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United Nations Economic Commission for Europe cycling network

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Submitted by the European Cyclists Federation and the secretariat

I. Introduction

1. The Group of Experts on cycling infrastructure module (GE.5) agreed on its third meeting on additional cycle route parameters to be developed for consideration at the next regular meeting. These should concern crossings, separation with pedestrians, inclination (slopes), and shade.

2. GE.5 decided also to consider minimum requirements / expectations for cycle highways to supplement the functional definition based on the experiences of the CHIPS project. In addition to parameters covered already, the following were highlighted in the conversation: priority of way, reduction of required stops at intersections, and aspects of accessibility.

3. ECF and the secretariat were requested to consolidate a proposal for the next session with these quality parameters while experts were invited to send their inputs.

4. This document proposes definitions of cycle route parameters, with different thresholds for the different levels of route quality in line with the categorisation adopted on the third meeting.

5. The recommended thresholds for crossing parameters, gradients, interruptions and delays were based on meta-analysis of guidelines and standards from 12 countries:[1]

(a) For basic cycle routes, the recommended maximum gradients are based on first quartiles (calculated for each parameter separately) of values from the analysed documents (which means that 75% of guidelines and standards have stricter requirements.

(b) For main cycle routes, median values were used.

[1] However, not all the parameters are defined in all the guidelines. While there are requirements for gradients in all 12 analysed countries, interruptions and delays have been quantified only in 5 cases.

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(c) For cycle highways, third quartiles from the analysed documents are listed as recommended.

6. Detailed comparisons and extracts from the national and regional guidelines for each of the analysed topics are available on the ECF website:

(a) At-grade uncontrolled crossings: https://ecf.com/users/aleksander-buczynski/trusted-content/quality-parameters-cycle-infrastructure-grade-uncontrolled-crossings

(b) Longitudinal gradients: https://ecf.com/users/aleksander-buczynski/trusted-content/quality-parameters-cycle-infrastructure-longitudinal-gradients

(c) Interruptions and delays: https://ecf.com/users/aleksander-buczynski/trusted-content/quality-parameters-cycle-infrastructure-interruptions-and-delays.

II. Quality parameters for crossings

7. Safety on crossings between cycle routes and motorised traffic depends on many factors, such as: volume of motor traffic, volume of heavy traffic, speed of traffic, number of lanes to cross, presence of merge or slip lanes, length of crossing, width (including present of pinch points), sharing space with pedestrians, crossing angle and visibility splays.

8. Volume and speed of motorised traffic are the key factors influencing the choice of type of crossing between cyclists and motorised traffic. For high volumes and speeds of motorised traffic, grade separated or traffic light controlled crossing are the only options. The section focuses on applicability and parameters for at-grade, uncontrolled crossings between cycle routes and motorised traffic.

9. Table 1 presents the range of applicability of at-grade, uncontrolled crossings.

Table 1
Range of applicability of at-grade, uncontrolled crossings

	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
Min traffic island width [m]	2.5	3.0	4.0

10. In addition to the safety considerations listed in the above table, the need to reduce interruptions and delays (see section IV) on a cycle route might be an argument for choosing a grade-separated instead of an at-grade crossing.

11. If a cycle crossing is located on an intersection:

(a) it is not recommended to have the priority on the intersection prescribed by the general priority rule (for example, “give way to the vehicle from the right”), the priority should be established by appropriate traffic signs;

(b) it is not recommended to have a bend in the priority road;

(c) the priority on the cycle crossing should be aligned with the priority on the intersection. This means:

- A cycle track along a priority road will have priority over a road on which a “give way” or a “stop” sign is placed,

