

INFRASTRUCTURE/ **INTERSECTIONS AND CROSSINGS****GRADE SEPARATION**

Overview

Grade-separation for cyclists includes cycling tunnels and cycling bridges. These are safe and direct ways to cross barriers, such as very busy roads and intersections, waterways or railways. Tunnels are more comfortable for cycling, but bridges may be more attractive and are potential landmarks. High-quality design is needed to reduce the slope and improve objective and perceived safety.

Background and Objectives

Function

Grade-separated facilities, such as cycling tunnels and cycling bridges, allow cyclists to cross extremely busy roads, railways and natural barriers safely and directly.

Scope

There are two major kinds of barriers for cyclists: dangerous road crossings and intersections (even with roundabouts or traffic lights), and physical obstacles such as rivers, canals and railroads.

Grade-separated solutions should be considered on any level of the cycling network, inside and outside built-up areas, for two key reasons, related to two cycle network quality requirements.

- To improve directness: avoiding the barrier would impose an unacceptable detour, considerably lengthen cycling journeys and compromise the attractiveness of the network;
- To improve safety: there is no at-grade solution that sufficiently guarantees the cyclists' safety when crossing the barrier.

They are recommended at the busiest intersections with fast and heavy-traffic distributor roads. Some typical situations:

- A cycle link crosses a very fast distributor road (speed over 70 km/h)
- A cycle link on a busy local access road (over 500 pcu/h) intersects with a very busy distributor road (over 1500 pcu/h), especially in case of a highly used top local or main cycle route
- A cycle link on a busy distributor road (over 1000 pcu/h) intersects with a very busy distributor road (over 1500 pcu/h)

Tunnels can be used to cross a busy road section or a busy two-lane roundabout.

Implementation

Definition

Grade-separation for cyclists includes cycling bridges and cycling tunnels, specially built for cyclists and possibly co-used by pedestrians.

Bridges or tunnels and general design issues

Urban areas often contain **major linear barriers** for cyclists: major roads, rivers, canals, railways. In most cases, crossing points are provided, but typically at great distances from each other. This creates a physical barrier for cyclists, imposing unattractive detours and considerably



raising the network mesh width. In other cases, crossing points are more numerous, but may be a psychological barrier, such as extremely busy road intersections. Cities should particularly be aware of **cycling barriers created by infrastructure projects.** Often existing roads are truncated and become dead ends: construction of motorways, ring roads and railway tracks; removing intersections to upgrade roads; closing level railway crossings for safety reasons. Removing the barrier is mostly not an option. But with a clear view of the cycling network, it is possible to **design in or add on grade-separated crossings.**

Once the decision has been made to provide grade-separation, there are two options: **a cycling bridge or a cycling tunnel**¹. Both have their advantages and disadvantages, summed up in the table below. The weight of each factor depends on the situation. For instance, the social safety argument will be less important in a busy urban area than in an isolated location outside the built-up area. Generally speaking,

- tunnels are the most comfortable solution for the cyclist, but they feel unsafe when badly designed and are usually more expensive to build;
- bridges are mostly cheaper, can be a potentially strong visual statement and make cyclists feel safe and respected, but they are usually harder to climb.

Aspect	BRIDGE	TUNNEL
Comfort	- Starts riding uphill	+ Starts riding downhill
	- Higher and steeper slopes, to go over trucks or trains	+ Lower and less steep slopes, because of the limited headroom needed for cyclists
	- Exposed to wind and rain	+ Sheltered from wind and rain
	- May induce fear of heights on long and narrow bridges	- May induce fear of closed spaces in long, narrow and bendy tunnels
Personal security	+ Feels safe in open space, visible from afar	- Feels unsafe in an enclosed space, out of sight and with no social control
		- May attract loiterers and graffiti
Urban landscape	- Strong visual impact, above ground and with long inclines	+ Limited visual impact, below ground and with short inclines
	+ Strong architectural and landmark potential	- Limited architectural and landmark potential
Costs	+ Generally cheaper	- Generally more expensive, especially taking into account groundwater measures

Adapted from CROW 2006, Design Manual for Bicycle Traffic

Cycling bridge and cycling tunnel design will have to make the most of their strengths and reduce their weaknesses.

Whenever possible, it is recommended to **raise or lower the level of the carriageway, to reduce slopes for cyclists.** Ideally, cyclists should keep riding on ground level. Raising the carriageway requires a less profound tunnel. Lowering the carriageway keeps the bridge lower.

On major roundabouts, a grade-separated cycling tunnel network can be created by raising the carriageway level. Tunnels converge in the open central space, where cyclists can change directions. An advantage is that tunnels are kept short between open spaces, taking away the major disadvantage.

Of course, creating a full-fledged tunnel or fly-over for motorized traffic keeps cyclists comfortably riding on the ground level. These costly, complex and space-consuming solutions can hardly be justified by the needs of cyclists alone, although cyclists' interests should be duly taken into account.

