Quality parameters for cycle infrastructure: at-grade uncontrolled crossings

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1. Introduction

Even on physically segregated cycle infrastructure, cyclists still need to interact with motorised vehicles on crossings. Badly designed crossings that are confusing, with speeding cars or insufficient visibility, might negate the safety benefits of segregation between the crossings.

The factsheet is about **at-grade, uncontrolled crossings, between cycle traffic on a cycle track and lateral motorised traffic**. This includes, for example, a cycle track along a major road crossing a minor arm of an X- or T-intersection, or a cycle track crossing a road in between intersections (mid-block).

Several guidelines have special requirements or separate fiches for roundabouts. As these vary greatly and are somewhat contradictory, roundabouts are not covered in this document. On-carriageway solutions (e.g. advanced stop lines, bike locks etc.) are also out of scope.

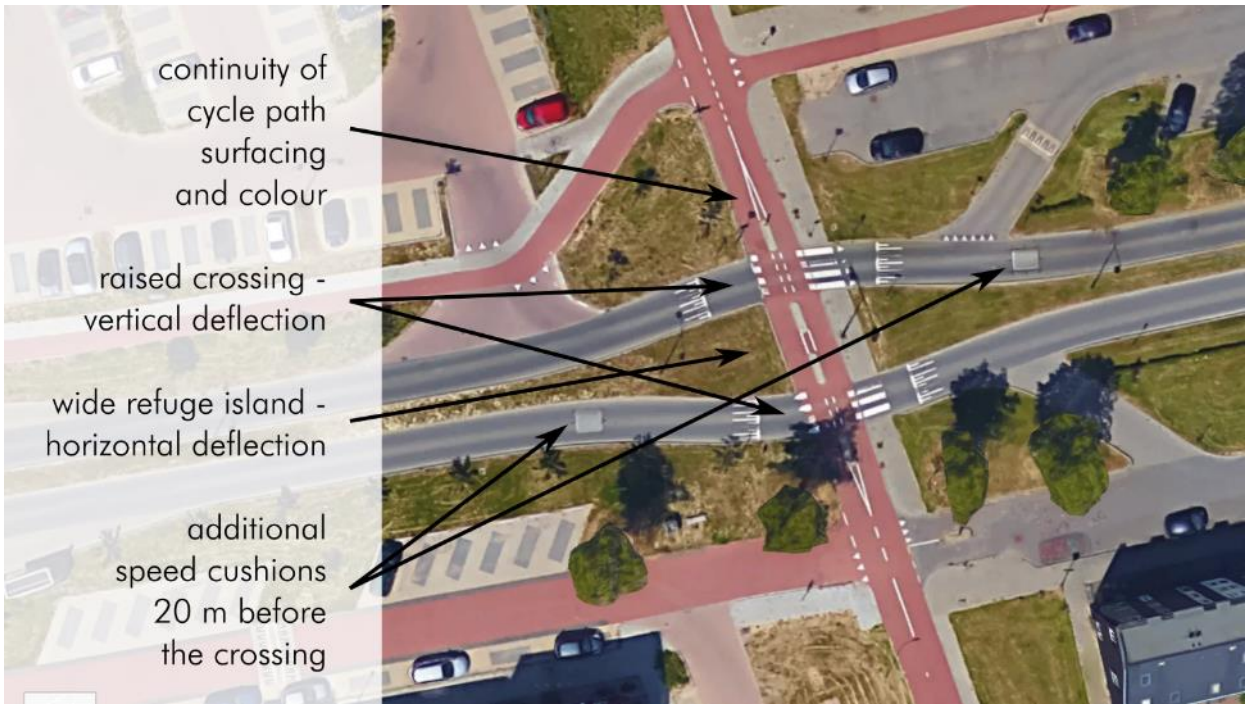

Figure 1. Various safety elements on a mid-block cycle crossing. Nijmegen, Netherlands.

Safety on crossings between cycle routes and motorised traffic depends on many factors and the factsheet does not aspire to provide a complete design guidance. Instead, we analyse quantifiable parameters and verifiable checklists across existing standards and guidance documents to identify the most universally applicable ones and compare the numerical values. The generally applicable parameters are:

- Maximum speed of motorised traffic (see section 3.1)
- Maximum volume of motorised traffic (ibidem)
    - Without traffic island
    - With traffic island

- Maximum number of lanes to cross and length of crossing (see section 3.2)
- Minimum width of traffic island if present/needed (see section 0)
- Visibility splay (Lcar x Lcycle, see section 3.4 for an explanation of the concept)

Several additional parameters are analysed for bent-out crossings of cycle tracks along priority roads (section 3.5):

- Distance between the cycle crossing and parallel carriageway.
- Minimum horizontal curve radii
- Minimum length of straight cycle track section before the crossing

The recommended set of parameters, summarised in section 4, can be used to assess both existing crossings and designs under development.

Other factors considered in some guidelines are:

- Presence of merge or slip lanes (taking into account the maximum number of lanes to cross)
- Width of the crossing/presence of pinchpoints (mostly determined by the width of the cycle tracks)
- Volume/share of heavy traffic (considering the volume of motorised traffic)
- Sharing space with pedestrians
- Crossing angle (affects visibility splay).

National standards usually also include details of signage and horizontal markings to apply in different situations. These are generalised into several key principles, included in the summary recommendations.

For grade-separated crossings, general requirements regarding geometric design parameters, such as horizontal and vertical curve radii and sight distances,[1] as well as longitudinal gradients,[2] should be observed. Requirements towards crossings controlled by traffic lights are partially covered by the factsheet on interruptions and delays.[3]

[1] See: https://ecf.com/files/reports/geometric-design-parameters-cycling-infrastructure
[2] See: https://ecf.com/users/aleksander-buczynski/trusted-content/quality-parameters-cycle-infrastructure-longitudinal-gradients
[3] See: https://ecf.com/users/aleksander-buczynski/trusted-content/quality-parameters-cycle-infrastructure-interruptions-and-delays

2. Analysed standards and guidelines

2.1. Belgium

Document: **Vademecum fietsvoorzieningen** (Handbook bicycle facilities), 2021[4]

The handbook produced by the Flemish road administration covers the issue of at-grade crossings in fiches from section E. For this factsheet, the fiche E.1 provides the most relevant general input.

