plans.
- (g) Curb types used.
- (h) Central island/Landscape design.
- (i) Bike and pedestrian design, including ADA requirements.

A roundabout review checklist and example package is located on the Project Development web page: www.wsdot.wa.gov/design/projectdev

1320.12 Documentation

Refer to [Chapter 300](#) for design documentation requirements.

