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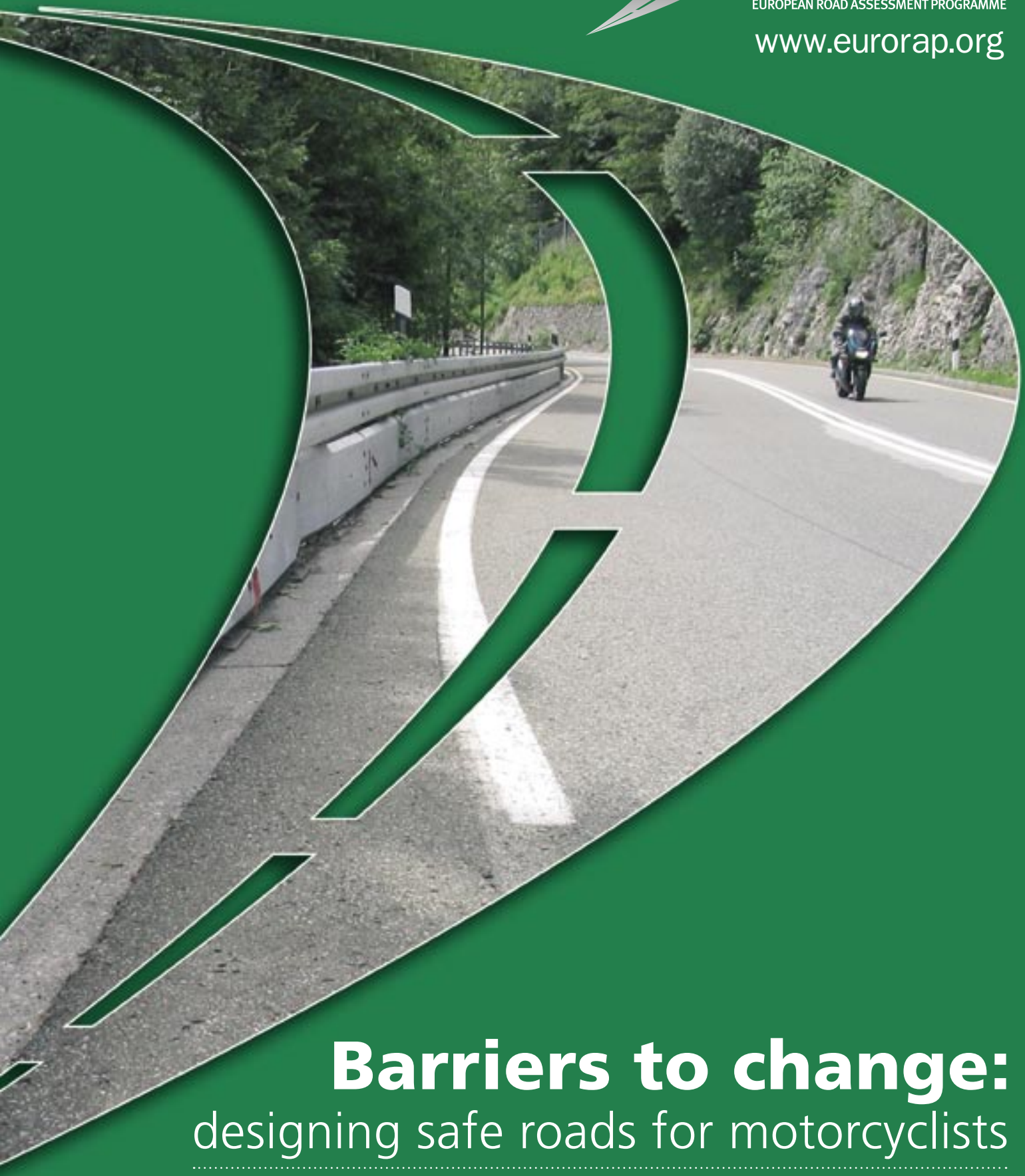

Barriers to change:

designing safe roads for motorcyclists

Position paper on motorcycles and crash barriers

The work of the EuroRAP Motorcycle Safety Review Panel was financially supported by IAM motoring trust

Preface

John Dawson
Chairman, EuroRAP

EuroRAP is a unique Association. Our Members include Europe's top performing road authorities and motoring and touring clubs with tens of millions of individual members and large motorcycle riding constituencies. Our Association includes world-class safety researchers and experts from the motor industry.

EuroRAP is making a unique contribution to road safety through its protocols, which have broken new ground by providing one international system to measure the general safety of Europe's roads based on the best research evidence available.

Just over two years ago there was vigorous debate among our Members about how to address motorcycle safety. However, EuroRAP had been unable to undertake a sound evidence-based assessment of the safety of road infrastructure for motorcycle users alone. There appeared more opinion than fact. With motorcyclists now accounting for 1 in 5 deaths on the roads of some countries – and much more on many individual stretches of road – it became essential to build an agreed base of evidence from which to work.

The EuroRAP Board therefore approved the establishment of a special Motorcycle Safety Review Panel when it became clear this would be widely supported by users, authorities and experts. The Panel was asked to review the available evidence base and, armed with that, to build consensus and recommend actions. Safety barriers were chosen as a key issue around which general understanding of motorcycle infrastructure safety could be forged. John Plowman, a skilled senior administrator in road safety, kindly agreed to chair this Panel.

The result was systematic collection of evidence, debate and growing understanding, and the consensus around the conclusions and recommendations in this readable and actionable report.

I am very grateful to John Plowman, his Panel members and all those worldwide who contributed to or reviewed this report. My special thanks to European Programme Director, Dr Joanne Hill, who has led the Panel's research review and analysis. I am deeply grateful to Britain's IAM for the generous financial support that made this work possible.

The very existence of the Panel and its work over two years has helped build momentum to act. The Panel's report provides a platform of understanding as well as practical recommendations that every country in Europe can follow to cut motorcycle casualties – whether in the short or medium term. EuroRAP will adopt the recommendations aimed at the Association itself. We will also use the extraordinary communications reach of our Members and Partners to ensure this report is seen, understood and acted on across Europe.

Contents

Forewords

Neil Greig
Director of Research and Policy, IAM

Crash barriers that save the lives of car occupants can be killers of motorcyclists. The statistics are stark: hitting a crash barrier is a factor in 8 to 16 per cent of rider deaths, and riders are 15 times more likely to be killed than car occupants. Barrier support posts are particularly aggressive, they can cause a 5-fold increase in injury severity compared to the average motorcycle crash.

The question is: can crash barriers be designed so that riders have some protection against the aggressive features that cause devastating injuries? The answer is yes. This is the conclusion of the Motorcycle Safety Review Panel brought together by EuroRAP, with financial support provided by the IAM.

The Panel, chaired by John Plowman, found clear evidence to justify new and immediate interim guidance on crash barrier design, showing road engineers where motorcycle-friendly systems should be fitted at new sites, and retro-fitted at existing high risk sites.

Some countries lead the way: France, for example, has completed a huge programme retro-fitting lower rails to prevent riders hitting crash barrier support posts at vulnerable sites, and has acted to change the culture in road administrations to be rider friendly. What has been done in France can and should be planned and implemented elsewhere.

Of course roadside crash protection can only be part of the solution. Riders must take responsibility to protect themselves by riding sensibly and safely. But the crash barriers that will protect unlucky, unfortunate or just plain careless drivers must be designed to do the same for motorcycle riders.

John Plowman
Chairman, EuroRAP Motorcycle Safety Review Panel

Road casualties remain a major cause of death worldwide. Despite the success of many countries in reducing casualties from vehicles, the figures for motorcycle deaths remain far too high. As more and more people are turning to motorcycling, it is imperative that we address the risks they run.

