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Geometric design parameters
for cycling infrastructure

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EU CYCLE
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Contents

Introduction

The geometry of cycling infrastructure is a critical aspect of its safety and comfort. Bicycles need to maintain a certain speed to keep their balance. They travel in curves and cannot change direction at straight angles. Sharp turns make it difficult for cyclists to stay on track or maintain stability, and difficult for other road users to predict the bicycle trajectory. This can lead to falls, “run-off-the-road” accidents and collisions between cyclists, other vehicles or pedestrians. Unsuitable geometry can also exclude some user groups, in particular those who need dedicated cycling infrastructure the most, such as elderly cyclists and parents with children.

Figure 1. Bicycles travel in curves and lean into the curves.

In section 1 of this factsheet we look at the design speeds of cycling infrastructure adopted across different national or regional standards and guidelines, as well as factors affecting the choice of the design speed. Sections 2, 3 and 4 look at the key parameters determined by the design speed (horizontal/vertical curve radii and sight distances[1]) and then compare specific values given by different documents. Section 5 provides key recommendations that can be used as a reference if a national standard is missing or does not cover the specific parameter. For each of the countries and regions included in the comparisons, the relevant sections of the analysed documents are summarised in section 6.

The focus of the factsheet is on the most common requirements in already existing national and regional regulations and guidelines. It should however be noted that there are also more in-depth, non-normative analytical models which consider more parameters.[2]

[1] Visibility splays on crossings are also determined on basis of design speed, but they have been omitted in this comparison. We reckon it makes more sense to discuss these together with other factors influencing crossing design.
[2] For example, “Analytical Geometric Design of Bicycle Paths” (Zain Ul-Abdin, Sarmad Zaman Rajper, Ken Schotte, Pieter De Winne, and Hans De Backer, 2020, https://doi.org/10.1680/jtran.17.00162) considers also ratio of curvature for upcoming and previous road segments, and transition curves.

1. Design speed

Design speed defines how fast cyclists can travel along the route section without endangering their safety. High design speed means shorter travel times, and therefore increases the competitiveness of cycling. Consistent design speed reduces the need of braking and accelerating. Good view of the route ahead gives advance time to make decisions.

National and regional standards vary design speed depending on the role of the route in the network and its location. Typically, it means 20 km/h for local and 30 km/h for main cycle routes, with even higher values (35-45 km/h) for cycle highways or outside built-up areas. Regardless of the route category, design speed needs to be increased on inclines/declines. On the other hand, some standards allow somewhat reduced design speed in the intersection area. 10-12 km/h is usually used as the lowest possible threshold; below that speed a standard two-wheeled cycle becomes unstable

Table 1. Comparison of design speeds in national and regional standards and guidelines.

Guidelines/ standard	Lowest possible	Side routes	Main routes	Inclines	Increased for other reason
Austria		20-30 km/h		30 km/h (3%) 40 km/h (6%)	
Belgium (Flanders)		20 km/h	30 km/h		
Bulgaria		20 km/h	30 km/h		
Croatia					
Czechia	10 km/h	20-25 km/h		30 km/h (3%) 40 km/h (6%)	
Denmark		30 km/h	35 km/h	36 km/h (3%) 40 km/h (5%)	
Finland		25-30 km/h	40 km/h	+10 km/h	45 km/h base for cycle highways or if mopeds allowed

Guidelines/ standard	Lowest possible	Side routes	Main routes	Inclines	Increased for other reason
Germany[3]	10 km/h	20 km/h	30 km/h	40 km/h	
Greece	Not defined				
Italy		20-25 km/h		40 km/h for gradients >5%	
Ireland	10-12 km/h	30 km/h		40 km/h 50 km/h for slopes >5% longer than 150 m	
Netherlands	12 km/h	20 km/h	30 km/h	35-40 km/h	40 km/h outside built-up areas
Poland	12 km/h	20 km/h	30 km/h		
Slovakia	10 km/h	25 km/h		40 km/h	
Spain (Catalonia)	20 km/h	30 km/h	50 km/h	+2 km/h per 1% incline	
UK	20 km/h	30 km/h		40 km/h for gradients >3%	

[3] In ERA 2010 the speeds assigned to route categories are given as ranges of travel speeds, not design speeds. In the table, higher end of the travel speed range is given as an equivalent of the design speed; lower end of the lowest category is in the “lowest possible column”.

2. Minimum horizontal curve radius

In all design standards and guidelines, except for Denmark, minimum horizontal curve radius is clearly tied to design speed. Germany and Catalonia also consider the type of surface, with Catalonia additionally considering the cant (elevation of one side) of the curve.

Nearly all standards agree that a curve radius between 20 and 25 m is required for a design speed of 30 km/h. Requirements vary more both for lower and higher speeds: between 8 and 15 m for 20 km/h and between 25 and 47 m for 40 km/h.

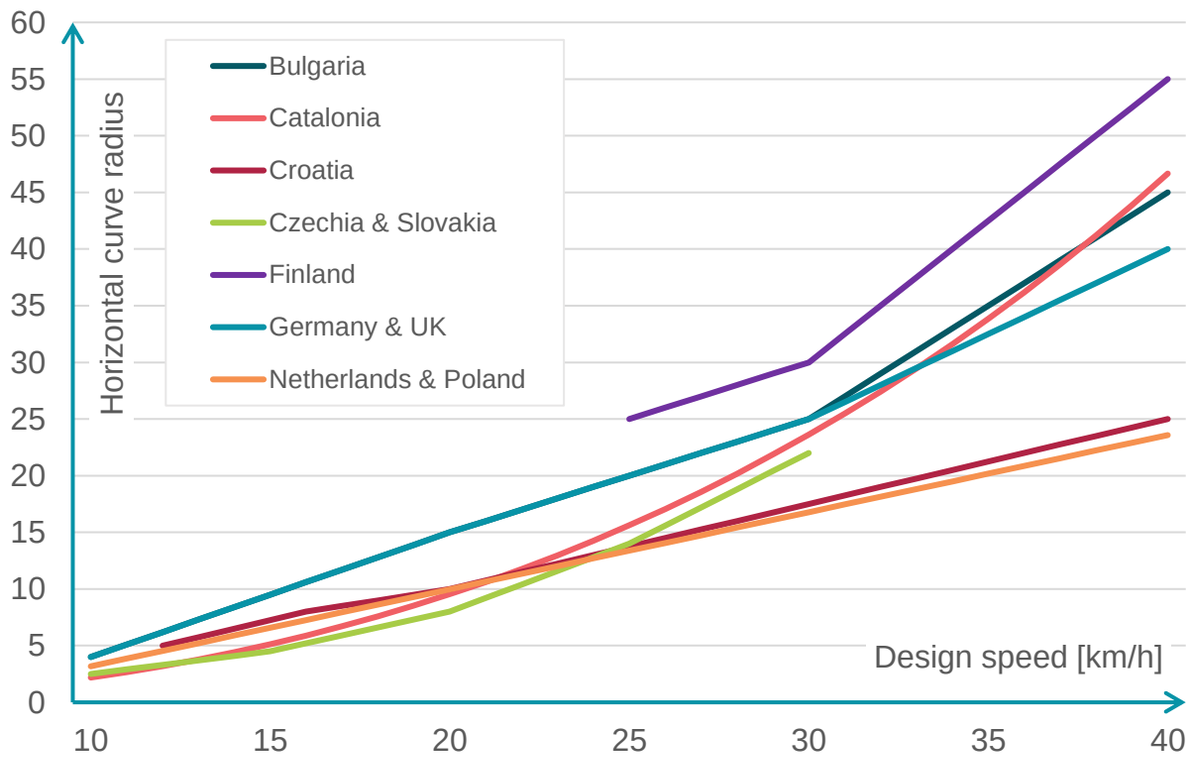
Table 2. Comparison of requirements for horizontal curve radii in national and regional standards and guidelines.

