Department for Transport

Traffic Advisory Leaflet 9/97
October 1997

Cyclists at roundabouts: continental design geometry

Introduction

10% of all reported accidents involving pedal cycles occur at roundabouts. Of that proportion, 11% involve fatal or serious injury to a cyclist. Cyclists feel especially vulnerable at large and busy roundabouts, often choosing a route to avoid such junctions or travelling by a different mode for particular journeys. This leaflet gives advice on the value of using principles of roundabout design developed in continental Europe, to improve conditions for cyclists at roundabouts in the UK. It is based on research carried out by the Transport Research Laboratory for the Driver Information and Traffic Management Division of the Department of the Environment, Transport and the Regions (DETR). The results are described fully in TRL report 285. **Advice in this leaflet should be read alongside Geometric Design of Roundabouts (Volume 6 of the UK Design Manual for Roads and Bridges)**.

Summary

As part of a range of actions to increase cycle use, highway authorities may like to consider engineering measures to improve the safety, convenience and attractiveness of roundabouts to cyclists. Conditions for cyclists at roundabouts can sometimes be improved by installing specific cycling facilities. An alternative, or contributory approach, may be for highway authorities to examine the geometry of the roundabout. Principles for roundabout design developed in continental Europe may be effective in reducing accidents and perceived dangers for cyclists. These focus on reducing the speed of motor vehicles on entering and negotiating the roundabout, and improving the visibility of cyclists. The capacity of such a roundabout is less than that of one based on UK geometric design parameters, but may still be adequate for entry flows of up to 2500 vehicles per hour.

Background

Roundabouts have become a common feature of the UK road environment since the first roundabout was constructed in Letchworth in 1910. TD16/93 is mandatory for roundabouts on the trunk road network, and is recommended as the basis of good design for roundabouts on other roads. Present advice is based on a detailed understanding of the effect of roundabout geometry on safety and capacity, and British roundabouts have a good accident record overall. However, pedal cycle accident rates at roundabouts are 14 times those for cars. In continental Europe roundabouts have been introduced much more recently, and designs reflect their use on more lightly trafficked roads; for traffic calming purposes; and to improve conditions for the generally higher numbers of cyclists on the local road network.

The most common accident type for cyclists at roundabouts involves a motor vehicle entering the roundabout and colliding with a cyclist on the circulatory carriageway. This often appears to be because the driver does not see, or does not register the presence of, the cyclist. Drivers tend to concentrate on detecting the more frequent and major dangers, at the expense of smaller, less common dangers such as those involving cyclists. This may explain why cycle accident rates tend to decrease with increased cycle flows at roundabouts, and also suggests that a modified geometry which increases the prominence of cyclists may be of value.

Other accident types comprising a significant minority of cycle accidents at roundabouts are a rear end shunt, and a motor vehicle exiting the junction colliding with a cycle continuing on the circulatory carriageway.

Method

6 roundabouts in Surrey and Oxfordshire were selected for study. Cyclists were involved in between 25% and 85% of reported accidents at these sites. The roundabouts ranged in size from 30-90m external diameter, with total entry flows between 11,000 and 41,000 vehicles in 12 hours, and between 1,500 and 3,700 per hour in the peak hours.

