6

chapter 6 Traffic Calming for Existing Roads

6.1 Introduction

Definition

Traffic calming can be defined in a variety of ways. To traffic engineers it is seen as a series of physical measures designed to reduce the adverse effects of traffic speed and/or volume in a street. To planners and architects it is seen more as a way of laying out the street and its built environment to reduce the dominance of motor vehicles and promote streets as living areas for people.

Objectives

Traffic calming primarily relates to speed reduction (traffic suppression relates to traffic volume reduction). It is essential that objectives are clarified in advance of designing and implementing any traffic calming scheme. Traffic engineers have employed traffic calming techniques primarily to tackle speeding and speed related road accident problems on existing roads. These have proved necessary because the design of many roads has done little to restrict vehicle speed and does not provide more vulnerable road users such as pedestrians and cyclists with adequate facilities for their needs. Residents have become concerned about their own safety and that of their families. Traffic calming measures have generally been very successful at tackling these problems and have saved many people from death and injury. However, some sections of the profession and the public have unrealistically high expectations of what such measures can achieve in practice and insufficient appreciation of their limitations.

Use

At their best, traffic calming measures can be integrated with good street layout and landscaping to change the appearance and feel of a street. This can alter the way drivers perceive the road and achieve a reduction in speed without creating resentment about the traffic calming features themselves. Very often however the measures are simply "retro fitted" to the existing road. Whilst limiting speed they do little to encourage a calm driving culture. Drivers who perceive they are being slowed down unnecessarily can resent traffic calming. Budget limitations, lack of resources, time constraints or lack of effort or imagination on the behalf of designers are common reasons for the latter effect.

Traffic calmed street

At their best, traffic calming measures can be integrated with good street layout and landscaping to change the appearance and feel of a street.

European experience

The concept of traffic calming originated in mainland Europe. The Dutch were the first to use physical measures to reduce the dominance of motor vehicles in their "Woonerfs" (living areas). In the Woonerfs, drivers had to travel at low speeds and share road space with pedestrians and cyclists. Residential areas were split into zones linked only by pedestrian and cycle routes, which removed through traffic. The streets were redesigned and parking arrangements reorganised to create lateral deflections. A lot of money was spent on environmental enhancement such as block paving and landscaping to create an area that had a pedestrian priority feel. The traditional provision of separate footways was abandoned in favour of a shared surface. Vertical deflections were not widely used in these schemes.

'Woonerf' layout

With the success of these measures their use spread throughout much of Europe in the 1970s and early 1980s. Countries such as Germany and Denmark, where concern about environmental and road safety issues were well advanced, developed further traffic calming techniques. In Holland, Germany and Denmark, environmental issues have had a significant role in the justification for providing traffic calming. Budget allocations for schemes have been higher and emphasis has been placed on using high quality materials together with hard and soft landscaping. Vertical deflections have not been so heavily relied upon.

Bends in the road reduce excessive forward visability and control speed on new roads

UK experience

Traffic calming started in the UK in the late 1970s. Schemes consisted primarily of road humps (ramps). A succession of revisions to regulations between 1983 and 1999 have allowed much greater flexibility in the type and dimensions of traffic calming features that can be used in the UK.

In the UK, vertical features such as ramps have been relied on heavily in many areas (often as accident reduction schemes). There has been a backlash against their use in some areas mainly as a result of unwelcome (and largely unanticipated) side effects such as noise and problems for bus and emergency services. However, many traffic calming schemes have been successfully implemented and have resulted in impressive savings in accidents (up to 70%) and reductions in speeds (up to 10mph).

Irish experience

Irish urban traffic calming schemes were first implemented in the 1970s in Shannon and Dublin. Most roads authorities have found them to be an effective tool for reducing vehicle speeds and road accidents on residential roads. Traffic calming on approaches to towns and villages on national routes was undertaken throughout the 1990s. Although there is little published information as yet on the effectiveness of traffic calming measures in Ireland, two studies are currently underway. The first of these is a report from University College Cork,[93] evaluating traffic calming on inter-urban roads in Ireland. The second is a report from the National Roads Authority,94 evaluating traffic calming on national routes. Traffic calming measures for smaller towns (Fermoy and Mitchellstown)95,96 were discussed in some accident studies in the mid-1980s.

Ramps have become commonplace in urban residential streets and have often been applied to single roads. These seem to have been fairly well accepted but care needs to be taken that "traffic calming" does not become synonymous with "ramps" and that a variety of appropriate features are used. Horizontal deflections and closures are rarely used and more consideration should be given to them when designing schemes. High quality finishes and landscaping should be incorporated into schemes wherever possible.

New roads

Ramps and chicanes are generally remedial treatments for problems on existing roads. They should not be used on new residential streets. For new roads the opportunity exists to limit speeds using a variety of mainly horizontal alignment constraints that are designed to complement the new road's environment. The careful positioning of buildings, landscaping and the materials used can help to reinforce the need to reduce speed and reduce the dominance of motor vehicles (Section C, Chapter 7).

The way forward

It is important to ensure that the side effects of traffic calming schemes as well as the benefits are recognised and considered by professionals and the community at large. Public consultation and participation in the development of schemes is essential to ensure that the measures are well accepted by the majority of people (Section B, Chapter 3). Traffic calming should not be seen and used as a panacea for traffic problems that it cannot realistically solve. This is crucial if traffic calming is to remain an appropriate and acceptable traffic management tool.

6.2 Legislation and procedures

Legislation and regulation

In 1988, the Road Traffic (Bollards and Ramps) Regulations (S.I. No. 32 of 1988) were introduced. This allowed road authorities to construct ramps, subject to quite stringent restrictions. These restrictions were relaxed in the Road Traffic Act, 1994, which now allows considerable flexibility in the types, dimensions and spacing of traffic calming features.

Design advice

Design advice is contained in the following NRA documents

- RS.387A – Speed control devices for residential roads, 1993 (now superseded by this publication)
- RS.387B – Speed control devices for roads other than residential, 1993
- Guidelines on Traffic Calming for Towns and Villages on National Routes, 1999

The design advice for residential roads has been superseded as a result of the relaxations allowed in the Road Traffic Act 1994 and by developing practice

from Ireland and the rest of Europe. This chapter will provide advice and references on good practice in the design and implementation of traffic calming schemes on existing roads in urban areas.

Procedures for implementing traffic calming schemes

Under Section 38 of the Road Traffic Act 1994, a road authority may, in the interest of the safety and convenience of road users, provide such traffic calming measures as they consider desirable in respect of public roads in their charge.

It should be noted that additional procedures must be followed for traffic calming measures which are prescribed by the Minister (see sub-section 3 of Section 38). To date, no traffic calming measures have been prescribed by the Minister so these specific procedures are not required.
If traffic calming measures include the provision of regulatory signs, then the normal requirement of consulting with the Garda Commissioner in respect of such signs, must be followed.

Traffic calming measures on a national road shall not be provided or removed without the prior consent of the National Roads Authority.

Tables 6.1 (a) and (b) provide a checklist of relevant legislation pertaining to various construction works and traffic measures (including traffic calming & traffic management).

TABLE 6.1a Legislation pertaining to Road Works & other works

Construction Works	Relevant Legislation
Construct a new road or widen/realign an existing road where it is a: – Motorway – Busway – new or widened road of 4 or more lanes which would be 8km or more in a rural area or 0.5km or more in an urban area – new bridge or tunnel which would be 100 metres or more in length – Proposed road development which would be likely to have significant effects on the environment	**Environmental Impact Statement (EIS) must be prepared:** Section 50 of Roads Act, 1993 Part 5 of Roads Regulations, 1994 (S.I. No. 119 of 1994) Article 14(a) of the European Communities (EIA) (Amendment) Regulations, 1999 (S.I. No. 93 of 1999)
Construct a new road or widen/realign an existing road **where a scheme does not require an EIS** but where it is: – 100 metres or more in an urban area – 1km or more in a rural area – a new bridge or tunnel	Section 179 of the Planning and Development Act, 2000 refers; Requirements set out in **Part 8 of the Planning and Development Regulations, 2001**
Abandonment of a public road	Section 12 of the Roads Act, 1993
Extinguishment of a public right of way	Section 73 of the Roads Act, 1993 And also Section 222 of the Planning and Development Act, 2000

TABLE 6.1b Legislation pertaining to Traffic Calming/Management

Traffic Calming / Management Measures	**Road Traffic Acts 1961, 1968, 1994 & 2002** **Road Traffic (Traffic and Parking) Regulations, 1997 (S.I. No. 182 of 1997) & Amendment Regulations, 1998 (SI 274 of 1998)** **Road Traffic (Signs) Regulations, 1997 (S.I. No. 181 of 1997) & Amendment Regulations, 1998 (SI 273 of 1998)**
Apply a Weight Restriction	Article 17 of S.I. No. 182 of 1997 makes provision for prohibiting vehicles above a specified weight from entering a road. Sign Number RUS 015 from S.I. No. 181 of 1997 is an example of the type of sign which must be used.
Apply a Height Restriction	Article 34 of S.I. No. 182 of 1997 makes provision for prohibiting vehicles above a specified height from proceeding past traffic sign number RUS 016. The Second Schedule of S.I. No. 181 of 1997 gives details of RUS 016.
Direction to Proceed along a Particular Route	Article 22 of S.I. No. 182 of 1997; Article 5 of S.I. No. 181 of 1997
Prohibit straight ahead or right or left turn movements	Article 23 of S.I. No. 182 of 1997; Article 6 of S.I. No. 181 of 1997
Apply Parking Restrictions	**Articles 36 to 45 of S.I. No. 182 of 1997** Article 36 - Prohibitions on Parking; Article 37 - Restrictions on Parking; Article 38 - Restrictions on Parking Heavy Goods Vehicles; Article 39 – Parking in Bus Lanes; Article 40 – Clearways; Article 41 - Prohibitions on Parking at School Entrances; Article 42 – Parking in Loading Bays; Article 43 – Disabled Persons' Permits; Article 44 – Disabled Persons' Parking Bays; Article 45 – Pedestrianised Streets **Articles 14 to 20 of S.I. No. 181 of 1997** Article 14 – Single Yellow Lines; Article 15 – Double Yellow Lines; Article 16 – Loading Bay; Article 17 – School Entrance; Article 18 – Parking Bays; Article 19 – Disabled Persons Parking Bay; Article 20 – Disc Parking Area
Apply Parking Charges	Sections 36 of the Road Traffic Act, 1994
Bus Lanes & Bus only street	Article 32 of S.I. 182 of 1997; Article 27 of S.I. 181 of 1997 Sign RUS 021 (Pedestrian only street) is used in association with an information plate to indicate a bus only street
Bus Stop	Under Sections 85 & 86 of the Road Traffic Act, 1961 the Garda Commissioner may specify stopping places and stands for buses and may make bye-laws in respect of same. When commenced, Section 16 of the Road Traffic Act, 2002 will devolve this function to Road Authorities. No date has yet been fixed for devolving this function. Articles 41 & 42 of S.I. 181 of 1997
Taxi Stand	From 1st February 2003, Road Authorities may make bye-laws for Taxi Stands under Section 15 of the Road Traffic Act, 2002 Article 32 of S.I. 181 of 1997
Cycle Tracks	S.I. 273 of 1998; S.I. 274 of 1998
Cycleway	Section 68 of Roads Act, 1993
Traffic Lights	Article 30 of S.I. 182 of 1997; Articles 33, 34, 35, 36 of S.I. 181 of 1997
Pedestrian Crossing (Zebra) & Crossing Complex	Article 46 of S.I. 182 of 1997; Articles 38 & 39 of S.I. 181 of 1997
Pedestrian Crossing Signals	Article 30 of S.I. 182 of 1997; Article 40 of S.I. 181 of 1997
Cycle Crossing Signals	Article 10 of S.I. 273 of 1998; Article 9 of S.I. 274 of 1998
No Entry	Article 28 of S.I. 182 of 1997; Article 23 of S.I. 181 of 1997
Speed Limits	Road Traffic Act, 1961, Road Traffic Act, 1968 & Sections 30 to 34 of the Road Traffic Act, 1994
Traffic Calming Measures	Section 38 of the Road Traffic Act, 1994

Public consultation

Although not specifically required, public consultation is an important part of the process for the design and implementation of traffic calming schemes. This is dealt with in detail in Section B, Chapter 3.

Consultation with emergency services organisations and bus operators

Whilst traffic calming measures offer general benefits to society as a whole, their provision could affect the operations of An Garda Siochana, fire, ambulance and bus services. It is important that these organisations be consulted. This is dealt with in Chapter 6.3 and Section B, Chapter 3.

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6.3 Emergency Service access requirements[16]

There is now a substantial body of evidence that well-designed and delivered traffic calming schemes are very effective at reducing road accidents and reducing excessive and inappropriate motor vehicle speeds. This success in turn reduces the drain on national resources for health care and emergency services costs. However, fire and ambulance services may have particular concerns about response times to emergency calls in general or in certain areas. This is especially true in access controlled areas (eg residential development with electronic gates).The cumulative effect of the growing number of traffic calming schemes may increase concern about response times.

There are also concerns about damage to specialist equipment carried by these services. Traffic calming schemes may lead to increased discomfort for drivers, passengers and patients in ambulances. Some fire services regularly use particular routes to respond to emergency calls.

Road authorities should consult with fire and ambulance services when designing their schemes, in the interests of maintaining effective emergency services. Road authorities should establish a constructive working relationship with these services and discuss traffic calming proposals at an early stage of the design process. It may be possible to agree that certain types of measures (such as speed cushions) that are more acceptable are used on sensitive routes. If the emergency services are unsure about new types of measures then undertaking trials to assess their suitability would be a positive step.

