Cycle-Friendly Infrastructure 2024

Design standards for cycle and road projects in the City of Copenhagen

CITY OF COPENHAGEN

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Introduction

Copenhagen is one of the world's best cycling cities. The city's official goal is that 50% of all journeys to work and education are done by cycle. To realise this and other cycle-related goals, the cycle infrastructure is continuously being expanded.

Cycle-Friendly Infrastructure 2024 helps to ensure that this expansion takes place in a consistent, safe, and secure manner. First developed in 2013, *Cycle-Friendly Infrastructure* has since been the City of Copenhagen's guidelines for cycle and road projects and has ensured a high standard for cycle infrastructure.

However, a lot has happened on cycle paths since 2013: The general population growth has led to more cyclists and there is congestion on cycle paths in many places. The number of cargo bikes, both privately and commercially owned, has increased significantly. Furthermore, the opening of 12 Cycle Superhighways in Copenhagen since 2012 has led to more commuter cyclists, some on e-bikes. More Copenhageners cycling contributes to creating a better city. To ensure that the cycle infrastructure in Copenhagen can handle the increasing number of cyclists and the growth in cargo and e-bikes, we have updated the design standards.

The purpose of *Cycle-Friendly Infrastructure 2024* remains to ensure a cycle-friendly design of cycle and road projects, but the publication has become more nuanced and in-depth to highlight cyclists' comfort, flow, safety, and security. In particular, the description of cycle streets, cycle path widths, the connection between cycle and other traffic infrastructure, and cycle-friendly intersections has been revised.

Cycle-Friendly Infrastructure 2024 sets a high standard for both the design of roads, intersections and maintenance of cycle and road projects in Copenhagen. The publication is a tool for traffic planners and consultants, but also urban planners, landscape architects, architects, and developers working with zoning plans, urban development, and housing construction.

The guidelines in *Cycle-Friendly Infrastructure 2024* follow current legislation and technical guidelines for construction projects in Copenhagen, as well as the Danish Road Standards. The Road Standards are a collection of documents with national recommendations for cycle and road infrastructure. The Road Standards are indicative and often ensure good solutions, but do not always accommodate Copenhagen's volumes of cyclists and the city's political goals.

When developing cycle and road projects, specific context and location will lead to variations. Furthermore, use of public space and other modes of transport and must be considered. Therefore, a site-specific assessment must always be made when planning and building cycle and road projects.

Cycle-Friendly Infrastructure 2024 describes guidelines for best practice, and the Technical and Environmental Committee will always decide to which degree they are followed when approving a specific project proposal.

A broad group of professionals within the Technical and Environmental Administration has prepared *Cycle-Friendly Infrastructure 2024*. The publication is updated every two years, and the English version is available on www.kk.dk/cityofcyclists.

Happy reading and enjoy using *Cycle-friendly infrastructure 2024*.

1 Cycle paths and cycle-friendly streets

Cycle paths form the backbone of Copenhagen's cycle infrastructure and have for more than 100 years been crucial in developing todays cycling city. Cycle paths are the preferred solution when planning cycle infrastructure in Copenhagen. This chapter describes cycle paths, cycle lanes, cycle streets and cycle-friendly solutions on roads - including minimum widths, materials, and technical equipment.

Figure 1 provides guidance on when cycle paths, cycle streets or cycling in mixed traffic are recommended depending on the volume of cycle and motorised traffic per day (average weekday daily traffic AWDT). These three types of cycle infrastructure are the most common in Copenhagen.

Cycle paths should be established on main cycle routes, on roads with higher motorised traffic volumes (over 2,500 motor vehicles per day) or at speed limits above 40 km/h. Cycle streets should generally only be established where there is or is expected to be more cycle than motorised traffic per day. In addition, cycle streets should not be established on roads with over 2,500 motor vehicles per day. Cycling in mixed traffic is only recommended at low cycle and motorised traffic volumes and low speed limits (max. 40 km/h). *Figure 1* is based on speed limits of 30 or 40 km/h, which will be most common in Copenhagen going forward. For speed limits over 40 km/h, cycle paths are always recommended.

The choice of cycle infrastructure depends on a site-specific assessment (see *"5.1 Site-specific assessment tool"*), where safety, security, flow and comfort of different road users are considered early on.

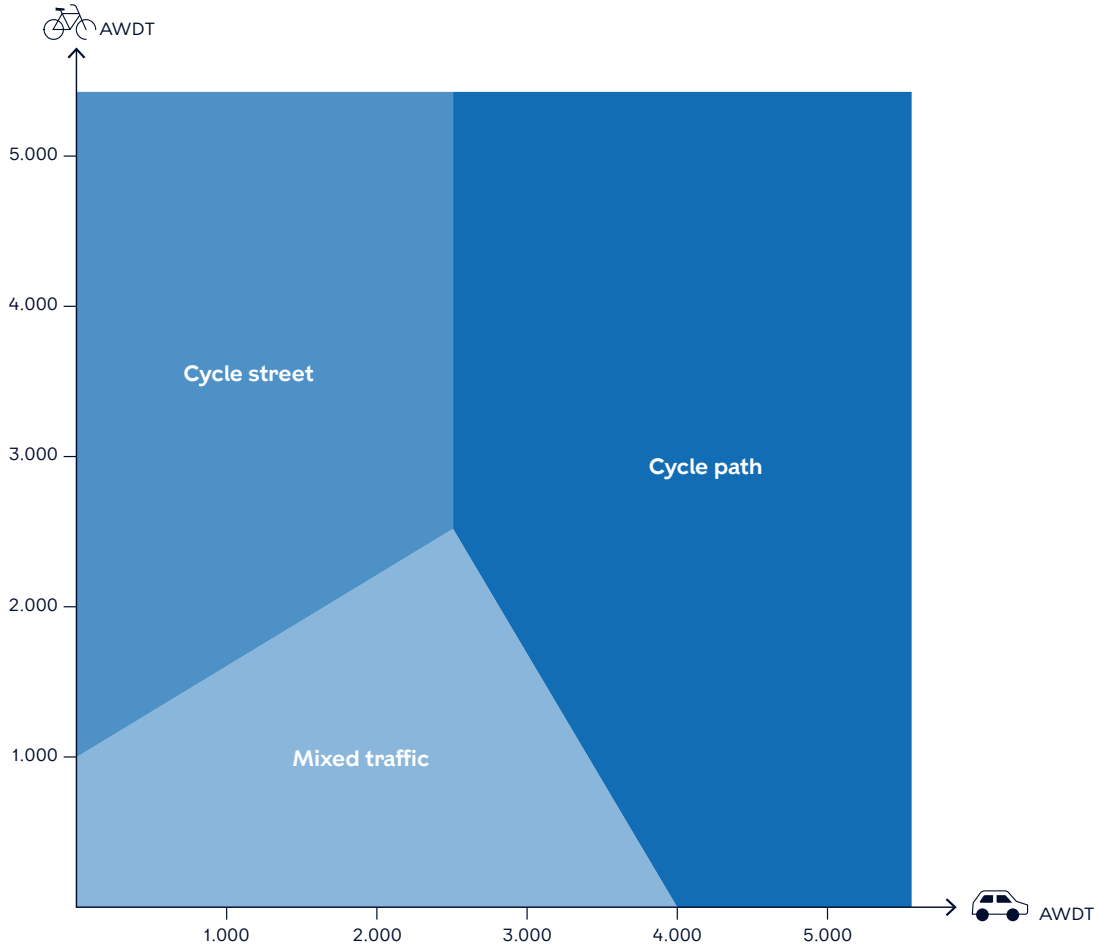


Figure 1 Guideline for cycle infrastructure depending on daily traffic volumes

Intersection at Dronning Louises Bro and Søtorvet

Cyclists, pedestrians and motorists

Cyclists include people riding bicycles, cargo bikes, multi-wheeled cycles, specialised and adapted cycles, bicycles with trailers, e-bikes (25 km/h), mopeds (30 km/h), speed pedelecs (45 km/h), electric scooters, electric skateboards, and self-balancing vehicles. Cyclists ride on cycle paths and lanes as well as on the carriageway when cycling in mixed traffic. To be more inclusive, we preferably use the term **cycle instead of bicycle** in this publication, unless specifically referring to two-wheeled bicycles.

Pedestrians include people walking, running, walking with prams, wheelchair users, skateboarders, and people on rollerblades or scooters. Pedestrians typically move on pavements.

Motorists include people driving motor vehicles (cars, vans, trucks, busses, taxis), large mopeds (45 km/h), and motorcycles. Motorists drive on singular (motor traffic) lanes and the entire carriageway. *Car parking* and *parked cars* include all forms of motor vehicle parking.

Road users are cyclists, pedestrians and motorists added together and include all people on roads.

Traffic volume, peak hour and rush hour

Traffic counts measure ***traffic volumes in terms of cyclists, pedestrians and motorists***. Vehicles are cycles and motor vehicles added together. Traffic counts for cyclists, pedestrians and motorists can be viewed at Copenhagen's spatial map and the Danish traffic registration system Mastra (requires login).

Average weekday daily traffic (AWDT) is the average traffic on a weekday outside the summer months (June, July and August). *Average annual daily traffic (AADT)* is the average traffic per day over the entire year. *Cycle-Friendly Infrastructure 2024* uses AWDT rather than AADT as a guiding principle. Traffic volumes are totalled for both directions unless otherwise stated.

Peak hour is the hour of the day with the most road users. As a rule of thumb, the peak hour is approximately 10–15% of AWDT. ***Rush hours*** are the hours of the day with the most road users in both directions and are typically on weekdays from 7–9am and 3–5pm.

1.1 Cycle paths and cycle-friendly streets

1.1.1 Cycle paths

Cycle paths should be constructed on main cycle routes, on roads with higher motorised traffic volumes (over 2,500 motor vehicles per day, see *Figure 1*), or at speed limits over 40 km/h.

Cycle paths are designed with kerbs against the carriageway and pavement to physically separate cyclists from motorists and pedestrians. Cycle paths provide comfort, security, safety and flow for cyclists. In other publications or countries, cycle paths are called cycle tracks or protected bike lanes.

Kerb clearance between carriageway and cycle path should be 8–12 cm. Kerb clearance between cycle path and pavement should be 6–8 cm.

The beginning and end of cycle paths for mixed traffic are designed by continuing the cycle path in a 15–20 m long wedge-shaped cycle lane (see *Figure 2*).

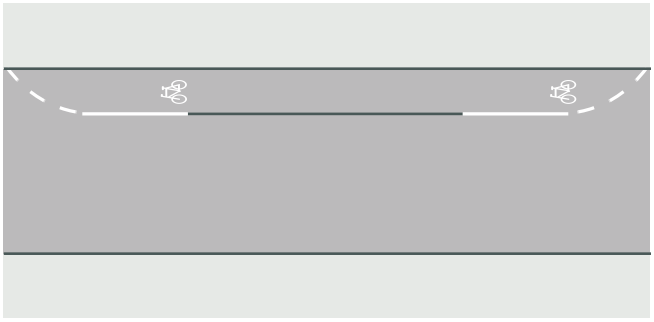


Figure 2: Beginning and end of cycle path for mixed traffic

Context and references

Cycle paths must be built on prioritised cycle routes: *"1.3.1 PLUSnet"* and *"1.3.3 Cycle Superhighways"*.

"1.2.1 Minimum widths for cycle paths".

"3.2 Field of view at intersections and conflict points".

At side roads with less motorised traffic, raised crossings should be established: *"3.5.2 Right-of-way and raised crossings"*.

Where a cycle path is interrupted on side roads with higher motorised traffic volumes, cycle marking should be used: *"3.4.1 Cycle marking"*.

"1.4.4 Ramps to and from cycle paths".

Existing and planned cycle paths can be seen on Copenhagen's spatial map.

Cycle path on Gyldenløvesgade

Beginning of cycle path on Kronprinsessegade

1.1.2 Cycle lanes

On most roads in Copenhagen, cycle paths are the starting point. There are cycle lanes in Copenhagen today, but they are not recommended for new construction. Cycle lanes are also discouraged at speed limits above 40 km/h or in areas with freight traffic.

Exceptionally, a cycle lane can be established temporarily before a cycle path and with the same recommended minimum widths, but only at low cycle and motorised traffic volumes (indicative traffic volumes corresponding to cycling in mixed traffic in *Figure 1*).

A cycle lane is a marked cycle area at the same level as the carriageway. Cycle lanes are marked with a wide white line and bicycle symbols placed approximately every 100 metres and at side roads. The beginning and end of the cycle lane for mixed traffic is designed by continuing the cycle lane in a 15–20 m long rounded wedge-shaped cycle lane (see *Figure 3*).

Cyclists perceive cycle lanes as less secure than cycle paths, but still more secure than cycling in mixed traffic. Cycle lanes are perceived most insecure by children and older cyclists. Cycle lanes present more challenges with parked cars. In snow, motorist can also overlook cycle lanes.

Reinforced cycle lanes at bus stops

Reinforced cycle lanes are cycle lanes supplemented with cycle paths on short stretches at bus stops or where motorists frequently stop, preventing buses and motorists from invading the cycle lane.

Figure 3: Beginning and end of cycle lane for mixed traffic

Context and references

"1.2.1 Minimum widths for cycle paths".

Along cycle lanes, parked cars can separate motorists from cyclists, but a dooring zone should be established between parked cars and the cycle lane: *"1.2.2 Dooring zone"*.

Cycle lane on Backersvej

Reinforced cycle lane at bus stop on Classensgade

1.1.3 Cycle streets

In a cycle street, cyclists have priority, and motorists may only enter if specifically allowed with a *Driving allowed* sub-sign.

In practice, motorists are often allowed on cycle streets but must drive at the same speed corresponding as cyclists (see *Figure 4*). This makes cycle streets a specific type of cycling in mixed traffic, where cyclists and motorists share the carriageway.

Cycle streets are a relatively new road type in Denmark with different designs. For future cycle streets in Copenhagen, we aim for a more uniform standard that supports the purpose of a cycle street.

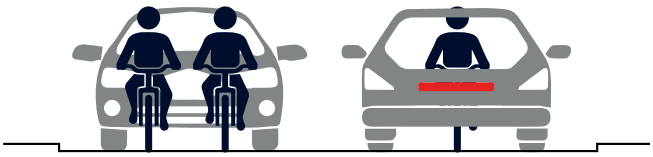


Figure 4: Cycle street principle

It is crucial that road users in the cycle street perceive a difference to a regular road with mixed traffic. This is achieved, for example, by making the carriageway stand out with a different road surfacing colour or type.

Traffic composition: more cyclists than motorists

To achieve the right balance, cycle streets should only be established where there is (or is expected to be) more cyclists than motorists per day. In addition, cycle streets should not be established on stretches with motorised traffic volumes above 2,500 per day. For indicative traffic volumes, see *Figure 1*, or use the rule of thumb with at least twice as much cycle traffic per day.

Furthermore, cycle streets should generally not be established on bus routes, as buses require wider lanes than recommended for cycle streets. In addition, bus stops in a cycle street can restrict cyclists' flow. Likewise, buses' manoeuvrability risks being impaired in cycle streets.

Narrow road profile, widened pavements and low speeds

A narrow road profile in cycle streets contributes to low speeds for motorists. With two-way motorised traffic, exceptionally low speeds (10–20 km/h) and few large motor vehicles, the carriageway width without a centre line can be 5.0 m (see *Figure 6*). Where this is not the case, or where a division into two lanes is desired, the carriageway width should be 5.6 m (see *Figure 7*).

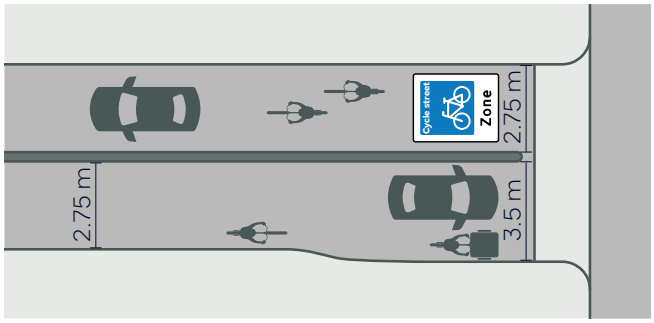


Figure 5: Cycle street with crossable cobblestone band

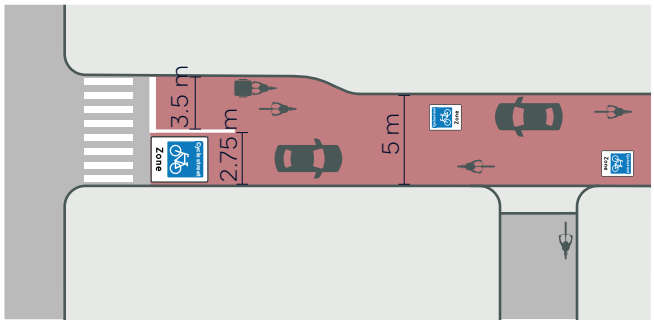


Figure 6: Narrow cycle street without centerline

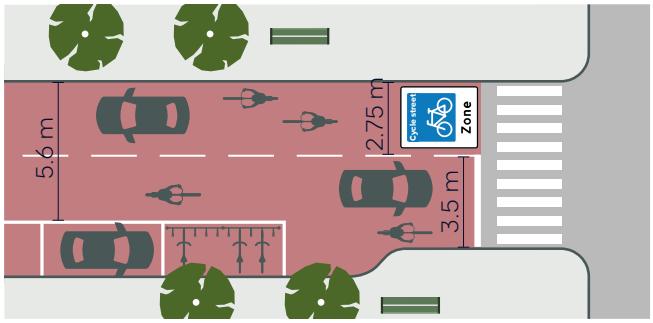


Figure 7: Cycle street with widened pavement, cycle and car parking

When the road profile narrows, the pavements can be widened to make room for wider walkways, benches, cycle racks, or trees (see *Figure 7*).

Low speed for motorists can be supported by visually narrowing the lane, e.g. with a crossable cobblestone band in the centre (see *Figure 5*). In addition, staggering can be added to ensure low speed.

In cycle streets where cyclists' flow is straight with little need to cross, double barrier lines can be used. Cyclists or motorists must not cross double barrier lines. This prevents motorists from invading the oncoming lane when overtaking. The double barrier line can be punctured where cyclists need to cross. Stretches with double barrier line should not be longer than 500 metres.

Traffic calming measures such as bumps designed for 20 or 30 km/h should only be used exceptionally, as they restrict cyclists' comfort and flow.

Recognisable design

The design of cycle streets should be recognisable and self-explanatory. All road users should easily understand the special traffic rules upon entering the cycle street.

A recognisable design is established with the following road marking: 2-metre cycle street marking at the start of the cycle street and 1-metre cycle street symbols every 100 metres, as well as on side roads (see *Figure 6*). The road marking supplement the mandatory cycle street signage.

To increase road user awareness, red asphalt is recommended in future cycle streets on the entire carriageway at motorised traffic volumes above 1,000 motorists per day. Red asphalt should be combined with cycle street signage and road marking. Red asphalt in cycle streets is widely used in Dutch, Belgian and German cities, but not yet in Danish cities.

Furthermore, supporting urban facilities such as trees, greenery, benches and cycle parking can be considered. Road surfacing in cycle streets should be asphalt, unless special consideration needs to be given to crossing pedestrians and urban design on short stretches.

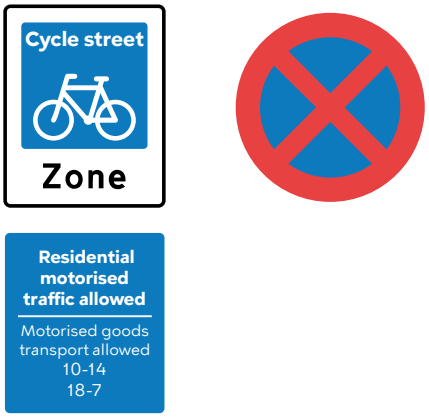


Figure 8: 'Cycle street zone' sign with different possible sub-signs limiting motorised traffic.

Limit motorised traffic and car parking

How to best limit motorised traffic and car parking should be assessed in each cycle street. Possible measures:

- One-way motorised traffic while allowing cycle traffic in both directions
- Time restrictions on motorised traffic during cyclists' rush hours
- Only motorised traffic for residents, commerce and goods
- Restrict or ban stopping for motor vehicles
- Remove car parking
- Road closures with cycle passages or bollards.

Car parking in cycle streets is only allowed in marked parking areas. Car parking bays are established as parallel parking with a dooring zone of 0.3–0.5 m towards the carriageway to prevent collisions between cyclists and opening motor vehicle doors. Angled car parking is discouraged in cycle streets.

Limited car parking and stopping in a cycle street is recommended, possibly with selected delivering and dropping off locations for a calm traffic environment. This also supports better field of view for crossing cyclists and pedestrians.

On cycle streets with side roads, the *20-metre rule* should be applied, which prevents car parking and stopping at least 20 m before a side road to improve the field of view.

Cycle street with widened pavements, trees, and cycle parking on Vendersgade

For significant goods delivery, separate areas outside the carriageway are recommended for deliveries so that cyclists do not have to navigate around stopping vans and use the opposite lane.

Intersection design

To allow cyclists to enter intersections alongside motorists, the road profile at the ends of the cycle street should be wider than the rest of the cycle street. Approximately 25 m before the intersection, the cycle street should therefore end into a 3.5 m wide shared lane (see *Figure 5*, *Figure 6* and *Figure 7*). Alternatively, the cycle street can stop 25 m before the intersection, and a cycle path can be built towards the intersection.

Consider pedestrian conditions

Cycle streets often result in more pedestrians or are established on roads that already have many pedestrians. Therefore, pedestrian conditions should be considered from the start, and if there is a high need for pedestrian crossings, raised platforms or crossing islands can be considered.

Communication and evaluation

As cycle streets are not yet widespread in Copenhagen, communication efforts towards citizens and thorough evaluation are recommended.

Context and references

"3.4.5 Waiting area for left-turning cyclists".

Consider cycle boxes on cycle streets with contraflow cycling, on accesses before cycle streets, and at three-way intersections: "3.4.2 Cycle box".

Red road surfacing in cycle streets: "1.4.1 Road surfacing".

Cycle streets are signposted cf. Executive order on road marking §27, 2023 and Executive order on the use of road marking §131, 2023, at the start and end of the cycle street and from side roads.

"1.2.2 Dooring zone".

"3.2 Field of view at intersections and conflict points".

"2.1 Traffic behaviour".

"1.1.4 Cycling in mixed traffic".

Cycle street on Vendersgade

1.1.4 Cycling in mixed traffic

Cycling on the carriageway without separate cycle infrastructure is only recommended at low motor vehicle and cycle traffic volumes (see *Figure 1* for indicative traffic volumes) and low speed limits of max. 40 km/h.