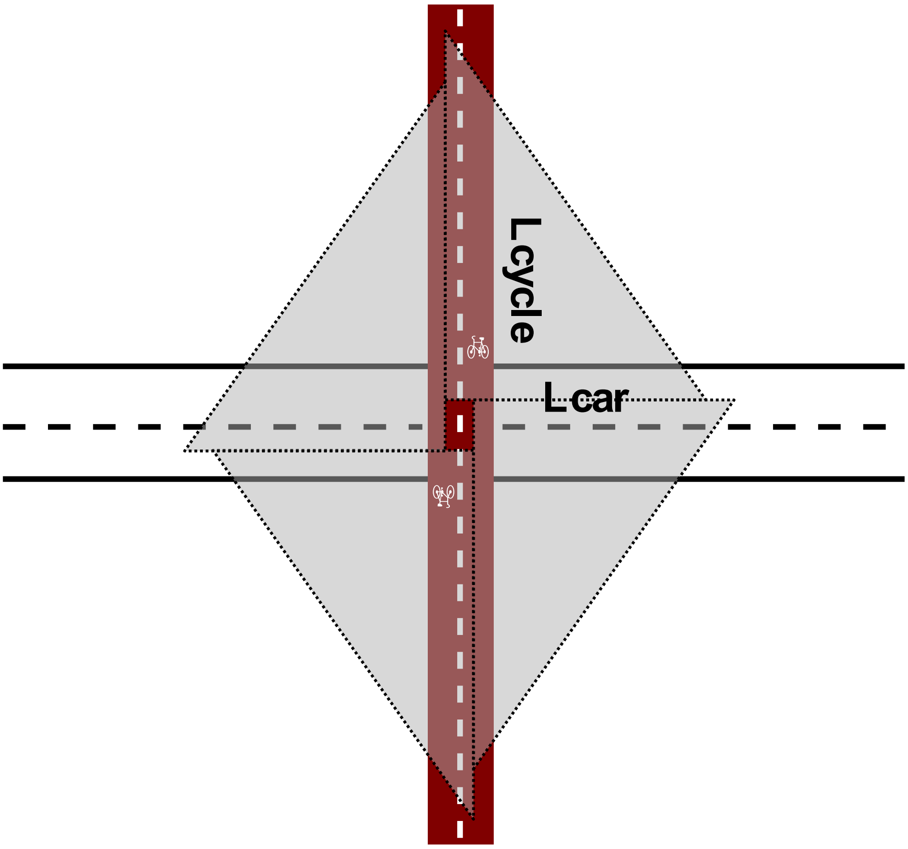
- Cyclists crossing the carriageway of a priority road will give way to vehicles travelling on the priority road.

12. If a cycle crossing is located outside 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.

13. In case a cycle crossing is located far enough from the parallel carriageway to raise doubts whether the cycle track is a part of one of the roads meeting on the intersection, priority signs can be added on the crossing as if it were located outside the intersection.

14. Sufficient visibility splays (see figure I) need to be ensured at crossings. The visibility splay is composed of triangles defined by Lcycle (distance along the cycle track) and Lcar (distance along the carriageway crossed). The number and location of triangles depends on whether the cycle track and carriageway are uni- or bidirectional. The values of Lcycle and Lcar are affected by which kind of traffic has the right of way on the crossing, the speed of motorised vehicles and the class of the cycle route (indirectly implying also speed of the cycles).

Figure I
Visibility splays on a cycle crossing of a bidirectional cycle track and a bidirectional carriageway in right hand traffic



15. Table 2 presents recommended minimum values for Lcycle and Lcar for crossings with right of way for cyclists and table 3 for crossings where cyclists are obliged to give way.

Table 2
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 3
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

16. 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, in order 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, shown on figure II. Table 4 presents the most common requirements for these.