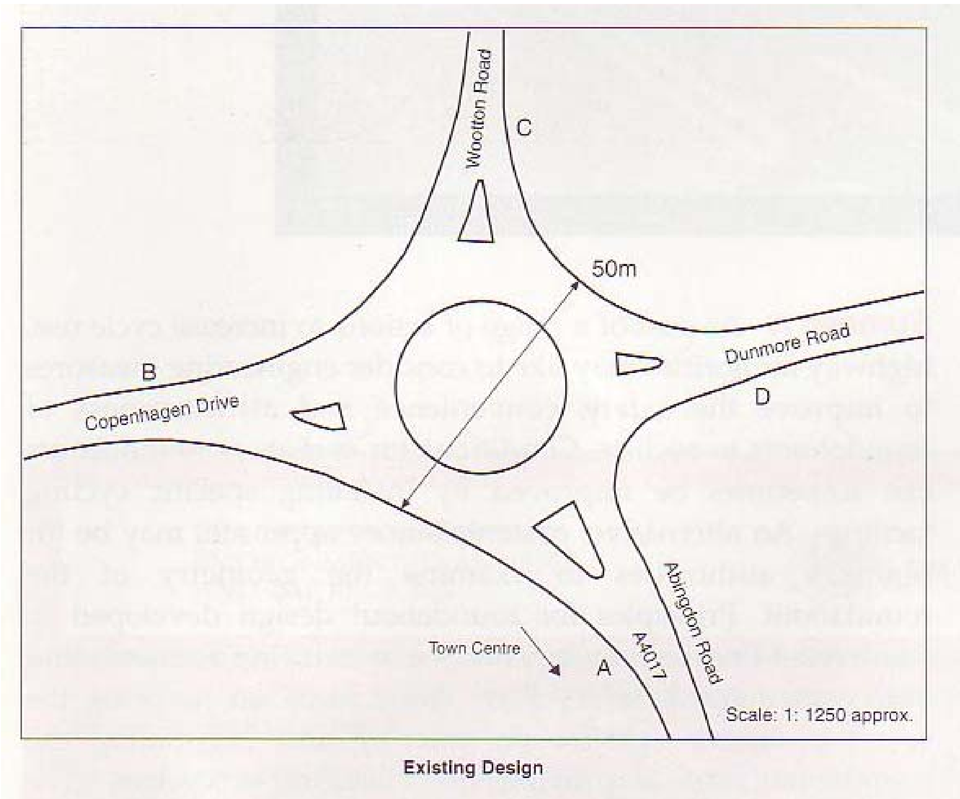
The traffic model ARCADY/3 was used to assess the potential effects on capacity and safety of modifying these roundabouts to a continental design. The morning peak period was modelled, based on observed turning counts. An iterative process allowed for amendments to the designs to achieve balance between safety and capacity within the physical constraints of the sites. Figure 1 illustrates the amendments to the design in Abingdon.