Guidelines/ standard	Lowest possible (10-12 km/h or intersection)	20 km/h	30 km/h	40 km/h	Notes
Austria	4 m	8 m	22 m		
Belgium	3-4 m (Brussels)	15 m (Flanders)	35 m (Flanders)		
Bulgaria	4 m	15 m	25 m	45 m	Up to 80 m for 50 km/h
Czechia	2.5 m	8 m	22 m		Width of the track must be increased by minimum: 0.25 m for R < 22 m, 0.5 m for R < 8 m
Croatia	5 m (1 m)	10 m	17.5 m	25 m	
Denmark	16-105 m, not clearly tied to design speed				Recommended tracing 210-360 m; for horizontal radii of less than 50 m a transverse inclination toward the bend's centre may be necessary

Guidelines/ standard	Lowest possible (10-12 km/h or intersection)	20 km/h	30 km/h	40 km/h	Notes
Finland	10-20 m	25 m (25 km/h)	30 m	55 m	Up to 130 m for 55 km/h (downhill sections of cycle highways)
Germany		10 m	20 m	30 m	50-130% higher radii required for unpaved surfaces
Greece	Not defined				
Italy	3-5 m	Not defined			Curve radii should be suitable for design speed, but no formula/values given
Ireland	3.6-4 m	8.4-10 m	16-25 m	20-25 m	Up to 94 m for 50 km/h
Netherlands	5 m	10 m	20 m	25 m (estimate)	Increase of width by 0.5 m advised in bends
Poland	5 m	10 m	20 m		Formula for other design speeds given.
Slovakia	2.5 m	8 m	22 m		
Spain (Catalonia)		10 m	24 m	47 m	70-80% higher radii required for unpaved surfaces
UK	4 m	15 m	25 m	40 m	

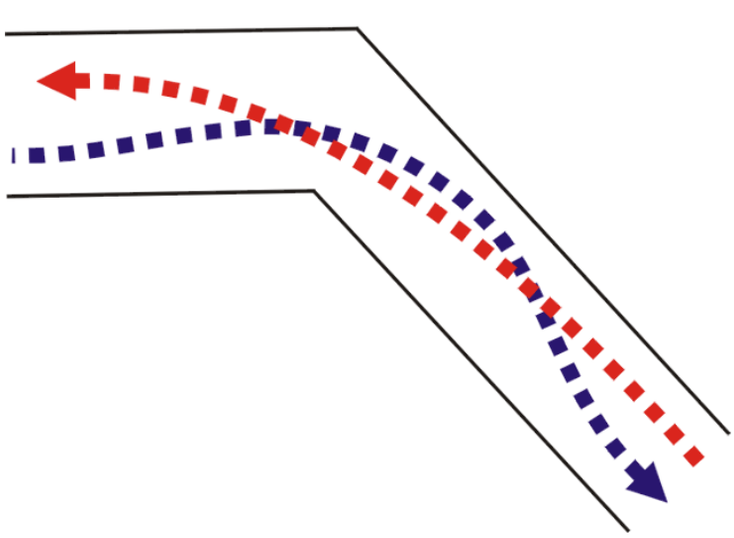
In some documents, the growth of the required curve radius with design speed is given as linear or nearly linear (Germany, Netherlands, UK), in some it is quadratic (Catalonia, probably also Austria and Czechia, though no explicit formula is given in the latter cases). The difference is negligible for lower speeds but becomes significant above 25 km/h. Given the growing popularity of electrically power assisted cycles and the potential of speed pedelecs (reaching speeds up to 45 km/h) in rural areas, additional analysis or research could be desirable.

Figure 2. Comparison of requirements for horizontal curve radii on asphalted cycle tracks in national and regional standards and guidelines. In the Catalonian formula we assumed p = 0.02 (transverse inclination of 2% towards the bend's centre).



To allow the full width of a cycle track to be effectively used, horizontal curve radius should be measured to the inner edge of the track.

Figure 3. Lack of curves or insufficient curve radius can cause head-on collisions, or single-vehicle accidents as a result of collision avoidance manoeuvre.



Several documents require or advise increased width of cycle tracks in bends. This is to accommodate the fact that cyclists lean into the curves (at higher speeds) or require additional space for balancing on the bike (at lower speeds).

Unless stated otherwise, the radii are calculated for clean asphalt surfaces. Non-asphalted or poorly maintained surfaces require roughly 1.5-2 times higher curve radii because of lower friction coefficient.

Figure 4. Bicycles need curves also to change direction at junctions. Not taking this into account results in cyclists travelling outside allocated space, potentially surprising other road users.

Figure 5. Because of insufficient curve radius at the connection of cycle tracks, the cyclist joining from the crossing will enter the part of the cycle track meant for traffic in the opposite direction.

3. Minimum vertical curve radius

Vertical curves are applied to avoid sudden changes of gradient. They need to ensure comfort and stability of riding, so the bicycle wheel does not jump on concave “bump”, or crash into the opposite wall of a convex “hole”. Vertical curves, especially concave, have also an impact on sight distance.

Figure 6. Vertical curves radii

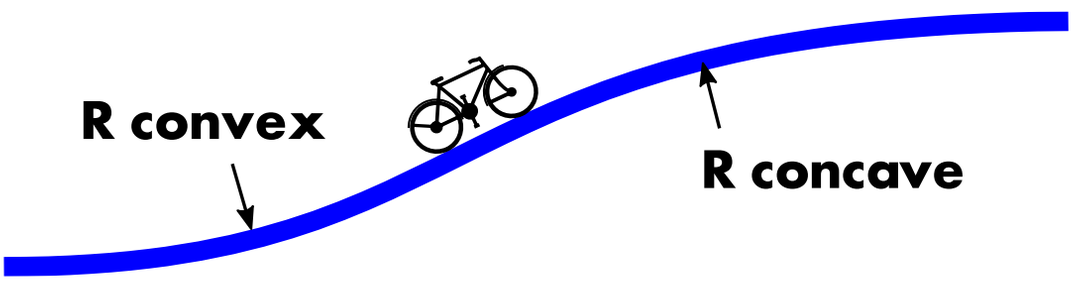


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Table 3. Comparison of requirements for vertical curve radii in national and regional standards and guidelines.