The cyclist should cross no more than one lane in each direction. Additionally, the length of the crossing should be “as short as possible” (no concrete value specified).

Figure 2. N25 road was reduced to a single lane per direction when approaching the at-grade cycle crossing. Oud-Heverlee, Belgium.

Signs and markings should indicate who has the right of way on the crossing. If the cyclists have the right of way, the speed limit for motorised traffic should not exceed 30 km/h, and it is recommended to raise the crossing.

Table 1 presents the relationship between the volume of motorised traffic, the need for a traffic island, and the crossability.

[4] https://wegenenverkeer.be/sites/default/files/uploads/documenten/Vademecum%20Fietsvoorzieningen.pdf

Table 1. The need for traffic island and crossability in the function of the volume of motorised traffic, according to Flemish guidelines.

The volume of motorised traffic [PCU/hour], in both directions together	Traffic island	Crossability
0 – 800	Not necessary	Reasonable
800 – 1600	Necessary	Reasonable
1600 – 2000	Necessary	Moderate/bad
Over 2000	Not applicable	Different solution necessary

The traffic island should be at least 3 m wide.

2.2. Finland

Document: **Pyöräliikenteen Suunnittelu** (Cycling Design), 2020[5]

The guidelines published by the Finnish Transport Infrastructure Agency are obligatory for cycling infrastructure managed on the national level. Municipalities often also apply the same parameters but, in some cases, have their own standards.[6] Requirements for crossings are specified in section 5 on page 108 of the guidelines.

Section 5.1.2 (page 109) lists the principles of establishing the right of way on a crossing. If a cycle track follows a road with priority and crosses an intersection arm up to 25 m from the main carriageway, it should also have priority. Diagram 92 on page 111 specifies that the give way sign on the road without priority should be located:

- Before the cycle crossing if the cycle track is less than 15 m away from the main road
- Both before the cycle crossing and before the carriageway of the road with priority if the cycle track is between 15 and 25 m away from the main road.

The obligation to give way indicated by the traffic sign is valid in the entire area of the intersection, also at the cycle crossing after the carriageway. Only in case the distance between the cycle track and the carriageway exceeds 30 m, the cycle crossing should be treated as independent from the intersection.

Section 5.1.5 stipulates that the alignment of a one-way cycle track has to be straight at least 20 m before the crossing area (figure 94). Two-way cycle tracks also need to be straight at least 20 m before crossing is located along the road with the right of way (see also figure 145 in section 5.7), or 5 m if perpendicular to it. If a cycle track is bent before the crossing, the minimum horizontal radius of 20 m should be used and the angle change should not exceed 20 degrees.

Section 5.2 (page 117) “Field of view at intersection” analyses visibility splays. First of all, the cycle track should lead in a straight line for 20 m before the crossing. This improves the visibility of the cyclist, helps the motorist anticipate the cyclist's direction of travel and makes

[5] https://ava.vaylapilvi.fi/ava/Julkaisut/Vaylavirasto/vo_2020-18_pyoraliikenteen_suunnittelu_web.pdf
[6] For example, Helsinki: https://pyoraliikenne.fi/

it easier for the cyclist to follow other traffic. Tables 28 and 29 on pages 118 and 119 present minimum values for Lcycle and Lcar for mid-block crossings and crossings on intersections respectively. In Table 2 and Table 3 below we summarise the values of Lcycle and Lcar from the guidelines, according to who has the right of way on the crossing.

Table 2. Visibility splays according to Finnish guidelines – minimum Lcycle values.

	Recommended	Adequate	Minimum (special cases)
Cyclists have the right of way	20 m	15 m	12 m
Motorised vehicles have the right of way			10 m

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Table 3. Visibility splays according to Finnish guidelines – minimum Lcar values.

	Location	Recommended	Adequate	Minimum (special cases)
Cyclists have the right of way	Outside built-up area	20 m		15 m
	Inside built-up area	15 m		10 m
	Stop sign on the junction arm	10 m		10 m
	Private roads	10 m		6 m
	Speed of motorised traffic			
Motorised vehicles have the right of way	30 km/h	25 m	25 m	15 m
	40 km/h	35 m	35 m	25 m
	50 km/h	55 m	50 m	35 m
	60 km/h	75 m	65 m	50 m
	70 km/h	95 m	85 m	65 m
	80 km/h	120 m	105 m	85 m

Section 5.4 stipulates the principles of using traffic islands on cycle crossings. The maximum length of the crossing should not exceed 7 m. On uncontrolled crossings, traffic island is obligatory if one has to cross more than 2 lanes at once. On roads with two lanes or less, with a speed limit of up to 50 km/h, traffic island can be replaced by narrowing the carriageway or raising the crossing. Arranging the intersection in the form of an “exit”, with continuity of the cycle track and the sidewalk across the minor arm, is also indicated as a safe arrangement (section 5.8.2, image 154).

The minimum traffic island width is set as 2.5 m.

2.3. France

Document: **Fiche 40 - Véloroutes et intersections** (Cycle routes and intersections), 2019[7]

The document is more of a discussion paper than a technical standard. It formulates the "hypotheses" that:

- On crossings with priority for motorised traffic, a Lcycle of 5 m is enough; Lcar should be equivalent to 8-10 s of car ride. According to the diagram on page 4, this translates to 110 m for motorised traffic travelling at 50 km/h and 221 m at 100 km/h.[8][9]
- On crossing with priority for cycles, Lcycle = 30 m and Lcar = 15 m; this assumes a cycle speed of 18 km/h when approaching the crossing.

