



## **PUBLISHED PROJECT REPORT PPR703**

### **Trials of segregation set-back at side roads**

Annex 1 - Review of existing guidance

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## Contents

1	Introduction	3
1.1	Background	3
1.2	Review of Existing Guidance	4
1.2.1	UK Guidance	4
1.2.2	USA	5
1.2.3	Ireland	5
1.2.4	The Netherlands	7
1.2.5	Germany	8
1.2.6	Denmark	8
1.3	Discussion	10

# 1 Introduction

## 1.1 Background

Current proposals for expansion of the London Cycle Superhighway network involve extensive use of segregated lanes created within the carriageway, for example using kerbs<sup>1</sup>. This approach has the advantage over off-road cycle tracks that priority is not lost at every side-road or driveway, as the cyclists remain within the carriageway. This also avoids taking space from pedestrians, which can also be a problem with off-carriageway and shared-use cycle tracks. However, it is still necessary to deal with the problem of how to provide for cyclists at junctions, which is where a majority of cycle accidents occur: a TRL report for DfT (*Infrastructure and Cycle Safety*) notes that over 70% of collisions took place within 20 metres of a junction, mostly involving other vehicles turning into or out of side-roads<sup>2</sup>.

There are different approaches that can be used for taking cyclists from a segregated cycle lane or track across side-roads. *Infrastructure and Cycle Safety (ibid)* reviewed evidence on the benefits of side road entry treatments such as raised tables, and concluded that they can “have a clear accident reduction benefit at uncontrolled junctions”.

The approach recommended in DfT’s and TfL’s current guidance for taking segregated cycle tracks across a side-road, reflecting practice in many other countries, is to mark an advisory cycle lane across the junction and so provide continuity between the segregated sections. However, with such an arrangement there is an increased risk of conflict between cyclists continuing straight ahead and other vehicles turning into the side road across their path. This type of conflict, a left turning vehicle cutting across a cyclist going straight ahead, was involved in two out of ten cyclist fatalities in 2010<sup>3</sup>. Evidence from analysis of accident data following the introduction of cycle tracks adjacent to the carriageway in Copenhagen found an 18% increase in accidents at junctions, with particularly large increases (129%) in the number involving right turning vehicles (left turning in the UK) and cyclists going straight ahead<sup>4</sup>.

One approach to mitigating this risk is to ‘set-back’ the segregation, i.e. ending it some distance before the junction so that cyclists are effectively re-introduced into the traffic flow, allowing them to adopt a prominent position when going ahead and giving drivers greater awareness of their presence when turning. However, as will be discussed in more detail later, there is currently limited guidance as to what the most appropriate set-back distance should be, and such guidance as exists does not appear to be based on specific research evidence. For this reason TfL has commissioned TRL to carry out test track

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<sup>1</sup> The Mayor’s Vision for Cycling. Greater London Authority March 2013.

<sup>2</sup> TRL report PPR580 “Infrastructure and Cycle Safety”, for DfT, 2010,

<sup>3</sup> Transport for London, Surface Transport, Topic Factsheet 2011- 1, September 2011, Pedal cyclist collisions and casualties in Greater London

<sup>4</sup> Jensen, S; Rosenkilde, C; and Jensen, N. *Road safety and perceived risk of cycle facilities in Copenhagen* 2006

trials to investigate the effect of different segregation set-back distances so that more precise guidance can be produced.

## 1.2 Review of Existing Guidance

A review was undertaken of cycling infrastructure guidance in the UK and elsewhere to identify what recommendations currently exist on segregation set-back, and to understand the evidential basis on which this guidance is based.

### 1.2.1 UK Guidance

There is currently limited experience in the UK of kerb-segregated cycle lanes within the carriageway (technically, these could also be referred to as cycle tracks)<sup>5</sup> and current UK cycling infrastructure guidance has little to say about that form of segregation. Most existing cycle tracks are off-carriageway, usually shared-use with pedestrians. At side roads they can either be given their own crossing provision over the side road (with various options available, such as whether controlled, raised, priority over the side-road traffic, how far set back down the side-road etc.). These options are described in TfL and DfT guidance, and a good summary is set out in Cycling England's Portfolio of Design Techniques (B02 Side Road crossings)<sup>6</sup>. However, the recommended approach now is to re-introduce the cyclists onto the road before the junction. DfT's Cycle infrastructure Design (LTN 2/08) advises that:

