Chapter 1320 Roundabouts

1320.01 General (Rewritten 2024)

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 other intersection types. 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. Modern roundabouts are near-circular intersections at grade. The decision to install a roundabout is the result of an Intersection Control Evaluation (ICE) (see Chapter 1300). Roundabout performance is a product of geometric design and traffic control. Benefits of roundabouts include:

All vehicles travel through the intersection in the same counterclockwise direction, reducing the number of conflict points and eliminating left-turn and head-on conflicts.

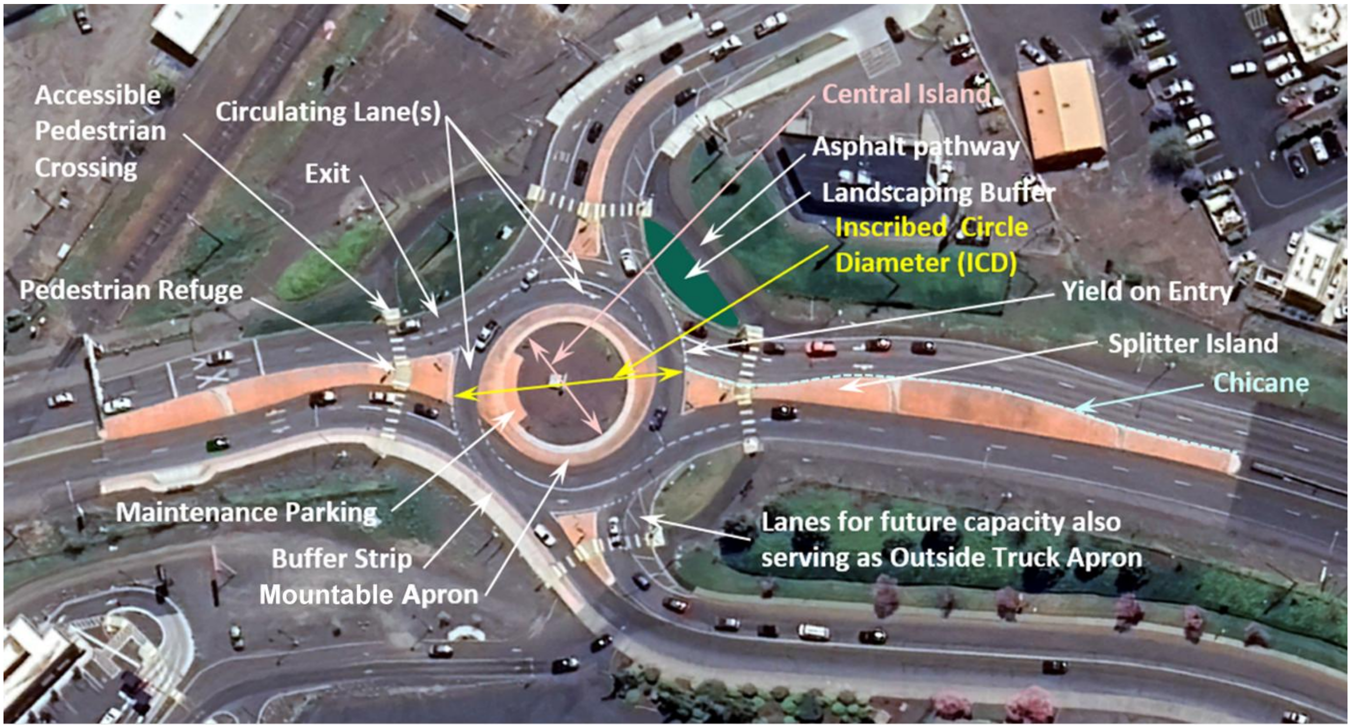
- Design features place a high priority on speed control, both lowering overall speeds as well as encouraging a narrower range of differing speeds. Lower and more consistent vehicle speeds lead to:
  - More predictable traffic interactions
  - More decision-making time for all users
  - Increased likelihood of drivers yielding to pedestrians
- Less frequent and less severe crashes, including crashes involving pedestrians and bicyclists
- As a result of reducing speeds and aligning traffic in a single direction, crashes that do occur at roundabouts are typically much less severe than crashes at traditional intersections
- Require less operations and maintenance than traffic signals:
  - Provide a longer service life than traffic signals
  - Require less maintenance associated with electronic signal equipment and signal heads
  - Provide a resilient intersection that continues to operate during a power outage
- Reduce user delays, fuel consumption, and air pollution

Roundabout

Designing a roundabout for all users is an iterative process of creating an easily navigable intersection through smooth curvature, channelization, sidewalks and buffers, deflection required to achieve consistent speeds, well-marked lane paths, accessible cross walks, and appropriate sight distance.

Pedestrians and bicyclists are best served by single lane roundabouts with no slip lanes. The roundabout design should address approach speeds of traffic ahead of the crosswalks. At higher approach speeds, pedestrians may be reluctant to step into a crosswalk if they cannot determine whether the driver can slow down in time.

1320.02 Roundabout Features (New 2024)



Feature	Description
Central island 1320.04(3)(c)	Center of a roundabout around which traffic circulates. The central island is typically non-traversable and is often landscaped, although on some smaller roundabouts, the central island may be completely traversable. If the central island is non-traversable, it is often supplemented with a mountable apron for larger vehicles (see below). The central island does not necessarily need to be circular.
Splitter island 1320.04(3)(d)	Raised or painted area on an approach that separates entering traffic from exiting traffic and establishes the channelization needed to slow entering and exiting traffic. If raised and of sufficient width, it can also provide a refuge for pedestrians to cross the road in two stages.
Circulatory roadway (circulating lanes) 1320.04(4)(a)	Lane or lanes that vehicles use to travel counterclockwise around the central island. The circulatory roadway does not necessarily need to be circular in shape. Note that the circulatory roadway of a roundabout cannot include conventional bike lane markings. If dedicated bicycle facilities are desired, they must be separated from the circulatory roadway by a buffer (see below).
Mountable apron 1320.04(3)(b)	Extended area of the travelled way adjacent to the center island are partially raised above the travel lanes and are designed to discourage smaller vehicles from driving over them but be traversable by large vehicles. Mountable aprons are most frequently used around the central island but can also be used on splitter islands or on the outside of the approach lanes for the same purpose.
Yield at entry 1320.05(1)	Entering vehicles must yield to any circulating traffic coming from the left before entering the circulatory roadway. The yield condition is established by yield signs, which may also be supplemented with yield pavement markings.

Feature	Description
Pedestrian/bicyclist crossing 1320.05(3)	The preferred location for a marked crossing is 20 feet away from the circulating lanes on both the entry and exit. Marked crossings are often located across and through a splitter island.
Buffer 1320.05(3)	Located between the circulatory roadway and the sidewalk to separate vehicular and pedestrian traffic and help guide pedestrians to designated crossing locations. In some cases, a buffer may also provide separation between the circulatory roadway and a separated bike lane.
Pedestrian Circulation Paths 1510.04	Pedestrian Circulation Paths (PCPs) are prepared exterior or interior ways of passage provided for pedestrian travel. They include independent walkways, sidewalks, shared-use paths, and other types of pedestrian facilities. For bicycle facilities see 1520.03(2).
Chicane 1320.04(3)(a)	A type of horizontal deflection used in traffic calming to reduce the speed of vehicles approaching the entrance of a roundabout.

1320.03 Roundabout Types

There are five basic roundabout types: mini, compact, single-lane, multilane, and teardrop described in the following sections.

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) Compact Roundabouts

Compact roundabouts are a hybrid of attributes found in mini- and single-lane roundabouts. Similar to a mini-roundabout, a compact roundabout may require minimal additional pavement, has a completely mountable center island, and in many cases existing curb or sidewalk can be left in place. As a result, compact roundabouts rarely require the purchase of right of way. Compact roundabouts are similar to single-lane roundabouts regarding design vehicle assumptions, ability to process traffic volumes, and signing.

Compact roundabouts

1320.03(3) 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 landscaped central island.

Single-lane roundabout

1320.03(4) Multilane Roundabouts

Multilane roundabouts have at least one entry or exit with two or more lanes and more than one circulating lane. Some multilane roundabouts provide only a single lane in some segments of the circulating area. The operational practice for trucks negotiating multilane roundabouts is to straddle adjacent lanes and is permitted by RCW 46.61.140 for all commercial vehicles.

Multilane roundabout

1320.03(5) 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 resulting in less vehicle conflicts as traffic traveling on the crossroad (link) between ramp terminal intersections (nodes) does not encounter a yield as it enters the teardrop intersections. At higher ADT locations this lack of conflicting vehicles can result in a higher throughput but can also result in limited gaps for the off-ramp approach. Teardrop roundabouts are often installed in pairs functioning together to provide complete interchange access; these pairs are sometimes referred to as “dumbbell” roundabouts. If they are positioned very close together, they function more as a single extended roundabout, sometimes called a “peanut” roundabout or “peanut-about”, suitable for locations with closely spaced offset intersections being converted to roundabout intersections. Consult the HQ or Region Transportation Operations Offices for guidance.

Teardrop roundabouts

1320.04 Motor Vehicle Geometric Design

1320.04(1) Capacity Analysis

Use the capacity analysis completed as part of the Intersection Control Evaluation (ICE) (see Chapter 1300) to verify the number of lanes required for every individual movement in the design year. All projects may not have an ICE. I2 projects are selected based on crash history and typically include a Crash Reduction Analysis (CAR), which then can be used in place of an ICE for documentation, with approval. At the discretion of the region traffic engineer, the analysis may need to be updated if conditions have changed or several years have passed from the completion of the Intersection Control Evaluation.

1320.04(2) Selecting Shape and Placement

Roundabout shape is an important decision, because the shape can affect design elements that affect safety performance and operation of the roundabout.

1320.04(2)(a) Circular

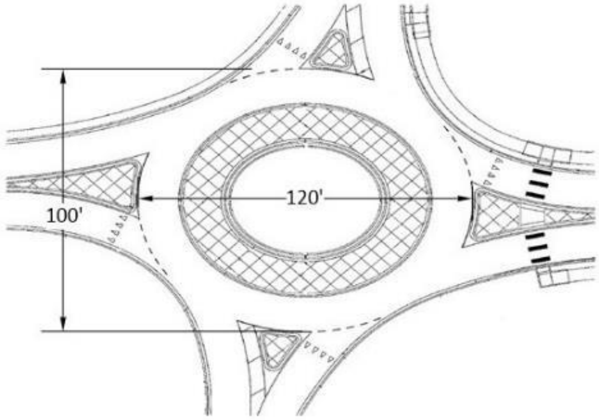
The circular shape is the most desirable roundabout shape when constraints allow. If a circular shape is not feasible, contact the Region Transportation Operations Office to investigate other shapes described below. Sometimes a circular shape can be used by slightly offsetting the placement of the roundabout.

