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THE MOTORCYCLE INDUSTRY IN EUROPE

GUIDELINES FOR PTW-SAFER ROAD DESIGN IN EUROPE

25 000
LIVES TO SAVE
European Road Safety Charter

Future Plaza
Intertraffic Amsterdam

www.acembike.org

FOREWORD

Powered Two Wheelers (PTW) belong to the European transport system. They provide the opportunity to make better use of the existing road system. In many circumstances PTWs offer an efficient form of transport allowing easy access to crowded cities and streets. However, despite these positive characteristics, PTWs have their weaknesses as any other transport mode. The number of accidents, in which PTWs are involved, is a major concern. Convergent studies –including the MAIDS study[1] – allow us today to state that significant number of accidents result from infrastructure shortcomings.

PTWs differ in their use of the road in a number of ways from other vehicles and riders have different needs. Predictable road geometry, good visibility, obstacle free zones and good quality road surface with high levels of skid resistance are some major examples. While important for all road users, they are essential for PTWs.

Some recent publications from Belgium, France, Germany, Norway, The Netherlands and The United Kingdom show that a civil engineering handbook is a practical instrument for improving road safety for PTWs, just by emphasising the engineering items to consider during the design and maintenance of infrastructure. In this handbook, ACEM has expanded this information on a European scale to further develop awareness.

This handbook describes the specific needs of riders and contains guidelines for those responsible for road design and road maintenance. It includes recommendations and examples from all over Europe. Predictable road geometry can be achieved by a good road design with consistent, clear traffic signs and road markings, and by improving traffic management, PTW riders can be better guided on the road.

In addition to road design and traffic management two other aspects have been included in this handbook: the use of a formalised and systematic assessment of road facilities and road safety campaigns considering PTWs, both are a vital ingredient in a mix of initiatives to address PTW safety.

Road safety needs an integrated approach and infrastructure is one of the leads to reach the EU target of halving the number of road accident victims by 2010. In parallel with the EU Road Safety Action Programme, the Motorcycle Industry has pursued a broad approach to cover all areas of PTW safety: the EU Road Safety Charter (vehicle technology), the Initial Rider Training project (user behaviour) and, today, the European road design guidelines (infrastructure).

Improvements in road safety are a "shared responsibility". When implementing these recommendations, road designers and traffic engineers will greatly contribute to this common target and make European roads a safer place for Powered Two Wheelers.

Jacques Compagne
ACEM Secretary General

[1] The Motorcycle Accident In-Depth Study (MAIDS) is the most actual and recent study of powered two wheeler accidents in Europe. The full report is available on http://maids.acembike.org

CONTENTS

1. INTRODUCTION

The European Commission strives for a better environment. It particularly aims for clean air, sustained mobility and improvement of road safety. As to road safety its goal is a reduction in casualties by 50% in the year 2010. The *Association des Constructeurs Européens de Motocycles* (ACEM) is strongly committed to this target. ACEM was founded in 1994 and represents the major motorcycle manufacturers in the European Union (either European or producing in Europe), as well as 12 associations at a national level. As a pledge to achieving this European target, ACEM, as representative of the Motorcycle Industry, signed the EU Road Safety Charter. Through this declaration the Motorcycle Industry has made a number of commitments such as, for instance, to progressively supply Powered Two Wheelers with advanced braking systems. As part of their contribution to the EU target ACEM initiated the idea of creating an integrated European roadway design handbook for Powered Two Wheelers. This handbook contains recommendations for a safe infrastructure. As such it promotes the improvement of road safety.

1.1 Background

Powered Two Wheelers (in short PTW's) form a rapidly growing substantial and integrated part of the European transportation system. For the greater part they are employed in so-called urban mobility. PTW's give their riders an excellent opportunity to make better use of the road system. In many circumstances PTW's offer an efficient way of transportation. They are flexible, small, faster than cars in congested traffic and easy to park. Furthermore, they offer easy access to crowded cities and streets. Despite these positive characteristics PTW's have their drawbacks. The number of accidents in which PTW's are involved, is of major concern to the authorities. In certain cases human failure is the primary cause of the accident. Nevertheless a large number of accidents is caused by shortcomings of the infrastructure. Frequently a motorcyclist gets injured or even killed due to deficiencies of and obstacles alongside the roadway. To understand both nature and causes of PTW accidents ACEM conducted the MAIDS study. This project was supported by the European Commission and other partners. MAIDS[2] is an extensive study in sampling five areas in Europe. It indicates that – after the passenger car - the roadway itself is the obstacle the PTW most likely crashes into. This conclusion emphasizes the need for a thorough analysis of elements of infrastructure.

Recent publications in The Netherlands, Norway, The United Kingdom, Belgium, France and Germany show that a civil engineering handbook may well be a helpful instrument for improving traffic safety for PTW's. Particularly by emphasizing engineering items to consider in the appropriate design and maintenance of the infrastructure. Therefore ACEM, taking into account the conclusions of the MAIDS study, took the initiative to integrate the existing national handbooks into one European handbook. To further broaden the scope of this handbook information of two Eastern European countries – Poland and Bulgaria, two areas in which personal transportation is expanding rapidly – are included whenever deemed appropriate.

[2] http://www.acembike.org

1.2 How to use this publication?

The contents of this handbook are based on the available literature, knowledge and experience in Europe. The core of the information comes from existing PTW handbooks available in various European countries. It is duly expanded with insights based on the latest findings gathered from all over Europe.

Each chapter has a similar layout. In almost every chapter recommendations, solutions, conclusions and possibilities are summarized and examples of Europe's best practice are given. References to documents in the bibliography are marked [L…]. References to Internet sites and other Internet sources are marked [www…]. The bibliography and a list of Internet sites can be found in the reference pages of this handbook.

Chapters 2 and 3 contain general information describing in brief prevailing policy and legislation issues as well as road safety problems. Chapter 4 describes the characteristics of a PTW. Road design is dealt with in chapter 5. Chapters 6 and 7 describe the influence of road maintenance and traffic management and in chapter 8 parking issues are discussed.

Besides improving the infrastructure it is also necessary to account for the usage of it. Training, education and instilling awareness of how to behave on the road, how to interact with other road users and how to anticipate deficiencies in and on the roadway are certainly needed to warrant a proper usage of improved infrastructure. Bearing this in mind appendix 3, "non-technical measures", offers scenarios for communication campaigns and training activities aimed at improving traffic safety. These scenarios combined with the contents of this handbook – the realization of road infrastructure that can safely be used by PTW's - will hopefully ensure the best results that may be achieved.

2. STRATEGIES AND POLICIES

2.1 EU – policy & legislation

Within the European Union transportation policy is the responsibility of the Directorate General for Transportation and Energy (DG TREN). The objectives the European Commission wants to achieve described in the White Paper on Transportation are:

- a reduction of the impact of congestion. It will account for 1% of EU's gross domestic product in 2010 if nothing is done;
- an improvement of road safety by reducing the number of casualties by 50 % in 2010;
- a shift in modes of transportation to environmentally more friendly means;
- a reduction in the dependency on scarce energy sources and improvement of the air quality by substantially reducing pollution caused by motor vehicles.

The Motorcycle Industry in Europe is strongly committed to its safety target. (appendix 4) ACEM hopes to contribute to it by publishing this handbook.

2.2 Environment

Besides the safety goals European transportation policy has set for 2010 it also aims at realizing a sustainable environment. For instance by stimulating the use of unconventional fuels. In order to achieve a cleaner environment and control of climate change the integration of both transportation and energy consumption is getting more and more important. Particularly so in clean public transportation in urban areas. A more rational use of energy and stimulating the use of alternative, less polluting modes of transportation is important here.

The importance of transportation in relation to energy use is illustrated in figure 2.1. Transportation is one of the main energy consuming activities. In the future the share of energy consumption by transportation compared to that of the industry sector will increase. Looking at oil consumption the share of transportation is even greater. It is the determining factor in the dependence of the EU on imported energy sources.

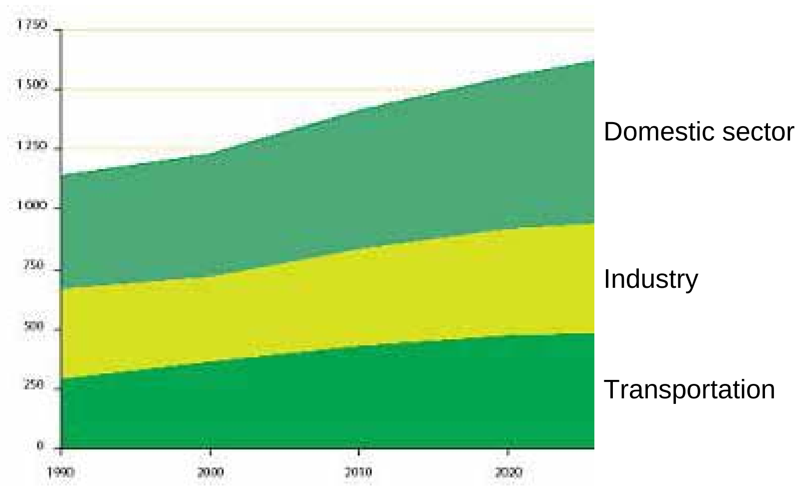


Figure 2.1 *EU-30 - Final energy consumption in millions of tons (source: White Paper).*

Emission

PTW's are gradually getting cleaner. Although their relative environmental performance has lagged behind the dramatic improvements achieved for passenger cars in recent years, the overall trend is heading for the right direction. More stringent emission standards and tougher testing are expected to improve the (low) emission performance of PTW's with respect to nitrogen oxides (NOX) and other regulated gases.
Despite the fact that implementation of regulations became effective at a later point in time compared to passenger cars, PTW's still have an advantage over cars in terms of carbon dioxide (CO2) emission. Their CO2 emission is less than 50% of that produced by cars covering the same distance. This is due to their smaller engine size and better occupancy rate. A switch from car to PTW contributes to the reduction of the impact transportation has on the environment, especially in densely populated urban areas.
A new world-wide harmonized type-approval testing method of PTW's has been finalized so as to more closely representing real-world riding. When incorporated into EU legislation this should give PTW's a much better rating than cars for both pollution and CO2 emission.

Figure 2.2 a

Figure 2.2 b

Safety and noise (or environmental) enforcement by the police. (source: Internet)

Noise

Despite the perception of the people at large standard PTW's are not to be rated as particularly noisy. Readings taken from various series of car and PTW types lead to the discovery that both types of vehicle perform far below the values set as the statutory limit under the given circumstances They do not represent a significant source of traffic noise. The main noise produced by cars is caused by the tyres. This noise increases almost linearly with the speed, whereas the engine and transmission are less noticeable due to their effective containment. As to PTW's, however, the noise is predominantly brought about by the engine and drive train, whereas the noise produced by the tyres plays a less significant role. This is why PTW's are marginally louder than cars at speeds below 60 km/h, whereas at speeds from 80 km/h and up they may even be quieter than cars [L21].

The noise produced by PTW's under normal traffic conditions is therefore in essence identical to that produced by passenger cars and much lower than that produced by heavy trucks. The low percentage of PTW's in the overall European vehicle pool, i.e. a little over 10%, also contributes to the fact that traffic noise produced by PTW's is already very low today.

That a PTW is perceived to be loud is mainly due to its high acoustic potential when it accelerates very fast in a quiet environment. This is why noise disturbance from PTW's is generally associated with single events and at peak noise levels. These mainly depend on riding behaviour such as high engine speed. Very often nuisance arises from vehicles equipped with illegal exhaust systems. Educating motorcyclists in matters of environmental protection therefore offers a reasonable potential for reducing the overall noise level. The overall effect of this can be estimated at 5 to 10 dB(A) on a long-term basis.

The real challenge, however, is to find effective measures against illegal exhaust systems. The number of PTW's operating with illegal systems is very high. It has been estimated that 35% of all motorcycles and 65% of the mopeds are fitted with illegal exhausts. The majority of these produce 10-15 dB(A) over the legal limit. When effective measures like enforcement were to be taken against illegal exhaust systems, a considerable reduction could be obtained in a very short time [L.15/L21].

Figure 2.3 a

Figure 2.3 b

Measurement of the sound level by the police. (source: Internet)

2.3 Sustainable mobility

The rapid growth of car traffic, coupled with an increasing demand for greater mobility has led to traffic congestion, chronic delays, road casualties, pollution and noise. One of the main claims made for motorcycling has been its ability to reduce congestion on the grounds that PTW's take up less space than cars and are able to filter through stationary traffic. Therefore it follows that switching from car to PTW is bound to increase network capacity.

The increase of capacity or the reduction of congestion is a goal set by DG TREN. This reduction may be realized by a shift in mode of transportation. The usual way is to try and make people travel by public transportation, cycle or walk. However, this kind of response may be complemented by the Powered Two Wheeler. The need people feel to preserve their personal mobility and flexibility is a key factor to the road-using public. By choosing the PTW as an alternative people still enjoy personal mobility and flexibility and congestion of traffic will be reduced.

3. SAFETY

3.1 Introduction

Road safety is an important issue at a European level. The total cost of traffic accidents in the whole of Europe is 2% of GNP (Gross National Product). DG TREN aims at reducing the number of casualties by 50% in 2010. It focuses on matters as a more stringent legislation on granting driving licenses, remediation of accident black spots and improving the behaviour of road users. However, the overall quality of design, construction and maintenance of infrastructure has been largely neglected as a factor in casualties concerning PTW's. In order to take effective measures there is a compelling need for fact-finding, analyzing and disseminating best practice. [L.8]

Motorcyclists form one of the most vulnerable groups of road users. The serious injuries they incur in traffic accidents should be of major concern in society. Therefore it is essential to reduce the potential risks of this mode of transportation. In order to better understand nature and causes of PTW accidents the Association of European Motorcycle Manufacturers (ACEM) with the support of the European Commission and other partners, have conducted an extensive in-depth study of motorcycle and moped accidents in the period 1999-2000 (MAIDS[3]). The data collected in this study represent the most comprehensive in-depth data base currently available on PTW accidents in Europe. These data provide much information required for conducting future research into public policy issues on this matter. It is important to note that the data were collected in the following five European countries: France, Germany, the Netherlands, Spain and Italy. Therefore other European countries may have come to different conclusions. For some insight in these differences, data from Poland and Bulgaria are included in appendix 5.

Based on the major findings of MAIDS a Plan of Action was launched in 2004. In this plan the European motorcycle manufacturers made a commitment to contribute to the advancement of safety in Europe (see appendix 4).

3.2 Key points

3.2.1 Where do PTW accidents occur?

Sampling took place in regions consisting of both urban and rural areas. The majority of accidents, however, took place in an urban setting. Approximately three-quarters of all accidents occur within city limits. Accidents involving type PTW< 50 cm^3 (mopeds) in urban areas outnumber the accidents involving PTW>50 cm^3. Figure 3.1 shows the relation between collisions in urban and in rural areas.

[3] http://www.acembike.org/html/docs/ACEM%20publications/maidsfolder.pdf

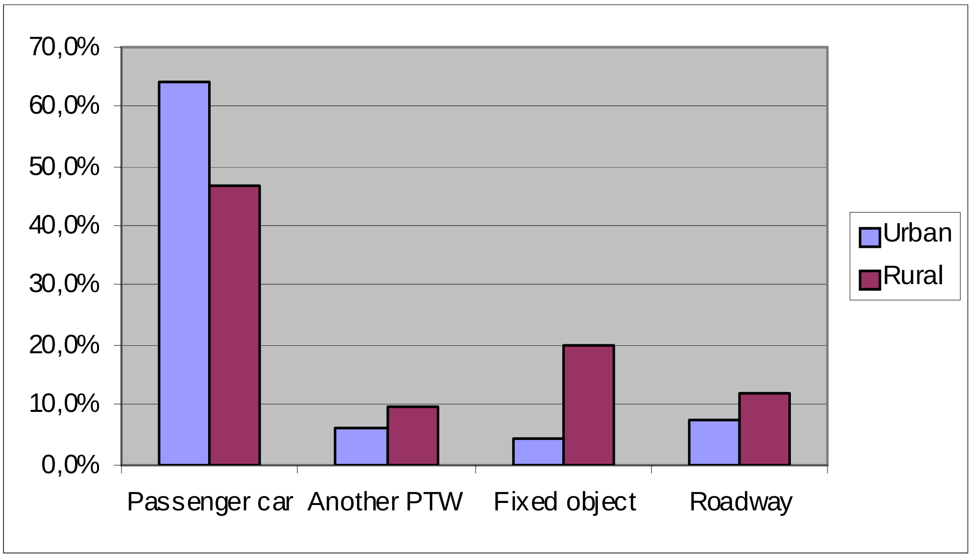


Figure 3.1 *PTW collision partner by type of area [L.11]. (source: ACEM, Maids study)*

3.2.2 Collision partners

The PTW accident data collected in MAIDS indicated that the obstacle most frequently struck in a PTW accident was a passenger car (60%). The second most frequently struck obstacle was the roadway itself (9%), either as the result of a single vehicle accident or in an attempt to avoid a collision with another vehicle. The third most struck obstacles were trucks, SUV' s and buses (8,4%). The fourth most struck obstacle was a fixed obstacle (8%) such as crash barriers, traffic signs and trees.

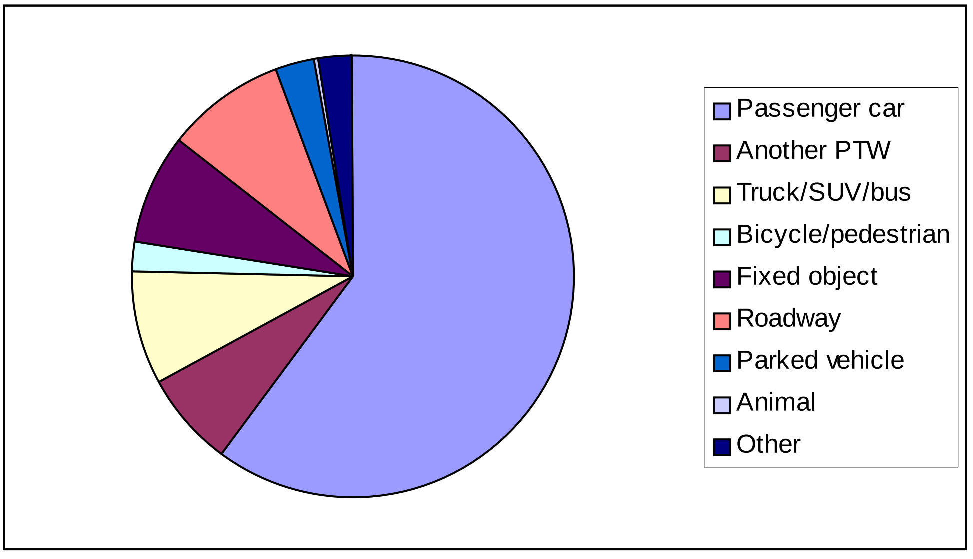


Figure 3.2 *Collision partner of a PTW [L.11]. (source: ACEM, Maids study)*

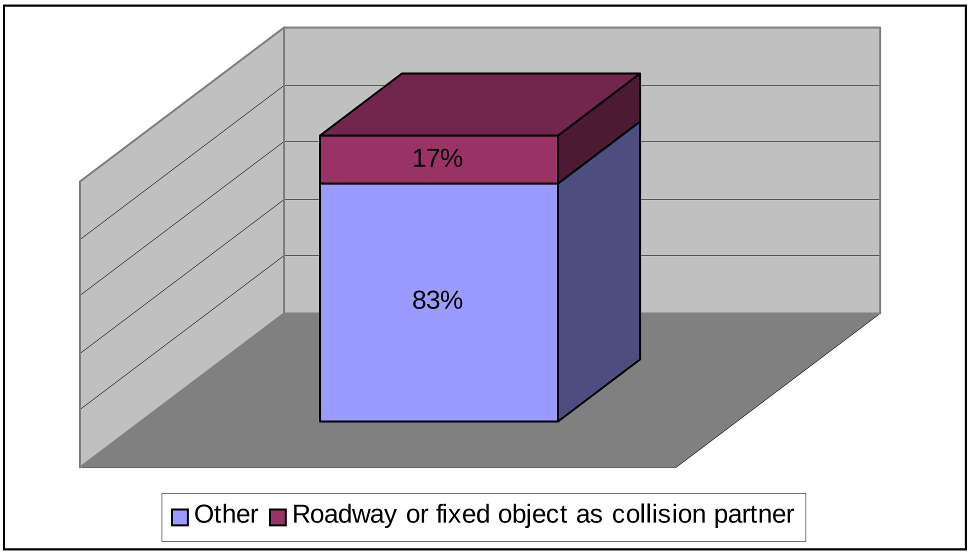


Figure 3.3 *Collision partner of a PTW { L.11].In 17% of the accidents the roadway or a fixed obstacle were the collision partner. (source: ACEM, Maids study)*

3.2.3 Contributing factors

Human failure

The MAIDS research team determined in each case the primary accident-contributing factor. They differentiated in human, vehicle and environmental factor.