¹ Also referred to as underpass or subway in the UK

In Utrecht, a major intersection was designed as a semi-raised roundabout. At a lower level, cycle paths pass under the carriageways and meet in the open space in the middle. Later on, also bus lane was led under the roundabout. The radical design has created a landmark effect. This is strengthened by decorative design of bear, invoking the name of “bear pit”.



Berenput Utrecht (Source: Google Earth)

Designing cycling tunnels

When designing **cycling tunnels**, it is essential to provide generous dimensions and to create a sense of space and openness. A narrow, bendy, dark and hidden tunnel will simply not be used.

The following recommendations should be kept in mind.

- Keep cyclists at **ground level** preferably. If this is not possible, **raise the carriageway level** app. 2 m to decrease the depth of the tunnel. This also avoids groundwater problems.
- Use **sufficiently comfortable dimensions**. The tunnel should be at least 2.5 m high and 3.5 m wide (3 m is there is a footpath), the same as the approaching cycle path. The gradient should be at most 1:20.
- Keep the **approach to entrances open and unobstructed**. Avoid high vegetation, corners or anything that obstructs the view and create opportunities for concealment.
- Make **the exit visible upon entering the tunnel**. Provide a straight path and avoid all bends and corners. This increases riding comfort and allows the cyclist to keep up speed with a good view on approaching cyclists. This also opens up space and improves social safety.
- Make sure **walls recede towards the top**, to create a feeling of open space. Avoid straight vertical walls.
- Create **daylight gaps in the tunnel roof**. Separating the traffic lanes makes it possible to create a daylight gap for the tunnel in between. The central traffic island of a roundabout should be opened up when a cycling tunnel passes below.
- Put-in **high-quality and vandal-proof lighting**, preferably lights sunk into ceiling or walls. Faces **NEED** to be clearly recognizable.
- When co-used with pedestrians, provide a **separate pedestrian footway** on one side (1 m. minimum).
- Provide **multiple approaches** when useful. Cyclist may approach from different directions. Stairs with a cycle channel allow cyclists to interchange with the road above.



Good cycling tunnel design and cycle tunnel (image sources: Fietsberaad, P. Kroeze)

Designing cycling bridges

When designing a bridge, it is essential to reduce the height differences as much as possible and give the cyclist a feeling of confidence and safety.

The following recommendations should be kept in mind.

- Keep cyclists as **close to ground level** as possible. **Lower the carriageway level** to decrease the height to climb.
- Use **sufficiently comfortable dimensions**. The bridge should be at least 3.5 m wide (3 m is there is a footpath), the same as the approaching cycle path. The incline should be at most 1:20.
- Provide **at least 4.5 m headroom**.
- Considering **covering the bridge**, as a protection from wind and rain.
- Provide a **handrail or parapet**, of at least 1.2 m high.
- When space is lacking, a **phased ramp** can be considered. The cyclist scales the height in phases, with a brief horizontal space in between. This may be a way to reduce inclines and provide brief resting points. However, bends or spirals should be designed to allow cyclists to keep riding.



Cycle bridges (image source: P. Kroeze, Fahrradportal)



Cycle bridges at Grenoble, FR and Newcastle, UK



If room for a ramp is missing, consider **designing stairs with a bicycle channel**. This is a second-best solution, since cyclists must step down and walk, pushing the bicycle. The channels should be high-quality, for maximum comfort and minimum effort, so that they can be widely used.

- Put in channels on both sides of the stairs.
- Construct channels out of concrete preferably. On existing stairs, metal channels can be installed, using the same quality criteria.
- The channel incline should be no more than 25% for comfort.
- The channel should be at 0.08 m to 0.12 m wide, and at a distance of 0.03m to 0.05m from the side of the stairs.
- Set the handrail close to the wall, to avoid contact with the handlebars.
- Make the top level with the top stair for easy entering and exiting.

Mechanical devices such as lifts or escalators can provide assistance. However, many users are not comfortable with these solutions. They can therefore only be recommended as an additional solution, not as the only option to scale a difference in height.

Considerations

Strengths

- Grade-separation strengthens the network, by providing safe and direct ways to cross obstacles for cycling
- With grade-separation, waiting times are reduced to zero when crossing busy traffic
- Grade-separation reassures inexperienced cyclists, keeping them away from traffic
- Bridges can become landmark architecture, benefiting the status of cycling
- Grade-separation can also benefit pedestrians

Weaknesses

- Grade-separation always demands extra effort from cyclists, which will especially be felt in flat countries.
- Grade-separation is costlier than roundabouts and traffic lights; tunnels generally costlier than bridges

Alternative options

With less busy intersections, at-grade solutions may be possible, preferably ROUNDABOUTS.