

INFRASTRUCTURE/ **INTERSECTIONS AND CROSSINGS****TRAFFIC-LIGHT INTERSECTIONS**

## Overview

Traffic-light intersections are inherently dangerous for cyclists. However, they are indispensable when cyclists cross heavy traffic flows. Cycle-friendly design must make cyclists clearly visible, allow short and easy maneuvers and reduce waiting time, such as a right-turn bypass or an advanced stop-line. On main cycle links, separate cycle traffic light and cycle-friendly light regulation can privilege cycle flows over motorized traffic.

## Background and Objectives

*Function*

Intersections are equipped with a traffic control system when they need to handle large flows of motorized traffic on the busiest urban roads, often with multiple lanes. A cycle-friendly design can greatly improve safety, speed and comfort, by increasing visibility, facilitating maneuvers and reducing waiting time.

*Scope*

Traffic-light intersections are **always a second-best solution for cyclists**, in terms of safety. Actually, traffic light intersections with four branches are very dangerous and should be avoided in general. Dutch guidance states that roundabouts are significantly safer than traffic lights for four-branch intersections of 10,000 to 20,000 pcu/day.

In practice, traffic lights are used when an intersection needs to **handle large flows of motorized traffic speedily**. They can handle up to 30,000 pcu/day, more than is possible with a roundabout. These will typically include at least one very busy distributor road with multiple traffic lanes (50 km/h in the built-up area, higher outside the built-up area).

Often, these busy roads are also of great interest as cycle links. Many of them correspond to historic routes, and connect important destinations, typically the city centre, in fairly straight lines. In these cases, it is only logical to have major local cycling routes or even main cycling links following the same paths. Cycling provision is needed to improve the situation for cyclists.

There are **some situations when traffic lights are recommended in a cycling network**.

- A top local or main cycling route along a busy distributor road crosses another busy distributor road (both roads app. above 1,000 pcu/h).
- A lower level of cycle link crosses an extremely busy distributor road (app. 1,500 pcu/h). The link may be on a solitary track, a local access road or a distributor road.

With intensities over 1,500 pcu/h a cycle tunnel is to be recommended.<sup>1</sup>

In principle, on distributor roads, cyclists are on separated tracks or cycle lanes at the least.

## Implementation

*Definition*

A traffic-light intersection is an intersection equipped with a traffic control system (TCS). The red, orange and green lights control access to the intersection for different movements in turn. This way, potential conflicts are separated in time rather than in space. A TCS serves to optimize traffic

<sup>1</sup> See fact sheet GRADE SEPARATION

flow, by balancing flows on the various branches and preventing the intersection from clogging up. One cycle consists of two or more phases. Successive traffic light intersections may be coordinated to improve the flow over a distance. Alternatively, regulation may serve to obstruct the flow, for instance to reduce the number of cars entering the city centre and push congestion further out.

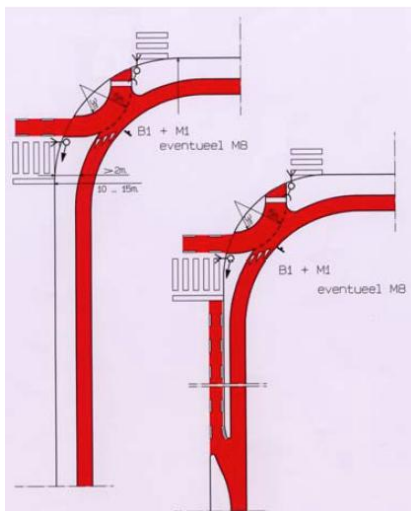
There are a number of design measures to improve cyclists' safety and the TCS regulation itself can be adapted to reduce cyclists' waiting time.

### Cycle-friendly design at traffic lights

Because of the large numbers of motorized vehicles involved, the intersection design needs to increase the visibility and safety of cyclists.

A simple and powerful provision is to allow cyclists a **right-turn past red**.

- A separate **right-turning cycle bypass** before the traffic light allows cyclists to turn right without stopping. To merge safely into traffic, cyclists must arrive on a cycle lane or track or an otherwise protected area. This gives the cyclist significant advantage over motorized traffic, without interfering with the TCS regulation.
- In some countries, such as the Netherlands, traffic regulations make it possible to **exempt right-turning cyclists from the traffic light**, even without a physical path.
- In both cases, there is a **possible conflict with crossing pedestrians**. This is best restricted to situations where few pedestrians cross.