Table 3.1 provides a summary of the general categories of primary accident contributing factors.

Table 3.1 *Primary accident contributing factor [L.11]*

	Frequency	Percent
Human _ PTW motorcyclist	341	37.1%
Human _ OV driver	464	50.4%
Vehicle	6	0.7%
Environmental	72	7.7%
Other failure	37	4.1%
Total	921	100%

The human factor was established as the primary factor in approximately 87.5% of all cases. Human failure can be defined as follows:

— Perception failure: the PTW motorcyclist or the driver of the other vehicle failed to detect the dangerous conditions he ought to have perceived by means of his strategy for detecting dangerous conditions.

— Comprehension failure: the PTW motorcyclist or the driver of the other vehicle did perceive a dangerous situation. However, he failed to comprehend the actual danger involved.

— Decision failure: the PTW motorcyclist or the driver of the OV failed to make the correct decision to avoid the dangerous conditions.

— Reaction failure: the PTW motorcyclist or the driver of the OV failed to react on the dangerous conditions resulting in faulty collision avoidance.

Table 3.2 *Human factors [L.11]*

	Frequency	Percent
PTW motorcyclist:		
Perception failure_ PTW motorcyclist	110	11.9%
Comprehension failure_ PTW motorcyclist	33	3.6%
Decision failure_ PTW motorcyclist	120	13.0%
Reaction failure_ PTW motorcyclist	51	5.5%
Other failure_ PTW motorcyclist	27	2.9%
Driver of the Other Vehicle		
Perception failure _ OV driver	337	36.6%
Comprehension failure_ OV driver	13	1.4%
Decision failure_ OV driver	91	9.9%
Reaction failure_ OV driver	2	0.2%
Other failure_ OV driver	22	2.4%
	806	87.5%
No human failure	115	12.5%
Total	921	100%

Table 3.2 shows that the most frequent human failure was the failure of the driver of the other vehicle to perceive the PTW in time. This may be due to lack of driver attention, temporary view obstruction or the relatively limited visibility (small profile) of the PTW. This was a primary contributing factor in 36.6% of all accidents. The second is a decision failure by the driver of the other vehicle.

Figure 3.4 *The VASCAR camera is trained on the rear window, showing the motorcyclist's lack of concentration. (source: www.blikopdeweg.nl)*

The road environment

The MAIDS team considered environmental factors to be contributory to the accident. It was the primary accident-contributory factor in 7.7% (table 3.1) of all cases. After human failure this is the second most frequent primary contributory factor. In addition to the primary contributory factor each research team identified possible additional contributory factors for each accident. They found that among all the contributing factors 14.6% were related to the environment.

Table 3.3 *Contributory factors in the PTW (pre-) crash path [L.11].*

Contributory factor	Frequency	Percent
Total of accidents analyzed	921	100%
Defective roadway design	57	6.2%
Defective roadway maintenance	146	15.9%
Traffic hazard	56	6.1%

In the MAIDS study three environmental factors have been found to contribute to PTW (pre-) crash path:

1. a roadway design defect;
2. a roadway maintenance defect;
3. traffic hazard.

A roadway design defect was defined as a condition presenting danger to the PTW-motorcyclist based solely upon the design of the roadway. Examples include matters such as failure to install reflectors on adjacent roadway structures or a curve with decreasing radius.
A roadway maintenance defect was defined as any stretch of roadway in poor repair or in need of repair. Examples include potholes, loose bitumen and poor kerb structures.
A traffic hazard was defined to be a temporary roadway obstruction or any obstacle or material on the roadway as a result of construction or maintenance operations.

Roadway design defect

Table 3.4 shows that in the PTW (pre-) crash path 57 (6.2%) of the 921 accidents analyzed there was a roadway design defect. In the OV (pre-) crash path 62 (8%) of the 778 investigated cases a roadway design defect was the culprit (table 3.5).

The data indicate that there were roadway design defects in 57 cases of PTW (pre-)crash. But in 47 % of these cases this did not actually contribute to the causation of the accident. In 4 cases the design defect was the precipitating event of the accident and in 7 cases the design defect was the primary contributing factor for accident causation. In the 19 remaining cases, the roadway design defect was a contributing factor to the accident.

In the OV (pre-)crash paths the roadway defect was found to contribute in 42% of all reported cases. The defect was considered to be the precipitating event in 8 cases and it was the primary contributing factor in another 6 cases (10% of all reported cases involving a roadway design defect). There were ten cases in which it was unknown if there was a roadway design defect in the (pre-)crash of the OV.

Roadway maintenance defect

Table 3.4 indicates the distribution of a roadway maintenance defect as a contributory factor to PTW (pre-)crashes. In 146 (15.9%) of the cases there was a roadway maintenance defect. As to the other vehicle (pre-)crash path in 106 (13.6%) of the 778 investigated cases there was a roadway maintenance defect. (table 3.5)

Traffic hazard

Table 3.4 indicates the distribution of traffic hazards, such as maintenance operations, as a contributory factor to the PTW (pre-)crash path. In 6,1 % of the cases there was a roadway maintenance defect. In the OV (pre-)crash path 46 (5.9 %) of the 778 investigated cases there was a traffic hazard. (table 3.5).

Table 3.4 *Environmental contributory factors in the PTW(pre-)crash path [L.11].*

PTW (pre-)crash path	Roadway design defect		Roadway maintenance defect		Traffic Hazard	
	Frequency	%	Frequency	%	Frequency	%
Total of accidents analyzed	921	100%	921	100%	921	100%
Factor defect present	57	6.2%	146	15.9%	56	6.1%
When factor was present:						
▪ It was **not** a contributory factor	27	47.3%	113	77.4%	22	39.3%
▪ It was a contributory factor	30	52.6%	33	22.6%	34	60.7%
When factor was present it was the:						
▪ precipitating event	4	7.0%	8	5.5%	10	17.5%
▪ primary contributory factor	7	12.3%	19	13%	6	10.7%
▪ a contributory factor	19	33.3%	6	4.1%	18	32.1%

Table 3.5 *Environmental contributory factors in the Other Vehicle (pre-)crash path [L.11].*

OV (pre-)crash path	Roadway design defect		Roadway maintenance defect		Traffic Hazard	
	Frequency	%	Frequency	%	Frequency	%
Total of accidents analyzed	778	100%	778	100%	778	100%
Factor defect present	62	8.0%	106	13.6%	46	5.9%
When factor was present:						
▪ It was **not** a contributory factor	22	35.5%	95	89.6%	24	52.2%
▪ It was a contributory factor	40	64.5%	11	10,4%	22	47.8%
When factor was present it was the:						
▪ precipitating event	8	12.9%	1	0.9%	3	625%
▪ primary contributory factor	6	9.7%	10	9.4%	6	13.0%
▪ a contributory factor	26	41.9%	0	0%	13	28.3%

Each of the variables must be treated separately, so they cannot be considered as a sum total. The presence of one of the variables (e.g. road design defect) does not exclude the presence of another; both of them can be present in one case. For the complete data we refer tot the MAIDS report.

These data, however, make clear that improvement of design and maintenance of the roadway, and the reduction of traffic hazards, such as maintenance operations, are helpful to improve safety of motorcyclists.

4. THE SCOPE OF THE GUIDELINES

4.1 Types of PTW

In this handbook the term ‘Powered Two Wheeler’ is used as a general expression for the whole range of motorcycles, scooters and mopeds. It speaks for itself that readers ought to distinguish between the classification employed in this handbook and the one laid down in the legislation of their home-country. .

1 Light weight PTW with a cylinder capacity of < 50 cm^3 (mopeds /scooters)

2 Scooters and light weight motorcycles
Cylinder capacity: ≥ 50 cm^3 < 250 cm^3

3 Heavy scooters and motorcycles
Cylinder capacity: ≥ 250 cm^3

(source: www.yamaha.com)

4.2 PTW characteristics

A PTW presents some strong points to its owner. It reduces travelling time, is comparatively inexpensive and is easy to park. In addition it offers its rider a sense of freedom. That is why the motorcyclist often has an emotional relationship with his PTW. A PTW can be used for commuting and for recreational purposes. Many a motorcyclist in his leisure time keeps on searching for stretches of highway where he can go for a spin on his PTW, either all by himself or in a group. [L.1]

PTW's differ in many respects from other motor vehicles. For the non-riding road designer and builder it is worth their while to understand how and in what respect motorcycles are different:

— Contrary to cars and other four-wheeled vehicles a PTW has only two points of contact with the surface and can therefore not remain upright when it has come to a standstill. Its centre of gravity and the absence of bodywork are distinctive features of a PTW compared to other motor vehicles [L.1 and L.2].
— A PTW has a relatively big engine capacity in relation to its mass. As a result of this it accelerates faster than a car.
— The motorcyclist is relatively vulnerable compared to a car driver. This vulnerability is particularly due to the lack of a cage construction, a lesser perceptibility of the PTW by other road users and the fact that a PTW is a vehicle with an unsteady balance.
— Most of the braking effort and all of the steering control is exerted through the front tyre. This accounts for the fact that motorcyclists tend to avoid a combination of braking and steering. This is to reduce the possibility of toppling over due to excessive grip of the front tyre while dealing with conflicting forces.
— The consistency of grip of the tyres on the surface is critical for the stability of the PTW. The consistency of grip together with the gyratory effect provide the essential stability and self-correcting balancing capability. A change in grip of the tyre on the road caused by, for instance, braking or an uneven roadway can lead to loss of control during the manoeuvre as the front wheel slides away. Loss of front-tyre-grip in a bend will almost invariably lead to a crash.
— The gyratory effect increases at a higher speed. From 0-20 km/h the gyratory effect is very small and provides little stability. From 20-40 km/h the gyratory effect provides sufficient stability, which however can be upset by other influences. From over 40 km/h the gyratory effect is strong enough to stabilize the PTW [L.14].
— In curves motorcyclists follow a different line than drivers of other motor vehicles. They traverse the width of the lane in order to maximize grip through minimizing steering input.
— The effect of steering by shifting one's weight is amplified as speed increases - a slight turn of the handlebar at 90 km/h turns the wheels much faster than at walking speed. At a lower speed the perception of balance by the motorcyclist is important. He balances the vehicle by small shifts in weight.
— There is anecdotal evidence that motorcyclists who lose control of their PTW in a bend tend to fix their attention on what seems to be the obstacle in their path most likely to hurt them, typically a tree or a signpost. It is believed that once this target fixation occurs, the motorcyclist will actually hit that obstacle. Whether or not target fixation is an actual phenomenon, research indicates that a significant percentage of PTW fatalities involves collision with roadside obstacles [L.3].
— Motorcyclists are more often affected by, for example, strong winds, rain or water on the road's surface.

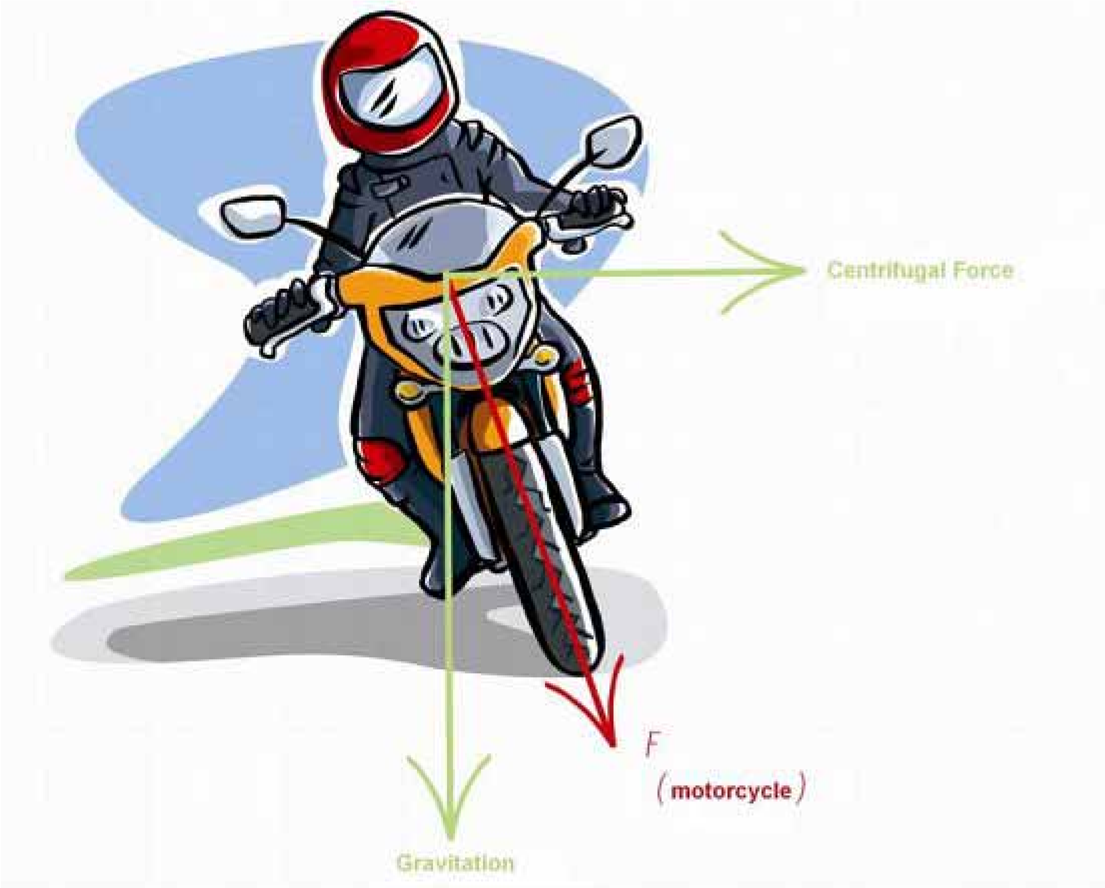
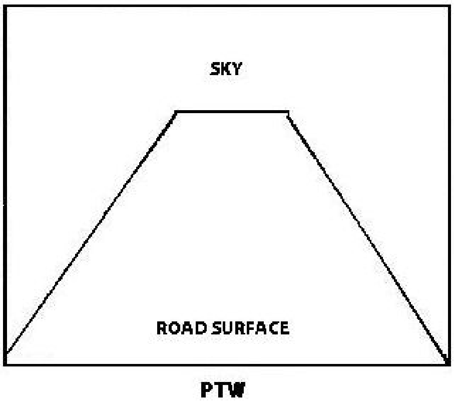


Figure 4.1 *Forces on a PTW [L.4].(source: BIVV, Aandacht voor motorrijders in de weginfrastructuur, 2005,)*

PTW's have a much greater need for a consistent and high coefficient of friction with the road surface than four-wheel vehicles. Especially on wet surfaces and in areas that require braking and steering. To negotiate a curve in the road motorcyclists lean over at an angle whose acuteness is related to speed and to radius of the curve – any change in grip of the tyres on the surface can destabilize the machine. Any deviation from a consistent surface can seriously impair the grip of the motorcycle on the road. A sudden change in surface level rapidly charges and discharges the shock absorbers, thus reducing the grip of the front wheel on the road surface. In other words: the wheel rebounds and may even lose contact with the surface. Unexpected changes in the road environment that call for rapid deceleration or braking in a curve may cause the PTW to 'sit- up' and break straight out of the bend.

Field of vision of the motorcyclist

The field of vision of the motorcyclist is different compared to that of a car driver. A car driver leans backwards whereas a motorcyclist usually leans forward, thus narrowing his field of vision (see the illustrations below). How much the field of vision will be narrowed depends on the position adopted by the motorcyclist. As speed increases, the field of vision of the motorcyclist becomes even more limited (figure 4.3), although this applies to car drivers as well. It is worth noting that the field of vision also depends on the shape of the crash helmet worn by the motorcyclist. Light open face helmets have almost no effect on the motorcyclist's field of vision. They perform even better compared to the view of the average car driver. On the other hand though, the predominant integral helmet limits a motorcyclist's field of vision considerably..



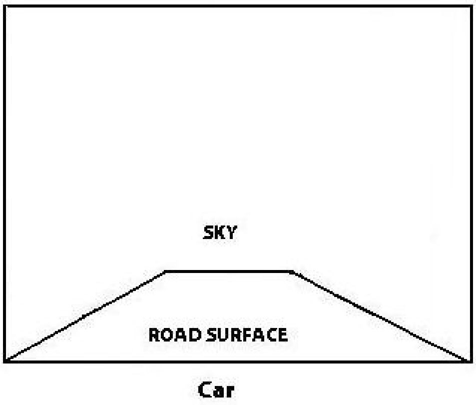


Figure 4.2 a Field of vision of a Motorcyclist   Figure 4.2 b Field of vision of a Car driver

Proportional visibility of sky and road surface (figure by DVT Consultants)

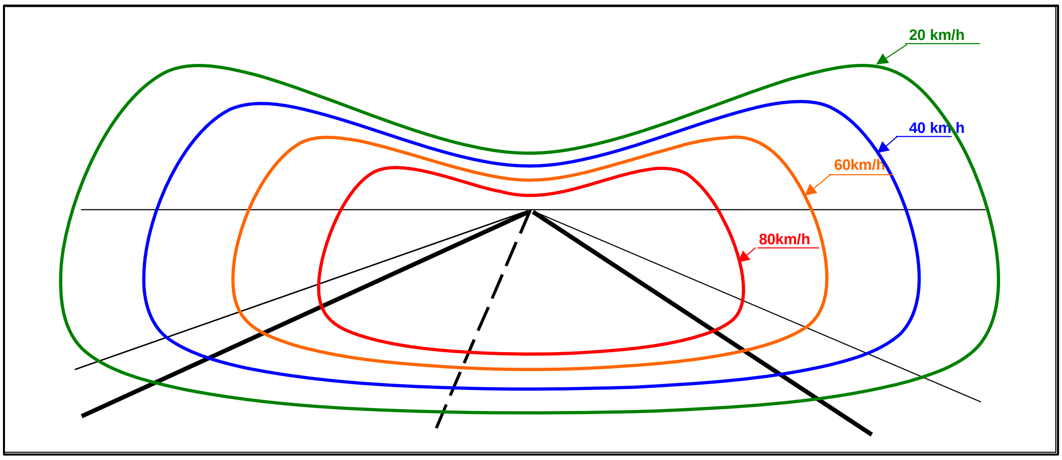


Figure 4.3   *Field of vision at varying speeds [L.16]. (source: V.Babkov and O.Andreev Road Design, 1986)*

Table 4.1 *Field of vision [L.16].*

Information perceived by the driver:	Distance to the point of driver's concentration			
	40 km/h	60 km/h	80 km/h	100 km/h
Maximum distance to estimate condition of the road surface	80 m	120 m	140 m	160 m
Reaction time	5.2 s	5.2 s	5.2 s	3.8 s
Average distance to estimate the condition of the road surface	25 m	45 m	55 m	60 m
Estimate of the speed of oncoming traffic	200 – 300 m	200 – 500 m	300 – 500	300 - 800
Estimate of general road conditions	200 - 100	500 – 1,000	1,000 - 1,500	1,000 – 1,500

4.3 Design vehicle

A design vehicle is a (partly imaginary) vehicle of which the characteristics are representative for the whole vehicle park or a part of it. Many roadways are designed for passenger cars or heavy freight traffic. Within this profile a PTW always fits. For bicycle paths the bicycle is the design vehicle, in spite of the fact that mopeds may or in some cases even must use the bicycle path (see figure 4.4).