*"As a result of concerns over the safety of parallel cycle tracks crossing side roads, it is becoming common European practice to reintroduce cyclists to the main road in advance of a junction. Cyclists pass the junction on the carriageway and then re-join the cycle track."*

LTN 2/08 also advises that: *"The merge onto the carriageway should be at least 30 metres from the junction to reduce the risk of conflict with left turning traffic."*

Cycling England's Portfolio of Design Techniques makes a similar recommendation: *"Designers should be aware that the need to cross [the side road] can be dispensed with altogether by allowing cyclists to join the carriageway into a cycle lane some distance (20m - 30m) before the junction with the side road, and returning them to the cycle track afterwards."*

Although these recommendations apply to the re-introduction of an off-carriageway track, rather than setting-back the segregation of a cycle lane within the carriageway, the reason (to reduce conflict with left—turning vehicles) is the same, so this is currently the most directly applicable UK guidance.

However, neither document cites any research evidence to support their recommendations, and no relevant research into set-back distance was identified in the course of this literature review.

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<sup>5</sup> London Cycling Design Standards (4.1.4) states: "Cycle facilities that are physically separated from general traffic and adjacent to the footway may be treated as either a mandatory lane or as a cycle track. Designers must be consistent in following the appropriate procedures for the designation chosen."

<sup>6</sup> Cycling England's Design Portfolio is now hosted by the Chartered Institute of Logistics and Transport, see 'The Hub' at [www.ciltuk.org.uk](http://www.ciltuk.org.uk)

### 1.2.2 USA

US guidance NACTO<sup>7</sup> states: *"The desirable distance to drop a cycle track prior to an intersection varies by the specific treatment and lane configuration. More space is required when bicyclists and motorists will be mixing or merging."* However, NACTO also refers to Leden et al (2005), which describes ending kerb segregation 20 to 30 metres from the junction. This source also states that *"according to Danish experience truncated tracks often makes cyclists feel less safe. A solution to the problem is to continue the cycle track into a cycle lane separated from vehicle lanes by a wide painted rumble line. The interaction can be further improved by adding a rumble pavement in the separation area between the lane and the pedestrian pavement the last 20 - 30 meters to make cyclists ride closer to the vehicles. The idea is to make the road users approaching a junction more visible to each other and thereby seen earlier"*.

NACTO also describes the use of markings and "Yield to bikes" signs to give cyclists priority over turning vehicles.

### 1.2.3 Ireland

The National Cycle Manual<sup>8</sup> describes a number of different approaches for taking cycle lanes past side roads, depending on local circumstances. As with UK guidance, there is no guidance specifically for kerb-segregated lanes within the carriageway, however there are relevant comparable situations.

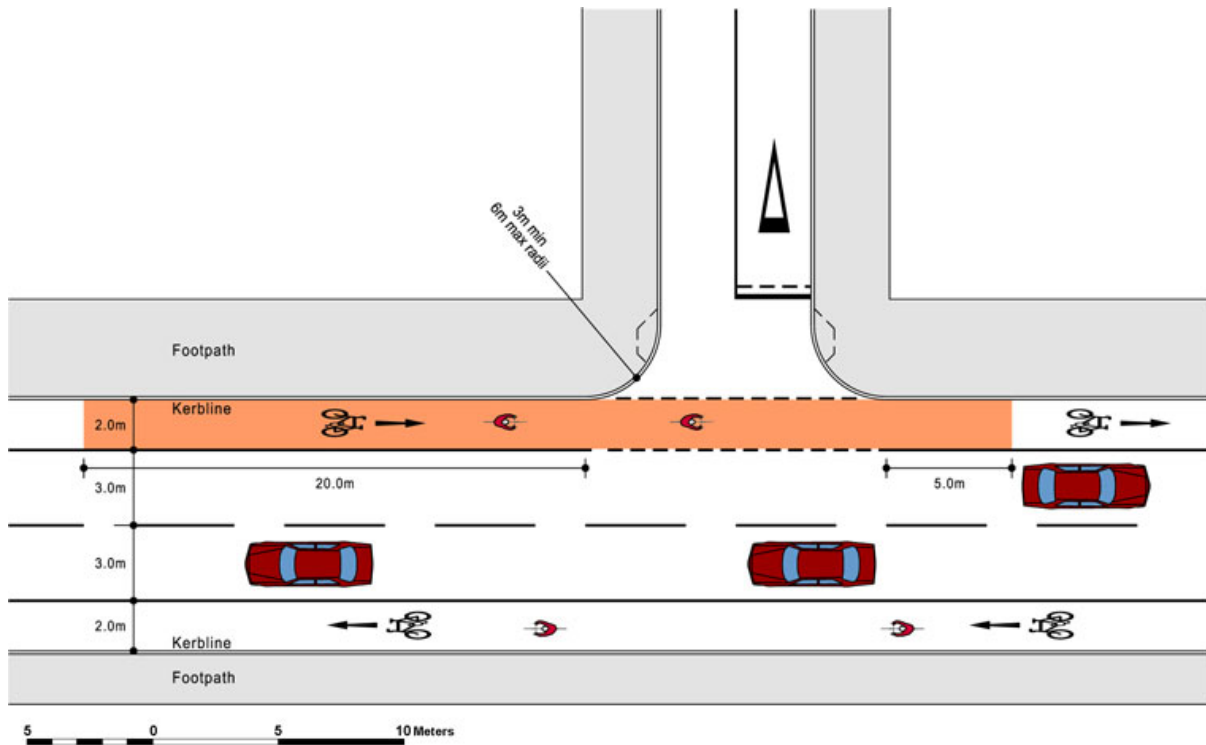
The general principles the Irish Cycle Manual recommends for taking a cycle lane past a side road are:

- using a tight turning radius for the side road turning to reduce the speed of turning vehicles (3m to 6m max);
- mandatory cycle lane approaching junction, to provide cycle space and preclude parking;
- coloured surface commencing 20.0m in advance of the side road to improve legibility; and
- cycle lane brought across mouth of junction.

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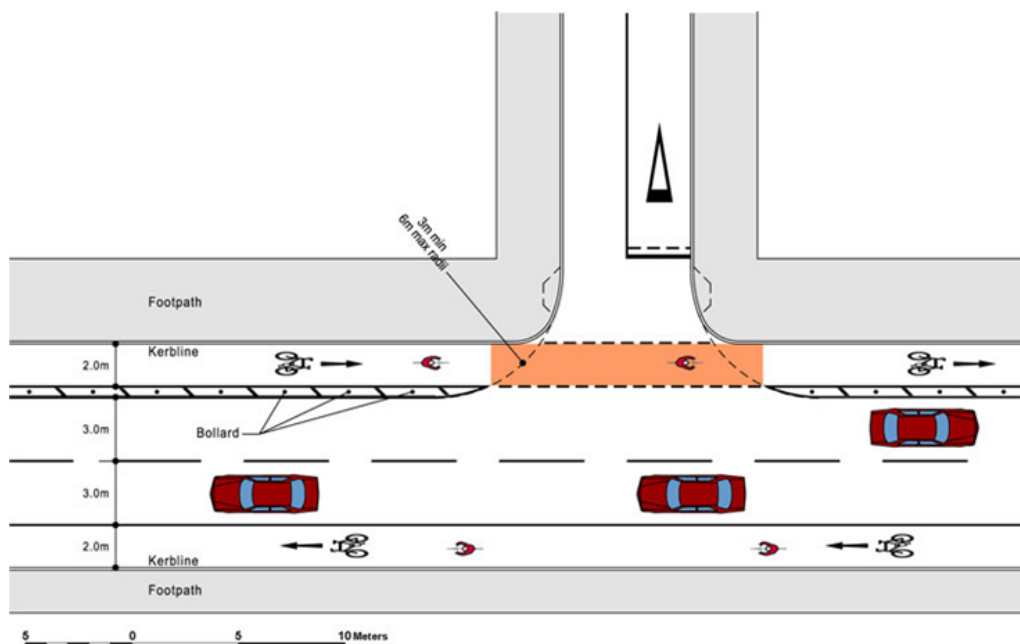
<sup>7</sup> National Association of City Transportation Officials (NACTO), Urban Bikeway Design Guide (2013). Available from: [nacto.org/cities-for-cycling/design-guide](http://nacto.org/cities-for-cycling/design-guide)

<sup>8</sup> Irish National Transport Authority, National Cycle Manual (2011). available from: [www.cyclemanual.ie](http://www.cyclemanual.ie)