Country	20 km/h	30 km/h	40 km/h
Austria	20 m concave 10 m convex	40 m concave 20 m convex	65 m concave 40 m convex
Belgium	Not specified		
Bulgaria	Not specified		
Croatia	40 m concave 25 m convex	80 m concave 50 m convex	150 m concave 100 m convex
Czechia	20 m concave 10 m convex	40 m concave 20 m convex	65 m concave 40 m convex
Denmark	175-580 m, not clearly tied to design speed		

Country	20 km/h	30 km/h	40 km/h
Finland	225 m concave 50 m convex (25 km/h)	385 m concave 70 m convex	940 m concave 125 m convex
Germany	40 m concave 25 m convex	80 m concave 50 m convex	150 m concave 100 m convex
Greece	Not specified		
Italy	Not specified		
Ireland	Not specified		
Netherlands	Not specified		
Poland	Not specified		
Slovakia	20 m concave 10 m convex	30 m concave 20 m convex	40 m
Spain (Catalonia)	10 m	20 m	40 m
UK	300 m concave 250 m convex		

Vertical curve radius represented the biggest variety in the analysed parameters. Half of analysed documents do not mention it at all, some set the minimum requirements relatively low (10-40 m), other go as high as 250-300 m (up to 1370 m in Finland).

Wherever there is a distinction between requirements for concave and convex curves, higher minimum curve radius is required for concave. [4] This can be justified by the impact of concave curves on visibility of the route ahead.

[4] Literal translation of some regulations or guidelines can suggest that it is not always the case (for example in Croatia), but the terms concave and convex are used differently in traffic engineering across European countries. The comparison takes these differences into account and normalises the terminology to the interpretation shown on the figure in the beginning of the section.

Figure 7. This obstacle, hidden behind a vertical curve for the cyclists coming from the opposite direction, was the cause of a serious accident. Photo credit: Agnieszka Fabiańczyk.

4. Minimum sight distances

A cyclist should be able to see the road ahead of them enough to have time to react to obstacles or other users. The required sight distance calculations involve the reaction time and the time needed to decelerate.

Table 4. Comparison of requirements for sight distances in national and regional standards and guidelines

Country	20 km/h	30 km/h	40 km/h	Notes
Austria	15 m	25 m	40 m	
Belgium	Not specified			
Bulgaria	25 m	35-45 m		
Croatia	30 m	40 m		
Czechia	15 m	25 m	40 m	
Denmark	Not specified[5]			Meeting the curve radii criteria should ensure sufficient visibility
Finland	26-34 m (25 km/h)	34-45 m	53-73 m	Higher values required on downhill section Double the values for encounter sight distance
Germany	15 m	25 m	40 m	
Greece	Not specified			
Italy	10-18 m	18-31 m	29-46 m	Values calculated for the maximum allowed friction coefficient of 0.35

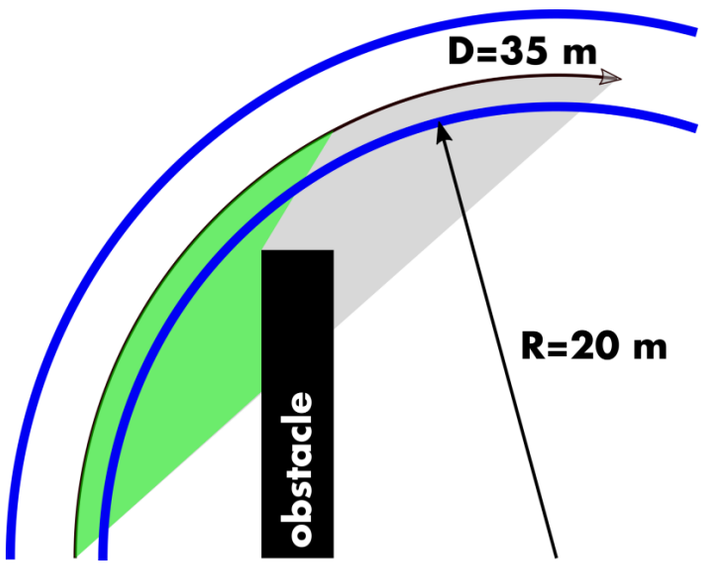
[5] A more general Handbook on Basic Design of Traffic Areas lists minimum stopping sight distances between 18 and 49 m, depending on the incline.

Country	20 km/h	30 km/h	40 km/h	Notes
Ireland	15 m (10 km/h)	35 m	60 m (50 km/h)	Should be increased by 50% on loose surfaces
Netherlands	21-60 m	35-84 m	42-112 m	Distinguishes between “sight distance in motion” and “stopping sight distance”
Poland	21 m 45 m	40 m 75 m		Required minimum Recommended minimum
Slovakia	15 m	25 m	30 m	Double values required on downhills >5% and unpaved sections
Spain (Catalonia)	20-25 m	35-45 m	55-70 m	Higher values required on downhill sections; add values for both directions on bidirectional tracks
UK	17 m	31 m	47 m	

Table 5. Comparison of underlying assumptions for calculating the stopping sight distance (where explicitly given)

	Reaction time	Deceleration	Eye level	Obstacle level
Denmark	2 s	2 m/s2		
Finland	2 s	2 m/s2	1.5 m	0.0 m
Italy	1-2.5 s	up to 3.4 m/s2		
Ireland	2 s	1.5 m/s2	1.0-2.2 m	0.0-2.2 m
Netherlands	2 s	1.5 m/s2		
Spain (Catalonia)	2.5 s	2.5 m/s2	1.4 m	0.0 m
UK			0.8-2.2 m	0.0-2.4 m

Figure 8. Example of a curve with radius sufficient for design speed of 30 km/h, but no satisfactory sight distance. The opaque obstacle inside the curve limits forward visibility below of 35 m (minimum value from the Dutch manual)



When evaluating the sight distance, a range of eye heights should be considered to accommodate different cyclists (children, adults) and different cycles (including recumbent). Specific values (0.8-2.2 m) are given for example by the UK guidelines.

On bidirectional cycle tracks the visibility should be ensured for double stopping sight distance (or sum of stopping distances for cyclists coming from the opposite directions). If it is not possible, the directions of traffic should be clearly separated.

Figure 9. A bidirectional cycle track split into two unidirectional to ensure sufficient curve radius and sight distance without cutting the tree.

5. Recommendations

The recommended quality criteria are grouped into three levels, following the classification of users developed in the frame of the EuroVelo European Certification Standard:[6]

- **Essential:** minimum requirements covering the most basic user needs. Can be applied if space is limited and the expected usage is not high. If the cycle infrastructure does not meet the Essential criteria, it is probably not safe and it definitely should not be obligatory to use. On this level, design speeds of 20 km/h and exceptionally 10 km/h are considered. When translating this design speed into minimum geometric parameters, we used the first quartiles from the analysed documents (which means that 75% of standards require higher parameters for the same design speeds).
- **Important:** addresses the needs of most regular and occasional users and is sufficient for typical cycle routes. On this level, a design speed of 30 km/h is assumed and median values from the analysed guidance documents are given as recommended.
- **Additional:** covers the widest range of cycle users, including those travelling on road bikes, electrically assisted pedal cycles, velomobiles, handbikes, tandems and bikes with trailers. It is an equivalent of a cycle highway in most guidelines, and can be considered the aspiration level for main, future-proof functional cycling connections. When translating the design speed into geometric parameters for this level, the third quartiles from the analysed documents are listed as recommended.

