INSTITUTE OF HIGHWAY ENGINEERS

Guidelines for **Motorcycling**

3 Road Design & Traffic Engineering

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Road Design & Traffic Engineering

3.1 Summary

The creation, enhancement and maintenance of highway infrastructure require appropriate consideration of the dimensions and dynamic stability of motorcycles. Designers need to “think bike” and this will involve:

- Sourcing input from suitably trained and experienced riders to inform designs at an early stage and prevent the inadvertent inclusion of features that exacerbate safety risks for riders;
- Understanding the key relationship between the road surface and motorcycle braking, steering and accelerating;
- Exploring new ideas and trialling initiatives (for example, allowing motorcycles to use bus lanes); and
- Taking steps to ensure that any proposed traffic calming schemes will not present unintentional yet serious safety risks to motorcyclists.

3.2 Context

Road designers and traffic engineers need to understand the specific needs of motorcyclists. Some features, benign to other road users, can present a particular hazard to motorcyclists. When considering engineering measures on existing roads it is recommended that any collision data analysis is supplemented by input from experienced riders in order to gain a deeper understanding of the relevant factors.

3.3 Consultation

Ideally a local authority should appoint a Motorcycling Officer to inform its transport policies and the design of new schemes. However, motorcyclists themselves can also provide valuable input to local authority transport planners, design and maintenance engineers in order to help reduce safety risks within transport projects or highway schemes. See Chapter 2 for guidance on rider consultation.

The Swedish ‘OLA’ approach is an example of a more formal means of stakeholder engagement that seeks to allow system designers to work with user groups and designers to identify problems and solutions.

3.4.1 Overview

For the benefit of non-rider highway designers and traffic engineers, the key differences between motorcycles and other vehicles are set out below:

- The consistency of grip between tyres and the road surface is critical to motorcycle stability, particularly when leaning over for cornering, braking or accelerating.
- Most braking effort and all steering control for a motorcycle is through the front tyre which means that riders try to avoid combining braking and steering in order to reduce the likelihood of overwhelming front tyre grip as it deals with conflicting forces. Any change in this grip, and particularly a sudden decrease, can lead to loss of control during the manoeuvre as the front wheel slides away. Loss of front tyre grip on a bend almost invariably leads to a crash.
- All accelerating force is through the small patch of the rear tyre in contact with the road. A sudden reduction in grip (eg because of a surface change midway through a bend) can result in the rear tyre slipping sideways and in loss of control.
- Motorcyclists adopt a different line through bends than drivers of twin-track vehicles, traversing the width of the lane in order to maximise grip through minimising steering inputs. This keeps the machine as upright as possible and maximises forward visibility and safety. Anything that forces riders to choose a less than optimum riding line through a bend increases the risk of loss of control.

3.4.2 Surface Grip and Consistency

Motorcycles have a much greater need for a consistent and high coefficient of friction from the road surface than twin-track vehicles, especially on wet surfaces and in areas requiring braking and steering. Riders adopt an angle of lean to negotiate a corner that is related to speed and bend radius; any change in grip between tyres and surface can destabilise the machine. Any deviation from a consistently level surface in the same areas can seriously impair the motorcycle's 'road holding' ability.

A sudden change in surface level or evenness rapidly loads and unloads the suspension, which reduces the grip between front wheel and road surface. In other words, the wheel rebounds upwards and in severe cases can lose contact with the surface.

Unpredictable changes in the road environment that call for rapid deceleration or braking while cornering can cause the motorcycle to 'sit up' and take a tangential line away from the bend.

3.4.3 Bends

Anecdotal evidence suggests that riders on a bend tend to 'fixate' on what seems to be the object in their path most likely to hurt them (eg a tree or sign post). Some argue that the rider will then usually hit that object. Whether or not target fixation is a genuine phenomenon, research indicates that 50-70% of all motorcyclist collisions with roadside furniture result in fatal or serious injuries (Safety Barriers and

Motorcyclists Transport for Scotland 2008). Wherever possible, highway furniture or signage should not be positioned on the outside of bends, creating a 'clear zone' in higher speed rural situations to minimise these risks. Other options include:

- Position road signs and other furniture back as far as possible; falling riders quickly lose speed on open verges (Fox et al 1979, cited in VicRoads 2001);
- On right-hand bends with sufficient forward visibility, position signs on the inside of the bend; and
- Consider opting for posts made from flexible materials (see image below).

