Transport for London

Urban Motorcycle Design Handbook

MAYOR OF LONDON

TRANSPORT FOR LONDON

Introduction

Motorcyclists are a unique road user group with specific characteristics. Motorcycles are very manoeuvrable, but their distinctive grip and balance requirements in combination with a range of other factors mean that they are at a higher risk of being involved in a collision.

This Urban Motorcycle Design Handbook sets out the key highway design requirements for motorcycle safety in London and has been developed with valuable input from stakeholder groups. Using this Handbook will lead to a better understanding of how road and traffic conditions affect motorcyclists and how risks can be reduced and hazards minimised for this vulnerable road user group. The key design issues for motorcyclists are:

1) Factors affecting grip
2) Issues around visibility
3) Road-side features
4) Traffic calming
5) Filtering

The aim of this handbook is to enhance understanding of the issues for all concerned with the planning, design, construction, operation and maintenance of London's streets or with any schemes that affect the highway. It is part of TfL's programme to cut casualties and is intended to complement other guides to best practice including the Institute of Highway Engineers Guidelines for Motorcycling (IHE, 2014).

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1.0 Design Requirements

1.1 Introduction

1.1.1 In partnership with representatives of rider groups and the motorcycle industry, TfL has conducted extensive analysis of techniques for reducing motorcycle casualties (note: the term 'motorcycle' in this Handbook, refers to mopeds, scooters and motorcycles).This showed that aspects of the highway network could adversely affect motorcycle riders in some circumstances.

Further investigation pointed to gaps in highway engineers' understanding of the unique characteristics of motorcycles. Engineering can improve the safety of motorcyclists; however, the behaviour of other road users is also important to address.

1.1.2 In London, motorcycles are mainly used for commuting. Elsewhere this isn't the case. Designing for motorcycles in London must therefore consider how effectively their passage through traffic can be made safer.

1.1.3 Riding past slow moving or stationary traffic, often referred to as 'filtering', allows motorcyclists and cyclists to make progress in traffic queues and is a significant factor in making motorcycling the chosen option for people in London. In some situations, motorcyclists can face hazards or barriers when attempting to legitimately filter and this Handbook looks at design options for making filtering safer.

1.1.4 The function of the Handbook is to clearly and simply explain the unique nature of London motorcycle road use, how riders use the road space differently to cars, vans, lorries, cyclists and pedestrians while travelling through the road network, and how these differences can be accommodated in highway design and maintenance work.

1.1.5 It is envisaged that this Handbook will be particularly valuable to designers and engineers who are not motorcyclists, not just in London but in other large urban areas throughout the UK. With a broader understanding of motorcycling issues, designers will be better placed to cater for motorcyclists and reduce any adverse impacts on their safety.

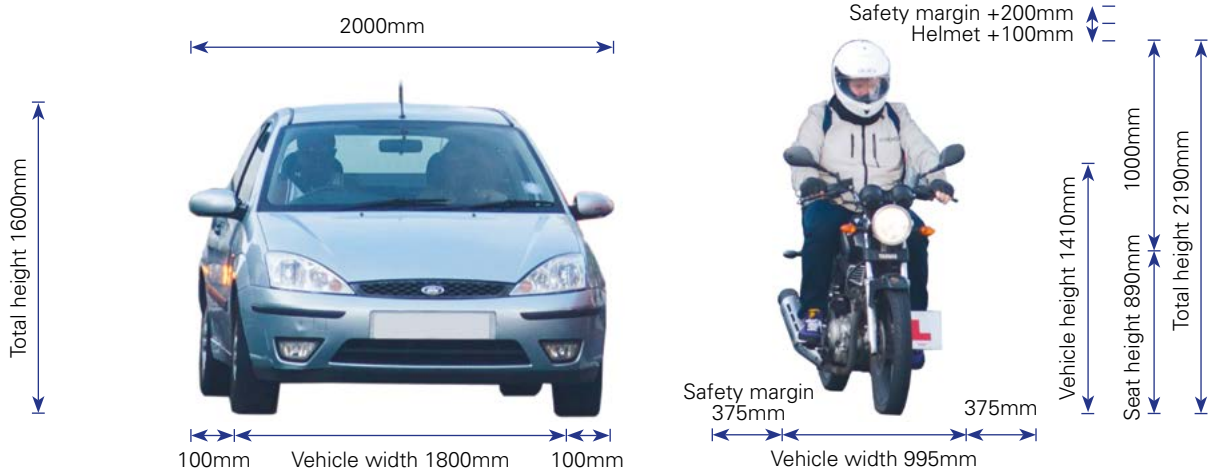
1.2 Factors Influencing Motorcyclist's Behaviour

1.2.1 To design and maintain a road network that meets the needs of motorcyclists, practitioners need to understand and appreciate their specific needs. Some of the key factors which influence a motorcyclist's behaviour are:

- A motorcycle only has two relatively small points of contact with the road surface (its tyres). Changes in the road surface condition can have a big impact on grip and stability;
- As most braking and steering control is directed through the front tyre, riders try to avoid skidding and losing control by not braking and steering at the same time;
- Anything that causes the tyre to lose grip can lead to a loss of control much more easily than with cars;
- In bends, motorcyclists generally follow a different line to that of other motor vehicles. They use the full width of the available traffic lane in order to minimise the amount of steering input required, maximise grip and also their view of the road ahead. This may seem counter-intuitive to non-motorcyclists;
- Motorcycles are very manoeuvrable. They can filter through traffic and overtake in places where other vehicles cannot. They may also appear in positions where other road users do not expect them;
- Motorcycles can usually accelerate faster than other vehicles and because the rider sits higher than a car driver, they can often see over other vehicles.

1.3 The 'Design' Motorcycle

1.3.1 There is a wide variety of motorcycles legally permitted to use UK roads. These range from light weight mopeds designed primarily for commuting by one person, to large touring type machines capable of carrying two people and luggage for long distances. The width of a gap likely to be accepted by motorcyclists will vary depending on speed, the size of the bike, the density and make up of traffic, the presence of adjacent features such as kerbs or islands, and the experience and confidence of the rider. As such there is no one 'design' motorcycle that should be used. The table below, however, outlines the key characteristics for a variety of motorcycle sizes, and is a useful reference guide for the designer. Typical car dimensions are also shown for comparison.



