

# **MINI-ROUNABOUTS: ENABLING GOOD PRACTICE**

Christian Bodé  
Faber Maunsell

## **1. INTRODUCTION**

Mini-roundabouts are a common form of junction in the United Kingdom. There is, however, some inconsistency in the application of the junction type, a degree of confusion regarding the safety and suitability in some locations and an apparent lack of awareness of regulations relating to mini-roundabouts. As a result of this the UK Department for Transport (DfT) and County Surveyors Society (CSS) commissioned Faber Maunsell to develop advice on the installation of mini roundabouts. This paper explores some of the issues identified during the project with consideration given to what is considered “good” and “bad” practice and the type of advice which will be published by the DfT and CSS.

## **2. BACKGROUND**

### **2.1 Research and data collection**

As part of the project a technical review of material relating to the design and use of mini roundabouts, their accident record and associated infrastructure and street furniture was undertaken. The documents reviewed include design advice that has since been superseded. The literature review highlighted both the changes in the advice given in respect of mini roundabouts since their introduction in the early 1970’s and some inconsistency in the advice that currently exists. The review has raised a number of issues that should be considered when assessing the suitability of a site for a mini roundabout.

Questionnaires were sent to 65 CSS members, the emergency services, Living Streets, Cyclist’s Touring Club and British Horse Society to collect:

- views on the most important criteria when assessing a site’s suitability for a mini roundabout
- examples of sites showing good or bad practice
- comments on a number of issues that were raised by the literature review

Twenty-three local authorities across England and Wales responded with comments also received from other organisations. The project team also met with some local authorities and their officers to discuss issues and sites. This has provided a range of views on mini-roundabouts and background material.

This has all been collected and reviewed by the project Steering Group consisting of representatives of Lancashire County Council on behalf of the CSS, the Department for Transport and Highways Agency.

## 2.1 What is a mini-roundabout?

In understanding some of the issues surrounding mini-roundabouts it is first necessary to understand what is a mini-roundabout. In the UK the specific way in which road signs and road markings can be placed on the highway is governed by regulations. These regulations control the form of the signs and road markings such as size, colour and font type. For the purpose of these regulations road markings are also termed “traffic signs” in a legal context. The principal piece of legislation relating to traffic signs is The Traffic Signs Regulations and General Directions 2002 (TSRGD). Within this document regulations are provided not only on the form of signs, but which signs are used with others and rules on illumination requirements. Each sign is allocated a number for reference purposes.

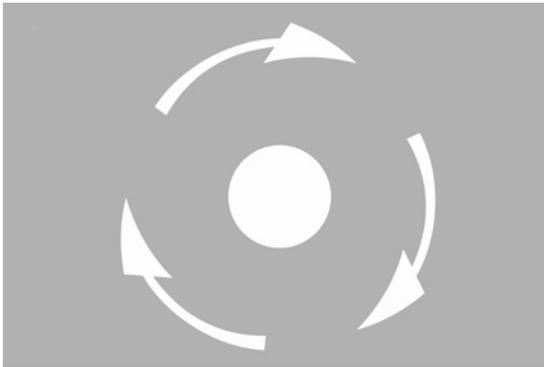


Figure 1: TSRGD diagram 1003.4



Photograph 1: A mini-roundabout

A mini-roundabout is a type or form of junction control at which vehicles circulate around a white, reflectorised, central circular road marking (central island) of between one and four metres in diameter, as shown in TSRGD diagram 1003.4. The central road marking is either flush or slightly raised as a dome. Three white arrows are painted on the carriageway, within the gyratory area, around the central road marking, showing the direction of circulation. A mini-roundabout is effectively a road marking.

A blue mini-roundabout sign (illuminated if sited within 50 metres of a street lamp), as shown in TSRGD diagram 611.1, precedes the mini-roundabout on each approach arm. This sign is usually accompanied by the transverse give way marking shown in TSRGD diagram 1003.3.

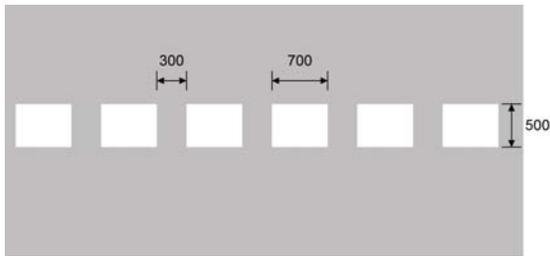


Figure 2: TSRGD diagram 1003.3



Photograph 2: TSRGD diagram 611.1



Photograph 3: TSRGD diagram 1003 and TSRGD diagram 611.1

However, the mandatory give way marking (TSRGD diagram 1003), and give way sign (TSRGD diagram 602), may be used in addition to TSRGD diagram 611.1 where appropriate. Where TSRGD diagram 1003 is used, TSRGD diagram 602 should be placed above TSRGD diagram 611.1.

