
VOLUME 6 ROAD GEOMETRY
SECTION 2 JUNCTIONS

PART 2

TD 54/07

DESIGN OF MINI-ROUNDBABOUTS

SUMMARY

This document sets out the design standards and advice for the design of mini-roundabouts. It supersedes the advice on mini-roundabouts that was previously contained in TD 16/93.

INSTRUCTIONS FOR USE

1. Remove contents pages from Volume 6 and insert new contents pages dated August 2007.
2. Insert new Standard TD 54/07 into Volume 6, Section 2.
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NORTHERN IRELAND**

Design of Mini-Roundabouts

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DESIGN OF MINI-ROUNDBABOUTS

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1. INTRODUCTION

General

1.1 A mini-roundabout has a central circular solid white road marking, which is flush with the road surface or slightly domed, instead of the central island found on conventional roundabouts. The marking is between one and four metres in diameter. If it is domed it may be up to 125mm at its highest point although this standard recommends it does not exceed 100mm. A mini-roundabout must have an Inscribed Circle Diameter (ICD) of 28m or less (see paragraph 6.1).

1.2 Traffic signs and road markings for mini-roundabouts are prescribed in the Traffic Signs Regulations and General Directions (TSRGD). The Traffic Signs Manual Chapters 3 and 5 include supporting advice on signs and road markings. These documents must be applied as part of the design process in conjunction with this standard.

1.3 The legislation referred to in this document may, in some instances, have a specific Northern Ireland equivalent. For schemes in Northern Ireland, the designer should refer to the Overseeing Organisation for advice.

1.4 For the purpose of this standard:

- TSRGD diagram numbers reference appropriate traffic signs and road markings.
- The central circular solid white road marking is referred to as the 'white circle'. The white circle and the associated circulatory arrow markings are to TSRGD diagram 1003.4.

Scope

1.5 This document sets out the requirements for the location and design of mini-roundabouts including:

- three-arm and four-arm mini-roundabouts;
- double mini-roundabouts.

1.6 Advice is given on the following:

- the safety of mini-roundabouts and their suitability for non-motorised road users (NMUs);
- the siting requirements for mini-roundabouts including a flowchart for preliminary assessment;
- the geometric design features and conspicuity of mini-roundabouts.

1.7 Advice on the design of mini-roundabouts was previously given in **TD 16/93**. The main changes from **TD 16/93** relate to:

- (i) assessment, safety and accessibility impacts with information on capacity and restrictions on siting;
- (ii) positioning of the white circle and Give Way markings using vehicle swept paths;
- (iii) forward visibility from approach arms and visibility between arms;
- (iv) road and lane widths, with restrictions on the number of entry lanes;
- (v) height of domed white circles and use of 'build-outs' and traffic islands;
- (vi) conspicuity of mini-roundabouts in all conditions.

Implementation

1.8 This standard must be used forthwith for the design of all schemes for the construction and improvement of all-purpose trunk roads currently being prepared, provided that in the opinion of the Overseeing Organisation, this would not result in any significant additional expense or delay. The Design Organisation must confirm its application to particular schemes with the Overseeing Organisation.

General Principles

1.9 The decision to introduce a mini-roundabout at a particular site should take account of locally prevalent types of junction, traffic control and driver expectation.

1.10 Mini-roundabouts with standard advisory give way markings (diagram 1003.3) rely on the 'priority to the right' rule for traffic (diagram 611.1).

1.11 Many existing mini-roundabouts have been introduced to replace priority junctions. The purpose of this has often been to address issues such as accident reduction, redistribution of queues and delays in a junction or road system or in conjunction with a traffic-calming scheme.

1.12 In some instances, for the space available, mini-roundabouts can achieve greater capacity than other types of junction, for example traffic signals. They are often a compact and low cost option for junction design.

1.13 Three-arm mini-roundabouts and less busy four-arm mini-roundabouts are relatively safe over a wide range of geometric variables. However, experience has shown that busy four-arm and double mini-roundabouts may not perform as well in operational or safety terms as alternative forms of junction. Four-arm mini-roundabouts are susceptible to widely variable accident rates.

1.14 Early discussions with the Maintaining Authority are recommended. Consideration should be given to all design measures that would improve the whole life value of the scheme by assisting safe and efficient maintenance.

1.15 Mini roundabouts may not be appropriate for use with Urban Traffic Control (UTC) or Integrated Demand Management (IDM) systems, or for other circumstances where access control is required.

Mandatory Sections

1.16 Mandatory sections of this document are contained in boxes. The Design Organisation must comply with these sections or obtain agreement to a Departure from Standard from the Overseeing Organisation. The remainder of the document contains advice and explanation, which is commended to users for consideration.

Departures from Standard

1.17 In exceptional situations, the Overseeing Organisation may be prepared to agree to a Departure from Standard where the standard, including permitted Relaxations, is not realistically achievable. Design Organisations faced by such situations and wishing to consider pursuing this course must discuss any such option at an early stage in design with the Overseeing Organisation. Proposals to adopt Departures from Standard must be submitted by the Design Organisation to the Overseeing Organisation and formal approval received **before** incorporation into a design layout.

Relaxations

1.18 In difficult circumstances Relaxations may be introduced at the discretion of the Design Organisation, having regard to all relevant local factors, but only where specifically permitted by this Standard. Careful consideration must be given to layout options incorporating Relaxations, having weighed the benefits and any potential disbenefits. Particular attention must be given to the safety aspects (including operation, maintenance, construction and demolition) and the environmental and monetary benefits/disbenefits that would result from the use of Relaxations. The consideration process must be recorded. The preferred option must be compared against options that would meet full Standards.

2. SITING AND USE OF MINI-ROUNDBABOUTS

Speeds and Speed Limits

2.1 Mini-roundabouts must only be used on roads with a speed limit of 30mph or less and where the 85th percentile dry weather speed of traffic is less than 35mph within a distance of 70 metres from the proposed give way line on all approaches, unless installed in combination with speed reduction measures.

2.2 Where the existing 85th percentile dry weather speed is 35mph and above and a mini-roundabout is installed in combination with speed reduction measures in anticipation of reducing speeds to the required level, post installation vehicle speed monitoring must be undertaken. In the event that vehicle speeds remain at 35mph or above, further speed reducing measures must be installed.

Road Network and Land Use

2.3 Mini-roundabouts are suitable as an improvement or remedial measure in a wide range of situations in built-up areas, including residential, business and shopping areas. However, where the forecast two-way Annual Average Daily Traffic Flow (AADT) on any arm is below 500 vehicles, a junction arrangement in accordance with **TD 42 (DMRB 6.2.6)** should provide the most appropriate design, with less likelihood of unwarranted disruption to the main traffic streams. Mini-roundabouts may be inappropriate for frequent use by long vehicles and some public service vehicles. The dimensions of these vehicles can often lead to relatively difficult manoeuvres within the space usually available. It may be inappropriate to locate mini-roundabouts along routes leading to industrial areas or ports and main bus routes.

2.4 A mini-roundabout can be used at an existing junction provided there is adequate visibility and space for kerb realignment (see Chapter 6).

2.5 Mini-roundabouts must not be used:

- at new junctions;
- at direct accesses. See **TD 41 (DMRB 6.1.7)**;
- on dual carriageways;
- at a junction where the forecast traffic flow on any arm is below 500 vehicles per day (2-way AADT).

2.6 It may be acceptable to introduce a four-arm mini-roundabout where the forecast traffic flow on one arm is less than 500 vehicles per day (2-way AADT) providing there is a strong expectation of the need to 'give way' on all approaches. This would be dependent upon the circulating movements at each junction. In this instance the Overseeing Organisation should be contacted for further advice.

2.7 The use of mini-roundabouts is not recommended at or near junctions where turns into or out from side roads are prohibited. This is because drivers do not expect to see vehicles U-turning on mini-roundabouts.

2.8 Introducing a mini-roundabout may lead to the reassignment of traffic to and from other routes. There is therefore a need to assess the surrounding network for the traffic and safety implications of introducing a new mini-roundabout.

2.9 Roundabouts in urban areas are not always compatible with Urban Traffic Control (UTC) systems. These systems move vehicles through controlled areas in platoons by adjusting traffic signal times to suit the required progress. Roundabouts can interfere with platoon movement to the extent that subsequent inflows to downstream traffic signals cannot be reliably predicted, and thus the sequence breaks down. However, in some cases, for example where there is a heavy right turn flow, a roundabout may be a better option.

2.10 The Design Organisation must assess the lengths of queue likely to be generated by the introduction of a mini-roundabout and ensure that any queues generated do not adversely affect the operation or safety of adjacent highway features.

Conflicts

2.11 Where a three-arm mini-roundabout with single lane approaches replaces a major/minor priority junction, the junction becomes easier to negotiate, as drivers only have to concentrate on one stream of traffic circulating at low speed from their right. However, as the number of arms and/or traffic lanes to the mini-roundabout increases, so does the potential for conflict.

2.12 The presence of two or more approach lanes encourages two abreast flow through the mini roundabout, increasing the number of potential conflicts. Division of entries into two lanes may require additional signing and marking to ensure safe and efficient operation. Division of entries into three lanes is not recommended, as this can be associated with high numbers of accidents, particularly involving two wheeled vehicles.