I therefore welcomed the opportunity to chair a group of national, European and international experts under EuroRAP auspices, with financial support from the IAM, to examine the potential risks to motorcyclists of crash barriers.

It is clear that, while road infrastructure in general and crash barriers in particular are designed with cars and heavier vehicles in mind, the vulnerable but growing minority of motorcyclists are generally ignored. This is largely because the information about the risks they run is not there.

Engineers are having to make life and death decisions on the basis of inadequate guidance. This cannot be right.

We must fill the gaps in our understanding of barrier design and location. Existing standards and guidelines for road infrastructure – and barriers in particular – need to be changed so that they take proper account of motorcyclists.

There are some signs of positive innovation. But much more needs to be done. We hope that this report will reinforce the process of more comprehensive barrier planning and help to reduce the risks to that particularly vulnerable group of road users, the motorcyclist.

I am very grateful to our financial supporters and our experts for the time and effort they've put in and to Dr Joanne Hill for pulling all this together.

Image courtesy of Cheshire County Council, UK

1. Summary

- There is a lack of attention to safe road infrastructure for motorcyclists†.
- Fatal and serious crashes involving motorcyclists cost £1.8 billion (€2.3 bn) annually in the UK alone.
- Motorcycling is becoming increasingly popular for both leisure and commuting. The number in use across Europe reached over 17 million in 2005 – an increase of nearly 50 per cent on 1998 figures.
- Across Europe, road fatalities are reducing, but rider deaths have stagnated, falling by less than 1.5 per cent annually.
- Motorcyclists represent 16 per cent of all road deaths, but just 2 per cent of the total distance travelled.
- Riders are 30 times more likely to be killed in a crash than car occupants and four times more likely than cyclists.
- Crash barriers are designed with only the majority of road-users in mind – cars, and to a lesser extent, heavy vehicles. The European testing standard makes no mention of motorcycles.
- Hitting a crash barrier is a factor in 8-16 per cent of rider deaths.
- In collisions with crash barriers, riders are 15 times more likely to be killed than a car occupant.
- Barrier support posts are particularly aggressive, irrespective of the barriers' other components, causing a five-fold increase in injury severity compared to the average motorcycle crash.
- Motorcycle-friendly systems have been shown to halve fatalities and offer high rates of return.
- The EuroRAP Motorcycle Safety Review Panel recommends that:

  i. the quality of crash data and the research base surrounding how motorcyclists are killed and injured in crashes involving infrastructure needs to improve substantially;

  ii. there is sufficient evidence to justify new and immediate interim guidance on crash barrier design to give road engineers clear guidance on where motorcycle-friendly systems should be incorporated at new sites, and to be able to review motorcyclist risk at existing sites. The Netherlands is commended for its 'decision tree' approach (See Annex 1);

  iii. where data permits, as in the UK and Spain, EuroRAP should map motorcycle risk across the road network separately from other traffic so as to highlight high-risk roads by mode of road user;

  iv. the decision in July 2008 to develop a new European testing standard for crash barriers that incorporates the needs of dismounted riders is commended – but concerns remain that testing should take place for riders striking the barrier whilst mounted and for protective equipment added to existing barriers;

  v. every road safety engineering department should have a motorcycle champion, as is the case in France, to introduce a cultural change to the way in which risk is viewed by a road authority.

† In this paper, the terms 'motorcyclists' and 'PTWs' are used synonymously and refer to all types of such vehicles.

Image courtesy of Ingal Civil

Panel members:

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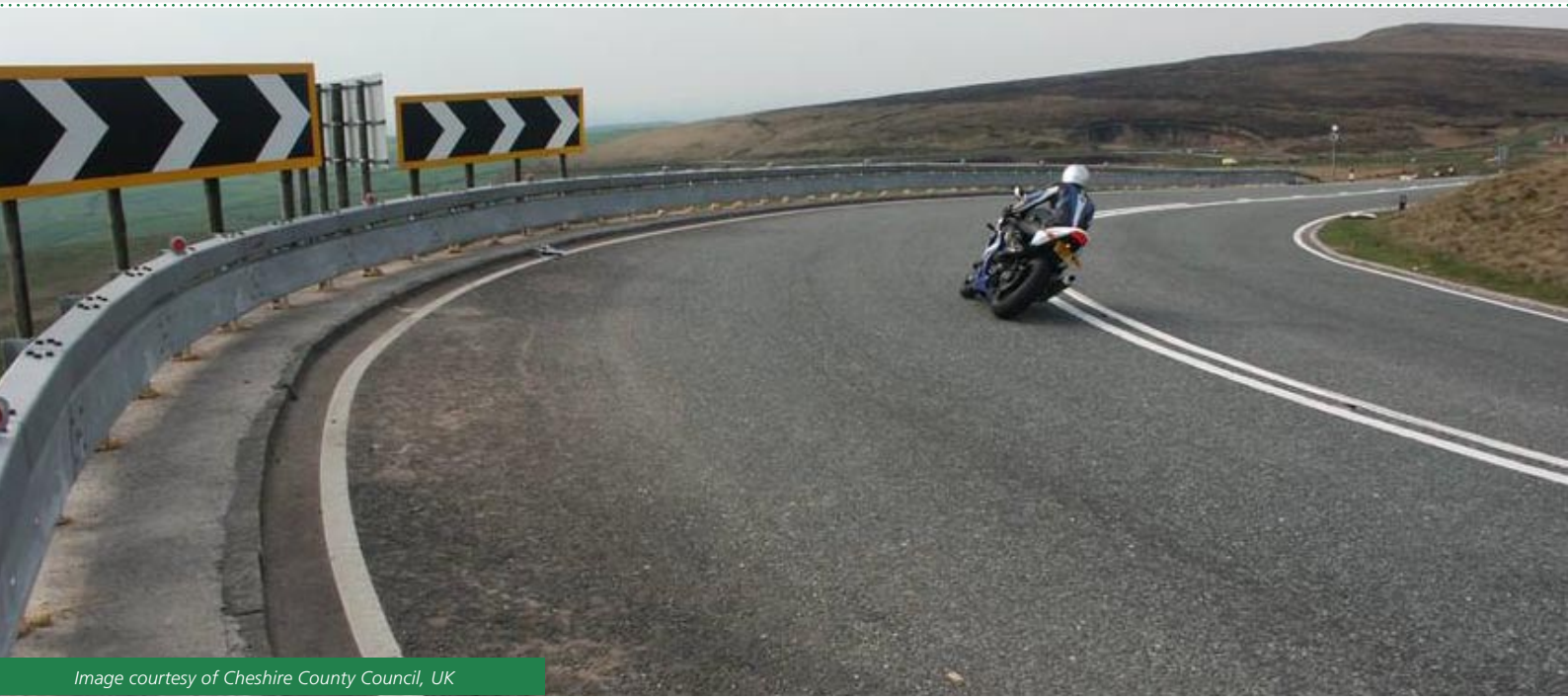

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2. Introduction

This position paper is based on the work of the European Road Assessment Programme (EuroRAP) Motorcycle Safety Review Panel. Established in October 2007, the Panel brought together leading European experts in the field of motorcycle safety and included representatives from motoring clubs, manufacturers, riders' organisations, practitioners, transport specialists in research institutions and professional associations, and national and regional road authorities. Advice was also taken from experts in Asia, Australia, and the United States.

EuroRAP aims to reduce death and serious injury on roads in all transport modes across Europe through systematic testing of risk, identifying major safety shortcomings that can be addressed by practical road improvement measures. It has become a unique association through which those responsible for a safe road system – users, road authorities and vehicle manufacturers – work together to effect change.