The central dome marking can be raised; however, this is restricted to a maximum of 125mm so that it can be driven over by larger vehicles that are physically incapable of maneuvering around it.

Vehicles entering the junction must cede priority to vehicles approaching from the right, circulating the central island. When negotiating a mini-roundabout drivers must pass round the central road marking on the left hand side unless the size of the vehicle or layout makes it impracticable to do so. Normally cars or similar sized vehicles should be able to avoid driving on the central road marking.

There are mini-roundabouts incorporating two central marking; double mini-roundabouts, although these are less common and tend to be used where there are offset crossroads.

When researching examples of mini-roundabouts it became apparent that there are a number of "variations". This principally concerns the central island. The central island of a mini-roundabout does not conform to the regulations if:

- it has a diameter less than 1m or greater than 4m;
- it cannot be driven over;
- it has a surface colouring other than white;

- it is not reflectorised;
- it is constructed of granite setts, block paving or other textured material (unless coloured white);
- it contains street furniture ;
- it has a raised kerb (more than 6mm);

The pictures below show examples of non-conforming layouts:



Photograph 4: Non-conforming concentric rings



Photograph 5: Street furniture on a domed central island in tarmac creating a small roundabout, not a mini-roundabout



Photograph 6: Non-conforming central marking in setts with white edge marking

## 2.2 Use of mini-roundabouts

Mini-roundabouts were first introduced experimentally in 1971 before being fully permitted for use in 1975. Since then they have become increasingly common on roads in the UK. They were initially used to improve existing junctions, however, in recent times they have also been used as new junctions on new developments, particularly residential sites.

In researching the use of mini-roundabouts it was identified that there are four main reasons for introducing a mini-roundabout:

- to improve the operation of an existing junction;
- as an accident remedial measure;
- as part of a traffic calming scheme; or
- to provide an access to a new development.

Mini-roundabouts have been used to improve the operation of priority junctions, traffic signal junctions and conventional roundabouts. Normally they are installed at T-junctions and crossroad junctions (3 or 4-armed junctions). Experience has shown that they should not be used at junctions with 5 or more arms.

A mini-roundabout can improve the operation of a junction by:

- Reducing the dominance of one traffic flow
- Giving priority to right turners
- Facilitating access and reducing delay at side roads
- Improving capacity at overloaded junctions

For a given road space, the mini-roundabout has a higher capacity than most alternatives and is very flexible in coping with variations in both volumes and proportions of traffic flow during the day.

Mini-roundabouts are most commonly introduced as an accident remedial measure. They have been shown to reduce the number of accidents at a junction. For three-arm sites, the mean accident rate for mini-roundabouts is similar to that of priority T-junctions and about 30% less than for signalled junctions.

They can also reduce the severity of accidents at a junction, due to the slowing effect. The severity of accidents (percentage of fatal and serious accidents to all injury accidents) at three-arm mini-roundabout sites is lower than at 3-arm signalled junctions and considerably lower than at 30 mph T-junctions.

The “slowing” effect has led to mini-roundabouts being used in traffic calming schemes either at the entry points, or at junctions within the traffic calmed area.

More contentious is the use of mini-roundabouts as a new junction for developments. The flexibility of the design allows mini-roundabouts to be used in locations unsuitable for other junction types. However, when introduced for this purpose most local authorities take account of side road flows as problems can result from using mini-roundabouts at lightly trafficked side roads, where emerging vehicles or turning movements are unexpected; if side road flows are too low then the main road will effectively operate under free flow conditions.

### **3. DESIGN ISSUES**

Through the literature review and consultation process a number of design issues were identified. Due to the many factors and options involved in introducing a mini-roundabout there is more scope for poor design. As one respondent stated, "It is easier to design a poor mini-roundabout than a poor set of traffic signals."

Provided below are the key issues arising from user experience:

### 3.1 Speed Limits

In accordance with current guidance the majority of mini-roundabouts are installed on roads with a 30 mph speed limit<sup>1</sup>. Mini-roundabouts should not be installed on high speed roads i.e. 85th percentile speed of 35 mph or more. Some local authorities have successfully installed a limited number of mini-roundabouts on 40 mph roads. Examples on roads with higher limits are extremely rare and not recommended.