2.13 When traffic flows are low, drivers may consider conflict with other road users to be unlikely with the result that they might approach the junction at inappropriate speeds. Drivers can also be caught out by traffic approaching from their right at a relatively high speed. Inadequate or excessive visibility can exacerbate this situation. In order to make the junction work in a more predictable way, it is best to avoid installing mini-roundabouts where traffic flows or turning proportions differ widely between arms, or where approach speeds are high.

Land Requirements

2.14 The alignment of the arms and the area of land required are determined by the requirements for lateral shift on entry (see paragraph 6.4) and those relating to visibility to the right (see paragraphs 6.17 and 6.18) and Stopping Sight Distance (see paragraph 6.22). An example of a mini-roundabout and its land requirement is given in Figure 2/1.

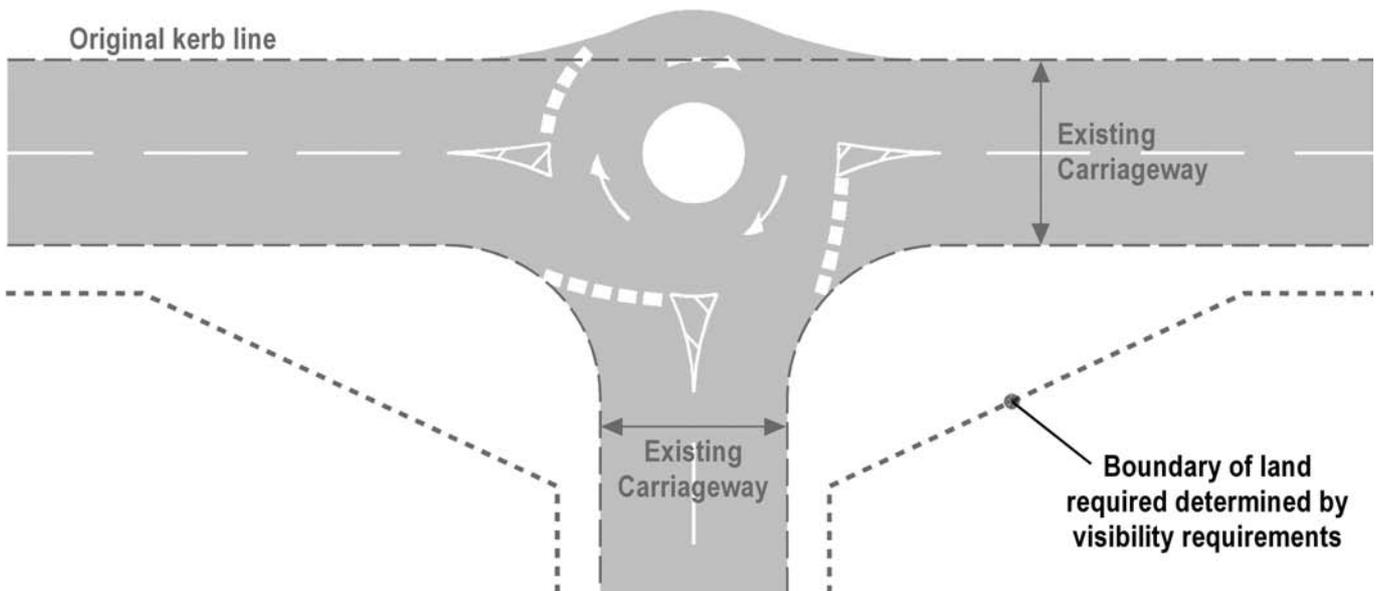


Figure 2/1 – Example of a Mini-roundabout Junction

Four-Arm Mini-roundabouts

2.15 Four-arm mini-roundabouts introduce additional conflicts and can create difficulty for drivers' perceptions of the layout and turning flows. They are not recommended where the sum of the maximum peak hour entry flows for all arms exceeds 500 veh/hr.

2.16 Mini-roundabouts with five or more arms must not be used.

Double Mini-roundabouts

2.17 Double mini-roundabouts separated by a short link can be effective in improving traffic flows at a pair

of closely spaced junctions, a staggered priority junction layout, or an existing normal roundabout.

2.18 It is important that there is sufficient space for vehicles waiting at the intermediate give way lines (i.e. those on the short link). Large opposing right-turning movements can produce gridlock at double mini-roundabouts, particularly if the network is congested (see paragraph 2.23). An example of a double mini-roundabout layout is shown in Figure 2/2.

2.19 The layout should be designed so that it is clear to drivers that they are approaching a double mini-roundabout in order to reduce the possibility of them crossing both roundabouts without noticing the intermediate give way lines.

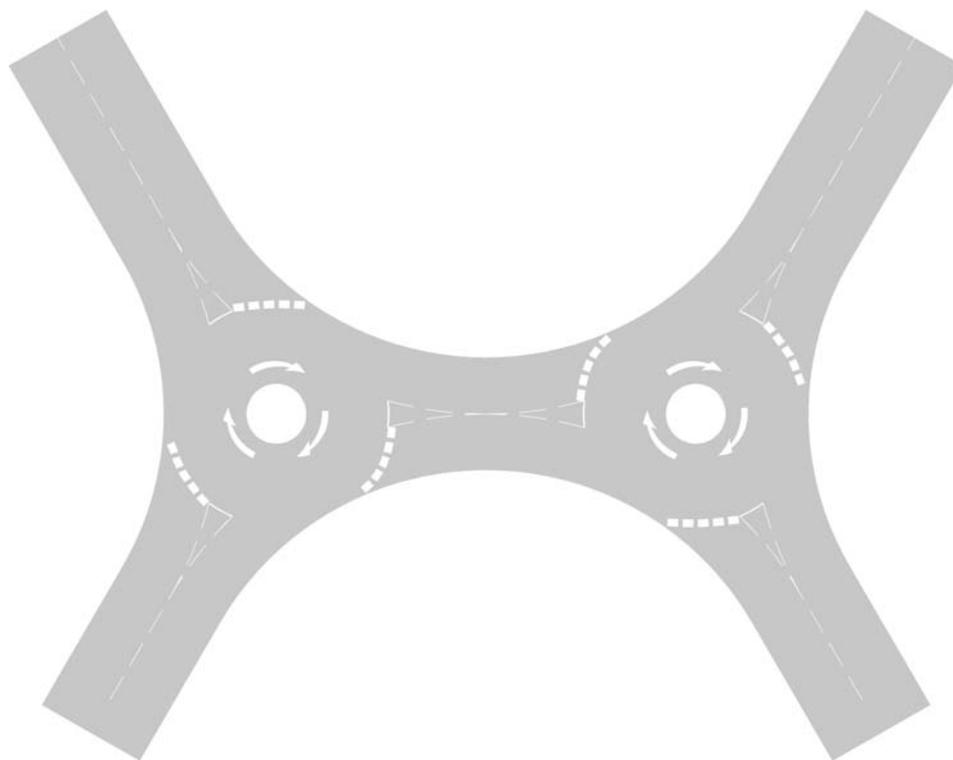


Figure 2/2 – Example of a Double Mini-Roundabout Junction

Traffic Calming Schemes

2.20 A mini-roundabout must not be used as a speed reduction measure in isolation. Where a mini-roundabout is used within a traffic-calming scheme, speed reduction must be achieved by means of suitable speed reduction measures on the approach. If the required speed reduction cannot be achieved, then a mini-roundabout must not be provided.

2.21 Any vertical deflection at a mini-roundabout must take the form of a speed table, the top of which must cover the whole junction area and extend outwards a minimum of 6m upstream of each give way line.

2.22 Refer to other publications for advice on speed reduction measures. A Traffic Calming Bibliography is contained in **Traffic Advisory Leaflet 2/05**. Advice on Trunk Road Traffic Calming is contained in **TA 87 (DMRB 6.3.5)**. Also refer to the **Highways (Traffic Calming) Regulations 1999**. Road humps must comply with the **Highways (Road Hump) Regulations 1999**. In Scotland the relevant regulations are: **Roads (Traffic Calming) (Scotland) Regulations 1994** and **The Road Humps (Scotland) Regulations 1998**.

Traffic Flow

2.23 The Design Organisation should undertake a detailed assessment of the peak capacity using suitable modelling software when making the final decision on junction choice.

2.24 The capacity at an intermediate give way line between double mini-roundabouts will be reduced by the effect of the first junction, and a queue at the intermediate give way line may interact with the first junction. Double junctions with short links of only one or two car lengths will be more susceptible than those with greater separation. In order to allow for this at the preliminary design stage, it is advisable to expect a reduction of 5% to 15% in the capacity of an intermediate give way.