**Figure 1: Cycle lane passing side road, Irish Cycle Design Manual**

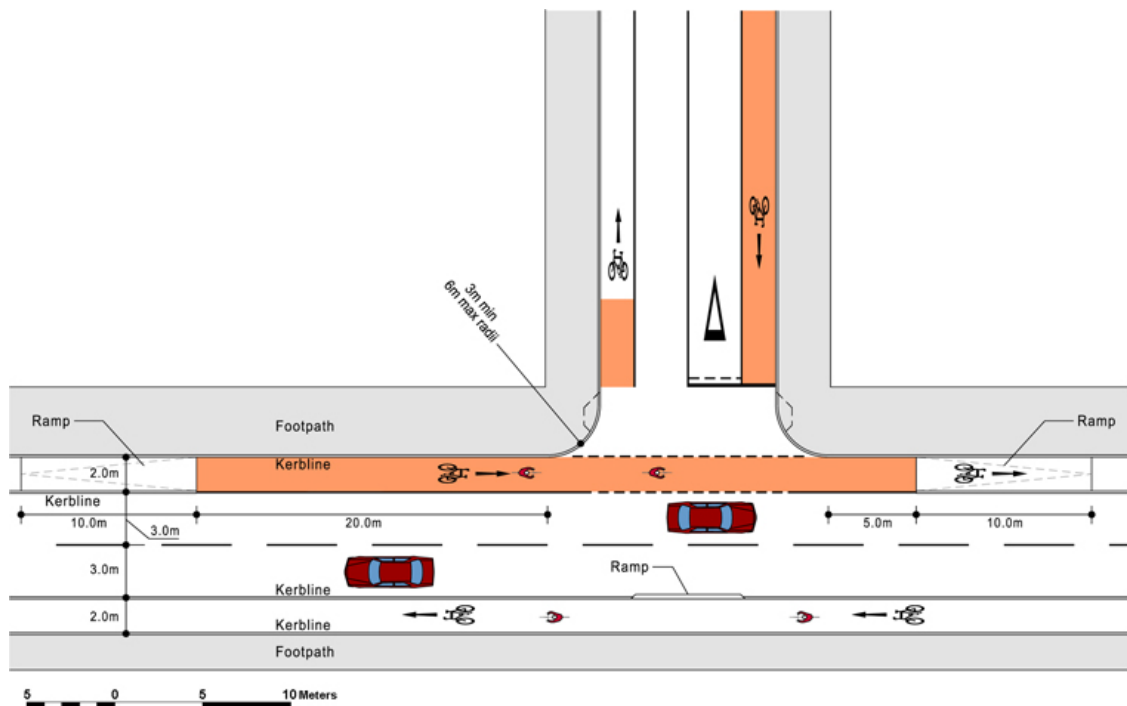
An alternative approach uses segregation with bollards ending very close to the start of the turn, the segregation helping to reduce the turning radius, and hence reduce the speed of turning vehicles, as well as to prevent encroachment into the cycle lane. This would correspond to a very short segregation set-back distance of around 5m.



**Figure 2: Intermittent separation using bollards and short 'set-back' distance**

Another method of segregation shown is for 'raised and adjacent' cycle tracks, also known as 'hybrid' cycle tracks. The cycle track is raised to an intermediate height between the carriageway and the adjacent footway. For this situation the Irish guidance recommends returning the track to carriageway height with a 10m long ramp ending 20m from the junction. As for the previous examples there is coloured surfacing, a mandatory cycle lane on approach and advisory lane across the mouth of the junction. Again, tight turning radii are recommended to reduce the speed of turning vehicles and to position them perpendicularly to the cycle lane when crossing, so as to improve visibility.

This example could be regarded as being very similar to a kerb-segregated cycle lane occupying the same space and location on the highway, and if applied to that situation is effectively recommending a 20m segregation set-back.