*Solutions for a right-turning bypass past red  
(source: Vademecum fietsvoorzieningen, Vlaanderen)*



*A cycling bypass past red – UK example (left-turn)  
(source: Cycling England, Rob Marshall)*

Another simple and very effective provision is an **advanced stop line** for cyclists.

- The stop line for motorized traffic is moved back and a cyclist stop-line drawn 4 to 5 m in front of it. This creates an **advanced waiting area across the entire carriageway** for cyclists in front of all motorized traffic lanes. This should be marked with a bicycle symbol. A colored surface may be considered.
- A **feeder cycle lane** is recommended. This allows cyclists to bypass waiting traffic and leads them to the advanced area. The length of the lane should correspond to the maximum length of the traffic queue. The lane is mostly on the edge of the carriageway, but sometimes also between traffic lanes. The feeder lane may be a bus/bike lane.
- The advanced area allows all cyclists (left-turning, right-turning, moving straight ahead) to position themselves with **maximum visibility** in front of motorized traffic. In addition, they get a **head start** when the light turns green.
- This measure can become a **popular generalized provision** at all traffic light intersections, creating a citywide, uniform and easily recognizable benefit.

An alternative is to insert **cycle stacking lanes** between the stacking lanes for cars. This can be done for left-turning, right-turning as well as for continuing straight ahead. This reserved space for cyclists makes them more visible. A cycle stacking lane should be approx. 10 m long and 1.5 m wide (the adjacent car stacking lane should be at least 2.75 m wide). This can be combined with an advanced stop line.

The **right-turning traffic lane** can be inserted **to the right of a cycle lane**. When the road is widened with a right-turning lane for traffic, the cycle lane can be simply continued straight ahead. This way, right-turning traffic must cross the visibly marked cycle lane when weaving to its right-turning lane, before it actually turns right. The same solution **also applies to a cycle track**: the cycle track continues straight ahead, and the right-turning traffic lane is inserted to its right. A crossable in-line speed hump between the cycle track and the turning lane can be considered.

**Turning left** is a difficult, oblique weaving movement at traffic lights. To avoid this, cyclists are often first led slightly to the right, before crossing the flow in a straight line. There are two ways of doing this.

- A **two-step left-turn** was traditionally imposed. When the light turns green, the cyclist on a lane or track first crosses the side road, and then needs to wait for the green light in the other direction to cross the second side road. This is not only indirect but very time-consuming.
- The same maneuver can be done in one step, by marking out a **left-turning cycle stacking area in front of the traffic lights**. At the green light, the cyclist first moves slightly to the right into the waiting area. This area is in front of the red traffic light on the right. As soon as there is a gap in traffic, the cyclist can cross. The disadvantage is that this maneuver may seem illogical and surprising to other road users: the cyclist crosses the intersection in a direction that has the red light.



*Advanced stop line (Copenhagen), right-turn lane to the left of the cycle lane (Dordrecht), left-turn stacking (Bremen)  
(image source: F. Boschetti, P. Kroeze)*

### *Cycle-friendly TCS regulation*

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**Traditionally, traffic lights are regulated to digest large flows of motorized vehicles.** Time for cyclists and pedestrians is often kept short and waiting times long. Cyclists' queues and saturation are not a problem, since these are very unlikely (only when there is on average over 1 cyclist per second on a cycle track). The real issue is the waiting time and the delay. Travel speed and journey time are crucial for the network quality, especially on the most important links. The less delay for the cyclist, the more competitive cycling becomes compared to other modes.

Within urban areas, other priorities can be set. It is recommended to **explicitly define TCS waiting time policies for all users**. These can, for instance, set a maximum waiting time for pedestrians and cyclists, even at the expense of traffic flow.

When cycling flows are important on major cycle routes, several measures can give cyclists the advantage over motorized traffic. The strongest measures should only be considered in CHAMPION CYCLING CITIES and possibly for high-intensity cycle links in CLIMBER CHAMPION CITIES.

A key measure is to **reduce the overall cycle duration** as much as possible.