Example: Buckinghamshire County Council

The Council implemented a site-specific engineering solution on one particular bend where there had been three motorcyclist fatalities in five years and a number of serious injuries including car drivers. The principle behind the scheme, now recognised by the Highways Agency, is called "where you look is where you go" (WYLIWYG) and works on the basis that if you can 'hold' the rider's/driver's eye around a bend then they are likely to successfully negotiate it. Filming of this and similar bends had indicated that incorrectly placed chevron signs could misrepresent the radius of the bend, especially at night. Hazard marker posts were positioned on the outer edge of the bend to focus the rider's eyes on the 'vanishing point'. For this to be effective, it is advisable that posts should be spaced no more than 5-7 metres apart. The owner of adjacent land also removed bramble overgrowth to maximise visibility across the inside of the bend. This low cost measure appears to have been successful, with no injury collisions more than two years after completion.

The predictability of bends is also important. Curves and bends are often popular among motorcyclists because of the technique challenges they present, the scenery with which they are often associated and their contribution to the riding experience. However, due to braking difficulties, unpredictable curvature and road grip represents a higher risk to motorcyclists than other motorists. Conversely, predictability benefits all.

The crossfall on bends can present challenges for motorcyclists due to the reduction in contact between the tyre and road surface, particularly in wet conditions. It is therefore also wise to optimize crossfall and longitudinal surface consistency.

3.4.4 Road Side Furniture

The Department for Transport has issued guidance on reducing street clutter in Traffic Advisory Leaflet 1/13 ‘Reducing Sign Clutter’. This aims to maximise safety, improve the appearance of towns and assist mobility and visually impaired people. Limiting the number of roadside objects with which a motorcyclist who leaves the carriageway can collide, reduces the likelihood of injury.

3.4.5 Visibility

Drivers often do not ‘see’ motorcyclists because of the relatively small frontal area presented by their machines, the presence of other road vehicles and roadside obstructions. Well-designed and maintained visibility splays at junctions are required so that drivers do not have their sight lines obscured.

3.4.6 Rural Roads

Potentially higher speed on rural roads, especially those that are attractive to leisure riders, means that much of this Chapter has significant importance for casualty reduction on rural roads.

3.4.7 Safety Barriers

Traditional designs of roadside safety barriers have received considerable criticism from rider groups and road safety auditors because of the specific risk of injury to motorcycle riders in a collision. Crash barriers have usually been designed to contain an impacting twin-track vehicle and prevent it crossing the path of oncoming traffic. However, the gap beneath the main panel of continuous barrier designs can allow motorcyclists to slide through and collide with the fixing posts. Although motorcyclists contribute only 1.1% of traffic, they account for 18.6% of fatal safety barrier casualties (Safety Barriers and Motorcyclists Transport for Scotland 2008). Further, impacts with barrier support posts have been estimated to cause a five-fold increase in injury severity compared to the average PTW crash (Barriers for Change, EuroRAP, 2008).

Very severe and fatal injuries to motorcycle riders from these impacts are a particular issue in rural areas or on motorways where these barriers are common. Similarly, wire rope type barriers, whilst providing a relatively low cost and effective method of containing vehicles, present potential additional hazards to sliding motorcyclists.

In 2012, FEMA published the document “New Standards for Road Restraint Systems for Motorcyclists”. This provides information on possible solutions for road authorities and infrastructure operators who wish to upgrade road restraint systems and presents the current technical standards, statistical data and research, best practice and case studies. It also lists and details many road restraint products available on the market.

Pending further research it seems that retrofitting impact mitigation measures to posts and some

means of preventing dismounted riders from passing under rails would improve secondary safety for falling riders in safety barrier collisions. TD 19/06 Requirement for Road Restraint Systems (DMRB Vol 2 Sec 2) advises designers that at high risk sites "it is recommended to use an 'add on' motorcycle protection system to post and rail type safety barriers to minimise the risk of injury to motorcyclists."