The emergency services should monitor response and journey times before and after the installation of traffic calming and discuss the results with the road authority. It should be noted that bus lanes are a vital part of the emergency service network.

6.4 Strategies for the use of traffic calming

Urban areas

Many traffic calming schemes are introduced as isolated treatments or along a route to solve a particular problem. While solving problems locally this can affect the traffic flow on the rest of the road network. It is important to ensure that if traffic is diverted it is not merely being diverted into adjacent residential streets, exacerbating problems there. Ensuring that traffic is

managed onto more appropriate roads is a fundamental feature of an Urban Safety Management strategy.[8] Such a strategy looks at the problems of an urban area as a whole and requires a structured systematic approach to managing traffic onto the most appropriate roads and treating traffic safety problems.

As part of a strategy to treat whole urban areas, a series of localised area wide approaches to managing traffic can be appropriate. Often these are linked to the introduction of a 20mph speed limit. This helps to minimise the risk of diverting traffic onto roads that are not suitable for dealing with increased levels of traffic.
A typical area-wide strategy would define a problem area using main roads (that can carry any diverted traffic) to define the boundaries (see Diagram 6.2). The area would be split up into smaller zones where traffic calming measures (on their own or in conjunction with other traffic management measures) would be introduced in stages over a period of time. The sequence of staging could then address the issue of diverting traffic to minimise the potential adverse impact.

Rural areas

Detailed consideration of traffic calming for rural roads is beyond the scope of this manual. The NRA has published "Guidelines on Traffic Calming for Towns and Villages on National Routes, 1999" and this contains useful advice on such measures. A number of other reference documents concerning these measures are listed in 6.15 at the end of this chapter.

6.5 Selection of appropriate measures

General

Traffic calming measures can be very beneficial to the local environment if used wisely. However they can also bring unwanted side effects such as noise and discomfort. In considering the most appropriate solution to a problem, alternatives such as road closures (partial, part-time, permanent etc.) should be considered first. If these are not feasible and a traffic calming scheme is required to mitigate the problems,

Diagram 6.1 Fire service vehicle trialling different traffic calming measures

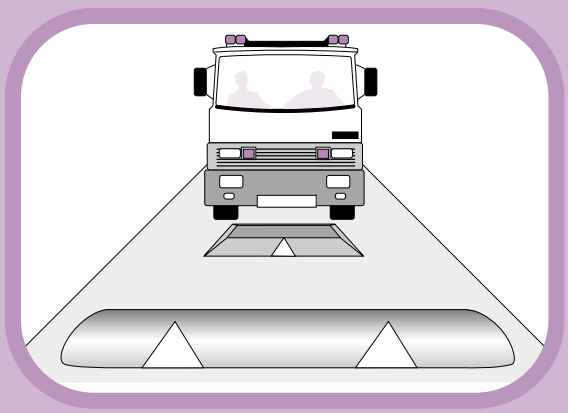
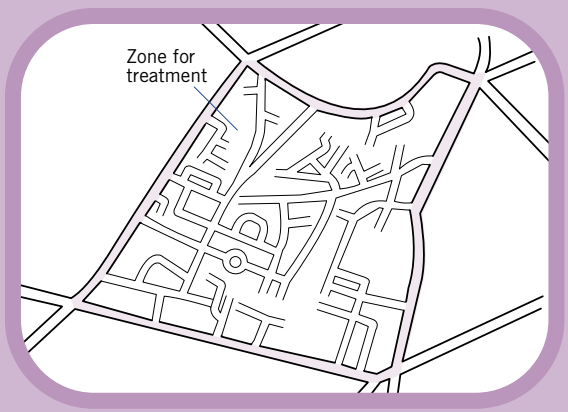


Diagram 6.2 Area wide treatment



careful consideration should be given to the type of measures that are most appropriate. While ramps are relatively cheap to install and maintain they do little to enhance the local environment and can easily be overused. The cumulative effect of successive ramp schemes could lead to unpopularity with drivers and residents.

Schemes should seek to include elements of enhancement in terms of both soft and hard landscaping. The inclusion of planting and the reduction of excessive forward visibility can help to reinforce the impression that drivers should be driving slowly. Schemes that incorporate appropriate enhancement measures are likely to be better accepted by residents and drivers.

Schemes using horizontal measures should be promoted more where appropriate. Ramps should only be chosen if no other suitable measures can be used.

On-street parking can be accommodated within traffic calming schemes where there are insufficient off-road spaces. This should be possible on most roads with flows up to 7,000 vehicles per day and on wider roads (10m or more with higher traffic flows. Build-outs and other horizontal measures can be used to shelter parking spaces and reduce speed.

Table 6.2 gives guidance on the type of traffic calming measures which can be used on various road categories.

Ramps should only be chosen if no other suitable measures can be used.

TABLE 6.2 SELECTION OF APPROPRIATE TRAFFIC CALMING MEASURES

MEASURE	TYPE OF ROAD		
	District Distributor	Local Collector	Access Road
Road closure	✗	✗	✓
Traffic island	✓	✓	✗
Gateway	✓	✓	✗
Entry treatment	✗	✓	✓
Overrun area	✓	✓	✓
Rumble device	✓	✗	✗
Mini-roundabout	✓	✓	✗
Build-out/Parking	✓	✓	✓
Pinch point	✗	✓	✓
Chicane	✗	✓	✓
Ramp	✗	✗	✓
Speed table	✗	✓	✓
Speed cushion	✗	✓	✓

6.6 Benefits and potential drawbacks

Traffic calming schemes are generally provided to tackle problems with speeding vehicles and accident problems and help to improve safety for pedestrians and cyclists. They can, however, have potential drawbacks.

The main benefits and potential drawbacks associated with traffic calming schemes are summarised in Table 6.3.

Producing a balanced scheme

When considering a traffic calming scheme as a solution to a traffic management problem, it is important to seek to minimise the potential drawbacks of the scheme. An acceptable balance has to be struck. The potential drawbacks as well as the benefits must be explained to interested parties. Effective local public consultation and participation can help to give people the scheme that matches most closely their needs. Advice is given here and in following sections on the main issues likely to arise and how these can be taken into account and how potential drawbacks can be mitigated.

It should be emphasised that with traffic calming, as with many other traffic management issues, it is difficult (if not impossible) to produce a scheme that pleases everybody. However every effort should be made to produce a scheme that has the support of a majority of people, whilst fulfilling the basic objective of the scheme. It would be inadvisable to proceed with a scheme that does not have support without having given serious consideration to alternative solutions.

6.7 Road closures

General

Road closures should always be considered as an alternative to traffic calming if the main problems are caused by through traffic that does not need to be on the road being considered for treatment. The form of road closure is usually a prohibition of driving over a short length of road, which is enforced by physical measures such as kerbs and bollards. The position of the length

Table 6.3 Main benefits and potential drawbacks of traffic calming schemes

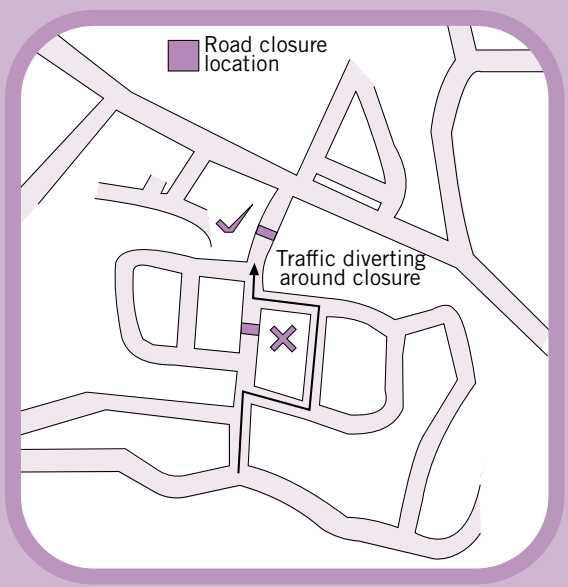
Benefits

- Reduces vehicle speeds
- Reduces the number and severity of accidents
- Lessens concern over road safety
- Reduces the dominance of motor vehicles
- Encourages walking and cycling
- Reduces the feeling of community severance
- Can be integrated into enhancement and regeneration schemes

Drawbacks

- Can cause discomfort for drivers and passengers particularly those with back or neck problems
- Can damage vehicles if driven over too quickly and result in increased maintenance costs
- Can delay emergency service vehicle response times and result in damage to their equipment and vehicles
- Can increase bus journey times
- Can increase noise and vehicle emissions: – usually associated with braking or acceleration of vehicles and body/load noise for lorries.

Diagram 6.3 Possible road closure locations



of road over which the closure is applied needs to be chosen carefully so that through traffic is diverted onto suitable alternative routes and the problem is not merely transferred onto adjacent residential roads.

It is possible to exempt certain classes of vehicle (generally cycles, emergency service vehicles and bus services) from the prohibition. This can help to remove some of the objections to closure but needs careful thought about how it will be enforced. It is unrealistic to expect Gardai to actively enforce closure because of resource constraints and priorities. A scheme should therefore contain self-enforcing engineering measures. Cyclists can be provided with gaps or bypasses. Demountable bollards can give access to emergency service vehicles. Bus entries (Section F, Chapter 15) can be provided to give access to buses, and can be lowered during off peak periods, if desired.

Road closures are generally cheaper than traffic calming schemes to construct but can take up a lot of staff time in dealing with consultations and objections. This however can be offset against savings in design time for alternative traffic calming measures. Road closures need careful consultation with local residents who may have to make longer journeys.

One of the main problems with the implementation of road closures is gaining a majority of local public support. The effects of the closure on the rest of the road network will also need to be considered. Alternative routes will need to be able to cope with the additional volumes of traffic, particularly in the peak hours.

If it is not possible to proceed with a closure then a traffic calming scheme may help to mitigate some of the problems and result in a proportion of drivers seeking alternative routes (see Chapter 6.14).

6.8 Traffic Islands[22] (Refuges)

General

Traffic islands or refuges can be used for a variety of purposes including:

- providing a facility for pedestrians and cyclists to cross a road
- providing a location for street furniture such as signs and signal poles (including gateways)
- segregating different streams of traffic (including cycle bypasses at traffic calming measures)
- as part of traffic calming schemes to narrow the road or provide deflection of vehicle paths in order to reduce speeds
- preventing overtaking and reducing speed by channellising traffic

Islands should be carefully situated so as to avoid obstructing access to properties and thought should be given to the consequences for future maintenance of the road on which they are placed. Adequate street lighting should be provided where islands are to be installed.

Pedestrians

Traffic islands can provide significant benefits for pedestrians wishing to cross a road without affecting traffic capacity. A 'string' of refuges (see Diagram 6.4) can be provided along a length of road where pedestrian crossing demand is not concentrated at a single point and where a controlled crossing such as a pelican crossing could not be justified. Refuges can also be incorporated into the hatched areas of turning lanes. Where pedestrians are likely to use an island, dished crossing points (flush with road surface or with a maximum upstand of 6mm) should be provided at both sides of the road. The minimum width of the island should be 2m (see Diagrams 6.5 and 6.6) but 1.5m will suffice if road space is tight. If it is not possible to fit in a 1.5m wide island then

a substandard one of 1.2m width could be considered. This may be better than no island at all. Pedestrians must have adequate visibility of approaching vehicles and vice versa.
Islands which are not located at junctions can cause a driving hazard if installed in isolation.

Cyclists

Cyclists can feel "squeezed" at islands where the road is narrowed. For widths between 3m and 4m a cycle bypass should be provided where appropriate (see also Chapter 6.12.1).

Signing

Refuges should incorporate signing to indicate which side of the island drivers and riders should pass. The signs are commonly in the form of internally illuminated "keep left" or "plain faced" bollards. When used on higher speed roads (85% speeds of 35mph and above) supplementary high mounted reflective "keep left" signs can be used to improve conspicuity of the islands. These signs give drivers better advance warning of the islands and reduce the likelihood of drivers running into the islands (and the consequent cost of maintaining the bollards). Any signs placed on the islands should have a clearance of 0.45m from the kerb edge.

Longer Vehicles

Traffic islands can present problems for longer vehicles, which may have difficulty in negotiating the island. This can be a problem when long vehicles are turning at a junction or access point and the islands are too close. Similarly if vehicles park close to the island then this can obstruct the passage of long vehicles. In such situations drivers of longer vehicles may have to (illegally) pass the island on the wrong side in contravention of the "keep left" sign. Where traffic islands are provided adequate clearance for vehicles likely to use the road should be provided.

It may be necessary to check use by abnormal loads and in rural areas particular attention will need to be given to the access requirements of tractors and other agricultural vehicles.