Figure 4.4 a

Traffic sign 'path for bikers and mopeds' in the Netherlands (source: DTV Consultants)

Figure 4.5 a *A PTW or not? (source: Internet)* Figure 4.5 b *A PTW or not? (source: Internet)*

In the tables below (4.2 and further) dimensions and legal aspects of the recommended design of PTW vehicles are shown[L.1]. Standards of some European countries slightly differ, but in general the legal characteristics are identical. The dimensions for design are recommendations for each country.

The dimensions are obtained as follows:

— An inventory of the dimensions of a large number of vehicles is drawn up;
— The 85-percentile score is established, i.e. the number not exceeded by 85% of the vehicles.

Table 4.2 *Dimensions of the design vehicle [L.1 and MCIA|.*

Characteristics	**PTW cylinder capacity ≤ 50 cm^3 (mopeds /scooters)**	**PTW cylinder capacity 51 cm^3 < 250 cm^3 (scooter)**	**PTW cylinder capacity 250 cm^3 < 2295 cm^3 (motorcycle)**
Length	1850 mm	2240 mm	2530 mm
Width	685 mm	785 mm	995 mm
Weight	85 kg	210 kg	375 kg
Height	1140 mm	1440 mm	1410 mm
Seat	765 mm	785 mm	890 mm

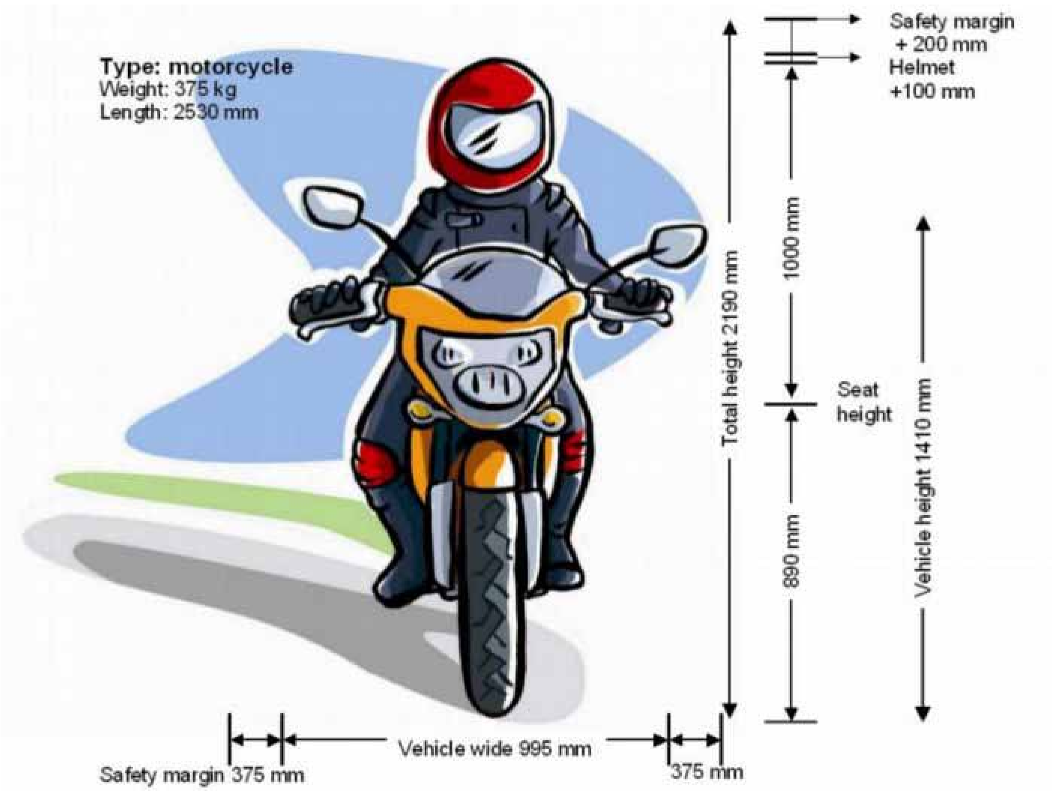


Figure 4.6 [L.4]

Dimensions of the design vehicle category Motorcycle. (source: DTV Consultants)

Table 4.3 *Characteristics of PTW's.*

Characteristics	**PTW cylinder capacity ≤ 50 cm^3**	**PTW cylinder capacity > 50 cm^3 <125 cm^3**	**PTW cylinder capacity > 125 cm^3**
Maximum construction speed	45 km/h (EU-25)	Over 45 km/h	
Legal maximum speed in residential area	45 km/h Except in NL: 30 km/h or 25 km/h	30/50/70 km/h Depending on road type versus legal maximum speed. Same as cars.	
Legal maximum speed outside residential area	45 km/h Except in NL: 40 km/h	60/70/80/100/120 km/h Depending on road type versus legal maximum speed. Same as cars.	
Usage in residential area	Mainly on roadway	On roadway	
Usage outside residential area	On roadway NL: On bicycle path BE: On bicycle path	On roadway	

5. ROAD DESIGN AND TRAFFIC ENGINEERING

Road designers and traffic engineers have to consider the specific needs of motorcyclists. As pointed out in chapter four PTW's have distinctive characteristics, which require specific provisions in road building.

Figure 5.1 a

Figure 5.1 b

Visibility of obstacles, for instance a narrowing of the road as in these pictures, is important, especially for PTW's. (source: H. Monderman, The Netherlands)

Figure 5.2 a *(source: A.J.Sharp IHIE)*

Figure 5.2 b *(source: Internet)*

A bumpy roadway is not only uncomfortable but is potentially dangerous to PTW's. The left picture shows that in the UK multiple signposts are a traffic hazard.

5.1 Bends

Curved roads are popular among leisure motorcyclists. This is most likely due to the fact that curves pose a challenge to the motorcyclist. The extra physical forces experienced appear to be exhilarating.

Manoeuvring a PTW is subject to different principles than driving a car. Centrifugal force drives the PTW to the outside of a curve. The motorcyclist compensates this force by leaning to the opposite side. In tackling a curve he takes a different line than drivers of other motor vehicles. He traverses the width of the lane for maximal grip through minimal steering. In case of gravel, dirt, oil etc. on the roadway grip may fail.

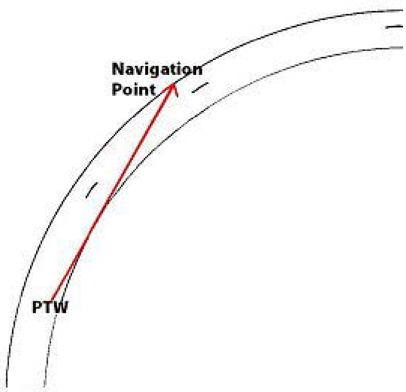
Figure 5.3 a Figure 5.3 b

Dirt on the roadway may cause motorcyclists to lose grip.(source: ITC, Bulgaria)

Even under favourable conditions many motorcyclists will encounter problems with grip on the roadway in case of forceful braking or making a turn. Forces that cause his motorcycle to maintain a straight course ahead counteract his directional changes.

For better navigation motorcyclists will look at a point on the horizon. Riding in a straight lane this point lies in the most distant part of the roadway the motorcyclist is capable of seeing. Exactly in the middle of his course. On a straight road the navigation-point is stable for a long time. Therefore on straight roads the motorcyclist can survey a large stretch of the roadway and can adjust his behaviour accordingly. In a curve the motorcyclist fixes his eyes along the line of the inner curve to a point on the horizon (see figure 5.4). Because of the curve and the changing position of the PTW in the curve the navigation point is constantly changing.

Therefore it is easier for the motorcyclist to survey a right hand turn. As stated above, the eyes of the motorcyclist are fixed on the inner curve. In right hand turns, the course of the PTW also lies in the inner curve. Therefore possible hazards as potholes or other unevenness lie in the field of vision of the motorcyclist. In left hand turns the eyes of the motorcyclist are also fixed on the inner curve. The course he follows, however, lies in the outer curve and therefore possible hazards do not appear immediately in his field of vision. The motorcyclist has to shift his eyes constantly from the inner curve to the path his PTW is following (See figure 5.5.).



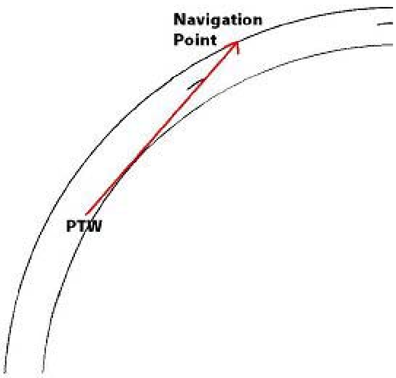
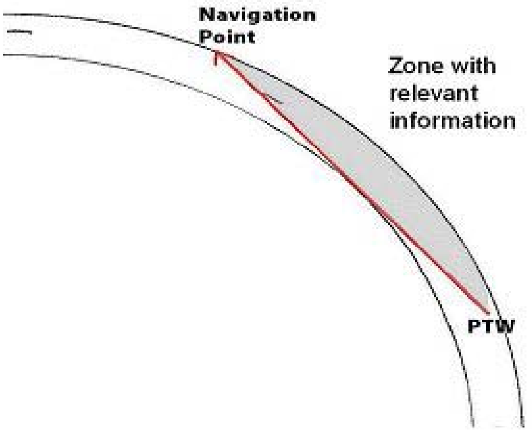


Figure 5.4 a Figure 5.4 b

The point of navigation is constantly changing. (figure by DTV Consultant)



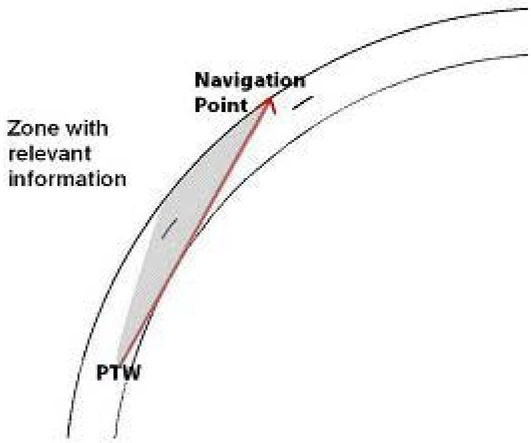


Figure 5.5 a

Figure 5.5 b

To receive correct information In curves to the left the PTW motorcyclist has to move his eyes more than in curves to the right. (figure by DTV Consultant)

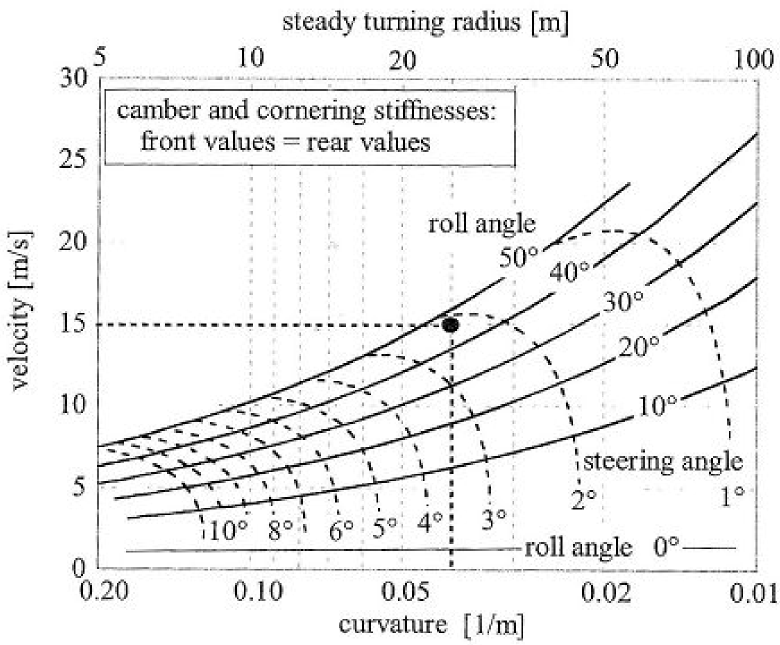


Figure 5.6 *Roll and steering angles as function of velocity and curvature [L.19]. (source: V. Cossalter, Motorcycle Dynamiscs, 2002)*

A greater angle of lean is necessary when radius of the curve is smaller (i.e. tight curve) and the speed is higher (to counter centrifugal force). Figure 5.7 can be used to calculate the needed curvature and length of the steady turning radius at different speeds.

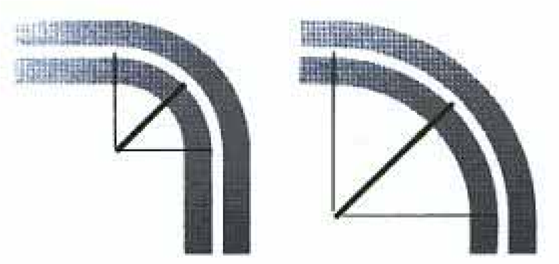


Figure 5.7 *(l) a small radius of a curve: 100 m and (r) a wider and safer radius: 200 m. [L.9] (source: http://www.fema.ridersrights.org)*

There is a specific danger when the radius of the curve is not constant, especially with a decreasing radius. When the radius of the curve is not constant and is decreasing during the course of the curve, it requires a change of path and speed for the motorcyclist. The motorcyclist can only see a small part of the curve (see figure 5.8) and may not be able to adapt his behaviour in time. Changing the path or speed in the middle of a turn is a hazardous manoeuvre for a leaning motorcyclist. A sudden change in speed can cause loss of surface grip between tyres and roadway, causing the PTW to slip away. [L.9 and L.14]

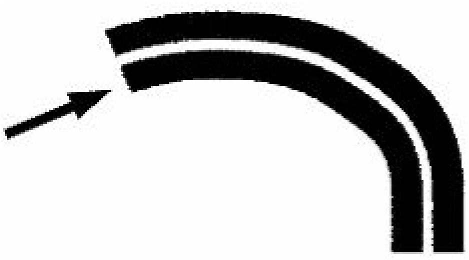


Figure 5.8 a

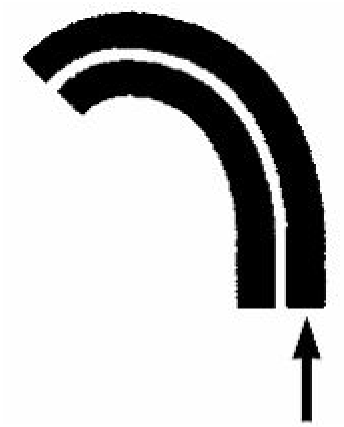


Figure 5.8 b

(l) Radius of the curve is not constant (r) the curve has a decreasing radius [L.9].
(source: http://www.fema.ridersrights.org)

Figure 5.9 a *(source: A.J.Sharp IHIE)*

Unpredictable bends are a hazard to the motorcyclist.

Figure 5.9 b *(source: A.J.Sharp IHIE)*

This bend has been fitted with marked posts to make it more predictable.

Accident contributing factors in a curve are according to statistics:

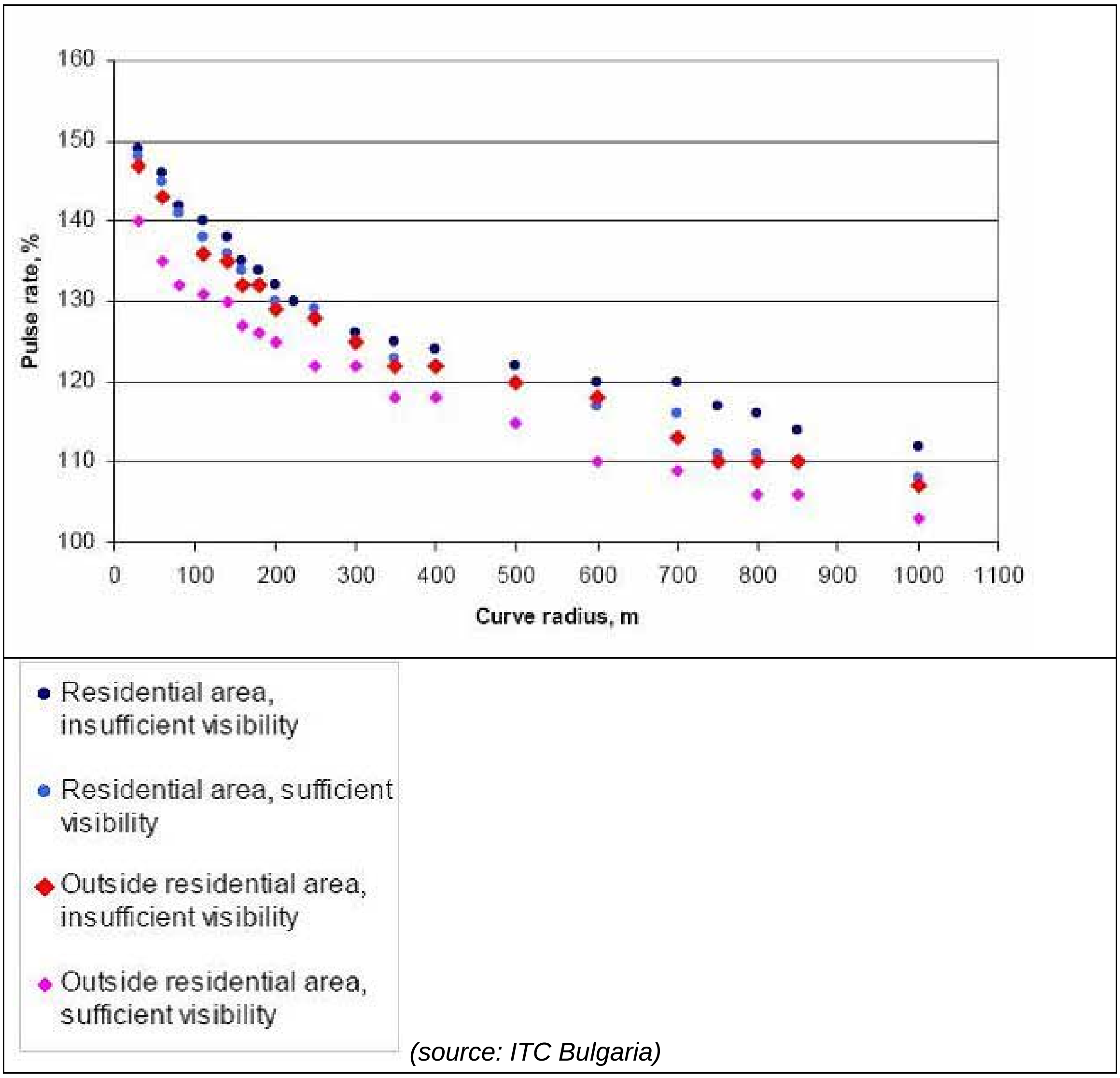
- The difference between the approach speed and the speed in the curve.
- A reduction of the curve radius.
- The predictability of the curve.
- The visibility of the curve.
- The length of the curve.

[L.4]

Motorcyclists develop different strategies for cornering manoeuvres depending on the type of corner and road conditions encountered. Clearly, a poorly maintained corner, or one with debris, diesel spillage etc, creates significant hazards for motorcyclists.

Because of the difficulties with balance in turns the motorcyclist really needs to be able to predict bends in the road, road grip and the direction of the road ahead. For example, when the road unexpectedly changes direction a motorcyclist can be mislead into choosing too high a speed when entering the turn.

