INFRASTRUCTURE/ **INTERSECTIONS AND CROSSINGS**

ROUNDABOUT INTERSECTIONS

Overview

Simple one-lane roundabouts are the safest intersection type for all users and for cyclists on moderately busy roads. Larger and multi-lane roundabouts can be made cycle-friendly by adding physically separated tracks. The cycle track can be given right of way or not, but design must be adapted to the choice made. Existing tight roundabouts can be improved to favor cycling.

Background and Objectives

Function

Intersections are laid out as roundabouts to assure fluid and safe interchange of traffic on moderately busy and fast roads. They are also used to reduce speeds, especially to mark the beginning of the built-up area and a change of speed limit. When important cycling routes meet moderately busy roads, roundabouts make it safer and easier for cyclists to cross and to turn left and right. Larger roundabouts with higher traffic intensities can be designed with additional provision for cycling safety and comfort.

Scope

Roundabout intersections are recommended when **a cycle link on a local access road** crosses a **moderately busy distributor road** (inside the built-up area 30km/h intersecting with 50 km/h, outside the built up area 50 km/h intersecting with 80 km/h). At low intensities all round, a right-of-way intersection with mixed traffic will be sufficient. When intensities start increasing, a roundabout should be considered, especially in the following situations.

- Both roads are moderately busy (up to 500 pcu/h on the local access road, up to 1.750 pcu/h on the distributor road) and there are fairly high numbers of cyclists (well-used local routes and top local routes, and less used main routes).
- Both roads are busier (even with fairly low numbers of cyclists).

Roundabout intersections are also often used whenever **two moderately busy distributor roads** intersect (50 km/h inside the built-up area, 80 km/h outside; intensities for an individual road up to 1.750 pcu/h). A single-lane roundabout can handle from 2,000 to 2,400 pcu/h. A two-lane roundabout can handle about 4,000 pcu/h. Cyclists can still use them, if the design includes special cycling provisions.

It should be remembered that roundabouts are not recommended on important public transport links (they slow down buses). They are also not pedestrian-friendly, because of the forced detours.

Implementation

Definition

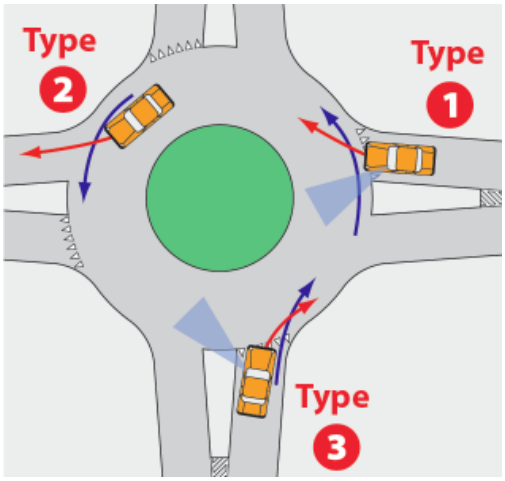
An intersection laid out as a roundabout has a circular central traffic island around which all interchanging vehicles must turn in the same direction in one or more lanes. Normally, approaching traffic must give way to traffic on the roundabout. The intensity of traffic flows determines capacity, dimensions and number of lanes.

Conflicting paths are replaced by weaving movements. This is the main safety benefit. Very busy and multi-lane roundabouts require specific cycle-friendly design.

General design issues for cyclists[1]

Roundabouts increase overall traffic safety. They do not eliminate all risk for cyclists, but **they reduce potential conflicts to just three types**. The first causes more accident than the second and the second more than the third.

1. Motorists entering the roundabout do not give way to the cyclist on the edge of the roundabout. This is mostly an issue on large, multiple-lane roundabouts, because motorists are focusing more towards the centre of the roundabout.
2. Motorists leaving the roundabout cut in front of the cyclist on the edge of the roundabout. This is more risky on large roundabouts, and when a cycle lane forces the cyclist to remain close to the edge.
3. A cyclist entering the roundabout cuts across a motorized vehicle entering the roundabout. This happens when cyclists want to cross in a straight line.