Feasibility Flowchart

2.25 The flowchart in Figure 2/3 shows how to assess the feasibility of using mini-roundabouts.

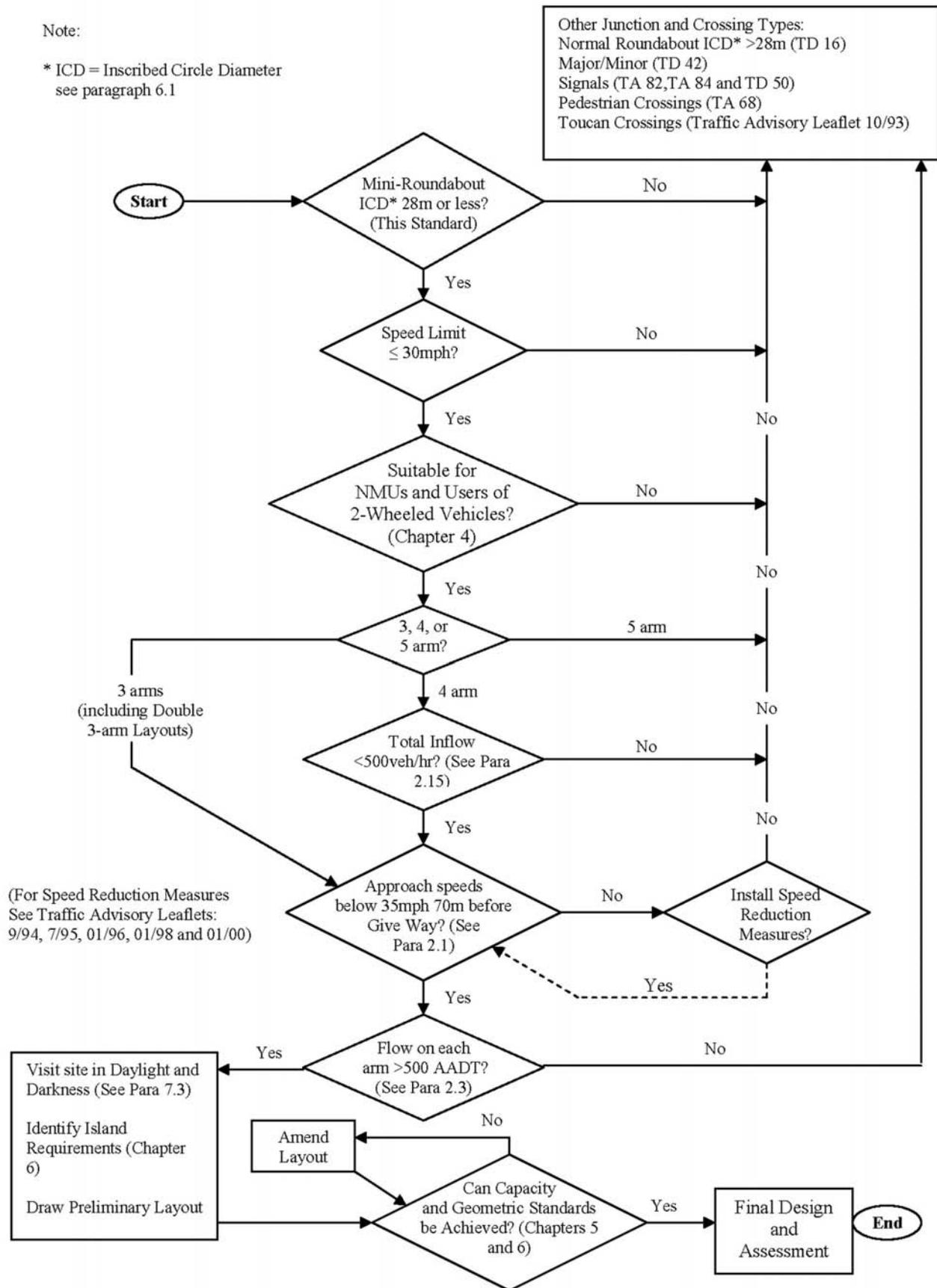


Figure 2/3 – Procedures for Assessing the Feasibility of a Mini-roundabout

3. SAFETY

General

3.1 It is important to predict, as accurately as possible, the accidents likely to occur after introducing a mini-roundabout.

3.2 Paragraphs 3.3 to 3.14 below give an indication of the frequencies of accidents at mini-roundabouts and other necessary considerations.

Sources of Information

3.3 Accidents at mini-roundabouts are identified in the national STATS19 database of Personal Injury Accidents (PIAs). **TRL Report 281 'Accidents at Urban Mini-Roundabouts'** develops relationships between accident frequency and traffic flow, road features, layout geometry, land use and other variables. It covers accidents between 1986 and 1992 at 300 single mini-roundabouts on roads with 30mph speed limits. There have been no other studies as comprehensive as TRL Report 281.

3.4 Further relevant information on accidents at existing junctions and mini-roundabouts in particular areas should also be available from highway authorities. Care should be taken to ensure that data is comparable and relevant.

3.5 The **Monitoring Of Local Authority Safety SchemES (MOLASSES)** database is a current source of information on accident savings resulting from improvements of various types including mini-roundabouts (refer to **TRL Report 512**). MOLASSES is predominantly designed for use by Local Highway Authorities within the United Kingdom and their representative organisations such as the County Surveyors' Society and the Association of London Authorities. The Highways Agency also contributes to MOLASSES.

Junction Type and Road User Involvement

3.6 For three-arm sites, the mean accident rate for mini-roundabouts is similar to that of priority T-junctions and about 30% less than that of signalised junctions. The severity of accidents (percentage of fatal and serious accidents compared to all injury accidents) at three-arm mini-roundabout sites is lower than at

three-arm signalised junctions and considerably lower than at 30mph T-junctions (Table 17, TRL Report 281 - data based upon a stratified sample).

3.7 Nearly 40% of accidents at mini-roundabouts involve two-wheeled vehicles, the majority of these being entry or circulating accidents (Table 10a, TRL Report 281).

3.8 Motorcycles and pedal cycles are, respectively, eight and nine times more likely than cars and light goods vehicles to be involved in injury accidents at three-arm mini-roundabouts. The equivalent risk for both modes at T-junctions or signals is six times the car/light goods vehicle rate. (See Table 18a, TRL report 281). This demonstrates the importance of carefully considering the safety of these modes when selecting the junction type.

Accident Categories

3.9 Table 8 of TRL Report 281 provides accident types that occur typically at mini-roundabouts. The data is combined for three and four-arm mini-roundabouts and includes vehicle accidents involving pedal cycles, motorcycles, cars, light goods vehicles, heavy goods vehicles and public service vehicles. The accident types and their respective proportions of the accident total at mini-roundabouts are revealed as:

- (i) single vehicle accidents (8.7%);
- (ii) shunts and side collision on entry (11.2%);
- (iii) entering/circulating (54.7%);
- (iv) other vehicle accidents (10.6%);
- (v) pedestrian accidents (14.8%).

Accident Prediction

3.10 The mean frequency of personal injury accidents for three-arm mini-roundabouts derived from TRL Report 281 is 1.35 per year in London and 0.79 elsewhere.

3.11 The mean frequency of personal injury accidents for four-arm mini-roundabouts derived from TRL Report 281 is 1.70 per year in London and 1.20 elsewhere.

3.12 Suitable computer programs, which incorporate models developed from the relationships in TRL Report 281, may be used to predict accidents in each category at mini-roundabouts. It is possible to make predictions using flow data alone, or flow data together with junction features and geometry.

3.13 The safety of most three-arm mini-roundabouts and some four-arm mini-roundabouts with low flows is robust over a wide range of variables. However, four-arm and double mini-roundabouts can produce several times more personal injury accidents than predictions or averages would suggest. At busy mini-roundabouts, drivers may be uncertain of conflicting movements, leading also to damage-only accidents.

3.14 Designers should also note that additional or unusual features at or near mini-roundabouts can give rise to higher accident rates than forecast by standard methods. At sites where accidents cannot be predicted with confidence, provision should be made for modification of the junction in the event of accidents exceeding expectations.

4. ROAD USERS SPECIFIC REQUIREMENTS

Pedestrians

4.1 Careful consideration is required where significant numbers of pedestrian crossing movements are likely to take place across any of the arms of a mini-roundabout. In these circumstances, the Design Organisation must either facilitate uncontrolled crossing movements by providing adequately sized traffic islands, avoiding entries or exits greater than single lane width, or they must provide conveniently situated controlled crossing facilities.

4.2 Guidance on providing for pedestrian (and other Non-Motorised User) requirements is provided by **TA 90 (DMRB 6.3.5)**, **TA 91 (DMRB 5.2.4)** and **HD 42 (DMRB 5.2.5)**.

4.3 Introducing a mini-roundabout can significantly affect accessibility for pedestrians. Lack of gaps in entering or exiting traffic streams and difficulty in perceiving turning movements can cause difficulty.

4.4 Pedestrian movement is considered significant where flows of pedestrians are high, or are likely to include children, elderly or disabled people (e.g. schools, health facilities, shops, public transport facilities and places of employment). The Design Organisation should allow for potential pedestrian routes that have been identified as part of a walking strategy or other local policies, or where future development would lead to significant pedestrian movement.

4.5 Requirements for islands are contained in paragraphs 6.23 to 6.31.

Two-Wheeled Vehicles

4.6 The safety of cyclists and motorcyclists must be considered when choosing, siting and designing a mini-roundabout. They should not be used at sites where inexperienced riders are likely to use them (on routes to schools for example) except in conjunction with adequate speed reduction measures. Alternative junction types, or

separate provision for cyclists at junctions on designated cycle routes must be provided where there are significant cycle flows (see paragraph 4.2).