Diagram 6.4 Traffic islands for pedestrians

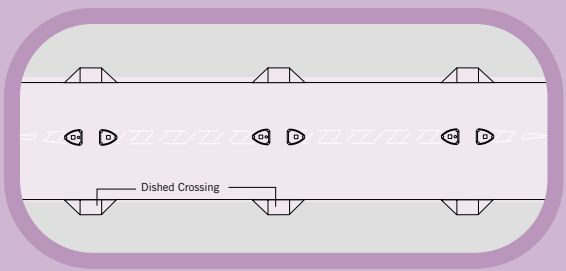
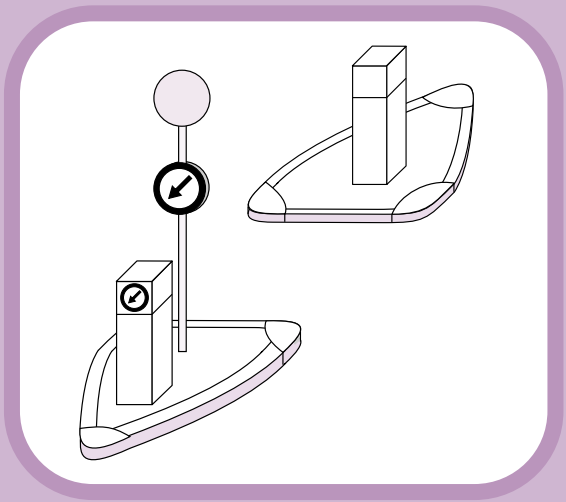


Diagram 6.5 Traffic island

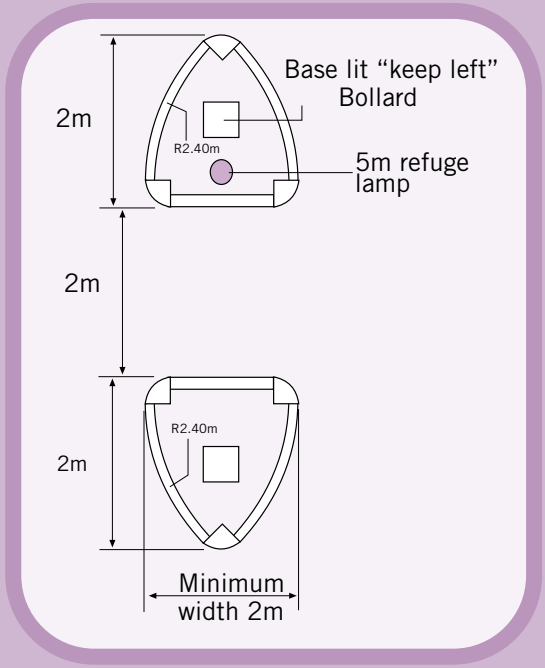


Series of Traffic Islands

Lighting

Traffic islands should be illuminated so that road users can see them in the hours of darkness. Where islands have been provided without adequate illumination the risk of vehicles colliding with them is significantly increased. Lighting can be incorporated into the design of the island to improve its conspicuity. The provision of internally illuminated bollards is also desirable in this regard.

Diagram 6.6 Traffic island incorporating street furniture, signing and lighting plan view



6.9 Gateways and Entry Treatments

General

Gateways and entry treatments are features which are intended to alert drivers to the fact that they are entering an area or length of road that has a different driving environment. They may have only a small effect on traffic speeds if used on their own and vehicles will speed up again after passing the feature.

Gateways commonly consist of one or more of the following:

- a higher level of signing and road markings
- the use of contrasting surface colour or textures
- street furniture such as bollards and timber posts
- vertical or horizontal deflections such as ramps or build-outs
- hard and soft landscaping

Traffic island with ramp

Gateways[13,50,51,88]

Gateways are commonly used on approaches to urban areas or villages, often in conjunction with a speed limit, or at the start of a traffic calming scheme. Their purpose is to slow down speeding drivers and make them more aware that the road they are entering is one where people live. Gateways should be sited so that they are clearly visible to drivers approaching them for at least the safe stopping distance appropriate for the 85%ile speed of traffic.

Gateways are more effective if the signing and road markings are highly conspicuous and incorporate other forms of physical traffic calming such as road narrowings, islands or chicanes. Gateways offer good opportunities for landscaping but this should be carried out in a way that is sympathetic to the local

Gateway entering a town

environment. The advice of a landscape architect or conservation officer should be sought. The NRA "Guideline on traffic calming for towns and villages on national routes, 1999[88]" gives useful guidance on landscaping.

Experience in the UK[17] suggests that more severe gateways incorporating physical measures can attain speed reductions of between 5mph and 10mph, but that drivers will speed up again after passing them unless further measures to reduce speed along the length of a road are taken.

Entry treatment incorporating raised area of contrasting surfacing

Entry treatments[15]

Entry treatments are normally used in urban areas to indicate the start of a traffic calming scheme often where drivers turn off a major road into a minor side road (AADT of 5000 or less). They commonly incorporate:

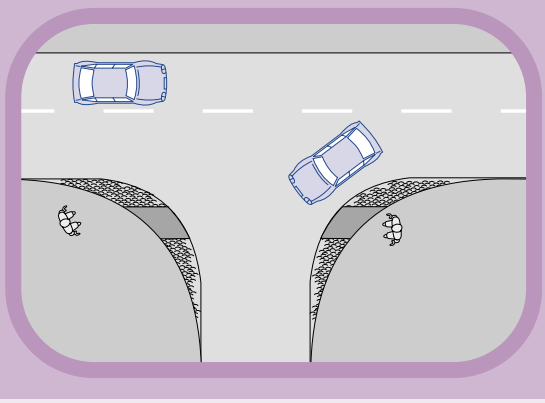
- raised areas of a high quality material, which contrasts with both the road surface and the footway surface. These are often raised to the footway level or dropped kerbs used to provide convenient crossing points for wheelchair and pushchair users. Appropriate tactile paving should be provided (see Chapter 13).
- high quality street furniture such as cast iron or timber bollards, which are used to enhance the feature and prevent vehicles overrunning the footway. Bollards and other street furniture should contrast in colour with the road surface and be located a minimum of 0.5m back from the kerb face. Bollards should incorporate reflective strips where appropriate. Bollards should not obstruct pedestrian movement across the entry treatment.
- landscaping to heighten the visual impact. This should not obscure drivers' and pedestrians' visibility of each other.
- reduced corner radii and build-outs on the side road. The corner radii can be reduced to 6m where large vehicles only require occasional access. The build-outs on the side road can help to shelter parking and reduce the width of the mouth of the junction for pedestrians to cross. A road width of 6m at the build-outs will cope with most traffic flows on the side road. This can be reduced to 5m if the side road is lightly trafficked.
- speed limit signs if appropriate.

Entry treatments are most effective if located prominently at the mouth of the junction. They will be more obvious to drivers on the major road and will provide an improved crossing opportunity for pedestrians. However, two-wheeled vehicles turning left into

the side road will have to negotiate any raised feature at an angle and it is important that the materials chosen are not slippery when wet.

Pedestrians will find the raised area of an entry treatment an attractive and convenient location to cross the mouth of the junction. The use of contrasting materials will alert pedestrians to potential conflicts with cars. Dished crossing points (flush with road surface or a maximum of 6mm upstand) should be provided where pedestrians cross the road and elsewhere a minimum kerb upstand of 25mm should be maintained (Section E, Chapter 12 and 13).

Diagram 6.7 Overrun area at corner of junction



6.10 Overrun areas and Rumble Devices

6.10.1 Overrun areas[12]

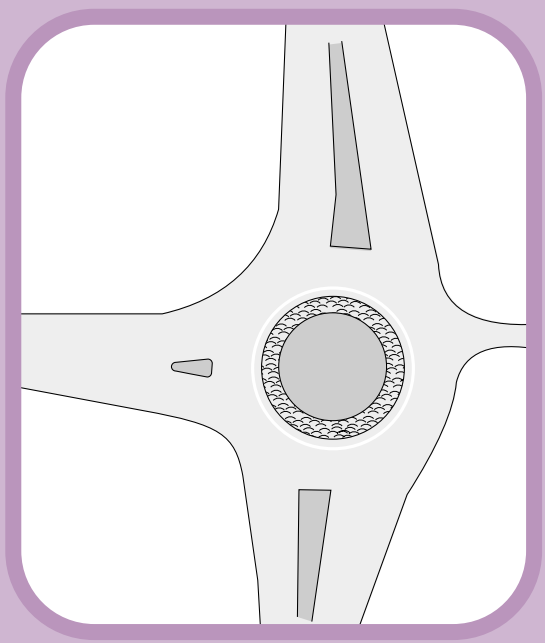
General

Overrun areas are areas of material that contrast visually and texturally from the normal road surface. Their purpose is to create the appearance that the carriageway is narrower than it actually is, and to help reduce vehicle speeds particularly those of cars. Car drivers are discouraged from encroaching into the overrun areas but long vehicles can mount these if necessary.

Overrun areas are commonly used at the following locations:

- bends and junction radii – to reduce the effective corner radii for smaller vehicles where longer vehicles must still be catered for
- roundabouts – to increase the effective deflection for smaller vehicles by deploying the overrun area around the central island
- road narrowings and islands (refuges) – to increase the effective deflection for smaller vehicles at the edge of the carriageway or alongside the narrowings

Diagram 6.8 Overrun area at roundabout



Height and materials

Raising the overrun areas and using rough textured material can enhance their effectiveness as this further discourages cars from encroaching onto the areas. Care does need to be taken that the raised areas do not de-stabilise two-wheeled vehicles or form trip hazards in areas where pedestrians may seek to cross a road.

If pedestrians are likely to cross at an overrun area then a path should be left clear of rough textured material and kerb upstands, so that pedestrians are less likely to trip.

The overrun areas can be raised from the existing carriageway and sloped. There are no prescribed dimensions for overrun areas but guidance on dimensions is given in a UK advice leaflet.[15] A maximum edge upstand of 15mm, with a vertical face not exceeding 6mm, together with a slope angle of 15° is recommended. The edge upstand can be achieved by using a 16–19mm radius bull-nose kerb.

Signing and lighting

Road users (particularly cyclists and motorcyclists) need to be able to see overrun areas clearly in both day and night light conditions. Street lighting should allow all road users to see the contrasting colours and textures thereby allowing them to choose the correct path. In unlit areas they may be difficult to see in darkness and therefore they may need to be specifically illuminated.

6.10.2 Rumble Devices[11]

General

Rumble devices are features that create a vibratory or audible effect at a location where drivers should slow down or take greater care. They are only used at rural locations, on the approach to a bend or junction, at the entry to a built-up area such as a village or incorporated into gateways. Rumble devices consist of a series of raised strips often in a colour that contrasts with the existing road surface.

Diagram 6.9 Overrun area at island

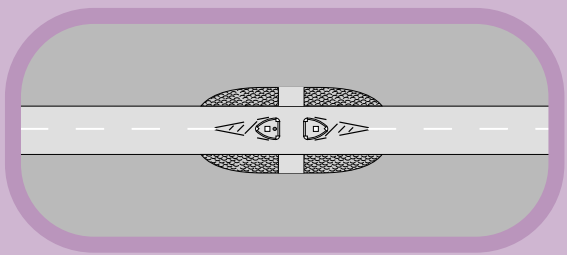
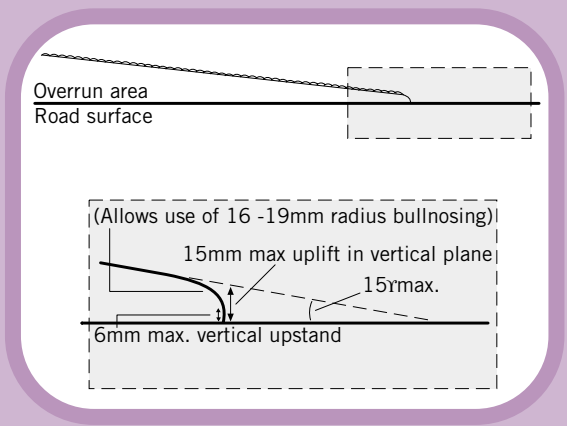


Diagram 6.10 Use of inclined overrun areas



Rumble strips on approach to a junction

Dimensions and layout

There are no prescribed dimensions for rumble devices in Ireland. UK regulations allow a height of up to 15mm providing there is no vertical face greater than 6mm, as with overrun areas.

The spacing between features can be varied. They can be laid in groups or in a single sequence. Guidance on the use of rumble devices is given in a variety of reference documents listed at the end of this chapter. Particular attention is drawn to RS.387B "Speed control devices for roads other than residential."[87] The strips are generally terminated before the edges of the road to allow them to drain adequately and allow cyclists a judder free route.

Noise

If rumble devices are located in the vicinity of residential properties then the noise that they generate can be a cause for concern. If they are to be located within 200m of a residential property then residents should be consulted over their use. There are examples where these measures have been installed close to isolated properties and the residents have campaigned for them to be removed. Similarly there are cases where residents have been consulted prior to installation and have accepted them (despite the nuisance) because of their concerns about speed or safety.

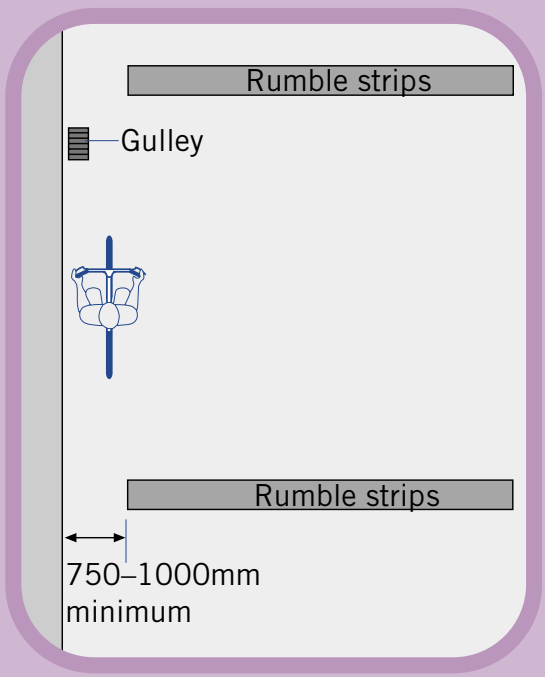
Use in urban areas

In urban areas, rumble devices have been used in new residential roads (in culs de sac, to signify the start of a shared use area) and in car parks where speeds are very low. They have been tried on busier urban roads, but generally with little success. On some roads the devices have had to be removed because of complaints about the additional noise that they generated.

Effectiveness

Evidence on the speed reducing effect of rumble devices is not robust. They are likely to have only a small impact on speeds if used on their own. However they do increase drivers' awareness and can reduce accidents significantly because of this.

Diagram 6.11 Termination of rumble devices at edge of carriageway



6.11 Mini-roundabouts[81]

Introduction

Mini-roundabouts consist of small painted central islands (between 1m and 4m in diameter) with arrows indicating the direction in which vehicles are required to proceed around them (Diagram 6.12).