Circular shape

1320.04(2)(b) Non-Circular

A non-circular roundabout is a good choice when constraints such as right of way, existing roadway alignments, buildings, and/or environmentally sensitive areas influence the shape.

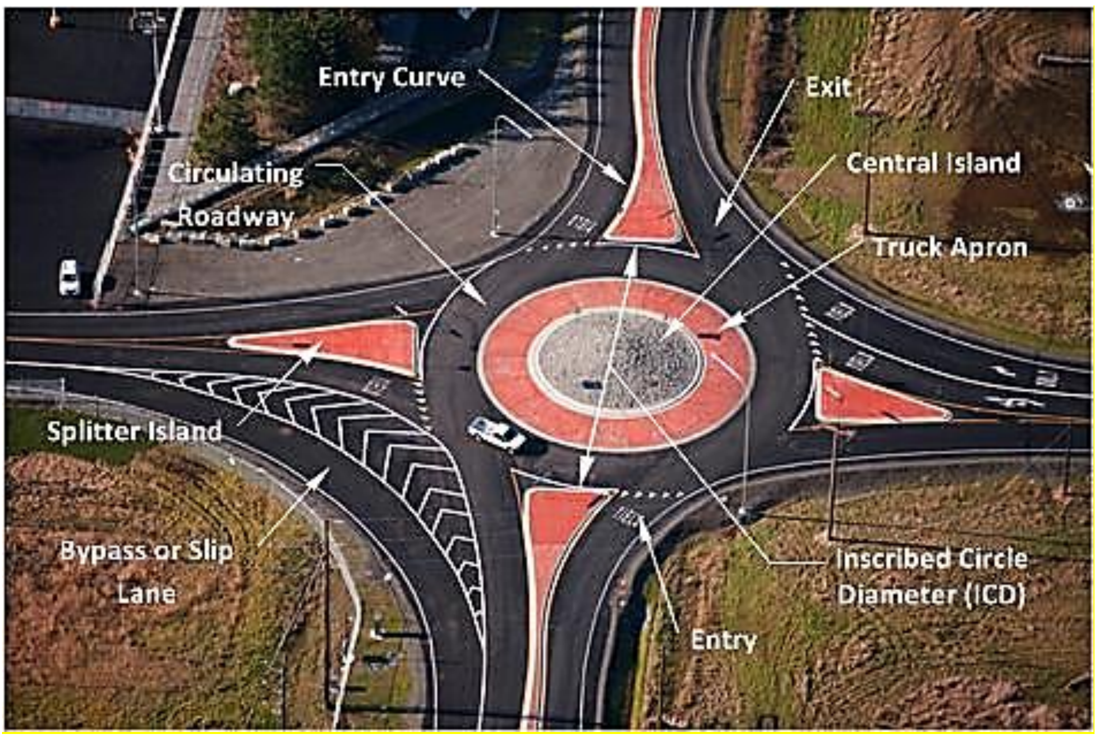
Experiment with different roundabout sizes and radii and use design vehicle turning software (such as AutoTURN®) to refine the shape to find the best operation while retaining desired speeds.



Non-circular roundabout with example dimensions

1320.04(3) Roundabout Design Elements

This section provides guidance for roundabout design elements. The photo below labels many of them.



Roundabout design elements

1320.04(3)(a) Curbing

Roundabout curbing generally should be mountable. The type of curbing appropriate for a roundabout is shown in the Standard Plan Roundabout Cement Concrete Curbs: F-10.18.

Exception: existing curb untouched as part of a mini or compact roundabout installation may remain.

Rural highways typically have no outside curbs. Instead, they often have paved or gravel shoulders. Adding curbs on the outside edges of pavement provides drivers with a sense that they are entering a more controlled setting that supports speed reduction. Curbing does not necessarily require closed drainage systems. Open drainage can often remain if gaps are provided in the curbs so that stormwater may drain to adjacent drainage ditches.

Provide justification if outside curbing is not provided on highway approach legs.

Raised curbing with gaps for drainage on State Route 500 at 182nd Ave.

Rolled curbing on SR542 at East Smith Rd

1320.04(3)(b) Mountable Apron for Roundabouts

A mountable apron is an extended area of a central island, splitter island, or exterior portion of the traveled way which is designed to be driven over by large vehicles but is uncomfortable for smaller vehicles. These aprons help control speeds of smaller vehicles while allowing the turning path of large vehicles to pass through the roundabout. Generally, a truck tractor can traverse the roundabout within the circulating lane while the trailer is allowed to off track onto the apron. The apron is slightly raised vertically above the circulating travel path with a different pattern or color to provide lane guidance to drivers in the circulating lane. Note that mountable aprons are part of the traveled way and must be designed as such in conjunction with the pedestrian facilities of the roundabout.

The outside of the apron is designed to establish the necessary roundabout deflection for passenger vehicles. The width of the apron. is based on the needs of the design and accommodated vehicle by using turn simulation software (such as AutoTURN®). If a bus uses the intersection for any movement routinely, the designer should try to minimize the need for buses to use the apron; however, this is not a requirement. Use turn simulation software to fine tune the width of apron needed, so as not to design too large of an apron width that won't be used.

There are rare circumstances where a combination of frequent low clearance trucks such as lowboys, roadway grades or other roadway features may lead to consideration of a mountable apron height of less than 3 inches. Any apron height other than 3 inches is documented in the DDP and requires region traffic engineer concurrence. Contact HQ Transportation Office for guidance.

The apron color should be distinguishable in contrast with the adjacent circulating roadway and pedestrian facilities. WSDOT practice generally includes encouraging the use of a red color with brick texturing. The use of grey or darker colors alone does not provide adequate contrast. However, designs using a mixture of color, textures, and geometric shapes such as incorporation of central island landscaping, or chevron patterns can provide desirable contrast to the adjacent circulating roadway. Work with the region Landscape Architect (HQ

Roadside and Site Development Section for regions without a Landscape Architect) and HQ Transportation Operations Division for color, texture, and design options.

Roundabout showing two-color mountable central island. Location is State Route 432 at Exit 36 on Interstate 5 in Kelso, WA

Roundabout apron with a chevron pattern at West 100th Ave and Northbound ramp terminal at the Walter J. Hickel Parkway, Anchorage, AK

Roundabout showing red concrete with brick texturing for the splitter island and central island, and river rock buffer between the roadway and sidewalk. Location is West Alder St at 1st St in Shelton, WA

Roundabout showing red concrete with brick texturing for the splitter island and central island, landscaped central island, and gravel and natural plantings at the edge of pavement. Location is State Route 9 at Francis Rd in Skagit County, WA

Roundabout that provides range of textures, colors, and shapes to achieve contrast. This example includes a rock blanket on the splitter islands, sidewalk buffer, and a wave pattern on the central island. Contrasting the rock blanket in the central island is tan concrete with brick texturing. Further contrast is provided by the red brushed concrete apron and a small circular landscaped area in the central island. The truck apron is red brushed concrete. The rock blanket could be placed in pervious concrete if needed for stormwater management purposes. Location is Handford Armona Rd at Exit 84 on State Route 198 in Handford, CA.

1320.04(3)(c) Central Island

The central island is the portion of the roundabout that is inside of the circulating roadway and mountable apron and often includes a landscaped area (except for mini-roundabouts and compact roundabouts, which are typically entirely mountable). On single- and multi-lane roundabouts, the central island is usually supplemented with a mountable apron (see above).

Central island shape is a function of the site-specific needs of a roundabout intersection. The design of the perimeter of the central island does not need to be an identical shape of the inscribed circle diameter (ICD) dimensions but should support the design principles of deflection and low speeds, and the accommodation of the design vehicle.

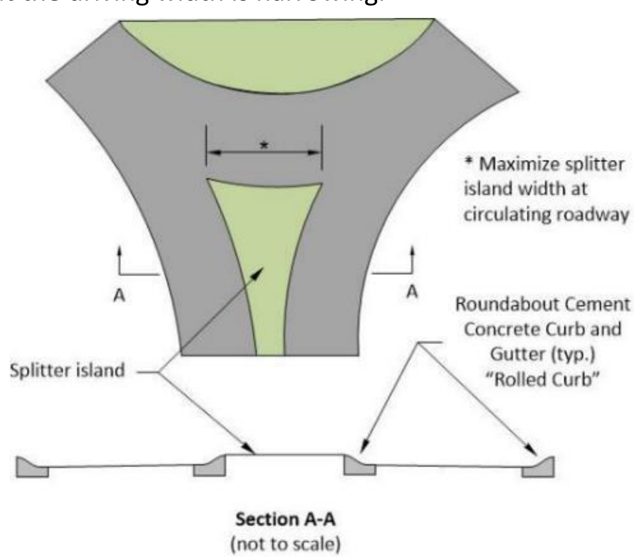
Roundabout central islands present opportunities to create community focal points, landscaping, and other gateway features within an intersection.

The central island may include enhancements (such as landscaping, sculptures, or fountains), which serve both an aesthetic purpose and provide visual indication of the intersection for approaching motorists (this is particularly important for high-speed approaches). Ideal central island treatments fit the context and result in minimal consequence to any vehicle that may encroach on the non-mountable portion of the central island. These treatments should not attract pedestrians to the central island, as pedestrians should never cross the circulating roadway. If access to the central island is needed for maintenance a pad in the central island next to the mountable apron can be designed (Consult with maintenance as to the size of vehicle needing access). Work with the region Landscape Architect (HQ Roadside and Site Development Section for regions without a Landscape Architect) for all central island features. See Chapter 950 for policy and guidance.

1320.04(3)(d) Splitter Island

A splitter island is the raised, or painted, island at each two-way leg between entering and exiting vehicles, designed primarily to control the entry and exit speeds by providing deflection and smooth transitions to/from the circulating lane. They also discourage wrong-way movements, and can provide pedestrian refuge in some cases. Splitter islands can have different shapes based on entry angle requirements and exit design speeds.

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.



Splitter Island

The length of the splitter island will vary (typical lengths: 30 ft. to 350 ft.) based on the terrain, access considerations, site-specific mainline and crossroad operational speeds and the stepdown speeds to the final desired entry speed, which is usually 15–25 mph. (See 1320.04(4)(a) for using chicanes on higher-speed roadways.)

The larger the splitter island width, the better an approaching driver can perceive whether a driver in the circulating lane will exit or continue inside the roundabout. This results in better gap acceptance.

In areas where dedicated Active Transportation facilities do not currently exist, for example rural intersections, provide 10-foot-wide median cut-throughs on longer splitter islands where vehicles are traveling at a slow speed to increase conspicuity for the preferred crossing location and to improve integration with future highway, transportation, or land use changes.