Traffic islands should be at least 3 m wide.

2.4. Germany

Document: **Empfehlungen für Radverkehrsanlagen** (Recommendations for cycling facilities), 2010[10]

German federal recommendations for cycling facilities discuss intersections in section 4 and mid-block crossings in section 5. The sections provide diagrams of recommended solutions in different situations, but only a limited number of quantifiable parameters.

Section 2.2.5 specifies that traffic islands on cycle crossings need to be at least 3 m wide, but for example, figure 62 in Section 5 implies a minimum width of 3.5 m.

If a crossing is further than 5 m from an intersection, it is considered a separate intersection and needs to be signed separately, otherwise, the priority signage on the intersection applies to cycle crossing as well. For bidirectional cycle crossings, an additional plate should be placed under the "give way" sign to warn drivers that they should expect cyclists from both directions (section 4.3.6).

Traffic islands are necessary at crossing points (section 5.1), if:

- the traffic volume exceeds 1,000 vehicles/h, or 500 vehicle/h with speed limit higher than 50 km/h,
- more than two lanes have to be crossed in a row,
- accidents have occurred in connection with crossing,
- an increased number of students, seniors or recreational cycling is to be expected.

[7] https://www.velo-territoires.org/wp-content/uploads/2019/10/Velo_intersection_veloroute_def.pdf
[8] Actually, it should be 111 m and 222 m for 8 s of driving at the given speeds. Perhaps the distances are measured to the edge of cycle track, not to the cyclists, as shown on the diagram?
[9] The speed of 100 km/h sounds rather excessive at a crossing point.
[10] https://www.fgsv-verlag.de/era

2.5. Ireland

Document: **Cycle Design Manual**, 2023[11]

Visibility splays are discussed in section 4.1.3. The manual uses Y Distance to denote the arm of the visibility splay triangle alongside the priority route, and X Distance along the route without priority. Therefore, depending on the situation, Y Distance might be measured along the carriageway and X Distance along the cycle track, or the other way around. For X Distance, only two values are given: a desirable minimum of 4 m, and an absolute minimum of 2 m. Y Distance depends on design speed or posted speed limit on the priority route and varies from 7 m for 10 km/h to 215 m for 100 km/h.

Section 4.5 guides mid-block cycle crossings. Table 4.25 presents the range of applicability of different types of crossings. Uncontrolled crossings are:

- not suitable for speeds of 80 km/h or higher,
- not recommended for speeds of 60 km/h or higher, speeds of 50 km/h and traffic volumes above 4000 PCU/day.

Cycle priority crossings are not recommended for speeds of 40 km/h or higher. Crossings without priority are not recommended if more than one traffic lane per direction is to be crossed.

Traffic islands are recommended on crossings without priority for cyclists and should be 3 m wide to cater for larger cycles. Traffic islands less than 2 m in width should not be used (section 4.5.2).

Raised crossings are recommended in all situations.

For bent-out cycle crossings (section 4.3.3.1 Crossing setback), a distance of 5 m between cycle crossing and carriageway is recommended. Regular horizontal curve radii requirements apply, as per the design speed of the cycle track.

Where cycle tracks lose priority at crossings, this should be indicated using appropriate markings and signage.

On bidirectional cycle crossings, motorists should be alerted that cyclists might approach from both directions.

[11] https://www.nationaltransport.ie/publications/cycle-design-manual/

2.6. Netherlands

Documents:

- **Design Manual for Bicycle Traffic**, 2016[12]
- **Sign up for the bike – design manual for a cycle-friendly infrastructure,** 1993[13]

The most recent version of the CROW manual discusses junctions in section 6. At-grade, uncontrolled crossings provide a reasonable crossability of up to 800 PCU/hour without a traffic island, and up to 1600 PCU/hour with a central traffic island (box “Crossability”). Outside built-up areas, the upper limit is reduced to 1400 PCU/hour.

According to the design sheets V24 and V25, the width of the traffic island should be at least 2.5 m. The width of the carriageway lanes on both sides of the island should be between 2.75 m and 3.5 m.

Speed bumps on the carriageway can reduce the differences in speed and make it easier for cyclists to identify the right moment for crossing.

For a typical junction of a distributor and a residential road, with a cycle track located along the distributor road, the manual stresses the need to ensure that the traffic emerging from the side road has an adequate view of cyclists travelling on the cycle track. A minimum angle of 45 degrees around 15 m before the crossing is mentioned, which translates to a visibility splay with Lcar = Lcycle = 15 m.

Junctions of distributor and residential roads can be arranged in the form of a so-called “exit” with continuity of cycle track and sidewalk surfacing over the entry arm of the side road.

For bent-out crossings, a distance of 5 m between the carriageway and the cycle track is recommended. Curve radii should be at least 12 m, and the cycle track should lead in a straight line for 5 m before the crossing.

The 1993 version of the manual provides also sight distance requirements for crossings without priority for cyclists, and somewhat more demanding requirements for bent-out crossings:

- If the cyclists do not have priority, they need to be able to see the approaching cars from a distance that depends on the length of the crossing and the speed of the cars. Table 6.6 provides specific values of Lcar, from 40 m for 30 km/h roads and crossing length of 6 m or less to 110 m for 70 km/h roads and crossing length of 8 m.
- For bent-out crossings, increased horizontal curve radii should be applied: a minimum of 30 m for one-way tracks, 60 m for two-way tracks, and 100 m outside built-up areas. This does not impose a feeling of detour for cyclists and makes it clear for other users that the cyclist is travelling straight and not turning. 30 m before crossing should be free from visual obstacles between the cycle track and carriageway to ensure good mutual visibility.