The islands may be flush or slightly "domed" (a maximum of 75mm high is recommended) and can be overrun by longer vehicles. Doming should be a maximum of 25mm high if buses turn right at the mini-roundabout. Mini-roundabouts are generally installed at existing 3 or 4-arm priority junctions in order to reduce accidents, vehicle speeds or to relieve queuing on the minor road. They can often be introduced with a minimum of alteration to the existing kerb lines in order to keep costs down.

It is more difficult to physically constrain speeds with mini-roundabouts because of their comparatively small size. Because of this, mini-roundabouts should not therefore generally be used on roads with 85% speeds greater than 30mph unless measures to reduce approach speeds are incorporated into the design. Mini-roundabouts should not be used on roads with 85%ile speeds greater than 40mph.

Applications

Mini-roundabouts can be used to reduce queues on side roads at locations where this is desirable. Care is needed that they are not used to exacerbate problems with rat-running traffic by allowing better access from the rat-run route onto the main road network. Mini-roundabouts should be regarded as a remedial measure to treat specific problems on existing roads rather than as a general traffic management solution. Where possible, the use of mini-roundabouts should be exceptional and limited to roads with low speeds. Their use has increased in recent years, often as part of traffic calming schemes where approach speeds are likely to be lower than on other roads. In such situations it may be that they have a lower accident rate.

Diagram 6.12 Mini-roundabout

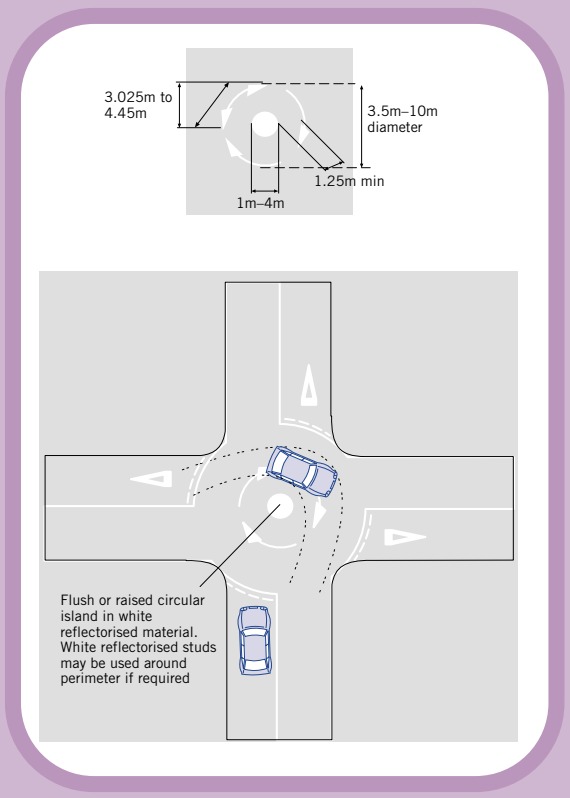
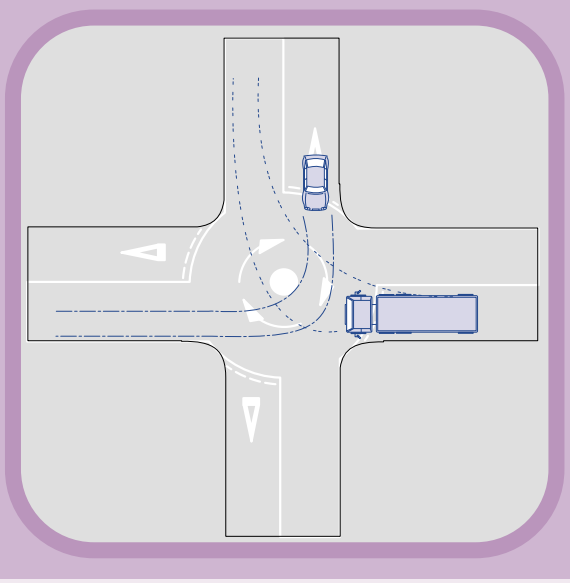


Diagram 6.13 Turning circles around mini-roundabout



On roads where 85% speeds are between 30mph and 40mph the following features should be incorporated into the design to reduce approach speeds and alert drivers to their presence (see Diagram 6.15):

- the introduction of some vehicle entry path deflection by "doming" the central island, building out kerb lines or hatching out with white lines on the approaches
- the introduction of splitter islands at the approaches to constrain racing lines and to house signs
- the introduction of improved signing (e.g. advanced warning signs, the doubling up of signs on the nearside and offside at the approach to create a gateway effect)
- the provision of high-friction surfacing
- the provision of a traffic islands or road narrowing in advance of the approaches

Care needs to be taken with the positioning of the central island and approach splitter islands to cater for vehicle turning movements. They should be located so that most vehicles can negotiate the central island without having to overrun it where possible.

Accidents

Mini-roundabouts can reduce the number and severity of accidents when introduced at existing problem junctions. However, if used at sites with a good safety record they could worsen it.

The results of a study[65] in the UK are shown in Table 6.4. The mean severity of the accidents was found to be significantly less than for comparable signal and priority junctions, probably because traffic speeds are generally lower at mini-roundabouts than at other forms of junction. A high proportion of accidents involved vulnerable road users (pedestrians and cyclists/motorcyclists).

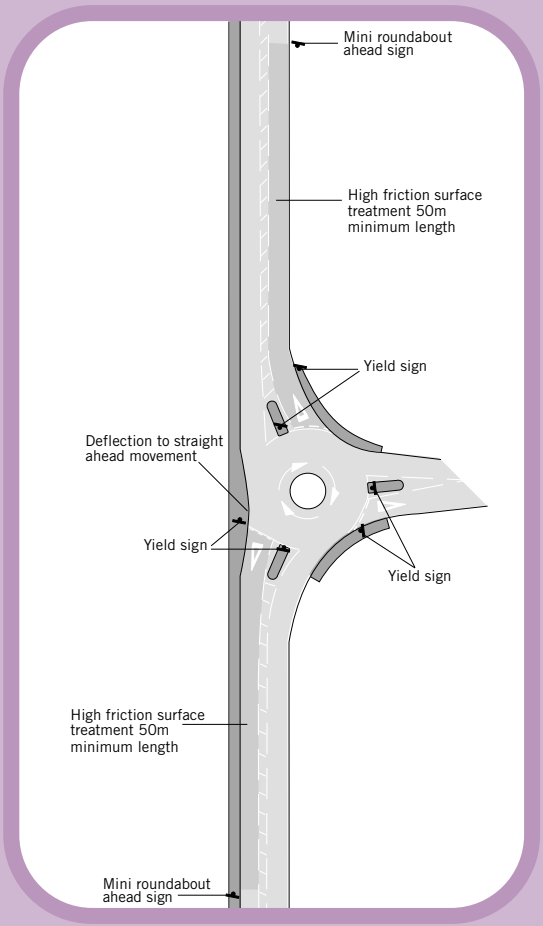
Pedestrians

Consideration should be given to the provision of pedestrian crossing facilities at mini-roundabouts. Where controlled crossings cannot be justified then traffic islands on the approaches should be designed to accommodate pedestrians. The islands should be constructed in accordance with the guidelines in Chapter 6.8. Any signs located on the islands should not obstruct the path or visibility of pedestrians.

Table 6.4 Accidents at mini-roundabouts

Accident factor	3-ARM	4-ARM
Number of injury accidents per year	0.9	1.35
Percentage of fatal and serious accidents	12	14
Percentage of accidents involving –		
Veh. entering hitting veh. circulating	46%	66%
Cyclists	23%	20%
Motorcyclists	17%	17%
Pedestrians	17%	12%

Diagram 6.14 Mini-roundabout with deflection, splitter islands and signing



Cyclists and motorcyclists

It is difficult to accommodate specific facilities for two-wheeled vehicles within mini-roundabouts. If there are significant flows of cyclists along routes where mini-roundabouts are proposed, consideration should be given to alternative forms of junction control. (See Cycle Manual)

Visibility

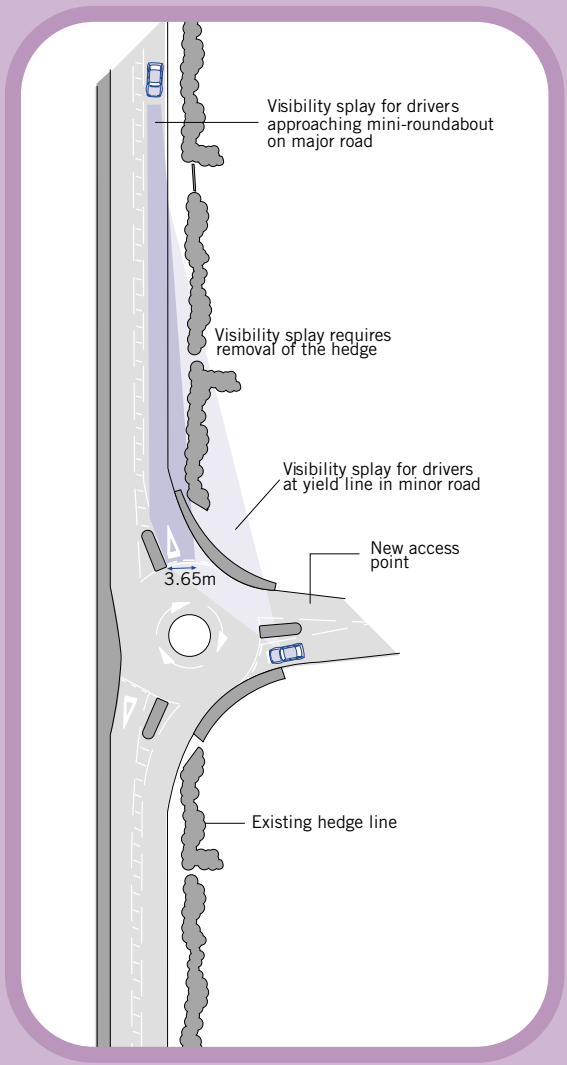
As with other forms of roundabout it is important that drivers have sufficient advance visibility of the island. This is often an issue when a three-arm mini-roundabout is built offset from the centre line of the main road and a hedge or fence line might obstruct forward visibility. In such cases a forward visibility equivalent to a Stopping Sight Distance (SSD) for the 85% speed of traffic on the road should be attained (see Table 6.5).

Visibility for vehicles at the yield line on this side of the road can be a problem particularly when the yield line is set back from the main road kerb edge. It may be appropriate to apply visibility splay requirements similar to those for priority junctions in this case to ensure that there is adequate visibility to the right for vehicles entering the main road from the minor road.

Table 6.5 Stopping sight distance

SSD-30mph	SSD-35mph	SSD-40mph
70m	90m	120m

Diagram 6.15 Visibility required at mini-roundabouts



6.12 Horizontal deflections – Build-outs, Pinch-points and Chicanes

6.12.1 General

Signing and road markings

Horizontal deflections may need to be signed in advance (for example "Road narrows"). This gives drivers adequate warning so that they can slow down to negotiate the feature. If the road is narrowed to a single lane width then yield markings should be provided to indicate which traffic flow direction has priority. Consideration should also be given to the use of yield signs to indicate priorities in situations where the markings alone would not have sufficient effect. Such situations would include locations where approach speeds may exceed 30mph (e.g. where it is the first in a series of traffic calming measures) or where the markings may be obscured by parked vehicles.

Narrowings to single lane traffic work best in a series for balanced vehicle flows of between 3,000 and 7,000 vehicles per day. If the traffic flow is below 3,000 vehicles per day, vehicles approaching horizontal deflections rarely have to give way to each other and the measure is ineffective. If the flow is above 7,000 vehicles per day then long queues can form in the peak hours. In off-peak hours vehicles can speed-up to get through the narrowing before an oncoming vehicle

Cyclists

Where the road is narrowed, cyclists can feel threatened by motor vehicles. Drivers may attempt to overtake cyclists where the width is more than 3m and therefore risk hitting them. Where possible, cyclists should be provided with a separate route around the deflection to avoid this conflict (see Diagram 6.17). (See Cycle Manual)

Aesthetics

The use of horizontal deflections often allows scope for enhancement of the road environment. The materials, planting and street furniture (such as bollards) used should be of a high quality. The advice of planners or landscape architects on appropriate materials should be sought. This is likely to enhance both the effectiveness of the scheme and the popularity of the scheme with residents and road users.

Visibility

The features should be located where drivers would have clear visibility of them. Planting and street furniture should not obstruct the visibility of pedestrians who may be crossing nearby. Similarly drivers approaching the feature from opposite directions should be able to see each other and yield (without sudden braking) if necessary (see Diagram 6.18).

Critical widths

If separate cycle facilities are provided the narrowing can be reduced to 3m for residential roads and 3.5m for major roads. If no separate cycle facilities can be provided then a width of 4m is preferable to avoid cyclists being 'squeezed'. Widths of 4.5m or greater may encourage 2 cars to try to get through together.