All of these risks are reduced on **single-lane roundabouts,** with **single lane entrance and exit roads**. This should be the preferred solution on cycle routes.

Experience has proven that a **single-lane mixed-traffic roundabout** is **the safest of all intersection types**.

- It avoids encounters between vehicles driving in opposite directions. A four-branch intersection with a roundabout contains only 8 potential conflict points (32 without).
- It simplifies conflict situations: vehicles weave in and out, without crossing paths.
- It reduces speed at conflict points: all vehicles have to follow a curved path, and slow down when entering the roundabout and weaving
- It reduces waiting time, since they have a large capacity and a relatively quick traffic flow.

All of these advantages are valid for cyclists too. When there is a gap, cyclists weave into a single file of traffic and leave easily. A car cannot overtake or cut across the cyclist's path. Cyclists' should not stay close to the edge of the roundabout, but take up position in the middle of the lane.

A **two-lane roundabout** is **a cyclist hazard**.

- Vehicles still move in the same direction, but with weaving movements between lanes.
- The cyclist risks being hit by a car leaving the roundabout from the central lane.
- Cars cutting a straight path across the lanes, approach circling cyclists at a straight angle.

[1] Source for all diagrams (unless otherwise indicated): Brussels Hoofdstedelijk Gewest 2009 *Fietsvademecum*.

Single-lane roundabouts with mixed traffic

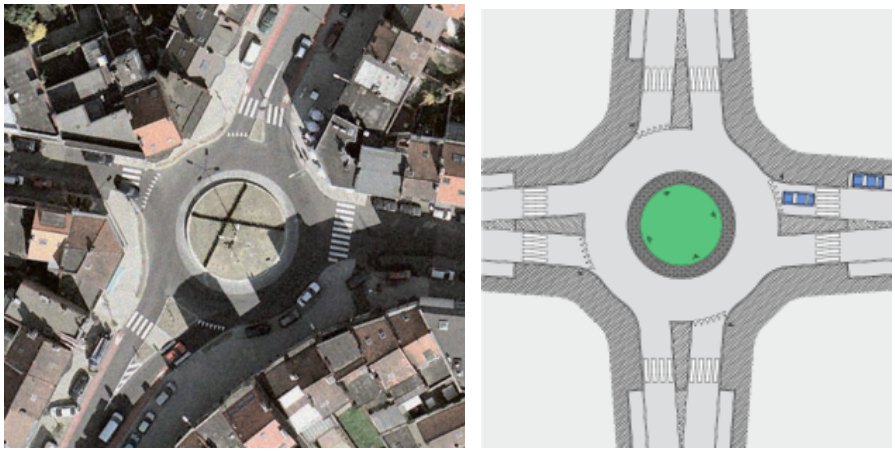
On a single-lane roundabout that handles less than 6000 pcu/day **no special facilities** for cyclists are required. This mostly applies to crossing local access roads busy enough to justify a roundabout, but with overall low speeds (30 km/h in the built-up area).

- **Allow a lane width of is 5 to 6 m**. The outside radius is from 12.5 m to 20 m wide and the radius of the traffic island from 6.5 m to 15 m.
- **Add a rumble strip** around the central traffic island to accommodate lorries and buses. The lane is narrowed down to the size needed by a passenger car, but wider vehicles can overrun the slightly elevated strip.
- **Bend in and truncate** any cycle facilities at 20 or 30 m before, so that cyclists arrive mixed in with traffic at the roundabout.
- **Avoid right-turning traffic bypasses.** Bypasses can significantly increase the roundabout's capacity and safety without an additional lane. However, this is not cycle-friendly: adding lanes means adding conflict points with cyclists, who will have to slow down more frequently. Especially on important cycling links, improved flow and safety for motorized vehicles will come at the expense of cycling flow and safety.
- **Avoid adding a roundabout cycle lane**. Several studies have shown that this is more dangerous than even no roundabout at all.[2] The cycle lane creates a false impression of safety. In reality, it adds another lane and doubles the number of conflict points. Cars can overtake cyclists and cut in front of them. Moreover, a cycle lane forces cyclists to the edge: this creates the impression they are exiting the roundabout even when still continuing. Without a cycle lane, the cyclist weaves between cars in the middle of the roundabout lane.