Table 5.1 *Relation between the curve radius and the pulse rate of the motorcyclist.*



(source: ITC Bulgaria)

Predictable geometry in road building
A predictable curvature will normally not represent major problems or particular risk to motorcyclists [L.2]

Improve visibility
Good forward visibility allows for timely detection of hazards and accordingly planning the riding. Visibility can be improved by the elimination of excessive vegetation, signs etc that impair forward visibility. [L.2]

Use of indication signs in sharp curves
The motorcyclist can anticipate curves more easily when adequate signs are being used. Rationalization in the use of traffic signs is essential. The need for signs in a curve mainly depends on the difference in speed while approaching the curve and the speed in the curve itself. It should be noted that the positioning of the signs could be a hazard in itself to motorcyclists.

Avoid any obstacle whatsoever in the outer curve
Obstacles that may aggravate the severity of injuries to a motorcyclist in case of a crash, such as sign posts, lighting poles or guard rails, should be avoided in places with a high accident potential. In case the installation of obstacles is imperative, e.g. guard rails on mountain roads, they should be positioned at a maximum distance from the edge of the road. Safety barrier use and obstacle-free space are discussed in a separate paragraph.

Design of safe curves with constant radius
It is important to design the curve with:
- A wide radius;
- A constant radius.

5.2 Intersections

The MAIDS study shows that half of all PTW accidents occur at an intersection. Poor visibility is an important contributing factor in PTW accidents on intersections. A PTW has a relatively small frontal area compared to other vehicles. Because of this other road users may easily overlook it even when using low beam headlights. A small frontal area of an oncoming vehicle often causes miscalculation in the estimated time of approach. This is due to the fact that the human brain estimates the speed by the difference in expansion rate. At a given distance the expansion rate for small obstacles is lower than for large ones.

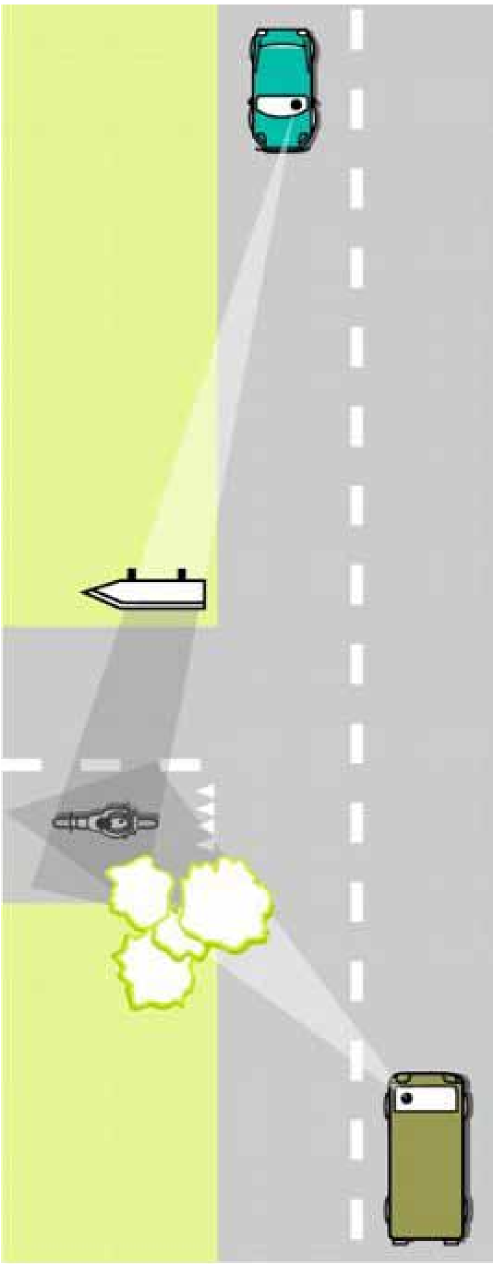


Figure 5.10 a [L4] *(source: BIVV, 2005)*

Figure 5.10 b [L4] *(source: BIVV, 2005)*

Figure 5.10 c (source: ITC Bulgaria)

Visibility of PTW's on intersections

The fact that the eye level of a motorcyclist is higher than that of a car driver should always be taken into account. The optimal sight line of a motorcyclist is different from the car driver's. That is why the motorcyclist often sees a car approaching an intersection before the driver of that vehicle can see him. This may give the motorcyclist a false sense of having been seen. Because of the fact that most roads are designed for four-wheel vehicles, there are certain obstacles that reduce the visibility of the road ahead for motorcyclists. For instance an underpass may conceal a traffic light further ahead on the road (figure 5.11).

Figure 5.11

An underpass may conceal elements on the road ahead (source: L1: CROW 2003, Handboek gemotoriseerde tweewielers)

Buildings or trees may also obstruct the line of sight of the motorcyclist, or conceal the PTW altogether from the driver of an oncoming vehicle. Sharp turns and vertical alignment (higher and lower points in the roadway) also decrease the line of sight. These obstructions may cause drivers to see each other too late. It is important for all road users to prevent obstruction of their range of vision.

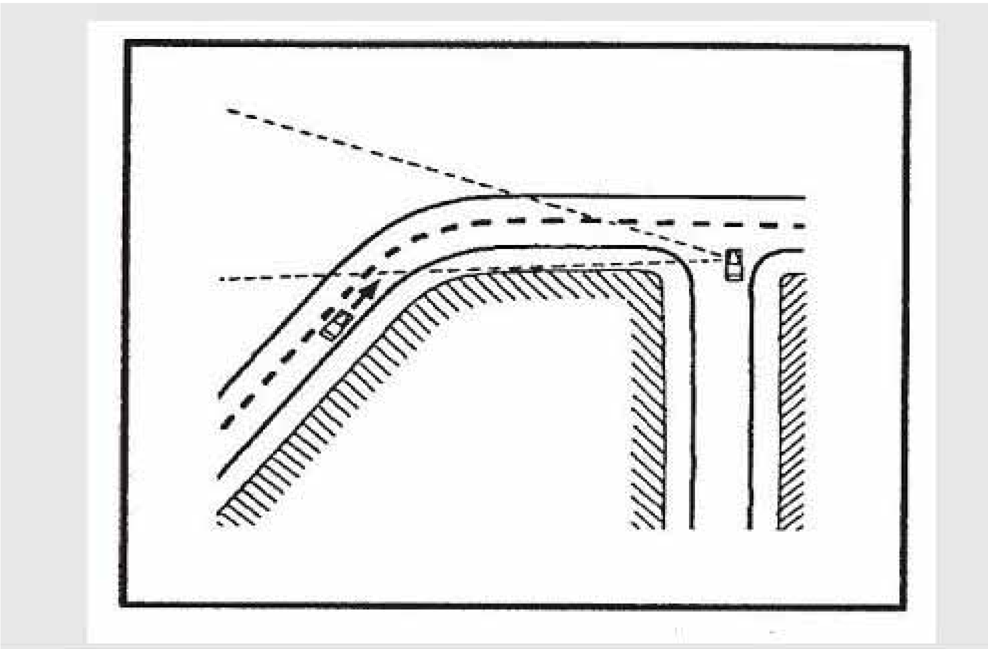


Figure 5.12 *Loss of sight because of a sharp bend at a short distance from the intersection. (source: IFZ, Motorradfreundlicher strassenbau, 2003)*

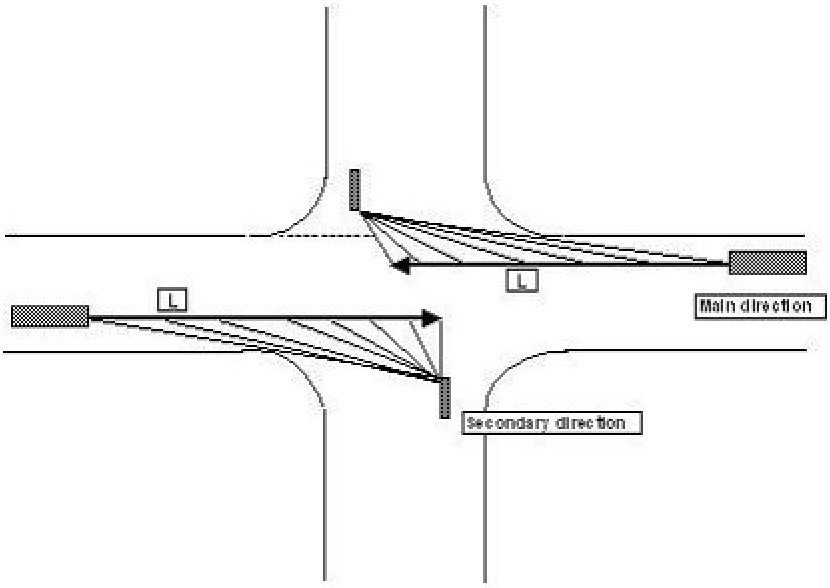


Figure 5.13 *Visibility on intersections. (source: ITC Bulgaria)*

A right turning lane often runs parallel to the through lane. Due to this design large vehicles in the turning lane may hide a PTW in the through lane. A driver on the side-road may not see the PTW and consequently drive onto the main road in the belief that all is clear.

Figure 5.14 *A large vehicle in the turning lane may hide a PTW in the through lane. (source: Norway Public Road Administration, MC Safety, Design and Operation of Roads and Traffic Systems, April 2004)*

At intersections with traffic lights PTW's and bicycles are not always detected by induction loops so the lights do not react. Motorcyclists may become impatient and decide to ignore the red light. This is not only illegal but also highly dangerous. Managers of this type of traffic signs should ensure that the equipment detects PTW's.

Sight zones must be free of obstacles

The comparative smallness of a PTW requires barriers, vegetation and road signs to be placed in such a manner that they do not hide motorcycles, not even partly, from view. It is a known fact that PTW motorcyclists often notice other vehicles before their drivers observe the PTW. The design of intersections should offer a complete view of a PTW in the entire sight zone. And on the other hand it ought to enable a PTW rider to get a complete view of the intersection as well, taking into account the higher eye level of a motorcyclist. [L.2]

Uncontrolled right turn lanes at junctions

Right turn lanes at junctions should be avoided. It should be considered to remove the right lane (at low turning volume) or to install traffic lights (at high turning volumes). In the United Kingdom the situation is reversed and therefore left turning lanes at junctions should be avoided.

PTW sensitive detectors at intersections with traffic actuated signal control

PTW sensitive detectors may prevent motorcyclists from becoming impatient and ignoring a red traffic light.

5.3 Roundabouts

Roundabouts generally have a low accident rate for most types of vehicles. However, PTW's score relatively high in accidents on roundabouts. Moreover they encounter specific problems. A too high entry angle may lead to excessive speed on approach and thus result in tail end collisions. A too low entry angle, however, will hide a PTW from the view of drivers of other vehicles. Central pillars on a roundabout may obscure it. The general issues discussed in the paragraph on intersection are also valid for roundabouts.

Entry angles between 30º and 40º

An entry angle between 30º and 40º tends to take the edge off potential problems as high speed or bad visibility of the PTW. [L.3]

Figure 5.15

A sharp entry angle may hide the PTW from the sight of other vehicles. (source: Keith Sharples Photography, UK)

Figure 5.16 a Figure 5.16 b

Materials applied on a roundabout should be PTW-safe. Using different types of pavement is not desirable; neither is the use of (uneven) clinkers. (source: IBZH, the Netherlands)

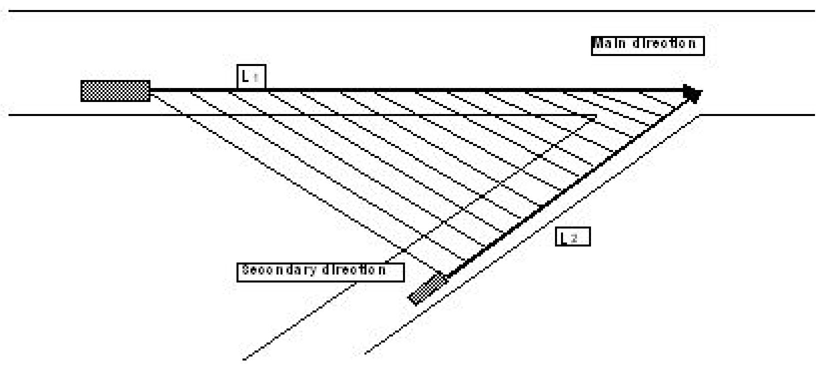


Figure 5.17 *Visibility on roundabouts [L18], (source I.Trifonov, Handbook for road intersections and interchanges design)*

Table 5.2 *Visibility on roundabouts [L.18]*

Design speed secondary direction in km/h	**L_2 (m)**	**Design speed main direction, km/h**	**L_1 (m)**
50	60	50	100
		65	135
65	85	65	170
		80	175
80	100	80	175
		95	200
95	145	95	225
		110	265
110	180	110	275

5.4 Obstacles alongside the road

Roadside and roadside safety constructions are mainly designed by using the motorcar as design vehicle. A PTW, however, requires another approach. The MAIDS study shows that the fourth most likely obstacle to be struck was a ‘fixed obstacle’ such as barriers, signs and trees.

The vulnerability of the motorcyclist often leads to major injuries or even fatal accidents because of the presence of obstacles alongside the road. In table 5.3 a standard is given for the dimensions of an obstacle-free zone.

Table 5.3 *Suggested standards for the obstacle-free zone [L.7].*

Speed (V)(km/h)	Obstacle-free zone (m) Measured from the inside of the edge marking
V= 120	13,00
V= 90 or 90 < V <120	10,00
60 < V < 90	6,00
V = 60 or V< 60	4,00

Figure 5.18 *(source: H.Monderman, NL)*

The warning sign on the outer curve indicating a deviation to the left may present a hazard to a PTW.

Figure 5.19 a *(source: H.Monderman, NL)* Figure 5.19 b *(source: DTV Consultant, NL)*

Road (design) with obstacles alongside the road.

Figure 5.20 a *(source: H.Monderman, NL)* Figure 5.20 b *(source: ITC, Bulgaria)*

Natural elements alongside the road can also be a hazard for the motorcyclist.

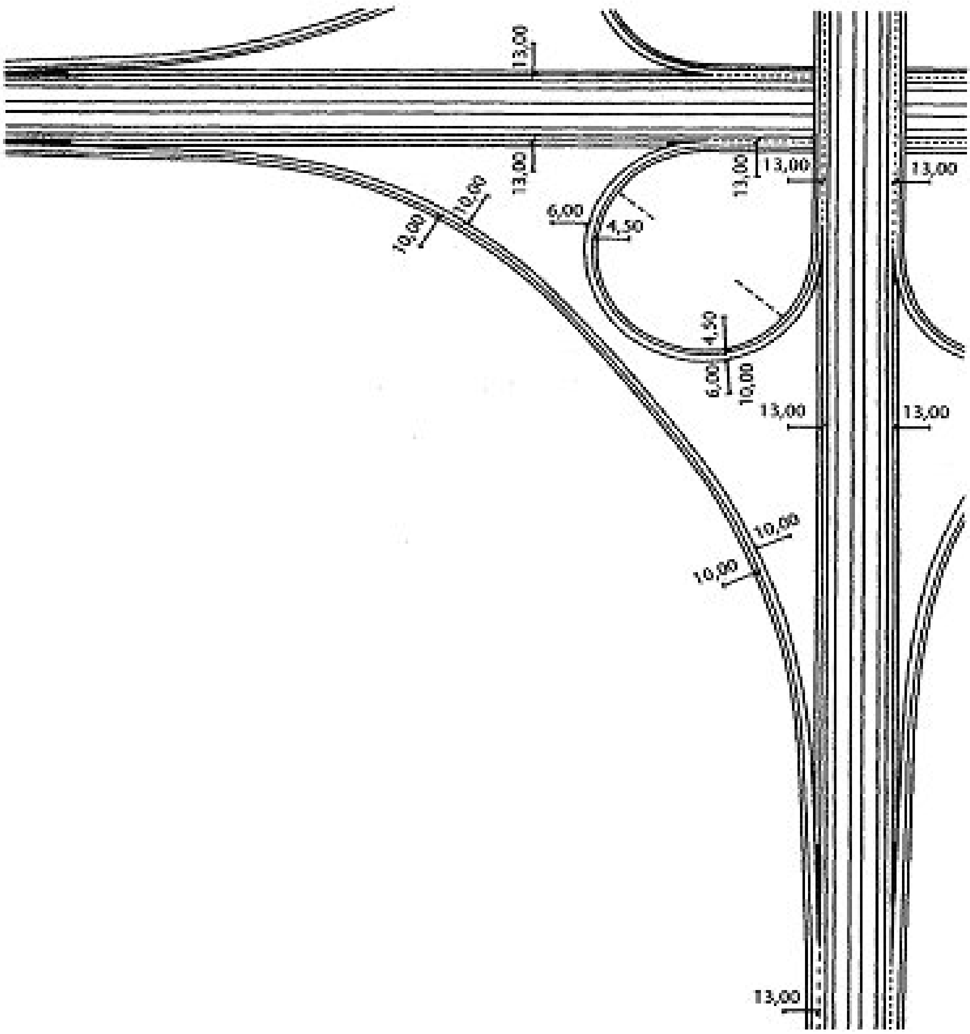


Figure 5.21 *Dimensions of the obstacle-free zone on highways.[L1]. (source: L1: CROW 2003, Handboek gemotoriseerde tweewielers)*

Roadside barriers

Roadside safety barriers are constructed mainly to protect car occupants and to prevent a car from crashing into other vehicles (physical separation of the lanes). Roadside barriers are not constructed with PTW's in mind, however. They provide relatively little protection for motorcyclists. Research in Australia has shown that when a motorcyclist loses command of his machine the probability of him getting killed doubles in case of crashing into a safety barrier system. Injuries were less severe from an impact with the beam or the face of a concrete safety barrier system than those sustained by colliding with the posts of the roadside barrier [L.5]. Falling motorcyclists while skidding along the road surface are most likely to be at risk of added injury inflicted by unprotected barrier support posts and parts jutting out or by sliding underneath barriers. A detailed study of 418 PTW's accidents involving road safety barriers by Brailly in 1998 [L.10] shows:

- in PTW accidents involving road barriers the risk of a fatal outcome is five times greater than the national rate for all PTW accidents;
- they account for 8% of all PTW fatalities;
- they account for 13% of all traffic fatalities.

Therefore the general principle of a PTW friendly safety barrier is to protect a fallen motorcyclist from crashing into support posts.

Figure 5.22 a

Example of hazardous barrier in the middle of an intersection. (source: H.Monderman, NL)

Figure 5.22 b

Example of a cable barrier. (source: http://www.fema.ridersrights.org)

Motorcyclists often express their concern about the perceived dangers of "wire rope safety fences" (WRSF) or "cable barriers". Lobbying by PTW organizations launched protests against the use of these devices. Sometimes the use of cable barriers is prohibited on specific locations. However, limited research done so far does not warrant the conclusion that cable barriers are more hazardous than other types of barrier. There is a general agreement that more research is required on the effects of different types of fence on falling motorcyclists. This also applies tot the posts that are common to all designs. They inflict the most serious injuries to motorcyclists crashing into a safety fence.

Although in the 1980's considered as very safe for cars, the so-called 'New Jersey' concrete roadside barriers are not suitable for the motorcyclist because of their circular profile. Even more so if the roadside is not maintained properly as illustrated in figure 5.23 a. Just imagine what the impact of the stones will be if somebody hits them.

It should be pointed out that safety levels of barriers differ in Europe. Some countries, like France, already use PTW-friendly roadside barriers.