Motorcycle Typical Dimensions

Characteristics	Motorcycle engine capacity ≤ 50cc (mopeds / scooters)	Motorcycle engine capacity 51cc < 250cc (scooters / small motorcycles)	Motorcycle engine capacity 250cc < 2295cc (motorcycles)
Length	1850mm	2240mm	2530mm
Width	685mm	785mm	995mm

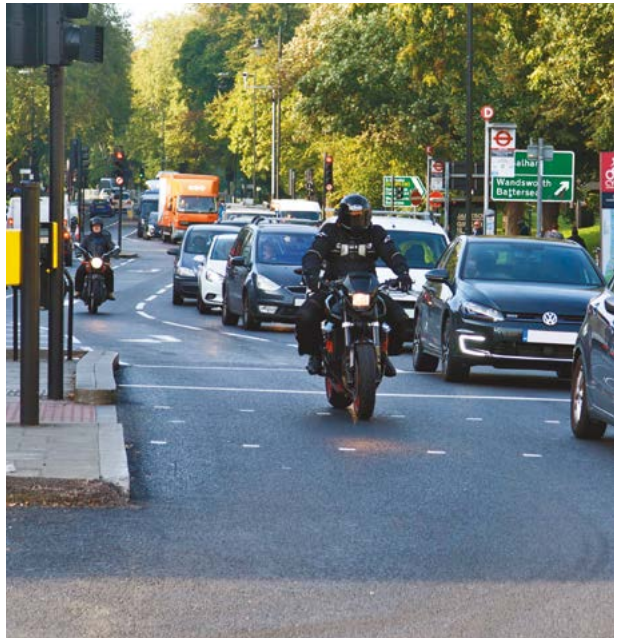
Source: ACEM 2005

1.4 London Specific Factors

1.4.1 Research into why people ride motorcycles and scooters in London, (ITS. 2004), identified the following key factors:

- Journey purpose and distance – a large proportion of motorcycle journeys in London are for commuting, and most are over 5km;
- Convenience – door to door journey times by motorcycle are often much shorter in time than the same journey using other modes;
- Efficiency – journey time reliability is more consistent, akin to cycling and walking, than with most other modes of motorised transport, as motorcycles are able to filter and continue moving when other traffic is very slow moving or stationary;
- Cost – a motorcycle can be considerably cheaper to run than an average family car, and parking is often free;
- Flexibility – motorcycles can be a useful option for shift workers at times when public transport isn't available.

1.4.2 Factors that make riding a motorcycle in London unique include the often constrained carriageway widths available, the extensive and complex network of streets, and the requirement to share the limited space available with a large number of other road users, generally lower speed limits and access to bus lanes. Also, many other road users in London may expect to encounter motorcyclists filtering in traffic – this may not always be the case in other towns and cities.



1.4.3 The most common paths that a motorcyclist will take when filtering through a two lane traffic queue are between the two rows of queuing four wheeled vehicles or on the offside of those vehicles, effectively to the right of the 'outside' traffic lane. If a design restricts these movements, either by reducing lanes widths (e.g. by installing bus or cycle lanes or creating pinch points through the provision of central refuges), then the motorcyclist may use the option of travelling between the kerb and the nearside of vehicles in lane 1, leading to potential conflict with cyclists, buses and pedestrians.

1.4.4 Across the UK in 2013, 33% of all motorcycles registered for the first time were scooters, (DfT, 2014a). The increasing popularity of smaller size motorcycles is also reflected by the fact that eight of the top ten new motorcycle registrations during 2013 had an engine size of between 100 and 125cc (DfT, 2014b).

1.4.5 The proportion of smaller commuter scooters and mopeds in London is higher than many other parts of the UK. Use of these machines brings with it unique road user behaviour, with riders of lower powered machines often choosing to ride nearer to the kerb than riders of larger motorcycles, making them more difficult to see for drivers emerging from side road junctions. On higher speed roads in London, such as those with 40mph limits, constrained lane widths can have a particularly negative impact on riders of mopeds who are unable to keep up with the general traffic flow.

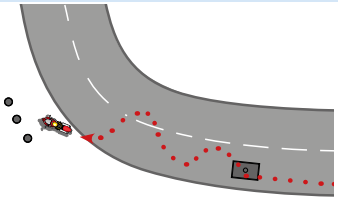
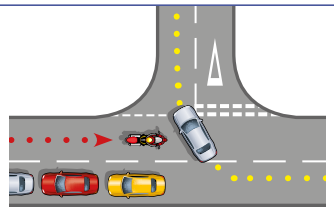
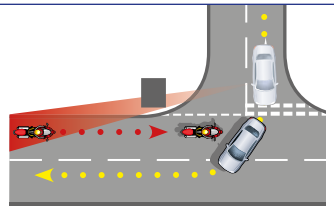
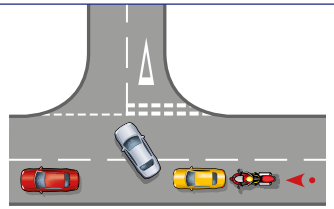
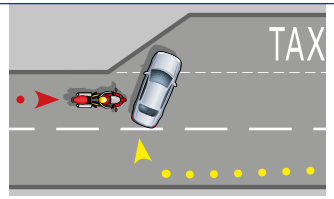
1.4.6 The role of technology may play a part in the future growth of two wheeled travel, with electrically assisted pedal cycles, electric mopeds and motorcycles offering a cleaner, quieter and more efficient means of travel, particularly over longer distances that many people may not wish to cycle. There is also potential for such vehicles to contribute significantly to reduced levels of air pollution in the future. This could lead to more people using motorcycles and further emphasises the need to appropriately cater and design for this travel mode.

1.5 How are London Motorcyclists Being Injured?

1.5.1 The table shows the five most common types of conflict that lead to motorcyclists being killed or seriously injured (KSI) in London in 2014.

1.5.2 The five most common types of conflict can be mitigated against with engineering interventions to some extent. However, there are many other interventions that can improve safety and road user behavior that are not engineering based.