In this first phase of work, the Panel's objectives were to review the evidence and research base on crash barriers and their impact on Powered Two-Wheeler (PTW) safety. The findings have been used to make recommendations on key actions to improve deficits in engineering standards and the knowledge base. They will also inform the development of the standardised RAP protocols used in programmes worldwide (iRAP, EuroRAP, AusRAP, usRAP, KiwiRAP) to assess risk by mode of road user. These protocols include:

- **Risk Mapping** using collision and traffic data to measure and map the risk that road users face as they move from one road to another
- **Performance Tracking** to examine road safety risk over time and the countermeasures that have led to casualty reduction in different circumstances, and
- **Star Rating** involving direct visual inspection and scoring of road-based features showing the likelihood of a collision occurring and the protection offered by the road in the event of a crash.

This review is not intended as an academic study, but instead aims to give a synopsis of current thinking in the area. In doing so, the Panel has evaluated research and statistics on collision and injury trends, crash barrier designs and their consequences for PTWs, PTW-friendly add-on products, and the European barrier testing standard. The following pages detail our findings and put forward recommendations the Panel believes are achievable in the short and longer term.

The Panel recognises that crash barrier design comprises just one feature of the road environment and that, alongside the road itself, rider behaviour and vehicle design also have a role to play.

3. Context

There is little doubt that motorcycling is becoming increasingly popular. The current market for motorcycles in Europe reached over 1.4 million new machines in 2006, continuing the positive trend of growth of previous years. While some countries have witnessed marginal reductions, these have been offset by growth in others, particularly in Italy, France, Spain, Greece, Denmark, Finland, and Sweden. The number of motorcycles in use across Europe reached over 17 million in 2005 – an increase of nearly 50 per cent on 1998 figures (ACEM, 2007).

In addition to the increase in motorcycling as a leisure activity, its benefits over other forms of transport are widely acknowledged. Motorcycles make efficient use of the road space in congested areas, require less parking space than cars, have lower environmental impact and running costs, offer an affordable alternative where public transport is limited and walking or cycling is unrealistic, and widen opportunities for employment in rural areas (UK Department for Transport, DfT, 1998).

Recent years have seen debate on whether PTW riders fall into the 'vulnerable' road user category. As with pedestrians and cyclists, motorcyclists are not normally protected by a vehicle body or the secondary safety measures such as seatbelts or side impact bars afforded to car occupants. Airbags are being developed on specific models but design complexity has meant that the process is slow and unlikely to be standard for some time to come (Kanbe *et al*., 2007). Moreover, in circumstances where a rider has been dismounted from their vehicle, protective equipment attached to the motorcycle will be of no benefit. Motorcyclists are therefore currently more exposed to the road environment than vehicle occupants and are at greater risk of fatal or serious injuries in the event of a crash, a fact borne out in the published literature.

Motorcyclists represent a large proportion of casualties in relation to their number. In 2006, at least 6,200 riders were killed in road crashes across the European Union, representing 16 per cent of all road deaths, but just 2 per cent of the total distance travelled (European Transport Safety Council, ETSC, 2007). Riders are around 30 times more likely to be killed in a road crash than car occupants, and, perhaps surprisingly, 4 times more likely than cyclists (DfT, 2004). It should be noted however, that on the latter point, the findings do not state whether the comparison was based on collisions in urban or rural settings. The ratio of serious to slight injuries is also greater – a factor only prevalent in this mode of transport.

Some European countries have made good progress in reducing PTW deaths over the last decade but, generally, while the figures for other road users have tended to decrease, rider deaths have stagnated. Between 2001 and 2006, rider deaths fell on average by less than 1.5 per cent annually across Europe and rose in 13 out of 27 countries (ETSC, 2007). The ETSC have warned that a failure to act now on PTW safety will jeopardise progress toward the European Union casualty reduction target of halving deaths by 2010. To achieve this goal, a 7.4 per cent annual reduction is needed, far higher than the current level (ETSC, 2007).

It is also important to recognise that making roads safer for PTW riders has benefits for society and the economy as a whole. In Britain alone, 588 motorcyclists were killed, and a further 6,149 seriously injured, in road crashes in 2007 (DfT, 2008).

Estimates of the cost-benefit values that would be obtained by prevention of road accidents, taking account of the human and direct economic costs, quote a single fatality costing £1,428,180 and a serious injury costing £160,480 (DfT, 2007). Based on these figures, the cost of fatal and serious collisions involving PTWs in the UK alone amounts to some £1.8 billion (€2.3 billion).

Rider fatality rate per billion PTW-km (2006)

Norway*	30	Netherlands	104
Switzerland	33	France	114
Denmark**	36	Great Britain	115
Finland	40	Belgium	137
Germany	48	Spain	171
Portugal	59	Poland	193
Austria	64	Latvia	275
Sweden	65	Hungary	298
Greece	76	Czech Republic	314
Estonia	92	Slovenia	357
Ireland	103		

Source: ETSC, Road Safety PIN 7 (2007)
*Passengers included; **Mopeds not included
2005 BE, PL, SI; 2004 EL; 2001 PT; 2000 NL

Within the field of road infrastructure design, crash barriers are by far the most debated and contentious with regard to PTW safety. A review of the relevant national and international literature on the nature of PTW collisions with crash barriers by the Panel revealed a paucity of hard facts on the relationship between the two. Of those studies that do exist, most are outdated and refer to the same fundamental research from the 1980s. This, in itself, suffers from a lack of harmonisation in the testing methods and criteria used. It is no wonder then that there is little weight justifying the claims of those calling for road design and safety engineering countermeasures targeted at motorcyclists.

4. PTW collisions with crash barriers

Published research has concluded that hitting a crash barrier is a factor in 8-16 per cent of PTW deaths (Brailly, 1998; Domhan, 1987). Riders are 15 times more likely to be killed than a car occupant in this type of collision (Williams, 2004) and injuries can be up to five times more severe than if a rider had hit the rigid object that the barrier was guarding against (Ellmers, 1997; Brailly, 1998). The nature of impacts with barriers is such that riders are more likely to suffer injuries to lower extremities and vital regions of the body, such as the spine, head and thorax (ACEM, 2004; Hell *et al*., 1993; Peldschus *et al*., 2007, Quincy *et al*., 1988). Typical injuries include fractures, open fractures, serious internal injuries and, in some cases,

Image courtesy of ADAC

traumatic amputation. In the case of head injuries, barriers are particularly severe when compared to other fixed objects, with injuries classed as 'serious' and above occurring in 66 per cent of impacts with barriers, compared to 59 per cent with trees and 19 per cent with pavements (Ouellet, 1982).

The issue of motorcycles and crash barriers is not concentrated in Europe, but has also been identified as a growing problem in the US. A recent study found that motorcycles comprise just 2 per cent of the vehicle fleet but account for 42 per cent of all fatalities resulting from guardrail collisions. From 2000-2005, the number of car occupants fatally injured in guardrail collisions decreased by 31 per cent, but among motorcyclists increased by 73 per cent. Approximately, one in eight motorcyclists who struck a guardrail were fatally injured – a fatality risk over 80 times higher than for car occupants (Gabler, 2007), and far higher than the European figures.

A recent study of the efficacy of traditional w-beam barriers, as used on dedicated motorcycle lanes in Malaysia, found them to present a danger to riders, causing sliding and tumbling along the top of guardrail before landing on the ground, resulting in severe head injury. The study concluded that traditional guardrails are not adequately designed to prevent run-off accidents involving motorcycles (Ibitoye *et al*., 2007).

PTWs are especially vulnerable to collisions on bends and curves, where acceleration or deceleration occurs, or where the stability of the motorcycle is at stake and loss of control is more likely. A disproportionately high number of impacts happen on slip roads (i.e. roads with a tight radius) and on roundabouts (Williams *et al*., unpublished). These are precisely the areas where barriers are installed and where attention to detail is needed to ensure that adequate protection is provided.