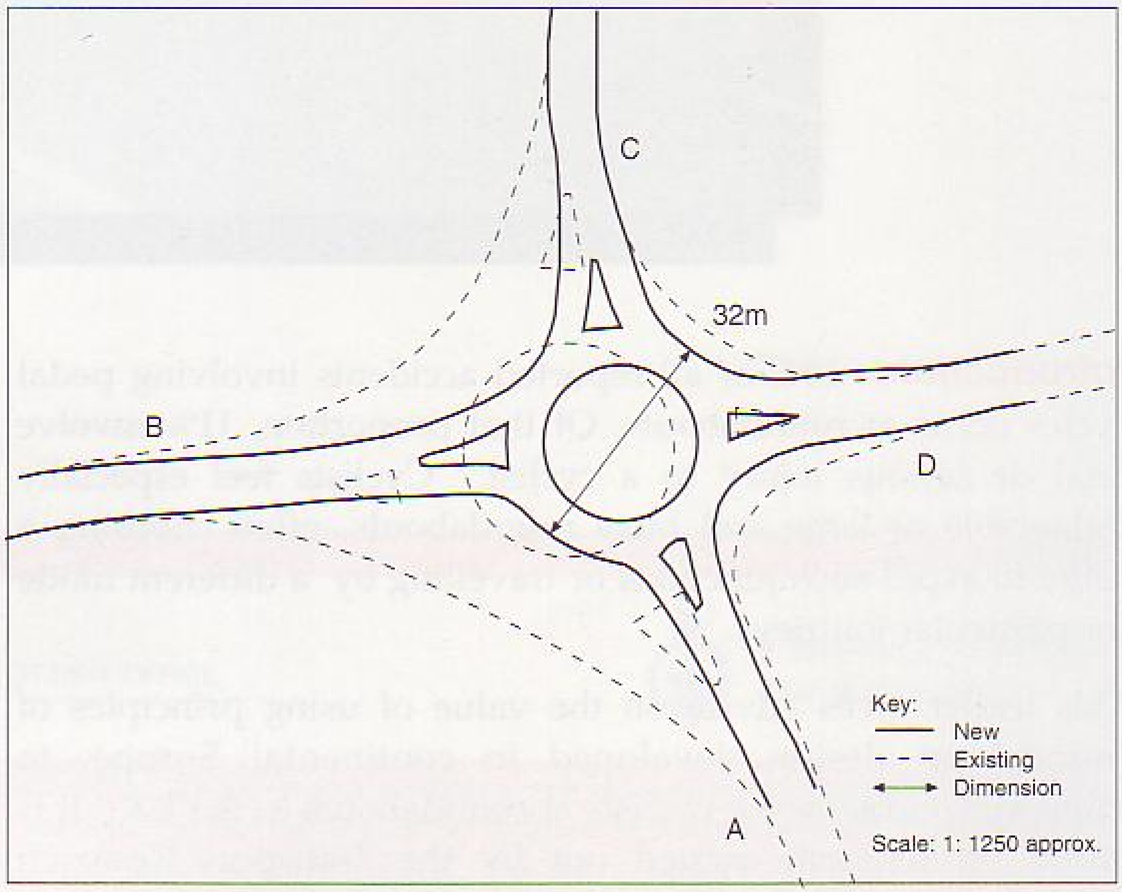
Limitations in the approach

ARCADY/3 is a fairly coarse tool for assessing cyclists safety. It does not address issues relating to specific road user groups and is not a behavioural or simulation model. It is uncertain whether the prediction facility is sufficiently sensitive to cycles to fully reflect likely changes. Where there is an unusually high proportion of two wheelers, entry-circulating accidents may not be well predicted.

Visual ARCADY/4 is now available from TRL.

Figure 1: Modifications to roundabout geometry according to parameters used in continental Europe





Continental Design

Effect on accidents

ARCADY/3s accident calculations do not distinguish accidents involving cycles from other accidents. Table 2 shows the change in the predicted accident index at each site, following the redesign of the junction. At the junctions where the overall accident index remained the same or increased, this was largely due to an increase in the accident index of a single arm. In general ARCADY/3 predicted that collisions between a vehicle on the circulatory carriageway and a vehicle on the approach arm will fall with the application of continental design principles. These are the most common type of accident at roundabouts in which cyclists are involved. This was offset in some cases by an increase in accidents on the approach arms, mainly rear end shunts.

ACCIDENT INDEX

	Existing Design	Modified Design
Abingdon	0.44	0.38
Didcot	0.44	0.39
Egham	0.70	0.70
Oxford	1.63	1.25
Redhill	0.91	0.88
Woking	0.58	0.70

Table 2: Effect of continental roundabout design on predicted safety

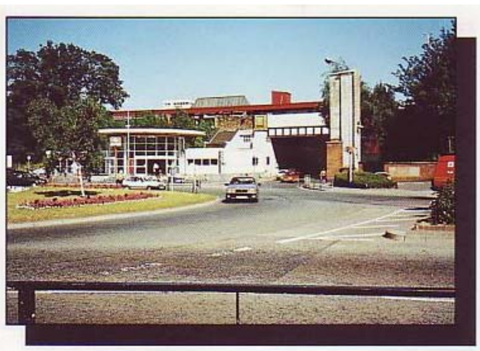
Speed reduction and accident severity

ARCADY/3 does not predict the severity of an accident. However, there is a link between tighter geometric design and lower vehicle speeds, so where a design results in reduced speed, a reduction in the severity of accidents may be expected. Dutch experience also suggests that continental design modifications result in reduced speeds. In Dutch studies, accident numbers remained the same but the severity of accidents was reduced. Reductions in capacity were also noted.

Speed on entry and on the circulatory carriageway will be higher with increased entry width, where entry deflection is minimal, and where the entry angle is very acute. Where designs are aimed at reducing vehicle speeds motorists need to have sufficient warning of the presence of the roundabout to be able to comfortably modify their speed before reaching it. Full consideration should be given to how this can be achieved effectively. Otherwise an increase in rear end shunts may result.