Figure 10. Additional criteria accommodate widest range of users and can be considered the aspiration level for main, future-proof cycling connections

[6] https://pro.eurovelo.com/projects/european-certification-standard

Table 6. Summary recommendations for geometric design parameters.

Criteria level	When to apply	Design speed	Minimum horizontal curve radius	Minimum vertical curve radius	Minimum stopping sight distance
Essential	Exceptional cases: when changing direction of travel, for example on an intersection or at a junction of cycle tracks	10 km/h	3 m	20 m concave 10 m convex	15 m
	Local cycle routes with low expected usage	20 km/h	10 m		
Important	Most typical cycle routes	30 km/h	22 m	60 m concave 35 m convex	35 m
Additional	Main, future-proof functional cycle routes Downhill sections on all routes	40 km/h	45 m	190 m concave 110 m convex	57 m

6. Analysed standards and guidelines

The analysed documents include standards and guidelines with varying level of detail and scope. They come from countries and regions with varying climates, level of cycle use, population density and topography. In the following subsections we provide short reviews of each of them, pointing out their unique features.

Table 7. Standards and guidelines included in the comparison.

Country	Document	Publication year	Link
Austria	RVS 03.02.13 Radverkehr (Guidelines and regulations for roads: cycle traffic)	2011	Available here (in German)
	Planungsleitfaden Radverkehr (Planning guide cycle traffic)	2007	Available here (in German)
Belgium	Vademecum Fietsvoorzieningen (Handbook cycle facilities)	2017	Available here (in Dutch)
	Vadémécum vélo en Région de Bruxelles-Capitale: Aménagements cyclables séparés de la chaussée partie 1[7] / Fietsvademecum Brussels Hoofdstedelijk Gewest: Van de rijbaan afgescheiden fietsinfrastructuur deel 1[8] (Handbook cycling: cycle infrastructure separated from the carriageway part 1)	2018	Available here (in French) Available here (in Dutch)
Bulgaria	Наредба № рд-02-20-2 от 20 декември 2017 г. за планиране и проектиране на комуникационно-транспортната система на урбанизираните територии (Ordinance on planning and design of the communication and transport system in urban areas)	2017	Available here (in Bulgarian)

[7] https://mobilite-mobiliteit.brussels/fr/professionnels-de-la-mobilite/publications-techniques-analyses-et-etudes
[8] https://mobilite-mobiliteit.brussels/nl/mobiliteitsberoepen/technische-publicaties

Country	Document	Publication year	Link
Czechia	Navrhování komunikací pro cyklisty (Design of routes for cyclists)	2017	Available here (in Czech)
Denmark	Collection of cycle concepts	2012	Available here (in English)
	Håndbog i cykeltrafik. En samling af de danske vejregler på cykelområdet (Handbook cycling traffic. A collection of the Danish road rules regarding cycling)	2014	Available here (in Danish)
	Håndbog supercykelstier. Anlæg og planlægning (Handbook supercyclehighways. Construction and planning)	2016	Available here (in Danish)
Finland	Pyöräliikenteen Suunnittelu (Cycling Design)	2020	Available here (in Finnish)
France	No relevant document identified		
Germany	Empfehlungen für Radverkehrsanlagen (Recommendations for cycling facilities)	2010	Available here (in German)
Greece	Τεχνικές οδηγίες για υποδομές ποδηλάτων (Technical instructions for bicycle infrastructure)	2016	Available here (in Greek)
Italy	Regolamento recante norme per la definizione delle caratteristiche tecniche delle piste ciclabili (Regulation laying down rules for the definition of the technical characteristics of cycle paths)	1999	Available here (in Italian)
Ireland	National Cycle Manual	2011	Available here (in English)
	Rural Cycleway Design	2017	Available here (in English)
Malta	No relevant document identified		

Country	Document	Publication year	Link
Netherlands	Design Manual on Bicycle Traffic	2016	Available here (in English)
Poland	Wytyczne organizacji bezpiecznego ruchu rowerowego (Guidelines for organisation of safe bicycle traffic)	2019	Available here (in Polish)
Slovakia	Technické podmienky. Navrhovanie cyklistickej infraštruktúry (Technical requirements. Cycle infrastructure design)	2019	Available here (in Slovakian)
Spain (Catalonia)	Manual for the design of cyclepaths in Catalonia	2008	Available here (in English)
UK	Cycle infrastructure design (LTN 1/20)	2020	Available here (in English)

6.1 Austria

Documents:

- ***RVS 03.02.13 Radverkehr*** (Guidelines and regulations for roads: cycle traffic), 2011 (federal)[9]
- ***Planungsleitfaden Radverkehr*** (Planning guide for cycle traffic), 2007 (regional/Tirol)[10]

The regional guidance recommends design speeds between 20 and 30 km/h within built-up areas (page 14). These design speeds are translated into minimum horizontal curve radii between 8 and 22 m, with 4 m permitted at intersection areas (page 15). The document stresses the safety aspect of sufficient curve radii, noting that tight bends force the cyclist to concentrate on the driving technique, and thus divert attention away from the road traffic.

The table with minimum stopping sight distances includes additionally a design speed of 40 km/h. While in the regional document it is not explicitly stated where this increased design speed should be applied, the federal document clarifies that 40 km/h should be applied on inclines with 6% gradient.

The federal document also lists requirements for vertical curves, not copied to the regional guide. For convex curves, the minimum curve radii vary between 10 and 40 m; for concave, between 20 m and 65 m, depending on the design speed.

[9] http://fsv.at/shop/produktdetail.aspx?IDProdukt=ec2dc99c-743f-4fdc-bd7b-84b3853acd87
[10] https://www.tirol.gv.at/fileadmin/themen/verkehr/verkehrsplanung/downloads/mobile04-07.pdf

Table 8. Geometric design parameters for cycling infrastructure in Austria.

Route	Design speed	Minimum horizontal curve radius	Minimum vertical curve radius	Minimum stopping sight distance
In the intersection area		4 m		
Within built-up areas	20 km/h	8 m	20 m concave, 10 m convex	15 m
	30 km/h	22 m	40 m concave, 20 m convex	25 m
General, **3% gradient**				
6% gradient	40 km/h		65 m concave, 40 m convex	40 m

6.2 Belgium

Documents:

- Flanders: ***Vademecum Fietsvoorzieningen*** (Handbook cycle facilities), 2017[11]
- Brussels: ***Vadémécum vélo en Région de Bruxelles-Capitale: Aménagements cyclables séparés de la chaussée partie 1***[12] **/ *Fietsvademecum Brussels Hoofdstedelijk Gewest: Van de rijbaan afgescheiden fietsinfrastructuur deel 1***[13] (Handbook cycling: cycle infrastructure separated from the carriageway part 1), 2018

In Belgium, separate handbooks for cycling infrastructure exist for two out of the three federated regions (Flanders and Brussels Capital Region). No similar document has been identified for the third region, Wallonia, or at the federal level.

Although the Flemish handbook for cycle facilities is a comprehensive document with more than 200 pages, geometric design parameters are only briefly mentioned in chapter 2. Minimum horizontal curve radius is given for design speeds of 20 and 30 km/h. No specific requirements regarding vertical curves or sight distances are provided.