Figure 5.23 a Figure 5.23 b

Examples of New Jersey roadside barrier. (source: ITC, Bulgaria)

Figure 5.24 a Figure 5.24 b

Example of PTW-friendly safety barrier. Motorcyclists are protected from the support posts. (source: Internet)

Design of an obstacle-free zone
The vulnerability of the motorcyclist asks for the design of an obstacle-free zone next to the road. It is essential to minimize the number of obstacles especially in high speed bends. The supports should not have jagged or sharp edges, nor have any protrusions that might hurt a fallen motorcyclist. On highways the path of the motorcyclist leaning into bends must be considered; a factor that is of no concern to four-wheeled vehicles. The dimension of the obstacle-free zone is related to the design speed of the road. Dimensions of the obstacle-free zone vary in individual countries. In France for instance the obstacle-free zone is 4 meters for newly constructed roads [L.4]. In the table a suggestion is given for the dimensions of the zone.

Avoid erecting road safety barriers if alternative measures suffice
Removing hazardous obstacles often provides greater safety to road users than a safety rail.

Place safety barrier away from the edge of the roadway
Placing a safety barrier is a matter of careful consideration. A motorcyclist who topples overs or falls off his PTW will normally continue in the direction of travel. The PTW seldom ends up far from the edge of the road; therefore it is important to keep the first few meters from the edge free of fixed obstacles.

Use of PTW-safe road safety barrier systems
The use of a PTW-friendly safety barrier system should be considered in places, for example in bends, where motorcyclists will be most at risk. The general principle of a PTW-friendly safety barrier is to protect the fallen motorcyclist from jutting support posts. These PTW-friendly safety systems may be newly installed or fitted on existing barriers. Other possibilities are using round posts instead of those with sharp edges or using crash barrier protection. [L.1, L.2]

5.5 Elements on or in the roadway

As explained in chapter 4, PTW's have a much greater need for a consistent and high coefficient of friction between tyre and road surface than four-wheel vehicles. Especially in areas requiring braking and steering any change in grip between tyres and surface can destabilize the machine. A sudden change in surface level rapidly loads and unloads suspension, thus reducing the grip between front wheel and road surface.

For safety reasons the speed of motorized vehicles in urban areas the must be slowed down. Therefore speed inhibitors such as speed bumps or other vertical elements are often placed on the roadway, The picture below shows an example of a speed inhibitor which is hazardous to a PTW. The red bicycle path is exclusively for cyclists so the motorcyclist cannot legally avoid the speed inhibitor by driving past it. It may be said that there is a conflict of interest between the motorcyclist and the residents of the area. The residents find it important to keep speed down. Unfortunately this is difficult to achieve without speed bumps or frequent control by the police.

Figure 5.25 a *(source: DTV Consultants, NL)*   Figure 5.25 b *(source: C. Carey-Clinch, MCI)*

The speed inhibitors in the pictures form a potential hazard for the motorcyclist because of the loss of grip on the surface.

Sometimes there is an urgent need for installing a speed bump, because safety of the public prevails. If this is the case the use of bumps with a predictable effect is recommended, like the ones used in the Netherlands (see figure 5.26). When a motorcyclist rides over it he must slow down just like all other road users. But he can pass it quite safely. So both motorcyclist and other road users (car driver, bicyclist, pedestrian) profit from it.

Figure 5.26 a   Figure 5.26 b

The speed inhibitors in the pictures form a small change in vertical alignment while maintaining their surface grip. Therefore these inhibitors are safe for the motorcyclist.(source: DTV Consultants, the NL)

Not only speed bumps but also other instances of unevenness in the surface of the roadway can destabilize a PTW. E.g. prominent road markings and drain covers. Faulty drainage has a much more negative impact on the PTW than on a car. Drainage should be taken into consideration in the design phase, as defects are difficult to repair in a later stage.

Figure 5.28 b (source: A.J.Sharp, IHIE)

Figure 5.28 a *(source: ITC Bulgaria)*

Hazardous situations in a rural area: a wide gap alongside the road (5.28 a) and the thickness of the road markings (5.28 b).

Figure 5.29 a

Figure 5.29 a

Acceptable situation in an urban area. The vertical alignment changes smoothly and the maximum speed in the area is low. (source: Bart Winkel, DTV Consultants, NL)

Figure 5.30 a

Figure 5.30 b

The use of these speed inhibitors can be hazardous to the motorcyclist. The bumps appear rather unexpectedly and give the road rugged surface. (source: ITC, Bulgaria)

Figure 5.31 a *(source: ITC, Bulgaria)*

Figure 5.31 b *(source: ITC, Bulgaria)*

Drains (covers) can be a problem for PTW's, because of the loss of surface grip.

Apply PTW-friendly solutions

If speed bumps are to be installed for the safety of vulnerable road users or the occupants of the houses along the road it is advisable to install bumps with a predictable impact.

Try to find other measures to reduce speed

For the motorcyclist a variety of elements on the roadway surface may be hazardous, because of the difference in friction between tyres and these materials and the problem of braking and steering at the same time. Instead of the usual speed bumps a search for other ways to reduce speed may solve this problem. Slowing down traffic should always be designed with the motorcyclist in mind.

Carefully consider the location of drainage covers or other items that are placed in the road. Especially in bends and areas that involve much braking or steering steps should be taken to ensure that motorcyclists can avoid riding over these surfaces

Figure 5.32 a

Figure 5.32 b

The use of different colours is another way of indicating speed limits. (source: Monderman, NL)

5.6 Building / material usage

Surface grip and consistency

As explained before it is important for PTW's to have a good and constant surface grip. Therefore consideration needs to be given to surface skid resistance of road surfaces, including surfaces of a different colour. This is especially important in bends, since the motorcyclist needs to vary his position across the lane for both maximum safety and forward visibility. Special attention must be given to surface grip and consistency in places where tram rails are imbedded in the roadway. Because of varying surface levels this situation is not ideal for PTW's.

Figure 5.33 a

Figure 5.33 b

Road condition should warrant the safety of all road users. Potholes and differently coloured surfaces may cause a loss of grip. (source: Craig Carey-Clinch, MCI, UK)

6. ROAD MAINTENANCE

It is clear that policy changes and innovative design can make a big difference to PTW's safety and its promotion as an alternative mode of travelling. The degree of maintenance, however, is critical to this. Sufficient maintenance ensures:

— a consistent road surface with proper skid-resistance;
— that the roads are kept clear of refuse and rubbish;
— that visibility is maintained, especially at curves and junctions;
— that the road-signs, studs and markings are maintained.
— that roadway defects are noticed and repaired quickly.

6.1 Maintenance aspects

Figure 6.1 a *(source: ITC, Bulgaria)* Figure 6.1 b *(IBZH, NL)*

Timely replacement of broken-down road signs etc..

Roadway cleaning

Due to their operational characteristics, PTW's are sensitive to dirt or debris on the roadway, especially at points where braking or steering is necessary. Diesel fuel spilled from vehicles will make the roadway slippery. This problem is specifically manifest in curves and on intersections near gas stations and goods distribution depots where fuel may be spilled from full tanks. Each year it appears that several PTW accidents could have been avoided by better cleaning.

> Consider the role that future level of maintenance of the infrastructure is likely going to have in continuous safety. Avoid features in design that require higher levels of maintenance than the road realistically is going to receive. These might even lead to future safety problems. [L.3]

Road work

The (re)construction of a road may pose significant problems, especially when the road remains open for traffic. Some of them create particular problems for PTW's and the consequences of an accident will most likely be more serious for a PTW rider than for a well-protected car occupant. The following should taken into account:

— Dirt and clay may be dragged onto the road open to traffic while being reconstructed. In wet weather conditions the road may become so slippery that motorcyclists will encounter serious problems.

- Transition to a gravel surface or spilled gravel on the asphalt might also cause the motorcyclist to lose control.
- Tools and equipment on the road may represent a collision hazard for all road users, especially PTW's.
- Insufficient signing, road marking, illumination and reflection increase the risk of accidents.

Signing especially for PTW's should be appropriate. In some cases a supplementary sign displaying a motorcycle symbol may be used.

Maintenance

Pavement damage can greatly influence a motorcyclist's command of his PTW. Situations may arise where the motorcyclist is incapable of handling, especially in a bend of the roadway. Badly executed patching of potholes and cracks in asphalt pavement results in a greater accident risk (see chapter 3).

Figure 6.2 a

Figure 6.2 b

Example of insufficient road maintenance. (source: Harry Beugelink, NL)

Figure 6.3 a Figure 6.3 b

Potholes in the road are a problem for PTW's because of loss of surface grip. (ICT, Bulgaria)

6.2 Maintenance the responsibility of the road authority

Road maintenance should never be considered a way of balancing the budget or as something to be overlooked by road authority. In many cases the road authority will be responsible for all the damage and costs caused by deficiencies of the roadway. In Poland, for instance, because of extreme weather conditions streets are cleaned relatively often, even during dry periods. Road repair teams are required to keep the roadway clear under penalty of a stiff fine. This ordinance is strongly enforced by the municipal police.

Road design and maintenance are quite different in various European countries. Each road authority may have its own policy and ideas. First of all, in many cases it is the road authority that is legally responsible. In the Netherlands, for instance, this responsibility is considered a civil right. In case of an accident because of neglect of maintenance individuals can sue the authorities for the expense evolving from injuries and damage. The burden of proof rests with the road authorities.
This applies not only to faulty road design, but also to insufficient measures during construction activities and to insufficient road maintenance.
A good practice may be to introduce facilities for road users to report deficiencies directly to the responsible road authority (see figure 6.4). This can shorten the period between the problem first cropping up and it being resolved.

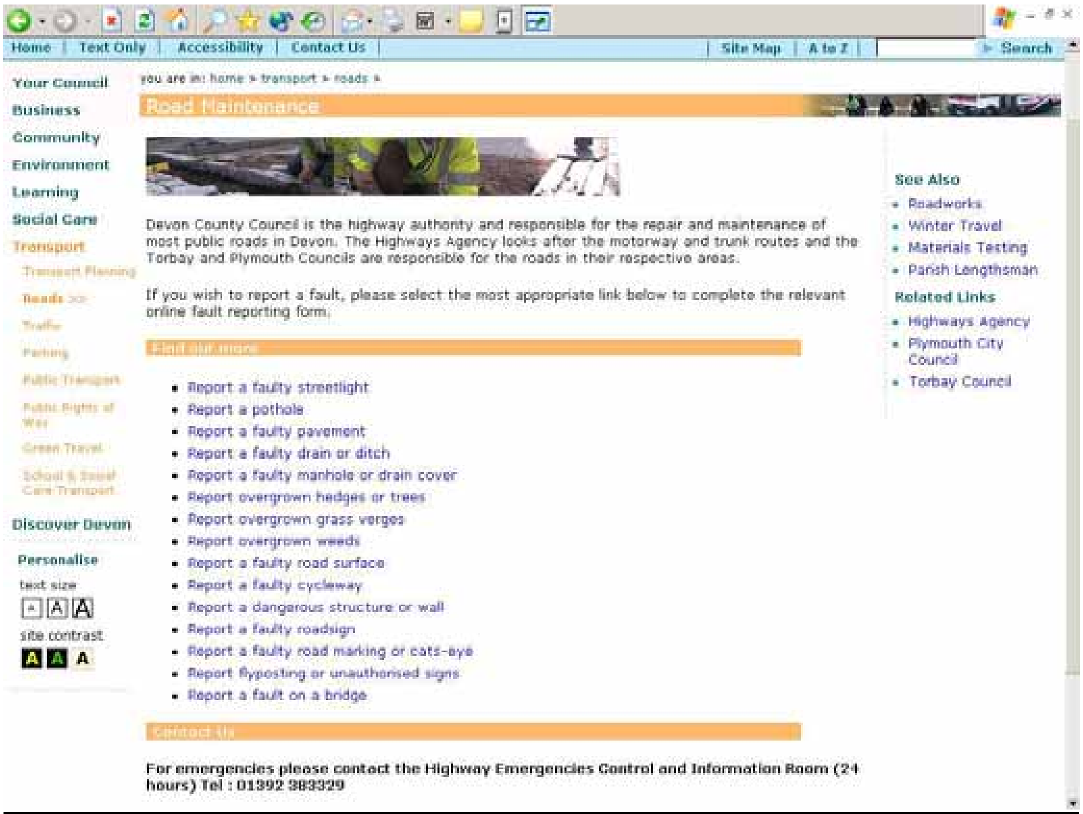


Figure 6.4 *An example of a form for reporting road deficiencies in the UK. (source: www.devon.gov.uk)*

The Dutch bicycle association has set up a reporting facility for its members. The association acts as intermediary between cyclists and all road authorities. This initiative has not only resulted in a spate of complaints, but it has also lead to improvement and expansion of road infrastructure for this target group.

Figure 6.5 *An example of a reporting facility for road deficiencies in The Netherlands. (source: www.fietsersbond.nl)*

7. TRAFFIC MANAGEMENT

7.1 Signs

The purpose of signage is mainly to give road users the information they need to arrive safely at their destination. The consequences of not getting this information can sometimes be very serious. There is a general problem that signs are not always seen by road-users. This may be caused by:

— too many signs at one location so the road user is not able to comprehend them all at once.
— signs are considered to be of no interest to the road user.
— signs are in poor condition.
— signs are placed so that they are hardly visible .

No signage at all may also be the problem. E.g. a motorcyclist does not receive information needed to adapt his speed when approaching a critical point. At some locations it is also a problem that signs hamper visibility and take attention away from traffic. Another problem is that signs are often positioned in the obstacle-free zone alongside the road. There is a clear conflict between good signing and safe zones alongside the road. (For information about obstacle-free zones see chapter 5)

Use consistent signing along a route so that the motorcyclist's expectation is met
Where possible the concept of the 'self explaining road' should be adopted. In particular the level of signing and marking should be proportional to the degree of potential hazard and consistent along the whole road. If road conditions may be deceptive warnings are required. A tightening radius or a horizontal deviation immediately over a crest are examples where advanced warning is appropriate.

Consider the placement of signs in relation to the obstacle-free zone
Especially on hazardous locations one should consider the placement of signs carefully in relation to the desired obstacle-free zone.

Use separate supplementary signs for PTW's
Where conditions are particularly difficult for PTW's, supplementary signs with special auxiliary signs with PTW symbols may be used. The motorcyclists probably notice these signs more easily. Of course, signing is no substitute for removing potential PTW hazards.

Figure 7.1 a

Figure 7.1 b

Part of the roadway is raised and therefore dangerous for a PTW. A specific sign warns the motorcyclist. (source: IBZH, NL)

Figure 7.2 a

Figure 7.2 b

Signs specific for PTW. (source: Craig Carey-Clinch, MCI, UK)

7.2 Road markings

Road markings rarely have the same skid resistance properties as the surrounding road surface. Arrows and destination markings in bends or roundabouts are of special concern to motorcyclists as the PTW may be leaning over or may be accelerating or braking. Therefore, the use of road markings needs careful consideration. Used inappropriately they can force motorcyclists off the safest line, or, if poorly designed or laid they may collect and divert water, adding to the loss of consistent grip.

The reduction in skid resistance over the years or in wet conditions causes problems for PTW's. Direction arrows and destination markings are of particular concern. Often they are used in bends whereas - if needed at al - they had better be placed in an advanced position on a straight section of the road.

A relatively small unevenness of 5 mm can cause stability problems. All countries have different legislation about acceptable unevenness. For example, UK regulations allow up to 6mm difference. Recommended are the following layer thicknesses: [L.6]

Table 7.1 Recommended layer thickness [L.6]

Types of layers	**thickness**
Road paint	0,35 mm
Thermo- plastic	3,0 or 1,5 mm
Prefab markings	0,5 to 3,0 mm
Road surface reflector	20 mm

When road markings need maintenance or are not needed any more because of a changed situation, it is best to remove the old marking and, if necessary, resurface it with a new layer of roadway. Road markings are likely to be re-laid on maintenance schedules, leading to layering and a significant build-up in relation to the surrounding surface. For PTW's the best solution is the removal of unnecessary road marking. Repainting may be a good alternative if correctly carried out. It is important to sprinkle sufficient grit after the marking is repainted. Research has shown that the amount of grit must be at least 200 gram/m^2. [L.6]

Use consistent and informative advance warning
Consistent and informative advance warning and direction signs should minimize the need for surface signing. Careful thought should be given to the effects before using large areas of hatching.

Remove old markings, prevent layering

7.3 Bus lanes and advanced stop lines

In busy urban areas there is a competition for road space among different groups of road users. Many traffic management measures involve giving priority to one group in particular areas or at particular times of the day. These measures are mainly focused on buses or taxis (bus/taxi lane). However, it may be good policy to allow PTW's into bus lanes and advanced stop lines at intersections.
Advanced stop lines are applied increasingly at intersections to provide a safer place for cyclists to wait for the green light. Local government could be persuaded to allow PTW's to also use these advanced stop lines.

Both measures improve the safety of PTW's, whereas there appears to be little or no disadvantage for other road users. Depending on local legislation authorities should look into this possibility. [L.13]

Figure 7.3 a

Figure 7.3 b

Use of bus lane by motorcyclists. (source: Craig Carey-Clinch, MCI, UK)

Figure 7.4 a

Figure 7.4 b

Advanced stop lines for PTW. (source: Ian Mutch, UK)

Legislation restrictions on filtering can limit the use of advanced stop lines. It is recommended to study the possibilities and limitations in advance before actually implementing these lines.

Detection of PTW's

PTW's are not always seen by the detection systems of (older) traffic lights. New technology in detection still have problems seeing a PTW due to its small profile.

Figure 7.5 *Are PTW's visible to a detection system? (source: CD-ROM Benutten Rijkswaterstaat, NL)*

8. PARKING ISSUES

Parking provision is an important tool in local transportation policies as well as in traffic management and crime reduction. It is also a fundamental requirement for any PTW user. PTW parking can be provided on- or off-street in surface parking or multi-storey parking. Special parking spaces for PTW's should decrease the number of illegally or antisocially parked PTW's.

Figure 8.1 a

Figure 8.1 b

Figure 8.1 c

Inappropriately or illegally parked PTW's. (source: Craig Carey-Clinch, MCI, UK)

8.1 PTW Parking Behaviour and Requirements

In terms of convenience, flexibility and security PTW's resemble bicycles rather than cars. Consequently the behaviour and requirements of motorcyclists often follow the bicycle parking model. Parking facilities for PTW's have similar features.

Motorcyclists will look for obvious parking opportunities **close to their destination**. A distance of 20 metres is desirable and facilities more than 50 metres from the destination will compete with unofficial opportunities closer at hand [L.3]. Good locations for parking places are in the immediacy of public transportation, Park&Ride facilities, city centres and other attractive places.

Covered off-street parking is desirable. This offers protection from the elements and other causes of inconvenience or damage to parked PTW's. Clearly signed, convenient and secure parking facilities reduce the attraction of informal parking. Marginal areas, especially those already utilized by motorcyclists can be formalized by relatively low-cost measures to protect the parked machines and other road users. [L.3]

Motorcycles do not have large cargo holds that can be secured, so motorcyclists appreciate the provision of secure places for expensive riding equipment such as protective helmets and clothing. [L.3]

Motorcyclists have less opportunity to carry food or drink so access to litter bins and vending machines is also worth considering. [L.3]

Motorcycle parking in multi-storey car parks is best provided as a specifically assigned area within sight of attendants, ideally on the ground floor at or near the entrance/exit in order to avoid ramps and circulation areas. [L.3]

Good practice in motorcycle parking can be summarized as "Near and Clear, Secure and Safe to use":
Near: Motorcyclists will naturally look for parking opportunities close to their destination, simply because the relatively small size and high flexibility of the motorcycle allow easy progress through traffic and exploitation of marginal parking opportunities without causing obstruction.
Clear: Any difficulty in finding a suitable formal parking area will tend to reduce the advantages of motorcycle use. Signing from main routes and on-site is important for motorcyclists to find formal facilities.
Secure: Physical security measures will be a strong attraction for most motorcyclists wanting to park for more than a few minutes. Casual users, motorcycle tourists and others unfamiliar with the area are likely to find the prospect of secure parking very attractive.
Safe to use: Personal safety considerations when using a parking area start with the surface on which the machine has to be manoeuvred and mounted/dismounted, as well as seclusion, lighting and the amount of passing pedestrian traffic. [L.3]

8.2 PTW Parking Resources

Parking capacity

Parking occupancy and duration can only be reliably assessed by manually conducted surveys. Observation should be more frequent where short-term parking is common. Linking observation of time and number of PTW's to data on demand and dimensions of parking spaces allows an objective judgement as to how well demand is balanced against supply. [L.3].