Splitter Island cut-through on State Route 14 at Wind River Highway

Splitter Island cut through on State Route 530 at 59th Ave NE

The splitter island should be distinguishable in contrast with the adjacent roadway and pedestrian facilities. See discussion and guidance for mountable aprons in Section 1320.04(3)(b).

1320.04(3)(e) Inscribed Circle Diameter

The Inscribed Circle Diameter (ICD), that is, the overall outside diameter of a roundabout's circulating roadway, is typically determined by the variables of design vehicle, design speed, and the number of circulatory lanes.

The ranges of ICD below are only suggestions to start a roundabout design. The ICD for noncircular shapes should be defined with dimensions along the widest and narrowest diameters of the noncircular shape.

Exhibit 1320-1 Suggested Initial Design Ranges

Design Element	Mini [1]	Compact	Single-Lane	Multilane
Number of Lanes	1	1+	1	2+
Inscribed Circle Diameter [2]	45' – 80'	65' – 120'	80' – 150'	120' – 165'
Circulating Roadway Width	N/A	N/A	14' – 19'	29'
Entry Widths	N/A	N/A	16' – 18'	25'

Notes:

The "+" symbol used here means that a portion of the circulating roadway may have more than one lane.

[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. Some conditions may require ICDs outside ranges shown here.

1320.04(3)(f) Entry

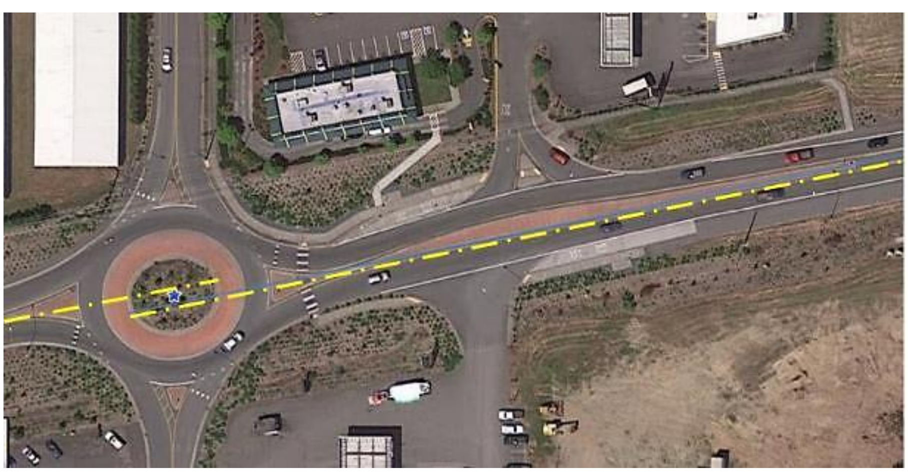
1. Entry Deflection

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 other intersection types are at 90º angles with through movements that are straight, entry deflections in a roundabout contribute to the safety performance. Deflection is primarily achieved with the central island and supported with splitter islands on all entries to the roundabout. See also Section 1320.04(4)(b).

2. Alignment Offset

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

- The offset left alignment constrains the entry, slowing a vehicle's approach speed. However, it opens up the exit for efficient egress which often increases the exit speed. If exit speeds can also be reduced, the offset left alignment is preferred.
- The symmetrical alignment is acceptable for lower speed contexts such as 30 mph. The entry and exit speeds are often more balanced.
- The offset right alignment tends to allow faster entry speeds and constrains the exit; it is undesirable.



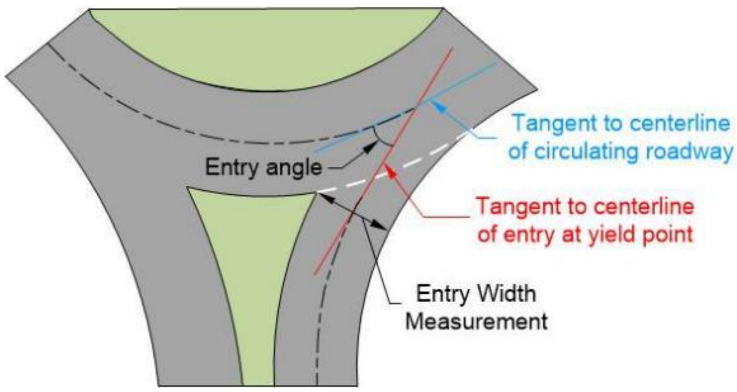
Offset left alignment (preferred)

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 desirable. This range is usually between 20 and 40 degrees. The purpose of entry angle is so vehicles don't hit broadside.

4. Entry Width

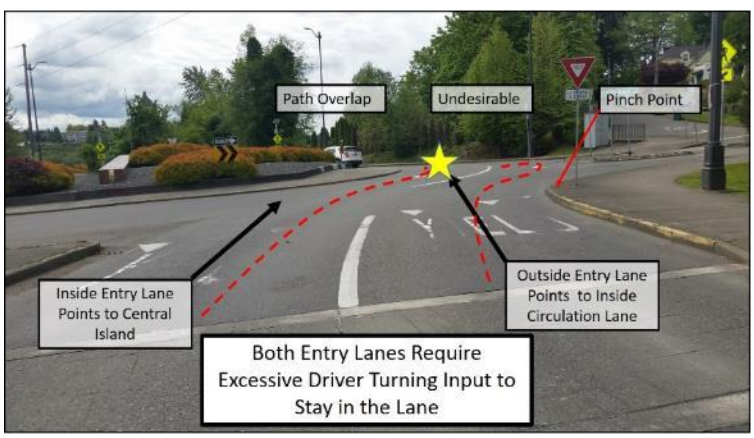
Entry width is determined by the turning template of the design vehicle turning through the entry curve at the desired entry speed. The ranges of entry widths in Exhibit 1320-1 are only suggestions to start a roundabout design.



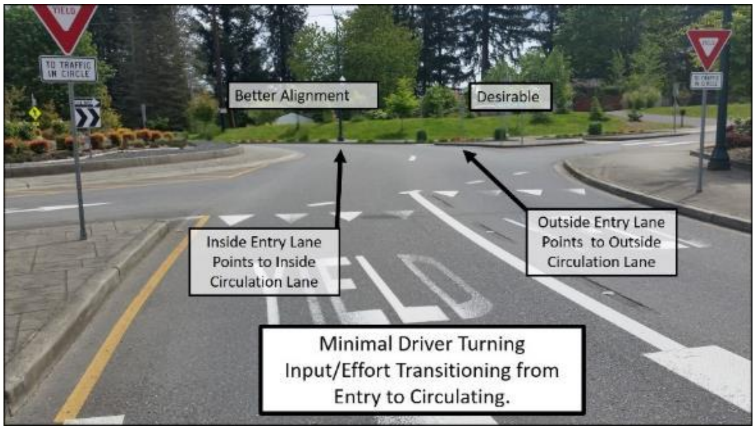
Entry angle and width

5. Path Overlap

In a multilane roundabout, 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. Avoid a design that aligns an entering vehicle at the incorrect lane in the circulatory roadway. As a vehicle enters the circulating roadway it should be headed directly toward its respective lane within the circulating roadway. For multilane roundabouts, if inside lane is pointing at truck apron this is also considered to be path overlap. If right entry lane is pointing to left circulatory lane, then there is path overlap.



Path overlap conflict



Good path alignment

1320.04(3)(g) Right-Turn Slip Lanes

Right-turn slip lanes are used to improve vehicle operations of an intersection by removing traffic that would otherwise enter the roundabout and reduce the available capacity to other movements. However, slip lanes expose pedestrians and bicyclists to an additional conflict point with motor vehicle traffic. A fully separated slip lane can also induce higher vehicular speeds due to the protected nature of the lane. Consider the trade-offs of vehicle capacity analysis to the possible increased exposure to pedestrians and bicyclists when determining whether to include right-turn slip lanes in the design. Consider raised crosswalks and other pedestrian or bicyclist crossing improvements at slip lanes to reduce driver speeds at the crossings. If right-turn slip lanes are used, design the slip lane travel path speeds to match the other travel path speeds of the roundabout. Refer to Section 1310.02(14) Islands, 1320.04(4)(a) for speed control, and 1510.09(7) Raised Crosswalks.

1320.04(4) Speed Control

Roundabout operation performance is dependent on low, consistent vehicle speeds. Low and consistent operating speeds facilitate appropriate gap acceptance by an entering driver. Design for travel path operating speeds between 15 mph and 25 mph (see Section 1320.04(4)(a)). Design to have low-speed differentials (12 mph or under) between entering and circulating traffic. Multilane roundabouts might have higher speeds along their respective travel paths, but generally 30 mph or less.

The ideal design speed mechanism has the entry and circulating speeds being similar. This varies due to size, shape and context of the roundabout.

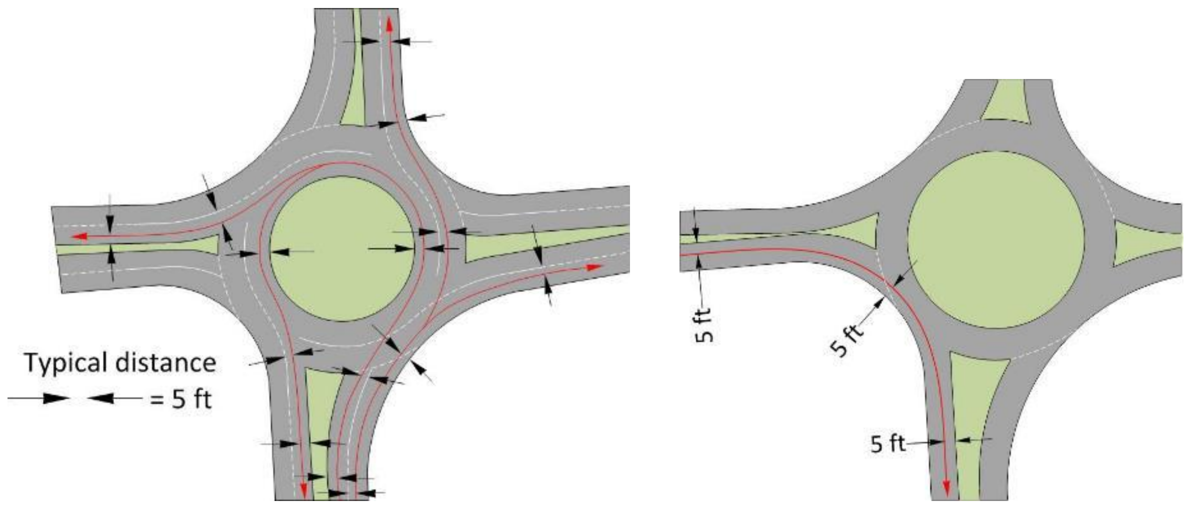
The vehicle then moves into and through the circulation lane, being controlled all along by the design speed of the circulating lane. The circulating design speed influences the exit speed.