Motorcycle Casualties in London 2014

Conflict Rank	Indicative Diagram	Manoeuvre Description	KSI Collisions (% of total)	Potential for design to influence the conflict type
1		All single vehicle 'loss of control' conflicts	86 (17%)	Yes, improved surfaces and removal of specific skidding hazards, plus 'softening' or relocation of roadside features can reduce risk and severity of collisions
2		Other vehicle turns right across path of motorcycle	79 (15%)	Yes – potential for visibility or signing/road marking improvements to reduce conflicts
3		Other vehicle disobeys junction control and turns right into path of motorcycle	53 (10%)	Yes – potential for visibility or signing/road marking improvements to reduce conflicts
4		Motorcycle runs into rear of other vehicle	38 (7%)	Yes – improved surfaces and removal of specific skidding hazards offers potential to reduce risk of collisions in some circumstances
5		Other vehicle u-turns into path of motorcycle	36 (7%)	Yes – potential for visibility improvements to reduce conflicts in some situations

1.6 Key Challenges Faced by Motorcyclists

Factors Affecting Grip:

- Loss of control features prominently in collisions involving motorcycles in London. There are numerous road surface design issues that can influence grip, both positively and negatively.

Visibility:

- "Failed to see" or "other vehicle turns into path of motorcycle" are key causation factors in many collisions involving motorcycles (and cyclists). These are so common they have a nickname amongst motorcycle groups, SMIDSY (Sorry Mate I Didn't See You). Many design interventions can influence the ability of drivers and riders to see other road users clearly and in good time.

Road-side Features:

- These include features that can form a collision hazard to motorcyclists within the carriageway, (poorly marked build-outs or refuge islands for example), and also some street furniture that can form a collision hazard for the rider if they lose control and leave the carriageway. Little more than a minor inconvenience to car drivers, these features can be a source of major injury or death to a motorcyclist. Road-side features can also contribute to collisions by restricting visibility.

Traffic Calming:

- Although traffic calming can help reduce road safety risk for motorcyclists, poorly designed traffic calming can be a source of danger to the motorcyclist. Better design of new traffic calming and revision of existing features can help address these issues.

Filtering:

- Motorcyclists can experience various barriers to safe filtering, some of which are infrastructural such as wide refuge islands or constrained traffic lane widths, and some behavioural in nature. Good design can facilitate safer filtering or at least not make conditions worse for motorcyclists.

1.7 Motorcyclists & Cyclists

1.7.1 As cycling grows ever more popular in London, it is important to recognise that motorcyclists and cyclists share a number of similar traits, many of which are relevant to the design process. These are listed below:

- Both users are vulnerable to injury as a result of a collision, due to the lack of physical protection afforded by the vehicle structure;
- Both are vulnerable to being involved in collisions due to their small frontal aspect making them more difficult to see in dense urban traffic;
- Both single tracked vehicles that are highly manoeuvrable;
- Both are able to filter through stationary or slow moving traffic;
- Both can usually find their way to the front at traffic signal junctions when other traffic is stationary, and can therefore get a head start on other traffic;
- Both have only small contact patches with the road surface and must lean over to negotiate bends, thus are susceptible to poor surfaces, loose material on the carriageway, poorly designed traffic calming features etc.;
- Both are relatively unstable at low speed.

1.7.2 It is also important to consider the differences between motorcyclists and cyclists and how these can influence the design process, as follows:

- Motorcyclists generally position themselves between the centre and offside of traffic lanes and cyclists generally occupy the first 1-2m of the nearside traffic lane;
- Cyclists tend to filter down the nearside with motorcyclists generally preferring to filter offside (although nearside filtering by motorcyclists does take place when other routes are blocked);
- Some traffic calming treatments which help to provide a more cycle-friendly environment by slowing general traffic can increase journey times for motorcyclists and make their journey less comfortable.

2.0 Design Issues

2.1 The Five Key Design Issues for Motorcyclists

2.1.1 Motorcyclists face a wide range of design issues and challenges, the previous section identified the five that matter most to motorcyclists, these being:

- Factors affecting grip;
- Visibility;
- Road-side features;
- Traffic calming; and
- Filtering.

2.1.2 Poor design or maintenance in relation to these issues can have significant adverse impacts on motorcyclists. This section provides examples of common problems and how these can be addressed. An advisory checklist is also included in Appendix 1 at the back of this document that can be used to assess sites, routes or proposed schemes against the key design considerations for motorcycles.

2.1.3 The examples in this Handbook are complemented by photographs as a visual aid to describe the issue. However, these photographs are taken during good daylight conditions, and designers should be aware that in the majority of the issues highlighted, the problem being described is exacerbated by bad weather or dark conditions.

The key design issues

2.2 Design Issue Number 1 – Factors Affecting Grip

1a Feature: *Surface material choices and surface condition.*

Problems: Different surface materials, such as granite setts and block paving, are often used as part of urban realm and traffic calming schemes. However, such materials can have poor skid resistance, especially when wet and at higher speeds, and can result in motorcyclists losing control. If roads are not adequately maintained, worn surfaces, sunken gullies, potholes and surfaces with different skid resistance can provide an unpredictable surface for all motorcyclists and a potential collision / loss of control hazard.

Typical Locations

- All carriageways.
- Urban realm schemes.
- Traffic calmed areas / Gateway treatments.
- Junctions and turning points.

This picture shows different surface types in close proximity, with varying frictional qualities and potholes that will all conspire to affect the stability of motorcycles.

The braking area on the approach to the junction has a granite sett down ramp, which is poorly maintained and has substandard reinstatement where it has been repaired.

Key Design Considerations

- Locate block paving and stone sett entry treatments away from areas where motorcyclists are required to turn. At junctions this can often be achieved by locating ramps further into the side road.
- Ensure that such materials are laid on a robust sub-base, with an appropriate flush edge detail provided at the transition point between the surface types.
- A regular inspection, maintenance and repair regime should be employed to ensure carriageway defects likely to affect motorcycle stability are identified and repaired in a timely manner.

The cobbled overrun area in this picture is in an area where motorcycles may be leant over, and could be slippery when wet. Also the white lines may guide motorcycles into the cobbled area at night, rather than around it.

2.2 Design Issue Number 1 – Factors Affecting Grip

2.2.1 Motorcycles are more sensitive to road surface conditions than other vehicles and consistent grip of the tyres on the road surface is critical to the stability of a two wheeled vehicle and the rider's control of the machine. Examples of common grip-related problems and design approaches which can help to ensure that a more consistent surface quality and therefore grip is provided, are outlined in this section.