The dangers of a cycle lane on a roundabout
(source: Vademecum fietsvoorzieningen – Brussels)

On some intersections of slow roads may be rather busy (local access roads, 30 km/h), but there may be no room for a full roundabout. In that case, a **mini-roundabout** can be created. For an intersection diameter below 10 m, the central traffic island may be 5 m across or less. The circular island will only be slightly elevated, so that it can be run over, especially by large vehicles. With proper signaling, the design is clear enough to make vehicles drive around it. Occasionally, vehicles may cut across the central island, especially when turning left.

[2] For instance: Daniels, S, e.a. 2008 – *Injury accidents with bicyclists at roundabouts*, Steunpunt verkeersveilgheid, Flanders, quoted in Fietsvademecum Brussels; R. Schnüll e.a., 1992 – *Sicherung von Radfahrern an städtischen Knotenpunkten* [*Safeguarding bicyclists in Urban Intersections*], Bericht der Bundesanstalt für Straßenwesen zum Forschungsprojekt 8952.



Single-lane roundabout with mixed traffic

Roundabouts with separate cycle tracks

On busy single-track roundabouts (over 6,000 pcu/day) and on two-lane roundabouts **segregated cycle tracks** are recommended. This will apply as soon as a distributor road is involved and up to an intersection load of up to 25,000 pcu/day. From 10,000 pcu/day, traffic lights or grade-separated solutions may be preferable.

Cyclists approach, circle and leave the roundabout on a separate track, crossing the branches of the intersection at a distance from the roundabout. This can safely accommodate fairly large cyclist flows when traffic is busy. Of course, cyclists do have to make detours, but safety is the overriding concern.

The crossings of entrance and exit roads must be designed for maximum visibility and safety.

- **Allow a width of 2 m to 2.5 m for the circular track.**
- **Separate the circular track 5 m from the roundabout carriageway.** This helps to separate and clarify conflict situations. Motorists entering the roundabout first concentrate on crossing cyclists and then on entering the roundabout. Motorists leaving the roundabout have sufficent time to notice crossing cyclists, and room to stack between the roundabout and the track (in cases where the cyclist has right of way, see below).
- **Narrow approaching traffic lanes** as much as possible to minimize crossing distance for cyclists and to slow down traffic.
- **Put in traffic islands** between the approaching traffic lanes, for safer crossing by cyclists.
- **Limit exits to one lane** on a two-lane roundabout. This greatly improves safety on the most risky crossing for cyclists. If there are two-lane exits, a car in one lane may block the view on the other lane and on the cyclist.
- **Consider a speed table for the crossings.** Cyclists should drive on a level path, but the slope reduces car speed and draws motorists' attention.
- **Juxtapose cycle crossing and pedestrian crossings**. This strengthens the visual interruption of the carriageway.
- **Use hard material for the separation between track and carriageway**. This underlines visually that the track belongs with the carriageway. Vegetation is not recommended, because this would stress the separation and possibly hinder visibility.

Right-of-way for cycle tracks on a roundabout

Should cyclists be given **right-of-way or not** on a roundabout? There are arguments for and against, depending on the location.

- If cyclists have right of way, they can drive more smoothly and reduce time delay on the roundabout. Also, legally speaking, a cycle track shares the right of way with the road it is associated with, so this also applies to roundabouts (unless the traffic code specifies otherwise). In this case, vehicles entering the roundabout must give way to vehicles on the

roundabout, including cyclists. This is generally recommended inside built-up areas and especially when cyclist flows are significant.