Designing geometric entry and exit speed control encourages lower speeds and lower speed differentials at conflict points, which reduces the potential for collisions.

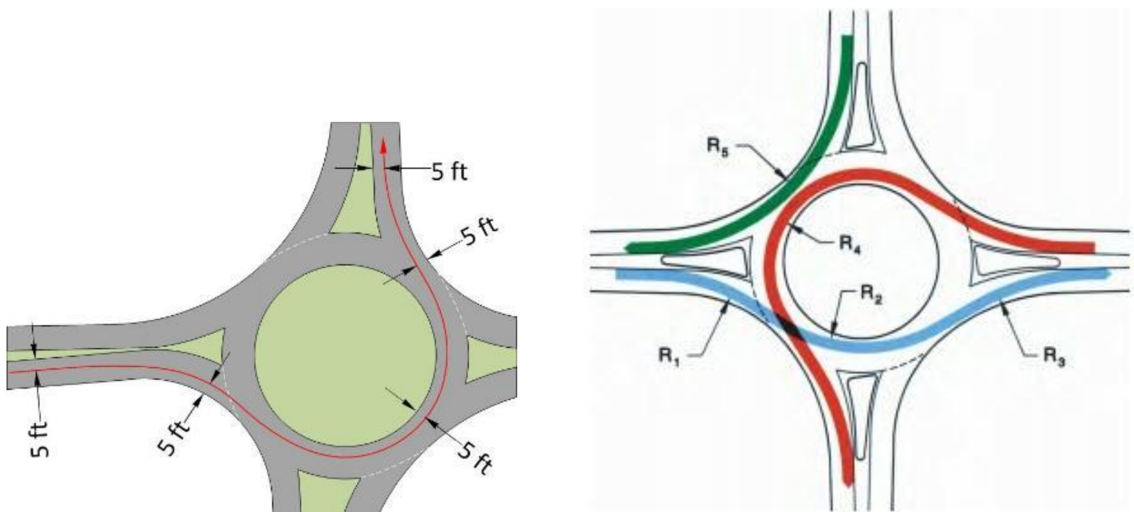
1320.04(4)(a) Roundabout Deflection and Travel Path Design Speeds

Vehicle deflection, or the degree to which a vehicle must travel off a straight line through the roundabout, is a key component of speed control through the roundabout. Deflection is controlled by the geometry of the outer entry curbs, entry width, circulating roadway width, and central island geometry, which together establish the fastest path through the roundabout.

Travel path calculations can be used on all roundabout designs to get an understanding of speeds for different paths throughout the roundabout including any right-turn slip lanes. A travel path is the shortest path through the roundabout that is no closer than 5 feet from any curb face or lane line as shown. Use Exhibit 1320-2 and R1 through R5 to determine Travel Path design speeds.

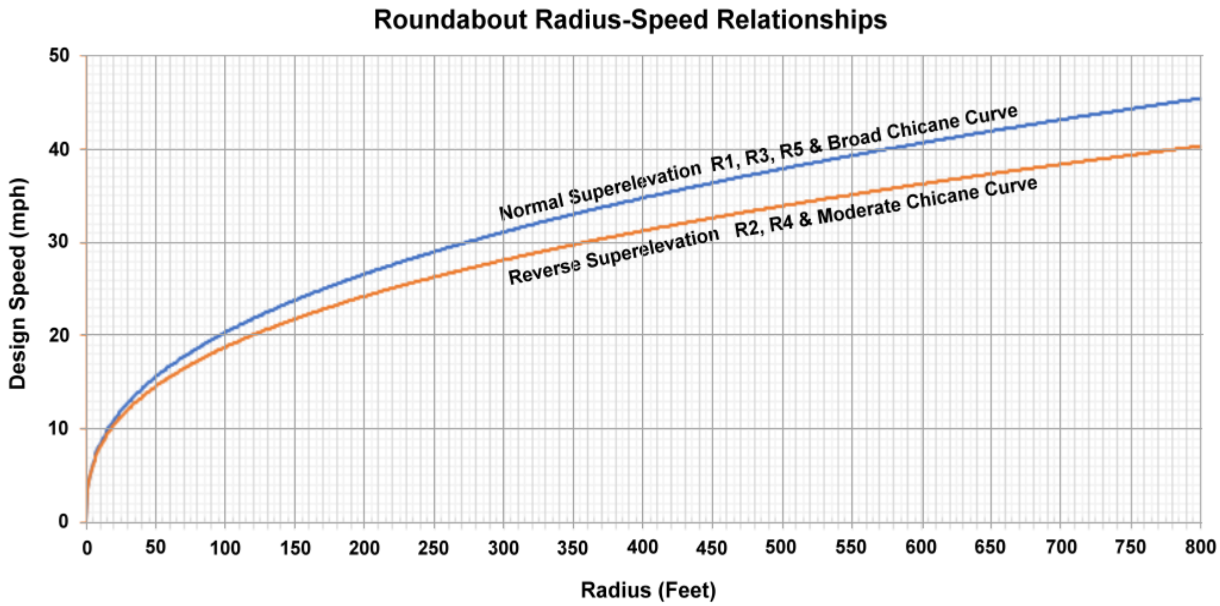


Travel paths



Source: NCHRP

Exhibit 1320-2 Radii-Speed Relationship on Approach Legs and R Value Relationships (Replotted 2024)



Normal Superelevation e = 0.02 $V = 3.4415 \times R^{0.3861}$

Reverse Superelevation e = 0.02 $V = 3.4614 \times R^{0.3673}$

Where:

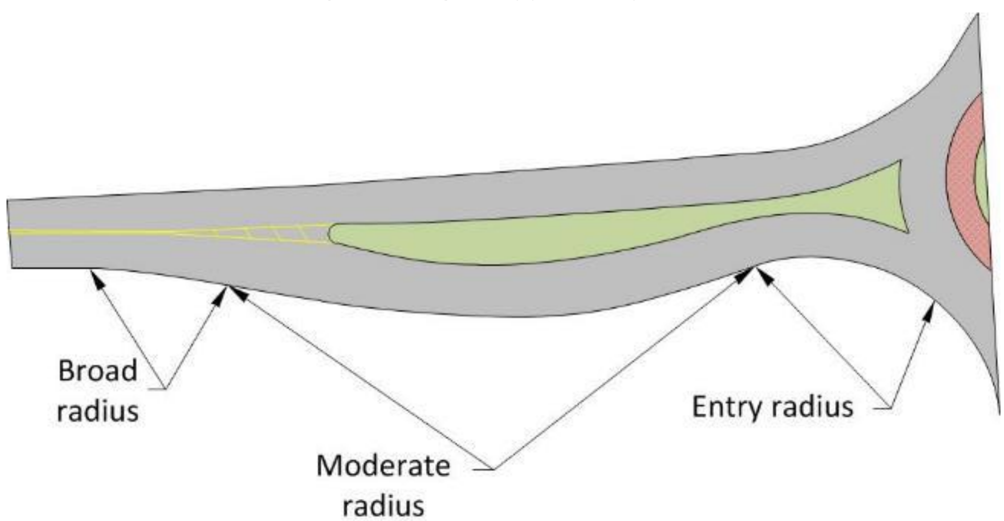
e = Cross slope (foot per foot)

V = Design speed (mph)

R = Radius (Feet)

1320.04(4)(b) 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.



Chicane

Consider chicanes where posted speeds near the roundabout are 45 mph or higher. Design chicane curves with successively smaller radii in order to successively reduce vehicle design speeds approaching the roundabout entry.

Chicanes are made up of three curves: the broad curve, the moderate curve, and the entry curve of the roundabout. Use Exhibit 1320-2 to determine the curves radii based on their design speeds.

Also, consider the grade of the chicanes, 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 1360-11.

This pdf tool, Chicane Fastest Path Curve Design Speeds, helps Designers design chicane curves. It determines the broad and moderate curves based on the speed of the posted mainline and the design speed of the entry curve.

1320.04(4)(c) Design Clear Zone (New 2024)

According to Section 1600.02(3), the Design Clear Zone is typically determined using the roadway's posted speed. However, in a roundabout, vehicles slow down due to the deflections of the fastest paths and the curve design speeds of any chicanes. For roundabout Design Clear Zone calculations, use the fastest path design speeds of the curves within the roundabout, including those of any chicanes (see Section 1320.04(3)).

Essentially, the clear zone widths should be based on the design speed of a curve throughout the curve and between curves, transition the speed from the design speed of one curve to the design speed of the next curve. The curve fastest path speeds and transition speeds serve as substitutes for the posted speed in Design Clear Zone calculations. The Design Clear Zone for roundabouts is then calculated using the standard process outlined in Section 1600.02, based on the fastest path design speeds.

In cases where there is an overlap, such as curves R4 (left-turn) and R5 (right-turn) (see Section 1320.04(4)(a)), use the design speed of the faster curve to determine the clear zone.

1320.04(5) Grades

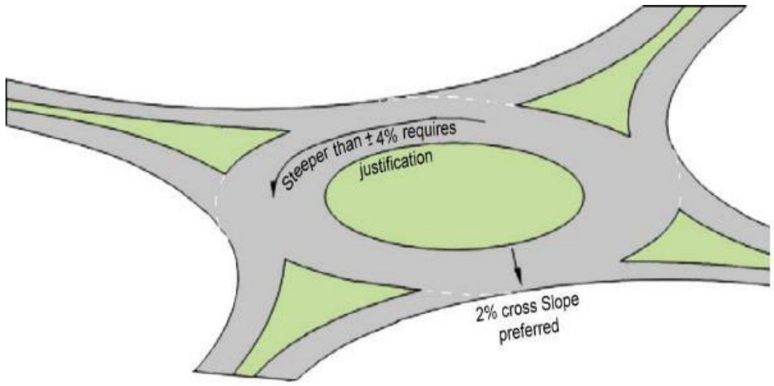
Consider the grades of the roadways into the roundabout, as a vehicle can more easily slow down on an upgrade into the roundabout than on a downgrade. Adjust the length of the deceleration based on the “Adjustment Factors for Grades Greater Than 3%” in Design Manual Exhibit 1360-11.

Do not use grades as a constraint during scoping to rule out a roundabout. Be aware of how the profiles mesh with sight distances and ADA pedestrian requirements.