1b Feature: *Large areas of thermoplastic road markings.*

Problems: Thermoplastic road markings rarely have the same skid resistance as the surrounding road surface and this can adversely affect motorcycle stability, particularly within steering, braking or accelerating areas and in wet conditions.

Typical Locations

- Bends (e.g. direction arrows, destination markings, hatching).
- Junctions (all types) and decision points.
- Pedestrian crossings.

The photograph shows a sharp bend with a large area of thermoplastic segregating the cycle lane from the traffic lane. This could present a loss of control hazard for motorcyclists, particularly when the road surface is wet.

Key Design Considerations

Extent to which markings are required:

- Level and size of markings should be proportional to the degree of potential hazard and consistent along the route (i.e. remove/ do not provide unnecessary markings).
- Consider whether advanced warning and direction signs can be used to minimise the need for surface markings.

Positioning and composition of markings:

- Position markings away from motorcycle steering, braking and accelerating zones where possible.
- Consider whether markings can be suitably placed in advance of bends or junctions rather than within them.
- Specify that markings are to have a similar skid resistance to the surrounding road surface.
- Consider future maintenance regimes – avoid repeated application of road marking material as this can form ridges that can make the motorcycle wander.
- Avoid using black paint to cover over markings that are no longer required as this can form a skid hazard.

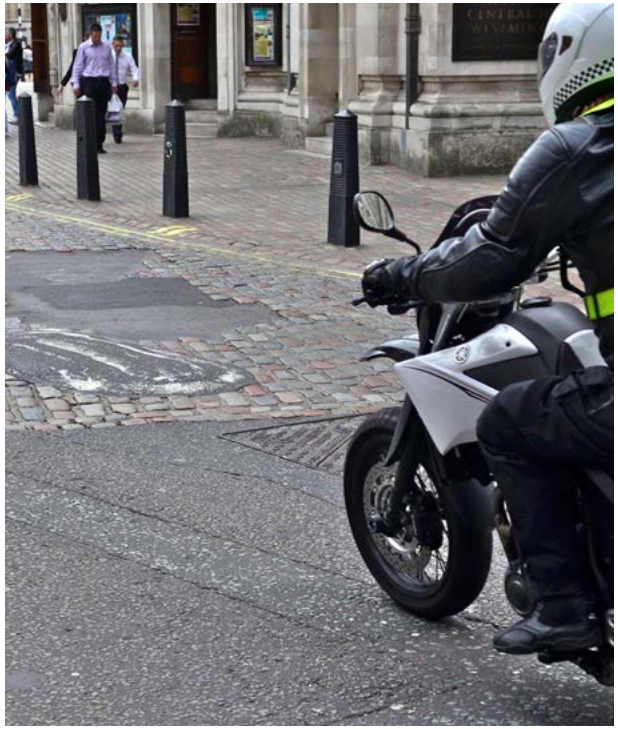
2.2 Design Issue Number 1 – Factors Affecting Grip

Feature: *Unexpected road markings or surface treatments.*

1c Problems: Road markings or changes in type of surfaces positioned in unexpected locations can adversely affect the stability of two wheeled vehicles. Attempting to avoid such features especially at speed or whilst turning, can also be hazardous for motorcyclists and other road users.

Typical Locations

- Various, but greatest impact likely to be on bends and within the vicinity of junctions.



Here there are four different road surfaces within close proximity. Tarmac, inspection covers, worn thermoplastic on a raised oval of tarmac (with no warning) and cobbles. In an area with a high pedestrian flow and busy traffic lanes, this will cause stability problems for motorcyclists.

Key Design Considerations

- Avoid providing road markings where possible. If absolutely necessary, position markings away from motorcycle steering, braking and accelerating zones.
- Avoid using multi-layers of marking material to form 'over-run' areas.
- Avoid changes in the type of road surface on bends and in areas where motorcyclists are likely to be braking or turning.
- Minimise the number of different surface types used. As well as potentially forming a skid hazard, changes in surface types can divert the riders away from other more significant traffic hazards.

2.2 Design Issue Number 1 – Factors Affecting Grip

1d Feature:
Worn high friction surfacing (HFS).

Problems: HFS provides additional skid resistance at locations where there is a high risk of skidding, particularly in the wet. However, if not suitably maintained, HFS becomes worn, loses its additional skid resistance properties and can also become detached from the underlying pavement, leading to an uneven surface. This can adversely affect the stability of two wheeled vehicles and a physical (but not visible) change to the surface properties can result in road users experiencing a lower braking performance than they expect.

Typical Locations

- Approaches to pedestrian crossings and junctions.
- Sharp bends.
- Steep gradients.
- Traffic calmed areas / gateway treatments.

This picture shows a deteriorated anti-skid surface on the approach to a signal junction where motorcyclists may be expected to filter.

Key Design Considerations

- Determine whether a site is suitable for a HFS treatment (some London boroughs are moving away from the use of HFS in light of expected collision savings/benefits and whole life costs).
- Ensure HFS sites are subject to an appropriate maintenance regime, including only installing HFS on a structurally sound surface.
- Provide an appropriate length of HFS, terminating the treatment on a straight section of road where possible to avoid providing differential skid resistance at a point where a motorcycle may be leant over (i.e. avoid surface changes on bends/corners).
- When new HFS is applied, ensure any excess material is swept up to avoid it forming a skid hazard for motorcyclists and cyclists.

2.2 Design Issue Number 1 – Factors Affecting Grip

1e Feature:
Location, maintenance and design of service covers.

Problems: Lack of sufficient skid resistance on service covers. When located on a bend it can mean that motorcyclists must travel over the cover whilst leant over, increasing the risk of loss of control. Riders may also swerve to avoid slippery covers, contributing to other forms of loss of control collisions or conflict with other road users. It is also important that service covers are subject to a regular inspection, maintenance and repair regime.

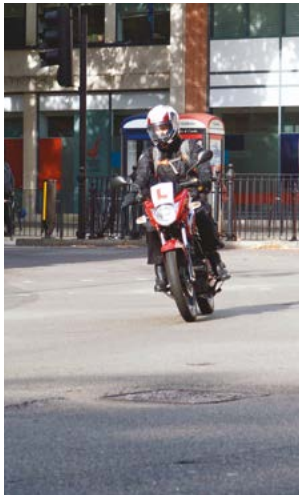
Typical Locations

- Bends.
- Roundabouts.
- Approaches to traffic signals.
- In the vicinity of junctions where motorcyclists are required to make turning movements.