3.4.8 Priority Junctions and Roundabouts

At priority junctions and roundabouts it is important to optimise sight lines and to provide good braking surfaces for all users. This will mitigate the risk of drivers not responding to motorcyclists' presence even when the latter have priority. The relatively small frontal aspect of motorcycles makes this particularly important because they are more difficult for drivers emerging from side roads to identify.

Where roads approach priority junctions at a shallow angle, car drivers are required to look over their shoulder to check for any oncoming vehicles. A driver's view can be obscured by the central door pillar, making it more likely they will fail to see approaching motorcyclists. Side roads approaching priority junctions as close as possible to 900 helps to reduce vehicle speeds and improve the visibility of motorcycles on the main road. Wide entries to priority junctions can encourage drivers to pull up on the offside of the rider, especially if the latter is on a low powered machine. Excessive width of the entry can also encourage two cars to pull up side by side, obscuring the adjacent driver's view of oncoming traffic on the main road.

Roundabouts should be designed with the correct entry path curvature to ensure that approaching vehicles are not positioned at an excessively oblique angle and to help reduce the speed of vehicles approaching the roundabout.

A balance will need to be struck between capacity and safety. Concentric overrun areas often feature on roundabouts to increase the deflection around the roundabout, reduce speeds and make more conspicuous to approaching vehicles. Care needs to be taken with this kind of treatment to ensure that it does not introduce an additional hazard for circulating motorcyclists. Some overrun areas have been implemented with a slight kerb up-stand (c. 10-20mm) between the 'extended' area and the remaining carriageway. As a motorcycle must lean to negotiate a roundabout, crossing the up-stand can cause a rider to lose control. Similarly, a substantial variation in the skidding resistance between two different types of material can also cause loss of control. Thermoplastic road markings and some types of block paving can be a particular problem for motorcyclists in these situations. A more acceptable alternative would be the use of a high quality, cold-applied, coloured antiskid material which provides the required visual effect without presenting a hazard for motorcyclists.

The positioning of street furniture and vegetation outside visibility splays is critical for safety at junctions. A significant proportion of collisions between motorcycles and cars in urban areas are caused by emerging drivers failing to see the oncoming motorcycle. Higher traffic speeds on rural roads make consideration of sight lines particularly crucial.

3.4.9 Rail and Light Rapid Transit Systems

The rails of on-street Light Rapid Transit (LRT) systems can have a destabilising effect for motorcyclists and cyclists. This equally applies to rails at traditional level crossings, particularly where the carriageway crosses the railway at an angle. When considering potential or existing schemes, seek out the experience of other LRT projects such as Manchester, Sheffield, West Midlands, Nottingham, Edinburgh and Croydon.

3.4.10 Design Points

To reduce sudden variations in steering or braking and to minimise the consequences of any loss of control for motorcyclists, consider the following:

- *Consistent horizontal alignment (eg avoiding bends that tighten after entry).*
  This minimises the need for change of steering angle and angle of lean and thereby mitigates critical risks where the road surface is compromised by water, detritus or leaves. 3.6 deals with vertical and horizontal alignment within the context of traffic calming. Chapter 8 considers this issue within Road Safety Audits.
- *Cross-sectional design consistent with the speed of the road and the radius of the bends.*
  This is more of a problem for roads that have 'evolved' over time, rather than new-build. Adverse camber or inadequate super-elevation can be a problem for all motor vehicles but has graver consequences for motorcyclists.
- *Motorcyclists should be able to brake and stop while upright, travelling in a straight line and on a surface which offers consistent grip.*
  Clear and adequate sight-lines to pedestrian crossings minimises 'last minute' reactive behaviour. Formal crossing facilities should not therefore be positioned by bends.
- *Consistent skid resistance including that of extra surface features such as coloured patches.*
  This is especially important on bends, given the rider's need to vary position across the lane to maximise safety and provide maximum forward visibility.
- *High friction surfacing at junctions with a history of drivers emerging against priority into the path of motorcyclists.*
  This maximises the rider's chances of braking safely.
- *High friction surfacing should terminate on straight sections.*
  Sudden changes in road surface properties on bends and at junctions, especially skid resistance, can lead to stability problems as the rider manages the sudden change in the dynamics and response of the motorcycle.
- *Avoidance of different surface materials, for example granite setts, to emphasise a change in circumstances at turning points.*
  This can destabilise motorcyclists at priority junctions and small roundabouts.
- *Thermoplastic markings rarely have the same skid resistance properties as the surrounding road and their skid resistance deteriorates faster than the road surfacing.*
  These are particularly hazardous to motorcycles in the wet. Arrows and destination markings on bends or roundabouts cause concern to riders as the motorcycle may be leaning over, accelerating or braking. Clear advance warning and direction signs should minimise the need for such surface signing. Careful thought should be given before using large areas of hatching.