4.7 Cyclists and motorcyclists are vulnerable at mini-roundabouts, and young or inexperienced riders are particularly at risk. The Design Organisation should provide facilities that would allow cyclists to avoid the entire junction whenever practicable. Refer to other publications where separate provision for cyclists is required, including **TA 90 (DMRB 6.3.5)**, **TA 91 (DMRB 5.2.4)** and **HD 42 (DMRB 5.2.5)**, and the Cycling Bibliography contained in **Traffic Advisory Leaflet 3/05**.

4.8 Road surfacing at a mini-roundabout can become polished or deformed by turning vehicles, particularly lorries. The skidding resistance of road markings and ironwork can also be different from that of surfacing materials. Surface features within the junction should not present a hazard for turning motorcyclists. It is recommended that ironwork is not positioned along the line a motorcyclist might be expected to take.

4.9 Ironwork must be carefully positioned to minimise the potential for powered two-wheeled vehicle loss-of-control accidents and have a suitable loading class with similar friction properties to that of the road surface.

4.10 Irregular surface features must be eliminated on the approaches to, and within the junction. Existing channels and changes in crossfall must be eliminated if they are likely to destabilise two-wheeled vehicles, or to deteriorate because of a change in wheel paths resulting from the introduction of the mini-roundabout.

4.11 Where a mini-roundabout is installed the entire junction should be considered for resurfacing. This can prevent problems at the joint between the old and new road caused by the scrubbing action of the rear tyres of heavy vehicles.

4.12 See **HD 36 (DMRB 7.5.1)** for further advice on appropriate surfacing materials and **HA 83 (DMRB 4.2.4)** for safety aspects of drainage features. See **IHIE Guidelines for Motorcycling** for more details on Powered Two Wheeled Vehicle issues.

4.13 Road marking materials with improved skid resistance must be used for the whole of the mini-roundabout road marking to diagram 1003.4. Details of the requirements for improved skid resistance of road markings are contained in Clause 1212 of **MCHW Volume 1**.

5. ASSESSMENT

General

5.1 A project appraisal should be carried out in accordance with the Overseeing Organisation's current practices and the requirements of this document.

Capacity and Delay

5.2 The design period and forecast of traffic growth should be subject to the requirements of the highway authority and local transport policies for the area in which the mini-roundabout is situated.

5.3 Once a preliminary geometric design has been produced, capacity and delays can be predicted for mini-roundabouts using suitable computer software, which incorporates models developed from the relationships in TRL Report 281.

5.4 A ratio of flow to capacity of 85% should be used where possible to allow for variation of $\pm 15\%$ in the accuracy of capacity prediction. Higher values may be acceptable, subject to the assessment of other impacts, such as that on safety for vulnerable road users and the effect of possible queuing on the road network.

6. GEOMETRIC DESIGN FEATURES

Inscribed Circle Diameter

6.1 The inscribed circle diameter (ICD) of a mini-roundabout is the diameter of the largest circle that can be inscribed within the junction kerbs. The maximum ICD of a mini-roundabout is 28m. Above this dimension, a normal roundabout can accommodate the largest design vehicle and must be used. For further guidance see **TD 16 (DMRB 6.2.3)**.

Vehicle Path

6.2 Both the speed and path of a vehicle through a mini-roundabout are important factors in accident causation. The layout should be designed so that the approaching drivers are aware of the circulatory nature of the junction ahead. Drivers need to be ready to stop if necessary on the approach so it is essential for entry (and circulatory) speed to be managed by careful design.

6.3 A design that encourages drivers to follow a suitable path at an appropriate speed is critical to safety. The construction of this path and the final layout is an iterative process that requires successive trial designs by repositioning traffic islands and the white circle to obtain the optimum solution. The use of a computer-simulated model for vehicle movements is preferred. The use of such techniques to predict swept paths should assist the design organisation with locating kerb lines and the alignment of road markings.

6.4 As vehicle speeds should already be low, full deflection as required for standard roundabouts need not be provided. However, some deflection on entry will help to induce gyratory movement and increase efficiency. A lateral shift (see Figure 6/1) of 0.8m minimum should be provided at entry. This shift should preferably be introduced on the offside of the approach arm. For offside shift, the lateral shift should be measured from the centre of the approach road, developed at rate 1 in 7.5 as shown in Figure 6/1 Example A. In difficult circumstances where there are land or other constraints, it is possible to consider an alternative method to develop shift along the nearside carriageway edge. This method is defined as 'nearside shift' as shown in Figure 6/1 Example B. Nearside shift can be an effective way of introducing deflection in

order to encourage low entry speeds. However, nearside shift can have the effect of deflecting traffic to the right, towards the central island, and is therefore often less effective in inducing a gyratory movement than offside shift. For this reason, nearside shift is deemed to be less desirable than offside shift. For nearside shift, the lateral shift should be measured from the nearside edge of the approach road, developed at a rate 1 in 12.5.

6.5 The value of 0.8m for lateral shift corresponds to the minimum width required to accommodate hatched road marking to diagram 1040 and diagram 1040.2. These markings are used to separate opposing traffic flows and further details can be found in Chapter 5 of the Traffic Signs Manual. The layout of road markings on the approaches should encourage drivers to follow the correct route through the junction. The design should take account of predicted swept paths, and the guidance in paragraph 6.2 relating to speed management.

6.6 Where the lateral shift referred to in paragraph 6.4 cannot be achieved or visibility to the right is limited (see paragraph 6.17), mandatory give way signs and markings (diagrams 602, 1003 and 1023) may be used on the approach. The only case where it may be appropriate to use these is at an approach to a three-arm mini-roundabout where there is another entry to the right but none to the left as shown in Figure 6/5 and Chapters 3 and 5 of the Traffic Signs Manual. Their use in other situations can confuse drivers as to who has priority and undermines the priority rule established for mini-roundabouts.

6.7 When diagram 602 is used, it must be accompanied by diagram 1023 and by the give way marking to diagram 1003.

6.8 The following requirements together determine the location of the white circle as illustrated in Figures 6/2 and 6/3:

- (i) It must be as large as practicable up to a maximum of four metres diameter and positioned using the inside of the swept path of cars.
- (ii) The centre of the design vehicle path must be at least 1 metre from kerbs, the perimeter of the white circle, and from any road marking separating opposing traffic.

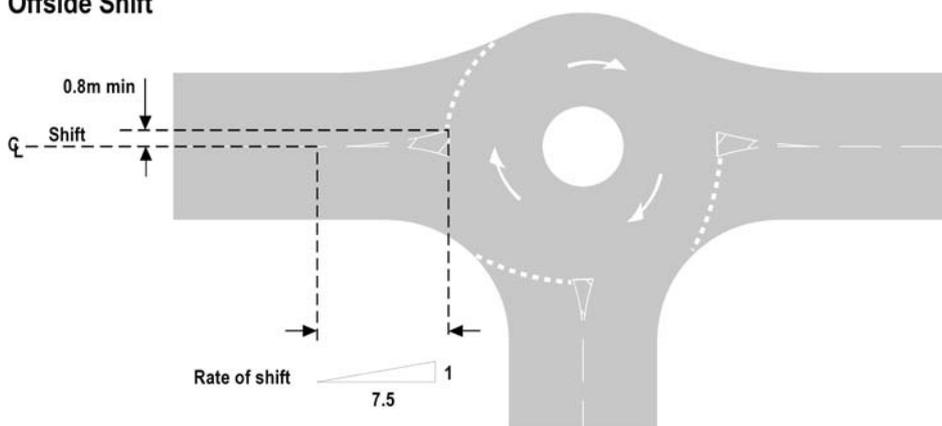
- (iii) A minimum design vehicle path radius of 6 metres, at the centre of the path, must be allowed for right turns. For this radius the vehicle path should be widened to 3m at the apex of the turn.
- (iv) For mini-roundabouts with two or three entry lanes (although three lane entries are not recommended, see paragraph 2.12), the width of the circulatory carriageway must be sufficient to enable cars to travel two abreast around the white circle.

6.9 TSRGD regulation 16(1) requires that a vehicle proceeding through the junction must keep to the left of the white circle, unless the size of the

vehicle or the layout of the junction makes it impracticable to do so. Therefore, the white circle must be sized and located so that drivers of light vehicles are not encouraged to drive on it or pass on the wrong side of it when negotiating the junction.

6.10 The white circle (1m to 4m diameter) should be formed and maintained in white reflectorised materials that provide a clear and durable contrast with the adjacent surface in all conditions. It may be domed in accordance with paragraph 6.13. No road markings or road studs other than the prescribed mini-roundabout markings (diagram 1003.4) are permitted at a mini-roundabout.