The lane width should be designed according to the speed limit, e.g. 2.75 m at 20–30 km/h. Additionally, traffic calming measures can be implemented, and car parking should be limited. The use of a wide kerb line to narrow the carriageway is not recommended as it can be misunderstood as a narrow cycle lane by both motorists and cyclists.

Cycling in mixed traffic is not recommended where the speed limit or measured speed for motorists is over 40 km/h.

Cycling in mixed traffic is also discouraged on bus routes, as these require wider lanes, which is not in line with the intention of an actual speed limit of 40 km/h. Cycling in mixed traffic on roads with freight traffic is also discouraged.

Context and references

Physical speed calming measures for an appropriate low speed for motorists: "*2.2 Cycle infrastructure and traffic calming*".

When cycling in mixed traffic, the amount of car parking should be limited to create sufficient field of view. Especially 20 metres before intersections and side roads, car parking and stopping should not be allowed: "*3.2 Field of view at intersections and conflict points*".

Only parallel car parking should be established in mixed traffic: "*2.3 Cycle infrastructure and car parking*". Additionally, a dooring zone is recommended: "*1.2.2 Dooring zone*".

Car parking next to crossing islands, trees or waste bins should be avoided as it creates poor field of view and thus insecurity for cyclists.

Cycling in mixed traffic on Nygårdsvej

Cycling in mixed traffic on Dybbølsgade

1.1.5 Contraflow cycling

One-way traffic should generally only apply to motorists. Contraflow cycling provides cyclists with better comfort and flow. It also minimises illegal and inappropriate behaviour among cyclists.

Contraflow cycle paths and lanes

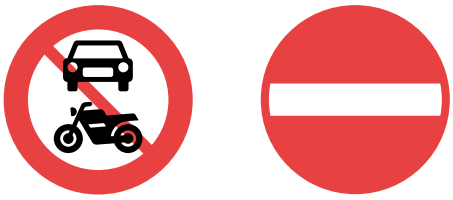
Contraflow cycle paths and lanes are recommended on one-way streets with speed limits above 30 km/h and on roads with buses. Contraflow cycle paths are preferred over lanes. Both solutions often involve removing car parking on one side of the road.

In intersections, crossing islands and pavement expansions can provide a safe way for contraflow cyclist to enter and exit the one-way street and helps making cyclists more visible. Contraflow cycle lanes are marked with double barrier lines and bicycle symbols.

Contraflow marking

Contraflow marking is used in one-way streets with sufficient field of view and no bus traffic that are too narrow for contraflow cycle paths or lanes. The road design should be straight, and the road profile narrow. The carriageway width should be 4.5 m, and a 0.3 m safety zone should be added to fixed objects (e.g. cycle parking). For kerb parked cars, the carriageway width should be 6.8 m. Contraflow marking is signposted as contraflow cycling and marked with at least 10 m double barrier line and bicycle symbols at both ends of the road (see *Figure 8*). An additional crossing island at intersections can increase safety and comfort.

Contraflow cycling signage: 'One-way traffic' sign and 'Cyclists excluded' sub-sign in one end of the one-way street



'No entry for motor vehicles' sign allows contraflow cycling at the other end of the one-way street, and replaces 'No entry' sign for all road users

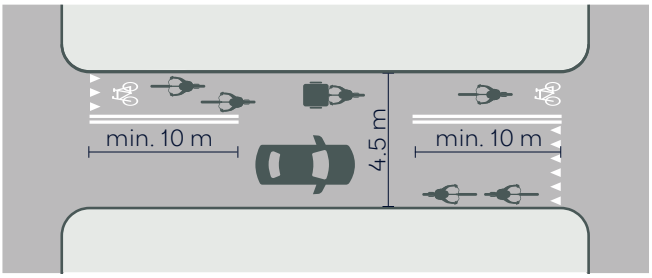


Figure 8: Contraflow marking

Contraflow marking and median island on Studiestræde

Contraflow cycle path on Elmegade

Context and references

In one-way streets, car parking should be pre-vented close to intersections to ensure sufficient field of view for motorists: *"3.2 Field of view at intersections and conflict points"*. This is especially important with contraflow marking.

In addition, car parking should be assessed and possibly minimised to improve field of view. Parallel car parking is the best solution for cyclists' and pedestrians' field of view: *"2.3 Cycle infrastructure and car parking"*.

Contraflow marking is the minimum solution for contraflow cycling cf. *Executive order on road marking §120 section 3*, 2023.

There must not be car parking or stopping 5 metres before the contraflow marking cf. *Traffic law §29*, 2023.

"3.4.2 Cycle box".

1.1.6 Two-way cycle paths

Two-way cycle paths are mainly used to create shortcuts away from busy roads and in recreational areas and are also called bidirectional cycle paths. A two-way cycle path can be secure and comfortable and should be built without many stops. In tunnels, on bridges and short stretches, moped traffic can be banned to increase safety and security for cyclists. On a two-way cycle path, cyclists travel in both directions, separated by a dashed centre line. In Copenhagen, two-way cycle paths are typically built off-street through e.g. recreational or residential areas and thus completely separated from roads.

Challenges at intersections with two-way cycle paths

Where an off-street two-way cycle path crosses a road, the following can reduce crossing challenges:

- Traffic signals if the requirements for establishment are met. Two-way cycle path crossing is generally not recommended at major signalised intersections, unless the crossing has its own signal phase
- Safe cycle path crossing with a median island, if cyclists are required to give way, and with a low speed limit on the crossing road
- Tunnel or bridge.

Two-way cycle paths along roads are discouraged

Two-way cycle paths along roads are discouraged in urban areas due to significant risk of collisions at intersections at side roads and where cycle paths end. This also applies to shared-use paths with two-way pedestrian and cycle flow, as they create potential conflicts between pedestrians and cyclists.

Exceptionally, however, two-way cycle paths can work along stretches without crossings, for example along a railway, or on shorter connections to a bridge, for example. However, the design of the ends of two-way cycle paths requires special attention to ensure safe and intuitive traffic flow.

Two-way cycle path on Halmtorvet

Two-way cycle paths signage with 'Cycle path' sign and 'Two-way cycle traffic' sub-sign

Context and references

"3.3.1 Traffic signals".

"3.5.3 Cycle path crossings".

"1.1.9 Tunnels, stairs and lifts".

"1.1.8 Cycle and pedestrian bridges".

"1.2.1 Minimum widths for cycle paths".

Two-way cycle path along the railway on Østbanegade

Two-way cycle path at Poul Henningsens Plads

1.1.7 Shared-use paths

Shared-use path with separation

A shared-use path with separation in Copenhagen typically runs off-street and has a clear separation between cycle path and walking path. It is signposted with the *Shared-use path with separation* sign.

The cycle path and walking path are separated by striping, road marking, deviating road surfacing, cobble-stones, or a buffer zone. On the cycle path there is typically asphalt and bicycle symbols. The walking path may have coloured or a different distinctive road surfacing. On short stretches, moped riding may be banned to enhance the safety and security of cyclists and pedestrians. Shared-use paths are mostly used with two-way cyclist flow. The cycle path on a shared-use path should there-fore be designed as a two-way cycle path with the recommended minimum widths. The walking path should be at least half the width of the cycle path, and at least 2 metres for fewer pedestrians.

On shared-use paths with full-width asphalt and a line as separation, doubts may arise about the correct placement - especially pedestrians. Therefore, bicycle symbols and clear signage should be used.

Shared-use path without separation only for very few cyclists and pedestrians

Shared-use paths without separation are only established exceptionally for very few cyclists (less than 150 cyclists per peak hour in both directions) and very few pedestrians, and where space is absolutely limited. Shared-use paths without separation close to the carriageways are not recommended. A shared-use path without separation in Copenhagen typically runs off-street and is signposted with the *Shared-use path without separation* sign.

The missing separation of shared-use paths without separation can lead to poorer conditions and insecurity for both cyclists and pedestrians compared to shared-use paths with separation. The primary function of shared-use paths without separation should be recreational trips outside of urban areas, which in Copenhagen is rarely possible, as recreational routes are often also used for commuting. For short stretches, moped riding can be banned to increase safety and security of cyclists and pedestrians.

'Shared-use path with separation' sign

'Shared-use path without separation' sign

Context and references

"1.2.1 Minimum widths for cycle paths".

"1.1.6 Two-way cycle paths".

"2.4 Cycle and pedestrian infrastructure".

Shared-use paths without separation are often sign-posted as two-way with the sub-sign *Two-way cycle traffic*. The width of a two-way shared-use paths with-out separation follows the recommended minimum widths for two-way cycle paths with a minimum of 1 metre added for pedestrians.

Shared-use path with separation at Svineryggen

Shared-use path with separation at Langelinie

Shared-use path without separation in Fælledparken, photo Ursula Bach

Photo Ursula Bach

1.1.8 Cycle and pedestrian bridges

Copenhagen's many cycle and pedestrian bridges increase comfort and flow for cyclists and pedestrians. These bridges create connections over water, railways, and busy roads, and contribute to the city as architectural landmarks.

Bridges should generally be built for both cyclists and pedestrians. A low gradient of 20–40‰ to a maximum of 45‰ is endeavoured to maintain good accessibility. On shorter stretches, 50‰ is acceptable, but here the width should be increased to compensate for cyclists' different speeds.

The minimum curve radius on cycle and pedestrian bridges is 40 metres. This avoids sharp curves and cyclists cutting into the curve. If a smaller curve radius is chosen anyway, the cycle path width should be increased.

Cycle and pedestrian paths on bridges should be designed as shared-use paths with separation.
When constructing cycle and pedestrian bridges, follow the recommended minimum widths for cycle paths and pavements and add an additional 0.3–0.5 m safety zone for guardrails.

Context and references

"1.1.7 Shared-use paths".

"1.2.1 Minimum widths for cycle paths".

Materials on bridges and bridge landings should have a high friction (minimum friction index 65) to minimise the risk of falling, especially in bends at bridge landings: *"1.4.1 Road surfacing".*

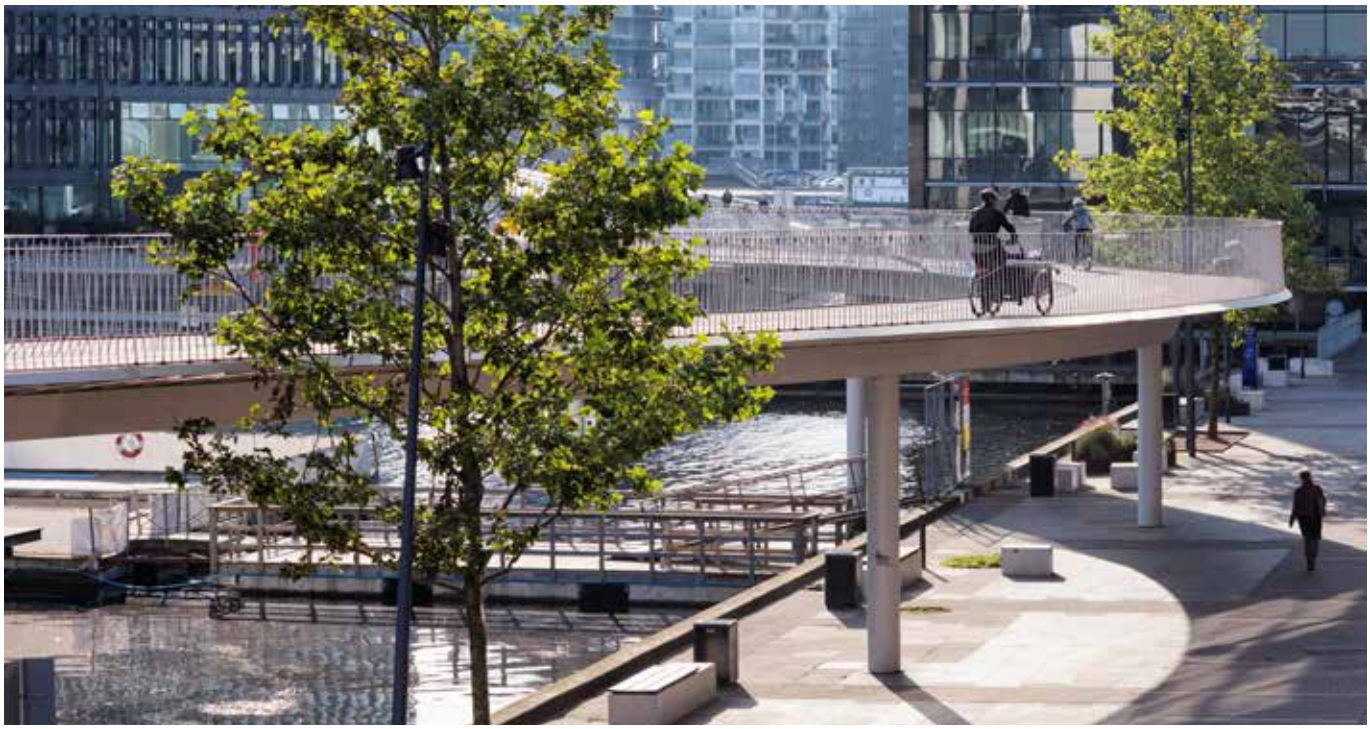
The driving curves of specialised and adapted cycles must be considered. Furthermore, the bridge should be designed to reduce the gradient at the landings to reduce the speed of cyclists. For more information on gradients for bridges: *"1.4.3 Geometric design".*

If conflicts between pedestrians and cyclists at bridge landings cannot be resolved with clear yield lines, additional elements to increase cyclists' awareness can be considered: *"2.5 Tactile marking to sharpen cyclists' attention".*

Lighting on cycle and pedestrian bridges: *"4.1 Lighting".*

"5.3 Traffic and simulation models".

Copenhagen's Accessibility checklist for bridges and ramps.



Cykelslangen / cycle snake, photo Troels Heien

Coherent bridge landings

Special attention must be paid to the bridge landings and the coherence between cycle, pedestrian and road network. Clear traffic flow and right-of-way must be ensured to provide comfort and flow for cyclists and pedestrians, as well as for all road users.

On cyclists' main routes, right-of-way at the end of the gradient should be avoided for the sake of cyclists' flow. If cyclists are nevertheless required to give way, the yield lines should be placed away from the slope on a relatively flat area.

Dimensioning new cycle and pedestrian bridges

For new cycle and pedestrian bridges, future traffic volume is calculated with Copenhagen's traffic model Compass.

The calculated future traffic volumes should include an additional reserve, as cycle and pedestrian bridges are built to last for 100 years and cannot easily be rebuilt if traffic volumes turn out to be higher than calculated.

Traffic model calculations can be input for the dimensioning of cycle and pedestrian bridges but should not stand alone. Actual traffic volumes on existing cycle and pedestrian bridges are also essential input. Traffic model calculations can also provide knowledge about how additional bridges will affect the existing cycle network.

Carlsberg viaduct, photo Troels Heien

Bridge landing at Lille Langebro

Lille Langebro, photo Troels Heien

1.1.9 Tunnels, stairs and lifts

Tunnels

Tunnels can create a safe and secure crossing of busy roads and railways.

Cycle and pedestrian infrastructure through tunnels are designed as shared-use paths with separation. The pedestrian path should be established with deviating road surfacing.

Cycle paths and pavements in tunnels follow the recommended minimum widths and a 0.3–0.5 m safety zone is added to each side. Tunnels should have a clearance height of min. 3.0–3.5 m to ensure security and clearance for maintenance vehicles.

Barriers, bollards, and sharp bends should be avoided in tunnels or just outside them. When entering and exiting the tunnel, the geometry should be designed to match the speed of the cyclists and field of view, to reduce the risk of collisions.

Access ramps for cyclists

Access ramps where cyclists can cycle up or down to cycle cellars or stations without dismounting are the starting point. Access ramps offer the best accessibility for cyclists and are also called direct access. For cyclists with cargo bikes, specialised or adapted cycles, access ramps or wide lifts are often the only possible solution.

Context and references

"1.1.7 Shared-use paths".

"1.2.1 Minimum widths for cycle paths".

Materials in tunnels should have a high friction (min. friction index 65) to minimise fall risks: "*1.4.1 Road surfacing*" and should be smooth for good comfort (e.g. tiles and stones are discouraged)

For more information on gradients for access ramps to tunnels, cycle cellars, stations etc.: "*1.4.3 Geometric design*".

Good lighting and light transmission are crucial for a secure tunnel: "*4.1 Lighting*". Furthermore, decorations or light installations can increase comfort.

For new tunnels, added daylight is recommended with light openings or outward sloping sides (see *Figure 9*), which also prevent graffiti.

Copenhagen's Checklist for accessibility on bridges and ramps.

Figure 9: Tunnel with outward sloping sides

Access ramp for cyclists to cycle cellar at Panum

Northwest tunnel under the railway

Cycle ramps and chutes

Where access ramps are not possible, cycle ramps or chutes can make it easier for cyclists to pull their cycles and pass stairs, for example at stations, cycle cellars, bridges, and tunnels. Cycle ramps are steeper than access ramps.

Most cyclists pull their cycles upwards on their right side. Where space allows, it is recommended to provide both a ramp for pull the cycle up, and one on the other side to pull the cycle down. In narrow spaces, the upward cycle ramp is most important to establish. Pe-destrians must still be able to use the handrail.

Cycle ramps on stairs should be min. 30 cm wide, and the handrail should be placed so that it does not hinder the cyclist pulling the cycle. A recess on the ramp for the wheels or a metal chute makes it easier to pull the cycle. If cargo bikes, special or adapted cycles or prams are using the ramp, the design should be adapted accordingly.

Cycle chutes should have a good inlet and a width of 120 mm so that different cycles can enter. For steep gradients, cycle chutes using friction (e.g. with brushes) are recommended to slow down cycles.

Lifts

Lifts at public transit hubs in the Capital Region of Denmark are used by passengers who take their cycle on the S-train, even though the lifts are not primarily built for it. In future development and renovation of stations ensure that there is space for at least two bikes in lifts, access or cycle ramps, and that lifts are placed close to the cycle network.

Cycle chute experiment at Amagerbro station

Cycle chute with good inlet and brushes at Lyngby station, photo Jacob Vimpel

Cycle chute at Lyngby station, photo Jacob Vimpel

Stairs and lift at Dybbølsbro station where capacity during rush hours is a challenge for passengers walking or taking their cycle

Cycle ramp at KEAs cycle cellar

1.2 Cycle path widths

1.2.1 Minimum widths for cycle paths

Wide cycle paths are crucial for cyclists' safety, comfort, and flow. Wide cycle paths can accommodate children and elderly, e-bikes and cargo bikes. With the recommended minimum widths, cyclists can ride comfortably and at their own pace.

The need for wider cycle paths has increased in Copenhagen due to more cyclists, e-bikes, cargo bikes, specialised and adapted cycles. Therefore, the guidelines for minimum widths for cycle paths have been revised and follow the number of cyclists. To indicate cyclists' numbers, expected peak hour cycle traffic per direction (AAWT) is used. The more cyclists, the wider the cycle paths should be. The new minimum widths for Copenhagen's cycle paths are based on experience with existing cycle path widths, maximum capacities, Road Standards and recommended cycle path widths in the Netherlands.

The new minimum widths will be introduced gradually in urban development areas, where space conditions allow in the existing city, and where cycling capacity needs to be improved. The minimum widths apply to the entire road and cycle network in Copenhagen. This includes the construction of roads and cycle paths, intersections, bridges, in the city and in urban development areas. The minimum widths must also be complied with during renovation and restoration

Cycle path on Jagtvej

where there is a mandate for them. The dimensions are inclusive of associated kerbs. The only exception is the PLUSnet, Copenhagen's main cycle network designated in *Copenhagen municipal plan 2019* where the minimum width starts at 2.8 m. For higher peak hour cycle traffic, the recommended minimum widths are followed.

The expected peak hour cycle traffic is calculated or estimated based on the latest cycle counts on the stretch or in the intersection. New traffic counts for cyclists, motorists and pedestrians should be conducted prior to a project in case of significant traffic changes or if traffic counts are older than five years. Cycle path widths must be determined in relation to existing number of cyclists and the expected increase derived from the traffic or urban development project.

Expected peak hour cycle traffic in one direction	**Up to 500**	**500–750**	**750–1.500**	**1.500–2.000**	**2.000–3.000**	**Over 3.000**
Cycle path	2,5 m[1]	2,8 m	3,0 m	3,5 m	4,0 m	4,0 m[2]
Cycle lane	2,5 m	Discouraged – cycle path recommended				
Dooring zone near parked cars and safety zone near guardrails and fixed objects	0,3–0,5 m					

Table 1: Minimum widths for one-way cycle paths

Expected peak hour cycle traffic in both directions	**Up to 1.500**	**1.500–3.000**	**3.000–4.000**	**Over 4.000**
Off-street two-way cycle path and two-way cycle path on bridges, in tunnels, etc.	4,0 m	4,5 m	5,0 m	6,0 m[2]
Two-way cycle path along roads	Discouraged – one-way cycle path or off-street two-way cycle path recommended			
Dooring zone near parked cars and safety zone near guardrails and fixed objects	0,3–0,5 m			

Table 2: Minimum widths for two-way cycle paths

[1]*Except PLUSnet, which starts with a minimum width of 2,8 m*
[2]*Or separate assessment*

Special methods for larger or complex construction projects

For larger or complex construction projects, it is recommended to use traffic and simulation models.

Cycle path widths in case of space constraints

As a guiding principle, the recommended minimum widths for cycle paths should be followed. However, it can be challenging to prioritise the recommended minimum widths when space is limited in in different urban settings.

Where there is no immediate space for the recommended minimum widths, the following measures are assessed in collaboration with the administrations traffic experts to create more space for cycle paths:

- Combine or remove lanes[3]
- Reduce lane width to 2,75 m[4]
- Omit car parking or stopping on one or both sides
- Establish one-way street for motorists
- Establish kerbside bus stops, where the bus stops on the carriageway and not in a bus stop pocket.[5]

Narrowing the pavement or urban space for pedestrians is discouraged. Cycle paths and lanes should never be below 2.0 m wide because of maintenance vehicles.

4 m wide cycle path at Dronning Louises Bro, photo Ursula Bach

Context and references

Theoretical maximum capacities for cycle paths: 3.4 Cycle traffic on stretches, Handbook Capacity and Service level, Road Standards portal, 2019.

4.7 Capacity for bicycle traffic, Handbook Basis for designing traffic areas, Road Standards portal, 2012.

The recommended width for a cycle path with significant cycle traffic and high cyclist accessibility is 2.45/2.55 metres (without/with parked cars along the cycle lane), Infrastructure for light road users on wheels, Road Standards portal, 2022.

The recommended standard width for a cycle path is 2.25 metres, with a minimum width of 1.8 metres. Handbook Cross sections in urban areas, Road Standards portal, 2024.

A bicycle may be up to 1.0 metre wide; cycles with three or more wheels up to 1.6 metres cf. Executive order on the design and equipment of cycles, etc.§5, 2016.

Recommended widths for cycle paths in the Netherlands are between 2.0–4.0 metres, depending on cycle traffic per peak hour in one direction: CROW Design Manual for Bicycle Traffic, CROW-Fietsberaad, 2016.