Detailed assessments of crash reports have allowed a better understanding of PTW collisions but, in almost all cases they fail to specify the type of barrier involved, whether it contributed to injury severity, or even if it prevented a more serious crash. While some studies have attempted to quantify crash trends by barrier type, these are typically drawn from small samples of data and fail to weight the numbers by exposure to different types of barrier on the road network. The Panel therefore undertook to collect anecdotal evidence from riders, and in the absence of national or regional figures, made enquiries with coroners and the insurance industry for insight into the issue.

5. The need for a European testing standard

Crash barriers are designed to turn a large uncontrolled collision into a small controlled event, absorbing impact energy and reducing injury severity. While this is a good central tenet, designing for PTWs requires a very different approach from that used for other transport modes. A car hitting a barrier is in a controlled collision designed to redirect it away from hazards such as trees, lampposts or lighting columns, slowing it down over a short distance. The car's rigid external structure and secondary safety technology does the rest to minimise injury. Riders currently have no secondary safety systems to cushion the impact or to protect from aggressive components. For the most part, their bodies take the full force.

In the European context, the current full-scale impact test requirements for crash barriers are documented within the CEN EN1317 (1&2) Standard (European Committee for Standardization (CEN) 1998). This aims to provide a procedure whereby national regulations across the European Union can be harmonised to form a common approach. The norm identifies systems according to the type of vehicle that it should be able to restrain and includes criteria for containment, impact severity and deformation levels. These performance indicators are then used by road authorities in selecting the vehicle restraint system needed on different

types of road according to location, geometrical layout, and the existence of roadside furniture or drops and culverts adjacent to the carriageway. While barrier manufacturers are now offering products designed to protect motorcyclists from severe injury, in general, barriers are currently designed with the majority of road-users in mind, with the European testing standard including specific provisions for cars and heavy vehicles. No mention is made of motorcycles.

The EC-funded ROBUST (Road Barrier Upgrade of Standards) project aims to evaluate the relevance of CEN EN1317 test methods and acceptance criteria to real-life road safety. Analysis of single vehicle crashes on British roads, in which the first object struck was a safety fence, supports previous findings showing an increased risk to PTWs over other forms of traffic. The author points to the need for adequate recording of PTW collisions with crash barriers as essential to being better able to assess the issue (Williams, 2004). Phase 2 of the project will look further into specific testing for motorcycles.

With increasing levels of PTW use across Europe, and their greater level of risk, it is a serious omission that CEN EN1317 does not take riders into account. This is leading to the introduction of barriers that, while protecting vehicle occupants, can be lethal to riders. Across Europe, motorcyclists are dependent on the goodwill of local, regional and national road authorities to adapt existing systems, without the support and information they need to make sound engineering judgments. This disregard for the specific needs of PTWs led the Federation of European Motorcyclists' Associations (FEMA) to conclude that:

> *"The very construction of certain crash barriers in common use, with their exposed, sharp-edged metal posts, the height and profile of their guardrails, their proximity to the carriageway... could not be more damaging to motorcyclists coming into contact with them than if they had been designed with that objective in mind." (FEMA, 2000)*

Annual number of moped and motorcycle rider and passenger fatalities (2007)

	Moped fatalities	Motorcycle fatalities	All road-user fatalities	% of total moped	% of total motorcycle
Austria	24	96	691	3	14
Belgium	36	130	1,069	3	12
Czech Republic	3	136	1,221	0	11
Denmark	48	36	406	12	9
Estonia	4	10	196	2	5
Finland	11	32	380	3	8
France	324	853	4,620	7	18
Greece	43	420	1,612	3	26
Ireland*	-	55	337	-	16
Italy	388	1,070	5,625	7	19
Latvia	4	10	419	1	2
Lithuania	1	10	50	2	20
Hungary	31	112	1,232	3	9
Malta	-	4	12	-	33
Netherlands	60	64	709	8	9
Poland	53	157	5,444	1	3
Portugal	70	145	974	7	15
Spain	308	480	4,104	8	12
Sweden	13	58	471	3	12
United Kingdom**	17	571	2,946	1	19

Source: CARE, November 2008
2006 BE, ES; 2005 PL; 2004 IT, LU; 2003 IE
*IE does not separate mopeds and motorcycles, mopeds are counted as motorcycles
**UK excludes scooters with engine size <50cc, they have been counted as motorcycles

Following growing pressure from the motorcycling and road safety community, on 13 July 2008, members of the CEN Technical Committee on Road Equipment (TC226) adopted a resolution to develop a European standard to reduce the impact severity of motorcyclist collisions with safety barriers, considering the existing national standards and the possibilities of present day technology. A draft standard is expected in 2009, with adoption in 2010. Although this represents a significant milestone, the new work item has yet to be agreed and will only contain provisions for the evaluation of barriers when a rider is sliding along the ground. Other types of impact will be considered as a second step. Moreover, the extension to the standard will not consider where, and under what circumstances, motorcycle-friendly systems should be implemented.

In the absence of a pan-European standard, in-country test houses in Spain (CIDAUT), France (LIER) and Italy (AISCIO) have developed their own, leading to the adoption of national guidelines on the design and implementation of motorcycle-friendly designs by road authorities. It should be noted however, that the methods used vary and all assume that the rider is dismounted from the motorcycle and sliding along the ground on impact. No allowance is made for a rolling action or for riders who may impact the barrier while still mounted on their vehicle, which evidence suggests is a major issue.

In an examination of fatal crashes in England and Wales involving motorcyclists colliding with crash barriers, Williams *et al.* (unpublished) found that 47 per cent of impacts occurred when the rider was still on their motorcycle, with only 37 per cent sliding across the carriageway. Of these, 47 per cent were rolling and 12 per cent were not in contact with the ground. This is further supported by Peldschus *et al*. (2007) who found that motorcycle impacts with roadside barriers typically occur at speeds above 50 km/h under shallow angles. At the time of impact, the rider seems to be more often seated on the motorcycle in an upright position, rather than sliding on the ground, a finding also published by the European Advanced PROtection SYStems (APROSYS) project (Peldshus, 2005).

6. Design guidelines for road engineers

At FEMA's request, in 2001 the European Parliament adopted a resolution on the 'Priorities in EU road safety' stating that *"safety barriers must meet the specific safety requirements of motorcyclists"* (FEMA, 2005). In the absence of a pan-European standard for motorcycle-friendly barriers, organisations including the Federation of European Motorcyclists' Associations (FEMA, 2000), the Association of European Motorcycle Manufacturers (ACEM, 2006), the UK's Institute of Highway Incorporated Engineers (IHIE, 2005), and the Norwegian Motorcycling Union (NMCU, 2004) are leading the way in educating road authorities on delivering a safer road environment, listing best practice and design innovation across Europe.

Road authorities are also recognising the importance of crash barrier design to PTWs. In August 2006, the Design Manual for Roads and Bridges (TD19/06), the road design standards for authorities throughout the UK, was revised to include a provision to address the needs of motorcyclists and recommends the use of an add-on motorcycle protection system to post and rail type barriers to minimise the risk of injury:

> *"At sites identified, e.g., through accident records, to be high risk to PTW, such as tight external bends, consideration should be given to the form of crash barrier chosen to minimise the risk to this category of driver" (DMRB, 2006)*

While this recognises the need for attention, without knowing the design criteria to follow, the provision leaves the decision-making process to the road engineer and lacks the specific details needed to make an informed choice. Road engineers in the Netherlands use a decision tree approach to guide them through the selection process (see Annex 1).

The Swedish Road Administration (SRA) is currently developing a national strategy to identify high risk roads for PTWs and plans to revise the technical road design guidelines to take riders into account. Swedish motorcycle organisations are also helping road authorities to assess the features needed on new builds. Similar guidelines are already in operation in France, Germany, Italy, the Netherlands, Portugal, Spain and Switzerland, although the policies themselves vary.