[11] https://mobielvlaanderen.be/vademecums/vademecumfiets01.php, chapter 2: https://www.mobielvlaanderen.be/pdf/vademecum/hfdst2.pdf
[12] https://mobilite-mobiliteit.brussels/fr/professionnels-de-la-mobilite/publications-techniques-analyses-et-etudes
[13] https://mobilite-mobiliteit.brussels/nl/mobiliteitsberoepen/technische-publicaties

Table 9. Geometric design parameters for cycling infrastructure in Flanders.

Route	Design speed	Minimum horizontal curve radius
Connecting routes	20 km/h	15 m
Cycle highways	30 km/h	35 m

The Brussels handbook is even more brief, with curves discussed in section 6.3. Minimum horizontal curve radius is set at 10 m, always measured to the internal edge of the curve. For connections of cycle tracks, 4 m is the recommended and 3 m the minimum horizontal curve radius. The document stresses (also in other parts) that cyclists are unable to make a 90 degree turn in place. Design speeds, vertical curves and stopping distances are not mentioned.

6.3 Bulgaria

Document: ***Наредба № рд-02-20-2 от 20 декември 2017 г. за планиране и проектиране на комуникационно-транспортната система на урбанизираните територии*** (Ordinance on planning and design of the communication and transport system in urban areas), 2017[14]

Bicycle infrastructure design is regulated in chapter 3, section 2 of the regulation (articles 61-70). Key parameters are gathered in tables in appendix 8 to article 62.

Table 10. Geometric design parameters for cycling infrastructure in Bulgaria.

Route	Design speed	Minimum horizontal curve radius	Minimum visibility distance	Minimum stopping sight distance
?	10 km/h	4 m		
Connecting routes	20 km/h	15 m	25 m	25 m
Through routes	30 km/h	25 m	45 m	35 m
?	40 km/h	45 m		
?	50 km/h	80 m		

Table 1 in the appendix sets design speed to 30 km/h for through cycle routes, and to 20 km/h for connecting routes. This translates to minimum visibility distances of respectively 45 m and 25 m, and stopping sight distances 35 m and 25 m.

Table 3 in the same appendix provides minimum values of horizontal curve radii for a wider range of design speeds, from 10 km/h to 50 km/h. It is not however explained when designs speeds other than 20 or 30 km/h should be used. Vertical curve radii are not discussed for cycling infrastructure.

[14] https://lex.bg/en/laws/ldoc/2137180231

6.4 Croatia

Document: ***Pravilnik o biciklističkoj infrastrukturi*** (Regulation on bicycle infrastructure), 2016[15]

Geometric parameters are provided in chapter V.II of the regulation, articles 16 (horizontal curves), 19 (vertical curves) and 20 (stopping sight distance).

No specific design speeds seem to be required. Different ranges of design speed are used for different parameters:

- 12-20 km/h for horizontal curve radii in table 1,
- 12-40 km/h for horizontal curve radii on figure 1,
- 20-50 km/h for vertical curve radii in table 3,
- 20-30 km/h for stopping sight distances in table 4.

Article 16(2) allows to use an exceptionally low minimum horizontal curve radius of 1.0 m for cycle tracks at intersections.

In horizontal curves, the cross slope is generally required to be directed towards the centre of the curve.

Vertical curves are only obligatory if the change in gradient exceeds 5%.

Table 11. Geometric design parameters for cycling infrastructure in Croatia.

Design speed	Minimum horizontal curve radius	Minimum vertical curve radius		Minimum stopping sight distance
		concave	convex	
12 km/h	5 m			
16 km/h	8 m			
20 km/h	10 m	40 m	25 m	30 m
30 km/h	17.5 m[16]	80 m	50 m	40 m
40 km/h	25 m[17]	150 m	100 m	
50 km/h		300 m	200 m	

[15] https://narodne-novine.nn.hr/clanci/sluzbeni/2016_03_28_803.html
[16] Estimated from the graph.
[17] Estimated from the graph.

6.5 Czechia

Document: ***Navrhování komunikací pro cyklisty*** (Design of routes for cyclists), 2017[18]

Chapter 3.1.3 "*Návrhová rychlost*" of the Czech standard assumes basic design speed of 20-25 km/h, with higher values needed on descents, and 10 km/h allowed in exceptional cases. This has been translated to horizontal curve radii between 2.5 and 22 m (chapter 3.1.5 "S*měrové vedení a rozšíření ve směrovém oblouku*"), with the required widening of the track of minimum 0.25 m for radii below 22 m, and minimum 0.5 m for radii below 8 m.

Stopping sight distances for different design speeds are listed in chapter "3.1.4 *Délka rozhledu pro zastavení*". These values are calculated for asphalt surface. For unpaved roads required minimums need to be increased by 50%. The same increase is recommended for inclines exceeding 5%.[19]

Table 12. Geometric design parameters for cycling infrastructure in Czechia.

Route	Design speed	Minimum horizontal curve radius	Minimum vertical curve radius	Minimum stopping sight distance
In the intersection area (exceptionally, in justified cases)	10 km/h	2.5 m		9 m
?	15 km/h	4.5 m		
Basic	20 km/h	8 m	20 m concave 10 m convex	15 m
	25 km/h	14 m		
More than 3% descent	30 km/h	22 m	40 m concave 20 m convex	25 m
More than 6% descent	40 km/h		65 m concave 40 m convex	40 m + 50%

6.6 Denmark

Documents:

- **Collection of cycle concepts**, 2012[20]

[18] http://www.pjpk.cz/data/USR_001_2_8_TP/TP_179_2017.pdf
[19] This might seem to be superfluous considering that slopes already require higher design speeds, but actually slopes have double effect on stopping distance: the initial speeds are higher, and the deceleration is lower.
[20] https://www.cycling-embassy.org.uk/sites/cycling-embassy.org.uk/files/documents/Collection%20of%20Cycle%20Concepts%202012.pdf

- ***Håndbog i cykeltrafik. En samling af de danske vejregler på cykelområdet*** (Handbook on cycling traffic. A collection of the Danish road rules regarding cycling"), 2014[21]
- ***Håndbog supercykelstier. Anlæg og planlægning*** (Handbook on supercyclehighways. Construction and planning), 2016[22]

In the Danish "Collection of cycle concepts," the section on "Horizontal and vertical radii" explains that curves on cycle tracks should be passable at 30 km/h for bicycles and mopeds. It does not provide specific dimensions, noting only that in horizontal radii of less than 50 m a transverse inclination toward the bend's centre may be necessary. Further on, in the section on gradients, the manual notes that cyclists' safety drops if a steep incline is combined with a sharp horizontal curve.

At a gradient of 5%, cycle paths should be dimensioned for 40 km/h and for 36 km/h at a gradient of 3% (the increase is equal to the 2 km/h per 1% gradient given in the Catalonian manual, see section 6.14.

In the handbook for cycle superhighways, 35 km/h is assumed as a basis for cycle highways.

Table 13. Design speeds for cycling infrastructure in Denmark.