Special minimum widths for channelling: *"3.4.4 Channeling on cycle paths"*.

"1.2.3 Widths for other traffic facilities".

"1.3.1 PLUSnet".

"5.3 Traffic and simulation models".

"1.4.6 Cleaning and winter maintenance".

Copenhagen municipal plan 2019.

[3] *For speed limits of 30–40 km/h, there should be a maximum of two lanes.*
[4] *For speed limits of 30–40 km/h. At 50 km/t the lane width can be reduced to 3,0 m.*
[5] *Investigate in dialogue with the public transit authority Movia for less than 10,000 motorists per day (AWDT).*

1.2.2 Dooring zone

Parallel car parking with a dooring zone is recommended next to cycle paths and lanes. A dooring zone between the cycle path/lane and the lane ensures greater distance to parked cars or other fixed objects along the cycle path. The dooring zone reduces the risk of collisions with cyclists and motor vehicle doors being opened, or collisions with fixed objects.

The minimum width of the cycle path is increased by min. 0.3–0.5 metres with a dooring zone along stretches with kerbside car parking, taxi parking, tourist buses and fixed objects such as electric charging points. Is space being available, the dooring zone should be 0.8–1.0 metres.

The dooring zone must be marked with deviating road surfacing or profiled kerb lines, and it should be possible to cycle across.

On a stretch without space for both a cycle path with the recommended minimum width plus a dooring zone, and where car parking cannot be omitted, the dooring zone is omitted to prioritise cycle path width.

Context and references

"2.3 Cycle infrastructure and car parking".

Dooring zone with road marking on Vester Farimagsgade

Dooring zone with deviating road surfacing on Niels Juels Gade

Wide pavement on Dronning Louises Bro, photo Ursula Bach

1.2.3 Widths for other traffic facilities

	Traffic facility	Standard width	Minimum width
	Copenhagen pavement:	2,5 m Wider for many pedestrians	Not defined
	Of which inventory zone for e.g. signs and electric charging points	Not defined	
	Of which walkway	Wider for many pedestrians	1,8 m[6]
	Of which buffer zone for e.g. cycle parking and furnishing (without reducing pavement width)	Not defined	
	Pedestrian crossing at traffic signals	Wider for many pedestrians	3,5 m
	Detached pedestrian crossing	Wider for many pedestrians	4,0 m
	Crossing island	Not defined	2,5 m[7]
	Bus platform	Wider for many pedestrians	2,0 m
	Lane at 30–40 km/h	3,0 m	2,75 m
	Lane at 50 km/h, bus lane or lane shared with busses	3,25 m	3,0 m
	Car parking lane/pocket incl. marking line	2,3 m	2,0 m

Table 3: Widths for other traffic facilities

[6] *Absolute minimum width 1,5 m*
[7] *Absolute minimum width 2,0 m is only used in absolute exceptions*

1.3 Cycle routes

1.3.1 PLUSnet

PLUSnet describes Copenhagen's main cycle network, with the highest volumes of cycle traffic occurring or expected.

The minimum PLUSnet width starts at 2.8 metres to ensure comfort, safety, and flow for diverse types of cyclists. This width allows a commuter cyclist to overtake a cargo bike, or a parent and a child cycling side by side.

Thus, the overall goal is to make it possible for everyone to cycle at their own pace on the main cycle network. For higher peak hour cycle traffic, the recommended minimum widths for cycle paths are followed.
The exact alignment of the PLUSnet is adjusted continuously based on traffic and urban development and is laid down in *Copenhagen municipal plan 2019*.

Context and references

"1.2.1 Minimum widths for cycle paths".

Part of the PLUSnet overlaps with the Cycle Superhighways: *"1.3.3 Cycle Superhighways".*

Copenhagen municipal plan 2019.

PLUSnet on Lygten

1.3.2 Green cycle routes

Green cycle routes are routes for cyclists and pedestrians that run through green areas, along the harbour, and on less busy roads.

Green cycle routes serve both a transport and recrea-tional purpose and provide an alternative to cycling and walking along busy roads. Along the way, there are opportunities for rest, exercise, and green spaces. The alignment of the green cycle routes is laid down in *Copenhagen municipal plan 2019*.

Context and references

"1.2.1 Minimum widths for cycle paths".

Green cycle routes are often designed as shared-use paths: *"1.1.7 Shared-use paths".*

Existing and planned green cycle routes can be seen on Copenhagen's spatial map.

Copenhagen municipal plan 2019.

The green cycle route, Nørrebroruten, connects Nørrebro, Frederiksberg and Valby, photo Ursula Bach

1.3.3 Cycle Superhighways

The city of Copenhagen participates in the Cycle Superhighway Collaboration along with many municipalities in the Capital Region of Denmark and a few municipalities in the Region of Zealand. Coordination with municipalities is handled by the Secretariat for Cycle Superhighways.

Cycle Superhighways focus on commuting across municipal boundaries and over longer distances. On Cycle Superhighways a high standard for cycle infrastructure must be ensured. For this, the Concept for Cycle Superhighways has been developed that is used on the designated routes.

In cases of differences between *Cycle-Friendly Infrastructure 2024* and the *Concept for Cycle Superhighways*, the highest standard must be chosen.

Cycle Superhighways often improve existing cycle paths in terms of width, signals, signage, and road marking rather than building new cycle paths.

Context and references

Cycle Superhighways and Concept for Cycle Superhighways, Cycle Superhighway Collaboration, Capital Region of Denmark, 2024.

Existing and planned Cycle Superhighways in Copenhagen can be seen on Copenhagen's spatial map.

Farum route, photo Nadia Horsted

Cycle Superhighway road marking

Copenhagen route on H.C. Andersens Boulevard

Inner ring route on Enghavevej, photo: Cycle Superhighways, Capital Region of Denmark

1.4 Cycle infrastructure material and technical equipment

1.4.1 Road surfacing

Asphalt is best

Asphalt AB6t is the standard surface for cycle infrastructure. Asphalt is smooth, has high friction and ensures good comfort for cyclists. The wearing course on cycle paths is replaced every 20-25 years and more frequently if needed due to excavations.

Coloured road surfacing

Coloured road surfacing can increase road users' awareness, support good traffic behaviour, and highlight special traffic regulations. Coloured road surfacing should always be combined with and support normal road marking and signage.

From a road user perspective, it is important to be consistent with the choice of colour so that road users can decode the function. In Denmark, the colours must not be confused with blue, white, green, or yellow, which are used for road marking cf. *Executive order on road marking*. In Copenhagen, reddish and brownish road surfacing is currently used for kerb strips, median strips, recreational cycle paths on selected cycle infrastructure (bridges and two-way cycle paths), and bus traps. Red road surfacing is recommended in future cycle streets above 1,000 motorists per day.

In Denmark, blue cycle marking is used for special attendance cf. *Executive order on road marking*.

With coloured road surfacing, is important to preserve the effect by using the same material for repairs and when the colour loses fades in subsequent maintenance or excavating work.

Context and references

Executive order on road marking § 54, 2023.

"3.4.1 Cycle marking".

"1.1.3 Cycle streets".

"1.4.2 Road marking".

New asphalt on cycle path, photo Ursula Bach

Red asphalt at Cirkelines Plads

Blue cycle marking, photo Ursula Bach

Cobblestones, paving stones and tiles only in exceptional cases

Materials such as cobblestones, paving stones and tiles are generally not recommended for cycle infrastructure as they are less comfortable for cyclists and can become slippery. In addition, these materials can easily become uneven with higher traffic volumes and require increased maintenance.

If cobblestones, paving stones or tiles are nonetheless chosen for cycle infrastructure due to urban space and aesthetics, it should only be used sparingly. Granite tiles should be saw-cut and chiselled. In some strategically selected locations, paving stones are used for speed calming. Furthermore, good friction must be ensured (friction index at least 55). The *Copenhagen tile* is reserved for pedestrian infrastructure.

Cobblestones do not provide good comfort for cyclists and are generally discouraged. If cobblestones are chosen due to urban space or aesthetics, the cobblestones in the cycle area should be chiselled to class 2 or jet-burned (for jet burning, the friction index must be verified). Copenhagen continuously tests and evaluates new methods to increase cyclists' comfort. Among other things, dry ice and lava-blasted cobblestones are being tested.

Higher friction at bends and braking situations

On stretches where cyclists turn or brake, for example at bridge landings and raised platforms, good friction (friction index of at least 65) should be ensured to reduce the risk of falls regardless of the material.

Jet burnt cobblestones on Nybrogade

Jet burnt cobblestones on Frederiksholm Kanal

Frederiksholm Kanal, photo Troels Heien

1.4.2 Road marking

Road marking regulates and guides road users on where to go. Road marking can improve flow and safety – for example by using bicycle symbols or striping. Thermoplastic road marking should have good friction (friction index of at least 55).

For wide cycle paths over 4 metres, visual division can be considered with small triangular arrows (see *photo below*).

Bicycle symbols are placed at relevant locations on stretches where cyclists and other road users need guidance cf. Executive order on road marking. The bicycle symbol is also used to indicate the position of cyclists at intersections where this differs from the position to the right of the lane.

If the bicycle symbol is in a cycle lane, cyclists must use the cycle lane. A bicycle symbol together with line marking at intersections is called cycle marking and makes road users aware of conflict points and clarifies that cyclists must use the cycle marking.

Where the bicycle symbol is primarily aimed at motorists, the large 2-metre bicycle symbol is used. Additionally, the large bicycle symbol is used on wide cycle paths. The 1-metre bicycle symbol is used on narrower cycle infrastructure.

Arrow marking on cycle paths

Arrow marking is used to channelise the cycle path into multiple lanes or at specific locations for cyclists at complicated intersections.

Either a long arrow or a bicycle symbol with a short arrow can be used (see *Figure 10*). The short arrows are like the arrows used in bus lanes. Unnecessary straight arrows are avoided where the course is self-explanatory (see *Figure 10*).

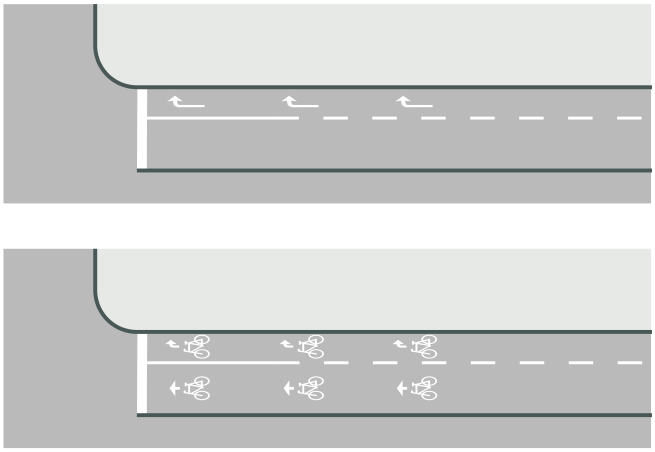


Figure 10: Two ways to mark channelling on cycle paths

Bicycle symbol on the cycle path on Store Kongensgade

Visual division on the wide cycle path on Østerbrogade

Marking of fixed objects on the cycle path

Bollards in the cycle path and other objects (lamp posts, signs, guardrails, footrests, etc.) must not be placed on the cycle path or closer than 30 cm from it. Fixed objects must be placed on crossing islands, pavements, kerb strips etc. If there nonetheless are (temporary) fixed objects on the cycle path, they must be clearly marked with kerb lines and barrier strip until it can be removed or repaired.

Bollards should be placed with a minimum distance of 1.7 metres between them for snow clearance and the passage of cargo bikes.

Context and references

Executive order on road marking §53 and §54, 2023.

Special marking for Cycle Superhighways: Concept for Cycle Superhighways, Cycle Superhighways, Capital Region of Denmark, 2024.

"3.4.4 Channeling on cycle paths".

"1.4.6 Cleaning and winter maintenance".

Bicycle symbol with short arrow on Åboulevard

Two-way cycle path with bollard, kerb lines and barrier strip area at Sankt Kjelds Plads

Right-turn arrows and Cycle Superhighway marking on the cycle path at H.C. Andersens Boulevard/Nørre Farimagsgade

Two-way cycle path with crossing island, bollard, kerb lines and barrier strip on Århusgade

1.4.3 Geometric design

The geometric design of cycle infrastructure, also known as alignment, must be able to handle different types of cyclists.

Horizontal and vertical curves and side gradients together contribute to the comfort and safety of cycle infrastructure.

Driving curves and dimensioning vehicles

Cycle paths should be designed without sharp bends and dimensioned for 30 km/h and with a minimum curve radius of 20 metres. The dimensioning vehicle for cycle paths and areas is a cycle with a trailer with a speed of 30 km/h. Comfort and safety are increased for all cyclists if cycle paths are designed based on the driving curves for this type of specialised cycle. On cycle paths where there are or expected to be many fast cyclists, it is recommended to design for 35 km/h.

Stopping sight / stopping distance

Stopping sight must be ensured on cycle paths and areas. Stopping sight is the same as stopping distance. Stopping distance is the distance that a cycle travels from the moment an obstacle is observed until the cycle is safely brought to a stop after normal heavy braking.

Stopping distance is 34 metres for a cyclist travelling at 30 km/h, and 26 metres at 25 km/h. Stopping distances are higher/lower when descending/ascending.

Horizontal curves / curve radii

Cycle paths along roads usually follow the course of the carriageway and do not require special curve radii. For staggering and off-street cycle paths, curve radii are used to allow specialised cycles, cargo bikes or several cyclists to ride side by side through the curve.

It is recommended that horizontal curves for off-street cycle paths follow the parameters in Table 4. Lower values (curve radius < 10 m) than recommended will result in cyclists having to brake or potentially struggling to keep the cycle upright, especially at very low values (curve radius < 5 m).

Staggering on the cycle path

Staggering or sharp bends on the cycle path often occur at bus stops or car parking bays. Kerbs should be radius kerbs without sharp edges for the benefit of both cyclists and maintenance. Staggering should be designed based on minimum radius requirements for cycle paths.

Gradient	Minimum radius (e.g. staggering)	Recommended minimum radius (off-street cycle path)
+ 50‰	20 m	70 m
0‰	20 m	85 m
- 50‰	20 m	425 m

Table 4: Minimum curve radii for horizontal curves

Staggering on the cycle lane on Langebro

Staggering on the cycle path on Elmegade

Gradient / slope

The longer and steeper the gradient, the harder it is for cyclists to climb the hill. Gradient is also called the longitudinal gradient or slope.

The Dutch guidelines for cycle infrastructure describe and calculate the degree of difficulty as a relationship between the steepness, the height overcome and the length, which is why steeper gradients can be used in some situations. A low gradient of 20–30‰ is endeavoured for longer cycle path stretches. For shorter stretches, gradients up to a maximum of 50‰ are acceptable, but here the width should be increased to compensate for the different speeds of cyclists. These gradients also apply to access ramps to cycle cellars, cycle and pedestrian bridges and tunnels.

Therefore, it is recommended that steepness and the ratio between gradients and lengths do not exceed the values in *Table 5*.

To ensure stopping sight on cycle paths, it is also neces-sary to provide the necessary radii in the longitudinal profile as listed in *Table 6*. The use of minimum radii for vertical curves will primarily be necessary for tunnels and bridges in Copenhagen.

Gradient	Maximum length	Overcome height differen-ce
50‰	50 m	2,5 m
45‰	100 m	4,5 m
40‰	200 m	8,0 m
35‰	300 m	10,5 m
30‰	500 m	15,0 m

Table 5: Steepness at e.g. bridge landings and access ramps to tunnels and cycle cellars

Speed	Minimum radius	Recommended minimum radius
Up to 30 km/t	175 m	340 m
Over 30 km/t	300 m	580 m

Table 6: Minimum radii for vertical curves on cycle paths, e.g. cycle and pedestrian bridges and tunnels

Bryggebroen, photo Ursula Bach

Context and references

Stopping distance: Infrastructure for light road users on wheels, Road Standards portal, 2022.

Tracing elements should be followed as a minimum: Handbook Cross sections in urban areas, Road Standards portal, 2024.

The turning radius for a cycle with a trailer must be followed as a minimum: Driving curves for different cycles, Danish Road Directorate, 2022.

Requirements for e.g. stopping and meeting sight, field of view when crossing and turning, alignment and longitudinal section, cross section and side gradient on cycle areas, Handbook Alignment in urban areas, Road Standards portal, 2024.

Special design requirements for accessibility and safety for people with disabilities, Handbook Traffic areas for everyone, Universal design and accessibility, Road Standards portal, 2023.

Arrows on cycle paths cf. Executive order on road marking §58, 2023 and Handbook Road marking, arrow marking, Road Standards portal, 2020.

CROW Design Manual for Bicycle Traffic, CROW-Fietsberaad, 2016.

1.4.4 Ramps to and from cycle paths

Ramps are designed with a soft transition between the carriageway and cycle path, allowing cyclists to smoothly get onto the cycle path without slowing down significantly. It is recommended that the difference in level between cycle path and carriageway is divided and constructed with ½ internal kerb (i.e. the kerb is lowered half of the kerb clearance) and a ½ asphalt ramp (on the carriageway or pavement). In some places, the existing kerb is cut at an angle.

The asphalt ramp must not have gradients steeper than 1:3, meaning that the asphalt ramp will have a depth of 30 cm if the kerb clearance is 10 cm and there is no lowered kerb. It is important that the ramp depth is not too great, preventing motorists or cyclists do not drive onto the ramp every time they travel along the kerb. Either one long or two separate ramps can be estab-lished for driving up to and down from the cycle path. Ramps or lowered kerbs are marked with white thermoplastic to make it easier for cyclists to see when entering and exiting the cycle path. For raised platforms, it is recommended that the kerb goes all the way through, combined with a ramp.

Make sure that the ramp is sufficiently long to ensure sufficient manoeuvring space, allowing e.g. cargo bikes getting on and off the ramp more easily. Ramps should be min. 3 metres long, and longer for higher volumes of cyclists (see *photos of long ramps* to the right). Additionally, ramps should be clearly marked with white thermoplastic or paint so cyclists can see them better in the dark from the opposite side.

Long ramp at Sortedam Dossering/Østerbrogade

Long ramp at Søtorvet

Lowered kerb and side drain on Nørrebrogade

Cyclist riding up the lowered kerb on Nørrebrogade

Photo Ursula Bach

1.4.5 Drainage and climate adaptation

Drainage and climate adaptation should be so that cyclists do not experience bumps, grooves or anything else that affects their comfort.

Side drains are integrated into the kerb along a road or cycle path. Side drains ensure full use of the cycle path width and are recommended on new cycle paths and when renovating cycle paths. Side drains can be cleaned via a small cover at the top but need to be swept more often as they clog more easily than regular drain grates. Side drains should be long enough to drain water during heavy rainfall.

If it is not possible to establish side drains, it is recommended that drains, drain grates, ramps at raised platforms etc. are placed outside the cycle path on the carriageway with drainage towards the carriageway. Covers must be level with the cycle path surface. Drain grates should be installed with a floating frame so they can be raised by a new wearing course.

If traditional drain grates are installed, the slats must be perpendicular to the direction of travel for safety reasons preventing cycle tyres driving into the groove (see *photo opposite*).

If cycle paths lead through green areas, do not drain over the cycle path from adjacent areas, as salt is not enough to prevent ice on the cycle path. Also, generally, if salt is used for de-icing, it should not be drained from the cycle path directly to urban planting.

For operational reasons and for the comfort of cyclists, cycle path starts and ends should not be marked with a lowered kerb across the cycle path, as this causes frost damage.

In terms of climate adaptation, cycle infrastructure and solutions for local drainage of rainwater (SuDS) can be combined.

Context and references

Drainage and climate adaptation: Copenhagen's Handling of water in construction and infrastructure, 2011.

Different scenarios regarding climate adaptation, as well as wells and drains and drain grates, can be seen on Copenhagen's spatial map.

Climate adaptation at Amagerbanen, photo Troels Heien

Side drain on Stormgade

Side drain on Gothersgade

Side drain grate on Gothersgade

Drain grate with slats perpendicular to the direction of cycling on Ørestads Boulevard

Climate adaptation at Folehaven, photo Troels Heien

1.4.6 Cleaning and winter maintenance

It is important to consider future cleaning and winter maintenance in the design of cycle and road projects by incorporating space requirements and durable materials.

Cleaning

Keeping cycle lanes and cycle infrastructure clean at the same level as the carriageway is important as cycle lanes can collect gravel and dirt from the carriageway, which can increase the risk of punctures and skidding. Cleaning removes gravel, leaves, litter and broken glass after events.

To allow cleaning and winter maintenance machines to manoeuvre, the absolute minimum clearance height is 2.8 metres. Absolute minimum widths for cycle paths and cycle lanes next to parked cars are 2.0 metres and follow the recommended minimum widths for cycle paths.

Winter maintenance

Cycle paths are maintained at service level A. This means that cycle paths are swept or ploughed in case of snow or slush at all times of the day.

Carriageways and cycle lanes are only cleared during significant snowfall, so the perceived service on cycle lanes may be lower than on cycle paths.

On cycle streets, de-icing is performed according to the carriageway service level, which can be either service level A or B.

Context and references

"1.2.1 Minimum widths for cycle paths".

"1.4 Cycle infrastructure material and technical equipment".

Winter maintenance service level

Service level A: Anti-icing and snow clearance at all times of the day:

- Preventive salting is endeavoured for anti-icing
- Snow clearance and salting as needed to managed traffic flow as smoothly as possible.

Cycle paths maintained at service level A can be viewed on Copenhagen's spatial map.

Service level B: Anti-icing and snow clearance every day between 6:00 and 22:00:

- Anti-icing during icy conditions
- Snow clearance as needed, allowing traf-fic flow as smoothly as possible
- Action is only initiated when service level A tasks are completed.

The cycle path is ploughed for snow before the carriageway on Østerbrogade

Autumn leaves on the cycle path by the lakes, photo Ursula Bach

1.4.7 Repair and restoration

The following guidelines must be met by the contractor when repairing, laying wearing courses and working on cycle paths and infrastructure.

For repairs on cycle paths, use asphalt AB6t if the layer thickness is less than 3 cm. Finish with AB6t when macadam is used as a base layer. The asphalt must not contain tile flint stones. Granite aggregates is used instead.

A new wearing course is often laid without raising kerbs and side areas. A thin layer is milled off and the same layer is applied. If the kerb clearance height is sufficient, a thin layer of asphalt can be laid. Repairs are carried out across the entire width of the cycle path and unexpected differences in level for cyclists must be levelled out.

For wearing course works that require raising kerbs, even ramps for cyclists must be established as soon as possible in all approaches and exits.

All asphalt repairs must be carried out without significant edges and level differences to the existing asphalt.

Correct road marking and signage must be ensured during repairs and restoration. Outdated and incorrect signs are removed by sawing the pole at asphalt level.