There are not many specific standards for PTW parking, but many local authorities and organized PTW-interested groups have published their own (local) standards. These are typically based on a proportion of car capacity (the modal split). For example, the proportion of PTW's in the U.K. is 3.6 % as compared to 14.5% in Spain. Accordingly, the proportion of parking places should be respectively 1:28 and 1:7. The British Motorcyclists Federation (BMF) suggests in their guidance notes a minimum PTW parking standard for different types of development.

Table 8.1 *PTW Parking Standards of the BMF*

Description of land use	**Minimum PTW Parking standard**
Camping sites	¼ staff, $^{1}/_{10}$ pitches
Marinas	¼ moorings
Car Parks	$^{1}/_{10}$ parking spaces
Park and Ride sites	$^{1}/_{10}$ parking spaces
Rail stations	10 - morning peak service
Bus stations	$^{4}/_{1}$ Bus Bay
Key Bus Stops	4/stops
Hospitals	¼ staff, 1/20 Beds

In addition to indicating likely uses, it is also possible to suggest other attributes of motorcycle parking that might vary with the length of stay. Broadly speaking, for short visits close proximity to destination will probably be the primary consideration, although even for short periods anchor points are desirable to reduce the risk of theft. For any visit longer than 30 minutes, while proximity remains important in the motorcyclists' choice of parking place, security features such as anchor points, regular monitoring and limited opportunity for theft will increase the desirability. Protection from weather and passing traffic also becomes more desirable for longer-term parking [L.3].

The table below shows information about the purpose of the journey compared to length of stay.

Table 8.2 *Journey purpose and length of stay*

Typical uses	**Length of stay**
Shopping Dropping passenger off Delivery	< 30 min
Shopping Leisure Personal Business	30 min -1 hour
Shopping Employment Leisure	1 hour - 3 hours
Shopping Employment Rail or bus use Education	4 or more hours

[Source: Department of Transportation, UK]

Design of PTW parking

The average width of a PTW is 700-1100mm. Taking into account the space necessary to mount/dismount the width of one parking space is minimally 1300mm [L.3 and L.4]. Motorcycle parking bays are generally not marked out for individual machines, allowing flexible and efficient use of limited space by machines of different sizes. PTW's range in length from around 2000 mm (moped) to 2500 mm (large cruiser). On-street motorcycle parking bays follow a layout ranging in depth from 2200 to 2700mm. If parked at 90º to the kerb the standard is 2500 mm; at an angle of 45º it is 2200 mm. The major advantage of parking at a 45º angle is the length of the PTW parking place (2,2 m) corresponding (approximately) with the width of a car-parking place. The disadvantage is the unfavourable usage of space caused by the increase in width of the bay. The number of parking places in a stretch of 10m at a 90º angle is 6 to 8; at a 45º angle it is only 4 to 6. Practically speaking this manner of parking means that even the largest machines should be capable of parking across a 2100mm bay without encroaching upon the carriageway.

For inside parking the height of the ceiling is also important. Maximum seat height of a motorcycle is 1000 mm and when a motorcyclist is sitting upright (including his helmet) another 1100 mm must be added to the total height. With a safety margin of 200 mm the necessary height of the ceiling amounts to 2300 mm. In case the motorcyclist (including helmet) is walking alongside the PTW the necessary height is around 2100. Of course in this case the designer of the parking garage must ensure that the motorcyclist of the PTW will walk instead of ride. More information about the dimension of PTW's is to be found in chapter 4.

Security

Providing physical security need not be difficult or expensive. Fixed and robust features such as rails, hoops or posts should be an early consideration for any parking scheme. Where motorcycles are parked in bays with one wheel against the kerb, a simple continuous steel rail suffices in most situations. It has the advantage of being easily and inexpensively installed. The continuous rail allows for efficient use by machines of varying style and size, is well understood by users and is compatible with most types of shackling devices. The rail should be set at around 600mm above the surface to accommodate the range of wheel sizes in use [L.3].

Other designs, such as posts with captive chains (with or without a captive lock) is advantageous for motorcyclists who do not carry a chain or locking device capable of securing their machine to a fixed obstacle. [L.3].

Figure 8.2 a *(source: Jan Paul Peters, Yamaha Nederland)*

Figure 8.2 b *(source: Craig Carey-Clinch, MCI, UK)*

Locking points for PTW's.

Safety

Safety includes issues arising from the actual process of manoeuvring a PTW whilst parking, but also broader issues of personal safety at or around the parking place. PTW parking areas should have limited gradients to enable easy manoeuvrability and to ensure that the PTW is unlikely to topple over. Parking areas must also be well-drained and free of debris or contamination that might cause faulty manoeuvring. European law requires all PTW's to have at least one device to maintain the machine in a vertical, or near vertical, parking position when left unattended. There are two main types of this device:

- The "prop stand" provides a triangulated point of contact, along with the front and rear tyres, so that the vehicle leans to the left. Motorcyclists will generally use the "prop stand" for ease and convenience, or when parking on a camber.
- The "centre stand" provides two centrally positioned triangular points so that the machine rests vertically, often with one wheel lifted from the floor. This usually requires more effort from the motorcyclist and is often less stable unless the parking area is level.

In each case the PTW will generally be parked with its steering locked in a left turn position. Based on EU regulations for motorcycle stand performance, surface slope angles should be less than 5 degrees (EC, 1993).

As PTW's are not fitted with a parking brake the motorcyclist must be able to position his machine so that it cannot roll forward because of its own weight and topple over. Therefore, when the ground is not level motorcyclists will try to park so that the weight tilts the machine towards the stand, usually with one wheel touching the kerb. In that case there must be sufficient space and visibility to manoeuvre the machine in and out of position safely.

Parking areas must have a firm surface capable of supporting the weight of a motorcycle on its stand. The foot of the stand might typically measure 10cm2 and carries a load of 10kg per cm2. The surface of the parking area must be capable of withstanding penetration by the stand. In the case of bitumen-based surfaces, care should be taken to ensure that the surface remains solid during hot weather.

Sufficient space and visibility must allow motorcyclists to manoeuvre without significant risk of conflict with other road users. On-street parking should not be positioned in such a way that a motorcyclist is tempted to use the sidewalk in order to access it. Local authorities should also ensure safe and legitimate means of access to off-street parking; even where access is needed from the road onto private property. Sites should be well lit and not located in secluded areas. Instead, designs should provide light, open spaces, without high walls or dense vegetation to provide cover for thieves.

Recommendations for the implementation

— Parking places, especially on the pavement, should not impede pedestrians.
— Parking places on the roadway designed exclusively for PTW's should have posts so that a car cannot enter the parking place.
— Use fixed and robust features such as rails, hoops or posts designed to provide a simple locking-point to secure a motorcycle using a chain or similar device.
— The parking place should be well lighted.
— Parking areas must be well drained and free of debris or contamination that might cause faulty manoeuvring of the PTW or its stand.
— The placement of litter bins, security boxes etc. is worth considering.
— The parking place areas should have limited gradients to enable manoeuvrability.

8.3 PTW parking possibilities

Figure 8.3 a *(source: JP Peters, Yamaha, NL)*

Figure 8.3 b *(source: id.)*

Figure 8.4 a *(source: id.)*

Figure 8.4 b *(source: id.)*

Figure 8.5 a *(source DTV, Nike Moederscheim, NL)*

Figure 8.5 b *(source: id.)*

Figure 8.6 a *(source: DTV Consultants, NL)*

Figure 8.6 b *(source: Vexpan)*

Different ways of realizing parking spaces and symbols.

9. SAFETY CAMPAIGNS

9.1 Road safety campaigns, education and training

As shown in the MAIDS study road safety campaigns may contribute to PTW road safety. In a majority of the cases PTW accidents were due to human failure. The more experienced a motorcyclist is the fewer the accidents. Road safety campaigns are a vital ingredient in the mix of initiatives needed to improve the safety record of motorcyclists. In appendix 3 examples are given of various past and ongoing campaigns directed at the road user. Many of these campaigns are indeed focused on the motorcyclists' behaviour. Motorcyclists' attitudes play a major role in determining their behaviour irrespective of age or trip purpose. Any measure designed to modify their behaviour must address these attitudes and take into account the individuality often expressed in choosing a motorcycle as travel mode.

Still there are some examples of campaigns focusing on the importance of road maintenance. Spilling of diesel fuel, potholes, bad maintenance in general are, as explained in previous chapters, aspects each road authority should consider for the advancement of road safety. Especially from a PTW point of view.

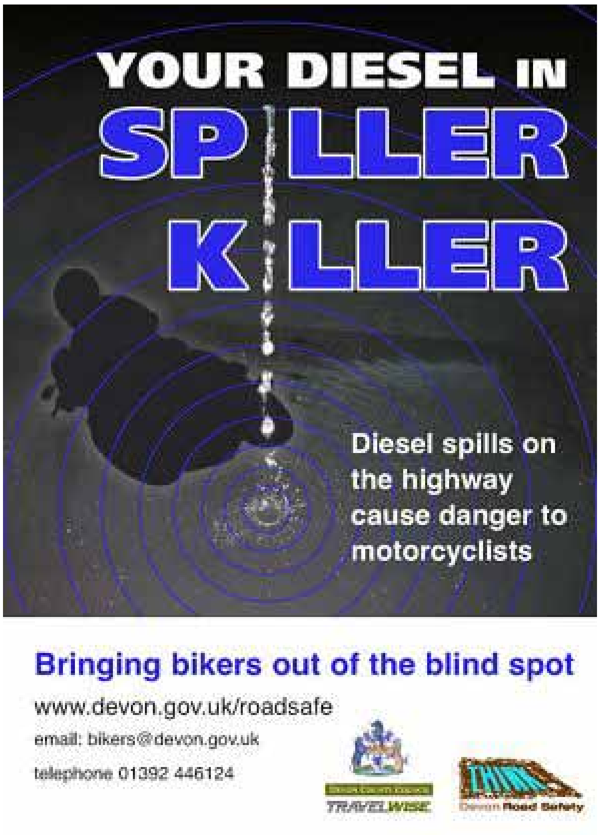


Figure 9.*1* *Example of road safety campaign aimed the prevention of spilling diesel fuel.*

(source: www.devon.gov.uk)

9.2 Useful links

The are many interesting examples of safety campaigns. The most promising ones are shown below.

Name	Internet site	Short description
Federation of European Motorcyclists Association (FEMA)	www.fema.kaalium.com	FEMA, the European Motorcyclists' organization, seeks to establish contacts with road motorcyclists' organizations in the new European states. The European Agenda for Motorcycle Safety gives legislators and decision makers a brief summary of motorcyclists' analysis as to why motorcycle accidents happen and recommendations on how to improve motorcycle safety.
UK Department of Transportation	www.dft.gov.uk	The Department of Transportation's objective is to oversee the delivery of a reliable, safe and secure transportation system that responds efficiently to the needs of individuals and business whilst safeguarding our environment.
BikeSafe	www.bikesafe.co.uk	BikeSafe is an initiative run by Police Forces around the United Kingdom who work with the whole of the biking world to help lowering the number of motorcycle casualties. This is done by passing on knowledge, skills and experience of police motorcyclists to other motorcyclists.

10. ROAD SAFETY AUDITS

10.1 EU wide initiatives

A road safety audit is a formalized assessment of road facilities to identify possible and probable road safety hazards. The main aim is to avoid safety problems in the design of roads right from the beginning and to minimize the possibility of getting involved in an accident and its consequences. Safety audits can be conducted during the design, construction and maintenance phases of road projects. Consideration for PTW's during safety auditing is a contribution to reducing PTW accidents in years to come. Many local authorities voluntarily carry out such road safety audits. In appendix 2 an example is given of a checklist for a road safety audit.

At the moment a European-wide initiative is at hand: The EuroRAP project (see figure 9.2 for all participating countries and organizations). The European Road Assessment Programme - EuroRAP AISBL - is an international non-profit association registered in Belgium. EuroRAP is a similar programme as EuroNCAP, the independent (pre)crash test programme that rates cars with stars for the (pre-) crash protection they provide to passengers and pedestrians. EuroRAP aims at providing independent, consistent safety ratings of roads across borders. Already thousands of road stretches across Europe have been assessed. This method is also being applied now in Australia and piloted in the USA.

EuroRAP has shown that the risk of death or crippling injury can vary tenfold on different roads in the same country. The public, politicians and road engineers must be able to see clearly where the roads with unacceptably high risk are - and be guided to what can be done to put them right. Simple risk mapping (see figure 7.3 for an example) shows where the high-risk roads are. And sometimes the cost of saving lives can be as little as the paint to provide clear road markings, so that drivers can read the road, or safety fencing to stop people being killed over and over again hitting the same trees close to the roadside.

EuroRAP aims to stimulate competition in providing the safest roads. With EuroRAP, road engineers can see clearly how well - or badly - their roads are performing compared to others both within and outside their own countries. And the public can see how quickly - or not - high risk roads are being fixed.

The formal objectives of EuroRAP are:

- reducing death and serious injury on European roads rapidly through a programme of systematic testing of risk that identifies major safety shortcomings which can be addressed by practical road improvement measures;
- ensuring assessment of risk that lies at the heart of strategic decisions on route improvements, (pre-) crash protection and standards of route management;
- forging partnerships between those responsible for a safe roads system: motoring organizations, vehicle manufacturers and road authorities.

Given these objectives it is recommended to also take up the task of incorporating PTW related infrastructure aspects within the EuroRAP reporting scheme. Road authorities can benefit to the max by doing so and helping to realize the goal of halving the number of casualties on European roads by 2010.

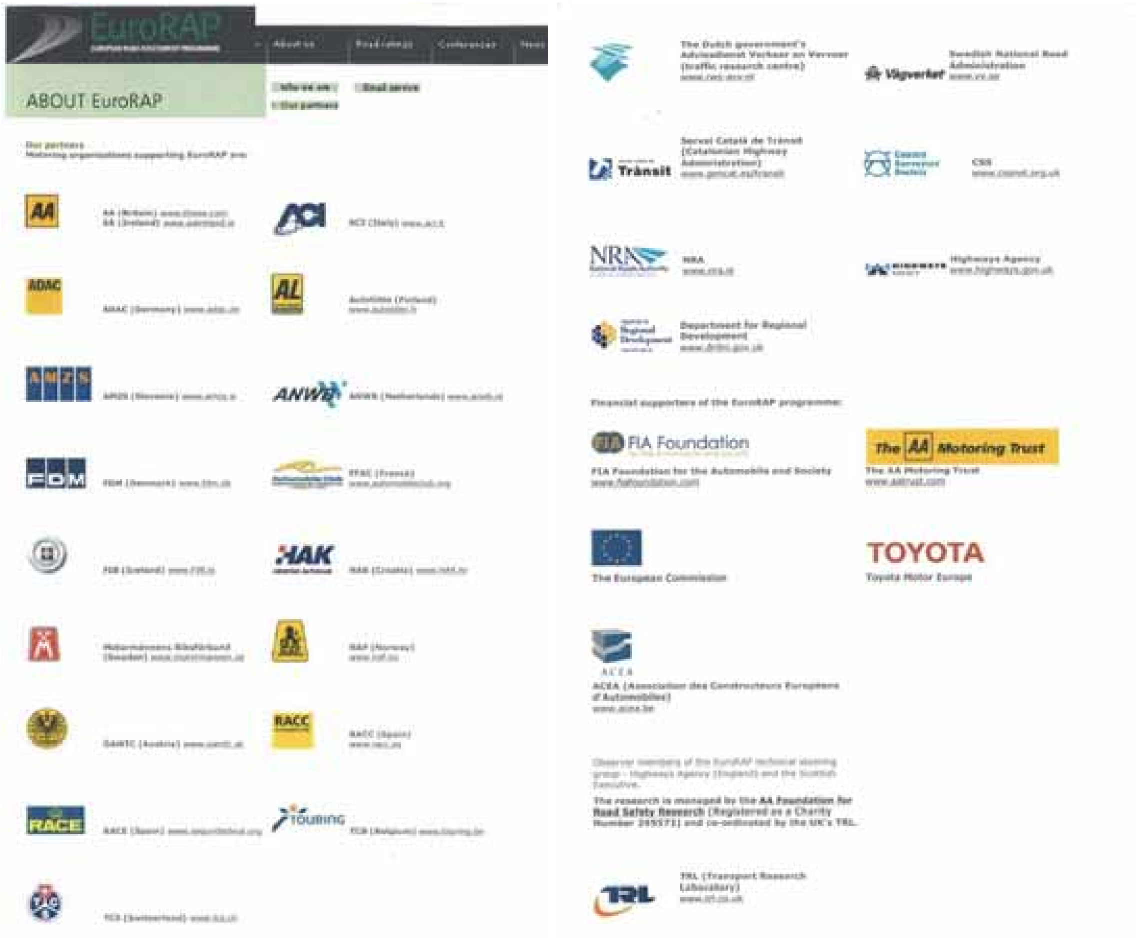


Figure 9.2 *The EuroRAP consortium (source: www.eurorap.org)*

The EuroRAP initiative mainly focuses on major roads. Therefore in road safety auditing for minor and local roads it is recommended to include more specific PTW related issues like:

— the common characteristics of motorcycle accidents;
— the more severe implications for motorcyclists of hazards that affect all road users;
— the road dynamics of motorcycles and the safety implications of their relationship to road surface properties, street furniture and obstructions;
— the different problems faced by motorcyclists in urban and rural environments.

Furthermore it is recommended to start discussions with motorcycle forums and to engage discussions with fellow practitioners who actually ride a PTW. This will all help to gain a better understanding of the safety problems likely to face the motorcyclist.

Some of the general requirements for carrying out a road safety audit are described below [L.22]:

— Impartiality of the auditor or auditing team;
— Commitment to the optimization of resources between auditor and managers in which the safety criterion must prevail;
— Transparency in the allocation of responsibilities
— A large measure of dialogue and consensus capacity among the auditors and managers so as to always make decisions bearing in mind the safety of road users;

Figure 10.3 *The EuroRAP risk map for Spain. (source: www.eurorap.org)*

10.2 Useful links

Besides the EuroRAP initiative there are other interesting examples. Below a selection of useful links is given, which may be a good starting point for further exploring the dimensions of European road design and road safety.

Name	Internet site	Short description
Safetynet	www.safetynet.swov.nl	The goal of this project is to bring together all of the most experienced organizations within the EU to assemble a co-ordinated set of data resources that together will meet the EC's needs for policy support. All data assembled or gathered within the project will be available on the internet to the entire road safety community.
Rsis	www.swov.nl	The SWOV has examined a Czech equivalent of the Netherlands Road Safety Information System (RSIS) The conclusion of the research is that a Rsis-system in Czechia is possible. SWOV has recommended a pilot.