While such initiatives are to be applauded, an integrated European-wide approach, where data are collated on a consistent basis and knowledge pooled and transferred, is essential in creating the momentum needed for real change.

Image courtesy of Cheshire County Council, UK

7. Motorcycle-friendly barrier systems

Current methods of achieving PTW-friendly crash barriers fall into one of three categories: secondary rail systems, protection for support posts, or barriers designed with motorcyclist safety incorporated. All are reactive rather than proactive measures, based on survivability in the event of a crash rather than preventing the collision in the first place. While quoted liberally in the existing literature in this area, in most cases the engineering evidence to support the design assumptions is lacking.

7.1. Secondary rails

Secondary rail systems such as *BikeGuard, Moto.Tub, Plastrail, Motorail* and *Shield* are metal rails or plastic tubes that fit below the existing barrier, preventing riders from sliding under the horizontal beams and offering protection from the metal support posts. They are the most common motorcycle-friendly systems being promoted.

France leads the way in applying these systems, with an ambitious five-year programme, begun in 2000, to retro-fit existing barriers at high-risk locations nationwide, particularly on slip road bends coming off and leading onto all motorways. The initiative is backed by a dedicated annual budget of €3 million for the fitting of new installations, with a further €2.3 million annually for the installation of systems to existing barriers at blackspots. Early evaluation suggests that these strategically placed systems will halve the number of biker deaths caused by traditional barrier designs.

Research has shown that injury risk to PTW riders, particularly to the head, is lower in modified steel guardrail systems (Berg *et al*., 2005; Williams *et al*., unpublished) and fatalities can be halved (Brailly, 1998) particularly when implemented in areas where collisions at shallow angles are likely (Domhan, 1987). Anecdotal evidence suggests that when fitted in areas of high PTW use in Switzerland, riders perceived the barrier to be a solid wall and slowed down on approach (TCS, personal communication). However, not all evidence is corroborative. Testing in Germany has suggested that secondary rail systems can have an adverse effect on cars, with an increased risk of mounting the barrier (BASt, 2004 cited in Williams *et al*., unpublished; LIER, personal communication).

7.2. Post design and protection

Despite inconsistent findings on the relationship between PTWs and different barrier types, most agree that the support posts are particularly aggressive, irrespective of the barriers' other components. Both the upright structure of the posts and their exposed tops present edges and corners that concentrate impact forces, exceeding biomechanical constraints and increasing injury severity. Impacts with barrier support posts have been estimated to cause a five-fold increase in injury severity compared to the average PTW crash (Pieribattesti *et al*., 1999).

Image courtesy of CIDAUT/Motoprotec

Increasingly implemented in mainland Europe, traditional I-shaped posts (IPE-100) are being replaced with large, thin-walled ∑-shaped versions with rounded edges. Where traditional I-shaped posts can cause fractures and amputations, sigma designs have been shown to result in bruising when tested under comparable conditions (Schmidt, 1985; Koch *et al*., 1987). FEMA cite an incident in which an I-shaped post was shown to have sliced through the helmet of a motorcyclist on impact resulting in instant death (FEMA, 2004). In the UK Z-shaped posts are more frequently used, but no research has been undertaken to examine the likelihood of injuries to motorcyclists from posts with this profile.

Unlike the secondary rail systems that use continuous protection along the length of the barrier, impact attenuators cover individual support posts. Such devices are easier to install in areas where PTWs are most vulnerable, such as on bends and curves. Considered to be cheap and effective, they can halve impact deceleration and force and double impact time (Jessel, cited in Williams *et al*., unpublished), and are capable of saving 25 per cent of all PTW fatalities and reducing injury severity by 50 per cent (Schnuell *et al*. cited in FEMA 2000). Spain is one of the few countries to have set safety standards for post impact protectors, with a number of devices approved for use by the Ministry of Transport.

7.3. Value for money

Precise costs for PTW-friendly products will be influenced by site conditions and market forces prevailing at the time, but FEMA (2005) estimates the total cost of installing a secondary rail to an existing barrier to be €18-25/metre. This compares with €19-25/metre for the installation of single-sided corrugated steel barriers, €9-15/metre for wire rope and approximately €31/metre for concrete barriers operating at the same level of containment as both corrugated steel and wire rope (quoted by the UK Highways Agency in Hansard, 23 March 2001).

Equipping just 10 per cent of all crash barriers with a PTW-friendly device offers a reasonable cost-benefit ratio (Domhan, 1987). If improvements are implemented only in areas where PTW crashes are concentrated or most likely, then the cost-benefits increase considerably. Evidence from trials of *BikeGuard* in the UK predicts good value for money with estimated rates of return of 400 per cent (personal communication).

7.4. Liability

Retro-fitting motorcycle-friendly systems has led to the issue of liability. According to the manufacturers of the *BikeGuard* system, the product has been tested to ensure that there are no adverse effects on the barrier to which it is attached. Subsequently, the providers of proprietary barriers in the UK have declined to accept responsibility for the performance of their device if an add-on product is used, stating that in these circumstances the responsibility will lie with the highway authority (personal communication).

The guidelines included in the UK's Design Manual for Roads and Bridges (TD 19/06) (DMRB, 2006) state that those responsible for designing a scheme using motorcycle-friendly devices must check with the barrier manufacturer that any such proposed protection will not invalidate the tests performed on them. Any add-on products must be approved by the highway authority responsible and be compatible with the barrier to which it is being attached.

Others have sought to clarify the legal implications of retro-fitting devices to existing systems. Epstein and Hunter (1984) concluded that an authority will not be held liable in the event that a person is injured on impact with a weak post system (such as the collapsible posts used in some wire rope designs). However, an authority that fails to use a safer post design when it is known that the existing structure presents a danger to road users may be held liable in negligence. Notwithstanding factors such as location, cost and road use, the authors concluded that there was no legal obstacle to the use of weak post systems, as used in wire rope barriers and indeed, the law may even compel their use.

8. The wire rope barrier debate

Much of the debate surrounding crash barriers and PTWs has stemmed from concern over wire rope barriers. Used extensively in Sweden and Australia for visibility at junctions, good post-impact behavior, low maintenance costs and good impact absorbing properties for cars, concerns over their safety implications for PTW riders has led to a moratorium on their use in a number of European countries, and strong opposition in others, while the risk is investigated.

Image courtesy of ADAC

Few crashes involving motorcyclists and wire rope barriers have been reported. Analysis of those that do exist shows a conflicting picture. In Sweden, wire rope barriers have reduced PTW fatalities on treated routes by up to 90 per cent (Larsson *et al*., 2003) and unpublished research commissioned by the SRA (and subsequently supported by experience in the Republic of Ireland and Iceland) found that more PTW lives were saved in situations where cars would have crossed into the opposing traffic flow, than PTW lives that would have been lost by crashes into the barrier itself. In contrast, others have shown that wire rope barriers are substantially less safe for PTWs compared with other road users (Pieglowski, 2005) or barrier types (Williams *et al*., unpublished), although both stress that the actual number of incidents is low.

Given the conclusion that the supporting posts of barriers present the greatest threat to injury severity in the event of a crash, wire rope systems have come under fire for both the prevalence and exposure of this component. So-called 'frangible posts', designed to collapse on impact, are used extensively in Sweden and Australia in combination with wire rope systems. But the concept of 'frangibility' depends on the nature of the object impacting them. Designed to collapse when struck by a car, their effectiveness when struck by objects of lesser mass and rigidity, such as a human body, has been questioned (Larsson *et al*., 2003). For example, the *Flexfence* wire rope system used in Victoria, Australia is tensioned to 80kN (4 cables each tensioned to 20kN) and designed to deflect 1.3 metres when impacted at 110kph by a 1.5 tonne vehicle (VicRoads, 1988). To a much lighter motorcyclist this would be equivalent to hitting a rigid object.