**Figure 3: Hybrid cycle track reintroduced to carriageway with 20m segregation set-back**

### 1.2.4 The Netherlands

The Design Manual for bicycle traffic<sup>9</sup> describes a range of approaches for different situations. Cycle tracks next to the carriageway (which can be raised above carriageway level, or separated by a verge) have the same right of way as the adjacent carriageway. Where cyclists have right of way over a side road "continuous paving of cycle track across junction" is recommended (CROW, V19). Triangular markings (also known as sharks teeth markings) are used to denote priority to cyclists. For cycle tracks that are

<sup>9</sup> The CROW Design Manual for Bicycle Traffic (2007). Available from: [www.crow.nl/publicaties/design-manual-for-bicycle-traffic](http://www.crow.nl/publicaties/design-manual-for-bicycle-traffic)



separate from the carriageway, it is recommended that these are 'bent in' 20- 30 metres from the junction; this is equivalent to the LTN 2/08 recommendation to reintroduce cyclists 30m in advance of junctions. However, this is not recommended for roads that have maximum speeds greater than 60km/h- in this situation it is recommended that the cycle track crosses the side road at last 5-7m from the main carriageway, to provide some space for turning vehicles to wait without presenting a risk of rear-end shunts from following vehicles continuing straight ahead.

### 1.2.5 Germany

German guidance ERA<sup>10</sup> describes, similarly to the Dutch guidance, a situation where cyclists on cycle tracks have priority over turning vehicles, clearly defined by signs and markings. Raised and adjacent cycle tracks are returned to carriageway level shortly before a side road, with very tight turning radii used to reduce the speed of turning vehicles and to position drivers for best visibility of cyclists. **Figure 4** shows that the kerb line does not form a quadrant, rather the end of the raised cycle track defines the turning radius.

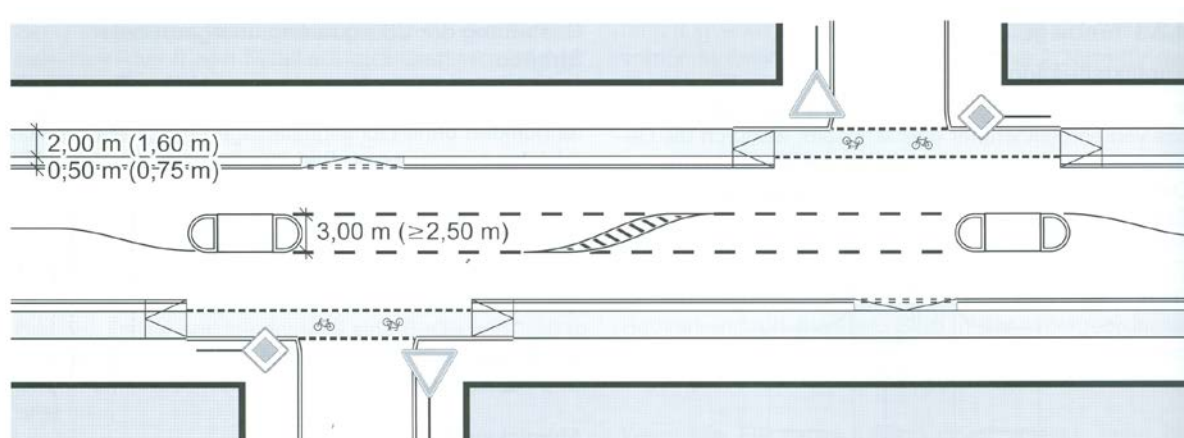


Bild 41: Beispiel für die Sicherung des Radverkehrs durch Mittelinseln an versetzten Einmündungen

**Figure 4: Raised cycle track crossing side road, German guidance**

### 1.2.6 Denmark

The collection of cycling concepts<sup>11</sup> provides advice and guidance on cycling designs. Hybrid (raised and adjacent) cycle tracks are widely used in Denmark. As with the Netherlands, cyclists using a cycle track which is parallel to a road and located 6 m or

<sup>10</sup> German Research Society for Road and Transportation, Recommendations for Bicycle Facilities (2010). Available from: [www.nationaler-radverkehrsplan.de/neuigkeiten/news.php?id=3111](http://www.nationaler-radverkehrsplan.de/neuigkeiten/news.php?id=3111)

<sup>11</sup> Cycling Embassy of Denmark. Collection of Cycle Concepts (2012). Available from: [www.cycling-embassy.dk/](http://www.cycling-embassy.dk/)

less from the carriageway, have the right-of-way over traffic on side roads. For providing continuity for cycle tracks at junctions the recommendation is:

“At intersections with small amounts of traffic on the secondary road, the cycle track should be continued through the intersection. A continuous cycle track has a traffic calming effect on motor vehicles entering and leaving the intersection on secondary roads since they are compelled to cross the cycle track and frequently the pavement as well. Crossing in this fashion makes it easier for road users on secondary roads to understand and observe the give-way rules.”