1320.04(6) Circulatory Roadway Profile and Cross Slope

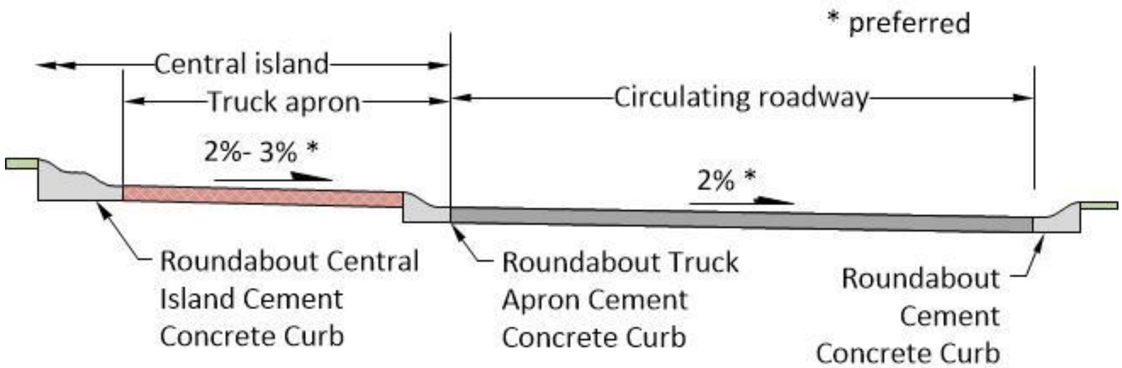
The preferred profile grades of the circulatory roadway of a roundabout are ±4% or flatter radially around the circulatory lane(s). Profile grades steeper than ±4% require **justification**. It is preferred to bench the roundabout if practicable to reduce profile grade.

Vertical curve calculations typical of tangential roadways are not applicable to roundabout geometry.



Preferred grades and cross slopes

The preferred circulatory roadway cross slope is 2% however, site conditions may require cross slopes ranging from 1.5% to 4.0%, sloping 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.



Drawing shows preferred cross slopes. Site conditions and drainage may require slopes outside these ranges.

1320.04(7) Design Tools

During the scoping or preliminary geometric design process, do not to use truck turning paths alone as a constraint to eliminate a roundabout at an intersection. There are several design tools available to aid in the design of a roundabout. It is important to understand how the software works, its default settings, and its application to the design process.

1320.04(7)(a) Vehicle Swept Path Flexibility

Managing vehicle speeds is a goal in roundabout design. Therefore, selection of a design vehicle that fits the transportation and land use context while balancing vehicle speed and accommodation is a key first step. Section 1103.03(4), states, “WSDOT policy provides flexibility when choosing the intersection design vehicle. The purpose for this policy is to balance user needs and avoid the unnecessary expense of oversizing intersections.” Once vehicle(s) have been selected for both design and accommodation, there are certain assumptions that must be made with software programs that replicate vehicle swept paths. Determine which defaults are to be used or modified so that different movements can be modeled. Every effort should be made to minimize swept paths using modeling software. Swept paths of infrequent vehicles also have the added benefit of drivable curbing that adds flexibility and redundancy to designs. See Section 1103.03(4) and 1310.02(5) for guidance on determining modal priority and design vehicles.

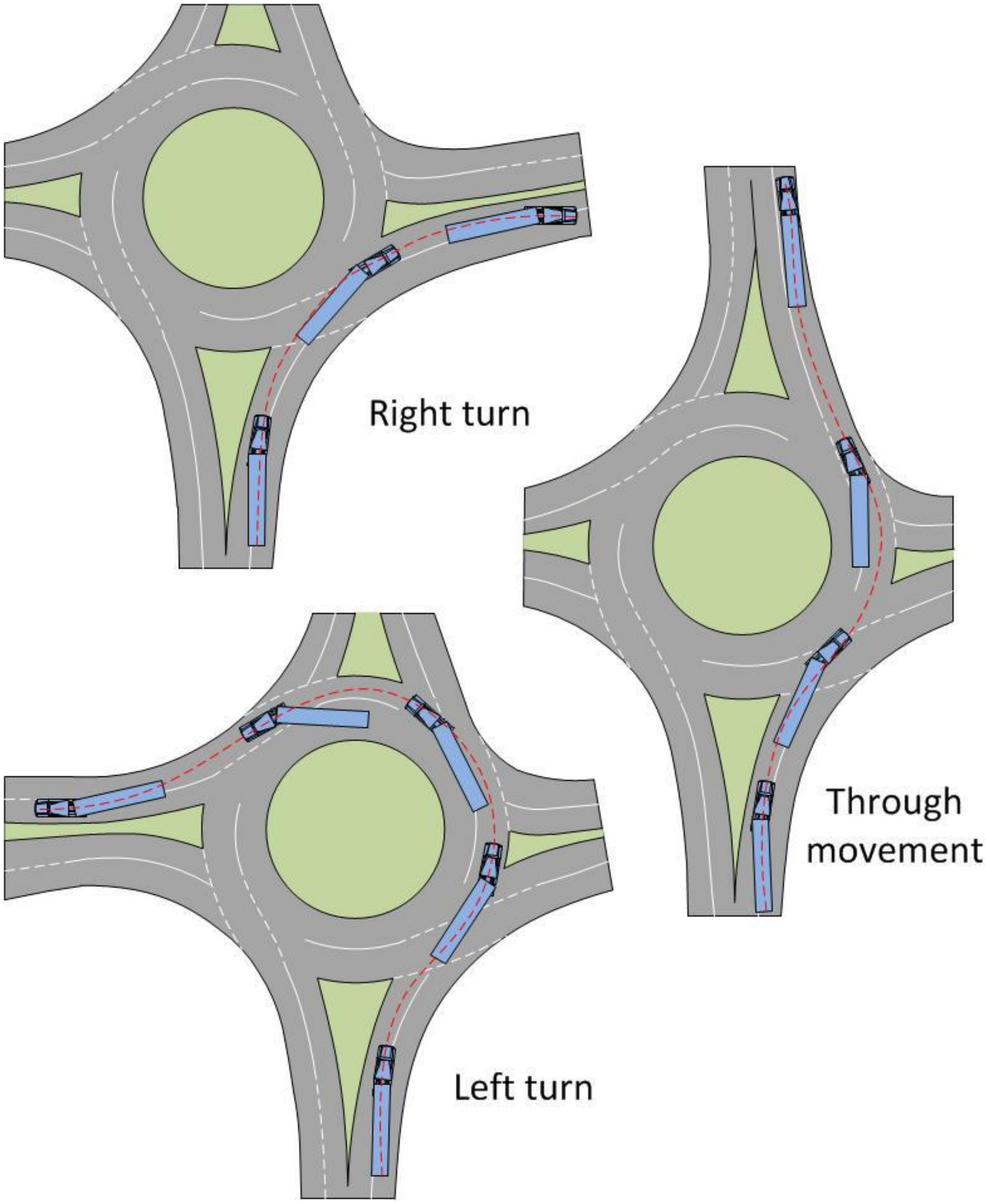
1320.04(7)(b) Vehicle Swept Path

In some cases, roundabouts of the perfect circular variety with symmetrical roadway attachments require less specific knowledge of truck-turning software and its applications. However, when looking at a non-circular shaped roundabout where the combination of the truck's speed, its turning angle settings, its rear axle locations, and its alignment are the critical design elements to address, a mastery of the software is required. Designers that are unfamiliar with how to apply the software inputs accurately to model a truck's swept path need to contact HQ Transportation Operations Division for guidance. Poor alignment of a truck swept path can result in unnecessarily large roundabout footprints, higher than desired Travel Path speeds, or uncomfortable driving maneuvers by the freight community.

Assume that a commercial vehicle will travel much slower through a roundabout than the Travel Path speed calculated for passenger vehicles (see Section 1320.04(4)(a)). Adjust the software input to allow a slower truck speed in order to make a good engineering judgment about how fast a truck may use a roundabout (for example, for AutoTURN® use 5 mph or less). Design tool default settings may not allow the maximization of the vehicle turning abilities and can limit the designer from getting a balanced design between passenger car speeds, commercial vehicle accommodation, and other intersection objectives.

Single lane roundabout - Truck using the truck apron

When using a truck-turning software tool like AutoTURN® on multilane roundabouts, assume a truck's travel path will occupy (straddle) parts of two adjacent lanes.



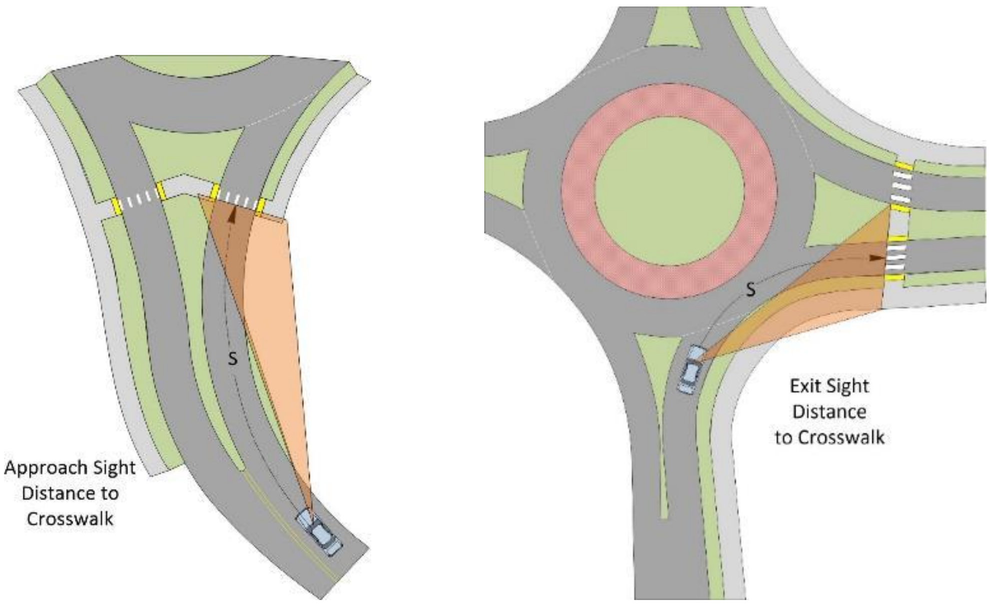
Multilane roundabout - truck straddles lanes

1320.04(8) Horizontal Sight Distance

Horizontal sight distance is an important design 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.

1320.04(8)(a) Stopping Sight Distance

Use the design stopping sight distance in Chapter 1260. Anticipated speeds throughout the roundabout can be calculated using Exhibit 1320-2, based on the Travel Path radius and direction of the particular curve. The design stopping sight distance is measured along the vehicle's path as it follows the curvature of the roadway; it is not measured as a straight line.