Diagram 6.16 Signs and markings at one-way road narrowing (centrally located)

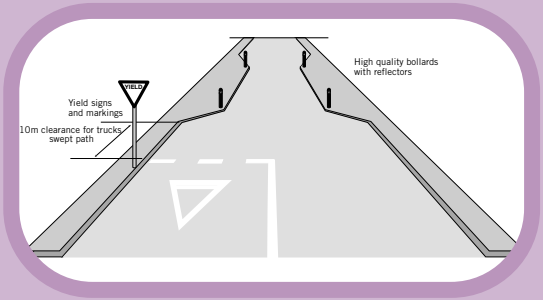


Diagram 6.17 Cycle by-pass at narrowing

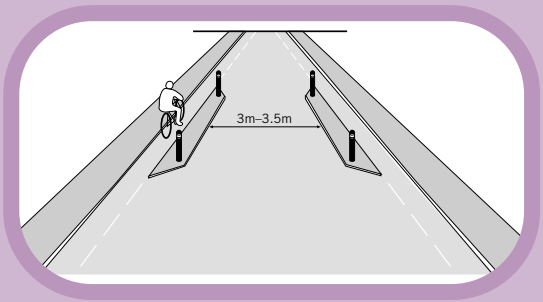
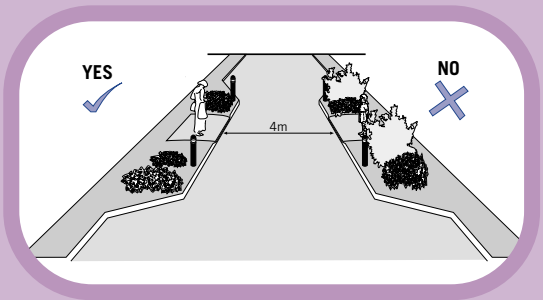


Diagram 6.18 Planting at road narrowing



6.12.2 Build-outs and pinch-point (road narrowings)[19]

Build-outs are an extension of the footway or verge into the road. They can be used for a variety of purposes, including to:

- provide sheltered parking bays
- improve visibility at junctions by allowing the give way markings to be moved forward
- assist in the formation of gateways and entry treatments (Chapter 6.9)
- provide opportunities for scheme enhancement including hard and soft landscaping
- form chicanes and pinch points
- provide bus boarders (Chapter 15.6)

Pinch-points work best when combined with other traffic calming measures such as ramps and speed cushions. When two vehicles are approaching single-way working pinch-points from opposing directions, some drivers approaching the yield sign may speed up to get through the gap before the other vehicle arrives, in order to avoid having to yield. This effect tends to be reduced if there is a ramp or speed cushion within the pinch-point. To be effective on their own, single-way working pinch-points require significant volumes of conflicting traffic. On many residential roads there is insufficient traffic volume for them to work effectively on their own for long periods of the day. Build-outs can also be used to form bus boarders (see Chapter 15.6).

6.12.3 Chicanes[19,29]

Chicanes consist of alternating road narrowings (or footway build-outs) on each side of the road. These induce the horizontal deflection of vehicles, which assists in reducing speed.

There are two main types of chicane:

- single-way working on roads with between 3,000 and 7,000 vehicles per day (controlled by yield markings and priority signs)
- two-way working for flows above 7,000 vehicles per day

Diagram 6.19 Built-out to provide sheltered parking and improve visability at junction

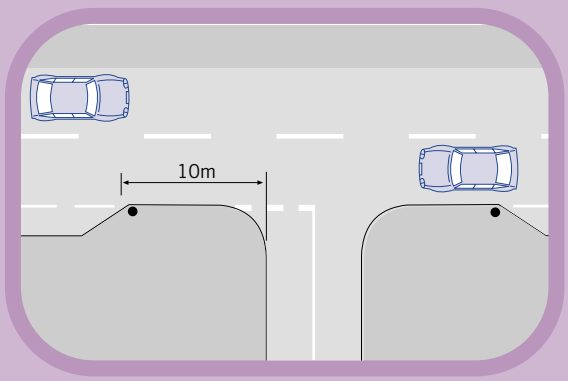
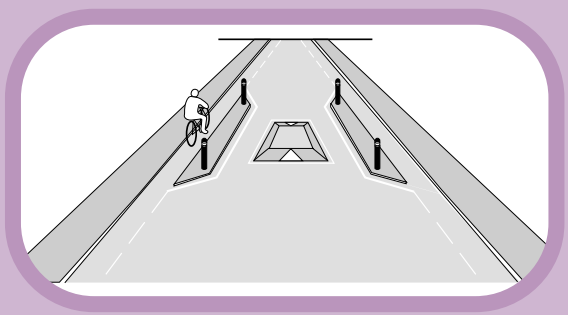


Diagram 6.20 Pinch-point with speed cushion



Design and effectiveness

The tighter a chicane is, the more effective it will be at reducing vehicle speeds. However, chicanes must be designed so that all vehicles allowed to use a particular road can negotiate the chicane. If there are long vehicles using the road then the dimensions will need to be more relaxed to cater for them. Different dimensions will be needed for different types of roads within the overall road hierarchy, taking into account the nature of traffic that they carry. Catering for long vehicles can reduce the effectiveness of chicanes for cars and motorcycles.

It is possible to design many different chicane layouts, but research and advice on the effectiveness of these is limited.

Reducing the field of view for drivers and the optical width of the road using landscaping and street furniture at the measure can help to reduce speeds. Care should be taken that visibility of oncoming traffic and other road users such as pedestrians and cyclists is maintained at a level appropriate to the design speed. Failure to do so may result in other types of accidents.

If planters are used to provide landscaping at build-outs, care should be taken that they do not obscure the visibility of pedestrians (particularly small children) who might cross in that area.

The use of overrun areas (see Chapter 6.10) can improve the effectiveness of chicanes. The overrun areas consist of slightly raised areas of contrasting material such as cobbles. They are laid in such a way as to encourage cars to take a tighter path through the chicane and thereby reduce their speed more. In order to be effective, the overrun strip must be designed in a way that will discourage cars from mounting it. However, long vehicles can mount the overrun area to negotiate the chicane. The overrun area should be conspicuous so that drivers and riders can easily see it. This will encourage them to reduce their speed and take a suitable path through the chicane although motorcycles can often take a relatively straight line through the chicane without reducing their speed.

Speed at Chicanes

Table 6.6 shows the results of a survey of car speeds at a variety of chicanes in the UK. The figures indicate the range of mean and 85%ile speeds at different chicane layouts within the

Diagram 6.21 Two-way working chicane

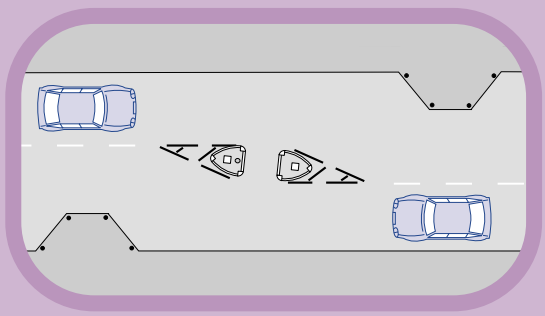


Table 6.6 Speeds at chicanes

TYPE OF CHICANE	Mean speed mph	85% speed mph
Single-lane working	18-23	21-30
Two-way working	21-33	25-38

Table 6.7 Speeds at chicanes

TYPE OF CHICANE	Mean speed mph	85% speed mph
Single-lane working	23	27
Two-way working	31	34

survey. The single-way working chicanes tend to reduce speeds more because they require one direction of traffic to give way to the other (if there is sufficient opposing flow).

Speed between Chicanes

The speed of cars between the chicanes was analysed from the same survey as referred to above, and is shown in Table 6.7.

There is little published information on how speed varies with the spacing of chicanes but it is likely to follow a similar pattern to that for road humps (see Chapter 6.13.1).

Parking

Care is needed with the design of chicanes because parked vehicles on their approaches can obstruct them if not regulated correctly. This can bring the measures into disrepute in areas where parking restrictions are not self-enforcing or where there is pressure for parking spaces. On wider roads or roads which can be narrowed to single-lane working, the chicane can be formed using build-outs to shelter parking. The example in Diagram 6.23 includes ways of accommodating parking.

Accidents[70]

Accidents at a selection of chicane sites in the UK showed an average reduction in injury accidents of 54%. The severity of the accidents occurring was also significantly reduced. However there was an increase in accidents at a small number of the sites.

6.13 Vertical deflections – Ramps, Speed Tables and Speed Cushions

6.13.1 General

Vertical deflections of the carriageway can be designed and constructed in a variety of ways. General advice on design, construction and maintenance issues is given in Chapter 6.14.

Types of feature

Ramps are the most common vertical deflection. Most ramps have either flat or round-top profiles.

Diagram 6.22 Visability at chicanes

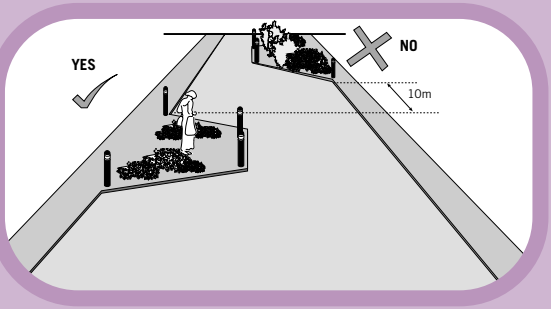
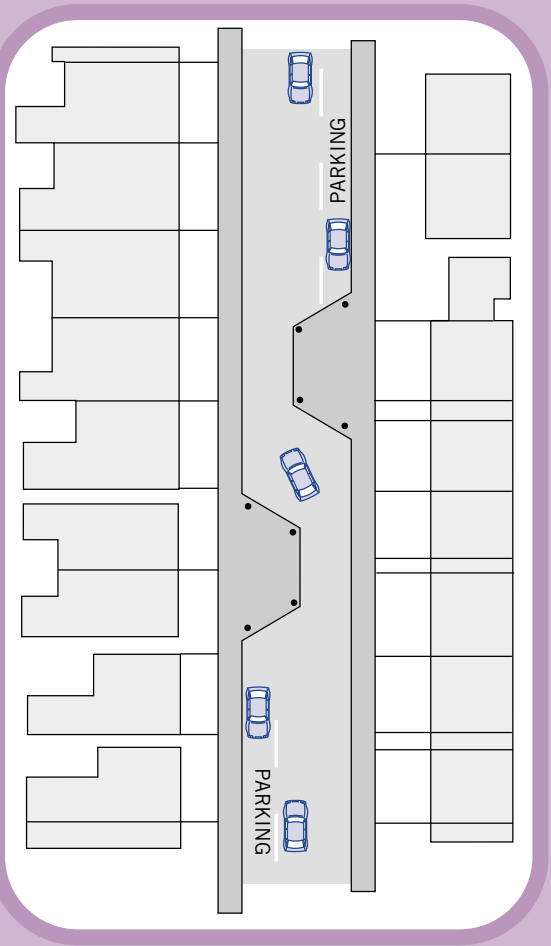


Diagram 6.23 Visability with parking



Ramps can either stretch from kerb to kerb (full width) or their sides can be tapered, finishing before they reach the kerb edge. Flat-top, full width ramps can be useful as places for pedestrians to cross the road. They are particularly useful for people in wheelchairs and those pushing prams, pushchairs etc. It is important that kerb upstands are flush or a maximum of 6mm high if they are to be used as pedestrian crossing points (Section E, Chapter 13). Tapered side ramps allow water to flow around them and therefore do not require the provision of additional drainage, which can save on implementation costs.

"Speed table" is a term used for longer flat-top ramps. When they stretch across a junction they are often termed "table junctions".

"Speed cushions" are a narrower form of ramp that wider vehicles can straddle (or partially straddle).

Size

No minimum or maximum dimensions are currently prescribed for the height, widths and lengths of vertical deflections in Ireland. However, it is important that these features are designed to attain an acceptable balance between the benefits and potential drawbacks outlined in Chapter 6.6. It is the combination of height, length and entry or exit slope (width and side slope for speed cushions) that determines the speed at which vehicles can travel over them.

Most of the ramps constructed on public roads in the UK are at least 3.7m long, to minimise the risk of vehicles grounding on them. This is recommended as good practice in Ireland. Ramps on public roads should not be less than 900mm long.
Details on dimensions of different types of feature are given in subsequent parts of this chapter.

Spacing

Whilst the height and shape of the features influence the speed at the feature, the spacing of features is an important factor in determining the speed between them.

Diagram 6.24 Full width ramp

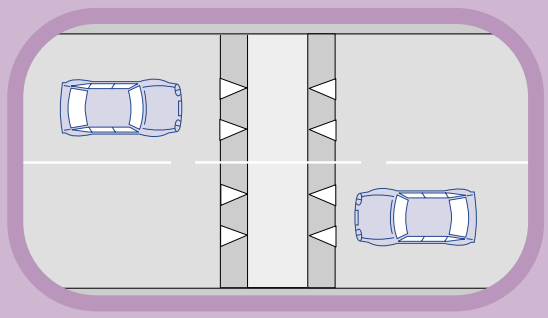


Diagram 6.25 Tapered side ramp

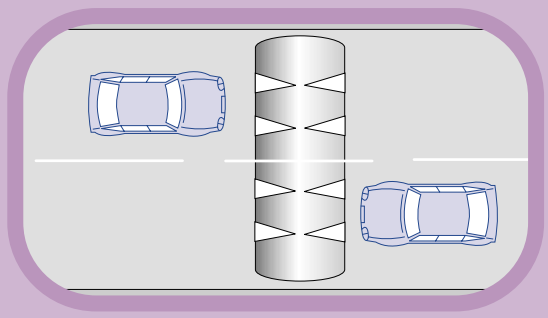
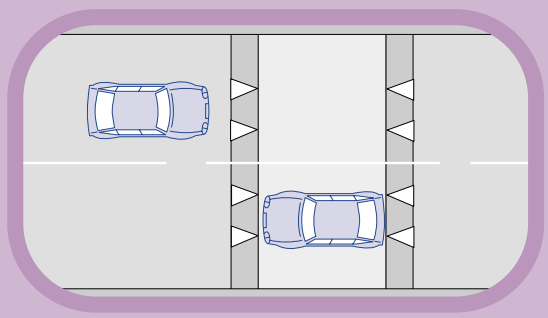


Diagram 6.26 Speed Table



Speed between Ramps

The mean "after" speeds of cars between ramps from a survey of UK traffic calming schemes is shown in Table 6.8.