Route	Design speed
General	30 km/h
Cycle highways	35 km/h
Gradient 3%	36 km/h
Gradient 5%	40 km/h

Another overview publication, "Handbook on cycling traffic," differentiates curve radii depending on whether the cycle track is designated for bicycles only or also for moped.

Table 14. Geometric design parameters for cycling infrastructure in Denmark

Route	Horizontal curve radius				Vertical curve radius	
	Exceptional minimum	Minimum	Minimum normal	Recommended tracing	Minimum radius	Recommended minimum radius
Pedal bicycles only	16 m	40 m	60 m	210 m	175 m	340 m
Mopeds allowed	20 m	70 m	105 m	360 m	300 m	580 m

[21] http://www.celis.dk/Haandbog_i_Cykeltrafik_Web_High.pdf
[22] https://idekatalogforcykeltrafik.dk/wp-content/uploads/2019/04/16-01540-3-H%C3%A5ndbog_Supercykelstier_h%C3%B8ring-3507636_1_1.pdf

The manual does not specify sight distances but notes that observing the given curve radii requirements ensures sufficient visibility on the cycle track.

The more general “Handbook on the basis of traffic area design. Construction and planning”[23] calculates the minimum stopping sight distances for cyclists on basis of the following assumptions: reaction time 2 seconds, deceleration 2 m/s2 on flat sections. Initial speed depends on gradient only and varies between 20 km/h (5% uphill) and 34 km/h (5% downhill). This translates to stopping sight distances between 18 and 49 m, depending on the incline. As the speeds assumed are not aligned with the recommendations of the cycle-specific guidelines, we do not include these values in the summary table.

6.7 Finland

Document: ***Pyöräliikenteen Suunnittelu*** (Cycling Design), 2020[24]

The guidelines are published by the Finnish Transport Infrastructure Agency Design and 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.[25]

Design speeds are defined in table 22 in section 4.9.1. of the document. Section 4.9.2. and table 23 cover the sight distances, section 4.9.3. and table 24 cover horizontal curve radii, while section 4.9.4 with tables 25 and 26 cover vertical curve radii.

Table 15. Design speeds for cycle routes in Finland.

Route	Design speed
Local	25 km/h
Regional	30 km/h
Main	40 km/h (30 km/h in tightly built environment)
Cycle highways	45 km/h (30 km/h in tightly built environment)
Regional and main routes with mopeds allowed	45 km/h

Design speeds vary from 25 km/h to 45 km/h, with the highest applied to cycle highways and sections of other routes where mopeds are allowed to use the cycling infrastructure. For establishing the minimum horizontal curve radii, on long descends the design speed needs to be additionally increased by 10 km/h.

[23] Håndbog grundlag for udformning af trafikarealer. Anlæg og planlægning: https://nmfv.dk/wp-content/uploads/2012/12/Grundlag-for-udformning-af-trafikarealer-H%C3%A5ndbog.pdf
[24] https://julkaisut.vayla.fi/pdf11/vo_2020-18_pyoraliikenteen_suunnittelu_web.pdf
[25] For example, Helsinki: https://pyoraliikenne.fi/

Table 16. Minimum horizontal curve radius in Finland.

Modified design speed	Minimum horizontal curve radius
25 km/h	25 m
30 km/h	30 m
40 km/h	55 m
45 km/h	75 m
50 km/h	100 m
55 km/h	130 m

Reduced curve radii (10-20 m) are allowed in built-up areas in the vicinity of an intersection. On the other hand, if the change in direction exceeds 90 degrees, higher curve radius should be applied.

For sight distances and vertical curve radii, unmodified design speed is used as a base, but gradient is taken into account as a separate parameter for sight distance.

Table 17. Minimum vertical curve radii and stopping sight distances for cycling infrastructure in Finland.

Design speed	Minimum vertical curve radius		Minimum stopping sight distance		
	Concave	Convex	Gradient 0%	Gradient 5%	Gradient 8%
25 km/h	225 m	50 m	26 m	30 m	34 m
30 km/h	385 m	70 m	34 m	40 m	45 m
40 km/h	940 m	125 m	53 m	63 m	73 m
45 km/h	1370 m	160 m	64 m	77 m	89 m

Sight distance in motion (encounter sight distance) is calculated as double of the stopping sight distance. Eye height is assumed to be 1.5 m. For stopping sight distance on concave vertical curves obstacles on surface level (0.0 m) need to be visible.

6.8 Germany

Document: ***Empfehlungen für Radverkehrsanlagen*** (Recommendations for cycling facilities), 2010[26]

German federal recommendations for cycling facilities present the desired speeds for different categories of cycle routes in table 2 on page 10. However, the values given are travel speeds for the whole route (taking into account time lost at crossings and waiting on traffic lights, for example), not design speeds for route elements.

Table 18. Desired travel speed for different route categories in Germany.

Route category	Travel speed
AR II – AR IV (interregional, regional and connections)	20-30 km/h
IR II (fast local cycle routes)	15-25 km/h
IR III – IR V (other local cycle routes)	10-20 km/h

Further on, table 6 on page 16 gives geometric parameters for specific design speeds between 20 and 40 km/h. No clear relation with route categories or table 2 is established, only a remark that speeds 20 and 30 km/h are suitable for flat sections, while 40 km/h might be necessary on longer downhill stretches. For horizontal curves, the table differentiates between asphalt and unbound surfaces; for vertical curves – between concave and convex.

Table 19. Geometric design parameters for cycling infrastructure in Germany.

Design speed	Minimum horizontal curve radius	Minimum vertical curve radius	Minimum stopping sight distance
20 km/h	10 m asphalt / concrete 15 m unbound surfaces	40 m concave 25 m convex	15 m
30 km/h	20 m asphalt / concrete 35 m unbound surfaces	80 m concave 50 m convex	25 m
40 km/h	30 m asphalt / concrete 70 m unbound surfaces	150 m concave 100 m convex	40 m

The recommendations clarify that the given geometric parameters are applicable also at intersections for the route going straight ahead.

[26] https://www.fgsv-verlag.de/era

In addition to the federal recommendations, there are more detailed standards in different federate states. However, the two documents we examined:

- Radnetz Hessen: *Qualitätsstandards und Musterlösungen*[27] (Hessen)
- *Qualitätsstandards für Radschnellverbindungen*[28] (Baden-Württemberg)

with regards to the geometric design parameters simply refer to the federal recommendation, copying the parameters for asphalted tracks with a design speed of 30 km/h.

6.9 Greece

Document: ***Τεχνικές οδηγίες για υποδομές ποδηλάτων*** (Technical instructions for bicycle infrastructure), 2016[29]

The Greek regulation, while quite extensive (232 pages) does not include guidance or quality requirements on design speed, sight distances, horizontal or vertical curve radii.

6.10 Ireland

Documents:

- **National Cycle Manual**, 2011[30]
- **Rural Cycleway Design**, 2017[31]

The National Cycle Manual does not contain a dedicated section on geometric design parameters. Some information on curve radii and sight distances is scattered around section 4.10, on transitions between different types of cycling infrastructure, and section 5.3, on public lighting. In the Rural Cycleway Design (RCD) the information is better organised (in sections 5 and 6.1), but the title implies that the scope of the document is limited.