- *Specifications for and positioning of inroad and roadside furniture, including impact characteristics when struck by a fallen or sliding body.*
  It is crucial to minimise the number of obstacles, especially on higher speed bends, and to use supports that do not shear off leaving sharp remains or that have protrusions that could snag a fallen rider. On higher speed roads consideration must also be given to the 'swept path' of the rider leaning into bends, even though this is not of concern for twin-track vehicles.
- *Smooth transitions in vertical alignment to minimise loss of tyre adhesion and to prevent water collection.*
  This has a greater effect on motorcycles than on twin-track vehicles.
- *The 'eye level' of riders is higher*
  This is a critical factor when positioning street furniture or planting, especially at junctions. Consider the full growth of trees and shrubs and leaf fall characteristics and maintenance.
- *Battered kerbing*
  Where it is absolutely necessary to use kerbs in rural areas, use battered kerbing to minimise potential injury to a sliding rider.
- *Utility covers with appropriate skid resistance*
  When redesigning an existing layout consider the position and level of utility covers, especially on bends and within braking or steering areas. Avoid forcing riders to overrun them whenever possible. If it is unavoidable, use covers with an "in service" skid resistance similar to the surrounding road surface.
- *Intuitive roads require consistent signage*
  Consistent signage along a route meets riders' expectations. This links to the concept of 'self-explaining roads'. This is where the level of signage and marking is proportionate to the severity of the hazard and the approach is consistent along the whole route. If the road can 'deceive' then warnings are required. This is particularly the case for a tightening radius or horizontal deviation immediately over a crest. The concept is already used for the highest road classes (motorways) but on lower class roads consistency in design can often be compromised by other objectives such as high access levels, variable alignment, mixed use and variable roadside development.
- *Identify areas where high friction surfaces are required (e.g. bends and junctions) and remember the friction levels of new asphalt surfaces.*
  The levels of friction in newly-laid asphalt surfaces are hindered by the presence of bitumen. Low friction levels can lead to loss of traction for motorcycles. Over time, vehicles passing over the surface naturally remove the bitumen and the friction levels rise. However, this timeframe may not be acceptable on roads with low volume traffic and locations where high friction is essential (i.e. junctions and bends).
- *Probable Future levels of Maintenance*
  Avoid including design features that require higher levels of maintenance than the road is going to receive in reality as this could lead to future safety problems. An example of this is high friction surfacing which has often been applied to address sites with a history of loss of control collisions. However, if it is not suitably maintained then the effects on motorcycle stability and grip can be more serious than before the intervention.

3.5.1 Advanced Stop Lines (ASLs)

The use of Advanced Stop Lines (ASLs) for cyclists at signal junctions is now widespread. They are intended to provide a safe location for waiting cyclists, especially those turning right. The Traffic Signs Regulations and General Directions (2002) (DfT 2002) clarified the legal position of ASLs and made it an offence for other vehicles, including motorcycles, to cross the first stop line and wait in the zone between stop lines, unless it was unable to stop safely. However, ASLs for two-wheelers at large intersections have been introduced in parts of Belgium, the Netherlands and Switzerland.

Several trials and pieces of research have revealed potential benefits of allowing ASLs to cater for motorcyclists. However, the results are generally considered to be inconclusive and many would welcome further research on safety and benefits for all in order to draw stronger conclusions.