[12] https://www.crow.nl/publicaties/design-manual-for-bicycle-traffic
[13] Earlier version of the Design Manual on Bicycle Traffic.

2.7. Norway

Document: **N100 Veg og gateutforming (road and street design)**, 2023[14]

The guidelines published by the Norwegian Public Roads Administration[15] cover all aspects of road and street design. Visibility requirements, including visibility splays on crossings, are set out in section 4.2.1.3. Requirement 4.2.1.3—2 applies to crossings without right of way for cyclists, 4.2.1.3—3 – to crossings with right of way for cyclists and 4.2.1.3—4 – to exits from property accesses. Requirements 4.2.1.3—3 and 4.2.1.3—4 refer back to 4.2.1.3—1 for the value of Lcycle.

Table 4. Visibility splays according to Norwegian guidelines.

	Lcycle	Lcar
Cyclists have the right of way	25-50 m, see table below	4 m (public road) 3 m (property access)
Motorised vehicles have the right of way	8 m 10 m for gradients >3%	20 m (?)

Table 5. Lcycle value for crossings with priority for cyclists according to Norwegian guidelines.

Cycle track longitudinal alignment	Flat	Downhill 5%
Urban area, local cycle route	25 m	40 m
Urban area, main cycle route	35 m	45 m
Outside urban area	35 m	50 m

Additionally:

- Requirement 4.2.1.3—5 stipulates that on junctions of solitary cycle tracks without priority set, Lcycle distances on all arms should be at least 8 m.
- Requirement 4.2.1.2—1 specifies the minimum horizontal curve radius on cycle tracks approaching crossings as 20 m (compared to 40 m on sections between crossings).

[14] https://viewers.vegnorm.vegvesen.no/product/859984?langUI=nb&filePath=db01916d-d18e-4033-b9d7-bb5196bfce6e.pdf&fileType=Pdf

[15] Some larger municipalities, such as Oslo and Trondheim, have created their own, more ambitious guidelines.

2.8. Poland

Documents:

- **WR-D-42 Wytyczne projektowania infrastruktury dla rowerów (Design guideline for cycle infrastructure),** 2022[16]

The whole part 3 (55 pages) of the national guidelines is dedicated to the design of cycle crossings and cycling infrastructure on intersections and interchanges.

Visibility requirements are set out in Section 4 and depend on:

- Speed limit on the road to be crossed
- Design speed of the cycle track
- The requirement to stop
- Gradient of the cycle track

Tables 4.1 and 4.2 provide specific values of Lcar and Lcycle respectively. Minimum Lcar varies from 28 m for the unlikely combination of a 20 km/h speed limit for cars and obligation to stop for cyclists, to 125 m for a 60 km/h speed limit and 6% gradient along the cycle track. An option to introduce an obligation to stop for cars does not seem to be considered. Lcycle varies from 2 m to 30 m.

Section 9.1 presents different types of cycle crossings and their range of applicability. No uncontrolled at-grade cycle crossings are allowed across roads with more than two lanes. Cycle crossings without a traffic island are allowed with:

- traffic volume with annual average daily traffic (AADT) of less than 3000 cars/day and speed up to 50 km/h, or
- between 3000 and 8000 cars/day and speed up to 30 km/h.

With a 3 m wide traffic island, uncontrolled cycle crossings are allowed up to 8000 cars/day and speed up to 50 km/h.

For bent-out cycle crossings at intersections, the following are required:

- Distance between the crossing and the parallel carriageway between 5 and 8 m,
- At least 10 m of straight cycle track before the cycle crossing,
- Horizontal curve radii of at least 20 m.

[16] https://www.gov.pl/web/infrastruktura/wr-d; direct link to download part 3 “Design of cycle crossings and cycle infrastructure at intersections and junctions”: https://www.gov.pl/attachment/9fffdb38-b061-4270-a1bc-97a1b9649587

2.9. Slovakia

Document: **Technické podmienky. Navrhovanie cyklistickej infraštruktúry** (Technical requirements. Cycle infrastructure design), 2019[17]

Technical requirements for cycle crossings are set out in section 7.2.8 “Priechody pre cyclist”.

Uncontrolled mid-block cycle crossings can be applied to up to 5,000 cars per day and up to 17% share of heavy traffic. If any of the conditions are not met, additional requirements apply regarding the colouring of the crossing and approach to the crossing. Priority for cyclists can be established with traffic signs, if there are more cyclists than cars or if there are fewer than 2,000 cars per day.

If a traffic island is applied, it should ensure a waiting area of at least 3.50 x 1.75 m.

2.10. Spain (Catalonia)

Document: **Manual for the design of cycle paths in Catalonia**, 2008[18]

Section 3.5 of the manual covers the design of intersections. At-grade uncontrolled intersections are acceptable up until 500 vehicles/peak hour. If the traffic exceeds 200 vehicles/peak hour, a 5-m wide traffic island is recommended.

The manual also recommends reducing the speed of motorised traffic in the crossing area, with figures 21 and 22 giving 40 km/h as an example of a speed limit.

2.11. UK

Document: **Cycle infrastructure design (LTN 1/20)**, 2020[19]

The Local Transport Note 1/20 on Cycle infrastructure design, issued by the UK Department of Transport and applicable in England and Northern Ireland, discusses junctions and crossings in section 10.