In the National Cycle Manual, the graph in section 4.10.1 implies that cycling[32] speeds between 12 and 40 km/h are considered, providing a formula for horizontal curve radius:[33]

Radius = 0.6 * speed – 3.62

In the same section, a curve radius of 16 m is recommended to accommodate cyclists travelling at 30 km/h as a general principle, with tighter curves allowed near junctions. Section 4.10.3 lists values of 10-25 m for cycling speeds between 20 and 40 km/h, giving downhill sections as an example of where

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[27] https://www.nahmobil-hessen.de/wp-content/uploads/2021/01/Qualitaetsstandards_und_Musterloesungen_2te_Auflage_web.pdf
[28] https://www.aktivmobil-bw.de/fileadmin/user_upload_fahrradlandbw/1_Radverkehr_in_BW/i_Radschnellverbindungen/Qualitaetsstandards_RSV_BW.pdf
[29] https://segm.gr/wp-content/uploads/2016/04/YA_DOY-OIK.1920-5.4.2015_B-1053.pdf
[30] https://www.cyclemanual.ie/; PDF available at: https://www.nationaltransport.ie/wp-content/uploads/2013/10/national_cycle_manual_1107281.pdf
[31] https://www.tiipublications.ie/library/DN-GEO-03047-02.pdf
[32] In section 4 the National Cycle Manual the term “cycling speed” is used.
[33] Similar to the formula provided by the Dutch manual, but with lower coefficient.

40 km/h should be applied. Stopping sight distance is mentioned in section 5.3.3.2 (on public lighting), as directly proportional to design speed. Minimum cycling sight distance between 20 and 40 m are required.

In the Rural Cycleway Design, design speeds between 10 and 50 km/h are listed (section 5.1), and translated to minimum horizontal curve radii between 4 and 94 m. For sight distances, a distinction between dynamic and stopping sight distances is made. In the first case a visibility envelope between heights of 1.0 and 2.2 m is considered (figure 5.1), in the second – eye height between 1.0 and 2.2 m and obstacles between 0.0 and 2.2 m (figure 5.2). A reaction time of 2 seconds and a deceleration rate of 0.15 g are assumed. The document specified also that minimum stopping sight distances should be increased by 50% on loose surface tracks.

Table 20. Cycling/design speed for cycling infrastructure in Ireland

Type of the route/context	National Cycle Manual	Rural Cycleway Design
Minimum	12 km/h (threshold of good stability)	10 km/h (on approach to obstacles)
Standard	30 km/h	30 km/h
Downhill	40 km/h	50 km/h

Table 21. Horizontal curve radii in Ireland

Cycling/design speed	National Cycle Manual		Rural Cycleway Design
	Section 4.10.1	Section 4.10.3	
10 km/h			4 m
12 km/h	3.6 m		
20 km/h	8.4 m	10 m	
30 km/h	16 (14) m	20 m	25 m
40 km/h	20 m	25 m	
50 km/h			94 m

Table 22. Minimum sight distances in Ireland

Cycling/design speed	National Cycle Manual	Rural Cycleway Design	
		Dynamic sight distance	Stopping sight distance
10 km/h	20-40 m (proportional to design speed, but no exact formula given)	15 m	15 m
30 km/h		65 m	35 m
50 km/h		110 m	60 m

6.11 Netherlands

Document: **Design Manual on Bicycle Traffic**, 2016[34]

The Dutch design manual, probably the most-often quoted set of guidelines for cycling infrastructure, discusses design speeds in chapters 3.2 and 3.3 (see page 46). The manual notes that for typical two-wheeled cycles, speeds of around 15 km/h are needed to cycle stably. With lower speeds cyclists need additional space, up to 0.8 m, to maintain balance. Speeds below 12 km/h are particularly problematic for elderly cyclists.

The consequences for curve radii and sight distances are elaborated further on in chapter 3.4 “Bends and view” (page 50-52). The manual quotes research demonstrating a linear dependency between the design speed and curve radius, with a concrete formula provided in an earlier edition of the manual[35]:

$$R = 0.68 * V – 3.62$$

where R – curve radius in meters, V – design speed in km/h

The manual also quotes research showing the following:

- With straight angles or insufficient curve radii cyclists need to travel outside the designed space, for example taking the part of a bidirectional cycle track designated for the opposite direction.[36]

- Sharp bends or insufficient sight distance can cause single-vehicle bicycle accidents, as well as accidents involving multiple bicycles.[37]

A more specialised “Design guide for bridges for slow traffic”[38] also warns that sharp bends on downhill slopes or just after them might cause single-vehicle bicycle accidents, and bicycle-bicycle accidents in case of two-directional cycle tracks.

Because cyclists lean into curves, increasing the width on bends by around 0.5 m is advised.

Regarding sight distances, the manual distinguishes sight distance in motion and stopping sight distance. The first one bases on the fact that the cyclist needs to be able to see the road ahead of them, on a distance equivalent to covered in 4-5 seconds (minimum) or 8-10 seconds (recommended). Stopping distances are calculated with the assumption of 2 seconds reaction time and deceleration of 1.5 m/s2.

[34] https://www.crow.nl/publicaties/design-manual-for-bicycle-traffic
[35] 1993 edition. The following article is referenced as a source for the formula: “Het verband tussen de snelheid van fietsers en hun vrij gekozen baan bij haakse bochten”; A. Dijkstra. In: Verkeerskunde 33, nr. 9, 1982.
[36] https://fietsberaad.nl/Kennisbank/Vrouwelijk-ontwerpen
[37] https://puc.overheid.nl/rijkswaterstaat/doc/PUC_133431_31/
[38] Ontwerpwijzer bruggen voor langzaam verkeer: https://www.crow.nl/publicaties/ontwerpwijzer-bruggen-voor-langzaam-verkeer

Table 23. Geometric design parameters for cycling infrastructure in Netherlands

Route	Design speed	Minimum horizontal curve radius	Minimum sight distance in motion	Minimum stopping sight distance
Lower limit	12 km/h	5 m		
Basic network	20 km/h	10 m	22-30 m (recommended: 44-60 m)	21 m
(Main) cycle route	30 km/h	20 m	35-42 m (recommended: 70-84 m)	40 m
Slopes	35-40 km/h			
Outside built-up areas	40 km/h	Not specified, can be estimated to ~25 m basing on the graph	Not specified, can be estimated to 44-56 m (recommended: 88-112 m)	Not specified, can be estimated to 42 m

6.12 Poland

Document: ***Wytyczne organizacji bezpiecznego ruchu rowerowego*** (Guidelines for organisation of safe bicycle traffic), 2019[39]

The Polish guidelines define the horizontal curve radii in section 6.1.1., and sight distances in section 6.1.3. Vertical curve radii are not mentioned. Horizontal curve radius should be measured to the inner side of the curve.

Table 24. Geometric design parameters for cycling infrastructure in Poland.