The design of a traffic calming scheme should aim to minimise accelerating and braking at and between features. It should encourage driving at a constant low speed. Good design practice is to space appropriate features as regularly and frequently as practicable (70m to 100m). Poor design practice is to have features that encourage harsh braking and consequent heavy acceleration in between (severe features or spacing greater than 120m apart).

Location

Where possible, it is advisable to locate the first feature in a system of traffic calming close (40m to 60m) to a point on the road where speeds are already lowered. Such locations include a junction, tight bend etc.[30] Where this is not possible advance signing and gateways or entry treatments (see Chapter 6.9) would help to alert drivers and riders to the need to slow down and take care.

Speed reduction

Research reports[59,69] in the UK have recorded average and 85%ile vehicle speeds on a variety of different vertical deflection schemes. The main results from these will be summarised later in this chapter.

Signing and road markings

It is important that drivers and riders are given adequate warning of vertical features so that they can reduce their speed accordingly.

Clear, conspicuous signs and road markings can help to do this. Signs should be provided in advance of the features and should incorporate a distance plate if appropriate. If the features are greater than 150m apart they should be signed individually. Although there is no prescribed marking to be placed on the features, they should be marked clearly. This can be achieved in a number of ways. In the UK triangular markings are required to be placed on the features. In Holland and Germany a chequer

Diagram 6.27 Speed cushions

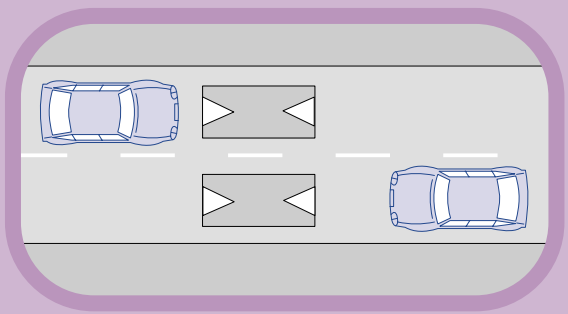
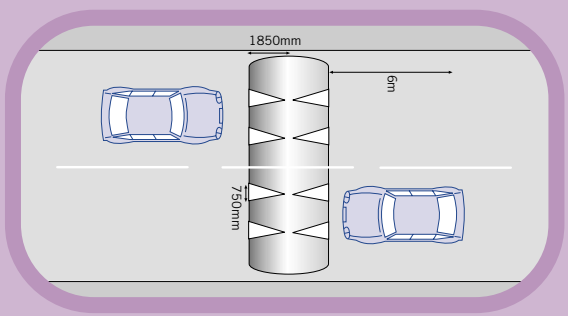


Table 6.8 Mean after speeds of cars (mph) between round-top and flat-top ramps

Mean Before Speed (mph)	RAMP Spacing (m) 60	80	100	120	140
30	19	20	22	23	24
35	21	22	24	25	26

Diagram 6.28 Recommended road markings for Ramps



marking is commonly used across the whole width of the measure. In Ireland a variety of markings have been used in recent years. It is the responsibility of each road authority to satisfy itself that the markings used are clear and unambiguous. The signs and markings should be positioned so that parked vehicles do not obscure their visibility.

The markings indicated in Diagrams 6.28 and 6.29 are recommended for use on ramps and speed tables. The offside markings are provided in case parked vehicles obscure the nearside ones but should be omitted if traffic is directed (for example by a keep left arrow at a refuge) to proceed across a particular part of a ramp only (see Diagram 6.36).

For speed cushions, a different marking is recommended (see also Chapter 6.13.6). The markings should be included on both sides of the cushion if parked vehicles are likely to obscure one of the cushions.

6.13.2 Round-top ramps

Round-top ramps have the cross-section of a segment of a circle. The height of the ramp referred to is the maximum height in the centre. Most of the round-top ramps that have been constructed on the public road in the UK are 3.7m long and between 50mm and 100mm high. Shorter ramps have been tried but it is more difficult to get an acceptable balance between speed reduction and some of the potential drawbacks. Diagrams 6.31 and 6.32 show typical details of the construction of a round-top ramp.

The 3.7m length is designed to minimise the risk of vehicles grounding on them. However, some vehicles have a lower suspension and other vehicles such as funeral cars have a longer wheelbase, without the extra ground clearance of a bus or emergency service vehicle. In such instances they can ground even at low speeds. Round-top ramps are generally constructed with tapered sides because they are not suitable places to encourage pedestrians to cross.

100mm high round-top ramps may result in vehicles grounding on them and also tend to be criticised by a larger proportion of drivers as being too severe and exacerbating the potential drawbacks such as discomfort, noise, vehicle damage etc. 50mm

Diagram 6.29 Recommended road markings for Speed Tables

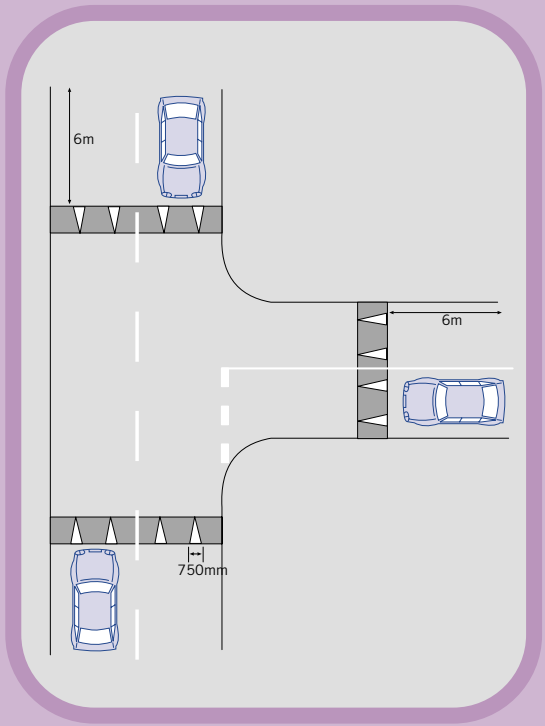


Diagram 6.30 Recommended road markings for Speed Cushions

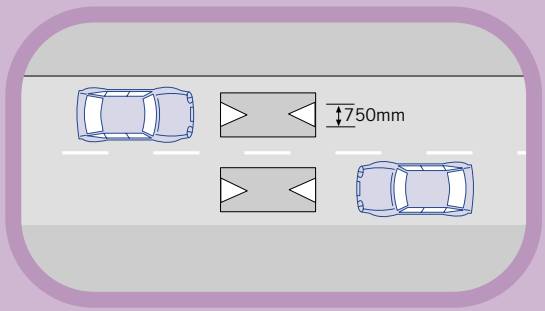


Table 6.9 Speed of cars at 75mm high round-top ramp

MEAN SPEED (mph)	85% SPEED (mph)
15	19

high round-top ramps are generally perceived as allowing too many vehicles to travel too fast over them and not effective enough for most areas. They can also exacerbate the noise of lorries. There are some exceptions to this e.g. on gradients steeper than 1 in 10.

75mm high round-top ramps represent a good balance between reducing vehicle speeds and some of the adverse impact of the measures as outlined in Chapter 6.6. Table 6.9 indicates the results of a survey of car speeds at 75mm round-top ramps in the UK.[59]

The same report also indicated that there was only 1mph difference in the mean crossing speed for 75mm and 100mm high ramps.

6.13.3 Flat-top ramps and speed tables

Flat-top ramps consist of a raised section of carriageway with inclined sections (entry/exit slopes) at either end. Most of the flat-top ramps constructed on the public road in the UK have a minimum flat-top length of between 2.5m and 3m (excluding entry/exit slopes). Shorter lengths could lead to vehicles grounding. Entry/exit slopes vary in gradient between 1 in 6 and 1 in 30. The height of features varies between 50mm and 100mm. Heights greater than 100mm are not allowed in the UK. Diagram 6.33 and 6.34 show typical details of the construction of a flat-top ramp.

The height of flat-top ramps and speed tables, is less critical than with round-top ramps because the entry/exit slope and length of the feature are also significant factors in the design. Table 6.10 indicates the results of a survey of car speeds at 75mm flat-top ramps in the UK.[59]

Entry/exit slopes steeper than 1 in 10 are little used as they are generally considered to be too severe. Slopes of 1 in 20 and shallower tend to be ineffective in terms of reducing speeds. Increasing the length of the flat-top is often favoured by bus operators and emergency services, as they perceive it to reduce the discomfort for drivers and passengers together with maintenance and repair costs for their vehicles.

Diagram 6.31 Plan view of round-top ramp

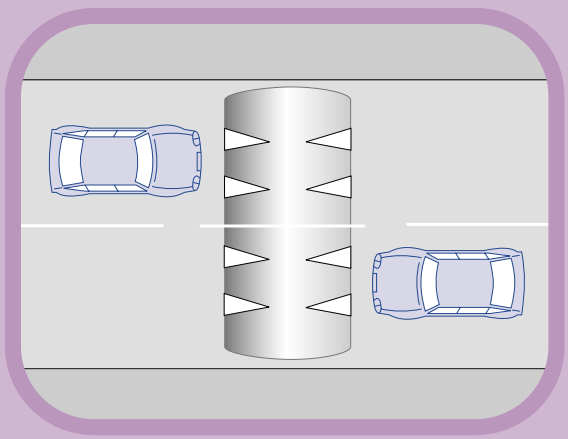


Diagram 6.32 Cross section of 75mm high round-top ramp

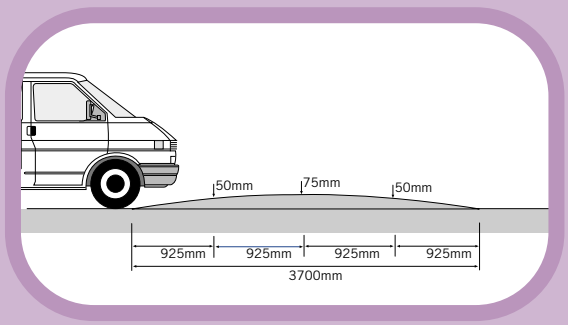


Table 6.10 Speed of cars at 75mph high flat-top ramp

ENTRY/EXIT slope	MEAN SPEED mph	85% SPEED mph
1:10	12	14
1:15	13	16
1:20	16	21
1:25	26	30

A minimum flat-top length of 2.5m (6m on bus routes), a height of 75mm together with ramp slopes of 1 in 15 represents a good balance between effective speed reduction and the potential drawbacks.

Speed tables tend to be located on more sensitive traffic routes, usually in response to bus or emergency service concerns. They have the advantage that they can be positioned at junctions. Because they are longer, the pitching movements associated with shorter ramps are not as pronounced and passenger comfort is generally improved. Mean vehicle speeds increase by around 1mph for each extra 6m length (up to 18m), when compared to standard 2.5m to 3m flat-top lengths. Where speed tables are located at junctions, it is common practice to extend the feature into the side road by around 6m to allow a car to wait with all four wheels on the raised area. Diagram 6.35 shows a typical speed table layout at a junction.

Pedestrian crossing points

Full road width flat-top ramps can be used in conjunction with both controlled (including zebra crossings) and uncontrolled pedestrian crossing points to create safer crossing locations. However, care needs to be taken at uncontrolled crossing points that the appearance of the ramp (surface finishes etc.) does not give pedestrians the impression that they have an increased level of priority. Chapter 13 gives details on the use of tactile paving at such crossings. In some areas of the UK there have been reports of problems with pedestrians walking out into streams of traffic and expecting drivers to stop as they would at a controlled crossing point.

Reducing passenger discomfort

Discomfort for drivers/passengers is one of the main drawbacks with ramps. The driving style adopted by the majority of drivers at these features is to reduce their speed on approach and to accelerate once the front wheels of the vehicle have cleared the ramp. Most of the discomfort is therefore experienced as the rear wheels traverse the feature. At certain locations (such as one-way streets or where the ramp can be constructed with a refuge island), it is possible to reduce the discomfort without compromising the desired speed reducing effect. This can be achieved by reducing the exit gradient of the ramp to around 1 in 30, whilst maintaining the entry gradient at 1 in 15 (see Diagram 6.36).

Diagram 6.33 Plan view of flat-top ramp

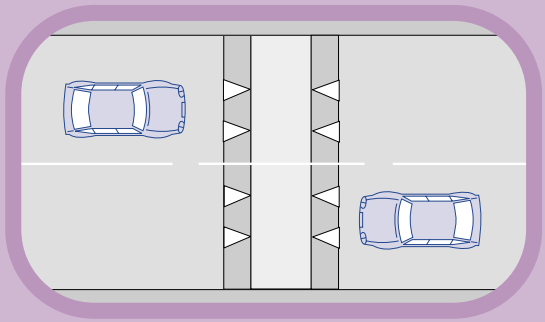


Diagram 6.34 Cross section of 75mm high flat-top ramp

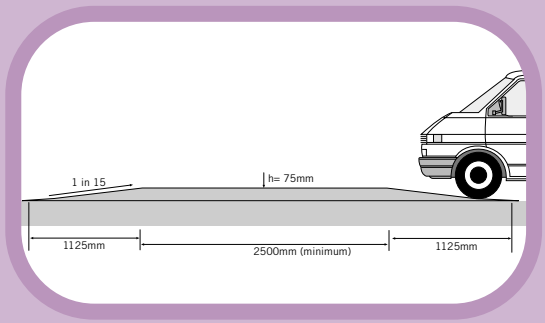
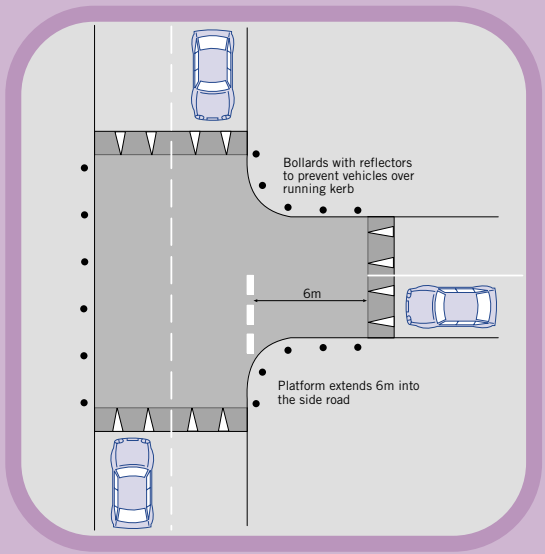


Diagram 6.35 Speed table layout at junction



Other types of vertical measure

There are a variety of other types of vertical measures that have been tried. Some of these are listed below with references for further reading. These features are not in widespread use but may have some limited applications in Ireland.