The Panel concludes that, despite the amount of high profile coverage that wire rope barriers have attracted, limited research does not warrant the inference that they are more or less dangerous than other types of barrier on the market.

9. Conclusion

Compared with developments in safe vehicles and safe behaviour, there has been a relative lack of attention to safe road infrastructure for motorcyclists. While there are many elements to the layout of a road and how traffic is managed on it in this respect, crash barriers have emerged as a focal point. When an obstacle-free roadside is not achievable and crash barriers are needed, the Panel believes that motorcyclists have the right to expect and demand safe vehicle restraint systems. In conjunction with motorcycle-based countermeasures, there is a critical need to adopt improved barrier designs to protect these vulnerable road users.

Existing crash figures, backed by new evidence coming to light, suggest that absolute numbers of PTW impacts with crash barriers are small but may be under-reported. When they do occur, injury severity is high. Building protection into the safe road system through the implementation of countermeasures that aim to reduce the likelihood of collisions occurring in the first place, and to protect from death or disabling injuries when a crash does occur, will minimise the cost burden to society and the economy as a whole and offers good value for money if installed in areas of high motorcycle use or where the likelihood of crashes involving motorcycles is high.

Building on previous work such as the Motorcycle Accidents In-Depth Study (MAIDS), the first complete European study in this area (ACEM, 2004), further research is needed to increase recognition of the importance of compatibility between the

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vehicle and the road infrastructure in this mode of transport. In-depth studies of PTW crashes across Europe are urgently needed to establish the criteria to which the designers of barriers should aspire and the circumstances under which an impact is likely to take place. If necessary, new barrier designs should be developed, or existing systems altered to meet the target specifications. Road authorities are looking for proactive strategies in terms of what will offer the best value for money, so attention must be given to ensuring cost effectiveness in terms of installation, return on investment and service life.

The Panel commends the good works across Europe that show innovation in practice. Anecdotal evidence and real-world demonstration projects suggest that PTW-friendly add-on products such as secondary rails and impact attenuators, in our belief, are likely to reduce injury severity. However, the lack of casualty data, evidence of causation and research into the engineering characteristics of such devices, warrants further investigation. In the meantime, cost-benefit estimations support fitting one or more PTW-friendly systems until further and better products are available. Mass action approaches to motorcycle-friendly design show the gains that can be made from dedicated investment proportionate to the problem and set a reference model for others to follow.

Engineers should not be forced to make life and death decisions on the basis of incomplete information at a time when PTW collisions are accounting for increasing proportions of fatal and serious injury figures across Europe. Existing standards and guidance must be revised to take account of crash barriers and restraint systems in the same way that they are available for other road safety countermeasures.

A technical design manual is needed that includes a clear formula for the implementation of systems appropriate to a specific site or route, both on existing roads and on new builds. Until such time, in the light of evidence suggesting a high risk to PTWs, road engineers should be encouraged to question the need for a crash barrier in the first instance. According to the Road Safety Department of the French Ministry of Transport, 15 per cent of crash barriers are useless and would be better if they were removed completely, i.e. it would be safer to exit the road into a field than to crash into the barrier (cited in FEMA, 2005). Where they are deemed necessary, the implications for all road users must be considered.

The road safety community must work closely with road engineers in defining and implementing a European-wide system that can sit within the structure of national guidelines and be followed as part of the normal process, both for existing roads and for new builds. This in turn will inform manufacturers of the decisions that road engineers take when designing and implementing a safe road environment. In the short term, countries that do not currently have road design standards for PTWs should develop their own using existing guidelines from others.

10. Recommendations

The EuroRAP Motorcycle Safety Review Panel recognises that any changes to the European testing standard will take time to implement. It therefore makes the following recommendations for action which it believes are achievable in the interim period:

- Identifying the roads most often used by PTWs is an important exposure factor in establishing risk, giving a more realistic view of what can be achieved by engineering countermeasures without over-estimating expectations. The standardised protocols used within Road Assessment Programmes worldwide are capable of measuring and mapping risk across a network according to crash type and road user mode. Member countries will be encouraged to extend their programmes to analyse the risk patterns for motorcyclists, and by doing so make a significant contribution to knowledge in this area.
- An essential step in identifying the true extent of the issue is the systematic collation of crashes involving PTWs to identify the true scale of the problem. Initiatives are due to commence in Australia (University of New South Wales, offering a scholarship for the study of Motorcycle Crashes into Roadside and Median Road Safety Barriers) and the US (Transportation Research Board, NCHRP 22-26, Factors Related to Serious Injury and Fatal Motorcycle Crashes with Traffic Barriers). When collisions involving crash barriers are reported, the nature of the barrier and the circumstances under which it was struck is vital information and should be included as standard on collision report forms. Consideration must be given to a way in which this can be done to prevent over burdening those involved in recording incidents.

- Demonstration projects showing the pre and post implementation of motorcycle-friendly devices under real-world conditions should be encouraged and collated. Impact assessment on other road users should not be forgotten. Such projects are essential in showing that casualty reduction is achievable, while not endangering other transport modes.
- Mode-specific risk reduction targets should be set. National statistics show that the motorcycle element does not match the profile of other accident trends. Setting targets separately in this way will be useful to road authorities and others in showing the contribution of PTW crashes to overall casualty figures and their effect on reaching national and European road safety targets.
- Road engineers urgently need clear criteria for the design of crash barriers and guidance on where they should be implemented, in the same way that they are available for passively safe support structures such as lampposts and lighting columns. The Netherlands, for example, already use a decision tree approach to guide them through the selection process (see Annex 1). In the absence of a pan-European approach, such in-country examples provide a good basis for others to adapt to their own circumstances.
- Every road safety engineering department should have a motorcycle champion, as is the case in France. Such a measure would introduce a cultural change to the way in which risk is viewed from a road authority perspective and highlight issues facing motorcyclists and the road infrastructure that are not currently being adequately addressed.
- The EuroRAP Motorcycle Safety Review Panel fully supports the developments underway to incorporate the specific needs of PTWs into crash barrier design and implementation. It commends the intention of CEN to extend the current testing standard but warns that the amendment only goes some way towards tackling the issue, testing only those situations where a rider has been dismounted from their vehicle and impacts the barrier in a sliding position. Pressure must be mounted to extend the testing standard further by including provisions for motorcyclists still mounted on their vehicle. Add-on protective devices must also be included.

Image courtesy of Highways Agency, UK

11. References

ACEM (2004). MAIDS: *In-depth investigation of accidents involving powered two wheelers.* Association of European Motorcycle Manufacturers, Brussels, September 2004.

ACEM (2006). *Guidelines for Powered Two-Wheelers - Safer Road Design in Europe.* Association of European Motorcycle Manufacturers, Brussels, April 2006.

ACEM (2007). *ACEM Yearbook 2007: Facts and figures on Powered Two-Wheelers in Europe.* Association of European Motorcycle Manufacturers, Brussels, November 2007.

Berg, F.A., Rucker, P., Gartner, M., Konig, J., Grzebieta, R. and Zou, R. (2005). *Motorcycle impacts to roadside barriers – real world accident studies, crash tests and simulations carried out in Germany and Australia.* International Technical Conference on the Enhanced Safety of Vehicles (ESV), Washington DC, June 2005.

Brailly, M. (1998). *Etude des accidents de motocyclistes avec choc contre glissières de sécurité.* Proceedings of the 2nd International Motorcycle Conference, Institut für Zweiradsicherheit, Essen, Alemanha, 1998.

Design Manual for Roads and Bridges (DMRB) (2006). Volume 2, Highway Structures: Design (Substructures and Special Structures) Materials, Section 2, Special Structures, part 8, TD19/06. Requirements for Road Restraint Systems. TSO, London, August 2006.