Route	Design speed	Minimum horizontal curve radius	Recommended minimum sight distance in motion	Minimum stopping sight distance
Minimum values	12 km/h	5 m		
Local and distributor cycle route	20 km/h	10 m	45 m	21 m
Main cycle route	30 km/h	20 m	70 m	40 m

[39] https://www.gov.pl/web/infrastruktura/wytyczne-bezpiecznego-ruchu-rowerowego

Given values seem to be based on the Dutch manual (discussed in section 6.11), with the following modifications:

- No design speeds higher than 30 km/h are mentioned.
- Formula for calculating horizontal curve radii is explicitly given.
- For recommended minimum sights distance in motion, the lower borders of the ranges are used.
- Additional minimum value for horizontal curve radii of 2 m is specified (allowed in situations where the cyclist needs to stop in order to give way).
- The requirements on slopes are not increased, there is only a mention in section 6.1.2 that for gradients above 5% sharp curves should be avoided.

6.13 Slovakia

Document: ***Technické podmienky. Navrhovanie cyklistickej infraštruktúry*** (Technical requirements. Cycle infrastructure design), 2019[40]

Design parameters are discussed in chapter 4 of the requirements. Section 4.8 "*Návrhová rýchlosť*" sets the default design speed to 25 km/h. In the areas of intersections or pedestrian crossings, the design speed can be reduced to 10 km/h. On the other hand, if gradient exceed 3%, 40 km/h design speed is required.

In section 4.4 "*Smerové oblúky*", table 8 translates design speeds between 10 and 30 km/h to horizontal curve radii between 2.5 and 22 m (so 40 km/h is not covered). In radii below 22 m, the track should be widened by at least 0.25 m, and in radii below 14 m – by at least 0.5 m. Additional widening is required on slopes exceeding 3%.

In section 4.5 "*Výškové vedenie*" tables 9 and 10 provide minimum and recommended vertical curve radii for design speeds between 20 and 40 km/h (but not for the default design speed of 25 km/h).

Finally, stopping sight distances for different design speeds are listed in section 4.6 "*Rozhľadové pomery*", tables 11 & 12. On flat and asphalted sections, a cyclist should be able to see at least 15-30 m of the route ahead. Double stopping sight distances are required for downhills exceeding 5% and unpaved roads. If the required distances cannot be achieved, traffic mirrors can be used to provide a better view of the route ahead.

For overtaking, uniform sight distance of 100 m is required. If it is not available, it should be indicated by horizontal markings.

Note: although the Czech document "*Navrhování komunikací pro cyklisty*" (see section 6.5) is referenced many times in the chapter, some of the Slovakian design parameters are different.

[40] https://www.ssc.sk/files/documents/technicke-predpisy/tp/tp_085.pdf

Table 25. Geometric design parameters for cycling infrastructure in Slovakia.

Route	Design speed	Minimum horizontal curve radius	Vertical curve radius		Stopping sight distance	
			minimum	recom-mended	minimum	gradients >5% & unpaved
Intersection areas	10 km/h	2.5 m				
?	15 km/h	4.5 m				
	20 km/h	8 m	20 m concave 10 m convex	40 m concave 25 m convex	15 m	30 m
Default	25 km/h	14 m			20 m	40 m
?	30 km/h	22 m	30 m concave 20 m convex	80 m concave 50 m convex	25 m	50 m
Gradient >3%	40 km/h		40 m concave 40 m convex	150 m concave 100 m convex	30 m	60 m

6.14 Spain (Catalonia)

Document: **Manual for the design of cycle paths in Catalonia**, 2008[41]

The Catalonian guidelines offer one of the highest ranges of design speeds, providing geometric parameters for cycling infrastructure up to 50 km/h (to accommodate sport cyclists or steep slopes?) The highest speeds are assumed for greenways with separations from pedestrians. Slopes increase the required design speed by 2 km/h per 1% incline.

The manual consistently differentiates geometric design parameters depending on the surface material. It observes correctly that unpaved surfaces (for example, stabilised gravel) are characterised by significantly lower friction coefficient. Therefore, they require larger curve radii and longer stopping sight distances.

[41] https://llibreria.gencat.cat/product_info.php?products_id=2283

Table 26. Geometric design parameters for cycling infrastructure in Catalonia.

Route	Design speed	Minimum horizontal curve radius	Minimum vertical curve radius	Minimum stopping sight distance
Greenway minimum	20 km/h	10 m paved 17 m unpaved	10 m	20 m on flat 25 m on 10% descent
Greenway general, bicycle lane minimum	30 km/h	24 m paved 44 m unpaved	20 m	35 m flat 45 m on 10% descent
	40 km/h	47 m paved 84 m unpaved	40 m	55 m flat 70 m on 10% descent
Greenway with separation for pedestrians, bicycle lane	50 km/h	86 m paved 151 m unpaved	70 m	75 m flat 100 m on 10% descent
Effect of slopes	+2 km/h per 1% incline	See formula		

The manual also provides a formula for individual calculation of horizontal curve radii, depending on design speed, cant of the curve and transversal friction coefficient. In contrast to linear dependency listed in the Dutch manual, the Catalonian document recommends curve radii proportional to square of the design speed.

R = V^2/127 (p + f)

Where:

- R = minimum radius of a curve [m]
- V = design speed [km/h]
- p = cant of the curve
- f = transversal friction coefficient

For stopping sight distances, the required lateral visibility should be equivalent to the sum of stopping distances for cyclists coming from the opposite directions.

6.15 UK

Document: **Cycle infrastructure design (LTN 1/20)**, 2020[42]

Chapter 5.6 of the guidance lists design speeds from 20 to 40 km/h, with 30 km/h being the default speed, 20 km/h absolute minimum and 40 km/h required on downhills with gradients exceeding 3%. The manual notes that the buffer space needed to maintain balance when cycling rises from 0.2 to 0.8 m when the speed drops below 7 mph (~11 km/h).

The table defining minimum horizontal radii in chapter 5.9 includes additional design speed of 10 km/h, below the "absolute minimum" listed in 5.6. It is not clear in what (exceptional?) situations this speed and curve radii can be used.

Table 27. Geometric design parameters for cycling infrastructure in the UK.

Route	Design speed	Minimum horizontal curve radius	Minimum vertical curve radius	Minimum stopping sight distance
?	10 km/h	4 m	Crest (concave): 300 m Sag (convex): 250 m	
Absolute minimum	20 km/h	15 m		17 m
General cycle tracks	30 km/h	25 m		31 m
Downhill gradients >3%	40 km/h	40 m		47 m

The guidance notes that introducing barriers or bends to slow cyclists is likely to increase the potential for user conflict and may prevent access for larger cycles and disabled people and so should not be used.

For designing vertical curves, the manual varies the curve length (not radius) depending on the difference between the gradients on neighbouring sections. The given method of calculation translates to nearly constant values of minimum radii: around 250 m for convex curves and 300 m for concave curves.

For stopping sight distances (chapter 5.7), the guidance recommends between 17-47 m. Obstacles should be visible from an eye height in the range of 0.8-2.2 m, to accommodate a range of cyclists including recumbent users, children and adults

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

7. Final remarks

The comparison was created with the help of ECF member organisations, with contributions from our project partners and participants of the workshops organised in the frame of Safer Cycling Advocacy Programme.[43] We would like to thank in particular:

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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 on cycling infrastructure geometry that should be mentioned in the document.

[43] https://safercycling.roadsafetyngos.org/

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