Example A
Offside Shift



Example B
Nearside Shift

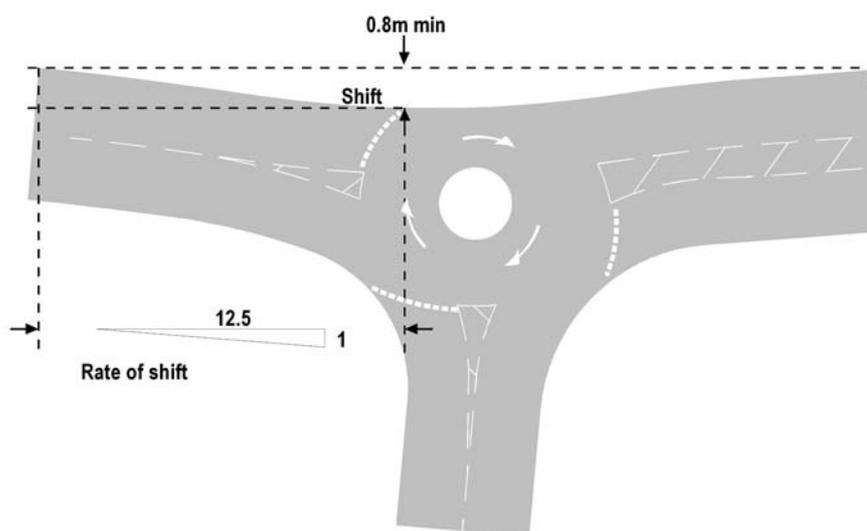


Figure 6/1 – Illustration of Lateral Shift

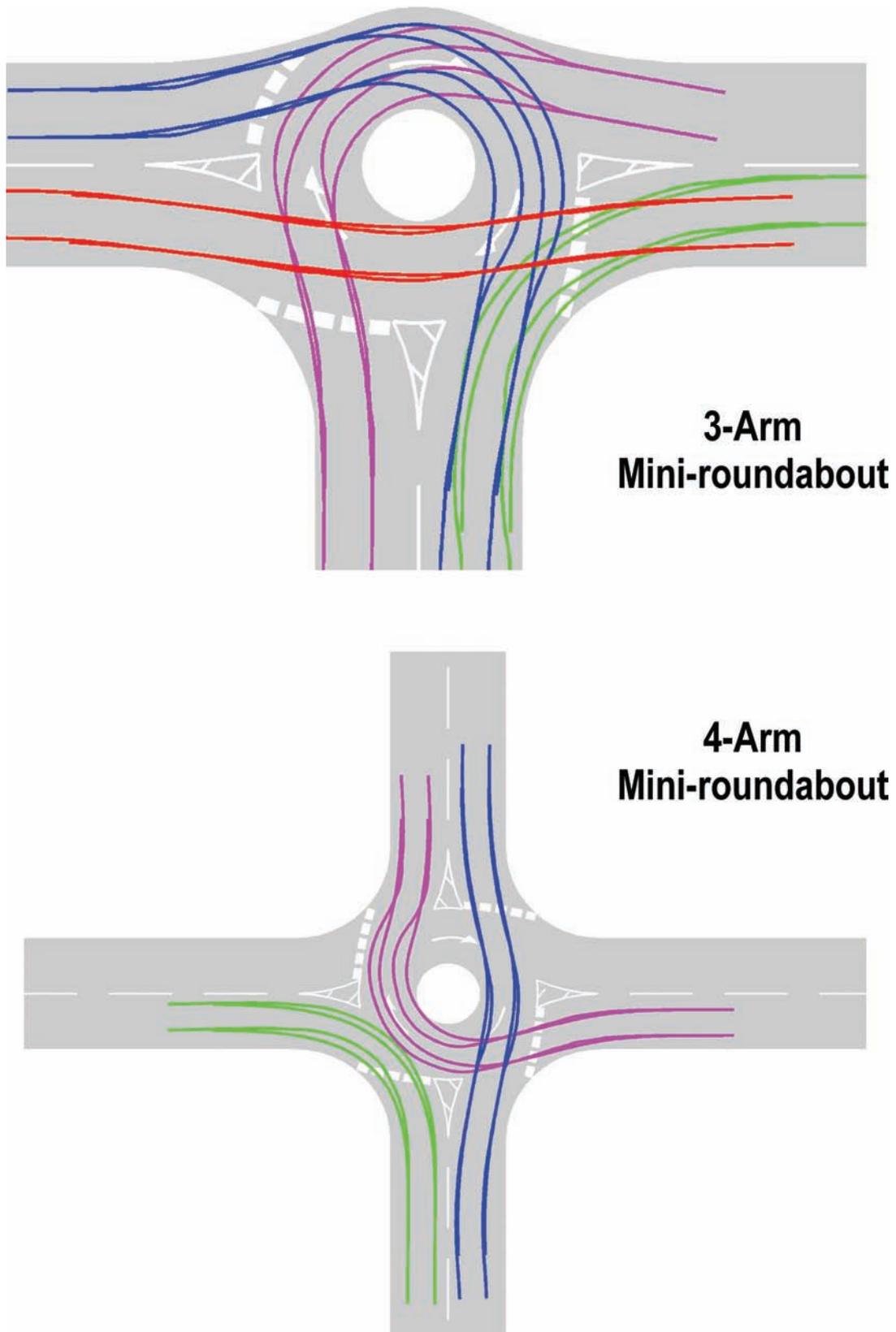
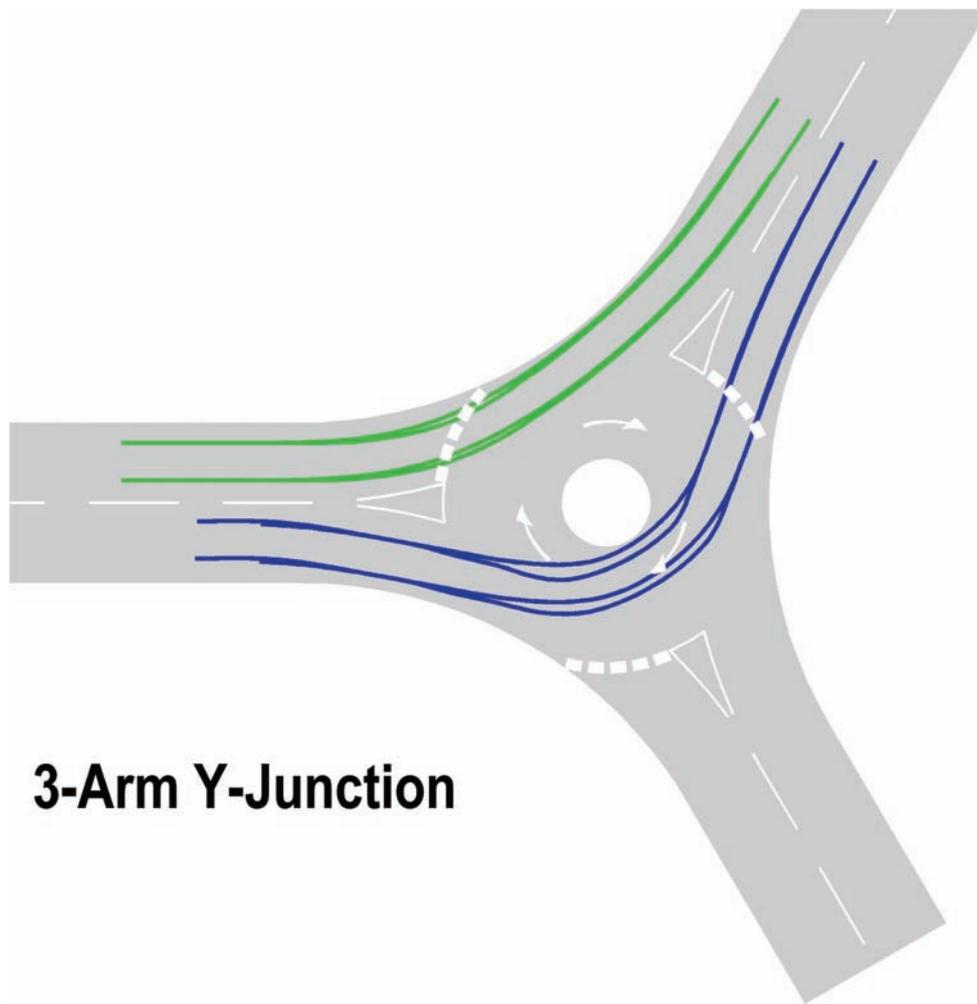


Figure 6/2 – Determination of Vehicle Path and White Circle location Using Swept Paths



3-Arm Y-Junction

Figure 6/3 – Determination of Vehicle Path and White Circle location Using Swept Paths

6.11 A concentric overrun area may be used if required to increase the deflection and conspicuity; the maximum diameter of the overrun area is 7.5m. See Figure 6/4. It should be noted that light vehicles are not legally obliged to avoid overrun areas in the same way as the white circle of a mini-roundabout and therefore concentric overrun areas cannot be relied upon for the purposes of achieving deflection. Additional road markings must not be placed on or around the edges of a concentric overrun area. The circulatory arrow

markings should be placed on the surrounding circulating area and not on the overrun area. Construction materials used for overrun areas should not resemble footways or refuges and measures should be taken if necessary to discourage direct pedestrian movements into them. Overrun areas may be sloped up to the white circle at an angle of up to 15°. Further advice on overrun areas is contained in **Traffic Advisory Leaflet 12/93 Overrun Areas**.