DfT (1998). *The White Paper on the future of transport, A New Deal for Transport: Better for Everyone.* Department for Transport, HMSO, London, 1998.

DfT (2004). *Advisory Group on Motorcycling: Final Report to Government.* Department for Transport, TSO, London, 2004.

DfT (2007). *Highways Economics Note No.1: 2005 Valuation of the Benefits of Prevention of Road Accidents and Casualties.* Department for Transport, TSO, London, January 2007.

DfT (2008). *Accidents and Casualties Great Britain 2007.* Department for Transport, TSO, September 2008.

Domhan, M. (1987). *Guardrails and Passive Safety for Motorcycles.* Vehicle Highway Infrastructure: Safety Compatibility. Warrendale, Pa.: Society of Automotive Engineers.

Ellmers, W. (1997). *Guardrail post-protection for improving the safety of motorcycle riders.* 7th International FERSI/TRB Conference, Traffic Safety on Two Continents. Lisbon, Portugal, September 1997.

Epstein, J. A. and Hunter. L.L. (1984). *The legal implications of frangible poles.* Office of Road Safety, Australian Department of Transport, Report No. CR 31.

European Committee for Standardization (CEN) (1998). *European Standard EN1317-1 & 2, Road restraint systems - Part 1: Terminology and general criteria for test methods, Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers.* European Committee for Standardization (CEN) Brussels, Belgium, 1998.

ETSC (2007). *Reducing motorcyclist deaths in Europe.* PIN: Road Safety Performance Index, Flash 7. European Transport Safety Council, 18 December 2007. Background tables available from http://www.etsc.be/documents/copy_of_Background%20tables.PDF

FEMA (2000). *Final report of the Motorcyclists and Crash Barriers Project.* Federation of European Motorcyclists' Associations, Brussels.

FEMA (2005). *The Road to Success – Improving Motorcyclists' Safety by Improving Crash Barriers.* Federation of European Motorcyclists' Associations, Brussels, July 2005.

Gabler, H.C. (2007). *The risk of fatality in motorcycle crashes with roadside barriers.* Proceedings of the 20th International Conference on Enhanced Safety of Vehicles, Lyons, France, June 2007.

Hell, W. and Lobb, G. (1993). *Typical injury patterns of motorcyclists in different crash types – effectiveness and improvements of countermeasures*. 37th Annual Proceedings for the Advancement of Automotive Medicine, San Antonio, Texas, 1993.

Image courtesy of FEMA

House of Commons Hansard, Written Answers for 23 March 2001 (part 7). Session 2000-01, volume 365. http://www.publications.parliament.uk/pa/cm200001/cmhansrd/vo010323/text/10323w07.htm

Ibitoye, A.B., Radin, R.S., and Hamouda, A.M.S (2007). *Roadside Barrier and Passive Safety of Motorcyclists along exclusive motorcycle lanes.* Journal of Engineering Science and Technology, Vol. 2, No. 1, pp. 1- 20.

IHIE (2005). *IHIE Engineering Guidelines for Motorcycling.* Institute of Highway Incorporated Engineers, London. http://www.motorcycleguidelines.org.uk/

Kanbe, S., Deguchi, M. and Hannya, Y. (2007). *Basic Research for a new airbag system for motorcycles.* Proceedings of the 20th International Conference on Enhanced Safety of Vehicles, Lyons, France, June 2007.

Koch, H., and Schueler F. (1987). *Reduction of injury severity involving guardrails by the use of additional W-beams, impact attenuators and 'sigma-posts' as a contribution to the passive safety of motorcyclists.* 11th International Technical Conference on Experimental Safety Vehicles, Washington DC, 1987.

Larsson, M., Candappa, N.L., and Corben, B.F. (2003). *Flexible Barrier Systems Along High-Speed Roads – a Lifesaving Opportunity.* Monash University Accident Research Centre Report No 210, 2003.

Norway Public Roads Administration (2004). *MC Safety. Design and Operation of Roads and Traffic Systems.* April 2004.

Ouellet, J.V. (1982). *Environmental hazards in motorcycle accidents.* 26th Annual Proceedings American Association for Automotive Medicine, Ottawa, October 4-6 1982. Proceedings, pp. 117-129.

Peldschus, S. (2005). *APROSYS SP4: Report on accident scenarios for motorcycle-motorcyclist infrastructure interaction*. State-of-the-art. Future research guidelines. AP-SP41-0003. http://www.aprosys.com/Documents/deliverables/AP_SP4_0003.pdf

Peldschus, S., Schuller, E., Koenig, J., Gaertner, M., Ruiz, D.G. and Mansilla, A. (2007). *Technical Bases for the development of a test standard for impacts of powered two-wheelers on roadside barriers.* Proceedings of the 20th International Conference on Enhanced Safety of Vehicles, Lyons, France June 2007.

Pieglowski, T. (2005). *The Influence of Wire Rope Barriers on Motorcyclists.* Master's Thesis, Lulea University of Technology, Sweden. ISSN: 1402-1617.

Pieribattesti, F. & Lescure, B. (1999). *New safety barriers better adapted to the restraint of motorcyclists.* RGRA No. 779.

Quincy, R., Vulin, D. and Mounier, B. (1988). *Motorcycle impacts with guardrails.* Transportation research circular. International roadside safety hardware research, No. 341, December.

Schmidt, G. (1985). *Essais biomechaniques conernmant la protection passive contre les accidents d'utilisateurs des deux roués motorises lors du choc contre les supports de glissieres de securite.* Heildelberg University, Germany.

Transportation Research Board (TRB): http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=2516

VicRoads (Road Safety Department). (1998). *Flexfence Wire Rope Safety Barrier.* Safe Roads, no.105.

Williams, G.L. (2004). *ROBUST: Road Barrier Upgrade of Standards*. Work Package 1, Barrier Performance for Real Life Accidents. Task 1.1. Collection of statistical data from real life use of barriers. Transport Research Laboratory, August 2004.

Williams, G.L., McKillop, J.K., and Cookson, R.E. (unpublished). *Safety Barriers and Motorcyclists.* Transport Scotland.

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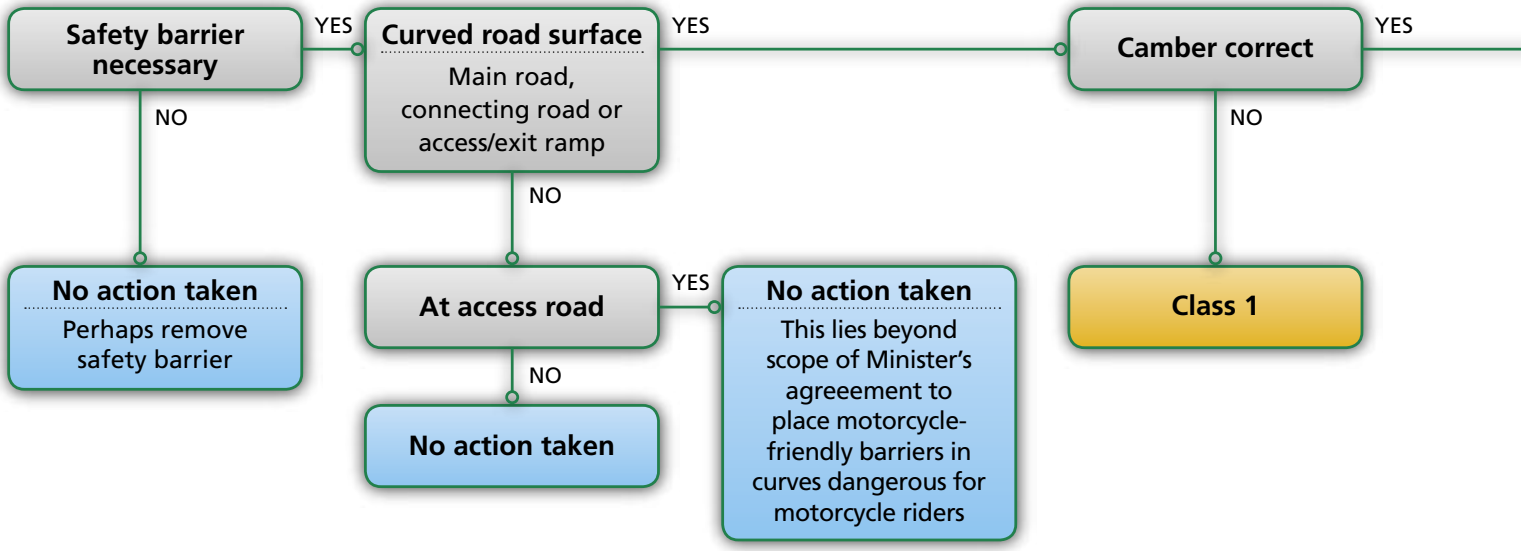
Annex 1: Dutch decision tree