In general, the safety implications of introducing continental designs are likely to be:

Reduction in approach widths and entry widths, leading to	↓	entry-circulating accidents
	↓	single vehicle accidents
	↑	approach arm accidents
Increase in ratio of central island to overall size of junction, leading to	↓	entry-circulating accidents
Increase in entry path curvature, leading to	↓	entry-circulating accidents
	↑	single vehicle accidents
	↑	approach arm accidents



Effect on capacity

The continental designs led to a reduction in predicted capacity at all the roundabouts studied. This is depicted in Figure 2 which shows the maximum ratio of flow to capacity (RFC) for each arm at each junction. A predicted maximum RFC of ¡Ü 0.85 is usually considered an acceptable coefficient for new design. This will usually mean considerable spare capacity in the off peak period. The results for the existing designs indicated spare capacity at all except 2 arms in the morning peak periods. The continental designs predicted an RFC in excess of 0.85 at 7 of the 23 arms in the morning peak periods. Oxford has been excluded from this figure as the very high proportion of cyclists using this junction (43% in the morning peak) cast serious doubt on the ability of ARCADY/3 to model delays accurately.

Figure 2: Effect of continental roundabout design on predicted capacity

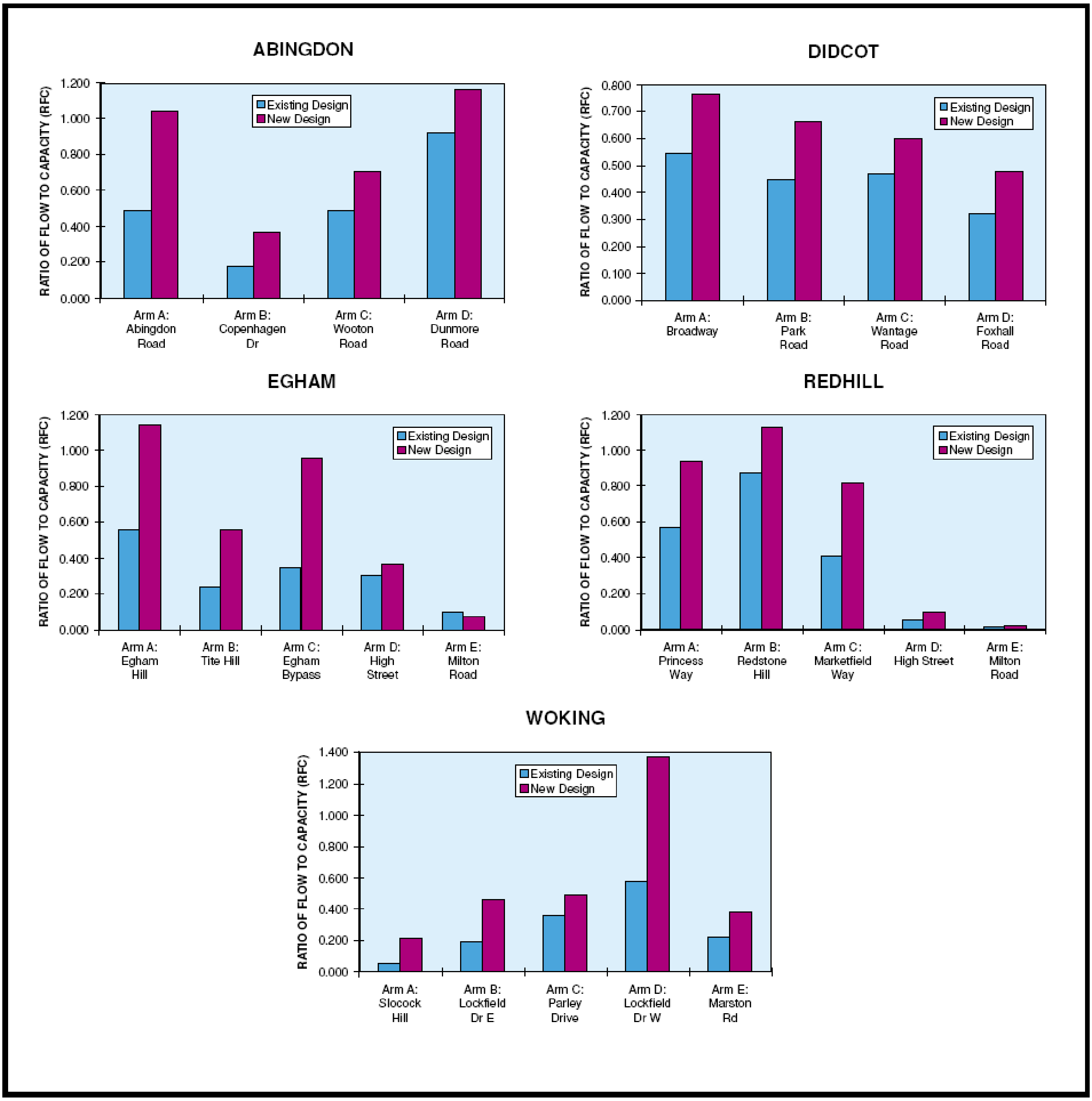


Figure 2 : Effect of continental roundabout design on predicted capacity

Table 1 compares the similarities and differences between roundabout design in the UK and in continental Europe. The main difference is the design capacity which will be greater for roundabouts in the UK. There is a great deal of scope within the parameters of TD16/93 to improve conditions for cyclists, and TD16/93 will not always be in conflict with continental design. **Careful reference should be made to TD16/93 for a precise definition of the design parameters referred to in this leaflet**.

The key features of continental roundabout design are:

- arms that are perpendicular, rather than tangential to the roundabout
- single lane entries and exits (widths 4-5m)
- minimal flare on entry
- inscribed circle diameter 25-35m
- circulatory carriageway 5-7

The information included in the Continental Practice column of Table 1 is drawn from the following references:

- Balsiger, O (1995) Cycling at roundabouts - Safety aspects. Proceedings of the 8th Velo-City conference. Switzerland
- Centre for Research and Contract Standardisation (CROW) (1993). Sign up for the bike - Design Manual for a Cycle Friendly Infrastructure. The Netherlands