In Denmark, where cyclists are reintroduced onto the carriageway to pass through junctions blue coloured lanes are commonly painted to highlight their presence to drivers. UK experience of hybrid lanes is very limited. Some have recently been constructed in Brighton. These use raised crossings at the side roads, so the hybrid track is not returned to carriageway level- effectively no set-back, and using tight geometry, and the raised crossing, to reduce vehicle speeds when turning and also to encourage overall speed reduction on the main carriageway. The design is based upon Danish practice<sup>12</sup>.



**Figure 5: Hybrid cycle tracks in Brighton, no set-back of segregation**

There are important contextual differences that have to be considered when seeking to apply European guidance to the UK. There are differences in priority rules, for example a default “give way to the right” rule where no priority is specified. In the Netherlands and Denmark cyclists on cycle tracks have the same priority at junctions as vehicles on the adjacent carriageway, whereas in the UK this cannot be assumed and drivers will not be used to giving way to cyclists emerging from a segregated cycle track. Furthermore, there are differing rules on liability in the event of a collision, which, to varying extents, place greater responsibilities on drivers to take care around cyclists and pedestrians.

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<sup>12</sup> Personal communication from Abby Hone, Brighton and Hove City Council (2013).

In Denmark, where cyclists are reintroduced onto the carriageway to pass through junctions blue coloured lanes are commonly painted to highlight their presence to drivers. A review by Jensen (2008)<sup>13</sup> (of the use of blue lanes at signalised crossings) concluded that such lanes reduced collisions by 10% when marked in a single direction through a junction, but resulted in an increase in collisions when multiple directions were marked. Jensen speculated that this was because drivers became confused by multiple lane markings. Although this study was on signalised junctions, Jensen concludes that benefits would also be achieved at smaller non-signalised junctions, citing experience from a different type of marking ('white harlequin', see Figure 6) at give way junctions. Danish practice also advocates the use of raised crossings at side-roads to improve pedestrian and cyclist safety- importantly, it does not matter particularly whether the cycle lane is raised as well as the pedestrian crossing, or just the pedestrian crossing, both have a similar effect on turning speed and position (Jensen et al, 2006)<sup>14</sup>.



**Figure 6 White Harlequin markings in Denmark**

### 1.3 Discussion

Guidance on segregation set-back distances is limited, especially for the kerb-segregated lanes being considered by TfL. Two distinct design approaches can be identified, although they do not appear to have been based on significant research evidence. Either:

- Design approach A: cyclists are returned to the carriageway level at least 20m before the junction, so as to establish their presence, or
- Design approach B: segregation is brought right up to the junction ( $\leq 5\text{m}$ ) and very tight geometry (and often raised crossings) used to keep turning speeds down and encourage vehicles to cross the cycle lane at close to 90 degrees.

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<sup>13</sup> Jensen, Søren Underlien *Safety effects of blue cycle crossings: A before-after study Accident Analysis & Prevention Volume 40, Issue 2, March 2008, Pages 742–750*

<sup>14</sup> Jensen, S; Rosenkilde, C; and Jensen, N. Road safety and perceived risk of cycle facilities in Copenhagen 2006

Examples of returning cyclists to the carriageway can be found in Dutch, German and Danish guidance, again with examples of both very short (or no) 'set-back', and longer distances of around 20 to 30m. As there are many important contextual differences, including different rules on priority for cyclists using adjacent cycle tracks, it is hard to draw direct comparisons with the UK. Both Danish and Dutch guidance mentions different approaches being taken at different junction.

Design approach A appears to be preferred where traffic speeds and flows are higher. Design approach B is particularly widespread in countries such as the Netherlands where cycling is commonplace and cyclists using cycle tracks adjacent to the carriageway are given explicit legal priority at side roads, as well as implied protection from rules on liability for motorists.

For both approaches (A and B), coloured cycle lanes and other markings are usually recommended to highlight the presence of cyclists to drivers where a cycle lane is marked across a side road. Also speed reduction measures, in particular raised crossings, are used to reduce vehicle speed when turning and to position turning vehicles at right angles to the cycle lane so as to improve visibility.