For mid-block crossings, table 10-2 provides a guidance matrix for the suitability of different solutions depending on the total traffic flow to be crossed and number of lanes to be crossed in one movement. Traffic islands can reduce the latter parameter and should be at least 3 m wide. Note that LTN 1/20 distinguishes uncontrolled (cyclists do not have right of way over motorised traffic), cycle priority (cyclists have right of way over motorised traffic) and parallel (cycle priority crossing next to a zebra crossing for pedestrians) crossings – all of them are considered uncontrolled at-grade crossings in this document. Interestingly, cycle-priority crossings are generally considered safer (the requirements are more relaxed) than crossings where cyclists have to give way to motorised traffic. Table 6 represents the suitability of different cycle crossing types (keeping the LTN 1/20 terminology) according to the guidelines

[17] https://www.ssc.sk/files/documents/technicke-predpisy/tp/tp_085.pdf
[18] https://llibreria.gencat.cat/product_info.php?products_id=2283, https://terra.bibliotecadigital.gencat.cat/bitstream/handle/20.500.13045/263/manual-design-cyclepaths-catalonia.pdf
[19] https://www.gov.uk/government/publications/cycle-infrastructure-design-ltn-120

for roads up to 30 mph (48 km/h). Additionally, uncontrolled crossings can also be applied on higher-speed roads (up to 50 mph or 80 km/h), if the cyclists do not have to cross more than one lane in one movement and the traffic does not exceed 10,000 PCU/day, with the reservation that such provision is not suitable for all people and will exclude some potential users and/or have safety concerns.

Table 6. The suitability of different cycle crossing types depends on the motorised traffic volume and the number of lanes to be crossed in one movement, with traffic speeds up to 30 mph, according to the UK guidelines (extract from LTN 1/20 table 10-2).

	Number of lanes to be crossed in one movement		
Motorised traffic volume	**1**	**2**	**More than 2**
Up to 4000 PCU/day	Any	Cycle priority, parallel, (uncontrolled)[20]	Not suitable[21]
4000 – 8000 PCU/day	Not specified	Parallel, (cycle priority), (uncontrolled)	Not suitable
Over 8000 PCU/day	Not specified	Not suitable	Not suitable

For cycle crossings at intersections, the document stresses the need for tight corner radii at the connection of minor and major carriageways, preferably no more than 4 m, and 6 m at most. Corner radii of 9 m or higher are classified as “most likely to give rise to the most common collision types”.

Visibility splays are discussed in section 5.8. The arm along the carriageway or cycle track with priority (Y distance) should be at least as long as the stopping sight distance for the carriageway or cycle track. The desirable minimum for the arm without priority (X distance) for cycle traffic is 4.5 m, with an absolute minimum of 2.4 m. For motorised traffic, X distances between 2.4 m and 9.0 m are required or advised. The visibility splays are currently under review.[22]

Appendix B provides a detailed Junction Assessment Tool, with specific criteria for different types of crossings.

[20] Parenthesised provision: “not suitable for all people and will exclude some potential users and/or have safety concerns.”
[21] To be exact: “suitable for few people and will exclude most potential users and/or have safety concerns.”
[22] https://www.ciht.org.uk/knowledge-resource-centre/resources/visibility-research/

3. Comparison of quality parameters

3.1. Maximum speed and volume of motorised traffic

Speed and volume of motorised traffic are critical parameters for determining crossing safety. In case of crossings without the right of way for cyclists, they also determine the time lost while waiting for an opening to cross the carriageway.

High speeds make it more difficult for the driver to notice the cyclist, and for the cyclists to correctly estimate the time the driver arrives at the crossing. On top of that, high speeds increase the severity of an accident. Table 7 presents the comparison of maximum speeds allowed for motorised traffic in cycle crossings. In some cases, if the maximum speed was not given explicitly, it was inferred from the range of values given, for example in tables used to determine the visibility splays.

Table 7. Comparison of maximum speeds of motorised traffic on cycle crossings.

	Maximum speed[23]	Comments
Belgium	-	30 km/h if the cycle crossing has priority
Finland	80 km/h	Based on the range of values in tables
France	100 km/h	Based on the examples provided
Germany	-	
Ireland	80 km/h	Not recommended above 60 km/h, 50 km/h for higher volumes of traffic
Netherlands	70 km/h	Based on the range of values in tables
Norway	-	
Poland	50 km/h	30 km/h for higher volumes of traffic
Slovakia	-	
Spain	40 km/h	The general recommendation to reduce speed, 40 km/h given as an example
UK	48 km/h (30 mph)	Up to 80 km/h (50 mph) is acceptable if no more than one lane is to be crossed in one movement and total traffic flow is up to 10,000 PCU/day, but not considered suitable for all users

It should also be noted that in many situations it might be desirable to reduce the speed below the maximum values given in the table, for example, if it is not possible to ensure sufficient visibility splays (see further).

Table 8 presents the comparison of daily traffic volumes of motorised traffic where, Interestingly, the requirements are stricter (maximum volumes lower) in countries with low cycle traffic and/or limited cycle infrastructure. This can be explained by the insufficient

[23] Note that in some cases the guidelines refer to legal speed limit and in some other to the real 85th percentile speed. Ideally, the values should not differ significantly. Realistically, the data about real speeds and their distribution is not available for most of cycle crossings.

awareness of drivers. They are not trained or used to look out for cyclists when approaching the crossing.

Table 8. Comparison of maximum daily volumes of motorised traffic allowed on cycle crossings.

	Maximum daily traffic [cars/day]		Comments
	without traffic island	**with traffic island**	
Belgium	8,000	20,000	Not recommended above 16,000
Finland	-	-	
France	-	-	
Germany	10,000	-	5,000 for speeds above 50 km/h
Ireland	4,000		Limit on traffic volume only for speeds above 50 km/h
Netherlands	8,000	16,000	14,000 with traffic islands outside built-up areas
Norway	-	-	
Poland	3,000	8,000	8,000 allowed also without traffic island with a speed limit of 30 km/h
Slovakia	5,000		2,000 or less than cyclists, if the cyclists have priority
Spain	2,000	5,000	
UK	8,000	10,000	The number provided for mid-block crossings only

3.2. Maximum length of crossing

Several guidelines stress the need to make cycle crossings as short as possible. However, only the older edition of the Dutch manual provides a concrete length in meters (and also in an indirect way, through the calculations for visibility splay). Several others provide, however, restrictions on the number of lanes to be crossed at once or in general.