- Kjemtrup, K (1993) Danish guidelines for roundabouts in urban areas. Giratoires 92. Actes du Seminaire International 1992. France
- Van Minnen (1993) Experiences with new roundabouts in the Netherlands. Giratoires 92. Actes du Seminaire International 1992. France

Table 1: Comparison of UK and continental European design guidelines for roundabouts

Design Feature	Continental Practice	UK Practice: DMRB V6, S2, TD 16/93 (DOT, 1993)	Variation
Approach arms	Perpendicular to roundabout centre. Preferably curved	Ideally perpendicular to carriageway however can be skewed if conforms to entry angle, entry path curvature	No
Entry width, e	Single lane, Usually 4m	Good practice to add at least one extra lane width to the entry approach	Yes
Entry radius, r	*Not specified, but tight geometry required (approximatly 10m from drawings)*	Minimum 6m: desirable 20m	No
Entry angle, Ø	*Not specified, but tight geometry required (approximately 30 to 45 degrees from drawings)*	If possible, between 20 and 60 degrees	No
Entry path curvature	*Not specified but, from drawings, not to exceed 100m*	The tightest radius of entry shall not exceed 100m	No
Exit arms	Perpendicular to roundabout centre	Easy exits (not perpendicular) encouraged with increased exit radius and space for faster vehicles to overtake	Yes
Exit radius	Not specified, but tight geometry required (approximately 10m)	Minimum 20m: desirable 40m	Yes
Exit width	Single carriageway	Where possible should allow for an extra traffic lane over and above that of the link downstream	Yes
Roundabout external diameter (Inscribed Circular Diameter)	Maximum 35m Minimum 25m	Minimum 28m <36 m = small (roundabout) >100 m acceptable	Yes
Central island diameter	Maximum 25m Minimum 16m	Minimum 4m	Yes
Circulatory carriageway	Single lane Width 5-7m Exit width < 5m	Lie between 1.0 and 1.2 times the maximum entry width. If the ICD is < 36 m (Continental requirement) the geometry varies.	Yes

Further Information

Walking and Cycling
3/27 Great Minster House
76 Marsham Street
LONDON SW1P 4DR
Tel 020 79442983

References

TRL Report 285: Cyclists at roundabouts - the effect of continental design on predicted safety and capacity.

TRL State of the Art review 1995: The Design of Roundabouts.

TD16/93 Geometric Design of Roundabouts. Design Manual for Road and Bridges Volume 6, Section 2 (DOT 1993)

Traffic Advisory leaflet 9/96: Cycling Bibliography

National Cycling Strategy 1996 (and Appendices)

Cycle Friendly Infrastructure: Guidelines for Planning and Design (Bicycle Association/ CTC/ DOT/ IHT 1996)

Cyclists and Roundabouts: A Review of Literature (Allott and Lomax, 1991 & 1993)

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