For excavations, asphalt ramps must be installed at all covers with high edges or alternatively rubber strips or ramps in cold asphalt must be installed.

All road works must be properly marked and signposted according to the approved construction traffic management plan.

Context and references

"1.2.1 Minimum widths for cycle paths".

"1.4 Cycle infrastructure material and technical equipment".

"2.8 Cycling during construction".

Repair on Nørregade, photo Christian Lindgren

Restoration on Vester Farimagsgade, photo Ursula Bach

Repair on the entire width of the cycle path on Gothersgade

2 Coherence between cycle and other traffic infrastructure

A densely populated city with many road users requires that cycle and road projects are designed with urban space and different road users in mind. To assess a secure, comfortable and safe solution for cyclists and other road users, a site-specific assessment is needed. For this, we use Copenhagen's assessment and dialogue tool, which is briefly elaborated in *chapter 5*.

This chapter further elaborates on the interaction and trade-offs between cycle infrastructure and infrastructure for pedestrians and motorists. Special consideration is given at bus stops, schools and childcare and elderly care institutions and during construction. With tactical urbanism, new solutions can be tested.

Store Kongensgade, photo Ursula Bach

2.1 Traffic behaviour

When constructing cycle infrastructure, it is important to support good traffic behaviour and ensure secure traffic flow for cyclists and other road users.

National studies from the Accident Investigation Board Denmark indicate that traffic behaviour is a contributing factor in more than 9 out of 10 traffic collisions. The most common traffic behaviour factors leading to collisions are insufficient orientation at intersections, inattention, misinterpretation of the situation and excessive speed by motorists.

It is therefore important that cycle and road projects are designed on a human scale, recognising that road users do not act flawlessly, but need support to more easily comply with the demands of the physical infrastructure. The expectation should not be that road users relate to multiple instructions at once, as their ability to pay attention and perceive many impressions is limited.

It must be possible to be guided to the correct behaviour and move in traffic without extensive prior knowledge, so that e.g. children and tourists can move securely and safely in traffic. In this context, we strive for both self-explanatory and forgiving roads.

In addition to designing roads to prevent collisions, traffic behaviour can also be improved through targeted communication, campaigns, education and advice, and supported by enforcement of traffic rules. The focus here is on road users respecting traffic rules, paying attention and showing consideration.

For new solutions, communication efforts should be continuous, such as the tactical urbanism projects in the Medieval City in 2021 and the cycle street in Nordre Frihavnsgade in 2022.

Physical measures such as design, signage, and traffic calming can support good traffic behaviour.

Self-explanatory and forgiving roads

Self-explanatory roads are designed to be uniform and recognisable, guiding road users to the desired traffic behaviour.

Forgiving roads are designed to prevent collisions and injuries, e.g. by separating different road users, oncoming and intersecting traffic.

Context and references

Why do traffic collisions happen, Accident Investigation Board Denmark, 2020.

'Motorist, you are guest' campaign poster on cycle street Nordre Frihavnsgade

Cyclist hand signal to turn right

'Use 2 seconds more' campaign, photo Nadia Horsted

2.2 Cycle infrastructure and traffic calming

When speed on roads is reduced with traffic calming measures, cyclists and pedestrians benefit greatly in terms of safety and security.

Traffic calming is established with signage and physical measures such as speed bumps, road closures, crossing islands, narrowing, road marking, median strips, staggering, plantings etc.

Speed reductions

The decreasing risk of collisions and injuries with reduced speed for motorists is thoroughly documented. The risk of cyclists or pedestrians being seriously injured or killed in collisions with motorists increases significantly at speeds above 30 km/h.

Speed and the interaction between road design and road users' choice of speed is therefore crucial for traffic safety. When the speed limit is above 40 km/h, it is recommended that motorists are separated from cyclists and pedestrians. In crossings between motor-ists and cyclists/pedestrians, the speed should be re-duced to a maximum of 30 km/h.

Cycle-friendly speed bumps

Physical measures for traffic calming are narrowing the road profile and/or speed bumps and staggering. As a guiding principle, modified trapezoidal speed bumps with rounding towards the carriageway edges are used. The rounding allows cyclists to pass by when cycling in mixed traffic and on cycle lanes. As trapezoidal speed bumps have a greater speed reduction effect, they are recommended over modified circular bumps.

For lower volumes of cycle traffic, it is accepted that bumps continue under parked cars and end 30 cm from the kerb for drainage purposes.

Additionally, traffic calming can be established as raised platforms across the entire width of the carriageway. Speed bumps must be maintainable in winter and passable for cyclists without having to hold back for motorists.

Context and references

Handbook Traffic safety calculations and collision prevention, Road Directorate, 2022.

Speed and traffic safety. New models, the Norwegian Institute of Transport Economics TØI, 2014.

In Copenhagen, the speed limit will be reduced to 40 km/h on most roads, and to 30 km/h in the city centre and central quarters. The new speed limits will be introduced gradually from 2023 to 2025. The upcoming speed limits and zones can be seen on Copenhagen's spatial map.

Speed measurements in Copenhagen can be seen on Copenhagen's spatial map.

Catalogue of approved speed bumps, Road Standards portal, 2024.

Trapezoidal bump on Ungarnsgade

Speed bumps and narrowing on Julius Bloms Gade

Speed bump and narrowing with cycle parking on Studiestræde

Cycle passages at road closures and dead ends

Cycle passages should be established at road closures and dead ends, and it is important that the right-of-way is clear. At dead ends, a two-way cycle path can be created.

Context and references

Road closures and cycle passages must ensure that vehicles for cleaning and winter maintenance can pass: "*1.4.6 Cleaning and winter maintenance*" and "*1.2.1 Minimum widths for cycle paths*".

Road closure with cycle passage and bollards on Guldbergsgade

Bollards prevent motorists from passing through

Bollards are only used exceptionally in a few locations in Copenhagen when undesirable motorised traffic is observed or registered (with gap widths above 1.75 m), for example at road closures with cycle passages or on two-way cycle paths. In these cases, bollards with spring-loaded wings are used, which allow maintenance vehicles to pass through but scratch motor vehicles.

Cycle barriers are generally not recommended because tricycles and cargo bikes have difficulty passing them. Both bollards and cycle barriers pose collision risks to cyclists.

Context and references

Bollards are established with a minimum gap of 1.7 m for snow removal: "*1.4.6 Cleaning and winter maintenance*" and to ensure that cargo bikes can pass.

Bollards must be placed at least 30 cm from the cycle path for clearance from fixed objects.

Where the cycle path is narrowed due to bollards, the course of the cycle path is clearly marked with kerb lines and barrier strips: "*1.4.2 Road marking*".

Road closure with cycle passage on Møntergade

Road closure with cycle passage on Reykjaviksgade

2.3 Cycle infrastructure and car parking

Parked cars affect traffic safety in different ways. There is a risk of collisions between road users and motorists manoeuvring or parking. Parked cars can limit fields of view and obscure pedestrians, cyclists or other motorists turning onto the carriageway from pavements, intersections and driveways. Open motor vehicle doors can pose a collision risk. In addition, parked cars pose a barrier to cyclists travelling up or down a cycle path.

In general, parallel car parking along cycle infrastructure with a dooring zone is recommended.

Sufficient field of view without car parking and stopping 30–50 m before conflict points

On approaches to intersections, the necessary field of view must be ensured to reduce the risk of motorists overlooking cyclists and pedestrians. Therefore, as a standard solution, there should be no kerbside car parking and stopping 30–50 m before conflict points at intersections. The car parking and stopping ban on this stretch is an effective traffic safety measure.
As an absolute minimum, good field of view is ensured before side roads with the *20-metre rule* that prevents car parking and stopping at least 20 m before side roads.

In general, car parking and stopping (including bus traffic) should take place in the exits after the intersec-tions and side roads. Sufficient field of view must also be ensured at entrances to properties.

Angled and perpendicular car parking is discouraged

Angled and perpendicular car parking is discouraged along cycle paths or cycle lanes due to the risk of motor vehicles invading the cycle area. This kind of car parking poses both a safety risk and can reduce comfort and flow for cyclists.

If angled and perpendicular car parking is installed anyway, a safety zone should be established with cobblestones and kerbs that limit motorists' ability to park too far over the cycle path.

For angled car parking, motorists can get a better field of view if motorists must reverse into the parking bay and drive forwards out.

Where cyclists ride in mixed traffic, parallel car parking is standard, and diagonal and perpendicular car parking is discouraged.

Context and references

The minimum width for car parking lanes/bays including marking is 2.0 m: *"1.2.3 Widths for other traffic facilities"*.

"1.2.2 Dooring zone".

At car parking lanes/bays, the cycle path must be designed so that the curve follows recommendations for horizontal curves: *"1.4.3 Geometric design"*.

"3.2 Field of view at intersections and conflict points".

"3.1.1 Advanced cycle path".

"3.1.2 Shortened cycle path".

"3.1.3 Cycle path between straight and right-turn lanes".

"1.1.4 Cycling in mixed traffic".

Different information regarding car parking, including road surfacing, car parking bays and scooter parking can be found at Copenhagen's spatial map.

Cobblestone dooring zone on Christian IXs Gade

2.4 Cycle and pedestrian infrastructure

When planning and constructing cycle infrastructure, aim for secure pedestrian conditions and flow. The width of the pavement should not be reduced, and the direct walking line should be preserved as far as possible.

Cycle paths and pedestrian areas should be separated, and it should be clear who is travelling where to avoid potential conflicts between cyclists and pedestrians. Separation can be created through level differences, kerb strips, different road surfacing or road marking.

Shared spaces only under certain conditions

Shared space is a concept where intersections, stretches or squares are shared between road users without or with limited use of signs, road marking and physical separation. Road users move with mutual consideration. In shared spaces, road users must negotiate and agree on who should move where.

For shared spaces to work, pedestrians must be the majority and cyclists and motorists should travel at low speed and on pedestrians' terms. Shared spaces should be designed to work for pedestrians and should be easily understood by children and the elderly.

There is no specific way to establish shared spaces according to the Road Standards. In Copenhagen, pedestrians can share a space with cyclists and motorists in pedestrian streets, play and leisure areas, shopping streets and squares. However, this requires certain conditions to be met. These are described in the following sections.

Pedestrian street with cycling allowed only exceptionally

Pedestrian streets are generally reserved for pedestrians. Cycling is only allowed if specifically approved.

Pedestrian streets with cycling allowed are used on a few selected streets and squares in Copenhagen (e.g., Strædet).

To minimise potential conflicts between pedestrians and cyclists, allowing time-limited cycling on pedestrian streets can be considered, e.g. outside of shop-opening hours from 9pm to 9am.

'Pedestrian street' sign with 'Time-limited cycling allowed' sub-sign

Context and references

The width for standard pavements is 2.5 m: *"1.2.3 Widths for other traffic facilities"*.

Raised crossings and continuous cycle paths are standard at minor side roads: *"3.5.2 Right-of-way and raised crossings"*.

Crossing islands are recommended where there are many crossing pedestrians: *"3.5.4 Crossing islands"*.

Pedestrian street with cycling allowed on Kompagnistræde

Pedestrian street with cycling allowed on Weidekampsgade

Pedestrian street with driving allowed only exceptionally

When considering a pedestrian street with driving allowed, motorised traffic should be restricted, e.g. with bollards and road closures. Another option is to only allow residents and goods deliveries. Furnishing can help to signal a high priority for pedestrians. Furthermore, car parking in pedestrian streets is discouraged or should only be used to a very limited extent.

If these conditions cannot be met, the administration does not recommend a pedestrian street with driving allowed. Instead, a 20 km/h zone could be considered.

Cycling across squares and plazas allowed only exceptionally

Squares and plazas are reserved and designed for pedestrians and recreational use. Therefore, as a matter of principle, cycle connections are not built across squares and plazas.

However, there are a few exceptions for important cycle connections across squares, such as Rådhuspladsen and Sankt Annæ Plads. In addition, crossing cyclists can contribute to life and movement, especially during off-peak hours, to make the area feel secure.

Establishing these cycle connections requires a separate assessment by urban planning professionals, who relate to the traffic and architectural context. Visual and physical road marking clarifies where cyclists and pedestrians travel.

Pedestrian street with driving allowed on Blågårdsgade, photo Ursula Bach

Shared-use path with separation across Sankt Annæ Plads

Two-way cycle path across Rådhuspladsen / City Hall Square

Pedestrian street with residential, work traffic and cycling allowed across on Sjællandsgade

Play and leisure streets primarily for pedestrians

In play and leisure streets, the entire road space can be used for play and leisure, while driving is allowed with a recommended speed of 15 km/h. Play and leisure streets are designed with pedestrians in mind and are most often found in residential areas. The recommended speed also applies to cyclists. Play and leisure streets are not recommended on roads with important cycle connections or where many cyclists or motorists are expected during the day.

Cycling through shopping streets

Shopping streets are streets with a high concentration of shops, cafés and restaurants and are designated in *Copenhagen municipal plan 2019*. On pedestrian shop-ping streets, pedestrians and cyclists should be able to move safely and securely. Good opportunities for stopping and crossing the road should be provided. Cyclists and pedestrians should be prioritised in the design of the street. Motorists should drive at low speed, and bus traffic should generally be prioritised over other motorised traffic.

Context and references

Cycle paths in shopping streets with sufficient cycle path widths: *"1.2.1 Minimum widths for cycle paths"*.

A dooring zone is recommended next to parked cars to reduce potential collisions with cyclists and open motor vehicle doors in shopping streets: *"1.2.2 Dooring zone"*.

In shopping streets, sufficient cycle parking must be provided for cyclists shopping in the street. Cycle parking must be established with clear guidance lines for people with vision impairment, and without compromising pedestrians' comfort and flow: *"4.5 Cycle parking"*.

"3.2 Field of view at intersections and conflict points".

Copenhagen municipal plan 2019.

Play and leisure street at Folkets Park

Shopping street on Valby Langgade, photo Ursula Bach

2.5 Tactile marking to sharpen cyclists' attention

In conflicts between cyclists and pedestrians, a clear division or road marking can often solve the problem. The design should clearly signal where pedestrians and cyclists should position themselves and who has the right-of-way. This is done with road design, road marking (cycle and pedestrian symbols, yield lines), and increased lighting. Potential conflicts can arise at bus for example, or when cyclists and pedestrians have limited space.

Where conflicts arise despite clear design, different measures can increase cyclists' attention. Rumble strips or speed bumps can be used on the cycle path, but these physical measures should only be used selectively and limited so as not to restrict cyclists' comfort too massively. In general, cobblestone strips are not recommended.

Rumble strips and speed bumps on the cycle path can be used in areas with poor field of view. While rumble strips are attention-grabbing, speed bumps are speed-reducing and are therefore used where cyclists need to slow down. This could be at cycle path crossings with primary roads or a transverse cycle or pedestrian route. Which measure is most suitable requires a specific local assessment. Speed bumps on cycle paths are typically designed for 10 km/h.

Bollards are used only in exceptional cases.

Context and references

"3.5.3 Cycle path crossings".

"1.2.3 Widths for other traffic facilities".

"1.2.1 Minimum widths for cycle paths".

"2.2 Cycle infrastructure and traffic calming".

"2.4 Cycle and pedestrian infrastructure".

"2.1 Traffic behaviour".

"2.7 Cycle and bus infrastructure".

Speed bump on two-way cycle path near Rolighedsvej

Rumble strips on Nørrebrogade

2.6 Cycle infrastructure near schools and childcare institutions

Near schools and childcare institutions, there is a high concentration of cyclists and pedestrians for short periods of time. Different measures are being worked on at schools and childcare institutions:

- Temporary motor vehicle stopping and parking bans near schools
- Temporary speed restrictions, e.g. 30 km/h speed limit during school hours
- Expansion of pavement at intersections
- Crossing islands so that children can cross one lane at a time
- Reduction or elimination of car parking
- One-way streets for motorists
- Speed bumps and raised platforms
- Variable message signs (VMS) to make children visible on the road.

School safety zones are also established near schools with temporary bans for motor vehicle driving between 7:30-8:30. This promotes traffic safety as well as security for children arriving on foot and by cycle.

In addition to signage, establishing school safety zones requires dialogue and communication with school and childcare institution management, parents, resident and the press. To ensure the temporary ban for driving is complied with and enforced, a coordinated effort with the police is required.

Context and references

"3.5.4 Crossing islands".

"1.2.3 Widths for other traffic facilities".

"2.2 Cycle infrastructure and traffic calming".

"2.4 Cycle and pedestrian infrastructure".

"2.1 Traffic behaviour".

"3.2 Field of view at intersections and conflict points".

Schools and childcare institutions can be seen on Copenhagen's spatial map.

School patrol and students pulling their cycles across the pedestrian crossing, photo Troels Heien

Two students cycle to school, photo Ursula Bach

2.7 Cycle and bus infrastructure

Ideally, cycle paths are led around bus platforms to avoid conflicts and ensure high comfort and flow for cyclists and secure conditions for bus passengers. The cycle path should be designed so that the curve for cyclists follows the recommendations for horizontal radii.

Bus platforms are constructed to make it easier for bus passengers to get on and off the bus without coming into direct conflict with cyclists. Generally, the cycle path continues straight ahead (see *Figure 11*), but in some places around the bus platform (see *Figure 12*). Bus platforms create better comfort and flow for cyclists because they don't necessarily have to stop for entering and exiting bus passengers. Bus platforms have a minimum width of 2.0 metres.

In Copenhagen, pedestrian crossings over the cycle path up to the bus doors are not used. Mixed bus and cycle lanes are discouraged.

If there is no room for a bus platform, cyclists must stop for entering and exiting bus passengers at bus stops (see *Figure 13*).

In case of conflicts between many cyclists and bus passengers, the design should clearly signal where pedestrians and cyclists should position themselves. Where conflicts between pedestrians and cyclists do occur, rumble strips can be used selectively on the cycle path.

Kerbside bus stops where the bus stops on the carriageway should be considered. This solution streamlines bus operations with quick stops while ensuring that motorists stop behind the bus, allowing the bus to continue its journey. The solution can be investigated in dialogue with Movia for indicative motorised traffic volumes below 10,000 vehicles per day (AWDT).

Bus platforms and bus stops should generally be placed 30–50 metres before intersections or conflict points to ensure the necessary field of view between the carriageway and cycle path. This prevents a stationary bus from concealing cyclists or pedestrians from right-turning motorists.

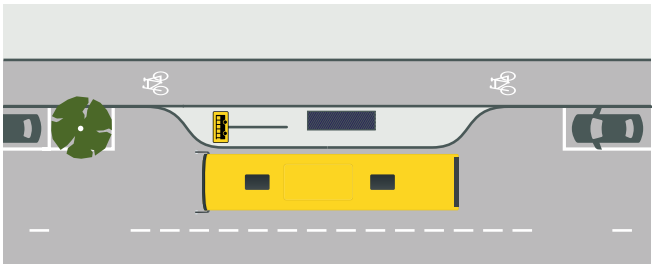


Figure 11: Bus platform

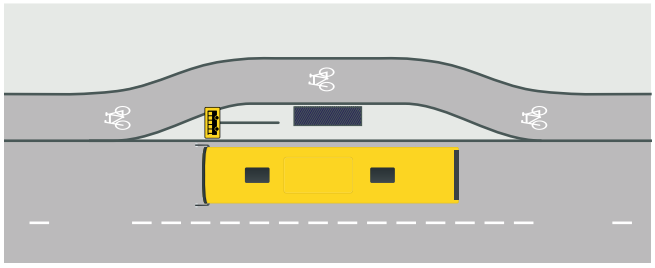


Figure 12: Bus platform with surrounding cycle path

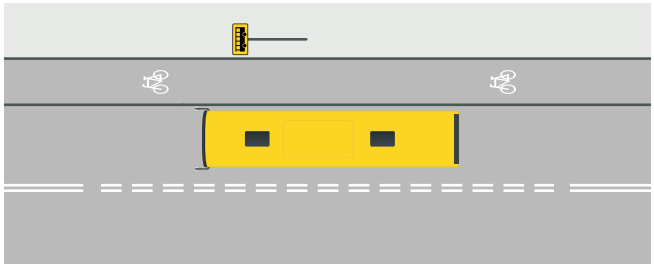


Figure 13: Bus stop

Context and references

"1.4.3 Geometric design".

"1.2.3 Widths for other traffic facilities".

"3.2 Field of view in junctions and conflict points".

"2.5 Tactile markings to sharpen cyclists' attention".

"3.1.2 Shortened cycle track".

"3.3.3 Pre-green".

Bus platform on Amagerbrogade

Kerbside bus stop on Enghavevej

Bus stop at Sankt Hans Torv

Bus patform on Nørrebrogade, photo Ursula Bach

2.8 Cycling during construction

For temporary cycling during construction, Copenhagen requires that roadworks meet a high standard in terms of smoothness, easily understandable signage and a coherent course. Before construction work begins, the design of the temporary cycling and traffic conditions must be clarified and approved by the *Road Inspectorate*.

For temporary rerouting the starting point is that the course for cyclists is changed to a shared-use path with separation if the existing cycle path and pavement cannot be maintained. In some cases, however, cyclists can temporarily travel on the shared-use path without separation, and only in exceptional cases on the carriageway. Where these solutions are not possible, alternatives for rerouting cycle traffic should be explored.

Context and references

Copenhagen's Excavating in a cycling city - 7 good barrier solutions, 2016.

Ongoing construction projects can be seen on Copenhagen's spatial map.

Temporary cycle lane at Rådhuspladsen

Temporary shared-use path with separation on Rantzausgade

Illuminated container for cyclists during construction work on Nørrebrogade

Information poster about construction project on Gothersgade

2.9 Tactical urbanism

Tactical urbanism can help to test solutions for future cycle infrastructure.

During the experiments in the Medieval City in 2021, several streets were transformed into pedestrian streets, car parking was removed, and urban furnishing was added. This created more space for pedestrians and cyclists, as well as opportunities for people to socialise.

Tactical urbanism like this can create dialogue, knowledge and experience among residents, road users, the administration and other stakeholders. By using cheaper and portable urban furnishing, paint and bollards, solutions can be tested before a more costly construction project is initiated.

Another example is the traffic experiment on Nørrebrogade, limiting motorists and promoting cycling and public transport, which became permanent in 2009 after a one-year experiment.

Citizen involvement in the cycle street experiment on Nordre Frihavnsgade

Tactical urbanism on Skindergade

3 Cycle-friendly intersections

When designing cycle-friendly intersections, cyclists must be prioritised. Most collisions involving cyclists in Copenhagen happen at intersections and involve motorists as the other party. A prerequisite for good traffic safety for cyclists at intersections is that turning motorists drive at low speed and have a good field of view.

Security, also called perceived safety, is a prerequisite for getting more people to cycle, especially children and the elderly. Several intersection solutions can be perceived as secure even though they are less safe.