Figure II
Additional parameters for bent-out cycle crossings

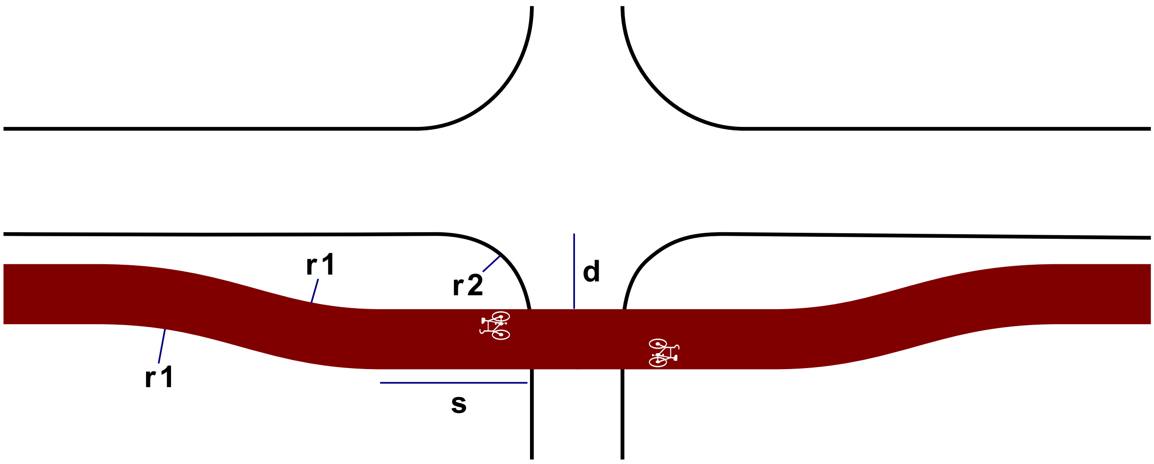


Table 4
Additional parameters for bent-out cycle crossings

	Parameter	*Value*
d	Distance between the carriageway and the crossing [m]	5 m Up to 8 m outside built-up areas
r1	Horizontal curve radius used to bend out the cycle track [m]	Minimum 20 m
s	Length of the straight section of a cycle track before the crossing [m]	Minimum 5 m

17. Additional recommendations, recurring across different guidelines:

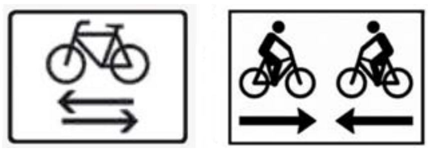
(a) Raising a cycle crossing improves its recognisability and reduces the speed of motorised vehicles in the conflict area.

(b) On an intersection, the minor arm can be arranged in a form of so-called "exit", with continuity of cycle track and sidewalk across the whole crossing (see figure … for an example).

(c) If a cycle crossing is bidirectional, signage should indicate to the approaching drivers that they should expect cyclists from both directions (see figure III and IV for example).[2]

Figure III
Example of an "exit" arrangement, with continuity of cycle track and sidewalk across a minor arm of an intersection

Figure IV
Example panels to apply under a priority/intersection signs to warn drivers about bidirectional cycle traffic on a cycle crossing. Left: Germany, right: Finland and Norway



18. Several guidelines provide additional special requirements for crossings located on different types of intersections (for example, roundabouts). For example, the Local Transport Note (LTN) 1/20 "Cycle infrastructure design"[3] contains in Appendix B a more detailed Junction Assessment Tool, taking into account different types of intersections and different types of cycle movements across the intersection.

19. For grade separated crossings, general requirements regarding geometric design parameters, such as curve radii and sight distances,[4] should be observed. Requirements

[2] Additional examples available in "Signs and signals for cyclists and pedestrians. Comparison of rules and practices in 13 countries": https://unece.org/DAM/thepep/Publications/2015_and_pdf_Signs_and_signals/Signs_and_signals_for_cyclists_and_pedestrians.pdf

[3] https://www.gov.uk/government/publications/cycle-infrastructure-design-ltn-120

[4] As discussed on the third session of GE.5.

towards signal-controlled crossings are partially covered in section IV (interruptions and delays).

III. Conditions for mixing pedestrian and cycle traffic

20. For cyclists and pedestrians sharing the same surface, three main types of infrastructure are to be considered:

(a) cycle tracks,[5]

(b) cycle and pedestrians tracks, and

(c) sidewalks (including pedestrian zones) with cycling allowed.

21. Table 5 presents applicability of these types of infrastructure on different categories of cycle routes. Table 6 presents maximum density of pedestrian traffic (per hour and per metre of obstacle-free width) and additional considerations.

Table 5
Parameters for mixing pedestrian and cycle traffic

	Basic cycle route	*Main cycle route*	*Cycle highway*
Cycle track	+	+	+
Cycle and pedestrian track	+	Exceptionally, e.g. on bridges	-
Sidewalk with cycling allowed	Exceptionally, e.g. on bridges, or as an access to trip destination, e.g. a shopping street	-	-

22. The key parameter in this case is maximum number of pedestrians per hour per 1 m cross-section allowing mixing cyclists and pedestrians on common surface. Table 6 presents proposed thresholds for this parameter and different types of solutions. It should be noted that:

(a) Some guidelines take into account also the number of cyclists. In the approach adopted by GE.5 the (expected) volume of cycle traffic is already considered in the selection of route category (basic / main / cycle highway), which limits the options as per table 5;

(b) Some guidelines consider additionally different degrees of separation between cyclists and pedestrians (surface type only, difference of height, dividing verge) with different thresholds for each of the solutions.