- Sinusoidal ramps[31,71] – These aim to improve ride quality for cyclists but their effect is comparatively small and they are difficult to construct.
- "H" and "S" ramps[31,71] – These aim to improve the ride quality for wider vehicles such as buses and emergency service vehicles. They are more difficult and costly to construct. Speed cushions and speed tables can produce similar benefits.

6.13.6 Speed Cushions[17,30,69]

"Speed cushions" are narrow versions of ramps that wider vehicles can straddle (or partially straddle), thereby reducing some of the potential drawbacks of traffic calming on buses, fire engines and lorries. The concept originates from Germany where they are widely used to great effect.

Application in Ireland

The way buses are constructed in Ireland reduces some of the potential benefits of speed cushions. In Germany, some large vehicles have a single wheel at each end of the rear axle; this gives them a much wider inner wheel track width than cars. In Ireland and the UK, larger vehicles have a double wheel combination on each end of the rear axle. This reduces the inner wheel track width to be much closer to that of a car (see Diagram 6.37).

Despite this, cushions are in widespread use in the UK, particularly on bus routes. They are also in use in Ireland.

Compared to 75mm high round and flat-top ramps, speed cushions can offer benefits for buses and other wider vehicles. They do however allow cars to travel faster (depending on the design of cushion used) and therefore may not be suitable for areas where speeds of 20mph or lower are required. They tend to be more popular with bus operators and can be considered for use on bus routes where appropriate.

Diagram 6.36 75mm high flat top ramp with different entry/exit gradients

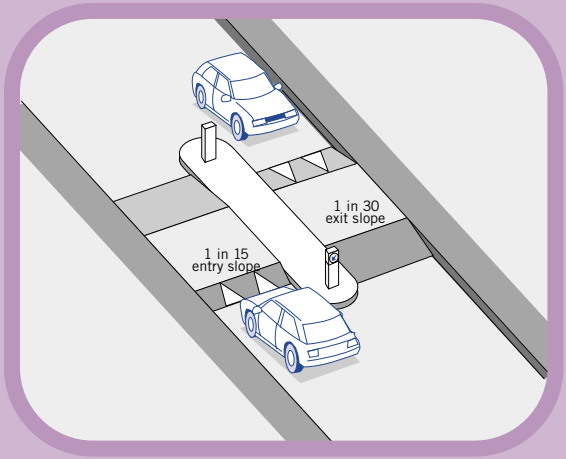
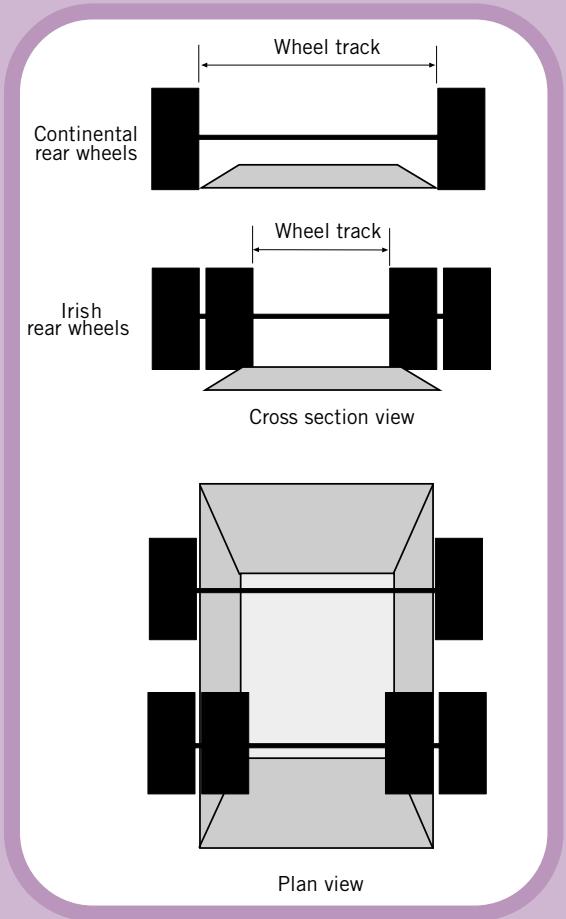


Diagram 6.37 Wheel track widths



Signing and road markings

Speed cushions can be signed in the same way as other vertical deflections. However because they are narrower, they are more difficult for drivers to see. In addition to the customary triangular markings, the use of a solid edge line around them can help to highlight them to drivers and aid speed reduction (see typical layouts).

Driver and rider behaviour

At speed cushions, some drivers will attempt to drive in the gaps, or drive with only one side of the vehicle on the cushion. If the lateral gap between adjacent cushions is too wide then it will become attractive for vehicles to drive through this rather than attempt to straddle the cushion. If the gap is too narrow then there is an increased risk of vehicles colliding with each other while negotiating the cushions.

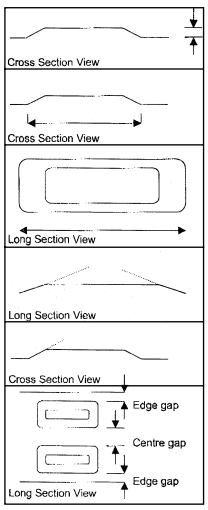
CUSHION DIMENSION	ILLUSTRATION	MINIMUM/MAXIMUM DIMENSIONS	COMMENTS
Height		65mm–75mm	Vehicles can ground more easily on narrow cushions
Width Edge to edge		1.5m–1.9m	Wider cushions tend to reduce car speeds more
Length		2.5m–3.5m	Longer cushions may be more comfortable
Entry/Exit Slope		1 in 8 max.	
Side slope		1 in 4 max.	
Transverse gaps		0.75m min at edge 1 to 1.2m max at edge or between adjacent cushions	Minimum edge gap for cyclists Maximum gap needed to minimise the number of vehicles using gap to avoid the cushion

Table 6.11 Practical minimum and maximum dimensions for speed cushions[69]

APPROXIMATE SPEEDS AT CUSHION (MPH)					
Cushion width (mm)	1,500	1,600	1,700	1,800	1,900
Mean speed (mph)	21	19	18	17	16
85% speed (mph)	28	26	24	22	20

Table 6.12 Speed of cushions of different widths (75mm high, 1:8 entry/exit slope, 1:4 side slope)[69]

APPROXIMATE SPEED BETWEEN CUSHION (MPH)					
Distance between (m)	60	70	80	90	100
Mean speed	21	22	23	24	25
85% speed	24	26	27	29	30

Table 6.13 Speeds between adjacent sets of cushions at different spacings[69]

Motor cycles can negotiate some speed cushion schemes without reducing speed significantly by using the gaps between them.

Design of Speed Cushions

Care needs to be taken with the design of speed cushions if they are to strike the desired balance between general speed reduction for cars (and powered two-wheelers) and mitigating the adverse effects for buses and emergency service vehicles. The dimensions are critical and need to be considered carefully in conjunction with the type of buses, ambulances and fire service vehicles using the route to be treated.

The dimensions given in Table 6.11 are recommended as practical minimum and maximum dimensions for speed cushions.

Table 6.12 below shows the results of a survey of car speeds at speed cushions of different widths in the UK.[69]

The spacing of sets of cushions will have a strong influence on vehicle speeds between them. Table 6.13 indicates the results of a survey of speeds between speed cushions in the UK.[69]
For situations where there is regular use by smaller buses/ambulances, 1600mm wide cushions can be used. These offer a good balance between improved passenger comfort and general speed reduction but they also allow cars to travel faster.

Wider cushions (1800mm–1900mm) may be appropriate on roads where larger buses operate and which are not main routes for ambulances.

It is recommended that discussions take place between roads authorities, emergency services, public transport operators and bodies representing goods vehicles interests (if appropriate) to discuss the types of measures to be used on more traffic sensitive routes.

Typical layouts

Cushions are often used in one of the following configurations.

- Single cushion with single-way pinch-points (controlled by yield markings). These are suitable for roads with flows between 3,000 and 7,000 vehicles per day and can accommodate parked vehicles (see Diagram 6.38).

Diagram 6.38 Single Cushion layout

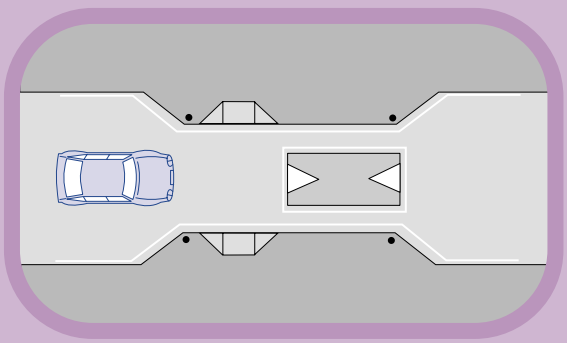


Diagram 6.39 Two cushion layout

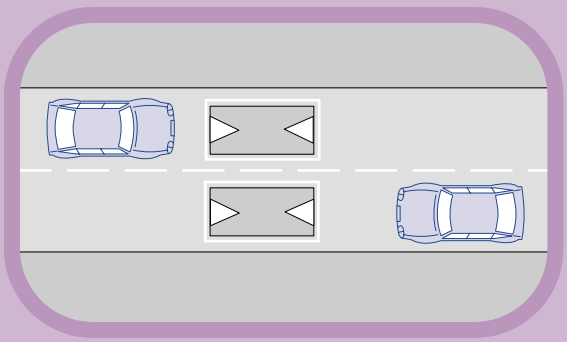
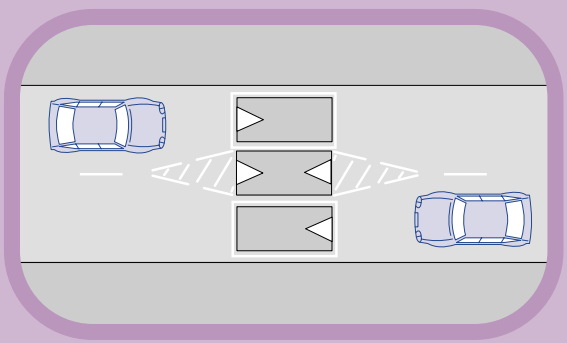


Diagram 6.40 Three cushion layout



- Pairs of cushions – allow two-way working but care is needed with the central gap (1.2m max). These are suitable for roads 5.5m–6.5m wide or where local narrowing is needed (see Diagram 6.39).
- Three abreast cushions – these are suitable for wider roads (7.3m–8.5m) and roads with parking which would obstruct the correct use of pairs (see Diagram 6.40).

The most appropriate configuration for a speed cushion layout will depend on the width of cushion used, the width of edge and centre gaps, and the available road width. It may be necessary to narrow or widen a road locally to ensure that the cushions fit the available road width and the recommended gaps are not exceeded (see Diagram 6.41).

On roads carrying significant volumes of buses or trucks, consideration should be given to using traffic islands to channelise the opposing flows. In this case, if the island is likely to be used by pedestrians, then the cushions should be staggered slightly from the islands so that they are not a trip hazard (see Diagram 6.42).

Where the road width prohibits the use of islands, then white line hatching (sometimes with a third cushion in it) can be used as an alternative to an island (see Diagram 6.40).

Parking on the approaches and exits from cushions can prevent vehicles from straddling them and negate the intended benefits. Due consideration needs to be given to parking at the design stage and appropriate measures taken to prevent this if it would cause problems for bus operators or emergency services (see Diagram 6.43).

6.14 General design, construction and maintenance issues

Design

A wide range of traffic calming features is described in detail in this chapter. Road authorities should use a range of appropriate measures on each scheme rather than rely solely on one feature such as ramps. Throughout the selection and design process of

Diagram 6.41 Cushions with road narrowing

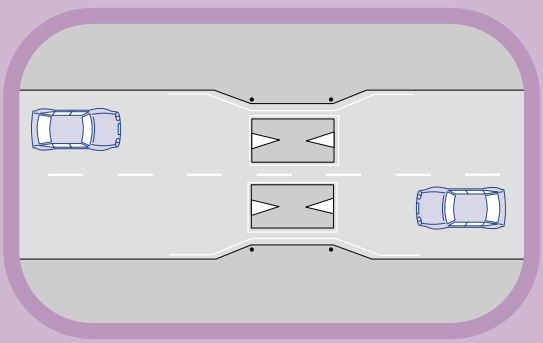


Diagram 6.42 Cushions with island

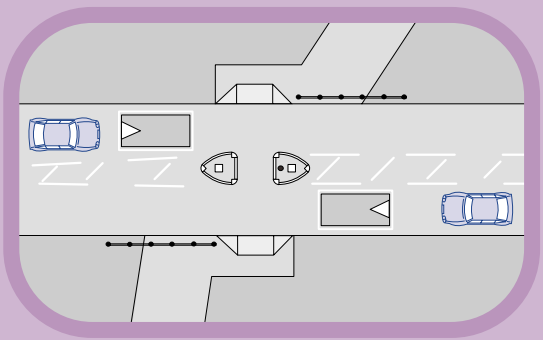
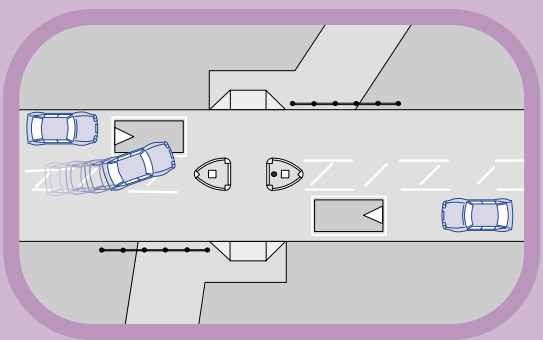


Diagram 6.43 Parking obstructing correct use of cushion



traffic calming features, it is necessary to consider a number of issues. It is very important that the materials used are of high quality and that the construction of the features is to a high standard. The opportunity to enhance measures through the use of hard and soft landscaping should be taken wherever possible. The advice of landscape architects should be sought where appropriate.