The inspection covers in these examples are within the braking and turning area for a motorcycle and present a loss of control hazard, particularly in the wet.

Key Design Considerations

- Although not always possible, consideration should be given to whether service covers can be moved/located away from areas of the carriageway where motorcyclists may be expected to be travelling, particularly in the vicinity of bends and junctions.
- To avoid unexpected bumps and potential loss of control, ensure that covers are sited flush rather than either above or below the road surface.
- Engineering constraints often mean that service covers must be located within the carriageway. In this situation it may be possible to replace the existing service cover with an alternative design incorporating high friction surfacing (which has a similar skid resistance to the surrounding road environment). A number of proprietary products are available, though to date these have been little used in London within the carriageway. They can also provide an opportunity to improve the visual amenity of schemes by matching the colour of the surrounding carriageway surface.
- Remember that motorcyclists tend to use the full width of the available traffic lane to minimise the steering input required and maximise their view of the road ahead. The location of service covers can adversely affect a motorcyclists ability to negotiate a bend safely.
- Note that many service covers within the highway are owned/maintained by public utilities. Highway Authorities have powers to require works to be undertaken on defective covers. Some authorities have worked with utilities to provide anti-skid covers.



2.2 Design Issue Number 1 – Factors Affecting Grip

1f Feature: *Surface debris in areas used by motorcyclists.*

Problems: Loose grit, gravel and spilt diesel fuel on the road surface represent a loss of control hazard for riders of two wheeled vehicles, particularly when found in areas where they are likely to be turning or filtering. Weather conditions can result in loose material spilling/blowing into the road from other areas such as unsealed footpaths and parks.

Typical Locations

- Various, but greatest impact likely to be on bends and within the vicinity of junctions.

Key Design Considerations

- A regular inspection and maintenance regime should be employed at sites where similar issues have previously been reported.
- Monitoring of diesel spills and surface treatments on accesses to private premises should identify problem areas, and relevant enforcement action should be taken where appropriate.

The owner of the dwelling to the left has treated the run from his private drive to the dropped kerb with gravel (unsealed surface). Vehicle movements from the private drive have transported gravel onto the road, in this case into braking and cornering areas for motorcycles at this mini roundabout.

The gravel on this bend is on the outside of the curve, where motorcyclists could be expected to ride.

2.3 Design Issue Number 2 – Visibility

2.3.1 Section 1 identified that four of the top five conflict types most commonly resulting in KSIs to motorcyclists involved turning manoeuvres. Restricted sideways or forward visibility, particularly at junctions, can often be contributory factors in these conflicts. The following provides examples of common visibility-related problems and design approaches which can help to ensure that suitable levels of inter-visibility are provided for all road users.

In the above example some of the restrictions to visibility could have been avoided by re-siting street furniture.

2 Feature:
Restricted visibility at junctions (sideways and forward visibility).

Problems: Suitable visibility splays are required at junctions to ensure that there is adequate inter-visibility between vehicles on the major and minor arms. There are two major components to visibility:

Typical Locations

- **Sideways visibility at junctions** – Vehicles waiting on a minor road need to be able to establish whether there is a sufficient gap for them to emerge onto the major road. A motorcycle has a relatively small frontal area compared to other vehicles and can often be 'masked' by other vehicles and road-side obstructions. This 'masking' can lead to vehicles emerging from the side road failing to appreciate the presence of approaching motorcyclists and can contribute to 'failure to give way' collisions.
- **Forward visibility** – Suitable forward visibility is required to allow for the timely detection of hazards. Street furniture, traffic signs, CCTV columns and other road side features can often impair forward visibility.

Key Design Considerations

Sideways visibility:

- Ensure that appropriate visibility splays are provided and that they are unobstructed by street furniture (i.e. CCTV installations, traffic signal equipment, traffic signs, bus shelters, bins, seating areas, car parking and vegetation).

Forward visibility:

- Ensure that the minimum forward visibility is equal to the minimum Stopping Sight Distance (SSD) and that the visibility envelope is free of obstructions. This should take into account the different road positions that motorcyclists occupy (e.g. at left hand bends, motorcyclists will usually be closer to the centre of the road than for right hand bends).
- Similar to sideways visibility, providing excessive forward visibility should be avoided as it can result in increased vehicle speeds, particularly on wider sections of road, and can increase collision risk.
- Consider future maintenance regimes, especially for vegetation in the Spring/Summer months, to ensure forward visibility doesn't become restricted over time.

2.4 Design Issue Number 3 – Roadside Features

3a Feature: *Inconspicuous, unmarked or poorly delineated kerbs/islands.*

Problems: Poorly delineated islands/kerbed areas that are designed to offer protection for cyclists and other road users can pose problems for motorcyclists. Failure to identify the feature can result in a collision with the island/kerbed area. For a four-wheeled vehicle this may be a minor inconvenience but for a motorcyclist could lead to serious injury. Cyclists attempting to overtake a slower cyclist could also collide with the feature.

Typical Locations

- Where cycle infrastructure is provided, particularly within the vicinity of junctions.
- Build-outs and refuge islands.

The kerbed island is not easy to identify (no bollards or other features) and forms a collision hazard for motorcyclists.

2.4.1 Road-side features can take various forms (for example, pedestrian refuges, kerbed islands, cycle lanes), and can be provided for numerous reasons (for example, to aid specific road users, general road safety reasons, public realm considerations). However, the installation of some road-side features can adversely impact on motorcyclists and careful consideration is required at the design stage to ensure that their needs are fully considered in such circumstances. The following provides some common problems with specific road-side features and the steps that can be taken to better account for the needs of motorcyclists.

The build-out forms a strike hazard, with the steel hoop forming an unforgiving structure if hit by a motorcyclist.

The small bollard on the refuge is low and not illuminated and the island forms a collision hazard, particularly in dark / wet conditions.

Key Design Considerations

Extent to which road side features are required:

- Take the needs of all road users into account and consider whether such features are required.