3.5.2 Shared Use of Bus Lanes

At congested periods, in a typical urban road layout with a bus lane and a single all-purpose lane, motorcyclists use the legal manoeuvre of 'filtering' or passing to the right of stationary traffic. This presents three potential hazards:

Conflict with oncoming traffic.
If the rider keeps close to stationary traffic in light of the above, this increases the risk of collision with an open door of a car.
Conflict with pedestrians crossing through stationary traffic. Many pedestrians, having crossed an empty bus lane and stationary traffic lane, assume their next hazard is traffic from the opposite direction and fail to look for filtering motorcycles.
However, allowing motorcycles to use bus lanes presents the following potential safety benefits:

Eliminating the risk of conflict with oncoming traffic while the rider is using the bus lane.
Reducing the risk of conflict between motorcycles and other traffic. Even if a car occupant opens a door on the nearside, they are more likely to check for vehicles in the bus lane and, in any event, the motorcycle is likely to be in the centre of the bus lane where they are visible, not close to the stationary traffic.
Reducing the risk of conflict with pedestrians because they will check for vehicles before crossing the bus lane.
Bus lane access for motorcyclists was first granted by Avon County Council in Bristol in the mid 1990s. Since then an increasing number of local authorities have allowed the shared use of bus lanes by cyclists, taxis and motorcycles. In 2007 The DfT produced a Traffic Advisory Leaflet TAL 2/07 "The Use of Bus Lanes by Motorcycles". This reversed previous advice against the practice and now recommends that local authorities actively consider it. In London, assessment of PTW collisions showed that six out of eight case studies did not involve an adverse effect on casualties and the measure did not lead to an increase in collisions.

Following the completion of two trials, Transport for London granted motorcyclists permanent access to bus lanes on the majority of the city's red routes from January 2012. Benefits cited included reduced

journey times and less carbon dioxide emissions.

The Traffic Signs (Amendment) (No.2) Regulations and General Directions 2011, which came into force on 30 January 2012, allowed for the inclusion of new signs (diagrams 958A and 959A) permitting solo motorcycles to use near-side, with-flow bus lanes. Both signs may be combined with the times of operation sign (diagram 961).

Local authorities are best placed to decide whether to allow motorcycles into with-flow bus lanes. Each case must be examined on its merits and fully consider published research, case studies and all potential advantages and disadvantages.

3.5.3 Road Markings

The use of road markings needs careful consideration, especially within motorcycle steering, braking or accelerating zones. Used inappropriately they can force riders off the safest line or, if poorly designed or laid, can collect and divert water which may diminish consistent grip. The reduction in skid resistance over time or in wet conditions causes problems for motorcyclists. Direction arrows and destination markings are of particular concern where large areas of thermoplastic marking are used. Often they are used on bends when they could be better placed in an advanced position on a straight section of the road. Further, they are likely to be re-laid on maintenance schedules, leading to layering and a significant up-stand from the surrounding surface; most road markings over 6mm in height are unlawful with a few exceptions for example rib line markings. ‘Blacking out’ redundant markings rather than burning or planing them off creates a higher up-stand with the added hazard of reduced skid resistance. In general, well positioned roadside advance warning and directions signs are preferred to surface markings. Count-down strips, rumble strips and coloured surface treatment should not be used close to or on bends or where steering or braking is required, unless constant skid resistance is guaranteed. Lining or hatching used to reduce apparent carriageway width in urban situations can squeeze low powered motorcycles and cycles into conflict with other traffic. This should be balanced against any anticipated general safety benefits.

3.6 Traffic Calming

Traffic calming measures can be very effective in reducing the number of injury collisions, especially in residential areas. However, motorcyclists are no more exempt from the intended effects of traffic calming than any other road user and, arguably, suffer disproportionately from the unintended effects. These unintended effects stem from issues that can be grouped under three headings: design, materials and maintenance. The key point to remember is that riding a motorcycle is a permanent balancing act and that the vehicle has only two small tyre “footprints” to provide grip. One of the first issues facing the designer of a traffic calming scheme should be whether to use physical traffic calming measures or not. The designer should examine the collision history for the area in order to define the objectives of a traffic calming scheme and to determine what level of speed reduction is appropriate in order to address the problems identified. Alternatively, more subtle changes to the environment, using existing environmental features and taking a holistic approach to the street scene, may be appropriate. It may be possible to adopt a psychological approach to traffic calming methods by modifying the built environment in such a way as to create a ‘negotiated space’ for all road users, with a concomitant reduction in speed and

thereby enable the reduction or even removal of the need for vertical traffic calming features. The choice of what type of physical measures to use is normally influenced by a number of factors, including:

- collision records
- traffic volume
- pedestrian activity
- target speed
- the presence of bus routes
- the needs of emergency services
- sensitivity of the local environment
- the views of local residents
- the budget.

Many motorcyclists support the use of speed cushions which give the option of riding between the speed cushions rather than over them. This does not negate the measure; the act of aligning a motorcycle to pass through a small gap between speed cushions will bring about a natural reduction in speed, although it may fall short of the target speed for the scheme. Useful publications in this area include Home Zone Design Guidelines (IHIE 2002) and Traffic Calming Techniques (IHT/CSS 2005) and the Traffic Advisory Leaflet 01/07 “Traffic Calming”. LTN1/07 provides a good summary of the different types of measures and a section on traffic calming and motorcyclists. It also offers a comprehensive summary of the research commissioned by the Department for Transport and external sources, to be used as guidance on traffic calming measures today. It covers relevant legislation, design, effectiveness and installation.

3.6.1 Location of Traffic Calming Measures

A major problem facing the designer of traffic calming schemes is choosing the location of the measures. The needs and vulnerabilities of motorcyclists should be accounted for along with all the other factors influencing this process. Some important issues are:

- Vertical traffic calming measures should not be located anywhere a motorcyclist will need to brake or change direction (i.e. not leaning over). Ramps for raised junctions should begin far enough back so that the motorcycle negotiates the ramp in a straight line.
- The design of the scheme should include adequate warning signs, both permanent and temporary, warning of the new road layout ahead. Consider using on-site publicity prior to installing the traffic calming measures but any temporary signs should be removed no later than three months after the completion of the scheme.
- Whenever possible a non-vertical speed reducing feature should be used at the entrance to a traffic calming scheme. Following changes in the regulations affecting traffic calming scheme design, some schemes have emerged that start with a speed hump or cushions. Without some form of non-vertical speed-reducing feature, there is always the risk that a motorcyclist will unintentionally hit the first vertical measure at speed. This could result in an uncomfortable bump for car driver, but a serious injury for a motorcyclist.

- A commonly used non-vertical speed reducing feature in traffic calming schemes is the mini-roundabout. Without careful design, motorcyclists, like other vulnerable road users, can suffer disproportionate risk at these junctions. Particular points to bear in mind include the following:
  - » Ensure adequate skidding resistance on the mini-roundabout central area and arrow markings.
  - » Most junction designs are checked to make sure that larger vehicles' swept paths can be accommodated. Motorcycles making tight right turns at mini-roundabouts can have stability problems, especially if the turn is more than 90°.
  - » Make sure there is adequate advanced warning of the junction type.
  - » Ensure adequate visibility; using a mini-roundabout because there is insufficient visibility for a priority junction is rarely a safe option for any road user.
- Mini roundabouts should not be used on roads with speed limits of more than 30mph and 4-arm mini roundabouts should be avoided due to the over representation of bicycle and motorcycle collisions. DMRB TD 54/07 sets out specific design considerations for mini roundabouts and, in particular, makes relevant recommendations for motorcycles.
- The design of horizontal schemes, often in the form of chicanes, should allow for the fact that motorcyclists on lower-powered machines tend to ride near the kerb. The build-outs often associated with these schemes can pose the following risks:
  - » They can catch riders unaware, leading to collision. This is especially a problem for new schemes. Build-outs should be conspicuous.
  - » They may force motorcyclists to move to the centre of the road or even, in priority working schemes, into oncoming traffic, much of which is unwilling to give way to a motorcycle.
  - » The use of low over-run areas as build-outs can cause stability problems if a rider clips the edge. The standards permit an up-stand of no more than 15mm but even this can cause problems to the rider of a smaller machine when turning.
- Islands or refuges used to reduce the width of the road should be conspicuous, allowing motorcyclists to position themselves correctly in advance, avoiding late and sudden changes of direction.
- Always ensure the location of traffic calming measures does not lead to poor drainage; standing surface water could compromise motorcycle safety, especially in freezing conditions.
- Humps and speed cushions should be located 10-15 metres away from junctions to allow riders to turn out and to pass over them without leaning over. This should be balanced against pedestrian desire lines where flat-topped humps are being specifically installed as crossings.
- Bicycle bypasses around traffic calming measures should be clearly marked in order to discourage use by motorcycles.
- Block paving treatments often have uneven characteristics and do not have the same friction value as the surrounding road surface. This is very important to remember at or near critical junctions.

