B.04 Junction and Forward Visibility

Key Principle

Adequate visibility (20m where the design speed is 12mph) should be provided or measures to manage speed considered (see also B08 Access and Speed Controls).

Design Guidance

Visibility criteria on cycle links

The ability of cyclists to see a sufficient distance ahead to assess hazards, obstacles and the tightness of bends etc is an important issue in the design and adaptation of cycle track links away from the carriageway. These issues will not normally need to be considered for on-carriageway routes as roads are typically wider and designed with better sightlines.

There are two critical visibility parameters which determine whether cyclists can ride comfortably at their own desired speed and react safely to hazards. They are called the Sight Distance in Motion (SDM) and the Stopping Sight Distance (SSD)

SDM could be called the comfort visibility zone when cycling. It is the distance that a cyclist needs to see ahead in order to make riding feel safe and comfortable. Research has determined this to be the distance a cyclist covers in 8 to 10 seconds i.e. between 50m and 80m at typical cycling speeds.

SSD is the distance that a cyclist needs to see a hazard, react to it and come to a halt. This is shorter than the SDM.

These two visibility parameters are critical in terms of assessing whether a cyclist will be able to use the cycle facility comfortably and safely. The ability of a cyclist to interact safely with other cyclists and pedestrians will depend on the sightlines available. These in turn affect the ability to maintain momentum, anticipate the actions of others and, if necessary stop in time when a potential hazard presents itself. It is also important for personal security that cyclists can assess the situation ahead.

Visibility is often restricted around bends and corners. This introduces a third factor; the radius of curvature of bends in the cycle track. Curvature affects both the forward visibility and the maximum speed at which cyclists can negotiate the bend.

Design speed

As far as possible, cycle facilities should be designed for cyclists to travel at their desired speed. The need to slow down then speed up requires additional effort and can act as a deterrent to cycling.

The average speed of cyclists on level surfaces is around 12 mph (5m/second), with a typical spread from 6 mph (2.7m/second) to 20 mph (9m/second). The speed mostly depends on the characteristics of the individual and the quality of the route. The average speed does not differ greatly between recreational and utility cyclists, ranging from 11 mph to 12.5 mph. Cyclist speeds on unsurfaced cycle tracks may be lower with an average speed of 9 mph.

A design speed of 20 mph should be used as the standard for assessing the suitability and safety of routes and designs for cycling. This allows nearly all cyclists to travel at their own preferred speed and allows a margin of safety for most cyclists. This is especially important where cyclists are to be encouraged to make longer journeys, such as on routes for commuting or into town centres.

However, the design speed depends on the nature of the cycle route. It may, for example, be desirable to encourage lower speeds where cyclists share a route with pedestrians. In these circumstances, a lower design speed of 15 mph can be applied, but it should be recognised these may be less attractive and comfortable to commuter cyclists. For access routes, such as those linking cycle tracks to the heads of culs de sac 12 mph is acceptable. On downhill gradients, a higher design speed should be used for safety reasons.

Pedestrian – cyclist conflict

The potential for cyclist-pedestrian conflict is an important issue. However, it is neither appropriate nor effective to attempt to reduce cyclist speeds by restricting forward visibility through the deliberate use of tight radii. In a study of cycle track interactions, the speed of cyclists was important in perceived conflict, but poor environmental conditions that reduced sight lines and visibility was the most important factor in increasing conflict. Where there is a potential for conflict, it is more appropriate to widen the track or, in exceptional circumstances, introduce other measures to slow down cyclists, such as humps or rumble surfaces.

Forward visibility parameters and stopping distances

The chart below gives minimum values for sight distance in motion, the stopping sight distance, and the radius of curvature for a level bitmac surface. Designers will need to ensure that any specific factors, such as gradient or surface, are taken into account when using these figures. For a given design speed, the SSD is lower than the SDM. Therefore, if the SDM can be achieved, making the alignment comfortable for cyclists, the SSD which governs the safety of the route is automatically achieved.

Forward visibility Parameters

Type of route	Design speed	Sight Distance in Motion[+]	Stopping Sight Distance*[#]	Min. Radius of curve
Commuter or long distance route	20mph	70-85m	≥30m	25m
Distributor or unsurfaced route	15mph	55-70m	≥20m	20m
Local access route	12mph	45-55m	≥15m	15m

Notes:

[+]The comfort factor provided by forward visibility varies with individuals and the higher figures should be applied to routes on which less confident cyclists are to be encouraged. The designer should always try to provide an adequate SDM.

*Actual stopping distances are dependent on a number of factors. The distance required to bring a bicycle to a full controlled stop is a function of the initial speed of the bicycle, the cyclist's perception and brake reaction time, the coefficient of friction between the tyres and the track surface, and the braking ability of the bicycle. These figures should be regarded as minima.

[#]In environments which are engineered to ensure slower speeds for all traffic , such as new developments, lower values for all traffic may apply – see panel below.

Manual for Streets:

Table 7.1 Derived SSDs for streets (figures rounded).