Details of physical features:

- If considered necessary, ensure that such features are clearly visible for all road users. This may involve providing more visible/ additional or higher bollards, illuminating them to ensure they remain conspicuous at night or providing a more conspicuous road marking treatment (taking into account the difficulties motorcyclists can experience with some road marking treatments).

These two pictures show the same refuge, one with a low-level keep left bollard and the other where the bollard is missing. The missing bollard increases the risk of a vehicle striking the refuge, particularly at night or in bad weather.

2.4 Design Issue Number 3 – Roadside Features

3b Feature: *Design and location of highway infrastructure and street furniture.*

Problems: In a collision, a rider will often be separated from their vehicle and may directly strike infrastructure within the highway adjacent to it (crash barrier, sign poles, street lights, guard railing etc). Badly designed or located highway infrastructure in the urban setting can result in serious or fatal injuries if struck by a motorcyclist.

Typical Locations

- Potentially at any point along the road-side, but most likely at or within the vicinity of bends and junctions.

In this underpass example there was a history of motorcyclists coming off their motorcycle and hitting the pillars on the off-side. In response to this, the gaps between the pillars were boarded to soften any impact in the event of a collision.

Key Design Considerations

Extent to which physical features are required:

- Take the needs of all road users into account and consider whether particular street furniture is required.

Details of physical features:

- If considered necessary, there are a number of techniques that can be used to 'soften' the road-side environment, these include:

  – Removing or minimising the provision of guard railing.

  – Can the road-side environment be de-cluttered as part of wider streetscape improvements to help reduce hazards posed to motorcyclists by street furniture?

  – Can signs be mounted on existing street lighting columns rather than requiring new posts? If new posts are required take care to locate them appropriately and consider frangible post options.

  – If bollards are required, can flexible ones be used?

  – If crash barriers are required can more motorcycle-friendly ones be used? (There is a tendency for motorcyclists to slide under crash barriers and hit the posts supporting the barriers which has much worse consequences).

  – Can more innovative design options (see opposite) be considered?

2.4 Design Issue Number 3 – Roadside Features

3c Feature:
Light segregation cycle facilities.

Problems: Light segregation is a technique that is increasing in popularity and refers to the use of physical objects intermittently placed alongside a cycle lane marking to give cyclists additional protection from motorised traffic. Where any object is used in the carriageway it may be struck by a vehicle and can have destabilising effects, to which motorcyclists are highly vulnerable. These risks to motorcyclists must be taken into account when designing infrastructure.

Typical Locations

- Where cycle lane infrastructure is provided (typically along links).

The reflective bollards helps to identify the start of light segregation to other road users.

**TRL, 2014. TfL Cycle Facility Trials: Alternative Separation Methods for Cycle Lanes.*

Key Design Considerations

If well designed, light segregation can enhance the level of service for cyclists when compared to a mandatory cycle lane. TfL is pursuing on-street trials of light segregation in the form of flexible posts implemented on the upgraded Cycle Superhighway 2 route. Research to-date* has identified the following important design considerations from the motorcyclist's point of view in relation to light segregation:

- The perception of risk from motorcyclists is higher for low level separators and there is a general preference amongst motorcyclists for the use of flexible posts;
- If low levels separators are to be used then they are generally better received by all road users (not just motorcyclists) when used with a taller, more visible object such as flexible posts at the beginning of a run;
- Good visibility of all physical objects is essential, including at night where objects need to have the recommended level of reflectiveness. Flexible posts used in the carriageway must have at least 60% of their surface covered in retro-reflective material;
- General traffic lanes of a suitable width should be provided to minimise the risk of a motorcyclist striking a physical object. Road marking treatments (offsetting lane markings and introducing hatched areas close to objects) can also help to reduce the risk of vehicle strikes (however, note previous comments regarding potential skid resistance issues with thermoplastic road markings);
- Suitable gaps should be provided between objects within the vicinity of side road junctions to reduce the risk of motorcyclists clipping such features whilst leant over in turning areas;
- Some forms of light segregation can be overrun by larger vehicles (i.e. low, pre-formed plastic objects and raised road markings) and have the benefits of timely installation, general cost savings and reduced maintenance requirements. However, such features can form loss of control hazards for motorcyclists and cyclists and can be a particular problem if they become detached from the road surface.

Although more difficult to see than up-right bollards, the low level 'Zicla' separators are positioned well away from the general traffic lane and do not cause a problem for motorcyclists.

2.5 Design Issue Number 4 – Traffic Calming

2.5.1 Physical traffic calming measures aim to reduce vehicle speeds and improve road safety. However, the vulnerability of a motorcyclist (small contact area with the road surface and constant need to balance) means that they can find some traffic calming features uncomfortable and/or difficult to negotiate. Examples of common issues associated with traffic calming, and design approaches that can help ensure that the needs of motorcyclists are better accounted for in traffic calming layouts are outlined in this section.

4a Feature: *Speed cushions.*

Problems: The placing of speed cushions can have unintended impacts on motorcycles. If drivers of cars, vans and lorries are encouraged to straddle a speed cushion in the centre of the road, their off side wheels may be in the path of oncoming vehicles. Riders of motorcycles can be inadvertently encouraged to choose a trajectory that compromises their safety. Consideration needs to be given to the gap between speed cushions and the line that motorcyclists are expected to take through them as loss of control collisions can arise if insufficient gaps and/or ill-advised driving lines are encouraged. Speed cushions should also not be positioned on bends as these form important braking, steering and leaning areas for motorcyclists.

Typical Locations

- Predominantly in residential areas but also high street and urban centre environments.

In these examples, parked cars require vehicles to straddle the central speed cushion, requiring motorcyclists to steer towards the kerb to avoid them. Problems for two wheeled vehicles are exacerbated when the distance between the edge of the speed cushion and the kerb are small (typically below 1.5m).