Table 6
Max density of pedestrian traffic

	Max density of pedestrian traffic [pedestrians/m/h]	*Additional considerations*
Cycle track	25	If it is not possible to use pavements (sidewalks) or verges, or if none is provided, pedestrians may

[5] „Cycle track" in this section refers only to situation where no usable sidewalk for pedestrians is present and the pedestrians may use the cycle track in line with article 20 paragraph 3 of the Convention on Road Traffic (typically outside built-up areas). If there is both a cycle track and a sidewalk, cyclists and pedestrians do not share the same surface, and the section is not applicable.

	Max density of pedestrian traffic [pedestrians/m/h]	*Additional considerations*
		walk on cycle track in line with article 20 paragraph 3 of the Convention on Road Traffic.
Cycle and pedestrian track	100	Need to be lit during nighttime to make it possible for cyclists to notice pedestrians early enough. Need to ensure quality parameters such as stopping sight distance, or distance from obstacles.
Sidewalk with cycling allowed	200	Usage by cyclists non-compulsory. Includes pedestrian zones in city centres, parks etc.[6]

23. Cycling traffic is highly self-regulating.[7] When the pedestrian density makes cycling difficult, cyclists seek an alternative route. The best way to avoid conflicts between pedestrians and cyclists in a crowded area is to provide a high quality cycle route that bypasses the area.

24. It should also be noted that the Convention on Road Traffic does not clarify whether pedestrians using a space shared with cyclists should keep to the side of the track appropriate to the direction of traffic, or the opposite one. Article 20 paragraph 4 and 5 of the Convention provide recommendations only for pedestrians walking on the carriageway. Lack of clarity in this area has been raised as an issue during discussions on mixing pedestrian and cycle traffic.[8] There are however arguments for both possible approaches:

(a) The advantage of pedestrians keeping to the side appropriate to the direction of traffic is that many cycle and pedestrian tracks (for example greenways) may be used by a variety of users (including for example runners, children on tricycles, rollerbladers…), with varying speeds, and the speeds of for example runners might be similar to slower cyclists. With everyone keeping to the same side, cyclists pass pedestrians in the same way as overtake slower cyclists.

(b) The advantage of pedestrians keeping to the side opposite to the direction of traffic is consistency with rules on other, similar types of infrastructure (e.g. agricultural roads), and better mutual visibility (in practice - only on very wide tracks).

IV. Other cycle route parameters

A. Inclination/slopes

25. Inclination/slopes: the key parameter in this case is longitudinal gradient. The gradient impacts on two issues; the physical limitations of a cyclist to climb inclines, and their safety when descending. While a short steep gradient might be acceptable, a longer climb or descent requires gentler slope. It is therefore proposed to express the maximum acceptable gradient in function of the height difference to overcome,[9] as stipulated in table 7.

[6] As the volume of pedestrian traffic in pedestrian zones varies during the day (typically lower in the morning, higher in the afternoon and evening), allowing cycle traffic only in selected hours (for example until 10 am or until noon) might be an option.

[7] See for example the PRESTO implementation fact sheet: https://www.eltis.org/sites/default/files/trainingmaterials/07_presto_infrastructure_fact_sheet_on_cyclists_and_pedestrians.pdf

[8] For example, „Kenniscafé - Mengen fietsers en voetgangers?" on 25 januari 2022: https://www.fietsberaad.nl/Kennisbank/Terugblik-Kenniscafe-Mengen-fietsers-en-voetganger

[9] Alternative ways to formulate the same requirement is to vary the maximum acceptable gradient depending on the length of the slope (Germany, Norway, Slovakia, UK), or to use „slope severity" instead of gradient (Netherlands). The different requirements were recalculated to be expressed in the same way for the purpose of the analysis.

Table 7
Recommended maximum gradient values for different categories of cycle routes in function of the height difference to overcome

Height difference to overcome	*Basic cycle route*	*Main cycle route*	*Cycle highway*
1 m	10.0%	8.0%	6.0%
2 m	10.0%	7.0%	4.5%
3 m	7.0%	6.0%	4.0%
5 m	5.5%	5.0%	3.5%
7.5 m	4.5%	4.0%	3.0%
10 m	4.5%	3.0%	2.5%
15 m	4.0%	3.0%	2.5%
100 m or more	3.0%	3.0%	2.0%

26. Additionally, on slopes with gradient exceeding 3%:

(a) Infrastructure width should be increased by at least … m,

(b) Design speed of at least 40 km/h should be assumed and all the related geometric parameters, i.e. curve radii and sight distances,[10] should be increased accordingly.