Ripcord	www.ripcord-iserest.com	RIPCoRD-ISEREST is an acronym for Road Infrastructure Safety Protection – Core-Research and Development for Road Safety in Europe, and Increasing Safety and Reliability of Secondary Roads for a Sustainable Surface Transportation. The goal of RIPCoRD is to offer scientific support to European transportation policy aimed at achieving the 2010 targets for road transportation safety and by developing 'best practice tools' and guidelines for infrastructure road safety measures.
Riser	www.riser-project.com	RISER is an acronym for Roadside infrastructure for safer European Roads. It is a European road safety project co-financed by the European Commission through its Competitive and Sustainable Growth Programme. The project provides the opportunity to do research on road infrastructure safety as a growing number of road authorities are in need of innovative approaches to reducing their road-related injury and mortality statistics.
EuroRAP	www.eurorap.org	EuroRAP is a European road assessment programme. It is an international non-profit association registered in Belgium. Its members are organizations for motorists, national and regional road authorities, and experts who have been elected because of the specific contribution they have made to EuroRAP. It aims at providing independent, consistent safety ratings of roads across borders.
ERF	www.erf.be	ERF is a Steering Committee Member of the European Road Transportation Research Advisory Council, a research platform established to develop a shared vision and ensure co-ordinated application of research resources to meet the continuing challenges of road transportation and European competitiveness
Rankers	www.erf.be/section/ep/rankers	Europe's most comprehensive research initiative on road safety engineering to date is Rankers. It develops a road safety evaluation index and a catalogue of remedial measures ranked according to their efficiency

Robust	www.robust-project.com	In infrastructure passive safety road restraint systems are perhaps the single most important roadside element. What can be done to improve their performance at the design and testing stage?
Safeway	www.erf.be/section/ep/safeway	A project to develop road barriers with both high-containment and injury-mitigating features built in. Safeway is a project funded under the Competitive and Sustainable Growth programme.
Black spot management	www.erf.be/section/ep/black_spots	A two-year research effort on road infrastructure safety co-ordinated by ERF, which has delivered a comprehensive assessment for road practitioners. The main objective of this project was to address the issue of HARRS (High Accident Rate Road Sections) - commonly known as Black Spots - through an integrated approach to road safety engineering. The published Guidelines constitute an invaluable publication of reference for road practitioners and authorities in their efforts to eradicate dangerous road sections.
European Asphalt Pavement Association (EAPA)	www.eapa.org	EAPA is the European industry association, which represents the manufacturers of bituminous mixtures, and companies engaged in asphalt road construction and maintenance.
International Road Federation (IRF)	www.irfnet.org	The International Road Federation (IRF) is a global platform that brings together public and private entities committed to road development. Working together with its members and associates, the IRF promotes social and economic benefits that flow from well-planned and environmentally sound transportation networks.
IRTAD OECD (International Road Accident Database)	www.bast.de/htdocs/fachthemen/irtad//english/irtadlan	The Federal Highway Research Institute (BASt) established an international road traffic and accident database. In 1988 BASt extended the database in close co-operation with the Commission of the European Community (CEC). Since January 2004 IRTAD has been kept up to date by the Joint OECD/ECMT Transportation Research Committee. IRTAD membership is

		open to all countries, including non-OECD (Organisation for Economic Co-operation and Development) or ECMT (European Conference of Ministers of Transportation) countries. BASt acts as database host and administrator.
CORDIS	www.cordis.lu	CORDIS is a source of information with regard to European research and development (R&D) and innovation activities. The main aims of CORDIS are: to facilitate participation in European research and innovation activities;. to improve exploitation of research results with an emphasis on sectors crucial to Europe's competitiveness; to promote the diffusion of knowledge fostering the innovation performance of enterprises and the societal acceptance of new technology.
Eltis	www.eltis.org	Eltis is an acronym for European Local Transportation Information Service. Eltis is an initiative of the Clean Transportation Unit of the European Commission's Directorate General for Energy and Transportation. The project is led by an international team of transportation related organizations. The aim of Eltis is to provide information and support, a practical transfer of knowledge and exchange of experience in the field of urban and regional transportation in Europe.
Ifz, institut für Zweiradsicherheit	www.ifz.de	Ifz (Institut für Zweiradsicherheid e.V.) offers voluminous information regarding national and international aspects in motorcycle safety, especially the aspects of infrastructure.
ERTICO-ITS	www.ertico.com	ERTICO – ITS Europe is a multi-sector public/private partnership pursuing the development and deployment of Intelligent Transportation Systems and Services (ITS).
MCIA	www.mcia.co.uk	The Motorcycle Industry Association Ltd. is the body that represents the interests of the supply side of the UK Motorcycle Industry.

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APPENDICES

APPENDIX 1 PTW USAGE IN EUROPE

In the European Union there are approximately 23 – 25 million PTW's in use. This comprises approximately 5 million in Germany, 3,5 million in Spain, 2,5 million in France, 1,2 million in Great Britain and 535.000 in Bulgaria (one PTW per 14 inhabitants).

The share of PTW's in surface transportation in Western Europe amounts to 2% (133 billion passenger km/year). This share may look small, but it equals half the transportation volume of Europe's railways. In 1997 about 24 million PTW's were in use in Western Europe compared to 160 million cars and 200 million bicycles. The intensity of PTW usage varies between the different European countries. Mainly for topographical reasons PTW Mileage in Austria and Switzerland exceeds bicycle mileage by about 50%, whereas in Italy non-car traffic is clearly dominated by PTW's.

North of the Alps PTW's are usually split into two segments: the leisure segment - essentially the domain of the larger type of motorcycle - and the segment of simpler, less powerful PTW versions.

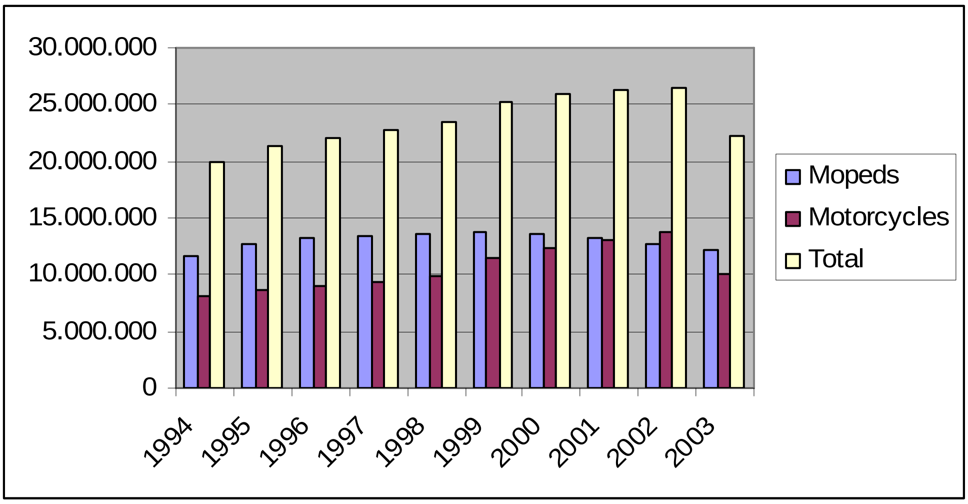


Figure 1 *Total of mopeds and motorcycles registration in Europe (source: ACEM)*

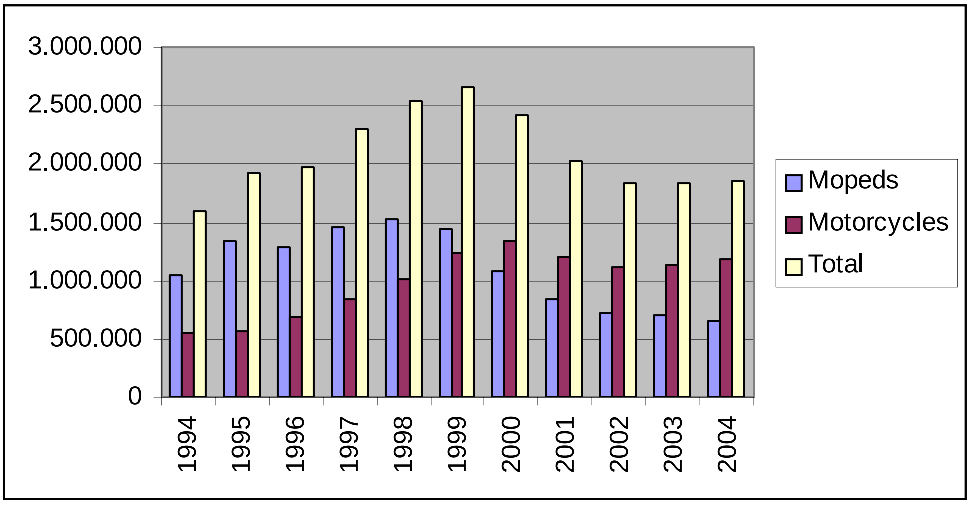


Figure 2 *Total mopeds and motorcycles in use in Europe (source: ACEM)*

Differences between the European countries

At the beginning of this chapter some figures are given about PTW usage in Europe. More interesting is the number of PTW's in comparison to the total figure of motorized vehicles in a country. Table 9.1 shows a difference between European countries.

Table 1 Percentage of PTW's of total motorized vehicles

Country	Total of Vehicles	PTW's	%PTW
France	35.982.000	2.441.000	6.8%
Germany	53.656.000	5.310.000	9.9%
Spain	25.170.000	3.658.000	14.5%
United Kingdom	31.950.000	1.162.000	3.6 %
Bulgaria	3.226.954	535.669	16.6%
Poland		800.000	

[Source: International Road Traffic and Accident Database (OECD), 2003 and Bulgarian Traffic Police, 2003]

Table 2 Fatalities related to Traffic Participation

Country	PTW's fatalities	% of total of PTW s
France	1.253	0.05%
Germany	1.080	0.02%
Spain	758	0.02%
United Kingdom	715	0.06%
Bulgaria	43	0.008%
Poland	?	?

(Source: International Road Traffic and Accident Database (OECD), 2003 and Bulgarian Traffic Police, 2003)

APPENDIX 2 EXAMPLE OF ROAD SAFETY AUDIT

Report road safety audit of the location
Please give a description of the location

Information about the audit visit	
The audit has been carried out by:	
Location	
Data and time	
Weather conditions	
Others present	

Documentation that has been used for the audit:		
Number	Kind of information	Description
1	Letter/ drawing/ pictures	
2		
3		
4		

Aim of the audit

Please state the aims set for the audit.

Checklist of audit questions concerning PTW's

1. Are pavement conditions adequate so that motorcyclists will not encounter unexpected problems as to loss of friction, cracks, rough spots, potholes, surface water, gravel, dirt, oil spills etc?

YES/ NO Observations:

………………………………………………………………………………
………………………………………………………………………………

2. Are safety barriers designed and placed so that they do not represent an unnecessarily large risk to PTW's?

YES/ NO Observations:

………………………………………………………………………………
………………………………………………………………………………

3. Can safety barriers be replaced by alternative solutions that will provide more safety for motorcyclists?

YES/ NO Observations:
…………………………………………………………………………
…………………………………………………………………………

4. Are road shoulders properly designed to prevent motorcyclists of PTW's from incurring injuries when driving off the road at locations where such accidents are likely to happen?

YES/ NO Observations:
…………………………………………………………………………
…………………………………………………………………………

5. Is the course a motorcyclist is likely to follow in bends and at junctions clear of obstacles such as manhole covers, gully gratings or large areas of road marking?

YES/ NO Observations:
…………………………………………………………………………
…………………………………………………………………………

6. Are signs and other road equipment placed properly so that they do not represent an additional hazard to motorcyclists?

YES/ NO Observations:
…………………………………………………………………………
…………………………………………………………………………

7. Are signs concerning motorcyclists sufficiently visible?

YES/ NO Observations:
…………………………………………………………………………
…………………………………………………………………………

8. Is supplementary signing advisable, including auxiliary warning signs for motorcyclists?

YES/ NO Observations:
…………………………………………………………………………
…………………………………………………………………………

9. Is the illumination adequate, including guide-lights and retro-reflective devices in tunnels and at locations where road conditions change?

YES/ NO   Observations:
……………………………………………………………………………
……………………………………………………………………………

10. Are measures being taken such as clearing of vegetation, putting up game fences or extra road lighting because of big game crossing the road?

YES/ NO   Observations:
……………………………………………………………………………
……………………………………………………………………………

11. Is there a need for sight clearance in inner curves so that motorcyclists and other traffic may obtain a better view on the road and the oncoming traffic?

YES/ NO   Observations:
……………………………………………………………………………
……………………………………………………………………………

12. Is the street lighting sufficient for a good visibility for motorcyclists? (motorcycle headlights are less powerful than those of other motor vehicles)

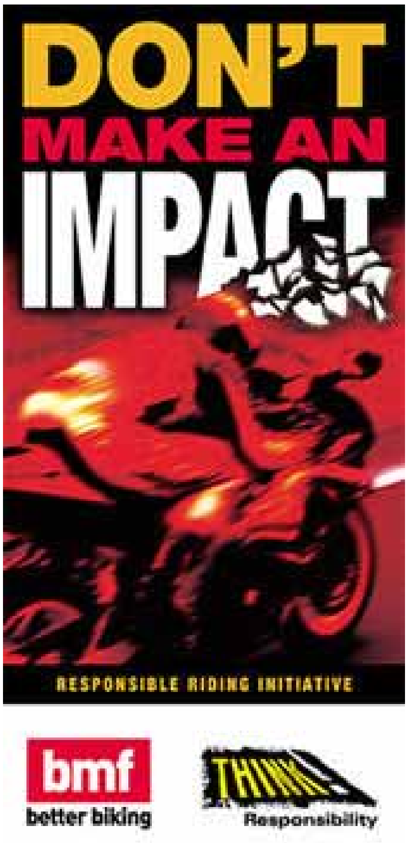
YES/ NO   Observations:
……………………………………………………………………………
……………………………………………………………………………

Summary of the most important recommendations of the road safety audit
Please give a summary of the audit

APPENDIX 3 ROAD SAFETY & COMMUNICATION CAMPAIGNS

Education and training

Appropriately designed training that addresses attitudinal as well as skill deficiencies and is aimed at the particular risks faced by road users is a beneficial supplement to publicity campaigns. For example the ‘Be a better biker’ campaign of Buckinghamshire Country Council (UK). The message to bikers is to enjoy biking, but to make sure their skills match their powerful machines. On assessment days bikers follow a more advanced programme focused on specific manoeuvres to improve their skills in the tricky art of biking. Part of the huge success of the campaign is due to the fact that Motorcyclists are involved in the campaign right from the start.



(source: Be a better biker campaign, UK, www.buckscc.gov.uk/beabetterbiker))

In the UK there are many more examples of how to raise the safety awareness of the PTW user (see below).

Examples of campaigns in the UK and Belgium (source: www.thinkroadsafety.uk and www.ikbenvoor.be)

Stills from the PTW safety movie about a motorcyclist enjoying a ride and who is being warned all the time for hazards that might crop up. Of course, nobody gets these warnings in the real world. (source: www.thinkroadsafety.gov.uk).

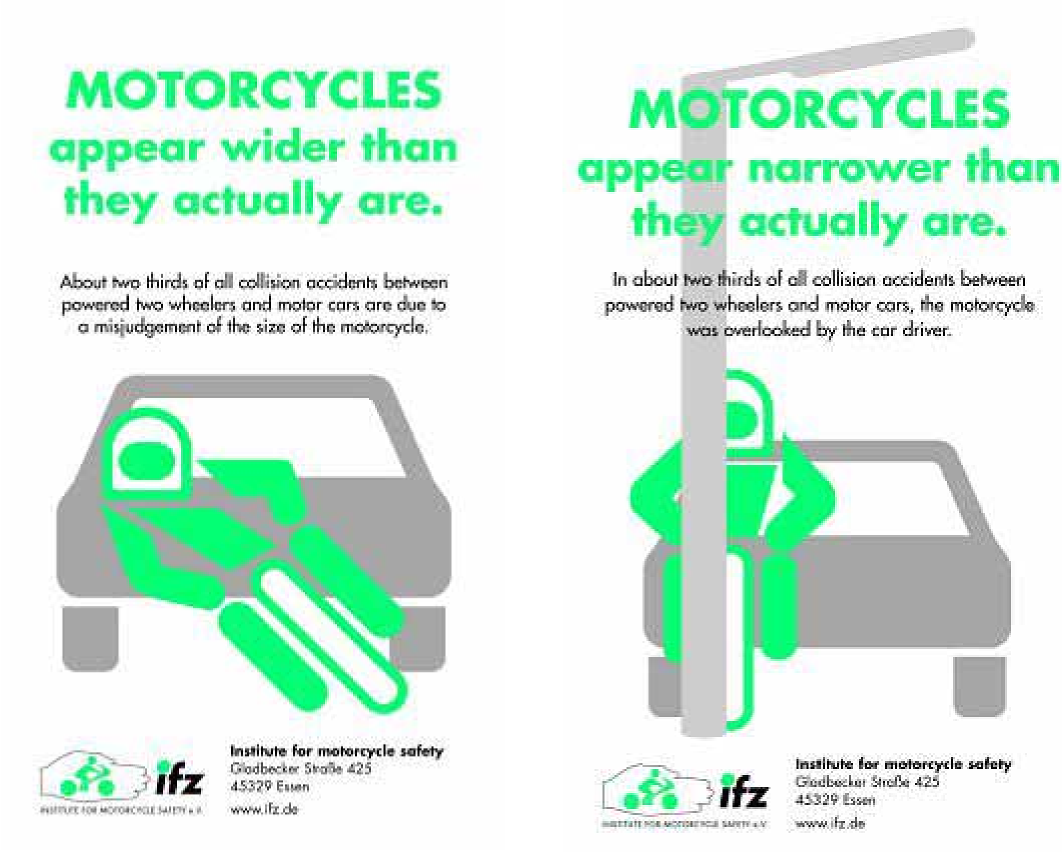
It speaks for itself that there is no single target or message for an overall effective campaign. Motorcyclists choose their mode of transportation depending on their individual needs or the culture groups to which they (aspire to) belong. This means that the message to be driven home differs considerably depending on the target audience. Groups that may need to be targeted include:

— Teenagers on mopeds and scooter motorcyclists. The attitude and behaviour exhibited by this group, often created by peer pressure or fashion trends, demand a different approach altogether than that for other motorcyclists.

— Urban (commuters) motorcyclists who in their particular environment are exposed to the risk of accidents at junctions and intersections where they did not get their lawful right of way.
— Leisure motorcyclists generally run a higher risk on rural roads.
(see for a campaign example figure 9.3.)

Training and education is conducted in many countries. See below for examples.

Example of a campaign focused on young riders of mopeds in the Netherlands.
(source: www.effechillen.nl)



A campaign focused on raising the awareness of car drivers of the vulnerability of PTW users because of being overlooked. (souce: IFZ, Germany)

APPENDIX 4 THE ACEM ROAD SAFETY CHARTER COMMITMENT

acem

The Motorcycle Industry in Europe

Brussels, 7 April 2004

PRESS RELEASE

EUROPEAN ROAD SAFETY CHARTER

The Motorcycle Industry in Europe signed the Charter and announced its Brake Commitment

The Motorcycle Industry in Europe supports European Commission initiative to save 20,000 lives and signed yesterday the *European Road Safety Charter*. It announced its commitment to supply progressively their powered two-wheelers with advanced braking systems.

The *European Road Safety Charter* is part of the European Road Safety Action Programme, a European Commission initiative aiming at reducing by 50% the number of road accident victims by 2010. To contribute to achieving this target, the Commission invited every group of civil society to sign the Charter and to commit themselves to undertake concrete measures.

The newly elected Vice-President Federico Minoli and Jacques Compagne, ACEM's new Secretary General, participated in the signature ceremony of the *EU Road Safety Charter*. On behalf of ACEM Members, M. Minoli signed the Charter.

The ceremony took place yesterday 6th of April in Dublin and was presided by Seamus Brennan, the Irish Minister of Transport, in the presence of EU Commissioner Loyola de Palacio, Ari Vatanen, Member of the EU parliament, Pat Cox, President of the EU parliament, Michael Schumacher, and Max Mosley, President of the FIA.

The Motorcycle Industry in Europe announced its commitment to supply progressively their powered two-wheelers with advanced braking systems taking into account their distinctive characteristics and cost-effectivenesss of the technical solutions. This commitment will result in the availability of a majority of street models equipped with advanced braking systems in 2010.