Speed
Kilometres per hour
16
20
24
25
30
32
40
45
48
50
60

Miles per hour
10
12
15
16
19
20
25
28
30
31
37

SSD (metres)
9
12
16
16
20
22
31
36

40
43
56

SSD adjusted for bonnet length (see 7.6.4)
11
14
17
18
23
25
33
39
43
45
53

Additional features will be needed to achieve low speeds

7.6.4 The SSD figure relates to the position of the driver. However, the distance between the driver and the front of the vehicle is typically up to 2.4 m, which is a significant proportion of shorter stopping distances. It is therefore recommended that an allowance is made by adding 2.4 m to the SSD.

The cycle track surface should have adequate skidding resistance when wet and be well drained, especially around curves. Some surfaces such as loose gravel or chippings reduce the ability to brake and increase the risk of skidding. Actual values have not been determined by research, but it is estimated that minimum stopping distances should be increased by around 50% for unsurfaced tracks.

Safety

As cyclists lean into a bend, the dynamic envelope can extend over the inner edge of the cycle track. This should be borne in mind when considering the location of poles, fences or any other vertical obstructions on the inside of bends.

Cycle tracks should have a crossfall of between 2.5% and 3% to ensure there is adequate drainage. Falls below this range may not drain the track properly and those exceeding it can be uncomfortable for some pedestrians and people in wheelchairs. Excessive crossfall can also create difficulties for cyclists in icy conditions. On straight sections, the track should ideally fall to either side from the centre. On bends, the track should always fall from the outer edge towards the inside of the curve. Additional superelevation to assist cyclists to manoeuvre around bends is generally unnecessary. On no account should the track fall to the outside of a bend (negative camber).

The presence of leaves, standing water or ice, other surface defects, gratings or slippery road markings can make curves and corners difficult for cyclists to negotiate. These hazards should be addressed through a suitable maintenance regime (see also C06 Maintenance) and proper initial design.

Designers should always ensure that obstacles in the cycle track are either removed or made more visible through the use of reflective material, or paint in high visibility colours. Routes likely to be used during the hours of darkness should therefore be audited during both day and nightime to identify any potential hazards.

Downhill gradients

The effect of gradient on cycle speed should always be considered (see also C09 Gradients). Downhill gradients can significantly increase cycle speed and at the same time reduce the ability of a cyclist to stop. For every 1% increase in downhill gradient, cycle speed is likely to increase by just over 1 mph. In addition, cyclists will tend to allow their speed to increase on downhill gradients to minimise the effort required after they have passed the downhill section. The design of curves on downhill slopes and at the bottom of hills need special care if potential safety hazards are not to be introduced.

Personal security issues

Visibility has an impact on personal security. The ability to scan ahead for possible danger is important, especially on cycle tracks. Landscaping and planting should not impede passive surveillance from surrounding properties, nor create hiding places close to a path. A mown verge of at least 0.5m, preferably 1m, should be provided on each side. Planting near the track should normally be kept below 800mm height; any vegetation likely to grow higher should be set back.

Site restrictions

There will be cases where physical constraints mean that it is not possible to meet visibility standards. Retrofitting a crucial cycle link can often have an important impact on the overall cycle network and may mean that a low cyclist speed and poor visibility parameters have to be accepted with cyclists' speed controlled by physical means if necessary.

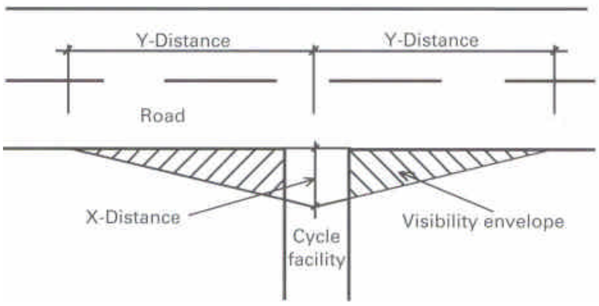
However, this should not be used as an excuse for implementing sub-standard routes in general. Every effort should be made to ensure that all cycle routes are properly designed, especially in respect of the requirements for forward visibility. Routes which fall significantly below the standard required for a design speed of 20mph are likely to deter commuter cyclists and those making longer journeys from using them.

Visibility criteria at road junctions and crossings (see also A14 Corner Radii and B03 Road Crossings – Mid-link)

Cyclists wishing to join or cross a major road need to be able to see, and be seen by, approaching traffic. A visibility splay is required to facilitate this. The splay is defined by the 'x' and 'y' distances as set out in TD 42/95 of the Design Manual for Roads and Bridges. The 'x' and 'y' distances are defined by the diagram below (x is measured along the centreline of the minor arm). The minimum preferred 'x' distance for a cyclist is 4m with an acceptable minimum value of 2.5m.

Where a cycle track meets a road on which speeds are at or below 20 mph, the 'x' distance may be reduced to 2.0m*. When a cyclist is stationary waiting to join or cross the carriageway the actual 'x' distance will, in effect, be 1m back from the channel line. However, a greater 'x' distance will allow cyclists more time to make their decision whether or not to stop on approaching a 'give-way' situation (see Moving 'x' and 'y' distance below).

> *Note that in this case, 20mph is the actual speed not the design speed - many 20 mph zones are created using signs only and these may not be enough to ensure motorists comply with the speed limit. In situations like this, 30 mph standards will be more appropriate.