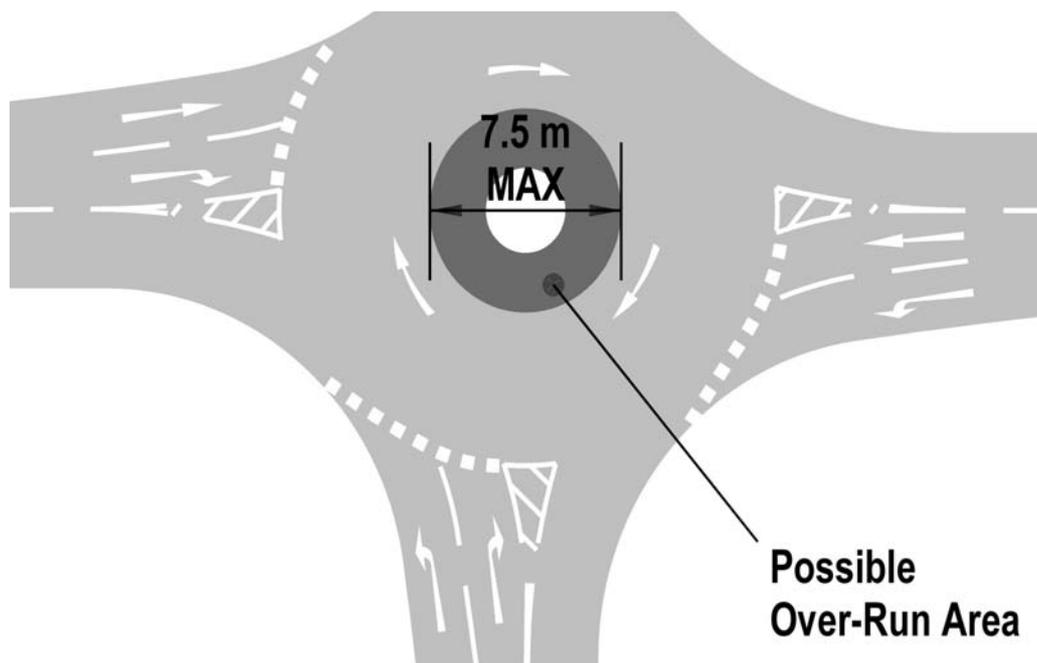


Figure 6/4 – Flared Approach with Central Overrun Area

Domed Central Markings

6.12 A domed white circle marking can be used to deter light vehicles from overrunning and improve conspicuity. The dome will normally be formed from bituminous material, concrete or block paving. Kerbing or edging block of uniform shape with an even surface may be used to contain the white circle provided that it is reflectorised, the maximum height above the road surface at the perimeter does not exceed 6mm and the appearance of the marking complies with diagram 1003.4. Other types of white circle edging may be a hazard, particularly to cyclists and should not be used.

6.13 The white circle may be domed to a recommended maximum height at the centre of 100mm for a four-metre diameter marking. For smaller diameter markings the height of the dome should be reduced pro-rata (i.e. by 25mm per metre). The absolute maximum height of the dome above the adjacent carriageway permitted by TSRGD is 125mm at its highest point (including construction tolerance), but this is not recommended. The maximum height permitted at its perimeter is 6mm.

6.14 The use of a domed white circle has been found to lead to the perception of vibration by residents and discomfort to bus drivers and passengers. A domed white circle should be avoided for mini-roundabouts likely to be regularly overrun by heavy goods vehicles or buses in residential areas.

6.15 Fire and ambulance services should be consulted about any proposal to introduce a mini-roundabout with a domed white circle. Guidance on consultation procedures is contained in **Traffic Advisory Leaflet 3/94 – Fire and Ambulance Services: A Code of Practice**.

Visibility

6.16 Road users approaching the give way line on any approach to a mini-roundabout need to be sure that it is safe to enter the circulatory area. The conflict point is defined by the construction in Figure 6/5. The time taken for a vehicle to travel from a stationary position at the give way line to the conflict point is defined as the 'gap acceptance time'. This is dependent on the size of the roundabout, and should be taken as two seconds when the distance from the give way line to the centre of the white circle is seven metres or less, otherwise three seconds.

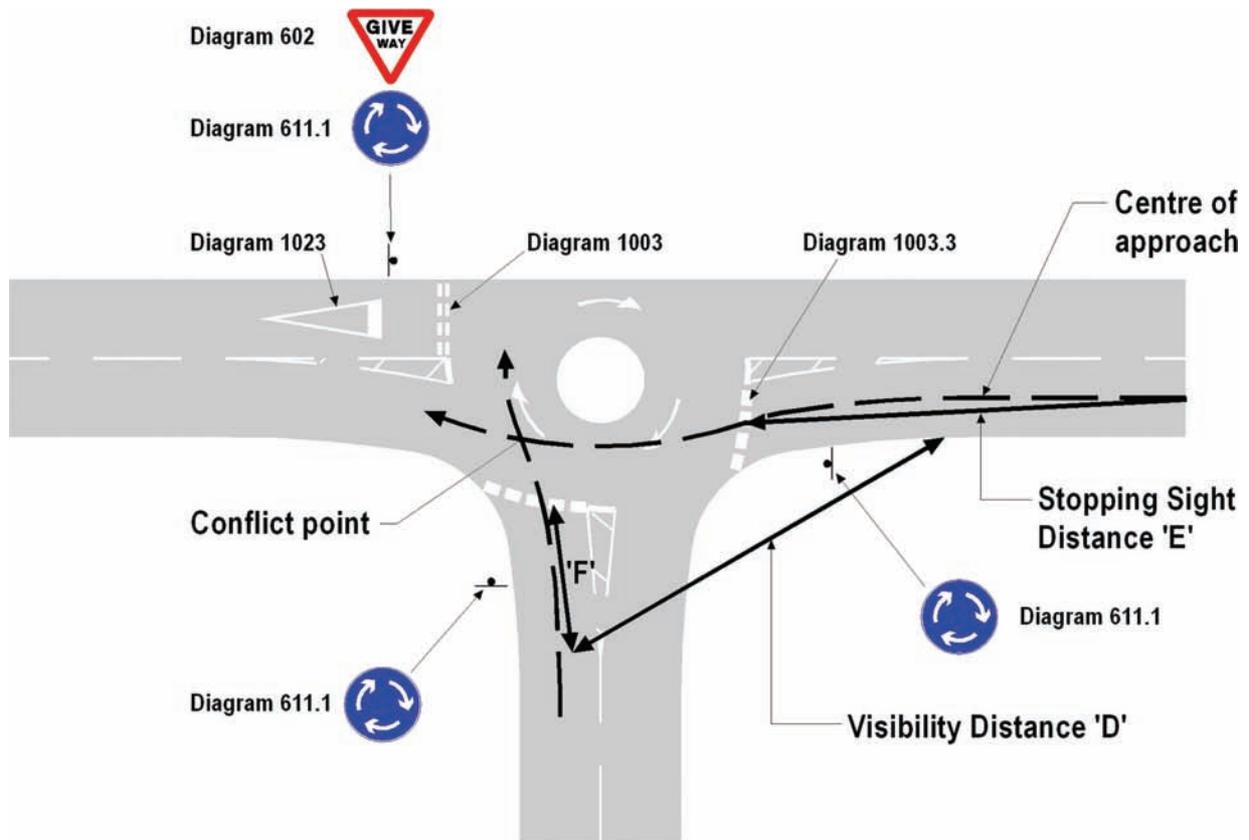


Figure 6/5 – Mini-Roundabout Visibility Distance ‘D’ and Stopping Sight Distance ‘E’

6.17 The visibility distance ‘D’, as shown in Figure 6/5 and Table 6/1, is the minimum sight distance required by a road user approaching the roundabout at a distance ‘F’ from the give way line. ‘D’ is measured from the centre of the offside approach lane to the nearside carriageway edge of the arm to the right. It enables the driver of an entering vehicle to observe vehicles coming from the right before they reach the conflict point. Distance ‘D’ varies with the 85th percentile ‘dry weather’ approach speed 70m before the give way line on the arm to the right and the ‘gap acceptance time’ as determined in paragraph 6.16. See **TA 22 (DMRB 5.1.4)** for guidance on speed measurement.

6.18 The visibility distance ‘D’ must be provided within the whole of the visibility envelope between driver’s eye heights of 1.05m and 2.0m at the centre of the offside approach lane to object heights between 0.26m and 2.0m at the nearside edge of the arm to the right.

85 th percentile speed of arm to the right (mph)	‘D’ distance (m)	
	For a Gap Acceptance Time of Two Seconds	For a Gap Acceptance Time of Three Seconds
35	40	55
30	35	50
25	25	40

Table 6/1 – Minimum Visibility Distance to the Right

6.19 The give way marking (to diagram 1003.3) used at mini-roundabouts requires road users to give way to circulating traffic at or immediately beyond the line. The 'F' distance in Figure 6/5 must be a minimum of 9m, so that the first two vehicles in the approach queue have visibility of traffic coming from the arm on the right, but see paragraphs 6.20 and 6.21.