When redesigning the infrastructure in Copenhagen, special attention must be paid to cyclists travelling through intersections. The road and traffic engineering conditions must contribute to creating safe, secure and comfortable conditions for cyclists. This can be achieved by reducing motorised traffic volume, lower speed limits, signal prioritisation, redistributing road space, banning right turns for motorists or measures that increase road users' awareness. The intersection solutions chosen can affect road users' flow and must be based on the trade-offs in the site-specific assessment.

Søtorvet/Dronning Louises Bro, photo Troels Heien

3.1 Cycle infrastructure in signalised intersections

In signalised intersections, there are many factors that influence the design of cycle infrastructure. Therefore, a site-specific assessment should always be made early in the process (see *"5.1 Site-specific assessment tool"*).

Advanced cycle path as the preferred approach

In Copenhagen, the advanced cycle path is the preferred approach as it provides the greatest security and flow for cyclists. Therefore, the advanced cycle path should always be included in the site-specific assessment.

Advanced cycle paths can present traffic safety challenges. Therefore, advanced cycle paths should be supplemented with measures supporting safe crossing. Separate right-turn lane and a set-back stop line is the standard solution to improve traffic safety. Separate signal regulation or a right-turning ban for motorists can be included to completely remove the safety challenges of advanced cycle paths, removing the potential conflict between right-turning motorists and cyclists.

Where sufficient field of view cannot be ensured 30–50 metres before the conflict point in the different intersection solutions described in *chapter 3.1*, the advanced cycle path must be established with separate signal regulation, or a right-turn ban for motorists.

If it is assessed that an advanced cycle path cannot be established with sufficient traffic safety, other solutions described in *chapter 3.1* must be used.

Advanced cycle path, Dronning Louises Bro/Søtorvet

Advanced cycle path, Jagtvej/Nørrebrogade

3.1.1 Advanced cycle path

An advanced cycle path is a cycle path led to the stop line and continued in a cycle marking.

An advanced cycle paths is the best solution in terms of security, as cyclists are guaranteed their own space. In addition, continuing the cycle path all the way to the intersection ensures good comfort and flow for cyclists as well as a visual and intuitive connection.

A Danish study as well as studies in Copenhagen show that shortened cycle paths that are converted to advanced cycle paths have a higher risk of right-turning collisions after the conversion. Despite Copenhagen's tradition of advanced cycle paths, there is still a lack of systematic knowledge about traffic safety and security of advanced cycle paths in the city.

When designing advanced cycle paths, different elements that improve or even completely ensure traffic safety are recommended.

Separate right-turn lane and 5 metres set-back stop line for motorists is standard design

Separate right-turn lane and 5 m set-back stop line for motorists improve traffic safety on advanced cycle paths and are therefore standard requirements for advanced cycle paths in Copenhagen (see *Figure 14*).

A separate right-turn lane requires space but must be established. An advanced cycle path next to a combined straight and right-turn lane is worse in terms of traffic safety.

5 m set-back stop line for motorists minimises blind spots for particularly truck drivers and can therefore help prevent right-turn collisions. The stop line on the cycle path is extended all the way to the pedestrian crossing. This solution is also called geometric pre-green for cyclists.

Where it is not possible to establish a 5 m set-back stop line for motorists, signalised pre-green for cyclists must be provided for cyclists. This allows waiting cyclists to enter the intersection before right-turning motorists get the green signal.

Sufficient field of view 30–50 metres before the intersection

To reduce the risk of motorists overlooking cyclists and pedestrians, sufficient field of view should be provided 30–50 metres before the intersection (see *Figure 14*) or conflict point.

Where sufficient field of view cannot be ensured 30–50 metres before the intersection or conflict point, separate signal regulation or right-turn bans for motorists is implemented, as described on the following pages.

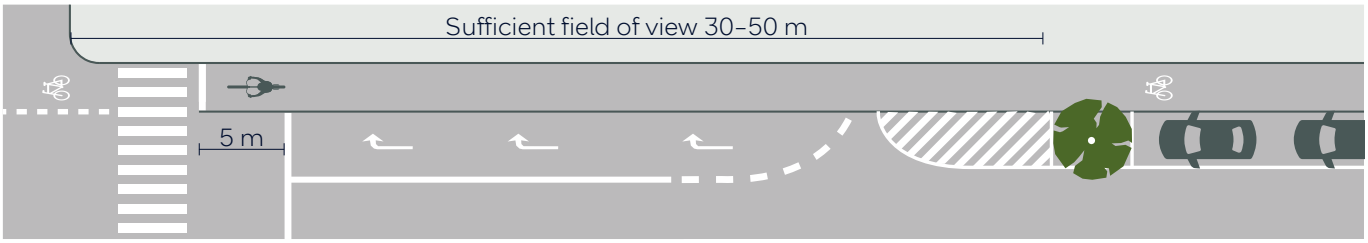


Figure 14: Advanced cycle path

Advanced cycle path, Jagtvej/Nørrebrogade

Advanced cycle path, Søtorvet/Frederiksborggade

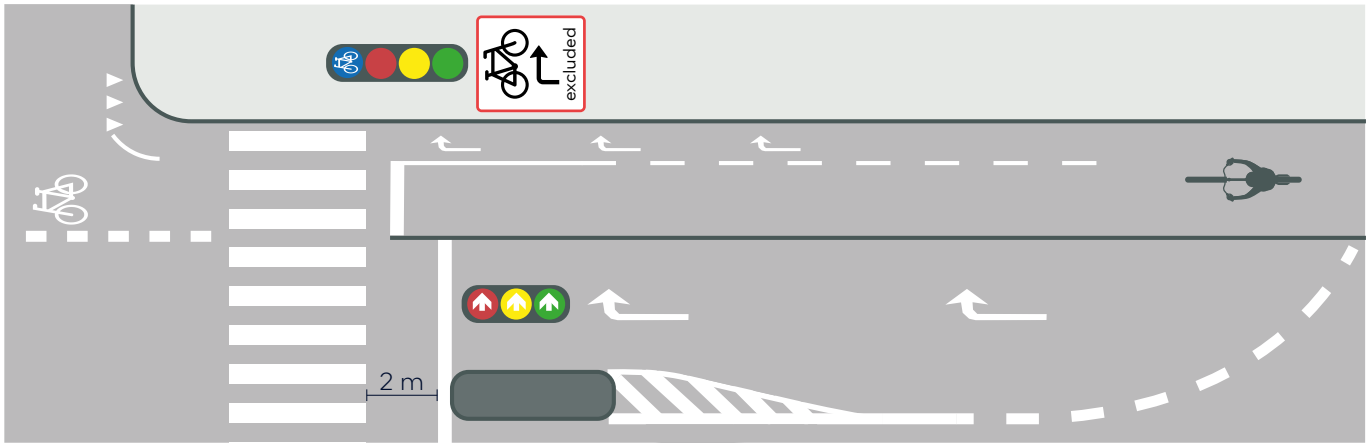


Figure 15: Advanced cycle path with separate signal regulation

Separate signal regulation ensures traffic safety

With separate signal regulation, right-turning motorists get their separate green signal phase (see Figure 15). Separate signal regulation is safe and secure as it eliminates the potential conflict between cyclists and right-turning motorists.

However, separate signal regulation, reduces flow for all road users, as green time is reduced by multiple signal phases. Flow is reduced especially for cyclists and pedestrians traveling straight ahead, but also for turning motorists. To reduce unnecessary waiting time for as many road users as possible, traffic management in these separate phases must be incorporated.

To ensure the necessary capacity, it is important to pay attention to green time and cycle path width. A shorter green time requires a wider cycle path so that the capacity for cyclists is maintained at the intersection. Pedestrians usually define the minimum green time and must be able to cross to the opposite pavement in one signal cycle.

Two or more right- or left-turn lanes must have separate signal regulation. Cycle islands are a form of separate signal regulation.

Context and references

Cyclists' security on advanced and shortened cycle paths, Rambøll, 2022.

Traffic safety for shortened and advanced cycle paths, Via Trafik, 2020.

"3.3.3 Pre-green".

"3.2 Field of view at intersections and conflict points".

"3.1.4 Cycle island".

"3.3.2 Cycle signals".

"3.4.3 Cyclists excluded from turning bans".

Advanced cycle path with separate signal regulation, Havnegade/Holmens Kanal

Separate signal regulation and pre-green for cyclists, Jagtvej/ Nørrebrogade

Right-turn bans for motorists

Where space is limited and where right-turning motorists have alternative routes, a right-turn ban for motor-sts can be established (see *Figure 16*). Cyclists are excluded from the right-turn ban with the sub-sign *Cyclists excluded*.

Right-turn bans for motorists are a safe solution for advanced cycle paths, as the potential conflict between cyclists and right-turning motorists is removed. As there is no right-turn lane, the solution is also less space-consuming.

In this solution, the stop line for motorists should be set back by 2 metres so that truck drivers can see crossing pedestrians.

Right-turn bans for motorists require a site-specific assessment of how motorists are re-routed.

Advanced cycle path and right-turn ban for motorists, Jagtvej/Ågade

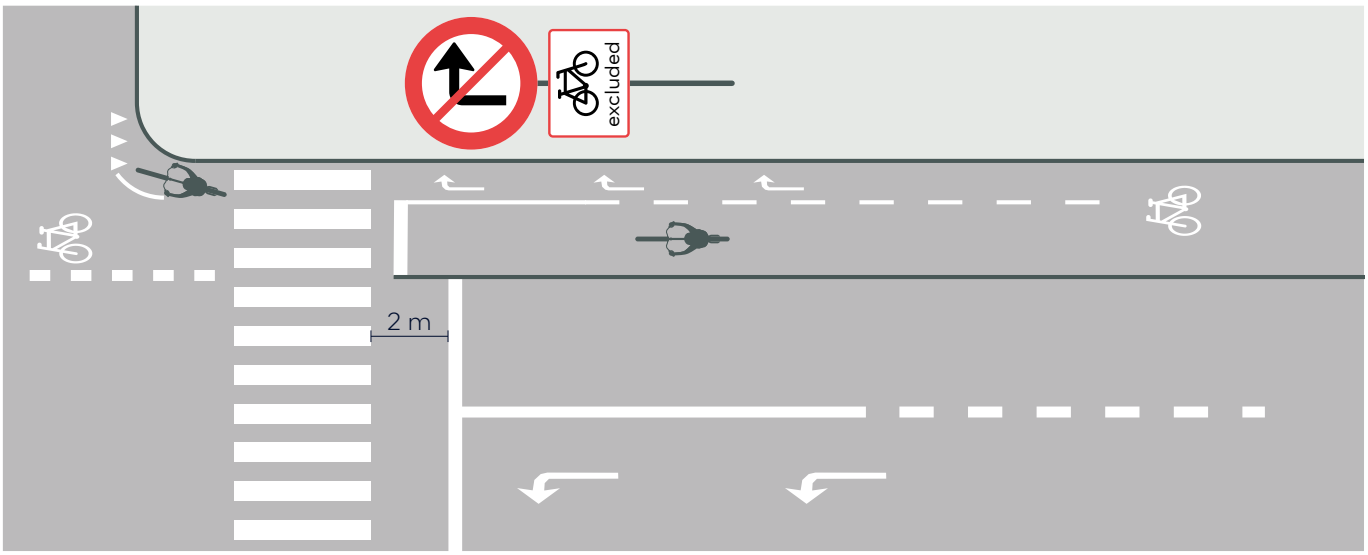


Figure 16: Advanced cycle path and right-turn ban for motorists

Advanced cycle path and right-turn ban for motorists, Østerbrogade/Rosenvængets Allé

Advanced cycle path and right-turn ban for motorists, Amagerbrogade/Brysselsgade

Photo Ursula Bach

3.1.2 Shortened cycle path

With a shortened cycle path, the cycle path ends before the intersection and cyclists merge with right-turning motorists in the right-turn lane.

The risk of right-turning collisions is low with a shortened cycle path, which is why this solution can be chosen at intersections with many right-turning collisions and where an advanced cycle path with separate signal regulation or a right-turn ban for motorists is not considered possible.

A shortened cycle path moves the potential conflict between cyclists and right-turning motorists away from the intersection to the merge point on the approach to the intersection. Motorists and cyclists must orient themselves in relation to each other and awareness is increased.

More than half of cyclists perceive a shortened cycle path as an insecure or very insecure solution. This is especially true among children and elderly cyclists. The design can create uncertainty about where cyclists should position themselves in relation to motorists, and many cyclists feel insecure to share space with motorists. For motorists, it can be confusing that cyclists can position themselves on both sides of the motor vehicle.

Traffic composition: many cyclists and few right-turning motorists plus no right-turning buses or freight traffic

Shortened cycle paths can be established where the traffic consists of a combination of many cyclists and few right-turning motorists. However, if there are too many right-turning motorists, this solution is less suitable for cyclists' comfort, flow, and security.

Shortened cycle paths are not recommended when there are right-turning buses or a large proportion of freight traffic, as the merging of large motor vehicles and cyclists in the same lane is not suitable.

Design: 3.5–4.0 m width and 15–25 m length

The combined cycle and right-turn lane must have a width of min. 3.5 m–max. 4.0 m (see *Figure 17*). This width ensures that cyclists can position themselves next to a motorist and prevents two motorists positioning them next to each other. The length of the combined cycle and right-turn lane should be 15–25 m.

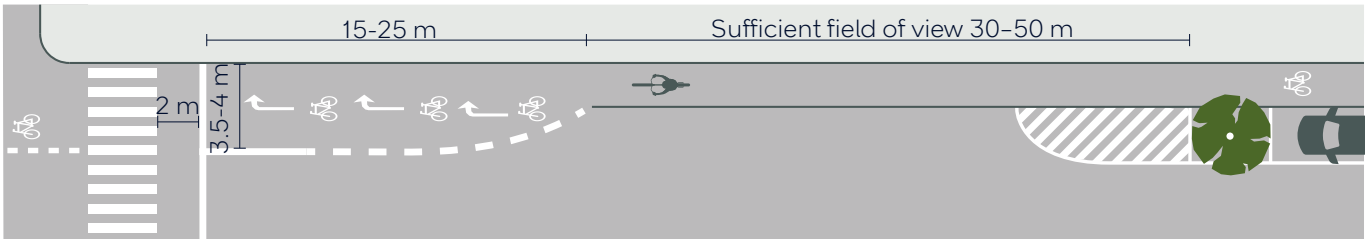


Figure 17: Shortened cycle path

Shortened cycle path with longitudinal drop 28‰, Tagensvej/Hovmestervej

Shortened cycle path, Njalsgade/Svend Aukens Plads

Sufficient field of view 30–50 m before shortened cycle path

To reduce the risk of motorists overlooking cyclists, sufficient field of view should be ensured 30–50 m before the conflict point where the cycle path is shortened (see *Figure 17*).

If sufficient field of view cannot be ensured before the conflict point, the solution should not be used.

Road marking: two to three large bicycle symbols

The combined cycle and right-turn lane should be marked with two to three large bicycle symbols. The first bicycle symbol is placed where cyclists enter the carriageway. The last bicycle symbol before the intersection is placed in the combined cycle and right-turn lane where the dashed line ends. If there are three bicycle symbols, the middle bicycle symbol is placed between the two others and the right-turn arrows (see *Figure 17*). Bicycle symbols cannot be placed along a continuous line, as this means that the lane is reserved for cyclists.

Steep longitudinal gradient

Shortened cycle path is recommended at a steep longitudinal drop of more than 30–40‰ into the intersection, as cyclists have higher speed here. Shortened cycle path is also recommended for right-turn collisions in the context of measured cyclist speeds above 25 km/h.

Context and references

Cyclists' security on advanced and shortened cycle path, Rambøll, 2022.

Traffic safety for shortened and advanced cycle path, Via Trafik, 2020.

"3.2 Field of view at intersections and conflict points".

Cyclists and right-turning motorists at shortened cycle path, H.C. Andersens Boulevard/Jernbanegade

Shortened cycle path with longitudinal drop 39‰, Frederiksborgvej/Tuborgvej

Cyclists position themselves on both sides of right-turning motorists at shortened cycle path, Gothersgade/Øster Voldgade

The last bicycle symbol before the intersection is placed where the dashed line ends

Shortened cycle path, Øresundsvej/Amager Strandvej

3.1.3 Cycle path between straight and right-turn lane

To separate straight and left-turning cyclists from right-turning motorists, a cycle path can be established to the left of the right-turn lane. Typically, this is a straight lane, and in a few cases, and in a few cases a combined straight and left-turn lane.

Straight and left-turning cyclists get better comfort and flow compared to a shortened cycle path, but the security is not on par with the security of an advanced cycle path. The cycle area between the two lanes should always be designed as a cycle path with kerbs on both sides for cyclists' security and safety. A cycle lane between the straight and right-turn lanes should only be established as an absolute exception, and it should be marked in blue all the way to the intersection.

The conflict between right-turning motorists and cyclists traveling straight ahead or left is moved back from the intersection to the point where motorists cross the blue cycle marking between the two lanes (see *Figure 18* and *Figure 19*).

The solution should be designed so that the cycle path continues straight ahead, and motorists must change direction when they cross the cycle marking. This ensures that motorists are more likely to slow down and orientate themselves.

This solution can ensure better comfort and flow for cyclists travelling straight ahead, as longer green time can be given for them.

Where there is a high proportion of right-turning motorists, an advanced cycle path for the right-turning cyclists can be established (see *Figure 18*).
Where there is no space for both the cycle path between the two lanes and the advanced cycle path, a shortened cycle path can be established (see Figure 19).

To reduce the risk of motorists overlooking cyclists, sufficient field of view should be ensured 30–50 metres before the conflict point at the blue cycle marking (see *Figure 18* and *Figure 19*).

If sufficient field of view cannot be ensured, the solution should not be used.

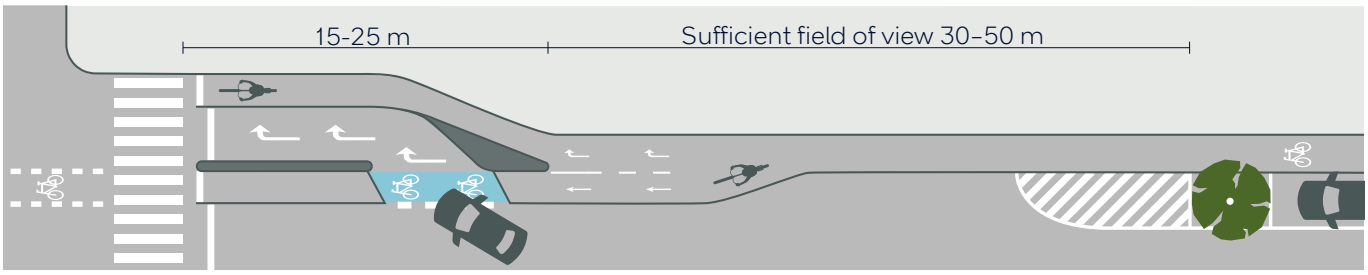


Figure 18: Cycle path between straight and right-turn lane

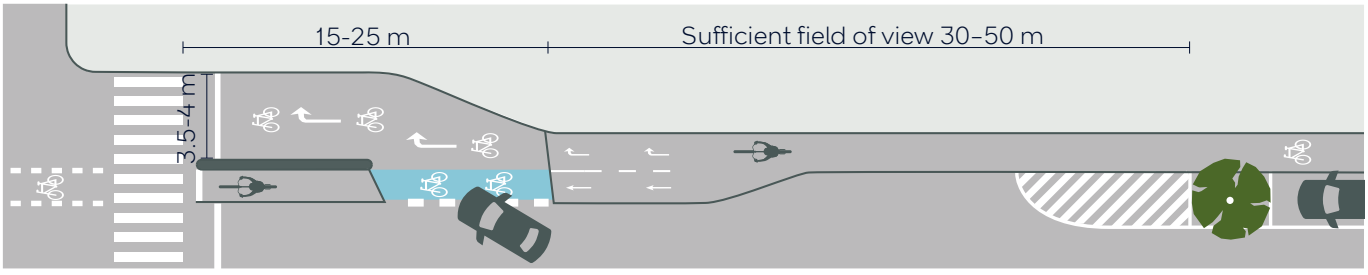


Figure 19: Cycle path between straight and right-turn lane with shortened cycle path

Context and references

The intersection is marked with a blue cycle marking: *"3.4.1 Cycle marking"*.

The cycle path width follows the recommended minimum widths: *"1.2.1 Minimum widths for cycle paths"*.

The recommended driving curves must be followed in the design: *"1.4.3 Geometric design"*.

"3.2 Field of view at intersections and conflict points".

"3.1.1 Advanced cycle path".

"3.1.2 Shortened cycle path".

Cycle path between straight and right-turn lane, Hillerødgade/Borups Allé

Cycle lane between straight and right-turn lane, P. Knudsens Gade/Enghavevej

Cycle lane between straight and right-turn lane with shortened cycle path, Vibenshus runddel/Jagtvej

Cycle lane between bus and right-turn lane, H.C. Andersens Boulevard/Vester Farimagsgade, photo Ursula Bach

3.1.4 Cycle island

A cycle island, also known in Copenhagen as 'prisoner island', can be established where right-turning motorists are prioritised in their own signal phase and where the proportion of right-turning motorists is high.

The cycle island is located between a straight lane and a right-turn bypass for motorists and cyclists. The solution means that straight and left-turning cyclists must first pass through a separate cycle signal and possibly wait to cross to the cycle island. Right-turning cyclists benefit from the bypass, as they are often excluded from the signal.

The cycle island is most optimal where left-turning motorists (from the road on the right) are given their own phase simultaneously with right-turning motorists. Here the signal can be regulated so that there is green both to and past the cycle island simultaneously, allowing cyclists to pass through the cycle island without an extra stop. Without this signal regulation, straight and left-turning cyclists will have to wait for a red on the cycle island, reducing cyclists' comfort and flow in favour of right-turning motorists.

The waiting area in the cycle island should be designed with enough space for waiting cyclists if they cannot continue through the cycle island for a green without stopping. In Copenhagen, the width of the waiting area should follow the recommended minimum width for cycle paths plus an additional 0.5 m and a length of min. 5 m. At the same time, the recommended driving curves must be followed.

Context and references

"1.2.1 Minimum widths of cycle paths".