Sight distance – Approach and Exit

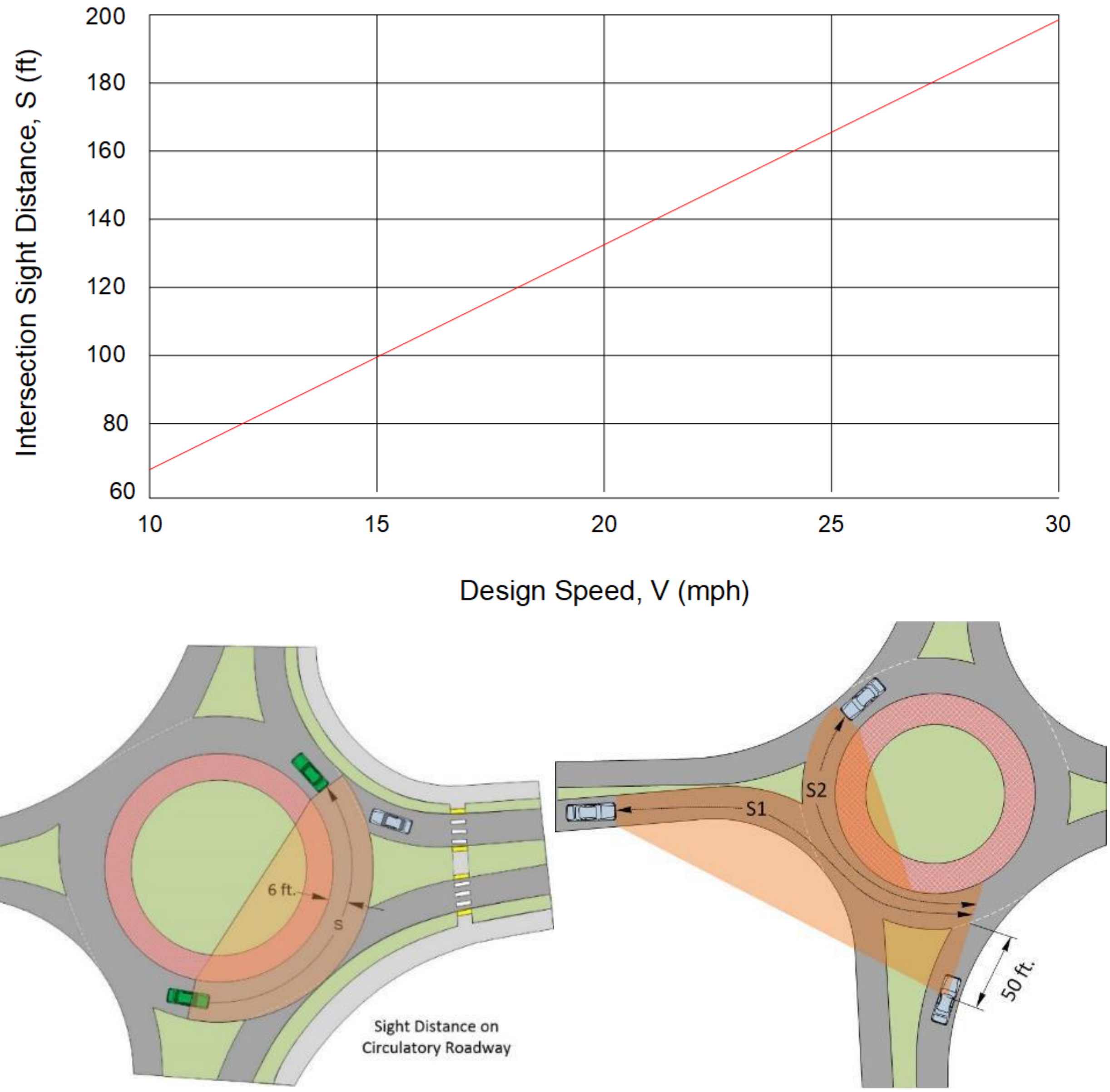
1320.04(8)(b) Intersection Sight Distance

Provide minimum intersection sight distance. 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 aid in judging an acceptable gap.

The intersection sight distance at roundabouts is given in Exhibit 1320-3. The S1 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 circulating speed only.

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.

Exhibit 1320-3 Intersection Sight Distance



1320.04(9) Railroad Crossings

Although it is undesirable to locate any intersection near an at-grade railroad crossing, this situation exists at many locations on the highway system. Experience shows that a roundabout placed near a crossing has some operational advantages. If there is a railroad crossing near the roundabout contact HQ Transportation Operations Division for further guidance.

1320.05 Active Transportation (New 2024)

Roundabouts have been shown to provide a greater degree of safety for active transportation users in comparison to traditional intersections. Properly designed roundabouts can support many of the functional characteristics described in Section 1310.03 to improve the safety and comfort of active transportation users at intersections, including:

- Decrease pedestrian/bicyclist **exposure** to points of conflict with motor vehicle traffic – roundabouts have fewer conflict points in comparison to signalized or stop-controlled intersections
- Decrease motor vehicle **operating speed** – roundabout motor vehicle design speeds are typically between 15 and 25 mph; additional features can also reinforce lower vehicular speeds at crosswalks
- Increase the **predictability** of all movements
- Increase **separation in space** between motor vehicles and pedestrians/bicyclists – achieved through minimizing crossing distances and providing separation between motor traffic and active transportation facilities

In addition, added features can improve the remaining functional characteristics:

- Increase **separation in time** between motorists and pedestrians/bicyclists – some roundabouts may use pedestrian hybrid beacons or pedestrian signals at crosswalks
- Increasing pedestrian/bicyclist user **conspicuity** – achieved through rectangular rapid flashing beacons, warning signage, and marked crosswalks for pedestrians and bicyclists

Although roundabouts have been shown to improve safety for active transportation users in comparison to traditional intersections, roundabouts can potentially introduce certain complexities to active transportation routes through the intersection since the active transportation path is typically not rectilinear and the preferred crossing locations may not be as easy to find for low vision pedestrians.

The route for pedestrians to execute a crossing at the preferred location for a roundabout must be clearly identified. The approved ICE may determine the level of pedestrian accommodation needed (see Chapter 1300). Always design the roundabout keeping in mind the ADA requirements for crosswalks, sidewalks, paths, and other pedestrian facilities even if those facilities are not included in the project. Existing land uses and the roadway context may change during a roundabout's service life. Even if sidewalk and crossing facilities are not constructed as part of the original project, the project's design should not preclude future crossings by requiring significant reconstruction to include pedestrian facilities in the future. For example, splitter island cut-throughs and electrical conduit and junction boxes for pedestrian activated crossing beacons or signals should be included in the project for future compatibility.

The expected route intended for cyclists must be clearly identified so that cyclists of different abilities are able to understand how to navigate the roundabout. When traveling through roundabout intersections, bicyclists of different abilities may choose to either join vehicular traffic in the circulatory roadway or, if provided, use separated bicycle facilities. Typically, conventional bike lanes are terminated on the approach to the roundabout and then resume after the roundabout. In this configuration, bike ramps are typically provided in order to provide bicycle access to the sidewalk or shared use path. Bike ramps (see Section 1520.05(5)) can also be used when no bike lanes are present as a means for cyclists to access the sidewalk through the roundabout.

Marked bike lanes within the circulating lane of a roundabout are prohibited under the MUTCD; however, separated bike lanes can be carried through a roundabout because they are physically separated from the circulating lane. In some locations it may be advantageous to use separated bike lanes in the roundabout even if the approach legs use conventional bike lanes.

1320.05(1) Facility Selection (New 2024)

Determine the appropriate type of pedestrian/bicyclist facility based on the bike and pedestrian facilities connecting to the roundabout and the land use context surrounding the roundabout. For additional information on facilities for bicyclists and pedestrians, refer to Chapter 1510, Chapter 1515, and Chapter 1520.

In most cases, a roundabout includes a widened sidewalk around the perimeter of the roundabout with bike ramps from street level to provide bike access to the sidewalk (see Section 1320.05(2)(b)). In some of these cases, the widened sidewalk functions as a shared-use path and should follow the design guidance provided in Chapter 1515. In locations where the widened sidewalk is not intended to function as a shared-use path, the minimum buffer of 3 feet is still used.

For roundabouts located on state routes that are within or near population centers but have no existing sidewalks on the highway, the roundabout should include raised sidewalks or curb-separated walkways around the roundabout that meet the requirements of Chapter 1510. Raised sidewalks can be ramped up from the roadway shoulder at the project limits.

In locations with very high bicycle activity, or in locations where separated bike lanes (see Chapter 1520) exist or are planned along any legs of the intersection, separated bike lanes can be considered within the roundabout. Separated bike lanes within the roundabout can be matched to either separated bike lanes or to conventional bike lanes on the legs of the intersection.

Roundabouts located in very rural areas with no existing or planned bike or pedestrian facilities on the approaches should use the same shoulder width present on the approaches around the perimeter of the roundabout, or wider. If there are any planned or otherwise expected land use or other contextual changes proposed in the area, the roundabout should include dedicated bicycle or pedestrian facilities.

1320.05(2) Active Transportation Design Elements (New 2024)

1320.05(2)(a) Buffers (Rewritten 2024)

The type of bicycle and pedestrian facilities and associated buffers directly affect the quality of service, comfort, and accessibility for people walking and biking at a roundabout. Buffers between biking and walking facilities and the circulatory roadway, such as landscape buffers or other detectable edge treatments, are required components of the design. The buffer may include landscaping or other surface treatments that are detectably different from a normal walking surface. These buffers provide many benefits, including increased comfort for people walking, room for signs and other street furniture, snow storage, and space for the overhang of large vehicles as they navigate the roundabout.

At locations where the pedestrian facility is a widened sidewalk that is not part of a shared use path, the minimum buffer width is 3 feet. At locations where a shared use path runs along the outside of the roundabout, the buffer should follow the separation guidance provided in Chapter 1515. Typically for a shared use path along a roundabout, a minimum buffer width of 5 feet is used, although other buffer options as described in Chapter 1515 may be applied. For roundabouts that include separated bike lanes, the separation between the bike lane and the roundabout circulating lane should follow the separation guidance provided in Chapter 1520. If separated bike lanes are used, no additional buffer is required between the separated bike lane and the sidewalk, unless the separated bike lane is raised to the same elevation as the sidewalk. See Chapter 1520 for details on separation between raised separated bike lanes and adjacent sidewalks.

Note that providing bike ramps as an option for cyclists to enter a widened sidewalk around the roundabout does not in itself create a shared use path; cyclists are legally allowed to ride on sidewalks at most locations. However, if the bike ramp is provided such that all cyclists are expected to enter the widened sidewalk around the roundabout, the sidewalk does become a shared use path and should be designed according to Chapter 1515.

Different treatments may be used on different legs of the roundabout depending on the type of bicycle and pedestrian facility provided on each individual leg (e.g., some roundabouts may have a shared use path on one leg and only widened sidewalks on the other legs).

See Standard Plan F-10.18 for typical roundabout buffer layout.

1320.05(2)(b) Bicycle Ramps (New 2024)

Design bike ramps in accordance with Chapter 1520.