6.20 In difficult circumstances, the 'F' distance in Figure 6/5 for an arm may be taken as a relaxation from 9m to 4.5m, providing that the maximum peak hour entry flow on the arm is less than 300 veh/hr. In exceptionally difficult circumstances, a relaxation to 2.4m (absolute minimum) is permissible, as it enables a road user who has reached the give way line to see approaching vehicles without encroaching past the give way line. This will, however, allow only one vehicle at a time to enter safely and requires following drivers to be prepared to stop and look. An 'F' dimension of 2.4m must only be used on an arm with a maximum peak hour entry flow of 300 veh/hr or less and where there is no entry arm to the left (see paragraph 6.6). In such cases the mandatory give way markings and upright sign (diagrams 1003, 1023 and 602) must be used to require road users to give way to circulating traffic at the line.

6.21 Excessive visibility between adjacent entries can result in approach and entry speeds greater than desirable for the junction geometry, with a tendency for approaching drivers to take a decision too early about whether to give way. Road users approaching a mini-roundabout need to be able to stop if vehicles are circulating or if there is an obstruction on the junction. Although the 'D' distance must always be provided, there is little or no advantage in increasing it as this could lead to excessive approach speeds. Design Organisations should consider limiting the visibility to the right of adjacent entries to a maximum 'F' distance of 15m back on the approach and to no more than the 'D' distance.

6.22 The Stopping Sight Distance 'E' in accordance with Table 6/2 and Figure 6/5 must be provided within the whole of an envelope between eye heights of 1.05m and 2.0m at the centre of the path of an approaching vehicle to object heights of 0.26m to 2.0m at the give way line.

85 th percentile speed (mph)	Minimum 'E' distance (m)
35	80
30	70
25	50

Table 6/2 – Minimum Stopping Sight Distance

Traffic Islands

6.23 Traffic islands may be provided to separate opposing streams of traffic and, if appropriate, to serve one or more of the following purposes as shown on Figure 6/6:

- assist provision of adequate deflection of the path of vehicles approaching the mini-roundabout;
- increased conspicuity to drivers approaching the mini-roundabout;
- pedestrian use (subject to the requirements of paragraph 6.28);
- calming feature (subject to the requirements of paragraph 2.20).

6.24 Islands for separating opposing streams of traffic or deflecting approaching vehicles may be kerbed physical islands or created using prescribed road markings. Solid or raised areas of markings at mini-roundabouts are not permitted other than for the white circle.

6.25 A kerbed splitter island must be provided where, without it, vehicles would encounter an easier path if they were to pass on the wrong side of the white circle.

6.26 A kerbed island may also be used at an entry to accommodate 'keep left' bollards, supplementary signs to diagram 611.1 (see paragraph 7.4) and, if appropriate, diagram 602 (see paragraph 6.7). Care should be taken to ensure that any sign on a kerbed island does not obscure visibility to the right.

6.27 **Local Transport Notes 1/95** and **2/95** on the Assessment and Design of Pedestrian Crossings contain advice on islands/refuges for pedestrian use.

6.28 Kerbed islands provided to assist crossing pedestrians must be located within 20m of the give way line at the nearest point. Pedestrian facilities located more than 20m from the junction may be too far from the desire line, which may cause pedestrians not to use the facility. Pedestrian facilities located over 60m from a mini-roundabout perform independently of the junction.

6.29 The minimum requirement for road markings on the approaches to kerbed physical islands is to provide warning lines to diagram 1004 (see Chapter 5, paragraph 4.23 of the Traffic Signs Manual). However, if a kerbed island is at risk of being overrun by approaching, circulating or exiting vehicles, it must be positioned at least 0.5m clear of any vehicle swept path.

6.30 **Traffic Advisory Leaflet 1/97 ‘Cyclists at Road Narrowings’** contains advice on safe widths of carriageways for cyclists.

6.31 Kerbed islands to narrow the carriageway within 40m of the give way line of a mini-roundabout may be used as a calming feature to control the speed of approaching traffic. Further guidance on the use of islands for this purpose is contained in **Traffic Advisory Leaflet 7/95 ‘Traffic Islands for Speed Control’**.

Entry and Lane Widths

6.32 The minimum lane width permitted at the give way line is 3.0m, except at a two lane approach where the minimum lane widths can be reduced to 2.5m, provided heavy goods vehicles and buses do not frequently use the entry. The maximum lane width at the give way line for a single lane entry is 4.0m.

6.33 At an entry with two or three lanes (although three lane entries are not recommended, see paragraph 2.12), no more than one lane must be marked as being for a given exit arm, such that traffic going ahead or turning proceeds in single file (see Figure 6/4). No more than two lanes must be provided at an intermediate give way line between double mini-roundabouts.

Approach Narrowing

6.34 Road markings, islands and existing kerbs may not create sufficient deflection of vehicle paths. A reduction in vehicle speeds may be achieved by narrowing the approach. Narrowings within 15 metres of the give way line have been found to be associated with fewer accidents at an entry. Overrun areas may be considered instead if narrowings would affect the swept path of long vehicles on the nearside of an entry. Further advice on Overrun Areas is contained in **Traffic Advisory Leaflet 12/93**.

6.35 Kerbed build-outs reduce the crossing width for pedestrians and permit the mini-roundabout sign to be located in a more visible position for approaching traffic. Where kerbed build-outs are used, care should be taken to avoid causing drainage problems or creating ‘dead’ areas of carriageway that are not used by traffic or are difficult to maintain. Build-outs can become a source of damage only accidents, especially in poor visibility (Refer to paragraph 7.9 for guidance on ensuring that build-outs are conspicuous).

Position of Give Way Markings

6.36 Typically the give way line (to diagram 1003.3) is placed on the circumference of the largest circle that can be inscribed within the junction kerbs. However, where the swept path of the largest design vehicle likely to use the junction crosses the inscribed circle, the give way markings for the affected arms must be moved back such that they are not crossed by the outside edge of the swept path. Where mandatory give way markings (to diagram 1003) are used (see Figure 6/5 and paragraph 6.7), they should be placed in a straight line at right angles to the vehicle path with no part of the marking inside the outer edge of the swept path of the largest design vehicle circulating past the entry.

Crossfall

6.37 Mini-roundabouts have often been superimposed on the existing carriageway profile with little or no change in level. Channels, which may give the impression of a former priority junction layout, should be eliminated. Where the carriageway levels are re-profiled, crossfall towards the centre island should be avoided. Ideally, some outward sloping crossfall assists conspicuity of the junction (see paragraph 7.16).