- Intuitively, it may seem safer to exclude cyclists from the right of way and require them to stop before crossing an entrance or exit road. However, empirical evidence is mixed and inconclusive. The quality of the design seems to be decisive. The drawbacks are clear: the cyclist potentially loses waiting time whenever encountering a motorized vehicle. This option is often recommended outside of built-up areas, where speeds are generally higher, although traffic can be made to slow down by the design.

The situation may differ significantly according to the **cycling level** in a city.

- In CHAMPION CYCLE CITIES, with a strong cycling climate and large numbers of cyclists, car drivers often spontaneously give way to cyclist, even when not legally required. Roundabouts without right of way for cyclists may be less of a disadvantage.
- In STARTER CYCLING CITIES, however, motorists tend to see the cyclist as subordinate, and may find it illogical to give way to an occasional cyclist. They may not accept or respect right of way for cyclists.

The choice between right of way for cyclists or not needs to be made at the start, since these options require a **significantly different design**.

If the choice is **right of way for cyclists**, this may not be understood by all drivers, especially in STARTER CYCLING CITIES. It is therefore recommended to **underline the priority status** of cyclists by the design.

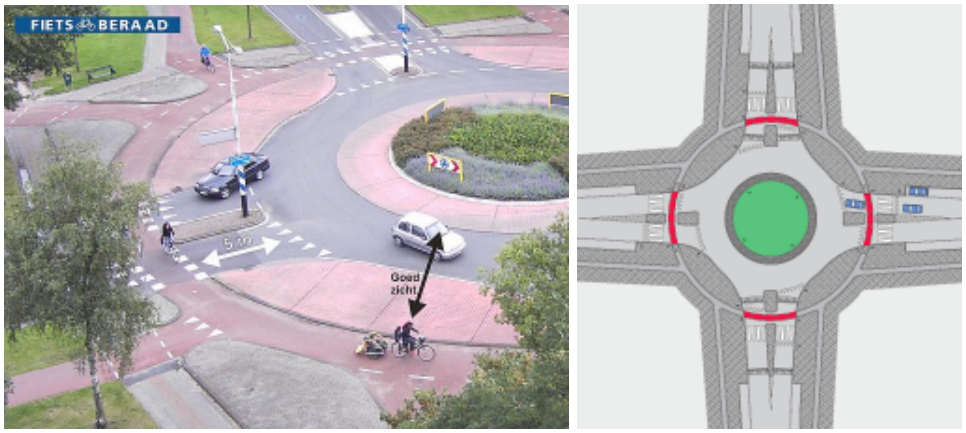
- Continue the **cycle track paving** across the approaching roads. This is crucial.
- Create a smooth **circular cycle path**. The visual parallel with the roundabout lane strengthens the similar priority status. This also more comfortable for cyclists.
- Add **priority markings** on both sides of the track. All traffic, both entering and leaving the roundabout, must give way to cyclists. A vehicle entering must first give way to cyclists at the track and next to motorized traffic when approaching the roundabout carriageway.
- Consider slightly **canting** the cycle track for improved visibility when crossing.

If the choice is **no right of way for cyclists**, this must be made clear and safe for the cyclists.

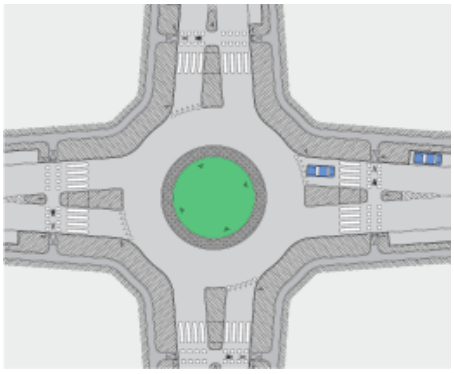
- Create an **angular cycle path**. Design tracks to cross entrance and exit lanes at straight angles. This underlines the priority status of road traffic. At the same time, the cyclist is forced to make a 90° turn and to slow down.
- Provide **wider traffic islands**, allowing cyclists to stock between lanes.
- Do **not continue the cycle track paving** across the approaching roads.