Table 9. Comparison of requirements for maximum length of crossings.

	Number of lanes	Length
Belgium	1/direction	As short as possible
Finland	2	7.0 m
France	-	
Germany	2 at once	
Ireland		
Netherlands		8.0 m (range of values in the table for visibility splays) 3.5 m (for crossings with traffic island)
Norway		
Poland		As short as possible
Slovakia	-	
Spain	-	
UK	1/manoeuvre (without priority for cyclists), 2 (general)	

Figure 3. Reduction of the crossing length to improve safety. Jönköping, Sweden.

3.3. Traffic island width

Traffic Island (Refuge Island, Central Island) serves as a traffic calming measure, and at the same time reduces the complexity of a crossing, allowing a cyclist to stop in between crossing different lanes. Table 10 provides a comparison of minimum widths for traffic islands across different countries.

Table 10. Comparison of minimum traffic island widths on a cycle crossing.

	Minimum width	Comments
Belgium	3.0 m	
Finland	2.5 m	
France	3.0 m	
Germany	3.0 m	
Ireland	3.0 m	Absolute minimum 2.0 m.
Netherlands	2.5 m	
Norway	(2.0 m)	Requirement for pedestrian crossings.
Poland	3.0 m	Possible to reduce in exceptional circumstances to 2.5 m (outside built-up area) or even 2.0 m (inside built-up area).
Slovakia	3.5 m	
Spain	5.0 m	Recommended width
UK	3.0 m	

A clear majority of guidelines and standards set the value at 2.5 m or 3.0 m, except Poland and Ireland allowing 2.0 m in exceptional circumstances, Slovakia requiring 3.5 m of waiting area and Spain recommending 5.0 m width. While the last value might seem excessive, it may be the only recommendation that is wide enough to safely accommodate some of the legally allowed cycles (for example, a tandem with a trailer).

Typically, traffic islands separate lanes in different directions, but they can also be applied between lanes in the same direction (see Figure 4. The traffic island is located between lanes in the same direction. Roermond, Netherlands. for an example). In such cases, extra attention must be given so that the cyclist is not confused about the direction from which motorised vehicles might approach.

Figure 4. The traffic island is located between lanes in the same direction. Roermond, Netherlands.

3.4. Visibility splays

A visibility splay is a triangle adjacent to the crossing, as shown in Figure 5. Visibility splays on a cycle crossing, Figure 5, that should be free from major obstacles obstructing visibility, such as fences, high greenery, advertisements etc. The splay is defined by values of:

- Lcycle – an arm of the triangle along the cycle track
- Lcar – an arm of the triangle along the carriageway crossed

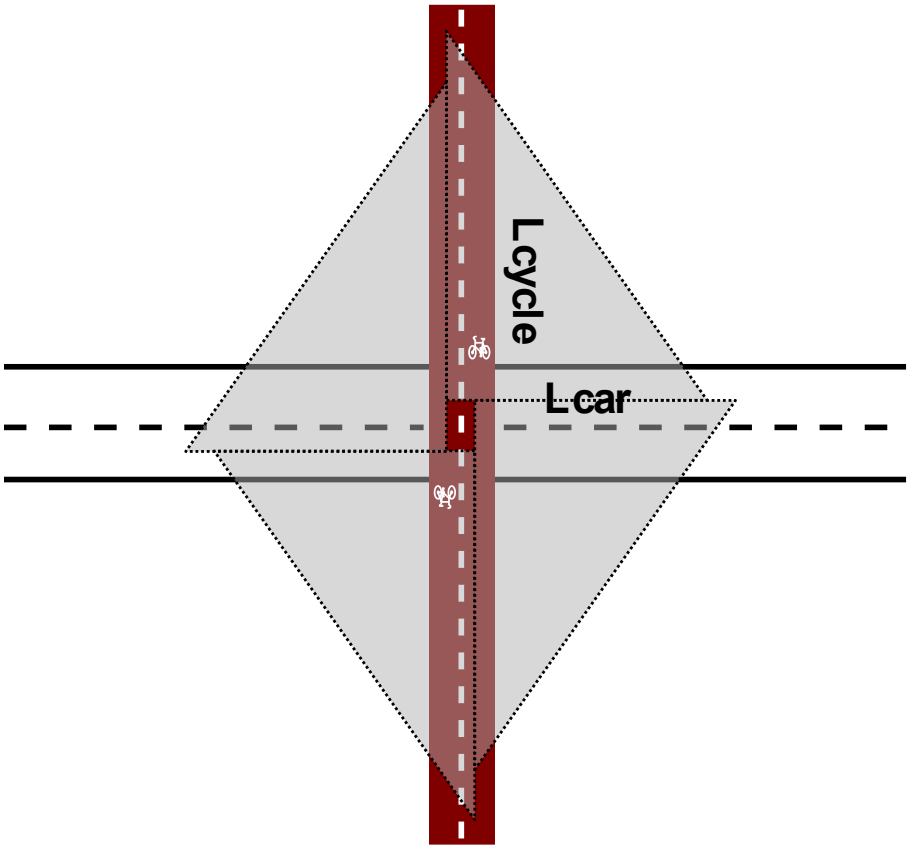

Figure 5. Visibility splays on a cycle crossing of a bidirectional cycle track and a bidirectional carriageway.

Table 11 and Table 12 present a comparison of recommended and minimum values of Lcycle and Lcar, for crossings with and without cyclists having right of way. On the crossings with priority for cyclists, the drivers need to be able to notice the approaching cyclists, therefore Lcycle depends on the design speed of the cycle track, and generally Lcycle > Lcar. On the crossings with priority for motorised traffic, the cyclists need to be able to notice the approaching vehicle, therefore Lcar depends on the speed on the carriageway and Lcar > Lcycle.