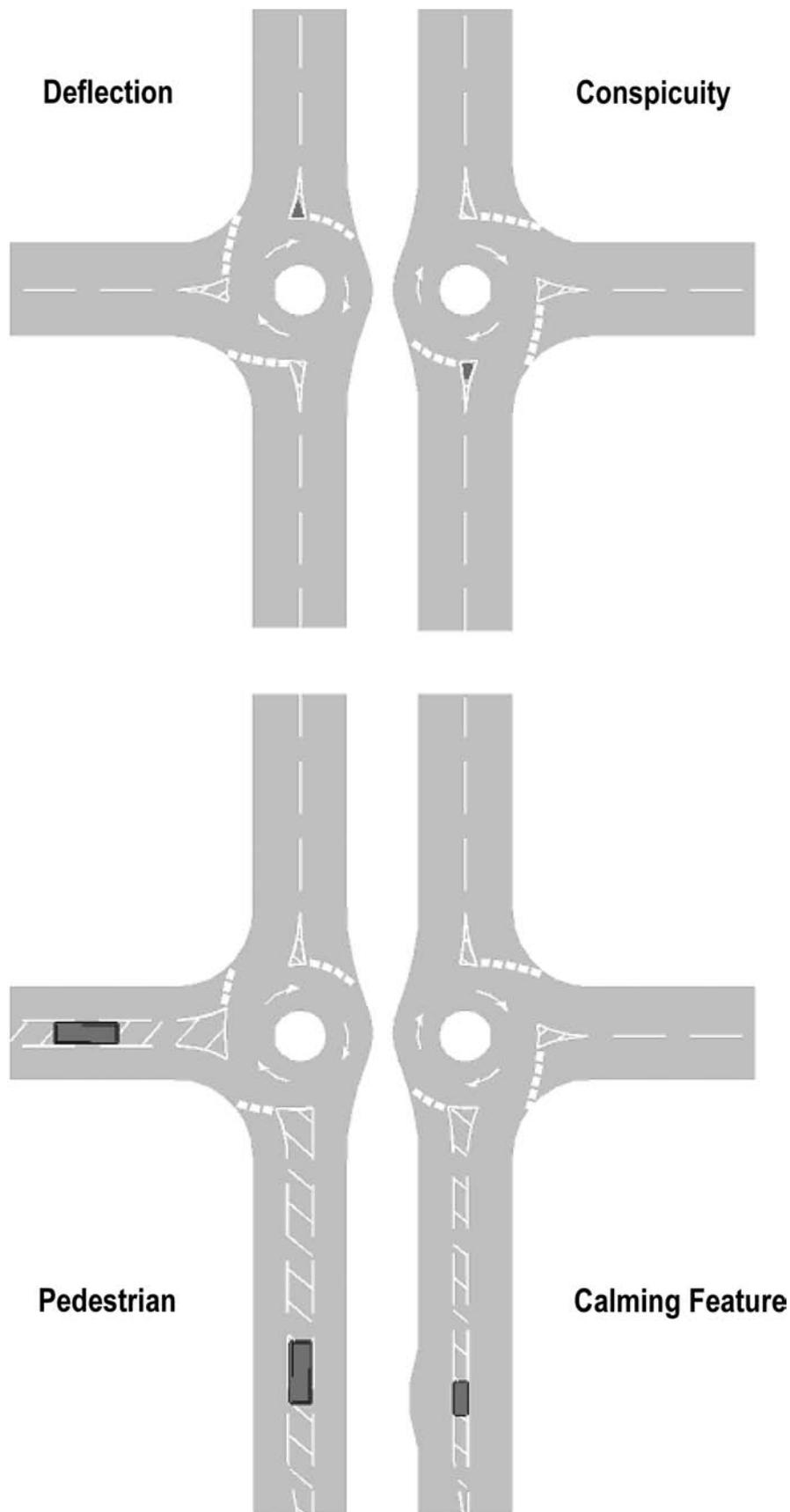


Figure 6/6 – Examples of Island Functions

7. CONSPICUITY

General

7.1 It is important that a mini-roundabout is conspicuous to approaching drivers at all times.

7.2 Designers should consider the driver's view of the junction and its approaches, including the combined effect of signs, road markings, road surfacing, islands, horizontal alignment, crossfalls, road lighting and permanent or temporary obstructions. These features must combine effectively to make the mini-roundabout stand out clearly to all road users, for all driving conditions, during the day and at night.

7.3 In particular, the design process for mini-roundabouts should involve site visits by the designer, in daylight and during the hours of darkness, who should carefully note the effect of the factors in this Chapter on conspicuity and drivers' likely perceptions of the junction.

Signs and Markings

7.4 If the regulatory sign to diagram 611.1 is not visible from 50m before the give way line or is not sufficiently conspicuous, an additional sign to diagram 611.1 should be provided on a kerbed splitter island, together with the mandatory give way sign if appropriate (see paragraph 6.7).

7.5 The layout and number of arms of a mini-roundabout should be clearly perceptible in all conditions at a distance of 15m before the give way lines. If not, advance warning should be provided using signs to diagram 2024, 2119 or 2120 as appropriate.

7.6 A roundabout warning sign (diagram 510) should be provided if the visibility distance to the mini-roundabout regulatory sign (diagram 611.1) is less than 50 metres and an advance direction sign to diagram 2024, 2119 or 2120 does not precede the junction. Further details on warning sign provision can be found in Chapter 4 of the Traffic Signs Manual.

7.7 Conspicuity should not rely solely on road markings, which can become worn or may be less conspicuous in the wet or in adverse lighting conditions.

7.8 It should be verified that visibility of regulatory and warning signs for a mini-roundabout cannot be adversely affected by trees in leaf, parked vehicles or other obstructions.

7.9 Where a build-out is provided, its conspicuity and that of the junction as a whole may be enhanced if vertical features such as bollards, directional or regulatory signs can safely be located on the build-out. Care must be taken to ensure that nothing is installed on the build-out that could be regarded as an unauthorised obstruction to the highway. Any bollards installed should be crash friendly.

7.10 The use of grey backing boards may be appropriate for enhancing conspicuity of the mini-roundabout regulatory sign or where a Give Way sign to diagram 602 is to be co-located with it. The Give Way sign should be uppermost (see Chapter 1 of the Traffic Signs Manual, paragraph 1.63). Generally, the use of yellow backing boards should be reserved for identified problems of drivers missing the sign until very late, or not seeing it at all. For further advice on the use of backing boards reference should be made to Chapter 1 of the Traffic Signs Manual.

Road Lighting

7.11 In Northern Ireland, Wales and Scotland, road lighting must be provided at mini-roundabouts.

7.12 In England, the provision of road lighting at mini-roundabouts must be considered in accordance with DMRB 8.3.

Surface Construction

7.13 The use of surfacing of a specific colour may be effective as a remedial measure; however the conspicuity of road markings must be taken into account. Coloured surfacing should not be laid in any shape or pattern intended to convey a meaning as a road marking. Further advice on coloured road surfacing is contained in **TA 81 (DMRB 6.3.4)**.

7.14 There are relatively few examples of mini-roundabouts with special surfacing on approaches. High friction material can be of benefit to motorcyclists on

the circulating area and on approaches to pedestrian facilities but, generally, appropriate design features should ensure safe speeds of approach. A need for high friction or contrasting surfacing on an approach may be indicative of lack of driver perception or excessive approach speeds, which should be eliminated in more appropriate ways.

7.15 Concentric overrun areas formed of contrasting materials and sloped as discussed in paragraph 6.11 can make a substantial contribution to the conspicuity of a mini-roundabout.

7.16 A domed white circle in conjunction with outward facing crossfall will also help to make a mini-roundabout more conspicuous. Gradients or crossfalls which result in the white circle being situated below the plane of the inscribed circle can reduce conspicuity of the white circle and introduce rapid reversals of crossfall in design vehicle paths and must therefore be avoided. In the treatment of crossfalls and gradients, designers must be careful not to create any ponding or significant accumulation of run-off at the white circle, since the installation of gullies is undesirable.

8. REFERENCES

Introduction

The Traffic Sign Regulations and General Directions (TSRGD)

Traffic Signs Manual: Chapters 1, 3, 4 & 5

TD 16 DMRB 6.2.3 Geometric Design of Roundabouts

Siting and Use of Mini-roundabouts

TD 42 DMRB 6.2.6 Geometric Design of Major/ Minor Priority Junctions

TD 41 DMRB 6.2.7 Vehicular Access to All Purpose Trunk Roads

TA 87 DMRB 6.3.5 Traffic Calming on Trunk Roads A Practical Guide

TA 82 DMRB 8.1.1 Installation of Traffic Signals and Associated Equipment

TA 84 DMRB 8.1.2 Code of Practice for Traffic Control and Information Systems for All-Purpose Roads

TD 50 DMRB 6.2.3 The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts

TA 68 DMRB 8.5.1 Assessment and Design of Pedestrian Crossings

DfT Traffic Advisory Leaflet: 2/05 Traffic Calming Bibliography

DfT Traffic Advisory Leaflet: 10/93 Toucan – An Unsegregated Crossing for Pedestrians and Cyclists

DfT Traffic Advisory Leaflet: 9/94 Horizontal Deflections

DfT Traffic Advisory Leaflet: 7/95 Traffic Islands for Speed Control

DfT Traffic Advisory Leaflet: 01/96 Traffic Management in Historic Areas

DfT Traffic Advisory Leaflet: 01/98 Speed Cushion Schemes

DfT Traffic Advisory Leaflet: 01/00 Traffic Calming on Major Roads

SI 1999 No 1025 The Highways (Road Humps) Regulations 1999: TSO

SI 1999 No 1026 The Highways (Traffic Calming) Regulations 1999: TSO

SI 1994 No 2488 The Roads (Traffic Calming) (Scotland) Regulations 1994

SI 1998 No 1448 The Road Humps (Scotland) Regulations 1998

Safety

TRL Report No 512 Monitoring Local Authority Road Safety Schemes using MOLASSES: TRL Ltd: 2001 and www.trl.co.uk/molasses

TRL Report 281 Accidents at Urban Mini-roundabouts (1998)

Road Users Specific Requirements

TA 90 DMRB 6.3.5 The Geometric Design of Pedestrian, Cycle and Equestrian Routes

TA 91 DMRB 5.2.4 Provision for Non-Motorised Users

HD 42 DMRB 5.2.5 Non-Motorised User Audits

HD 36 DMRB 7.5.1 Surfacing Materials for New and Maintenance Construction

HA 83 DMRB 4.2.4 Safety Aspects of Road Edge Drainage Features

DfT Traffic Advisory Leaflet: 3/05 Cycling Bibliography

Manual of Contract Documents for Highway Works Volume 1: Specification for Highway Works

IHIE Guidelines for Motorcycling – Improving Safety through Engineering and Integration. (April 2005).

Geometric Design Features

TA 22 DMRB 5.1.4 Vehicle Speed Measurement on All Purpose Roads

DfT Traffic Advisory Leaflet: 12/93 Overrun Areas

DfT Traffic Advisory Leaflet: 3/94 Fire and Ambulance Services – A Code of Practice

DfT Traffic Advisory Leaflet: 1/97 Cyclists at Road Narrowings

Local Transport Note: 1/95 The Assessment of Pedestrian Crossings

Local Transport Note: 2/95 The Design of Pedestrian Crossings

Conspicuity

DMRB 8.3 Traffic Signs and Lighting, Section 3: Lighting

TA 81 DMRB 6.3.4 Coloured Road Surfacing in Road Layout (Excluding Traffic Calming)

9. ENQUIRIES

All technical enquiries or comments on this Standard should be sent in writing as appropriate to:

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