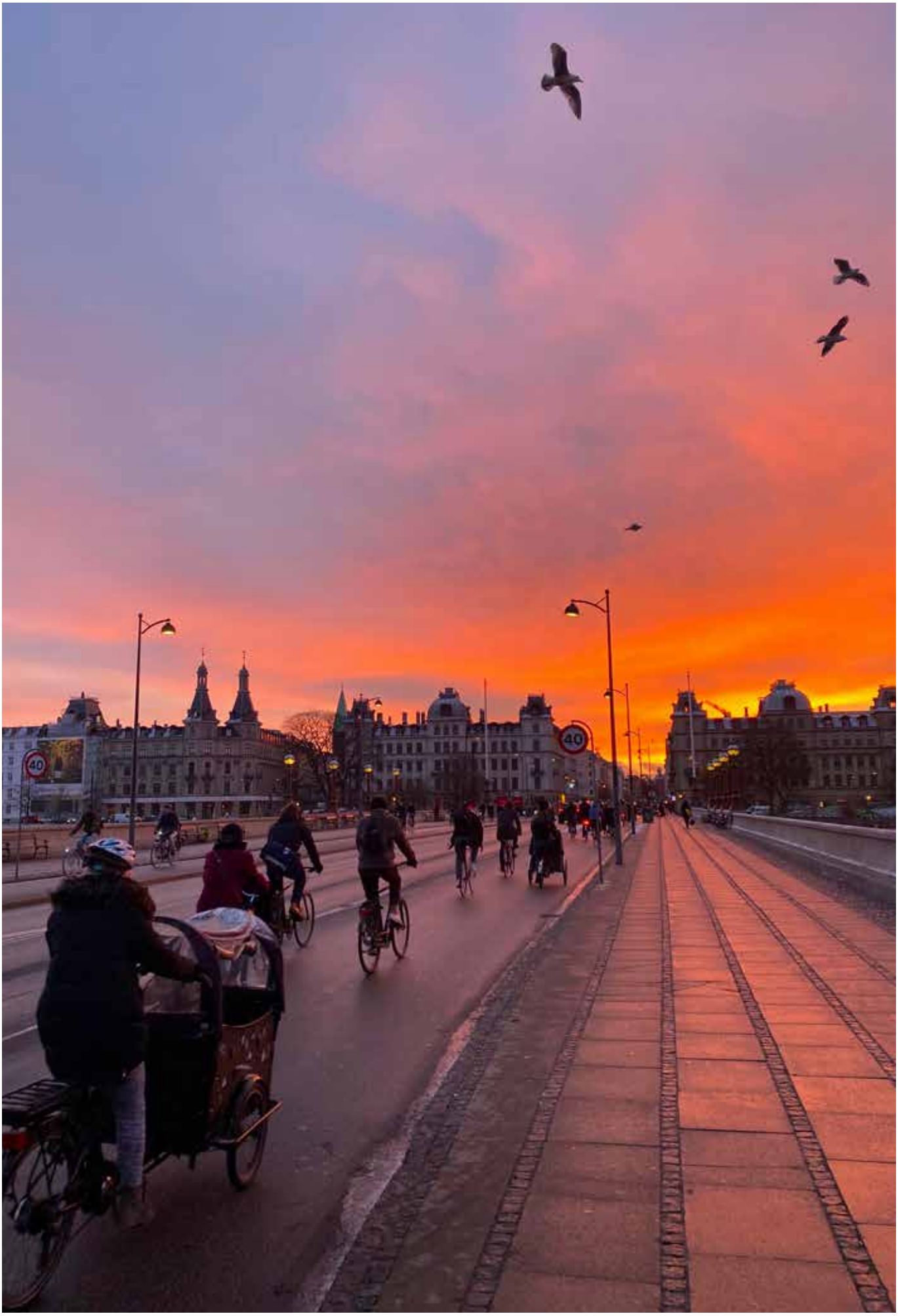
"3.4.6 Cycle bypass".

Recommended driving curves: *"1.4.3 Geometric design".*

Driving curves for specialised cycles and analysis of cycle islands, Via Trafik, 2023.

Cycle island, Blegdamsvej/Tagensvej

Cycle island, Christmas Møllers Plads



Dronning Louises Bro

3.2 Field of view at intersections and conflict points

To reduce the risk of motorists overlooking cyclists and pedestrians, sufficient field of view should be ensured 30–50 metres before potential conflict points. Therefore, a site-specific assessment should be made with the assessment and dialogue tools. Sufficient field of view here at intersections and conflict points an effective road safety measure to reduce potential right-turning collisions.

Standard solution: sufficient field of view 30–50 metres before the conflict point

Road Standards' recommendations for field of view depend on many different factors, such as the speed of the primary road, the width of the carriageway and the distance between cycle path and carriageway.

Based on these recommendations, roads with cycle paths next to parked cars should not have parked or stopped vehicles 32 metres before and after a side road. This applies to roads with a speed limit of 30 km/h. At higher speeds, the distance should be increased further. At 50 km/h, the recommendation would be no stopping or parking for 60 metres on either side of the conflict point.

In simple terms, sufficient field of view should be ensured as a standard solution by avoiding obstructions between carriageway and cycle path 30–50 metres before the conflict point. The conflict point can be the stop line, yield line, or cycle marking depending on the intersection design. Obstructive elements include car parking, trees, urban planting, entrances and driveways. Additionally, the cycle path should be directly next to the carriageway (e.g. no kerb strip, bus platform or bus stop in between).

If the recommendations in the Road Standards are followed, the possibility of having kerbside parked cars next to cycle paths will be significantly reduced.

Options in case of poor field of view

If sufficient field of view cannot be ensured at an intersection, an advanced cycle path with separate signal regulation or a right-turn ban for motorists should be established, as this removes the conflict point.

Minimum solution: '20-metre rule' at side roads

The *10-metre rule* describes that motorists are not allowed to park or stop within 10 metres of the intersection according to Traffic Law. 10 metres is the legal minimum distance. However, Road Standards recommend a significantly longer distance to ensure sufficient field of view at side roads.

Going forward, the *20-metre rule* is the recommended minimum solution at side roads. This approximates the Road Standards' recommendations of 30–50 metres

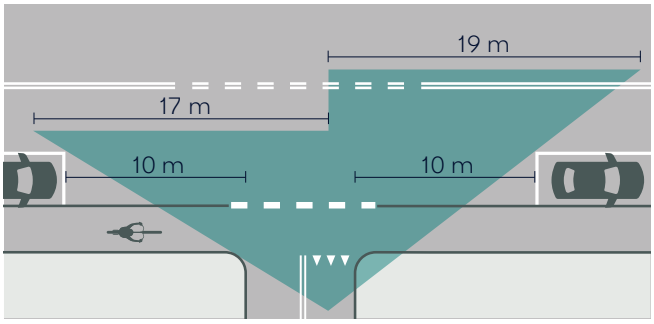


Figure 20: Field of view with car parking 10 m from the side road

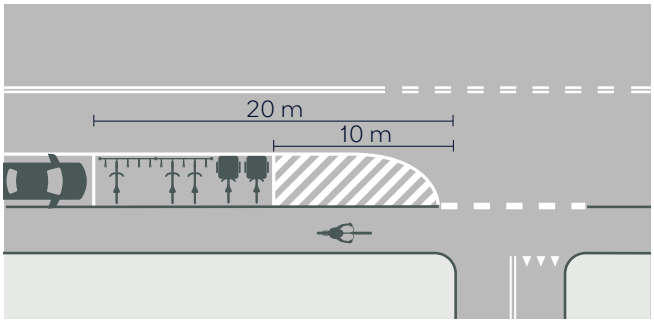


Figure 21: '20-metre rule' where cycle parking can be established between 10–20 m from the side road

before the conflict point. The *20-metre rule* is used on primary roads with cycle paths, cycle lanes, cycle streets, contraflow cycling or mixed traffic.

With the *20-metre rule*, motorists can still park and stop 20 metres before and 10 metres after the side road. The extension to 20 metres gives right-turning motorists and motorists and cyclists from the side road a better field of view.

The extension to 20 m will mean a need to reallocate parking spaces. The *20-metre rule* is already used today in road safety projects. The 20-metre rule will be introduced in urban development areas, where there is space in the existing city, and where the field of view needs to be improved due to recorded collisions or risk of collisions.

Unlike the *10-metre rule*, the *20-metre rule* requires road marking or signage. Depending on the conditions, car parking and stopping can be prevented in different ways:

- Barrier strip
- Signed ban
- Divider islands
- Median islands
- Cycle parking can be established between 10–20 metres from the side road (see *Figure 21*).

Context and references

Executive order of the Traffic law §29, 2024.

Chapter 5: Field of view at intersections, Handbook Intersections in urban areas, Road Standards portal, 2024.

"5.1 Site-specific assessment tool".

"3.1 Cycle infrastructure in signalised intersections".

"3.1.1 Advanced cycle path".

"2.3 Cycle infrastructure and car parking".

"4.6 Urban planting and greening".

"2.7 Cycle and bus infrastructure".

Cycle parking combined with barrier strip, Frederiksborggade/Nansensgade

Better field of view from the side road, Frederiksborggade/Nansensgade

3.3 Signal technical measures

3.3.1 Traffic signals

Traffic signals should only be installed where a sufficiently high volume of traffic must cross the road, and where traffic has long waiting times without a traffic signal system.

Minimise cyclists' stopping and waiting times

To promote capacity and flow through a traffic signal, it is important to consider the programming of the signals and the geometry of the intersections. More cyclists can pass through a traffic signal the more green time there is, and the more space cyclists have.

Cyclists' stopping and waiting times should be minimised by reviewing the signal programming and physical intersection design. Alternatively, multiple signals can be coordinated on a route.

To optimise and ensure enough green time for cycle flows, CYKAP can be used. The aim is to reduce cyclists stopping for unnecessary red lights.

When calculating green time, it may make sense to examine peak hour traffic for cyclists, as cycle traffic is often concentrated in shorter time intervals than an hour. This can be investigated at high cyclist volumes (e.g. peak hour traffic over 2,000 cyclists in one direction).

At some Copenhagen intersections, and along some stretches, there is a particular lack of capacity during a very short period of morning rush hour. Here there is a peak period of 5–15 minutes. The signal programme can be adjusted to improve the capacity for cyclists during the peak period, and it can be investigated whether the cycle path should be widened before and after the intersection.

Criteria and guidelines for traffic signals

Traffic signal systems should only be installed where a sufficiently high volume of traffic is to cross the road or if one of the following criteria is met (Chapter 2.4.3, Handbook: Use of Traffic Signals, Road Standards portal, 2023):

- High traffic intensity (indicatively over 750 vehicles/h in the 8 busiest hours of the day, of which 175 are from the side road)
- Long waiting times for side road traffic
- High cyclist and pedestrian volumes (indicatively over 200 cyclists and pedestrians/h in the 4 busiest hours of the day to cross a road with over 600 vehicles/h)
- Improving coordination
- Intersections between major roads
- Risk of collisions
- Poor fields of view.

Additionally, Copenhagen's Guidelines for traffic signals must be followed.

Context and references

"5.3 Traffic and simulation models".

"3.4.7 Widened cycle path".

"4.3 ITS equipment".

Cycle signal with pre-green for cyclists, Gothersgade/Søtorvet

3.3.2 Cycle signals

Cycle signals are signals where cyclists have their own signal phase either entirely or partially. Cycle signals can provide cyclists with increased security and safety. Cycle signals should be used at large intersections for safety reasons, when cyclists are separately regulated, or when there are no motorists traveling in the same direction. Cycle signals can only be used at advanced cycle paths or off-street cycle paths.

Cycle signals should be placed low and facing downward so that they are in the cyclists' field of vision, but at least 1.5 metres high. Other cycle signals should be placed high, unless main signals are installed at the same height. Cycle signals must be placed so that there is no doubt as to who the signal is directed at.

Cycle masts are not recommended due to the risk of collision with winter maintenance vehicles. If used anyway, cycle masts should always be placed lower than motor vehicle signals on the same mast. Cycle/pedestrian push signals are not used in Copenhagen. However, confirmations lights are used to inform road users that they have been automatically detected.

Post-green for motorists is discouraged

Where cycle signals are combined with arrow signals to prioritise motorists, cyclists' comfort and flow are reduced. The solution is therefore discouraged or only used as a last resort, where turning motorists or trucks are prioritised. Where possible, unnecessary turning arrows for motorists should be deactivated.

If there is a very high proportion of right-turning motorists, an advanced cycle path with a reduced green time for cyclists at the end of the phase can be chosen. A right-turn arrow at the end of the phase directs motorised traffic at the end of the green phase to the disadvantage of cyclists' and pedestrians' comfort and flow. The solution should be supplemented with detection of both cyclists and motorists so that cyclists are only held back when needed, and so that motorists only get the green when there are no cyclists.

Context and references

"3.1.1 Advanced cycle path".

"3.3.5 Cyclists' detection".

Pre-green for cyclists and deactivated post-green right-turn arrow for motorists, Tagensvej/Nørre Allé

Cycle signal, Århusgade/Kalkbrænderihavnsgade

Deactivated post-green right-turn arrow for motorists, Holmbladsgade

3.3.3 Pre-green

Cyclists and pedestrians are made more visible and safer at intersections by being guided into the intersection before motorists. This is called pre-green and there is a distinction between geometric and signalling pre-green. Pre-green mitigates potential conflicts at the start of the green phase, but not those conflicts in the middle and end of the phase.

Geometric pre-green is the standard solution for advanced cycle paths where the motorists' stop line is placed 5 metres behind the cyclists' stop line.

Signalling pre-green for cyclists

With signalling pre-green, cyclists are given the green light a few seconds before motorists. In Copenhagen, a 2-second pre-green signal is typically established. With pre-green, the stop line for motorists must be placed 2 metres behind the pedestrian crossing. This distance ensures the visibility of pedestrians who may otherwise be hidden in front of a truck.

In three-way intersections, a 4-second pre-green signal is typically established to guide left-turning cyclists towards the side road into the intersection before motorists are given the green. From the side road, a cycle path or cycle lane should be established so that pre-green can also be established from here. This saves cyclists time and reduces potential conflicts with right-turning motorists.

Where buses are given pre-green, cyclists should also have pre-green with a cycle signal.

Context and references

"3.1.1 Advanced cycle path".

"3.5.1 Three-way intersection and straight on red allowed".

"2.7 Cycle and bus infrastructure".

Pre-green for cyclists, Jagtvej/Nørrebrogade

Pre-green for cyclists, Frederikssundsvej/Frederiksborgvej

Pre-green for cyclists, Nørrebrogade/Jagtvej

3.3.4 Green wave

Cyclists' comfort and flow can be increased by coordinating green time in traffic signals to create a green wave. In a green wave, cyclists get green at several consecutive intersections at a given speed on a stretch of the road, which reduces the number of stops.

Green waves can be achieved by coordinated intersections that operating with fixed turn times, which most of Copenhagen's signal regulation uses.

A green wave should always be considered for large volumes of cyclists through several closely spaced traffic signals. A green wave should be strived for in both directions at a speed of 15–25 km/h. This means that the signals should either be synchronised to have green at the same time or be in counter phase, where one signal is green at the same time as the other is red.

The speed of the two-way green wave depends on the spacing and turn time of the signalised intersections and varies from intersection to intersection.

If counts show at least twice as much traffic in one direction, a perfect green wave should be created with a speed of 20 km/h in that direction for a limited period. The period for one-way green waves should be relatively short to ensure good flow for cyclists in both directions.

Any signal changes should consider the coordination with nearby signals so that existing green waves continue to be prioritised, or new ones are created.

Green wave on Nørrebrogade

Green wave, photo Ursula Bach

3.3.5 Cyclists' detection

In traffic signals, detection is an effective way to prioritise cyclists to reduce stops and ensure cyclists' comfort, flow, and sufficient capacity.

Thermal detection is the recommended solution in Copenhagen, as experience shows it works best for cyclists. Cyclists should be detected on equal terms with motorists, but further away from the intersection so they can either get green before they reach the stop line or have their green time extended without having to stop.

Outside central city areas, traffic signals with traffic management can be established, where road users can activate or extend the green light. Here it's important to detect cyclists from a distance on equal terms with motorists. If cyclists do not get green unless they are detected, a confirmation light should be installed.

Even if a traffic signal has traffic management, cyclists and pedestrians should always get green if motorists are detected in the same direction. When extending the green time, e.g. for buses, the green lights for cyclists and pedestrians should always be included.

With few pedestrians and cyclists, a short minimum green time can be used to increase capacity for motorists at the intersection, while thermal cameras detect and extend the green time for pedestrians and cyclists

Detection, Strandboulevarden/Svendborggade

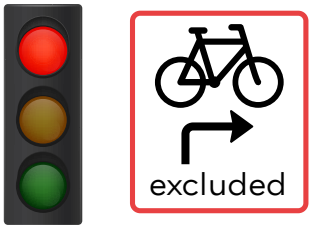
Photo Ursula Bach

3.3.6 Right turn on red allowed

At intersections with signal regulation and advanced cycle paths, cyclists should be excluded from the signal regulation where conditions allow (see Figure 22). Comfort and flow for right-turning cyclists is improved with this solution, but flow for straight-ahead cyclists may be compromised. The solution requires a cycle path in both the approach and exit lanes.

In this solution, cyclists are allowed to turn right on red if they do not inconvenience other road users. Cyclists have duty to give away to crossing vehicles and must always give way to pedestrians in pedestrian crossings. When channelling in different lanes on the cycle path, special minimum widths apply.

Right-turning cyclists can also be excluded from signal regulation by establishing a cycle bypass.



Right turn on red allowed for cyclists is marked with sub-sign 'Cyclists excluded' and right-turn arrow on the signal mast

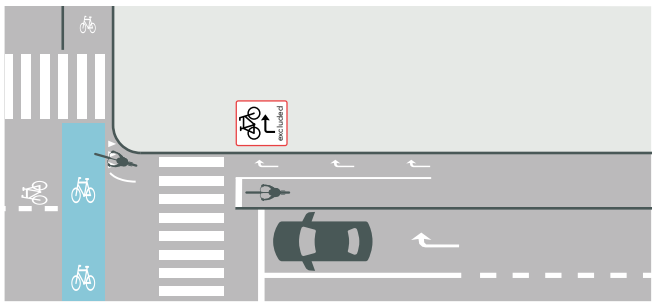


Figure 22: Right turn on red allowed for cyclists

Context and references

"3.1.1 Advanced cycle path".

"3.3.1 Traffic signals".

"3.4.4 Channeling on cycle paths".

"3.4.6 Cycle bypass".

Right turn on red allowed for cyclists, Ørestads Boulevard/Vejlands Allé

3.4 Cycle measures at intersections

3.4.1 Cycle marking

Cycle marking guides cyclists through intersections and make motorists aware of cyclists. Cycle marking is marked with road marking (dashed white lines or blue marking) plus bicycle symbols. Cycle marking in intersections must be marked at least up to the conflict point for left-turning, oncoming road users.

Cycle marking must not be established where cyclists must give way or where there is priority to the right.

There are four different kinds of cycle marking: quarter, half, full and blue cycle marking (see *Figure 23*). Quarter cycle marking is standard in all legs of signalised intersections, and two bicycle symbols are typically placed next to a shortened dashed line. Half cycle marking is used when both cyclists and motorists need to be guided through a slightly staggered intersection. Half cycle marking is marked with a dashed line and two bicycle symbols. Full cycle marking is used to guide cyclists either through a complicated intersection or an intersection with high motorised traffic volumes and is marked with two dashed lines and two bicycle symbols.

The waiting area for left-turning cyclists should be marked as a full or half cycle marking. There should be no overlap of other road marking at an intersection, and cycle marking should not overlap.

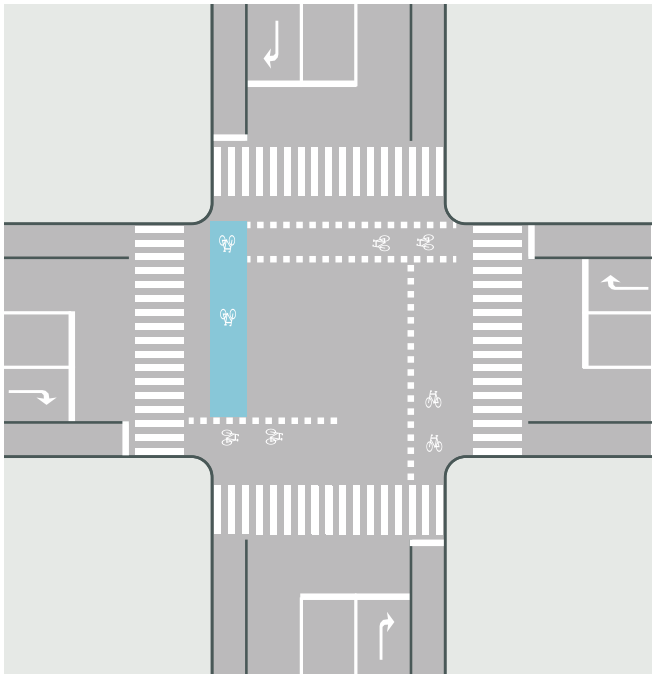


Figure 23: Intersection with quarter, half, full and blue cycle marking

Quarter cycle marking, Njalsgade/Isafjordsgade

Full cycle marking, Østerbrogade/Sporsløjfen

Half cycle marking at raised crossing on Ørestads Boulevard

Full cycle marking with two-way cycle traffic, Århusgade/Kalkbrænderihavnsvej

Blue cycle lane for special attention

Blue cycle marking is established to emphasise cyclists and right-of-way. The blue colour complements regular cycle marking and can increase cyclists' security.

In general, blue cycle marking should be limited to one or maximum two at intersections for traffic safety reasons.

In general, blue cycle marking should only be established at a complicated road layout or a hight need to guide motorists and cyclists. Instead of blue cycle marking, full cycle marking can be considered.

Blue cycle marking is used for special attention such as:

- Cycle lane between straight and right-turn lane
- Particularly complicated intersections (see *photo of Dybbølsbro*)
- Waiting area for left-turning cyclists
- Where a cycle path is unexpectedly crossed by a lane (see *photo of Nørre Voldgade*).

Context and references

"3.1.3 Cycle path between straight and right-turn lanes".

"3.4.5 Waiting area for left-turning cyclists".