By signing the Charter and annoucing its Brake Commitment, the Motorcycle Industry in Europe demonstrated its continued long-term interest in the enhancement of road safety in Europe.

ACEM will regularly report on the progress of advanced braking systems available on the market.

NOTES

1. ACEM is the professional association of the Motorcycle Industry in Europe and represents 12 manufacturers and 10 associations at European level.

   ACEM was founded in 1994 as a merger of 2 previous associations, namely COLIMO and ACEM.

   The product range goes from 50cc town vehicles, up to motorcylces with 1000cc and more. ACEM Members are responsible for 85% of the total production and up to 90% of the total market in Europe.

2. ACEM's full members list can be found on ACEM's website : www.acembike.org

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APPENDIX 5 PTW ROAD SAFETY IN POLAND AND BULGARIA

In this appendix a survey of the situation in Poland and Bulgaria is given. Cracow University of Technology supplied the Polish contribution. The Institute of Transportation and Communication provided the Bulgarian contribution.

Poland

In spite of a relatively significant number of motorcycles in Poland not much attention is given to motorcyclists' problems. PTW's are especially popular in big cities with a high level of congestion. However, due tot weather conditions in Poland (the average temperature during the winter is below 0^o C and there is a lot of snow) PTW's are not as popular as they are in southern Europe.

The number of PTW's in Poland has been quite stable in the last few years. In the early nineties the number of motorbikes was close to 1,4 million. Five years later the number had considerably decreased to 0,9 million. At the beginning of the new century the number of PTW's was 0,8 million. In spite of a steady number of motorcycles its percentage of the sum total of motor vehicles has slightly decreased. The reason is that in the last couple of years the number of privately owned cars in Poland has grown rapidly.

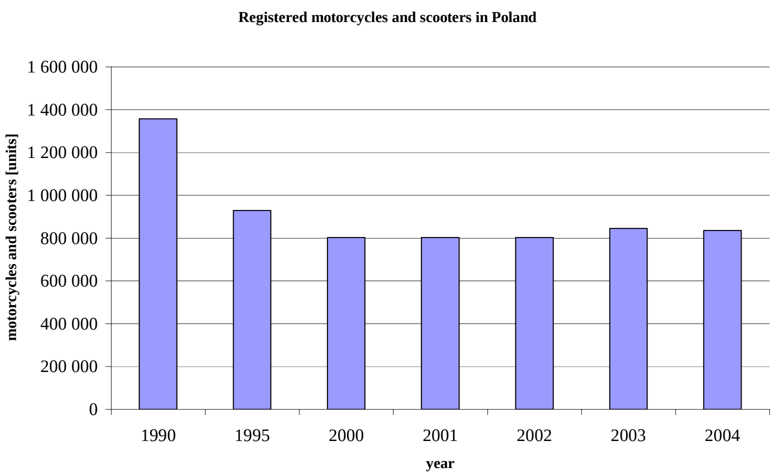


Figure 1 Number of registered motorbikes in Poland.
(source: ITC, Bulgaria and the Cracow University of Technology)

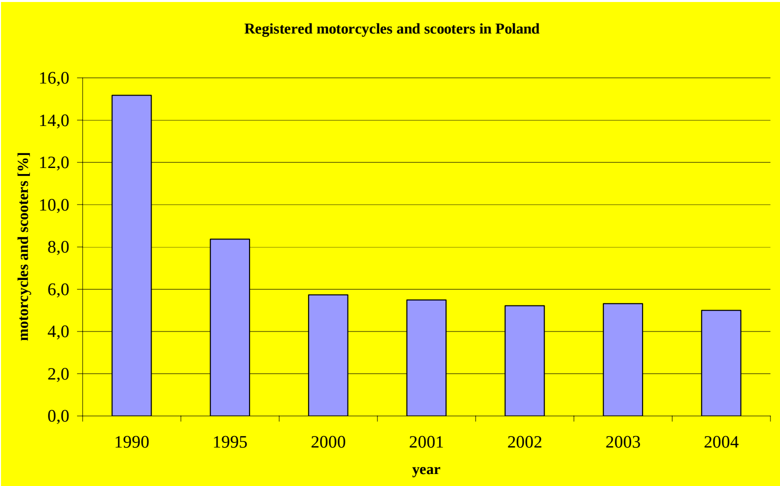


Figure 2 Percentage share of motorbikes in Poland.
(source: ITC, Bulgaria and the Cracow University of Technology)

The problem of PTW's in Poland is that they are overlooked by decision makers and designers. Study of accessible professional journals for street and road designers in the last two years show that they didn't even mention PTW issues. In Poland no measures are taken specifically for motorcycles, such as parking bays or signing.

Examples of road design in Poland

In Poland, obstacles are frequently to be found alongside the road (Fig. 3). They are part of the architectural setting of the renovated streets, especially in older parts of the cities. The obstacles are placed to prevent vehicles from parking illegally on the footpath.

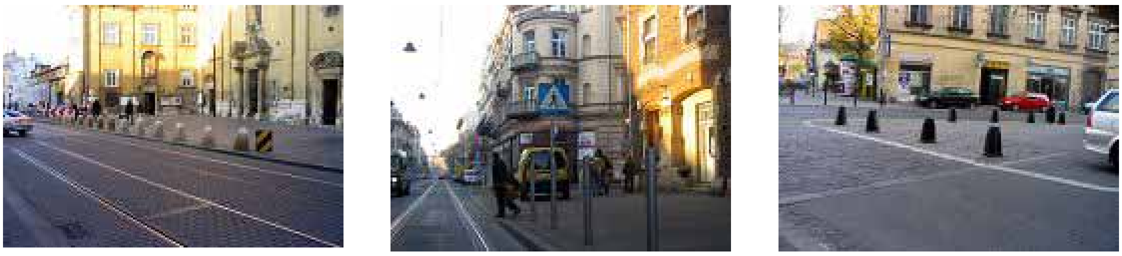


Figure. 3 Road design with obstacles alongside the road.(source: id.)

In Poland there are two major groups of road barriers: concrete barriers (called *Zakopiańska*) and steel barriers (fig. 4). Concrete barriers are not installed any longer, but are still to be found along older roads, especially outside residential areas. Steel barriers are commonly used while streets are being repaired both inside the cities and outside. In Poland there are no cable barriers.

Figure 4 Road barriers: concrete barrier (Zakopiańska) and steel barrier. (source: ITC, Bulgaria and the Cracow University of Technology)

There is another kind of physical barrier in some Polish cities – kerbs built in the pavement to separate tram/bus lanes from the other traffic (Fig. 5). These kerbs can be dangerous for PTW's. Moreover they make it impossible to overtake cars queuing up in a traffic jam.

Figure 5 Kerb as a lane separator (width of the lane is 3,50m), (source: id.)

Other obstacles for PTW's are built in the roadway. In many cases speed bumps consist of concrete cubes of a dark colour. There are also a few examples of speed bumps placed directly behind a curve. Quite often it is difficult to see the bump, which makes for a hazardous situation for motorcyclists (Fig. 6).

Figure 6 Speed bumps with low visibility and in a curve.(source: id.)

Another obstacle is an unexpected change in pavement material. In the presented example the turning lane consists of concrete cubes which have less surface grip than the asphalt concrete of the through lane, especially in rainy circumstances. This dangerous situation is worsened by the relative high speed of vehicles travelling in rural areas. The same situation is relatively common in urban areas.

Road maintenance

Roads in Poland are in rather bad repair. The pavement is of inferior quality and there are many stretches with rather deep ruts (Fig.7). A vast problem are the potholes in early springtime. Then the surface of the roadway is covered with holes caused by frequent temperature changes between sub zero and above. In that time of year roads are extremely hazardous not only for motorcyclists but for cars also. This situation arises every year.

Figure 7 Hazardous situation in rural (left) and urban areas. (source: id.)

In Poland there are hardly any problems as to contamination and debris in the streets. Street cleaning lorries scour the streets rather frequently, even in dry periods. During (re)construction activities road building companies are required to keep the pavement clean. This is a strict regulation strongly enforced by the municipal police.

Traffic management

There are two traffic symbols that represent a PTW (Fig.8). According to the Polish Manual of Traffic Signs the distance between the sign and the edge of the roadway should be 0,5 m, which is considered a safe distance for motorcyclists. Road markings in Poland have a PTW-friendly character. A few years ago, however, a new type of paint for road marking was introduced. This paint was very slippery and therefore hazardous to PTW's. Due to these markings many accidents occurred. At present a high quality so-called thermoplastic paint is used. In some places the problem remains, because the 'old' markings are not removed properly and may confuse drivers.

Figure 8 PTW's on traffic signs in Poland.(source: id.)

Author: Andrzej Szarata.
Professional journals: Drogownictwo, BRD, Polskie Drogi, Autostrady, Transportation miejski i regionalny.
Legal documents: National Transportation Policy, Polish Highway Code,
Web sites: www.scigacz.pl, http://forum.gazeta.pl/forum/71,1.html?f=10420

Bulgaria

From 1989 – 1999 the number of PTW's in Bulgaria increased by an average of 4.5% per year. In the last 5 years the average increase was even 7.6%.
No data of PTW mileage are available for Bulgaria. It is most likely to be lower than the European average as the mobility of the Bulgarian population is lower.

Table 1 Percentage PTW's of total motor vehicles

Bulgaria	**Total of vehicles**	**PTW's**	**% PTW**
2002	3,070,614	530,262	17.3%
2003	3,226,594	535,669	16.6%

Source: Bulgarian Traffic Police

Safety

Data supplied by Bulgarian Traffic Police are not detailed enough to make a specific analysis of the causes of traffic accidents involving PTW's. The next table presents information regarding road safety in Bulgaria in 2003 and 2004 for all motor vehicles including PTW's.

Cause	**2003**						**2004**					
	Accidents		Fatalities		Injured		Accidents		Fatalities		Injured	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Total	**6 997**	**100**	**960**	**100**	**8 488**	**100**	**7 612**	**100**	**943**	**100**	**9 308**	**100**
Driver's incorrect action	6 491	92.8	906	94.4	7 990	94.1	7 076	93.0	898	95.2	8 757	94.1
Technical defect of the vehicle	37	0.5	2	0.2	52	0.6	39	0.5	7	0.8	50	0.5
Passenger's offence	4	0.1	1	0.1	3	0.1	9	0.1	-	-	9	0.1
Pedestrian's offence	406	5.8	42	4.4	368	4.3	399	5.2	23	2.4	382	4.1
Bad road conditions	11	0.2	1	0.1	14	0.2	8	0.1	3	0.3	9	0.1
Others	48	0.6	8	0.8	61	0.7	81	1.1	12	1.3	101	1.1
Human failure	6 901	98.6	949	98.9	8 361	98.6	7 484	98.3	921	97.7	9 148	98.3

In Bulgaria human failure, speeding included, amounts to a high percentage of accident causation : > 98%.

The next table shows Bulgarian data of the accidents caused by motorcyclists and moped riders:

Cause	2003						2004					
	Accidents		Fatalities		Injured		Accidents		Fatalities		Injured	
	Freq.	%	Freq.	%	Freq.	%	.	%		%		%
All vehicles	6 997	100.0	960	100.0	8 488	100.0	7 612	100.0	943	100.0	9 308	100.0
Motorcycles	259	4.0	37	4.1	278	3.4	304	4.3	32	3.6	330	3.8
Mopeds	104	1.6	6	0.7	107	1.3	94	1.3	10	1.1	91	1.0
Total PTW's	363	0.1	43	0.05	385	0.05	398	0.1	42	0.05	421	0.05

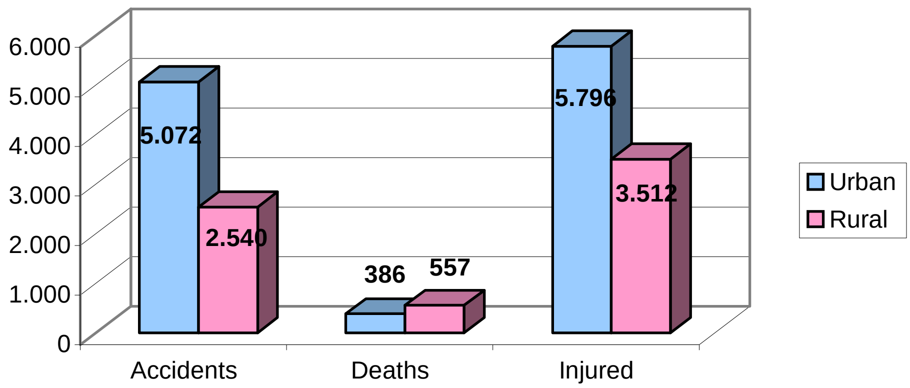
Among the defects of the roadway causing traffic accidents of all types of vehicles in Bulgaria slippery pavement was the most common cause
Data for 2003 and 2004 are presented in the next table:

Cause	2003						2004					
	Accidents		Fatalities		Injured		Accidents		Fatalities		Injured	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Total	11	100.0	1	100.0	14	100.0	8	100.0	3	100.0	9	100.0
Slippery pavement	6	54.5	0	0.0	10	71.5	4	50.0	2	66.7	5	55.6
Uneven pavement	0	0.0	0	0.0	0	0.0	1	12.5	0	0.0	2	22.2
Damaged pavement	2	18.2	1	100.0	1	7.1	1	12.5	0	0.0	1	11.1
Lack of sidewalks	0	0.0	0	0.0	0	0.0	1	12.5	0	0.0	1	11.1
Faulty light signals	2	18.2	0	0.0	2	14.3	0	0.0	0	0.0	0	0.0
Other road defects	1	9.1	0	0.0	1	7.1	1	12.5	1	33.3	0	0.0

Type of area

In 2004 some 66% of the accidents with all types of vehicle occurred in urban areas, whereas almost 60% of the fatalities were in rural areas. These data tally with the findings of MAIDS.

Distribution of accidents by type of area



Bulgarian road safety data confirm the conclusion that the highest safety risk for PTW's lies in urban areas rather than in rural parts. The share of accidents involving PTW's at a national scale (both urban and rural areas) is only 0.1%. For the capital city of Sofia though, it amounts to 14.9%.
A similar conclusion may be drawn from data concerning fatalities. At a national level the share of fatalities in accidents involving PTW's is 0.05%, but for Sofia it is 4.8%.
The MAIDS data further indicate that half of all PTW accidents were found to have taken place at an intersection. In this respect the situation in Bulgaria is different. In urban areas 60% and in rural areas 84% of all accidents take place on a stretch of street/road. However, in urban areas the second most dangerous location is the intersection. It amounts to 35.7% of all accidents. Besides 23% of fatalities and 37% of injuries occur at intersections.

	Total			Urban areas					
	Acci-dents	Deaths	Injured	Acci-dents	%	Deaths	%	Injured	%
Total	**7 612**	**943**	**9 308**	**5 072**	**100.0**	**386**	**100.0**	**5 796**	**100.0**
Intersection	2 054	133	2 510	1 812	35.7	91	23.6	2 160	37.3
Interchange	98	15	115	56	1.1	10	2.6	56	1.0
Bridge	66	13	93	24	0.4	4	1.0	27	0.4
Tunnel	15	-	19	10	0.2	-	-	12	0.2
Road/street section	5 226	760	6 382	3 088	60.9	273	70.7	3 456	59.6
Guarded railway level crossing	5	2	5	5	0.1	2	0.5	5	0.1
Unguarded railway level crossing	5	3	8	3	0.1	3	0.8	3	0.1
Other	143	17	176	74	1.5	3	0.8	77	1.3

(source: 2004 Road safety statistics, Traffic Police)

	Total			Rural areas					
	Acci-dents	Deaths	Injured	Acci-dents	%	Deaths	%	Injured	%
Total	**7 612**	**943**	**9 308**	**2 540**	**100.0**	**557**	**100.0**	**3 512**	**100.0**
Intersection	2 054	133	2 510	242	9.5	42	7.6	350	10.0
Interchange	98	15	115	42	1.7	5	0.9	59	1.7
Bridge	66	13	93	42	1.7	9	1.6	66	1.9
Tunnel	15	-	19	5	0.2	-	-	7	0.2
Road/street section	5 226	760	6 382	2 138	84.1	487	87.4	2 926	83.3
Guarded railway level crossing	5	2	5	-	-	-	-	-	-
Unguarded railway level crossing	5	3	8	2	0.1	-	-	5	0.1
Other	143	17	176	69	2.7	14	2.5	99	2.8

(source: 2004 Road safety statistics, Traffic Police)

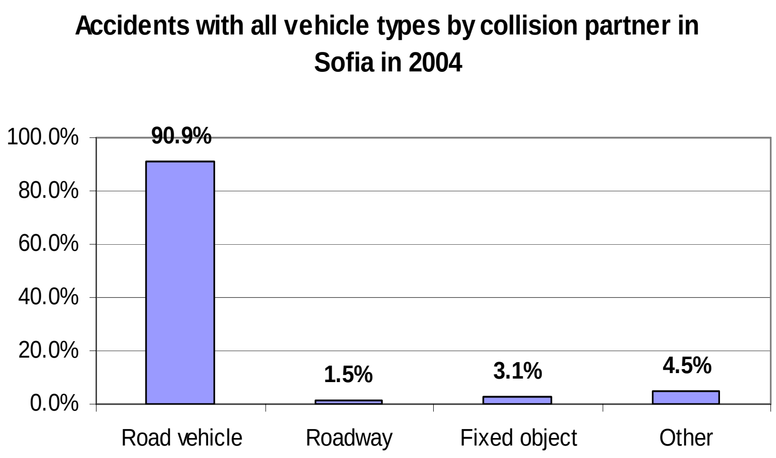
Fatalities by Traffic Participation

Bulgaria	**PTW's fatalities**	**% of total PTW's**
2003	43	4.48%
2004	42	4.45%

(source: Bulgarian Traffic Police)

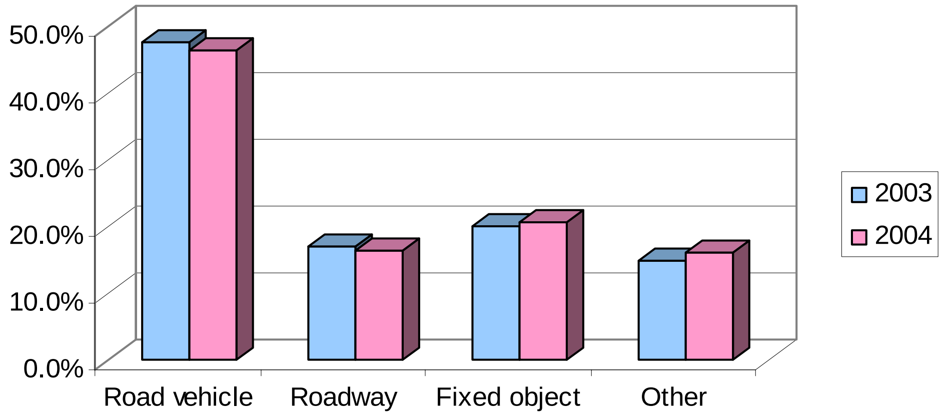
Collision partners

In Bulgaria in 47% of the accidents the collision partner is another motor vehicle. Fixed obstacles rate second: 20%, whereas the roadway causes 16-17% of the accidents.



(source: ITC, Bulgaria and the Cracow University of Technology)

Accidents with all vehicle types by collision partner



(source: ITC, Bulgaria and the Cracow University of Technology)

ACEM,

ACEM - Association des Constructeurs Européens de Motocycles G.E.I.E. - was founded in 1994 and represents all major motorcycle manufacturers in the European Union (European or producing in Europe), as well as 12 motorcycle industry associations in the member states. Their products range from 50cc. mopeds to the biggest cruiser and touring bikes. ACEM members are fully committed to their environmental, safety, mobility and economic responsibilities.

TRANSPORT SAFETY:

ACEM is committed to continually improve safety of PTW'S and willingly takes its share of the collective responsibility that Governments and stakeholders share.

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