The project identified that there has been in the past confusion in the advice given in relation to appropriate vehicle speeds at mini roundabout junctions. It became apparent to the project team that the speed limit of the road is of less relevance than the approach speed of vehicles and that vehicles should have slowed down to an appropriate speed prior to reaching the junction and should then maintain this speed when circulating the mini roundabout.

At some junctions, the physical characteristics of the road or existing traffic calming features may ensure that the approach speed of vehicles is already appropriate. At other junctions where a mini roundabout is desirable, speed-reducing measures may need to be introduced as part of the junction improvements

Experience has shown that mini-roundabouts can work safely in 40mph limit areas if the vehicle approach speeds are reduced prior to entry to say 20 to 25 mph. It is important to ensure that the design will assist in influencing driver speeds. Reliance should not be placed on the central island itself as a speed reducing feature. Reducing the approach speed is important.

As has been discussed mini-roundabouts are used as part of the traffic calming toolkit. In some instances mini-roundabouts are used in isolation as a speed reducing feature. This is problematic and should be avoided.

### 3.2 Number of Arms

Usually mini-roundabouts have been introduced on 3 arm junctions with a preference for this number of arms. Equally most local authorities had examples where 4 had worked, however some felt that 4 arm junctions work less well. No local authorities had examples of 5 arms or more, instead relying on double or even triple mini-roundabout junctions to handle such circumstances.

### 3.2 Position and height of Central Island

This is one of the most critical aspects of the design process. It is worth noting that the UK Highway Code states that mini roundabouts should be approached in the same way as normal roundabouts and that “all vehicles MUST pass round the central markings except large vehicles which are physically incapable of doing so.” Drivers who pass over the central island open themselves to potential prosecution.

There are plenty of examples of mini-roundabouts where the central island position is poor. The most usual practice was to determine the position of the central island by the swept paths of turning traffic. This sometimes resulted in an island not at the centre of the inscribed circle and, where traffic might be tempted to pass the “wrong” side of the island, use was made of splitter islands or build-outs to encourage “correct” behaviour.

What is clear is that the design should ensure that drivers should not be encouraged to either consistently pass over the central island, or drive the wrong side.



Photograph 7: Driver passing over central island



Photograph 8: Central island positioned so drivers have to pass over it to negotiate junction

Regulations allow for the central island to be domed to a maximum dome height of 125mm. This is principally to provide for improved conspicuity, however, it is more generally used to encourage circulatory behaviour. When providing a dome consideration should be given to noise which can be generated when driven over by heavy goods vehicles. A raised dome can also cause discomfort for bus passengers. A height of 100mm is usually used, and it is advised that no more than 60mm is used on bus routes. If possible noise is an issue the dome can be flat but consideration should be given as to how this may affect driver behaviour; particularly driving over the island.

### 3.3 Deflection, Build-outs and Splitter Islands

All those involved in the consultation felt that deflection was important and this is partly linked to the central island issue. In practice many sites reviewed failed to provide adequate deflection and this is a key area, which should be addressed when a mini-roundabout is introduced. A mini-roundabout should not simply be a matter of painting the markings on the road. Without adequate deflection speed may not be appropriate, there may be failure to give way and the obvious path through the junction may pass over the central island.



Photograph 9: No deflection on approach or through junction  
*Note: signs wrong way round*



Photograph 10: Deflection through alignment and traffic island

There is a tendency to avoid providing deflection by simply using the mandatory give way as shown in Photograph 9. Mandatory give way signs (TSRGD diagram 602) may be used on approaches where drivers may not be expecting to give way to traffic to their right e.g. on the main road approach to a former priority T-junction. However, this layout is over used.

### 3.4 Visibility

For a mini-roundabout to operate as intended, it is essential that the junction type can be recognised and that drivers have adequate forward visibility of the junction. Visibility to the right, and of vehicles within the junction, is important. Visibility to the left for turning traffic did not seem to be as critical a factor to satisfactory operation.

Some practitioners have commented that 'excessive' visibility to the right has been a problem, with drivers deciding whether to yield or not on the junction approach and not at the give way line.



Photograph 11: Site with restricted approach visibility



Photograph 12: Site with good visibility on all approaches

Taking account of the importance of visibility in the design some guidance on visibility design criteria has been developed for inclusion in the guidance document; in particular the visibility distance to the right and forward visibility.

### 3.5 U turns

There was no clear consensus about whether or not vehicles should be able to U-turn at a mini-roundabout. Drivers may feel as it is a roundabout that U-turns should be possible. It was generally felt that mini-roundabouts should not specifically be designed to allow U-turns although consideration should be given to some vehicles making this manoeuvre. Designers should think about the effect of nearby traffic management or junction arrangements that may encourage U-turning at the proposed mini-roundabout (for example prohibited or difficult turning movements).