- An average waiting time for cyclists of 15 s is considered good, one over 20 s is poor (average waiting time corresponds to half the red light time). When crossing a main road without traffic lights, the average waiting time may be shorter than this, but at peak hours the cyclist may have to wait four times as long.
- The recommended maximum waiting time for cyclists is 90 s inside the built-up area and 100 s outside the built-up area (maximum waiting corresponds to the red light time). Often traffic phase duration is set unnecessarily high, at 120 s, as a precaution. In many cases, reducing this time not only favors cyclists but improves general traffic flow.

Separate **cyclist traffic lights** can be used in various ways to give cyclists more green time.

- Cyclists can receive an **early start**. This allows cyclists to move onto the intersection safely in front of motorized traffic and in a highly visible way. This is especially useful when many cyclists turn left or many cars turn right. The effect is similar to advanced stop lines (see above).
- Cyclists may be **allowed to move on together with non- conflicting movements**. This can be built into the system as a standard.
- Cyclists may receive a separate phase of **green light for all directions**. Cyclists can cross, turn right and turn left from all directions at the same time, while all motorized traffic is stopped. All conflicts between cyclists and cars are eliminated, but there is the risk of bicycle-bicycle collisions, which are however much less serious. The disadvantage is that this increases the waiting time for motorized traffic.
- Alternatively, **button-activated cycle lights** can be used when a solitary track crosses a main route. This is recommended for safety reasons when the right of way is not likely to be respected, or when the traffic flow is too high.
- Cyclists can be favoured by using **dynamic traffic detection systems**. For instance, the green light for cyclists can be held on green as long as there is no other traffic (detection of motorized traffic). Alternatively, motorized traffic may be refused the green phase as long as there is cycle traffic (detection of bicycles). The disadvantage of the second solution is that waiting times may become longer and unpredictable for motorists, who may be confused, suspect a malfunction and drive on anyway.
- Cycling traffic lights may be fitted with a **countdown indication** before the light turns green. Experience in the Netherlands shows that cyclists perceive waiting time as 50% shorter. Cyclists also ignore red lights less often. The disadvantage is the countdown is only trustworthy with static light regulation. With dynamic traffic lights, dependent on detection of vehicles, countdown speed would become irregular and useless.

Lights can be **regulated in favor of cyclists without separate lights** as well.

- When left turns are frequent, a light phase can **group all left-turning traffic**, including bicycles. Only left-turning traffic gets the green light, while traffic moving straight ahead is made to wait. This creates a smooth left-turning movement without conflicts. There is no

more need for the two-step maneuver when left-turning and moving ahead are allowed at the same time.

- Cyclist flows may be concentrated in one direction. In such a case, it may be considered to give the major cycling direction **green light twice in one cycle**. In this way, waiting time is reduced by half. The disadvantage is that this lengthens the cycle as a whole and increases waiting time in the other directions.
- Traffic lights can be coordinated across intersections to create a **cycling green wave**. The approach is well-known for motorized traffic, but can be applied for cyclists as well. This can be considered on routes with a high flow of cyclists, either on a cycle lane or a segregated cycle track. This is only recommended when intersections are not too far from each other (approx. 100 m); otherwise cycling groups become stretched out because of differing speeds. This can be combined with a detection signal, so that the green wave is interrupted when the cycling flow is too small. The cycling green wave may lead to increased waiting times in the other directions.



Green light for cyclists in all directions and right turn always allowed for cyclists (image source: T. Asperges)

## Considerations

### Strengths

- Road markings can be a cost-effective provision, improving cyclists' visibility, safety and comfort: advance stop-line, turning lanes, left-turn stacking areas. They can be easily applied at the majority of existing traffic-light intersections.
- Physical design can provide cycling bypasses, eliminating waiting time.
- Regulation of traffic lights favoring cyclists, with or without specific cycling traffic lights, can create major benefits for important flows of cyclists.

### Weaknesses

- Traffic-light intersections handling large masses of traffic are inherently dangerous for cyclists and unattractive because of waiting times.
- Road markings will support fairly confident cyclists, but are insufficient for less experienced cyclists and unaccompanied children. Alternative routes will have to be found.
- Some regulation solutions in favor of cyclists will increase waiting times for motorized traffic, and can only be justified when (current or expected) cyclist flows are important.

### Alternative options

- Replace traffic lights with a ROUNDABOUT, when traffic intensity is not too high or when policy is to reduce traffic intensity.
- GRADE SEPARATION when traffic intensities are too intense for cyclists' safety.