Key Design Considerations

A balanced approach should take into account the needs of all road users when designing traffic calming layouts. Some points to consider from a motorcyclist point of view include:

- Are vertical traffic measures required, or are other non-physical measures suitable (e.g. reduced speed limits, centre line removal etc)?
- If speed cushions are required consider the spacing between them and also between the outer-most cushions and the kerb – ideally gaps of 1.5m minimum should be provided. The road surface between the kerb and the cushion should be in good condition. Consider whether straight across, speed table, raised crossings, or 2 or 3 cushion layouts are most appropriate (unless there are parking restrictions either side of the cushions, motorcycles can be forced to take inappropriate lines through them).
- Do sinusoidal road humps, which provide a shallower initial rise and provide additional comfort for cyclists, represent a viable alternative to speed cushions?
- The route for motorcyclists through speed cushions should be clear and direct, avoiding the need for them to deviate from a direct line.
- Locate vertical traffic calming features away from turning or braking areas for motorcyclists.

2.5 Design Issue Number 4 – Traffic Calming

4b Feature: ***Material choice at side-road entry ramps / entry treatments.***

Problems: When negotiating a corner, motorcyclists are required to lean over and while doing so any change from a consistent surface can adversely affect the grip of the tyres on the road (particularly in wet weather conditions), potentially resulting in the rider falling. Surface materials, such as granite setts and block paving, can be useful to emphasise a change in circumstance at junctions and other turning points but these materials can have poor skid resistance, especially when wet. These surface materials can be difficult to suitably maintain, with displaced/loose setts and blocks providing an unpredictable surface for riders of two wheeled vehicles. A sudden change in surface level can also temporarily reduce the grip of the front wheel on the road surface.

Typical Locations

- Predominantly in residential areas but also high street and urban centre environments.

This entry ramp is set back from the main carriageway, so for a motorcyclist the road surface doesn't change until the manoeuvre is almost completed. However, towards the end of the manoeuvre, on the up ramp, there are potentially slippery granite setts which can cause problems especially when wet.

Key Design Considerations

Some points to consider from a motorcyclists' point of view include:

- Are side-road entry ramps required or can other methods, such as tighter corner radii, be used to reduce vehicle speeds?
- Can a surface material which has a similar skid resistance to the surrounding road environment be used?
- If granite setts / block paving are used a regular inspection, maintenance and repair regime should be employed.

The up ramp starts directly at the border with the main carriageway at the point where the motorcyclist will start the turning manoeuvre. There is also a change in road surface at this location.

2.5 Design Issue Number 4 – Traffic Calming

4c Feature: ***Proximity of side-road entry ramps / entry treatments to junctions.***

Problems: One of the most vulnerable periods for a motorcyclist is when they are leaning over and turning and this vulnerability increases if a change in surface level is experienced during such a manoeuvre. Locating side-road entry ramps within close proximity of junctions can cause stability problems for motorcyclists as they are leaning, turning and experiencing a change in surface level.

Typical Locations

- Predominantly in residential areas but also high street and urban centre environments.

This example has a good road surface on the up ramp, but the ramp is directly on the border of the main carriageway and has a gradient of 1 in 5, which can cause problems for motorcyclists.

Key Design Considerations

Some points to consider from a motorcyclists' point of view include:

- Locating the ramp further away from the junction and the turning area is preferable for motorcyclists, (though the design must also consider pedestrian desire lines).
- If the ramp has to be close to the turning area, ramp gradient and material choice is more critical in terms of the impact on motorcyclists.
- Could tightening the kerb radii or narrowing the width of the junction help to lower speeds without the need for the ramp?
- Can less severe ramps be used to reduce the change in level for motorcyclists? Longer and lower ramps are preferred by motorcyclists compared to shorter and higher ramps.

2.6 Design Issue Number 5 – Filtering

2.6.1 Motorcyclists can overtake or 'filter' past queues of stationary or slow moving traffic, with Rule 151 of the 'Highway Code' (DSA, 2015) advising car drivers in slow moving traffic "to be aware of cyclists and motorcyclists who may be passing on either side". Rules 88, 160 and 211 of the Highway Code also refer to filtering and outline the mutual need for motorcyclists to take care and be aware of other road users when filtering and for other road users to be aware of filtering motorcyclists.

2.6.2 Filtering can provide significant benefits, both in terms of reducing the individual's journey time, and reducing congestion within the overall highway system. Usually, motorcyclists filter along the offside of stationary traffic queues but can also legitimately do so on the nearside in certain circumstances. Filtering is prohibited in the following circumstances: if a solid white line is crossed, if a motorcyclist passes the wrong side of a keep left bollard, where signs prohibit overtaking and on the approach to a controlled pedestrian crossing where you must not overtake the vehicle nearest the crossing which has stopped to give way to pedestrians. It should be noted that motorcyclists may still attempt to filter, even if there is insufficient space to facilitate it.

2.6.3 Motorcyclists can experience various barriers to filtering, some of which are infrastructural in nature. However, providing that it is undertaken appropriately, there should not be significant road safety issues associated with filtering and a number of specific design considerations are highlighted below.

2.6.4 Section 1.3 provides typical dimensions for various types and sizes of motorcycle.

2.6 Design Issue Number 5 – Filtering

5a Feature: *Constrained traffic lane widths.*

Problems: Narrow traffic lanes can prevent motorcyclists from legitimately filtering on the off-side of slow or stationary traffic, and their progress can be halted by the presence of pedestrian refuges / traffic islands. This can result in motorcyclists having to rely on other drivers to allow them back in to the line of traffic, sometimes leading to conflicts between vehicles and motorcyclists (vehicles fail to see filtering motorcyclists / drivers preferring not to let motorcyclists filter).

Note: If an island has a 'keep left' arrow and bollard on it, it is illegal (i.e. a prosecutable offence) for motorcyclists to filter to the offside of the island.

Typical Locations

- Various, but most likely to be where vehicles queue on the approach to junctions.

The available lane widths and position of the central refuge prevents both cyclists and motorcyclists from filtering on the approach to the traffic signals.

Key Design Considerations

- Consider whether there is likely to be a demand for offside filtering by motorcyclists and how this can be best and safely accommodated. Motorcyclist's behaviour should be observed at the site in order to help determine their requirements.
- Consider providing wider traffic lanes which would allow motorcyclist's to filter 'in lane' to the offside.
- Consider whether there is potential to improve network resilience to reduce queuing and the need for motorcyclists or cyclists to filter.
- Provide clear 'keep left' signing on all islands.
- Consider providing double white lines to prevent vehicles from using the opposing carriageway.