(c) Timings of traffic signals should be increased for cyclists travelling in the uphill direction.

27. Moreover:

(a) No sharp curves, obstacles or crossings without priority should be located in the middle or at the bottom of the slope; a section of flat, straight cycle track is necessary to safely reduce the speed after descending the slope.

(b) Level sections can also be used in-between inclines to provide opportunity to rest or reduce speed, especially if the height difference exceeds 5 m. The recommended length of such level section varies between 5 and 25 m.

(c) There should be no sudden changes of gradient, which may cause “bumps” and crashes. Transition between flat sections and slopes, or between slopes with different gradient, should be designed with the use of vertical curves. See section 3 of “Geometric design parameters for cycling infrastructure”[11] for specific parameters.

B. Shade

28. Shade: no guidelines or standards covering this topic have been contributed. A “Cool Walkshed Index” has recently been proposed by the Victoria Transport Policy Institute[12] to evaluate suitability of pedestrian facilities in hot-climate cities, but it is specific for walking, it has not yet been tested in practice, and it does not cover suburban and rural areas. “Manual for the design of cyclepaths in Catalonia”[13] recommends planting trees in lines of ten alternating the sides of cycle track, but it is not known whether the recommendation has been tested in practice. It is proposed to recognise the importance of the subject, follow the developments in the area, and to take it into account in future research project, but refrain for now from stipulating specific parameters.

[10] See https://ecf.com/files/reports/geometric-design-parameters-cycling-infrastructure

[11] Design manual for bicycle traffic. CROW 2017. https://www.crow.nl/publicaties/design-manual-for-bicycle-traffic

[12] Cool Walkability Planning: https://vtpi.org/cwi.pdf

[13] https://terra.bibliotecadigital.gencat.cat/bitstream/handle/20.500.13045/263/manual-design-cyclepaths-catalonia.pdf?sequence=1

C. Priority of way and reduction of required stops at intersections

29. Priority of way and reduction of required stops at intersections: with single stop taking up as much energy as cycling additional 75-100 m, and up to 85% of time lost by a cyclist in a built-up area being caused by traffic lights,[14] frequent stops and/or long waits reduce the credibility and usability of dedicated cycling infrastructure. Interruptions are also a safety hazard: a cyclist losing balance while slowing down or completely stopping in order to give right of way to another road user is one of the typical scenarios of single vehicle crashes for older cyclists.

30. The most common quantifiable parameter used is the number of interruptions (full stops) per kilometre. Interruptions counted include:

(a) The need to yield to other traffic;

(b) The need to stop on traffic lights; if a crossing is divided into several sections with separate traffic lights and the traffic lights are not synchronised for cycle traffic, each of them should be counted as a separate interruption;

(c) Other situations that might require a full stop, for example because of a railway level crossing, a moveable bridge, or the need to use a lift to continue journey along the route.

31. A related parameter is the expected time loss. Expected time loss takes into account the probability of stopping and average waiting time in case of a stop. For example, if cyclists have 12 seconds of green light in a 60 seconds traffic light cycle, the probability of stopping is 80% and average waiting time is 24 s (half of maximum of 48 s). This translates to expected time loss of 24 s * 80% = 19.2 s.

32. Table 8 presents maximum number of interruptions per kilometre and maximum expected time loss on different categories of cycle routes.

Table 8
Recommended quality parameters for different categories of cycle routes

		Maximum value		
Parameter	*Unit*	*Basic cycle route*	*Main cycle route*	*Cycle highway*
Interruptions per kilometre	Stops/km	1.5	1	0.4
Delay per kilometre	Seconds/km	40	20	15

D. Accessibility

33. Accessibility: the quality can be quantified in terms of cycle network grid size (also known as cycle network mesh width), measured as the distance between parallel cycle routes, or maximum distance to the closest cycle route. Experts are invited to provide the planning guidelines applied in different member states in this area or alternative proposals for quantifying different aspects of accessibility.

[14] Design manual for bicycle traffic. CROW 2017. https://www.crow.nl/publicaties/design-manual-for-bicycle-traffic