If cycling flows are very high in one direction, a **cycling tunnel below the roundabout** can be considered. In this case, the central traffic island can be opened up to let in daylight into the tunnel.[3]

[3] See fact sheet GRADE SEPARATION



Single-lane roundabout with cycle track, with right of way for cyclists (Enschede, NL). Notice the typical circular design of the track and the colored crossings.



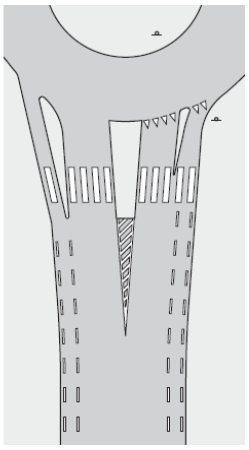
Single-lane roundabout with cycle track, without right-of way for cyclists. Notice the more angular design.

Retrofitting tight roundabouts

Roundabouts with separate cycle tracks are particularly space-consuming. **Often space is simply not available**, particularly on existing roundabouts. However, busy roundabouts on cycle links are risky and unattractive to cyclists and may become a real and perceived physical barrier. Less experienced cyclists will avoid them or feel obliged to step down and walk around them. Alternatively, cyclists may drive on zebra crossing, creating potential conflicts with pedestrians.

The following options can be considered to make a roundabout safer and easier to cross for cyclists. These should be especially considered on top local links in the cycling network.

- **Convert a two-lane roundabout to a one-lane roundabout**, either for mixed traffic or with a separated cycle track. If traffic flows are too high, this needs traffic reduction measures, deviating traffic or traffic calming within an entire neighbourhood.
- **Narrow a wide roundabout lane to 6 m or less**. This reduces conflicts because cyclists and cars weave into a single file.
- **Take out a lane from individual entrances or exits**. This may be done by replacing a traffic lane with a dedicated bus lane, possibly co-used by cyclists.
- **Install speed tables** across entrance and exit lanes.
- **Mark a circular cycle lane (or suggestion lane) on the roundabout, at a distance from the edge.** This improves safety and visibility for cyclists. It creates a clear space for cyclists and draws motorists' attention to their presence. It incites cyclists to ride away from the edge, so that exiting cars can pass them on the outside. Cyclists only weave to the side when exiting themselves.
- **Add splitter islands for safer entering and exiting.** A short narrow separation strip cyclists safe from right-turning entering cars. This can be useful on entry lanes (just before the roundabout) and on the roundabout itself (as as slightly bent out small bypass just before an exit lane).



Splitter islands for safe entering and exiting of cyclists

A cycle lane marked in the middle of the roundabout lane (image source: Fietsberaad)

Considerations

Strengths

- Single-lane mixed-traffic roundabouts are the safest intersection for cyclists, in moderately busy traffic, without any need for special cycling provision.
- Roundabouts with right-of-way separate cycle tracks allow for a fluid and comfortable cycle flow on busy and large roundabouts.

Weaknesses

- Roundabouts with separate cycle tracks are space-consuming and costly.
- On roundabouts with separate cycle tracks but no right-of-way, cyclists are forced to make detours and to stop and start whenever they encounter a motorized vehicle. This reduces the cycle flow to some extent.
- Existing roundabouts that are not cycle-friendly (wide, busy) are a strong barrier on a cycle link, and require cycle-friendly adaptations.
- In starter cities with little cycling culture, motorists may not respect right of way for cyclists, unless strongly underlined and enforced.

Alternative options

- RIGHT-OF-WAY INTERSECTION, when traffic flows can be reduced.
- GRADE-SEPARATION or TRAFFIC-LIGHT INTERSECTIONS when traffic flows are very large.