2.6 Design Issue Number 5 – Filtering

5b Feature: *Filtering within advisory cycle lanes.*

Problems: Although filtering on the offside is generally more common for motorcyclists, some motorcyclists do filter within advisory cycle lanes (which, in certain circumstances they are permitted to enter) on the nearside. This can be as a result of narrow traffic lanes reducing the possibility of filtering elsewhere within the available road space or the presence of regular traffic islands / pedestrian refuges in the central area preventing offside filtering. Advisory cycle lanes that are heavily populated by both cyclists and motorcyclists can introduce additional potential for road user conflict. Motorcyclists filtering on the nearside, particularly across side road junctions, can be at increased risk of collisions with turning vehicles.

Typical Locations

- On approaches to junctions.
- Within advisory cycle lanes.

Key Design Considerations

- Consider whether there is likely to be a demand for nearside filtering by motorcyclists and if so how this can be best and safely accommodated taking into account the needs of all road users. Cyclists and motorcyclists behaviour should be observed in order to help determine their requirements.
- Consider providing wider traffic lanes to allow motorcyclists to filter within a general traffic lane.
- Consider whether there are opportunities to better accommodate the more readily expected offside filtering (e.g. adjustments to central refuge islands).
- Consider whether there is potential to improve network resilience to reduce queuing and the need for motorcyclists or cyclists to filter.

In this example, the cycle lane has been widened and this has narrowed the general traffic lane (there is also a kerbed central reserve on the offside of lane 2). Consequently, large vehicles cannot travel within the available lane width and, as a result, the cycle lane is only advisory. Because motorcycles cannot filter along the offside, the wide cycle lane encourages some motorcyclists to use it, as a means to progress their journeys.

3.0 Conclusions

This Urban Motorcycle Design Handbook sets out the key highway design requirements for motorcycle safety in London. Using this Handbook, including the Design Checklist in Appendix 1 and the additional resources listed in the Bibliography, will lead to a better understanding of how road and traffic conditions affect motorcyclists. With a broader understanding of motorcycling issues, designers will be better placed to cater for motorcyclists and reduce any adverse impacts on the safety of this vulnerable road user group.

4.0 Bibliography

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Appendix 1 – Design Checklist

Possible Issues

Surfacing and skid resistance

- Are pavement conditions adequate so that motorcyclists will not encounter problems with changes in friction, cracks, potholes, surface water, gravel etc.?
- Are there locations where high skid resistance surfacing (such as on bends or approaches to junctions) would be beneficial?
- Do changes between different types of surfaces occur at locations where they could adversely affect motorcycle stability (such as on bends or approaches to junctions), and are they perpendicular to the carriageway?
- Do the locations of features such as service covers give concern for motorcycle/cyclist stability? Can they be relocated or provided with high friction covers.

Road markings

- The skid resistance value of road markings is often different to that of the surrounding carriageway surface. Do road marking materials have an adequate level of skid resistance?
- Are directional arrows and other road markings placed in a manner that will not create poor skid resistance for motorcyclists at critical locations (e.g. bends, immediate approaches to junctions)?
- Are all road markings/studs clear and appropriate for their location?
- Have old road markings and road studs been adequately removed?
- Are there any large areas of road markings that could be removed or reduced in size?
- Do longitudinal road markings direct vehicles around refuges and other obstructions (rather than leading vehicles towards the feature)?

Drainage

- Will the scheme drain adequately, or could areas of excess surface water form, (causing a greater hazard for motorcyclists than for other vehicles)?
- Could excess surface water turn to ice during freezing conditions?
- Could excessive water drain across the highway from adjacent land?

Visibility

- Are visibility splays adequate and clear of obstructions such as street furniture and landscaping?
- Will sight lines be obstructed by permanent or temporary features e.g. bridge abutments or parked vehicles?
- Are sight lines adequate on and through junction approaches and from the minor arm?

Landscaping

- Could areas of landscaping conflict with sight lines?
- Could planting affect lighting or shed leaves on to the carriageway?

Runoff zones

- Can placing of street furniture be avoided or rationalised where the risk of being hit by motorcyclists is particularly high?
- Have areas in the runoff zone been made as ‘forgiving’ as possible with motorcyclists in mind (e.g. use of energy absorbing cushions for roadside objects)?

Signs

- Have traffic signs been located away from locations where there is a high strike risk?
- Are sign posts passively safe or protected by safety barriers where appropriate?

Appendix 1 – Design Checklist (Continued)

Possible Issues

Public Utilities Services Apparatus

- Are boxes, pillars, posts and cabinets located in safe positions away from locations that may have a high potential of errant vehicle strikes? Do they interfere with visibility?
- Are there any utility inspection chambers in live traffic lanes and/or likely motorcycle wheel tracks?

Fences and Road Restraint Systems

- Is there a need for road restraint systems to protect road users from signs, gantries, parapets, abutments, steep embankments or water hazards?
- Do the road restraint systems provided give adequate protection?
- Are the road restraint systems long enough?
- Are specific restraint facilities required for motorcyclists?

Maintenance issues

- General traffic (cars, lorries, buses) often push loose chippings, broken glass and other detritus into parts of the carriageway that are used by motorcyclists, either to filter or in order to take the most appropriate line around a bend or through junctions. If these areas are not regularly swept as part of routine maintenance they can form a loss of control hazard for motorcyclists.
- Successive application of road marking material as part of routine maintenance can result in a build-up of layers forming a stability hazard for motorcycles – this should be avoided.
- Are sufficient procedures in place for the reporting and cleaning up of diesel fuel spills?

Streetworks

- Any road plates used must be made of suitable material with an appropriate skid resistant surface. Their installation must not represent a hazard to motorcyclists and they should be adequately signed.
- Temporary signs should be placed and maintained to ensure they cannot form a collision hazard for motorcyclists.
- Reinstatement of road surfaces, either temporary or permanent, should ensure that they do not adversely affect the stability of motorcycles.
- Prevent the spread of building material, mud, gravel etc. on the carriageway.
- Ensure clear signing is provided in advance of all works and take account of how motorcyclists requirement may differ from other road users, in the warning given.
- Longitudinal grooving (in the direction of traffic flow) can adversely affect the stability of motorcycles. Carriageway planing that results in grooving should be adequately signed in advance.
- Joint sealing should ensure that excess bitumen is not left on the road surface as this can form a skid hazard for motorcyclists.