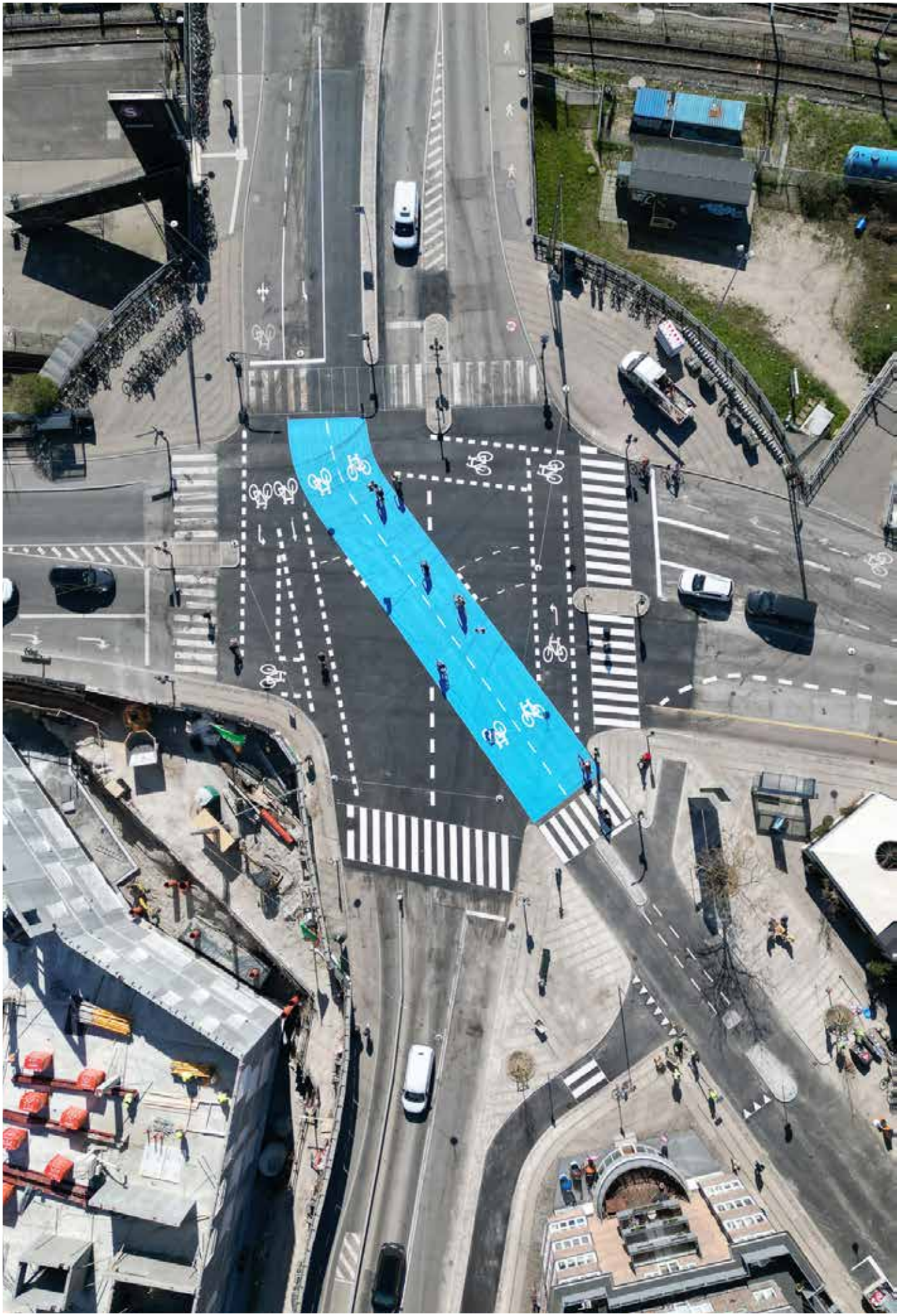
"1.4.1 Road surfacing".

Blue cycle marking where the cycle pass is unexpectedly crossed by a right-turn lane on Nørre Voldgade

Blue cycle marking guides cyclists through a complicated intersection, Holmbladsgade/Vermlandsgade

Quarter, half, and blue cycle marking, Torvegade/Prinsessegade, photo Troels Heien

Quarter, half, and blue cycle marking from Dybbølsgade to Dybbølsbro



Diagonal two-way blue cycle marking from Dybbølsbro to Dybbølsgade, photo Rune Johansen

3.4.2 Cycle box

A cycle box is a designated waiting area for cyclists, marked with a bicycle symbol and placed in front of motorists' stop line in a right-turn lane. Cyclists waiting at a red light become more visible to motorists. Also, cyclists can enter the intersection before motorists.

Cycle boxes have benefits for both cyclists and motorists, as a group of cyclists can be processed quickly, allowing motorists to turn right earlier than if they had to wait for a long tail of cyclists to pass first. However, cycle boxes have a limited effect at four-legged intersections, as cyclists must pull back to the right anyway. Cycle boxes are particularly suitable for the following designs:

- On a staggered intersection (see *Figure 24*)
- On the approach to a cycle street
- When contraflow cycling
- On the side road at three-way intersection (see *Figure 25*).

In general, cyclists are not yet using the cycle boxes as intended, and motorists do not respect the cycle boxes and stop on top of them. This is largely because both motorists and cyclists are not yet familiar with the solution and there are relatively few cycle boxes due to right-turn lane requirements.

Cycle box design and road marking

The cycle box should always be marked with a bicycle symbol. To guide cyclists to use the entire cycle box, a 2-metre bicycle symbol is used, as well as blue road surfacing in the cycle box. After the pedestrian crossing, a half or full cycle marking is placed. Blue road surfacing in cycle boxes has not been the practice in Copenhagen, but it is recommended for the future.

It is a requirement that the cycle box is placed in front of a right-turn lane. However, the requirement does not apply on side road at three-way intersections, where the cycle box is placed in front of the combined right and left-turn lane. The requirement also does not apply to contraflow cycling, where the cycle box is placed in the exit lane of motorists.

There must be a cycle path or cycle lane leading up to the cycle box, and good access to the cycle box can be ensured by narrowing the lane and widening the cycle area. For cycle paths, the kerb should be lowered in the last part so that cyclists can easily enter the cycle box. The cycle box should be at least 5 metres long so that cyclists can enter and be visible, especially to truck drivers. The cycle path in the exit lane should be wide enough in the first part to accommodate a group of cyclists.

A cycle box in the side road of a three-way intersection must also have a cycle signal with pre-green for cyclists simultaneously with left-turning cyclists towards the side road.

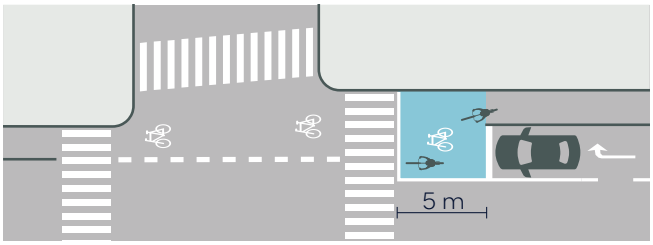


Figure 24: Cycle box on a staggered intersection

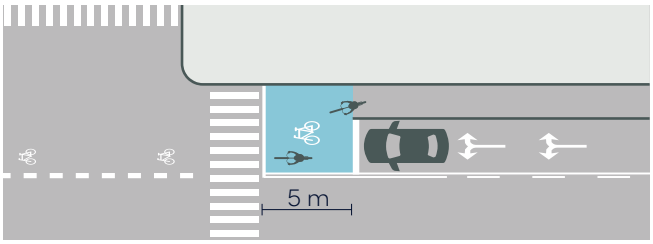


Figure 25: Cycle box at a three-way intersection

Context and references

"3.4.1 Cycle marking".

"1.1.3 Cycle streets".

"3.5.1 Three-way intersection and straight on red allowed".

"1.1.5 Contraflow cycling".

"3.3.3 Pre-green".

Cycle box at staggered intersection, Østerbrogade/Trianglen

Cycle box at three-way intersection, Njalsgade/Islands Brygge

3.4.3 Cyclists excluded from turning bans

Where turning bans are not intended for cyclists, cyclists must be excluded with a sub-sign. This applies to both right and left turns. Without the sub-sign, cyclists are also subject to the turning ban and their comfort and flow is reduced. At traffic signals, the sub-signs are placed on a high signal mast.

Cyclists excluded from right-turn ban with 'Right turn prohibition for vehicles' sign and 'Cyclists excluded (right)' sub-sign

Cyclists excluded from left-turn ban, H.C. Andersens Boulevard/Rysteensgade

Cyclists excluded from right-turn ban, Frederiksborggade/Sølorvet

3.4.4 Channeling on cycle paths

Channelling by dividing the cycle path into straight, right-turn or left-turn lanes can improve cyclists' comfort and flow. The solution can be used in both signalised and right-of-way intersections with many turning cyclists.

Channelling allows for right turn on red for cyclists, simultaneously with right-turning motorised traffic at the end of the green phase.

It is only at intersections with a higher proportion of right-turning cyclists than straight-ahead traffic that a right-turn lane can be established without losing capacity.

When channelling, the recommended minimum width for the straight lane should be maintained (adding 1.0 m for the right-turn lane or 1.5 m for the left-turn lane, see *Table 7*). Channelling should generally start at least 20 m before the intersection. The straight lane should generally be wider than the right- or left-turn lane.

Channelling for low cyclist volumes

At signalised intersections with low cyclist volumes (under 500 cyclists per peak hour and direction), channelling can be established within the minimum width of 2.5 m. Here, the lane closest to the carriageway has an absolute minimum width of 1.5 m.

For the same low cyclist volumes, channelling in the straight-ahead cycle path at three-way intersections can be established with an absolute minimum width of 3.0 m. Here, both the lane closest to the carriageway and the straight-ahead lane have an absolute minimum width of 1.5 m.

Context and references

"3.3.6 Right turn on red allowed".

"1.2.1 Minimum widths for cycle paths".

"3.5.1 Three-way intersection and straight on red allowed".

Channelling	Minimum width
Straight and right-turn lanes	Minimum width for cycle paths + 1.0 m
Straight and left-turn lanes	Minimum width for cycle paths + 1.5 m

Table 7: Minimum widths for channelling on cycle paths

Channelling in left-turn lane and wide straight lane, H.C. Andersens Boulevard/Vesterbrogade

Channelling in straight and right-turn lane, Ørestads Boulevard /Amager Boulevard

3.4.5 Waiting area for left-turning cyclists

The waiting area allows left-turning cyclists to wait safely on the corner without being a nuisance to pedestrians or cyclists going straight and motorists.

Waiting areas should be created where there are many left-turning cyclists and at complicated intersections where the geometry allows it.

The waiting area should be marked with a full or half cycle marking to help cyclists position themselves appropriately and can also be marked blue.

The waiting area, marked or not, should be at least 2.5 m wide and 2.0 m long, and larger for many left-turning cyclists.

The waiting area can be established by moving the pedestrian crossing 2–3 m back from the intersection. The pedestrian crossing should not be moved further away, as this creates a detour for pedestrians, and thus poorer conditions, especially for disabled people, as well as a greater risk of turning motorists overlooking pedestrians.

A retracted pedestrian crossing can be established for many left-turning cyclists in the same place as a separate right-turn arrow for motorists. Signal regulation should not create a conflict between left-turning cyclists and other traffic.

To calculate the need for a waiting area for left-turning cyclists, CYKAP can be used.

Context and references

"3.4.1 Cycle marking".

"5.3 Traffic and simulation models".

Waiting area for left-turning cyclists with blue cycle marking, Gyldenløvesgade/Nørre Søgade

Waiting area for left-turning cyclists with retracted pedestrian crossing, Frederiksborggade/Nordre Farimagsgade

Waiting area for left-turning cyclists with retracted pedestrian crossing, Hallandsgade/Amagerbrogade

Waiting area for left-turning cyclists with blue cycle marking, Gyldenløvesgade/Nørre Søgade

3.4.6 Cycle bypass

In some intersections, right-turning cyclists can be excluded from signal regulation with a cycle bypass (see *Figure 26*).

Cycle bypasses can be considered where there are many cyclists and few pedestrians. Negative effects on pedestrian comfort and security must be assessed. Right-of-way must be clearly marked.

Considered whether right turn on red allowed for cyclists might be a better solution to minimise negative effects on pedestrians.

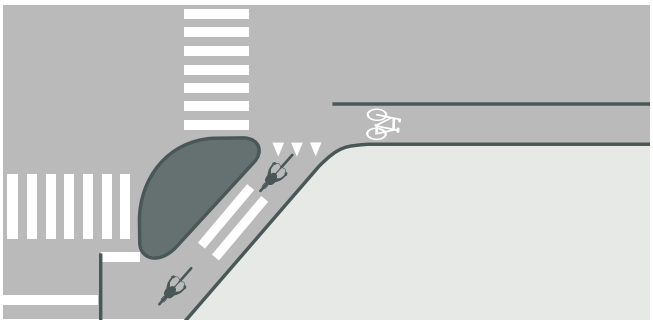


Figure 26: Cycle bypass

Context and references

"3.1.4 Cycle island".

"3.3.6 Right turn on red allowed".

"2.4 Cycle and pedestrian infrastructure".

Cycle bypass at cycle island, Jarmers Plads

Cycle bypass at Vibenshus runddel

3.4.7 Widened cycle path

Widened cycle path immediately before and after signalised intersections should be considered for high cyclist volumes (e.g. over 2,000 cyclists per peak hour in one direction) or if there is a particular lack of capacity during a very short period of morning rush hour traffic, or if the signal has many phases.

As a standard, the recommended minimum widths for cycle paths are followed. With even wider cycle paths, the capacity for the number of cyclists that can pass in one signal phase increases. This reduces cyclists having to wait through multiple signal phases, and allows them to merge after the intersection, before the cycle path gradually narrows again after 20–30 metres to the recommended minimum cycle path width.

The signal programme can also be adjusted to improve capacity for cyclists during the busiest times of the day.

Context and references

"1.2.1 Minimum widths for cycle paths".

"3.4.4 Channeling on cycle paths".

"3.3.1 Traffic signals".

Widened cycle path on Nørre Voldgade

3.5 Other intersection types and crossings

3.5.1 Three-way intersection and straight on red allowed

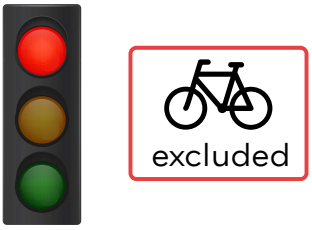
At three-way intersections, cyclists should be excluded from signal regulation in the straight-ahead cycle path. Allowing cyclists to go straight on red ensures good comfort and flow for cyclists.

Pedestrian safety and security are supported by establishing a crossing island between the cycle path and carriageway. The crossing island allows pedestrians to cross the cycle path and wait for green to cross the carriageway. The crossing island should divide the pedestrian crossing so that it is offset from the cyclists' direction of travel (see *Figure 27*). At the intersection, at least a quarter cycle marking for left-turning cyclists from the side road is established. This may be supplemented by white marking for *End of turning lane* for oncoming, left-turning motorists.

Cycle signals should be used with a 4-second pre-green. Ramps or lowered kerbs should be marked with white thermoplastic so cyclists can better see the approach to and exit from the cycle path. The stop line for left-turning cyclists should be 0.5 m wide. A cycle path or cycle lane should be established from the side road. Cycle box can be used if a large proportion of cyclists turn left from the side road.

Channelling in three-way intersections

The straight-ahead cycle path in three-way intersections should be widened and channelled into lanes with awaiting area for left-turning cyclists. The left-turn lane helps left-turning cyclists to position themselves ap-



Straight on red allowed in three-way intersections with 'Cyclists excluded' sign on the signal mast

Left-turn lane in three-way intersection, Amager Boulevard/Ørestads Boulevard

Cyclist from side road in three-way intersection, Amager Boulevard/Ørestads Boulevard

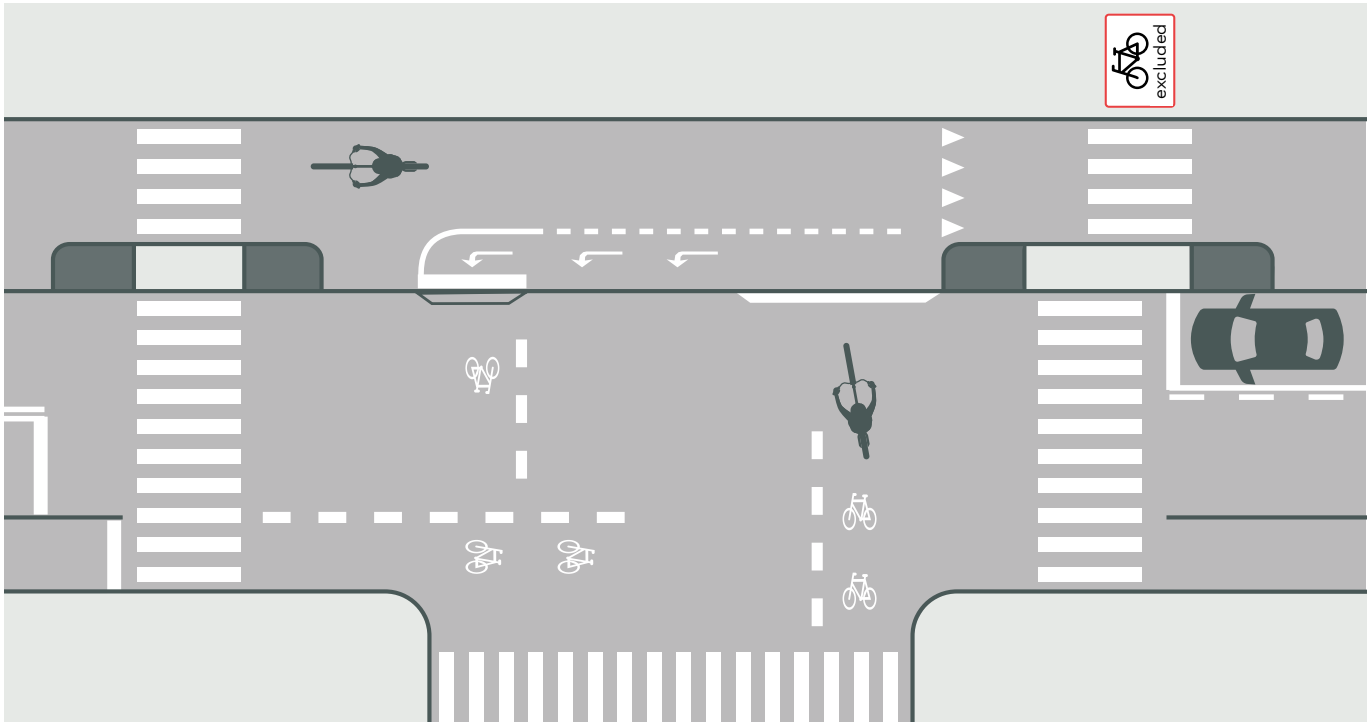


Figure 27: Three-way intersection with channelling and straight on red allowed

propriately and do not get in the way of cyclists going straight. This is especially important when there are many left-turning cyclists from the side road.

When channelling in the straight-ahead cycle path in three-way intersections, the minimum width for the straight lane is maintained and a minimum of 1.5 m is added for the left-turn lane. For low cyclist volumes (less than 500 cyclists per peak hour/direction), channelling can be established with an absolute minimum width of 3.0 m. Any expansion of the cycle path area in connection with channelling should not reduce pedestrian comfort or restrict the walkway on the pavement.

Straight on red allowed

It is recommended to allow cyclists to go straight ahead on red in the straight-ahead cycle path of a three-way intersection or at cycle path crossings (see *Figure 27*).

Where this solution leads to conflicts between pedestrians and cyclists, rumble strips before the pedestrian crossing may be considered.

Context and references

"3.4.1 Cycle marking".

"3.3.3 Pre-green".

"1.2.1 Minimum widths for cycle paths".

"3.4.4 Channeling on cycle paths".

"1.4.4 Ramps to and from cycle paths".

"3.4.2 Cycle box".

"2.5 Tactile marking to sharpen cyclists' attention".

Left-turn lane and wide straight-ahead lane in three-way intersection, H.C. Andersens Boulevard/Vesterbrogade

Left-turn lane and cycle marking in three-way intersection, Amagerbrogade/Brysselsgade

Straight on red allowed in three-way intersection, Ørestads Boulevard/Ejler Billes Allé

Straight on red allowed in three-way intersection, Grønningen

3.5.2 Right-of-way and raised crossings

In Copenhagen, right-of-way intersections mainly occur when there is a relatively low volume of motorised traffic in one direction. Right-of-way should be clearly marked with yield lines ('shark teeth'), crossing islands and speed calming measures such as raised platforms.

At intersections where cycle routes cross, the route with the most cyclists should be prioritised. Road users on the road with less motorised traffic should give way. The primary road should have a visual design that supports yielding.

To reduce the risk of motorists overlooking cyclists and pedestrians, sufficient field of view should be ensured with the *20-metre rule*, which prevents car parking and stopping at least 20 m before side roads.

Raised crossings on minor side roads

When there is less motorised traffic on the side road (indicatively less than 800 motorist per day AAWT), a granite raised crossing with continuous pavement and continuous cycle path is a safe and secure solution for pedestrians and cyclists. These crossings are in English also called 'Copenhagen crossings '. In addition to ensuring comfort and flow for cyclists and pedestrians, the solution creates clear right-of-way. The continuous cycle path should be paved with asphalt and marked with bicycle symbols.

Dynamic turning curves for motorists from side roads should be made more static. This means that turning motorists must slow down to turn to and from the side road, which minimises the risk of collisions.

With higher motorised traffic volumes on the side road, cycle path and pavement are interrupted. The cycle path continues as a cycle marking through the intersection.

Context and references

"3.2 Field of view at intersections and conflict points".

Copenhagen's Standards for access over pavements (raised crossings), 2020, describes standard crossings on public or private roads.

"3.4.1 Cycle marking".

Raised crossing with continuous cycle path and pavement on Jagtvej

Raised crossing with continuous cycle path and pavement, Østerbrogade/Gustav Adolfs Gade

3.5.3 Cycle path crossings

At cycle path crossings, cycle routes or off-street cycle paths cross a transverse road. Cycle path crossings can be established with right-of way or signal regulation.

Cycle path crossings with right-of-way

Here, right-of-way must be clear to minimise potential conflicts. The cycle path or road with the least traffic should give way.

Unless otherwise marked, cyclists and pedestrians on the intersecting cycle path must give way to road users on the road.

At cycle path crossings where cyclists are required to give way, median islands are recommended. Right-of-way must be signposted with *Unconditional yield* signs and yield lines ('shark teeth'). The sign can only be omitted if there are very few road users.

If motorists give way to cyclists and pedestrians on the crossing cycle and pedestrian path, a raised platform with yield lines and right-of-way sign must be established.

Cycle path crossing with signal regulation

At signalised cycle path crossings, the cycle path crossing is marked with a full cycle marking and directional division for two-way cycle paths.

Four-legged crossings are staggered

Four-legged crossings between two cycle paths or routes should generally be avoided. Instead, they should be designed as two staggered three-way intersections where the busiest cycle path or route passes through. This makes yielding clear.

Context and references

"3.5.4 Crossing islands".

"3.4.1 Cycle marking".

"1.3 Cycle routes".

"3.5.2 Right-of-way and raised crossings".

"3.3.1 Traffic signals".

As at all intersections, lighting and field of view must be adequate and uniform at cycle path crossings: *"4.1 Lighting".*

Cycle path crossing, Nørrebro route/Stefansgade

Cycle path crossing with median island, Nørrebro route/Stefansgade

Cycle path crossing, Nørrebro route/Jagtvej

3.5.4 Crossing islands

A crossing island allows cyclists and pedestrians to be protected while waiting to cross the carriageway or cycle path. As a guiding principle, median island should be established at crossings. This allows a two-lane road to be crossed in two stages. Median islands are used for pedestrians and for cyclists where cycle paths or routes are crossing roads without signal regulation.

Median islands improve cyclist and pedestrian safety, security, comfort and flow, especially at higher motorised traffic volumes (recommended over 600 vehicles per peak hour) and at high speeds.