## 4 ASSESSMENT PROCESS

As part of the project an assessment process was developed to assist designers in deciding if a location was suitable for treatment as a mini-roundabout. Following the technical literature review a number of factors were identified as important in the decision process. These were reviewed and prioritized by consultees. The following factors were identified (in alphabetical order):

- Accident record
- Approach speed
- Cost of measure
- Number of arms
- Physical constraints (i.e. available highway space)
- Road character / context ( e.g. Urban/rural, types of control in locality – traffic signals, UTC, roundabouts, etc)
- Speed limit
- Traffic composition (e.g. percentage of lorries, buses, etc)
- Traffic flows

The factors considered by the local authorities to be the most important in deciding if a mini roundabout is suitable for a location are:

1. Accident record
2. Physical Constraints
3. Approach Speed
4. Number of Arms

This was used to develop an assessment methodology. The methodology adopted is a two stage process. Before using the assessment process sites should be rejected if:

- on a dual carriageway;
- at a junction with 5 or more arms; and
- where the 85th percentile speed exceeds 35mph; and
- where there is no scope to reduce approach speeds

#### 4.1 Stage 1 Assessment

Every site should be surveyed and data collected on the way the junction operates such as flows, speeds, accidents, etc. Then it will be possible to answer a number of key questions in the decision process. These are:

##### *1. Is there enough space available for construction of a mini-roundabout?*

An obvious requirement but designers need to ensure they have sufficient space to implement a suitable layout. The inscribed circle diameter (ICD) of a mini-roundabout is the diameter of the largest circle that can be inscribed within the junction kerbs. A suggested maximum ICD for a mini-roundabout is 28m. At this size there may be issues achieving adequate deflection without substantial highway works. Above this dimension a conventional roundabout should be used. A minimum ICD should also be considered, taking account of the requirement for drivers to drive around, and not over, the central island. As has been indicated previously layouts that do not allow car drivers to negotiate the central island without overrunning are unlikely to be good designs. A minimum ICD of 12m is suggested.

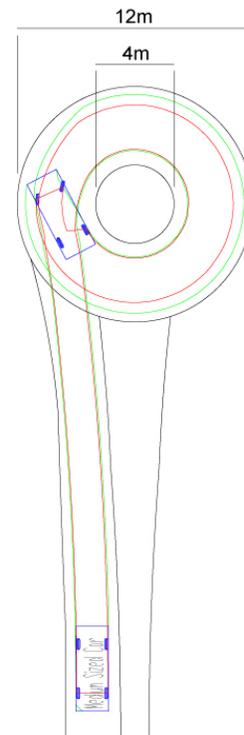


Figure 3: Sample Desirable Minimum ICD

*2. Will the installation of a mini-roundabout adversely affect the safety performance of the junction?*

This is simply a matter of predicting the possible accident performance of a mini-roundabout layout. When doing this, consideration should be given to the scope of the works required for the new layout against benefits possible from simple improvements in existing layout and the actual undertaking of routine maintenance.

*3. Is a mini-roundabout likely to be affordable and economically viable?*

Mini-roundabouts are often considered as a design solution because they are felt to be relatively inexpensive compared to other junction types. Whilst not providing a 'perfect' solution, a mini-roundabout may provide sufficient improvement over the existing junction performance to justify installation on a value for money basis.

As discussed a well designed mini-roundabout is unlikely to be just a lining and signing exercise and may require, for example, additional works such as carriageway realignment, build-outs, street lighting (provision and modification), carriageway resurfacing and traffic islands. It is essential that these costs are not overlooked.

Through Local Authority consultation it has been established that the cost for a mini-roundabout can vary greatly dependent on the level of work involved. The range of costs for 3 or 4-arm single mini-roundabouts can be between £10,000 to £50,000 (€14,700 to €73,500).

It is also important that the whole life cost of the junction is taken into account. Mini-roundabouts incur ongoing maintenance costs and these should not be overlooked. For example, a domed central island subject to high turning movements by HGVs may be scuffed regularly and will need to be re-painted to maintain conspicuity.

#### 4.2 Stage 2 Assessment

The second stage of the assessment should consider a range of other factors taking account of engineering judgement and assessment of data. These factors include:

- visibility;
- vehicle speed;
- road character;
- traffic volume;
- number of arms;

- traffic composition;
- vulnerable road users;
- road network; and
- noise and vibration.

The issues surrounding a number of these factors have already been discussed. For the others there are issues to consider.

Road character relates to the characteristics of the site in question and covers matters such as gradients, highway status, number of traffic lanes, pedestrians and cycle facilities and urban or rural nature of the roads.