1320.05(3) Pedestrian/Bicyclist Marked Crossings (New 2024)

Marked crosswalks are typically used to establish crossing locations for pedestrians and cyclists. In locations where separated bike lanes are included with the roundabout, the standard crosswalks may be supplemented with separate bikecross markings to separate the bicycle and pedestrian crossing movements. See Chapter 1520 for information about bikecross markings.

At all crossing types, adequate sight distance must be provided so motorists entering or exiting the roundabout can recognize a potential conflict and stop as required. See Section 1320.04(8)(a). Similarly, pedestrians and bicyclists approaching the crossing can make better gap acceptance choices with adequate sight distance. Sidewalk landings and pedestrian approaches to crossings should be oriented in such a way as to provide a clear view of oncoming traffic. Avoid orienting pedestrian crossing approaches such that pedestrians must look over their shoulder to view conflicting traffic. Determining the crossing configuration early in planning and design helps establish the roundabout footprint.

Crosswalks are typically located about 20 feet from the outside edge of the circulating lane. For the entry side of the approach this allows a pedestrian to walk behind a vehicle that is waiting at the yield line of the circulating lane, and for the exit side this allows a vehicle to stop for pedestrians without blocking the circulating lane. Verify that sight distance is provided throughout the roundabout, based on design speed based on Section 1320.04(4)(a).

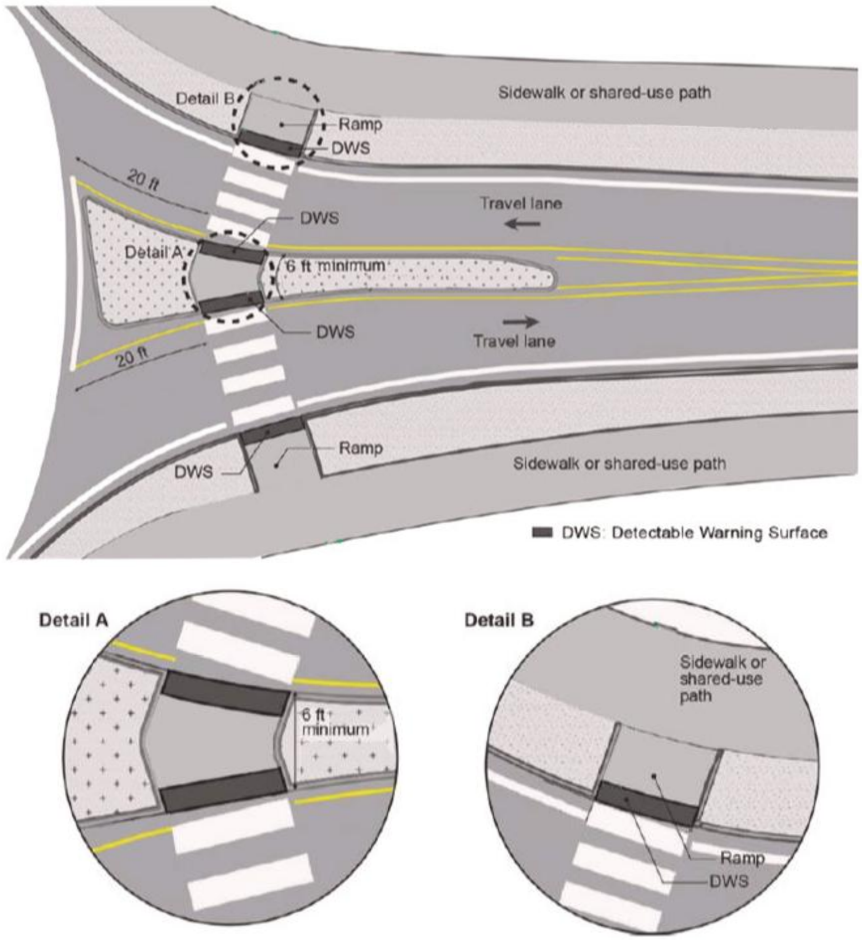
1320.05(3)(a) Crossing Alignment (New 2024)

Avoid staggered or Z-crossing alignments. Due to splitter island design, staggered crossings can incorrectly orient pedestrians to face away from traffic while crossing the island, can create a barrier for larger bicycles such as family bicycles and adult tricycles, and lateral curbing used to channelize the crossing in a narrow splitter island may create a tripping hazard. If a staggered or Z-crossing is used, document the decision in the Design Documentation Package.

Angled Crossings

Angled crossings are appropriate for use with larger roundabouts because they minimize pedestrian crossing distance. When developing angled crossings, place each leg of the crosswalk perpendicular to the outside curb of the entry and exit lanes and locate the angle point near the center of the splitter island. Exhibit 1320-4 shows this option.

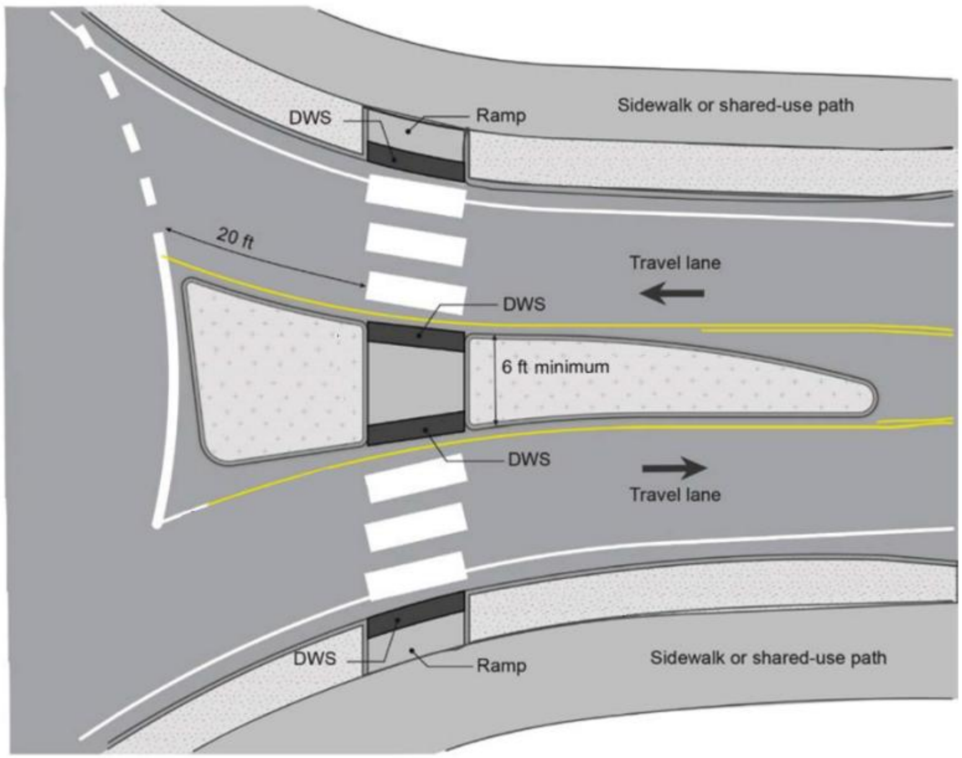
Exhibit 1320-4 Typical Features of Angled Crossing (New 2024)



Straight Crossings

Straight crossings are appropriate for use when providing continuity of a shared-use path, and on smaller roundabouts. For straight crossings, place the entire crosswalk perpendicular to the centerline of the approach roadway. Exhibit 1320-5 shows this option.

Exhibit 1320-5 Typical Features of Straight Crossing (New 2024)



1320.05(3)(b) Ramps and Landings (New 2024)

Ramps connect to the sidewalks at each end of the crosswalk. Design crossing or crosswalk ramps in accordance with Section 1510.08 and Section 1515.02. Depending on topography, in some locations the connection will be designed as a landing rather than a ramp.

1320.05(3)(c) Splitter Islands (New 2024)

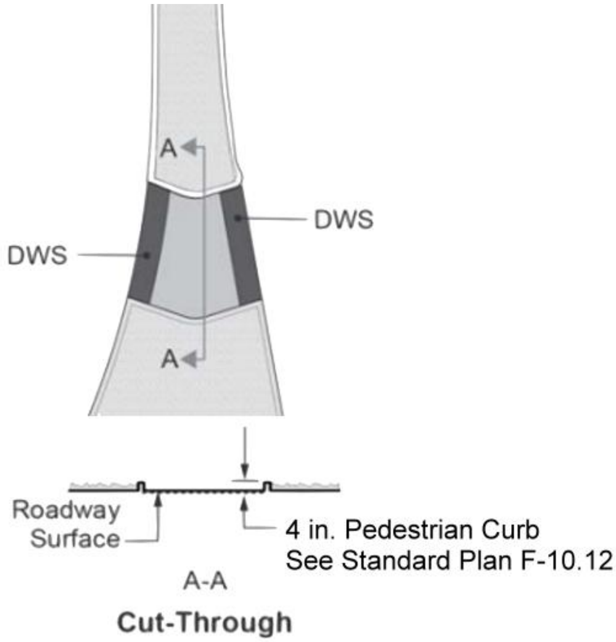
If the splitter island is intended for use as a pedestrian refuge, refer to Section 1510.10(1) for design guidance.

On small roundabouts with very narrow (i.e., narrower than 6 feet) or very short splitter islands, the splitter island may not be sufficient to provide a pedestrian refuge area. In this case, if a marked crosswalk is provided the crosswalk should be marked all the way through the island.

Consider site context and whether there is a need to design for larger groups of people, people pushing strollers, people on cargo bicycles or bicycles with trailers, equestrians, or other anticipated users.

Design walkway through the splitter island to be cut through as shown in Exhibit 1320-6.

Exhibit 1320-6 Splitter Island Pedestrian Refuge Design Details (New 2024)



1320.05(3)(d) Bicycle Crossing (New 2024)

At roundabouts with separated bike lanes, design separated bicycle and pedestrian crossings in accordance with Chapter 1520. At roundabouts with bike lanes on the approach that provide bike ramps up to meet sidewalks, design the crosswalk widths to match or exceed the widths of the widened sidewalks or shared use paths that are used around the perimeter of the roundabout.

1320.05(3)(e) Enhancements (New 2024)

For multi-lane crossings, at all roundabout approaches or exits, crossings must be enhanced with pedestrian actuated Rectangular Rapid Flash Beacons (RRFB) or a raised crossing, or both. The enhancement should be applied across the entire crossing even if only one direction of the leg has more than one lane. Consult with the Region Traffic Office regarding design and placement of RRFB equipment.

In some cases, other enhancements such as pedestrian signals or a pedestrian hybrid beacon can be used on multi-lane approaches in lieu of an RRFB or raised crossing but contact HQ Transportation Operations office if these devices are under consideration. The Region Traffic Engineer approves the final signing, delineation, and use of activated traffic control devices such as RRFBs.

For single lane roundabouts, there may be locations where enhancements may be considered based upon transportation context, land use context, and intersection geometry.