For more than 1,000 vehicles per peak hour, signal regulation is recommended, possibly without a median island. In signalised intersections, crossing islands should generally be avoided, as it is desirable that pedestrians can cross the entire road without being caught in the middle.

Crossing islands are established under these circumstances:

- Crossing islands can be established on wide carriageways or where there is a need for pedestrians to cross in multiple stages, e.g. near schools
- Crossing islands should be established when the signal has multiple phases and pedestrians can cross in multiple stages
- Median islands should always be established at large crossings over 24 metres wide
- Crossing islands between cycle path and carriageway are established when cyclists are exempt from signal regulation.

The median island should be wide enough for specialised or cargo bikes. Especially on roads with crossing school traffic, median islands should be wide enough. The median island must be min. 2.5 m wide and min. 4.0 m long (3.5 m in traffic signals) to accommodate pedestrians with prams and cyclists with trailers. Only exceptionally, with very few crossing pedestrians and cyclists, a minimum width of 2.0 m is acceptable.

The design of the median island, e.g. width and lowered kerbs or asphalt ramp, must be accessible for cyclists, pedestrians and disabled people. Separate cycle and pedestrian areas on the median island are desirable. The median island should be placed conveniently and visibly, even in darkness. Lighting must be installed right at the crossing.

Crossings with cycle paths should be established with three crossing islands (except when the crossing is signalised). One in the middle of the carriageway and two between the lane and cycle path on both sides. If there is no room for three crossing islands, one can be omitted where cyclists' speed is estimated lowest.

Difference between crossing island, median island and divider island

A ***crossing island*** meets the minimum width requirements for pedestrians and cyclists to stand protected while waiting to cross a carriageway or cycle path.

A ***median island*** separates different traffic directions in the middle of the road. At a median island, pedestrians and cyclists can cross in two stages.

A ***divider island*** separates traffic areas such as the carriageway, the cycle path or the pavement.

Context and references

Criteria and guidelines for traffic signals: *"3.3.1 Traffic signals".*

"3.5.3 Cycle path crossings".

"1.2.3 Widths for other traffic facilities".

Median island with cycle area on Østerbrogade

Median island with cycle area on Langebrogade

3.5.5 Priority to the right not recommended

Priority to the right (without yield lines) at four- and three-way intersections is not recommended in Copenhagen. Most road users, and especially inexperienced cyclists and children are not familiar with the rules of priority to the right. Therefore, it is recommended that right-of-way is clearly marked with yield lines ('shark teeth') regardless of the intersection type.

If priority to the right is used anyway, it should only be in quiet residential areas and should be designed with a raised platform.

3.5.6 Roundabouts not recommended

Roundabouts are rarely used in Copenhagen. Other intersection solutions should be found, as evaluations show that roundabouts are not recommended for cyclists and pedestrians in terms of safety.

Roundabouts are particularly prone to serious collisions between circulating cycle traffic and entering or exiting trucks. Wide entry and exit lanes can handle higher motorised traffic volumes through the roundabout but mean that motorists can exit the roundabouts at high speeds. This can pose a safety risk for both circulating cyclists and crossing pedestrians. The use of a deviating and speed calming road surfacing around the entrances and exits is discouraged as it poses a safety risk to motorcyclists and cyclists, especially in wet conditions. There are increased requirements for lighting at roundabouts.

If a roundabout is established anyway, a smaller roundabout with a traversable central island is recommended over a larger roundabout with wide entry and exit lanes and additional speed calming.

Context and references

"4.1 Lighting".

Urban roundabout design and cyclist safety, Via Trafik, 2020.

Raised platform, Wesselsgade/Baggesensgade

Roundabout at Sankt Kjelds Plads

4 Urban facilities for cyclists

Urban facilities for cyclists can contribute to cyclists' comfort and safety. When placing them, it is important to consider cleaning, maintenance and other road users.

Urban facilities should be placed with consideration for existing facilities and urban spaces.

If these facilities are placed on pavements, pedestrian conditions should be minimally affected. There must be a free walkway of at least 1.6 metres around facilities to allow wheelchair users to manoeuvre.

Context and references

Copenhagen's Guidelines for the design of urban spaces, 2017, describes urban facilities and road surfacing in different urban spaces.

Fixtures and facilities should be placed min. 30 cm from the cycle path and 50 cm from the carriageway. If placed closer, road marking should be added: *"1.4.2 Road marking"*.

Lighting and signal masts should be placed min. 40 cm from the cycle path and 60 cm from the carriageway: *"4.1 Lighting"*.

On narrow pavements, facilities can be place facilitets at the back edge of the pavement, furthest from the carriageway.

"2.4 Cycle and pedestrian infrastructure".

Inclined waste bin along the Cycle Superhighway, photo Cycle Superhighway Collaboration, Capital Region of Denmark

4.1 Lighting

Lighting contributes to cyclists' security and safety and is especially important during rush hour after dark.

Lighting on cycle paths

Copenhagen's cycle paths should have good lighting in all surroundings.

Cycle paths along roads are usually illuminated by general road lighting and lighting class E1+ with min. E2+ for cycle infrastructure.

On off-street recreational cycle paths, a min. E2 lighting class is recommended. In nature areas, lighting is set up more carefully with a focus on protecting animal and plant life. Guiding lights, such as solar LEDs, can be used to mark the course of cycle path e.g. if conservation conditions do not allow otherwise. Guiding lights are only for orientation on the cycle path and do not function as primary lighting. Guiding lights typically have a relatively short lifespan.

Lighting in signalised intersections and roundabouts

There are increased requirements for lighting in signalised intersections and roundabouts according to the road lighting handbook. Copenhagen requires lighting class LE4 for traffic signals.

Lighting in cycle tunnels and on cycle and pedestrian bridges

When cycle or pedestrian paths are crossing roads, lighting should be established right at the crossing. The illuminance should be three times greater at the crossing than the average illuminance for the rest of the road and with a regularity of 0.25.

Lighting on Farum route, photo Nadia Horsted

Context and references

Handbook Street lighting, Road Standards portal, 2020.

"3.3.1 Traffic signals".

"3.5.3 Cycle path crossings".

"3.5.6 Roundabouts not recommended".

"1.1.8 Cycle and pedestrian bridges".

"1.1.9 Tunnels, stairs and lifts".

Lighting in cycle tunnels and on cycle and pedestrian bridges

Lighting in cycle and pedestrian tunnels must be lighting class E1+ after dark, and during daylight hours the minimum illuminance must be 25 lux with a regularity min. 0.4 (for daytime light demand). The need for daytime lighting and possibly different day and night lighting is assessed depending on the length of the tunnel and the area of the tunnel opening.

Cycle and pedestrian bridges should have min. E2 lighting class, or at least equivalent to adjacent cycle paths or roads if they are ≥ E2. Focus should be on illuminating adjacent cycle paths and ramps before and after bridges and tunnels. The lighting should reflect the design of the bridge or tunnel.

Lighting on Lille Langebro, photo Arne Munter

Light wheel, photo Cycle Superhighway Collaboration, The Capital Region of Denmark

4.2 Signage

Where possible, road surfacing is preferred over signage. Road surfacing is in the cyclists' field of vision and does not contribute to the 'sign forest,' that has negative consequences for aesthetics and pedestrian comfort. Signage includes traffic signs to regulate traffic behaviour and wayfinding signs to guide to a route to follow or destination.

Wayfinding signs should be clear, continuous and placed where cyclists change direction, such as at intersections and junctions. Signs should be visibly placed to help cyclists navigate and confirm that they are on the right path. At the same time, the signs must be integrated with existing signage and blend in with existing urban furnishing and urban spaces.

In Copenhagen, signposts are often placed on a high pole, as the clearance height must be min. 2.3 m over the cycle path and 2.2 m above the pavement. For snow removal and maintenance, it may be necessary to place the sign higher, but the height should not exceed 2.8 m to the bottom edge of the lowest sign.

Outside dense urban areas, hanger signs and low hangers can be used with a height of 0.9 m from the pavement to the top of the upper sign.

Wayfinding on cycle routes

Wayfinding signage on cycle routes can show distant destinations (e.g. a neighbourhood), nearby destinations and how many minutes it takes to cycle there.

In Copenhagen, wayfinding signage is used for green, local, regional, national and European cycle routes as well as Cycle Superhighways.

As a guiding principle, wayfinding signs should have dimensions of height: 480mm and width: 300 mm. Sub-signs can be height: 150 mm and width: 300 mm, e.g. showing distance and nearby destinations, or height: 300 mm and width: 300 mm with an arrow or bent arrow indicating that the route turns.

Context and references

"1.4.2 Road marking".

"1.4.6 Cleaning and winter maintenance".

"1.3.2 Green cycle routes".

Cycle Superhighways have specific requirements for route guidance and wayfinding, see Concept for Cycle Superhighways, 2024, and *"1.3.3 Cycle Superhighways"*.

Recommendations for the design and use of wayfinding on cycle routes cf. Executive order on road marking, 2023.

Handbook Wayfinding for cyclists, Road Standards portal, 2017.

Appendix for Wayfinding for cyclists, hiking and horseback riding routes, Road Standards portal, 2017.

Distant and nearby destinations wayfinding sign, Islands Brygge

Wayfinding sign on the Harbour Ring route

Wayfinding outside of cycle routes

Wayfinding outside of cycle routes guides cyclists to a specific destination, such as a cycle route or a station. Here, you can use directional signs with service symbols and/or the name of the destination. Wayfinding outside of cycle routes is typically used for short distances from a route or major road.

Temporary wayfinding

Temporary wayfinding is used for temporary destinations, e.g. during major cultural events. It is also used in connection with temporary re-routing of existing roads and wayfinding. Permanent wayfinding that is temporarily not in use should be covered. For longer detours, information should be set up at the start of the detour showing the route and explaining the reason.

Temporary wayfinding for cyclists during the Tour de France

Wayfinding sign on Farum route, photo Nadia Horsted

Cyclists take over H.C. Andersens Boulevard, closed to motorist the day after the Tour de France

Wayfinding sign with distance and minutes, H.C. Andersens Boulevard

4.3 ITS equipment

ITS (Intelligent Transportation Systems) includes different types of electronic devices. The equipment is typically connected to power and a modem.

Variable cycle panels

VMS (Variable Message Signs) can display a range of information such as route choice and travel time. In general, the content should be traffic-related, the amount of information limited, and the equipment blend fit into the context and urban space.

Cycle barometers, also called cycle counters, detect the cyclists passing by and display the number of cyclists. Dynamic cycle parking panels show the number of available cycle parking spaces, e.g. in a cycle cellar.

Countdown indicator

Countdown indicators show cyclists how much time is left until the signal changes. The correct remaining time should be displayed in seconds or with symbols (e.g. a bar or circle). The countdown indicator should be set up at an appropriate distance before the intersection so that cyclists can react and adjust their speed. Countdown to green and to red can be displayed.

Guiding light

Yellow guiding lights are activated when cyclists are detected. They have yellow blinking lights to alert right-turning motorists and truck drivers to cyclists. Green and red guiding lights can show approaching cyclists how fast they need to ride to catch the green ahead.

Other ITS equipment includes traffic signals that can dynamically prioritise cyclists.

Countdown indicator at Nørre Allé/Jagtvej

Cycle barometer on Dronning Louises Bro

Variable cycle panel on Nørrebrogade

Dynamic cycle parking panel at Amagerbro Station

4.4 Furnishing

Furnishing adds extra comfort to the cycling journey. New knowledge is used in the development and improvement of various furnishing.

Footrests are placed at signalised intersections and increase comfort for cyclists waiting at red. Cyclists can take care of minor repairs themselves at service stations equipped with tools and cycle pumps. Thirst can be quenched at water hydrants.

Inclined waste bins should always be set up in collaboration with the maintenance unit and based on the need and possibility for emptying.

Footrests and waste bins should have approx. 40 cm to other fixed objects so that sweeping is possible. Additionally, there should also be min. 30 cm between the cycle path and fixed objects, but preferably not more for footrests. Footrests are placed 30–50 cm after the cycle path's stop line. Footrests are not paced on shortened cycle paths or right turn on red allowed for cyclists.

Context and references

"1.4.6 Cleaning and winter maintenance".

"3.1.2 Shortened cycle path".

"3.3.6 Right turn on red allowed".

Footrests on both sides of the cycle path at Fredensbo

Footrest, photo Ursula Bach

Inclined waste bin, photo Ursula Bach

4.5 Cycle parking

Better cycle parking can help encourage more Copenhageners to cycle.

A general rule of thumb when designing cycle parking is that it should be placed so that it is:

1. easily accessible to users
2. in the immediate vicinity of entrance areas (journey destination).

Standard racks

In Copenhagen, two standard racks are primarily used. The Copenhagen cycle rack is a modular rack for two-wheeled bicycles (see *Figure 28*).

The Copenhagen Pq cargo bike rack is a double rack with space for two cargo bikes (see *Figure 29*). However, it is also possible to have the cargo bike rack as a solo rack, e.g. for mounting it along a facade.

Road space for cycle parking

Where there is a high demand for cycle parking but difficulty to find space on e.g. pavement expansions, the administration assesses the possibility of converting car parking spaces into cycle parking. One car parking space can be converted into parking spaces for 8–10 cycles or 2–4 cargo bikes.

Flexible parking

In places with a fixed usage pattern throughout the day, flexible solutions can be introduced where motor vehicle and cycle parking are allowed at different times of the day. This can be near schools and works best with an agreement with local maintenance staff to keep the space clear.

Copenhagen Pq cargo bike rack at Sankt Hans Torv

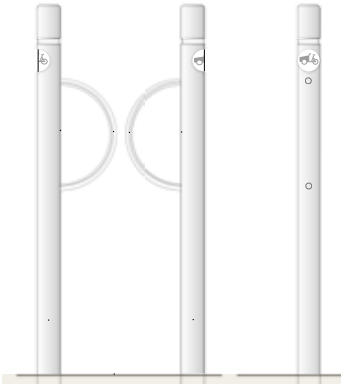


Figure 28: Copenhagen Pq cargo bike rack

Figure 29: Copenhagen cycle rack

Cycle parking on pavements

Cycle racks placed on pavements must comply with the city's accessibility guidelines, which means that walkways and guidance lines must be maintained, and the walkway must be min. 1.5 metres wide. Cycle racks must be placed so that the rear tyre of the cycle is min. 50 cm from guidance lines.

Cycle parking next to the main entrance, Fisketorvet shopping centre

Context and references

Copenhagen's Cycle parking and parking of smaller rental vehicles, 2021.

Copenhagen's Guidelines for establishing cycle parking, 2017.

Copenhagen's standards for cycle parking are binding in connection with zoning plans for new construction, construction projects in urban spaces etc., but can also be used as a guide to assess cycle parking needs in other contexts: Copenhagen municipal plan 2019.

"1.1.9 Tunnels, stairs and lifts".

Elaboration on gradients for access ramps to cycle cellars: *"1.4.3 Geometric design"*.

Cycle parking at Nordhavn Station

Cycle cellar with good location and easy access at Panum

Flexible parking at Gasværksvejens school

Flexible parking on Nordre Frihavnsgade

4.6 Urban planting and greening

Copenhagen's urban nature should be increased through construction projects.

Cyclists appreciate roadside trees, providing shelter from rain and shade on hot days. Cycle and road projects must consider existing trees' root zones and ensure sufficient space in kerb strips for good growing conditions for urban planting. Additionally, it must be ensured that the urban planting complies with requirements for fields of view, clearance and traffic safety conditions both during construction and in the long term. Finally, it must be ensured that the urban planting can be maintained in an efficient and environmental responsible manner.

Pruning bushes and trees and removing fallen leaves on cycle infrastructure contribute to sufficient field of view and traffic safety for cyclists and other road users. Particularly at intersections, sufficient field of view must be ensured with regular pruning or regulation of urban planting. Additionally, traffic signs, lamps and signposts must be kept clear of urban planting.

Trees should be selected so that they can be pruned in relation to nearby road users, and trees that produce large amounts of fallen fruit, nuts, pinecones or similar should generally be avoided at traffic areas. When choosing herbs and grasses, care should be taken to not obstruct the field of view and overhang traffic areas.

Context and references

To ensure long-term quality for urban greening in cycle and road projects, it is important to follow Copenhagen's Guidelines for working with trees, 2022, and 32 requirements for operational design of facilities, 2017.

To reduce the risk of motorists overlooking cyclists, there should be no trees or urban planting 30–50 metres before intersections or conflict points: *"3.2 Field of view at intersections and conflict points"*.

"1.4.6 Cleaning and winter maintenance".

Various green areas can be seen on Copenhagen's spatial map.

Tree on Gothersgade, photo Nadia Horsted

Tree on Østerbrogade, photo Troels Heien

Trees along cyclepath, photo Troels Heien

5 Assessment and evaluation of cycle and road projects

Many factors influence the design of cycle and road projects. Therefore, the site-specific assessment tool should always be used early in the process.

Evaluation is crucial to document impact and assess quality and potential. In addition, traffic and simulation models can support and future-proof the design of major cycle and road projects.

5.1 Site-specific assessment tool

To assess and select the design that best fulfils a secure, comfortable, and safe solution for cyclists and other road users, a site-specific assessment is needed.

For this, Copenhagen's assessment tool is being developed. The tool aims to clarify how the safety, security, and flow of different road users are affected by different solutions and to support dialogue.

The starting point is that it should be secure, comfortable, and safe for everyone to cycle in the city. The dilemma is that it is often not possible to prioritise equally between these factors, as there are some contradictions when other road users and the transportation network must be considered. Regardless, there is no universal solution, and a specific assessment must always be based on factors such as:

- Traffic: e.g. the proportion of cyclists compared to right-turning motorists, or location close to a school, childcare or elderly care institution
- Layout of road space for cyclists, pedestrians, and motorists
- Character of the urban space
- Prioritisation between flow, security and safety for different road users.

Citizen meeting, photo Ursula Bach

Citizen meeting, photo Nadia Horsted

5.2 Process and evaluation

A general set up for evaluating of construction projects is being developed. Below the minimum requirements for evaluating cycle and road projects are outlined.

Førmåling

- **Before-pictures:** during and outside rush hours.
- **Traffic counts:** traffic volumes are determined with machine traffic counts for cyclists, motorists and pedestrians. Tube counts, recording the pressure of passing by cycles or motor vehicles, are recommended with a duration of min. one week and preferably 4–8 weeks to obtain a more reliable data basis. Traffic counts should either be on a road stretch or at the intersection depending on the project location. Traffic counts must be quality assured before use. Exixting traffic counts should be a maximum of 5 years old, and there should be no significant changes in the area since the counts were conducted.
- **Comprehensive pre-measurements:** for complex or large construction projects (indicative for construction costs over 5 million DKK), a more comprehensive pre-measurement is carried out. Relevant methods are determined by the administration and communicated to consultants.
- **Assessment of different (intersection) solutions:** Different simulations (COMPASS, VISSIM, or DANKAP/CYKAP) and the assessment and dialogue tool are used to assess different solutions, including solutions in signalised intersections.

Post-measurements

- **After-images:** during and outside peak hours at the same locations and times as the before-images.
- **Traffic counts:** traffic volumes for cyclists, motorists, and pedestrians are determined with machine traffic counts at the same time and place as the pre-measurement counts. If this is not possible, the traffic counts should be carried out at the earliest 3 months, and preferabley 6 months after project completion.
- **Comprehensive post-measurements:** for large or complex construction projects, continuous monitoring during construction and/or an evaluation like the pre-measurements.

Evaluering

- **Project impact and challenges:** the project's impact and challenges in terms of flow, safety, security and comfort for cyclists based on post-measurements, for example:
  - Increase in cycle traffic
  - Modal shift from other transportation modes to cycling
  - Cyclists' perception of flow, security, and comfort.
- **Collision analysis:** when there is a special focus on traffic safety, a collision analysis with a focus on cyclists can be conducted after 5 years.

Cycle funding projects

For cycle projects that have received funding from the Danish Road Directorate before 2023, there are specific evaluation requirements (see Table 8). Application for funding includes an evaluation plan that must be implemented before the project is finalised.

Parameter	Type	Method	Time period
Flow	Quantitative	Simulation programme	Before and after construction
Number of cyclists	Quantitative	Temporary counting stations	Before and after construction

Table 8: Evaluation requirements for cycle funding projects

5.3 Traffic and simulation models

Traffic and simulation models support and future-proof the design of Copenhagen's infrastructure. This is especially important when building cycle and pedestrian bridges or major construction projects with over 750 cyclists per peak hour per direction.

Simulations and models are based on calculations and therefore there is a level of uncertainty in the results. The uncertainty is particularly pronounced for pedestrian traffic and to some extent for cycle traffic. A traffic analysis must therefore always interpret the results in the current context and then assess how the infrastructure should be designed. The main tools used for different levels of simulation are briefly described below.

COMPASS

The COMPASS model (Copenhagen Greater Area Model for Passenger Transport) is a strategic traffic model for the Greater Copenhagen area. COMPASS serves as a comprehensive planning tool that can model how transportation mode and route choices are affected by changes in the road network or transport prices.

The model simulates transport behaviour and uses this to calculate expected traffic volumes for cyclists, pedestrians, passengers and motorists on a weekday. This is called modelling the demand for traffic. COMPASS then calculates the road users' choice of transportation mode and route. The model provides scenarios for the years 2021, 2025 and 2035, which should be used as a starting point for the calculation.

VISSIM

VISSIM is a microsimulation tool primarily used to calculate travel times, congestion and capacity at intersections and on road stretches. VISSIM needs the expected number of road users as input and cannot calculate the demand for traffic. The strength of VISSIM is a very detailed simulation of road users at individual intersections or between intersections. VISSIM can simulate how traffic will flow with a certain design, right-of-way or signal regulation by systematically simulating all movements for different types of traffic.

VISSIM can be used to predict how road stretches and multiple intersections interact. In more detail, the method can show whether the waiting area at a planned intersection is large enough to accommodate the waiting cyclists, or whether all cyclists can cross on green in one go, or how cyclists and motorists affect each other.

CYKAP

The capacity for cyclists at signalised intersections can be calculated with CYKAP (Cycling Capacity Model), which the administration can provide access to. For every second of green light, 0.8 cyclists can travel per metre of cycle path width. Cargo bikes are measured as 3.5 regular cycles.

The model can be used to quickly assess whether the planned cycle path widths (see *"1.2.1 Minimum widths for cycle paths"*) and green times are sufficient to future-proof capacity for cyclists, and if not, what is needed.

CYKAP also provides a way to calculate waiting area for left-turning cyclists. CYKAP allows you to calculate delays for cyclists and optimise green time according to the flow of cyclists.

Videosimulering and AI (Artificial Intelligence)

There are various options for simulating traffic volumes and movement behaviour using video recording and AI. It is not yet widespread in Copenhagen, but in special cases it can add extra value to a traffic analysis.

Citizen meeting, photos Nadia Horsted

Borgermøde, photos Ursula Bach

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