Classification of radius of curve

	Curve [m]
Radius 1	R < 100
Radius 2	100 < R < 250
Radius 3	250 < R < 400

* Problems of visibility

The present guidelines are considered standards in determining if there are problems of visibility. Below is a table that summarises the minimum distances for vision in various situations.

	distance of vision in various situations [m]		
design-speed [km/h]	continuous view of course of road	view of stationary traffic queue	view of obstacle in one lane
120	165	260	235
90	120	135	165
70	90	80	100
50	55	40	70

† Room to swerve out of the way

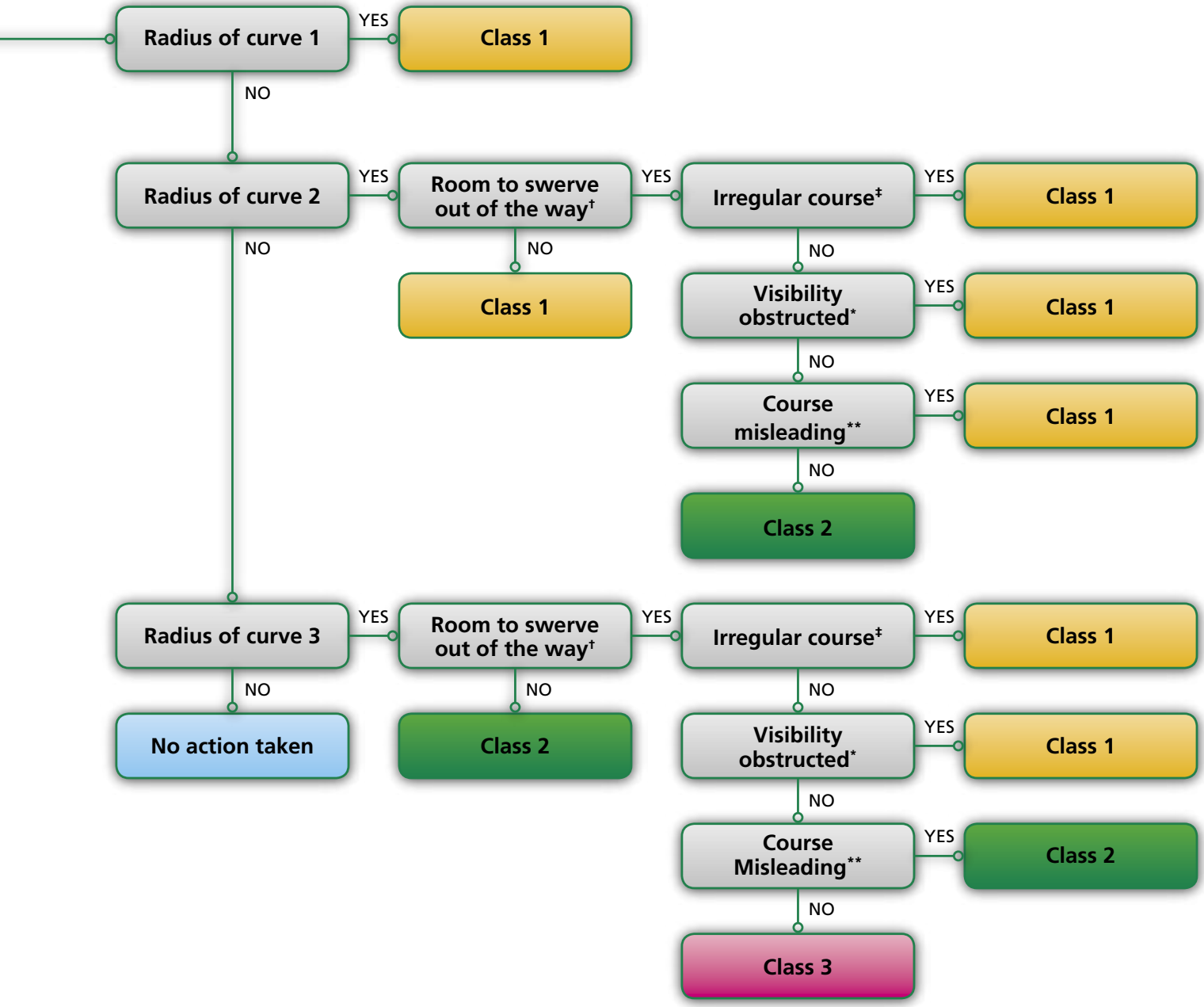
There is sufficient room to swerve out of the way if on the outside of the curve there is a hard strip of at least 1.75 m between the inside of the sideline and the safety barrier.

‡ Irregular course

e.g. sudden changes in the radius of the curve.

** Course misleading

Misleading course occurs if the appearance of the road suggests something other than its actual course. This is often the case if vertical elements (trees, lampposts) follow a course that differs from the hard surface.



No action taken	no measures
Class 1	measures to be taken soon
Class 2	measures to be taken before too long
Class 3	(for the moment) no measures

Compiled by the Dutch Ministry of Transport (AVV), Motorcycle Action Group (MAG) Netherlands, & Royal Dutch Motorcycle Club (KNMW)

Barriers to change
designing safe roads for motorcyclists

Position paper on motorcycles and crash barriers

Motorcycling is becoming increasingly popular for both leisure and commuting. The number of bikes in use across Europe reached over 17 million in 2005, an increase of nearly 50 per cent in less than ten years.

Motorcyclists are more likely to be killed in crashes than other road users. They account for just two per cent of road travel but 16 per cent of all road deaths. Bikers are four times more likely to die than pedal cyclists and 30 times more likely than car occupants. Whilst road deaths in the EU have reduced significantly, motorcycle deaths have not. As a result, the EU may fail to reach the target of reducing road deaths by a half this decade.

This paper is from the international Panel established by EuroRAP to look at safe road design for motorcyclists. The Panel included motoring clubs, motorcycle manufacturers, riders' organisations, practitioners, and national and regional road authorities.

The paper shows that motorcycle crashes cost the European economy billions annually and argues that the response is not proportionate to the scale of the problem. It examines crash barriers that routinely save the lives of car occupants but can cause traumatic death to motorcyclists.

The Panel's work shows that simple measures, such as adding protection to barriers on tight curves where riders are most likely to be hurt, need to be systematically introduced on a large scale. EuroRAP risk analysis can help guide engineers to priority sites. Road authorities can appoint in-house champions, as in France, to assure action on unacceptable risks to motorcyclists.

The Panel welcomes the proposed extension of the European barrier testing standard to take account of motorcyclists for the first time, but argues that the proposed changes do not go far enough to address the majority of real world crashes.

This paper needs to be read by everyone who wants practical action on designing safer roads for motorcyclists.

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