Location of features

When locating traffic calming features on a road, consideration must be given to a number of operational requirements:

- Turning movements into and out of junctions and private accesses will need to be maintained.
- Safe access to manholes, access chambers and service covers will be needed. Positioning a traffic calming feature near one may require a temporary road closure and signed diversion route before they can be accessed.
- Routine maintenance activities such as gully cleaning, channel sweeping and lamp replacement must be catered for.

Signs and road markings

Signs and road markings warning drivers of the presence of traffic calming schemes are required. These should be located so that drivers approaching the measures can see them clearly and do not have to brake suddenly. Signs should be positioned so that visibility of them is not obscured, e.g. by parked vehicles. More detailed advice is given in the previous sections on different types of traffic calming feature.

Parking

Some traffic calming measures such as chicanes and road narrowings require the removal of parking spaces to operate effectively unless schemes are designed specifically to cater for parking (see Diagram 6.44). In built-up areas, parking can be a very sensitive issue and it needs to be addressed at the early stages of a design. The careful design and selection of features can often minimise potential problems.

Lighting

Illumination of the features in the dark should enable road users to see the features clearly. It is important for road users to be

Build-outs to form chicane offering scope for landscaping

Series of ramps

Lighting of measures

able to see their path through the deflection. Overrun areas must be clearly distinguishable both in daylight and night-time conditions. Improvements to existing lighting should be considered as part of the scheme design process. Lighting in accordance with BS 5489 should be provided along the whole of the traffic calmed road where possible. If this is not possible then the measures should be individually lit to this standard. Assistance should be sought from an experienced street lighting engineer on these matters.

Cyclists

Traffic calmed streets are a more attractive environment for cyclists because of the reduction in the dominance of motor vehicles. Traffic calming schemes reduce the speed of vehicles to a level that is closer to the speed of cyclists. Schemes do however need to be designed to meet cyclists' needs and should not put them at greater risk by putting them in conflict with vehicles at features such as road narrowings and chicanes. Cyclists can feel threatened if they are "squeezed" by motor vehicles, so where possible cycle bypasses should be provided. These are short segregated alternative routes, which allow cyclists to pass horizontal traffic calming measures separately from vehicular traffic (see Chapter 6.12). It is important that cycle tracks and other facilities are adequately maintained, as the general flow of traffic will not clear them of stones and detritus. If cycle tracks are not regularly swept cyclists will not use them.

Traffic diversion[62]

Studies in the UK have shown that it is common for traffic to divert from traffic calmed roads onto alternative routes. An average reduction in traffic of 25% was recorded in a survey of traffic calming schemes. Factors such as the availability of convenient alternative routes influence the actual level of usage. Care should be taken that traffic is diverted onto appropriate main roads rather than onto adjacent residential streets (as in Diagram 6.46).

Landscaping and enhancement

Traffic calming schemes (particularly those where road narrowings provide more space) offer the opportunity to

Diagram 6.44 Chicane with parking facilities

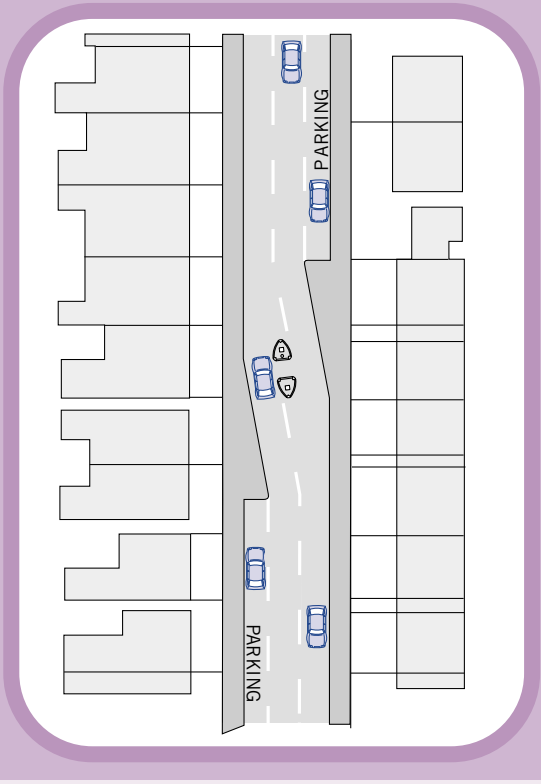
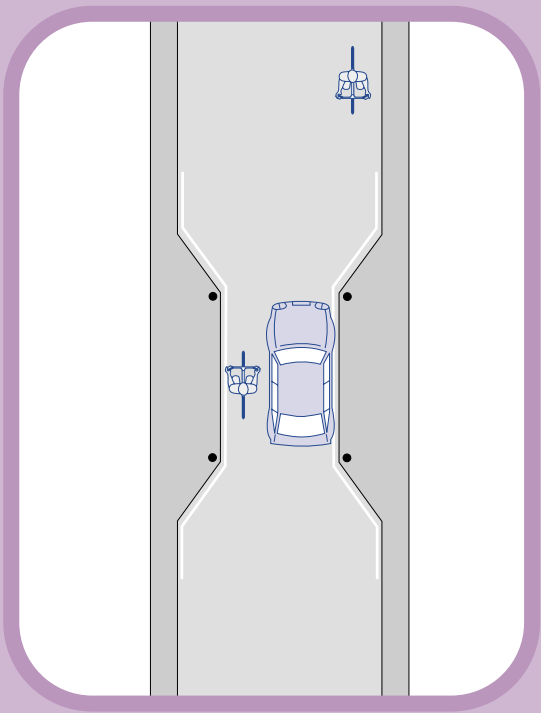


Diagram 6.45 Cyclist squeezed by car at road narrowing



incorporate hard and soft landscaping into schemes. Whilst it is common practice to provide planters for this purpose, they are not always appropriate and their maintenance needs to be considered so that they do not become overgrown. Similarly, lack of attention may result in planters falling into disrepair or the plants dying. Permanent planting options should be considered where possible. "Guidelines on traffic calming for towns and villages on national routes, 1999[88]" published by the NRA gives advice on these issues and where possible an experienced landscape architect should be consulted.

Noise[25, 57,76]

General traffic noise levels are likely to reduce in traffic calmed areas due mainly to either a reduction in the volume of traffic or tyre noise. However, there may be localised problems with noise from vehicles braking and accelerating and truck body/load rattle. The latter is most associated with vertical deflections.

Air quality[57,67,75]

Most studies have found that vehicle emissions are reduced in traffic calmed areas, principally through the reduced volume of traffic. Air quality can be difficult to assess as it depends on prevailing atmospheric conditions. At lower speeds some pollutants increase and others decrease. A scheme that promotes uniform driving speeds and discourages harsh acceleration and deceleration is likely to be of least detrimental impact in terms of air quality.

Construction materials and maintenance issues

Asphalt and bituminous macadam

Asphalt and bituminous macadam are the most commonly used construction materials. They are smooth, flexible and are generally cheap to lay and maintain. They can be pigmented to provide different colours but this increases the costs of installation and also maintenance (as the colour fades in a comparatively short time). Tyre marks and fuel spillage on the running lanes also discolour the surface. Like all surfacing materials, the correct specification needs to be chosen to reduce deformation problems such as wheel track rutting.

Diagram 6.46 Traffic diverting along adjacent residential route

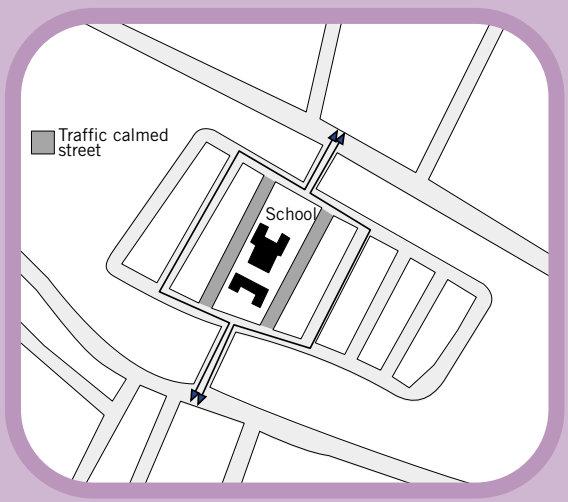
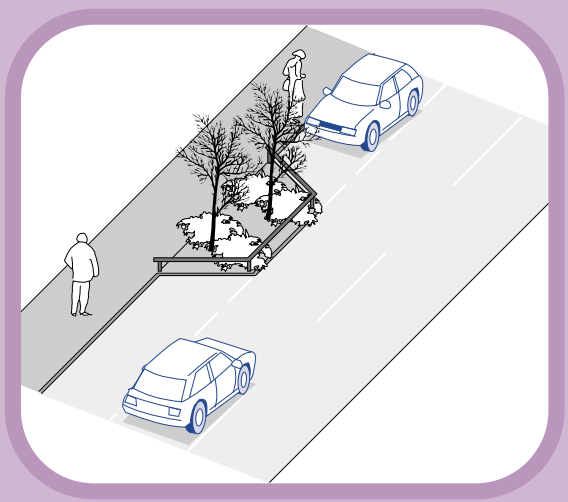


Diagram 6.47 Built-out to provide area for landscaping



Blocks

Blocks such as concrete blocks and clay pavers are used to provide enhancement and improve the aesthetics of features. The clay pavers provide better colour retention than concrete blocks but can polish and be slippery when wet and should not generally be used in areas where braking or turning movements take place. Blocks with a natural colour and irregular surface finish do not discolour as noticeably in running lanes. Their rougher surface texture and appearance enhance the speed reduction effect. Materials that easily polish (such as granite) should not be used in running lanes except at very low speeds or away from braking and turning areas.

Asphalt ramp

Designers should exercise considerable caution before deciding on the use of block pavers in ramps.

Block pavers should not be used in the following situations:

- where traffic speeds are high
- where they will be subjected to a high number of turning movements by heavy goods vehicles
- where road gradients are high

Block ramps deformed

Blocks are traditionally laid on a bed of sand. Whilst this generally works well in pedestrian areas, the forces imparted by vehicles on ramps has led to problems with the blocks becoming loose and dislodged into the road. The problems are compounded by mechanical channel sweepers, which can suck up the sand from joints and weaken their structural integrity. Some of these problems can be eradicated by setting the blocks in a mortar mix and mortaring the joints. An experienced materials engineer should be consulted over specifications for the mix to minimise future maintenance problems. Thermoplastic paint markings (often used to highlight the presence of features such as ramps) do not adhere well to blocks because the blocks can move individually. This leads to the thermoplastic breaking up and being removed by the action of traffic.

Composite constructions

Care is needed when vertical deflections use a combination of materials such as asphalt slopes and block-work tops. Asphalt is a flexible material and blocks are more rigid. This can lead to differential movement between the two materials with the asphalt compressing particularly in the wheel tracks. This can

leave a "lip" between the two materials, which can exacerbate noise or form a potential hazard for two-wheeled vehicles. The existing road may have some deformation in the wheel tracks, which could increase the effective height of the ramps. When constructing vertical deflections, it may be necessary to re-profile the immediate approaches to the ramp to reduce this effect.

Ramp with composite construction and 'lip' between materials

Other materials

A variety of other materials such as rubber and concrete sections can be used to construct traffic calming features and are available as proprietary products from manufacturers.

One of the systems involves the use of a hot applied bitumen based compound between 10mm and 25mm thick. A pattern can be pressed into it to create a 'blockwork' effect. It can be provided in a variety of colours and can accommodate thermoplastic road markings.

Bitumen based material with block pattern

The potential advantage that the system offers is the appearance of a high quality block work surface without the maintenance problems associated with blocks.

These materials are relatively new so little is known about their longer term durability.

Drainage

Additional drainage gullies may need to be provided for some traffic calming measures such as:

- full width ramps and speed tables
- build-outs, pinch-point and chicanes

This is because they can interfere with the flow of rainwater and cause localised ponding. Care should be taken that the gullies are positioned at low spots and that they are not positioned at locations where pedestrians cross. The gratings used should be cycle friendly.

Strengthening of existing road

Where traffic calming features are placed on existing roads they can change the path that vehicles take and the loading

conditions for the road. This can cause localised failure of the road surface if it is not in good condition and lead to criticism of the scheme. Prior to the installation of any horizontal or vertical traffic calming measure, consideration should be given to the condition of the existing road and the carriageway should be strengthened as part of the works if appropriate.

Routine maintenance

Traffic calming measures such as chicane and road narrowings may need additional routine maintenance such as channel sweeping and litter collection. This is because road detritus can accumulate in narrower channels, which are not trafficked by motor vehicles and could discourage cyclists from using features such as cycle by-passes specifically provided for them.

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