Comparing values across different guidelines, on crossings with priority for cyclists there is a significant difference in Lcar between UK and Ireland on one side (2–2.4 m acceptable) and Finland, France and Netherlands on the other (10–20 m required or recommended). For crossings without priority for cyclists, Finland stands out with higher requirements towards Lcycle (10–20 m instead of 2–5 m) and France expects the highest values of Lcar.

Table 11. Visibility splay for a crossing with priority for cyclists.

	Lcycle [m]			Liar [m]	
	20 km/h	30 km/h	40 km/h	minimum	recommended
Belgium					
Finland	12 (minimum) 20 (recommended)			10	15 (built-up area) 20 (outside built-up area)
France	30			15	
Germany					
Ireland	14	23	33	2	4
Netherlands	15				15
Norway[24]	25 35	35	45 50	3 (property access) 4 (public road)	
Poland	24			unclear	
Slovakia					
Spain					
UK[25]	17	31	47	2.4	9.0

Table 12. Visibility splay for a crossing without priority for cyclists.

	Lcycle [m]		Liar [m]				
	minimum	recommended	30 km/h	50 km/h	60 km/h	70 km/h	80 km/h
Belgium							
Finland	10	20	25	55	75	95	120
France[26]	5		66	111	122	133	145
Germany							
Ireland[27]	2	4	23	45	59	99	140
Netherlands[28]			40	75	90	105	
Norway	8 (flat) 10 (if downhill >3%)		20				
Poland	2	4	42	70	91	106	
Slovakia							
Spain							
UK	2.4	4.5	23	45	59		

[24] First value for crossings in urban areas, second outside.
[25] Lcar values based on: https://www.ciht.org.uk/media/11665/visibility-and-road-safety-at-priority-junctions-eoi-final.pdf
[26] Values basing on the 8 seconds principle.
[27] Values for 70 km/h and 80 km/h are interpolated.
[28] Assuming carriageway width 5 to 6 m for 30 km/h and 7 m for higher speeds. Value for 60 km/h is interpolated.

Insufficient visibility splay can be addressed by:

- removing obstacles from the field of view,
- reducing the speed of cars approaching the crossing,
- changes in traffic circulation, for example turning a bidirectional road into unidirectional.

Figure 6. Insufficient visibility splay was a contributing factor in several crashes on the crossing. The problem was remedied by making the street one-way, with contraflow cycling allowed. Warsaw, Poland.

3.5. Additional requirements for bent-out crossings

One of the most typical locations for a cycle crossing is on an intersection of a main and a side road, with the cycle track along the main road crossing the side road. If the cycle track runs close to the carriageway of the main road, it might be slightly bent out before the crossing, to provide a space for a turning car to stop between the carriageway and the crossing. In this case, several guidelines and standards provide additional parameters, as shown in Figure 7:

- d – distance between the carriageway of the main road and the crossing,
- r1 – horizontal curve radius used to bend out the cycle track,
- r2 – horizontal curve radius on the connection of carriageways of the main and the side road,
- s – length of the straight section of a cycle track before the crossing.

Table 13 compares the requirements across the analysed guidelines. Concrete values for the r2 radius were provided in the UK document, but as this was the only such case, r2 was not included in the comparison or final recommendations.

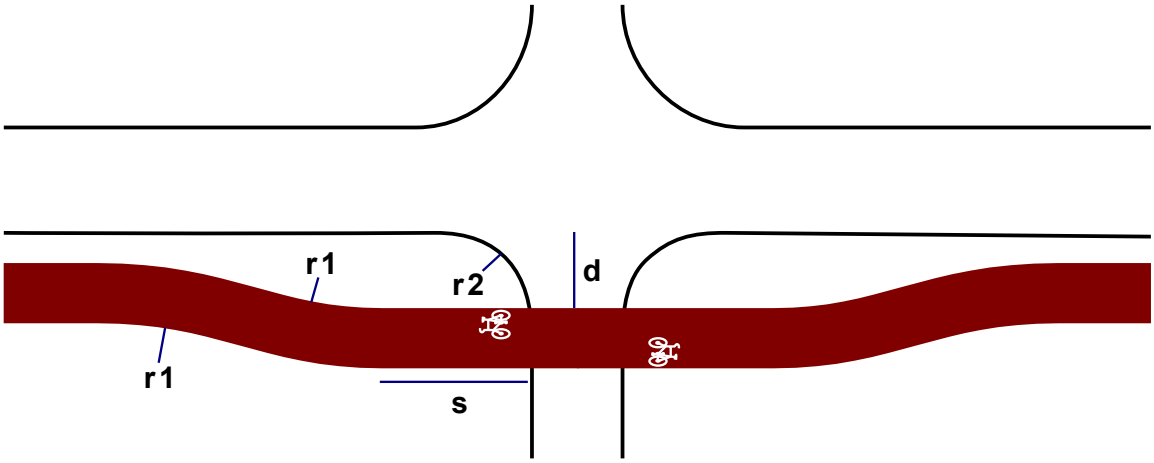

Figure 7. Additional parameters for bent-out crossings.

Table 13. Comparison of additional parameters for bent-out crossings.

	d [m]	Minimum r1 [m]	s [m]
Belgium			
Finland		20	20 (along main road) 5 (across the main road)
France			
Germany			
Ireland	5	as per cycle track design speed	
Netherlands (2016)	5	12	5
Netherlands (1993)	4 to 5 up to 8 outside built-up area	30 for one-way tracks, 60 for two-way tracks, 100 outside built-up areas	
Norway		20	
Poland	5 to 8	20	10
Slovakia			
Spain			
UK			

The distance between the cycle crossing and the carriageway of the main road is usually set to around 5 m. The closer location does not leave enough space for a car to stop between the carriageway and the crossing. A farther location increases the risk that the vehicle from the side road does not slow down enough before the crossing and might hurt visibility splay.