3.6.2 Materials

There is an array of choices facing the designer when selecting materials for traffic calming measures. Influential factors may relate to the local environment, technical performance, maintenance, finances and purchasing policy. The safety of road users, including motorcyclists, must be equally influential. Particular issues to consider include the following:

- The use of block paving or stone setts, including on speed tables and raised junctions. These often have poor skid resistance, especially when wet. They are hard to maintain and displaced blocks and alternative reinstatement materials result in uneven and unpredictable surfaces for motorcyclists.
- Pre-cast concrete traffic calming features can crack or rock and become displaced if not properly laid. Pre-formed rubber features can also deform over time and lift at the edges. This presents a hazard for motorcyclists and, during the winter, is difficult to treat for ice prevention.
- The use of white thermoplastic on traffic calming measures. White triangles used to highlight humps, for example, are mandatory but can cause problems when:
- The material used has insufficient skid resistance. Markings are often at the centre of a lane, just where the wheel tracks of motorcycles will pass.
- High traffic levels or poorly specified material can cause them to fade quickly, making a bitumen-based measure hard to distinguish against the road surface, especially at night.
- Transverse bars, rumble strips and “dragon’s teeth” markings on the approach to gateways and other traffic calming measures are often in the braking zone for road users. If the materials do not provide suitable skid resistance or if they present a series of vertical displacements they can constitute an added hazard for motorcyclists.
- The potential to use collapsible or frangible street furniture, especially in locations that could conceivably be in the path of a falling rider.
- The use of bitumen to seal cracks and reinstatements. This material has very low skid resistance in wet conditions, yet is routinely used to seal the joints in traffic calming measures, particularly speed cushions. Alternative materials should be specified where possible.

3.6.3 Lighting

Street lighting is a specialised subject requiring an increasingly sophisticated approach and comprehensive knowledge of the types of light sources available and the best places to use them. It is of vital importance that the night-time safety and performance of traffic calming measures are not compromised by inadequate street lighting. Motorcycle headlamps are typically less bright than those of other vehicles and therefore good lighting within the scheme is crucial. Obviously the first point of contact will be the local authority street lighting team; if this is not possible, then the Institution of Lighting Engineers (ILE) can provide advice on the technical aspects of scheme lighting to suit all road users, including motorcyclists. The ILE has published a technical report called Lighting for Traffic Calming Features (ILE 2002). Bear in mind the following particular issues:

- The scheme should be evenly illuminated, with particular attention being paid to traffic calming measures that alter the normal road alignment, for example build-outs and chicanes.
- The lighting should provide good colour rendering, especially where colour is an integral part of the scheme.

3.6.4 Maintenance

The first traffic calming schemes were installed on public roads in the UK in the 1980s and maintenance of these older schemes is now becoming a problem for many local authorities across the country. Poorly maintained traffic calming schemes can be a hazard to both road users and pedestrians but the

consequences will often be most severe for motorcyclists. Maintenance issues in general are dealt with in Chapter 7, but, in relation to traffic calming schemes, be alert to:

- Reinstatement using non-original materials that presents an inconsistent road surface to riders.
- Uneven wear on vertical measures (especially where block paving, pre-cast concrete or rubber is used) leading to unexpected depressions.
- Road markings that fall below acceptable standards for retro-reflectivity and skid resistance (assuming they met them when new) or even fade away completely.

View the Guidelines online at
www.motorcycleguidelines.org.uk