Visibility splays for priority junctions and crossings

Design speed of major road (mph)	20*	31	37.5	43.5	53	62
Design speed of major road (kph)	32*	50	60	70	85	100
'y' distance (m)	40	70	90	120	160	215

* Actual speed (20mph column is not covered in TD 42/95)

If these guidelines are being used to design for a track with a large proportion of young cyclists the designer may wish to provide a facility to a higher standard. For example, if a cycle track is used by school children, and it meets the carriageway on the inside of a bend, it may justify an increase in the 'y' distance, or measures could be introduced to reduce the speed of approaching vehicles. Consideration could also be given to installing a controlled crossing.

Note: Manual for streets recommends that, for the design of new 'streets' which are laid out to ensure low speeds, the 'y' distance should equal the stopping sight distance (SSD) recommended within that document, see panel above.

Moving X and Y distance

Cyclists will do their best not to lose momentum at junctions and crossing points. If there are no immediate gaps in the traffic, they will tend to slow down on the approach. This gives an increased chance of a gap appearing which they can slot into without stopping. For this reason, cyclists will benefit from being able to look at approaching traffic from a point further back from the carriageway edge.

To allow this, the visibility splay needs to be increased using moving X and Y distances. A balance will need to be struck between the extra convenience for cyclists against the amount of vegetation removal necessary.

The moving X and Y distances are related to the speed of traffic on both the major and minor arms. These figures are given in the table below. The table allows for cyclists to cross the junction on the major arm. Note that the traffic speeds on the major arm are 85th percentile values. Values above 40mph are not given because cyclists are less likely to be able to make a decision to proceed safely at higher speeds.

Visibility parameters for cyclists approaching a junction

Cycle route design speed	Moving X distance (SSD)*	85th %ile speed on major arm		
		20mph	30mph	40mph
		Moving Y distance		
20 mph (8.3m/s)	40m	65m	105m	150m
15 mph (6.9m/s)	30m	55m	90m	130m
12 mph (5.5m/s)	20m	50m	80m	110m

*This Table is based on SSDs which are more conservative than used elsewhere in this guidance. The moving Y distances are therefore similarly conservative.

As an example, at 20m from the junction, a cyclist travelling at 12 mph will need to be able to see 50m along a 20mph main road (both ways if the cyclist is crossing both streams of traffic). Given this level of visibility, the cyclist can safely decide whether to stop or continue at 12 mph to cross the junction. Such standards are particularly useful where cyclists do not have priority.

Traffic calming on the main road can give cyclists more certainty of the approach speeds of vehicles. Build outs into the main carriageway where the cycle track joins it can be used to improve visibility and shorten crossing times. They can also prevent vehicles parking and obstructing the cycle track. Care should be taken that they do not introduce pinch points for cyclists on the main carriageway.

Junctions between cycle facilities (see also A14 Corner Radii**,** B07 Cycle Track Junctions and B08 Access and Speed Controls**)**

Where two cycle tracks cross, the moving X and Y distances are the same (the X distance on one arm equates to the Y distance on the other). If the design speed is 20mph, a value of 40m can be used for the X and Y distances. As noted in the table above, 40m is greater than the SSD of 30m generally used in this guidance but increasing it to 40m gives cyclists in potential conflict the opportunity for one of them to give way.

Connections within the off-carriageway local network should have a radius of ≥ 10m for a design speed of 12 mph. For the main network cycle routes should have a radius of ≥ 20m for a design speed of 20mph.

Publications

Design manual for bicycle traffic CROW 2007

Manual for Streets DfT, Communities & Local Government 2007

Policy, Planning and Design for Walking and Cycling – Local Transport Note 1/04, Public consultation Draft, DfT 2004

TAL 7/91, *20 mph Speed Limit Zones*, 1991, DoT

London Cycling Design Standards – A guide to the design of a better cycling environment (Sections 3.4, 3.5, and 3.6) TfL 2005

Lancashire - The Cyclists' County (pdf - 5.45Mb) (Section 3) – creating pleasant road conditions Lancashire County Council, 2005

CTC Benchmarking – Best practice case studies

Cushioning the Blow? – the use of speed cushions (pdf - 743kb) CTC Cycle Digest, Issue 33 2002

Other references

National Cycle Network – Guidelines and Practical details, Issue 2 Sustrans 1997

Cycle Friendly Infrastructure - Guidelines for Planning and Design, Bicycle Association et al 1996

Sign up for the bike: design manual for a cycle-friendly infrastructure, CROW 1993

Operational Analysis of Uninterrupted Bicycle Facilities, Allen P et al 1998

Safety and Locational Criteria for Bicycle Facilities, Smith DT 1976

User Interaction on Non-motorised Shared Use Routes, Uzzel D et al. 2000

Cycling by Design, Scottish Executive 1999

Guide to the development of bicycle facilities AASHTO 1999

Bikeway Planning and Design Chapter 1000 (Highway Design Manual) California DOT 2001

Collection of Cycle Concepts (pdf - 7.12Mb) Danish Road Directorate 2000