Gentle curve radii and/or straight section of the cycle track before the crossing minimise the feeling of detour for cyclists and allows other users to avoid confusion about the intentions and direction of travel of the cyclist.

4. Recommendations

The section summarises the quality parameters discussed in section 3, and additional common recommendations from analysed standards and guidelines. For most of the parameters, three thresholds are listed, reflecting three quality levels:

1. For basic cycle routes, the recommended thresholds are based on the first quartiles (calculated for each parameter separately) of values from the analysed documents (which means that 75% of standards are more strict in this aspect).
2. For main cycle routes, median values were used.
3. For cycle highways, third quartiles from the analysed documents are listed as recommended.

Volume and speed of motorised traffic are the key factors influencing the choice of type of crossing between cyclists and motorised traffic. For moderate volumes of traffic, a traffic island on the crossing is necessary. For high volumes and/or speeds of motorised traffic, grade-separated or traffic light-controlled crossings are necessary (or reducing traffic speed/volume or redirecting the traffic to another road).

Table 14 presents the range of applicability of at-grade, uncontrolled crossings between cycle tracks and motorised traffic. It also includes basic dimensions of cycle crossings and traffic islands (if necessary). Shorter cycle crossings reduce the time spent by cyclists in conflict zones, while traffic islands can simplify the traffic situation.

Table 14. Recommended conditions of applicability and dimensions of a crossing.

	Basic cycle route	Main cycle route	Cycle highway
Max speed of intersecting traffic [km/h]	80	70	50
Max volume of intersecting traffic – without central traffic island [PCU/day]	8,000	5,000	3,000
Max volume of intersecting traffic – with central traffic island [PCU/day]	16,000	12,000	8,000
Max number of lanes to cross [lanes]	2	1/direction	1/manoeuvre
Max length of the crossing [m]	-	8.0	7.0
Traffic island width [m]	2.5	3.0	4.0

The priority on the crossing – whether the cyclists or the motorists have the right of way – should be established by appropriate traffic signs.

If a cycle crossing is located at an intersection, the priority on the crossing should be aligned with the priority on the intersection. In particular:

- A cycle track along a priority road should have priority over a road on which a “give way” or a “stop” sign is placed,
- Cyclists crossing a carriageway of a priority road should give way to vehicles travelling on the priority road.

- On intersections with cycle crossings, it is not recommended to have the priority prescribed by the general priority rule (usually: right-of-way for vehicles approaching from the right), or to have a bend in the priority road.

On crossings between intersections, priority should be established by appropriate traffic signs, taking into account the role of the cycle route and the role of the road crossed.

The priority decision affects the visibility splay that needs to be ensured at crossings. If the cycle track has the right of way, motorists need to be able to see the approaching cyclist. If the carriageway has the right of way, cyclists need to be able to see the approaching motor vehicles. Table 15 presents the minimum dimensions of a clear field of view for crossings with right of way for cyclists;[29] Table 16 – for crossings without right of way for cyclists.[30]

Table 15. Recommended minimum visibility splay dimensions for crossings with right of way for cyclists.

	Basic cycle route	Main cycle route	Cycle highway
Lcycle	14	22	48
Lcar	2	10	15

Table 16. Recommended minimum visibility splay dimensions for crossings without right of way for cyclists.

		Basic cycle route	Main cycle route	Cycle highway
Lcycle		2	4	8
Lcar	**30 km/h**	23	33	48
	50 km/h	45	63	84
	60 km/h	59	83	99
	70 km/h	97	105	120
	80 km/h	120	140	145

Table 17 presents a summary of additional parameters for so-called bent-out cycle crossings, sometimes designed when a cycle track along a main carriageway crosses a side road.

Table 17. Additional parameters for bent-out cycle crossings.

Parameter	Value
Distance between the carriageway and the crossing [m]	5 m Up to 8 m outside built-up areas
Horizontal curve radius used to bend out the cycle track [m]	Minimum 20 m
Length of the straight section of a cycle track before the crossing [m]	Minimum 5 m

Additional recommendations, recurring across different guidelines:

[29] Lcycle should be increased if the cycle track approaches the crossing with a downward slope.
[30] Assuming typical carriageway width of 6-7 m. Wider carriageways (longer crossings) require bigger visibility splay, as the cyclist needs more time to cross to the other side and therefore needs to see the approaching vehicles more in advance.

1. Raising a cycle crossing improves its recognisability and reduces the speed of motorised vehicles in the conflict area.
2. On an intersection, the minor arm can be arranged in the form of a so-called “exit”, with continuity of cycle track and sidewalk across the whole crossing (see Figure 8 for an example).
3. On an intersection, if a cycle crossing is located further than 5-15 m from the carriageway, it should be signed with separate signs establishing the right of way.
4. If a cycle crossing is bidirectional, signage should indicate to the approaching drivers that they should expect cyclists from both directions.

Figure 8. So-called exit from a residential street, with continuity of cycle track across the minor arm of an intersection. Malmö, Sweden.

Quality parameters for cycle infrastructure: at-grade uncontrolled crossings

Selected quality parameters for cycling infrastructure in national and regional guidelines were compared in the frame of the REALLOCATE project, with additional contributions from the UNECE Group of Experts on Cycling Infrastructure and ECF member organisations. We would like to thank in particular Jakob Bernhard from the Norwegian Cyclists' Association and Martti Tulenheimo from the Finnish Cyclists' Federation.

A considerable effort has been made to ensure that the information presented is current and accurate. If outdated or incorrect information is brought to our attention, ECF will correct or remove it. Please also let us know if you would like to see other standards or guidelines added to the comparison or if you know about other relevant research that should be mentioned in the document.

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