Raised crosswalks (see Section 1510.09(3)) can be applied to any crossing alignment option to encourage slow vehicle speeds and enhanced driver stopping behavior. The ADT and posted speed requirements in Section 1510.09(3) for the use of raised crosswalks do not apply at roundabouts. The raised crosswalk elevation should not be higher than the roundabout curbing elevation.

RRFBs may also be used on single lane roundabouts at locations with no pedestrian refuge between opposing lanes of traffic, high pedestrian use, near schools, or other contextual circumstances that may indicate a benefit in their use.

1320.05(4) Rural Roundabouts and Active Transportation (New 2024)

At rural roundabouts in low density contexts where there are no dedicated pedestrian and bicyclist facilities, existing or planned, it is best practice to provide splitter island cut-throughs that may be compatible with potential construction of future pedestrian facilities. Do not mark or sign crosswalks if no dedicated pedestrian facilities exist (note that a roadway shoulder is not a pedestrian facility). Refer to Section 1320.04(3)(d) for more information on splitter islands.

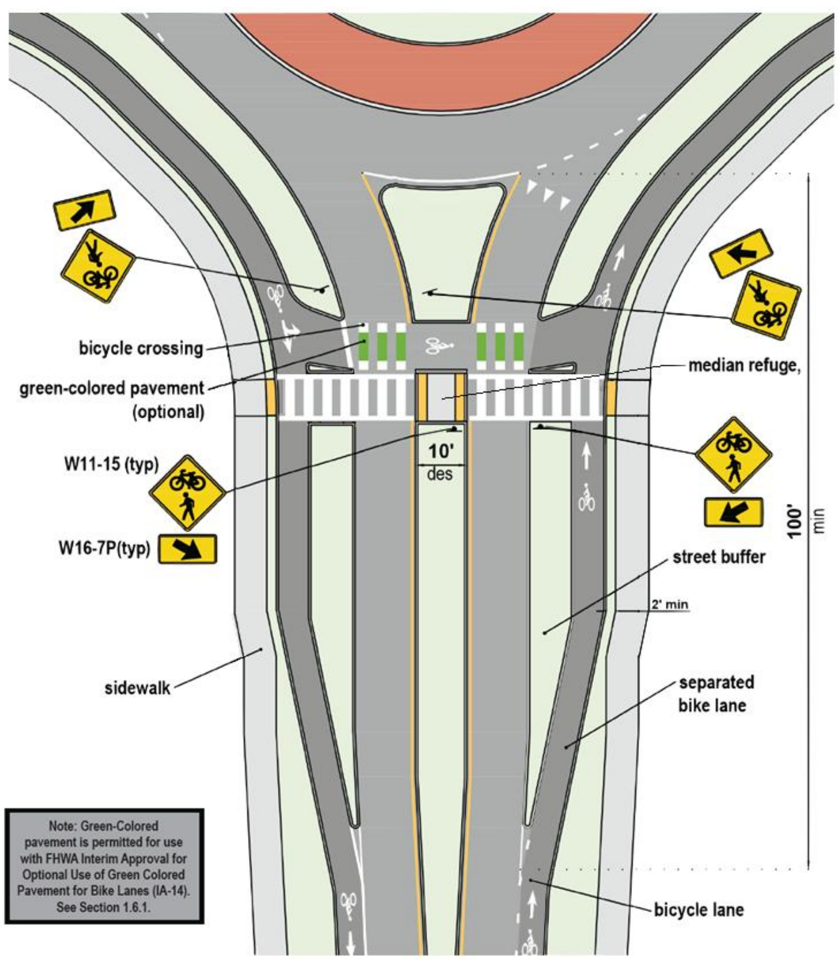
1320.05(5) Signing (New 2024)

For additional information, refer to the MUTCD, Plan Sheet Library, Sign Fabrication Manual and the *Standard Plans* for details on signing.

A preliminary sign plan is developed to identify existing and proposed signing on state highways. Sign plans on state routes are to be reviewed and approved by the region Traffic Engineer

The plan provides an easily understood graphic representation of the signing, and it provides statewide uniformity and consistency for regulatory, warning, and guide signs at roundabouts on the state highway system.

Exhibit 1320-7 Typical Layout of Separated Bike Lanes at Roundabouts (New 2024)



Signing example

1320.06 Drainage Features

The type, frequency, and placement of drainage features in a roundabout can influence operational performance and cause the drainage features to be damaged by vehicles. For example, vehicles in a multi-lane roundabout may shy away from drain inlets placed in the traveled way thus compromising the roundabout's optimal performance of channelizing vehicles and speed control. Consult with the Region Hydraulics Engineer early in the project development process to identify the best design characteristics that both facilitates drainage features and optimizes roundabout performance.

1320.07 Pavement Marking

See Standard Plan M-12.10 for roundabout pavement marking details. Consult Region Transportation Operations on traffic pavement markings and materials.

1320.08 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. Consult with the Region Transportation Operations Office for illumination design. (See Chapter 1040 for additional information on illumination.) On higher-speed approaches, consider internally illuminated bollards (IIB) in lieu of other illumination.

1320.09 Road Approach, Parking, and Transit Facilities

Road approaches are typically not located on the approach or departure legs within the length of the splitter island. If a road approach is necessary in the splitter island area, it is limited to right-in/right-out.

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. When minimum corner clearance cannot be met, document the decision in accordance with Chapter 530 and Chapter 540.

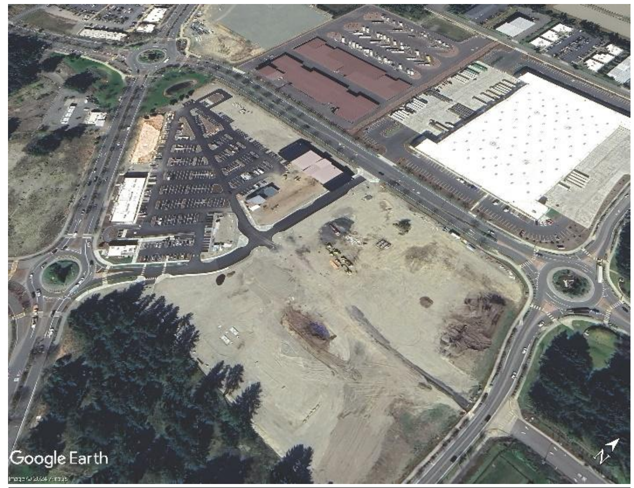
Driveway access within the circulating roadway is not desired if other access locations exist onto a property or if relocating them to the roundabout approach is reasonable. If a parcel adjoins two legs of the roundabout, it is acceptable to provide a right-in/right-out driveway within the length of the splitter islands on both legs.

For roadway links between roundabouts consider access management strategies such as raised medians. Left-turn access is 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.

Roundabouts are an effective intersection control strategy on transit corridors and bus stops are commonly located in the vicinity of roundabouts. The placement of bus or other transit stops near roundabouts should be consistent with the needs of the users and the desired operations of the roundabout and transit provider. Transit stops are not allowed in the circulating roadway, however nearside and farside stops are operationally effective. Coordinate transit stop location and design with local public transportation provider.

Driveway approach within circulating area - Yelm Hwy SE, Olympia WA (Source: Google)



Access Management - Marvin Rd NE and Willamette Dr, Lacey WA (Source: Google Earth)

Five-leg roundabout with commercial property access driveways split between two approaches – 84th Ave at SR520, Bellevue (Source: Google Earth)

In-lane transit stop on near side of roundabout approach – Carpenter Rd SE, Lacey WA (Source: Google)

1320.10 Geometric Design Peer Review (Rewritten 2024)

A peer review is a crucial part of the roundabout design process, which is iterative and benefits from expert feedback. Conduct a peer review for new roundabouts and changes to existing roundabouts that affect the capacity or the geometry of the roundabout. The peer review should take place soon after the conceptual roundabout layout is developed, and its goal is to examine, discuss, evaluate, and comment on the preliminary 2-D roundabout layout design.

The participants of the peer review team should include:

- Region Traffic Office
- Assistant State Traffic Engineer
- Region Project Development Engineer
- Engineering Manager
- Assistant State Design Engineer
- Region Landscape Architect in roundabouts with special architectural features

The peer review team should be presented with a clear and comprehensive description of the project and the roundabout development up to that point, including the following elements:

- Basis of Design (BOD)
- Intersection Control Evaluation (ICE)
- Design vehicle and accommodated vehicle turning paths (for each leg)
- The existing intersection operational performances (traffic volumes, level of service, and sight distances, vehicle speeds).
- The presence of bikes and pedestrians and what ideas have been developed to accommodate them.

After the peer review, all the discussions, decisions made, and the reasons behind them should be documented. This will help keep track of the design changes and justify them if needed.

Additionally, it is best practice to schedule another roundabout peer team meeting before the PS&E review, to update the team members and verify the final design.

1320.11 Intersection Plan for Approval (New 2024)

Provide intersection plans for any changes in capacity, modification of channelization, or change of intersection geometrics. Support the need for intersection or channelization modifications with history; school bus and mail route studies; hazardous materials route studies; pedestrian use; transit routes and stops; public meeting comments; etc.

For information to be included on the intersection plan for approval, consult your region Plans for approval (PFA) checklist, or if your region does not have one, see the Plan for Approval Checklist on the following website: Design guidance & support | WSDOT (wa.gov)

1320.12 References

1320.12(1) Federal/State Laws and Codes

See Chapter 1510 for Americans with Disabilities Act Policy and references

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

1320.12(2) Design Guidance

Roundabout Cement Concrete Curbs: *Standard Plan F-10.18-03*

Roundabout Pavement Markings: *Standard Plan M-12.10*

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)

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

1320.12(3) Supporting Information

Roundabouts: An Informational Guide (First edition 2000), FHWA-RD-00-067, USDOT, FHWA

www.fhwa.dot.gov/publications/research/safety/00067/index.cfm

Roundabouts: An Informational Guide (Second Edition 2010), NCHRP Report 672, Transportation Research Board, 2010 fhwa.dot.gov/publications/research/safety/00067/00067.pdf

Guide for Roundabouts, NCHRP Report 1043, Transportation Research Board, 2023

Highway Capacity Manual (HCM), Transportation Research Board, National Research Council, Washington D.C., 2000

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

Manual on Uniform Traffic Control Devices, U.S. Department of Transportation, Federal Highway Administration, Washington D.C. as adopted by Washington State. https://wsdot.wa.gov/engineering-standards/all-manuals-and-standards/manuals/manual-uniform-traffic-control-devices-mutcd.

Roundabouts, Insurance Institute for Highway Safety (IIHS). https://www.iihs.org/topics/roundabouts#safety-benefits.

Intersection Safety, Federal Highway Administration. https://highways.dot.gov/safety/intersection-safety/about.