Ideally, mini-roundabouts should be located on level ground or in sags but not at the top of hills. Installations at the bottom of long descents or on steep gradients should be avoided as there may be an issue with approach speeds.

As has been previously stated it is not considered good practice to introduce mini-roundabouts on dual carriageway roads. Care should be taken when designing mini-roundabout junctions with multiple lane approaches as lane discipline may be poor and vehicular paths through the roundabout can vary. Two lane approaches can encourage drivers to overrun the central island and can impair visibility. There are also deflection issues and attention may need to be given to reducing approach speeds. The number of lanes on the approach to a mini-roundabout should not exceed the number of exit lanes.

There has been a tendency to see mini-roundabouts as an urban phenomenon, however, they can be appropriate in a rural location although consideration needs to be given to the visual impact on the rural environment. Mini-roundabouts have been increasingly used in rural areas, particularly at busy intersections in villages or as part of rural traffic calming schemes.



Photograph 13: Mini-roundabout in rural type location



Photograph 14: HGV driving over central island

Mini-roundabouts can, in some situations, improve the capacity of junctions particularly where there are high proportions of right turning traffic. Designers should use capacity assessment programmes such as ARCADY to assess capacity implications in greater detail.

Vehicle composition can affect the operation and effectiveness of a mini-roundabout. It is generally not appropriate for mini-roundabouts to be sited at junctions that are used by a high proportion of heavy goods vehicles, agricultural vehicles or buses and coaches. In these circumstances there are issues with long term maintenance, noise and passenger discomfort.

Cyclists are vulnerable at all types of road junction although roundabouts pose particular problems, however cyclists are not necessarily more at risk with a mini-roundabout. Cyclists are vulnerable when circulating and entering vehicles fail to yield, especially during hours of darkness, due to their lack of size and conspicuity. Mini-roundabouts present fewer problems to cyclists than small conventional roundabouts with flared entries and large conventional roundabouts, as they may result in high speeds.

In locations with large pedestrian numbers, particularly children or elderly and disabled people, a mini-roundabout may not be the best junction option and positive control offered by traffic signals may be a better junction alternative. If controlled crossing facilities are provided for pedestrians experience tends to suggest crossings are better located closer, within 20m of the a mini-roundabout. This may be due to relatively low speeds through the junction. Where crossings are further away approach and exit speed may be unaffected by the mini-roundabout.

In addition to a road's specific characteristics, the character of the local road network will be influential in deciding that a specific junction is a suitable location for a mini-roundabout. Mini-roundabouts may not be compatible with local junctions if the area is largely subject to traffic signal control. Similarly mini-roundabouts tend not to suit bus priority corridors but work well in traffic calmed areas. Local context is the key.

#### 4.3 Other issues

Implementing a mini-roundabout should not be seen as the end of the story. The ongoing success of a mini-roundabout is dependent on continued maintenance to ensure the lining and signing and other measures are kept to a good standard. It is clear that maintenance is an issue in some areas and a continued problem with wear, such as on the central island, can indicate a problem with the design.

Consideration should also be given to driver education and behaviour. It is apparent that both drivers and some designers are not always clear as to the various rules governing mini-roundabouts, especially concerning driving over the

central island. There may be some need when introducing a mini-roundabout scheme to undertake some local driver education/publicity to ensure correct usage.

## **5. CONCLUSIONS**

The project undertook an investigation into mini-roundabouts, how they are working, how they should work and the issues to take account when designing. The result of this work will soon be published in a guidance document published by the Department for Transport and County Surveyors Society. Mini-roundabouts are a very useful tool in the traffic engineer's toolkit and present a solution to a variety of problems. Mini-roundabouts should not be considered as a simple lining and signing exercise, a cheap and cheerful solution to the difficult problem of junction operation, but in many ways a relatively more complex design solution which it is easy to get wrong.

## NOTES

It should be noted that the views expressed in this paper are those of the author and not necessarily those of the Department for Transport or County Surveyors Society.

1. '*The Highway Code*', '*Road Traffic Act 1984*' and '*The Traffic Signs Regulations and General Directions 2002*'. See TSRGD Regulation 16 (1) Table item "...a vehicle proceeding through the junction must keep to the left of the white circle at the centre of the marking shown in diagram 1003.4, unless the size of the vehicle or the layout of the junction makes it impracticable to do so."

2. (2003), *Chapter 5 Traffic Signs Manual 2003*, TSO, London "Mini-roundabouts should only be used when all approaches are subject to a speed limit of 30 mph or less. Their use on roads with a higher limit is not recommended...", para 8.11

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