

DEKRA Automobil GmbH

MOTORCYCLE ROAD SAFETY REPORT 2010

Strategies for preventing accidents
on the roads of Europe



Accident frequency:
Risk for motorcyclists
remains high

Human Factor:
Fair cooperation on
two and four wheels

Vehicle safety:
ABS and airbags
save lives

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Increased partnership is necessary

Motorcycling is enjoying an extraordinary boom in popularity. According to the "Report 2010" of the Association des Constructeurs Européens de Motocycles (ACEM) (European motorcycle manufacturers' association), the number of motorcycles throughout the European Union rose from 16 million to more than 22 million between 2001 and 2008. This is a growth of, believe it or not, around 38%. Taking all two-wheeled motor vehicles into account, in 2008 approximately 33 million vehicles were registered.

At the same time, motorcycles are by far the most dangerous means of transport. In 2008 the European accident database CARE (Community database on road accidents) recorded 5,126 fatalities amongst motorcyclists (EU-24), which is around 14% of the 37,234 fatalities in these 24 States. When one considers that, according to CARE, two-wheeled motor vehicles account for just 2% of all road users (2006 survey), 14% is a very high proportion. This underlines the potential risk for motorcyclists on Europe's roads. That is precisely the reason why DEKRA is devoting its Road Safety Report 2010 to this category of vehicle.

DEKRA has attached great importance to motorcycles for many years. By carrying out main inspections, accident analyses and crash tests, and by being involved in countless national and international projects, DEKRA has committed itself in many ways to the safety of motorcyclists on our roads.

In addition to single-vehicle accidents, the focus here is always on the passenger car, as the other vehicle most frequently involved in a collision with a motorcycle. A survey of 1,500 motorists and motorcyclists just published by DEKRA showed that cooperation between these two target groups could be much improved. Three out of four motorcyclists called for greater consideration from motorists. Conversely, one in two non-motorcyclists demanded that greater consideration be paid by motorcyclists to other road users. Of those surveyed, 40% were even of the opinion that motorcyclists and motorists often behaved not as partners but as opponents.

According to the survey, 69% of motorists accused motorcyclists of driving dangerously. Surprisingly, one in two motorcyclists agreed. As to how motorcycling could be made safer, 61% of respondents were in favour of regular safety training for motorcyclists, 56% advocated more noticeable clothing for motorcyclists, and 54% were in favour of introducing minimum criteria for protective clothing for motorcyclists. Half of respondents were of the opinion that fitting new motorcycles with an anti-lock braking system as standard would ensure greater safety.

Most of this report is devoted to the passive and active safety of motorcycles, supported by some remarkable figures. But the publication is much more than a collection of facts about the real-world situation. In matters of the road safety of



Dipl.-Ing. Clemens Klinke, Member of the Board of DEKRA AG, Head of the Business Unit DEKRA Automotive, and Chairman of the Management Board of DEKRA Automobil GmbH.

motorcycles, questions need to be asked of politicians, traffic experts, manufacturers, as well as scientific institutions and associations. For them, this publication is intended to give food for thought and advice. The report also makes recommendations to all motorcyclists on how they can make a positive contribution towards further reducing the number of accidents resulting in death and injury.



NOTE

This report deals with the road safety of motorcycles. The German Federal Motor Transport Authority responsible for stock statistics uses the term "Kraftträder", over 98% of which are two-wheeled vehicles (motorcycles and scooters) with a registration plate, including light motorcycles with a cylinder capacity of up to 125 cm³. The rest are three-wheeled vehicles and light four-wheeled vehicles with registration plates. For this group of vehicles the German Federal Motor Transport Authority responsible for accident statistics uses the phrase "motorcycles with registration plates" ("Motorräder mit amtlichem Kennzeichen"). The corresponding driving licences are categorised as category A1 (for light motorcycles) and A (for motorcycles and scooters).

Two-wheeled motor vehicles with insurance registration plates (powered cycles, mopeds, small motorbikes up to 50 cc, three- and four-wheeled vehicles and electrical wheelchairs) are not considered. These vehicles can already be driven with a category M driving licence or even a special driving licence. In international language use the vehicles dealt with in this report are referred to as "motorcycles and scooters". The phrase "powered two-wheelers" also covers "mopeds".

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High fun factor – but also high risk

Motorcycling has always been fascinating. No other form of motorised locomotion gives the driver a comparable feeling of dynamism, agility and freedom. But right from the start the special fascination of motorcycling was accompanied by an increased risk of serious accidents. On top of that, motorcycles – despite all the positive developments, especially in recent years – cannot possibly offer the same active and passive safety as passenger cars.

Although the 2009 economic and financial crisis no more spared the motorcycle industry than any other vehicle manufacturer, the fascination of the motorcycle is undiminished. According to the “Report 2010” of the Association des Constructeurs Européens de Motocycles (ACEM) (European motorcycle manufacturers’ association), in 2008 there were more than 33 million two-wheeled motor vehicles in use in Europe. The ACEM is expecting this figure to rise to between 35 and 37 million by 2020. Two-wheeled motor vehicles encompass motorcycles, scooters and mopeds. At 22.2 million, motorcycles accounted for around 66%

of the 33.7 million two-wheeled motor vehicles. This means a rise of almost 40% compared to 2001, when there were some 16 million motorcycles. At 1 January 2009, the EU countries with the most registered motorcycles were Italy (5.9 million), Germany (3.7 million), Spain (2.5 million) and France (1.4 million).

As far as Germany is concerned, engines with a cylinder capacity of between 500 cm³ and 749 cm³ accounted for the biggest proportion (27.5%) of all registered motorcycles. The larger cylinder capacity categories taken together had a share of 32.6% (Figure 1). It is also interesting to note that, in the last 20

years the average age of all registered motorcycles has risen much higher than that of the passenger car. While, in 1990, the average age of motorcycles was just under eight years and that of passenger cars was more than six years, in 2009 the average age of registered motorcycles was just over thirteen years, whereas that of passenger cars was “just” a little over eight years. These Federal Motor Transport Authority figures are also reflected in the main inspections carried out by DEKRA of both these categories of vehicles (Figures 2 and 3).

Motorcycles, at least in the northern and central countries of the EU, are

Safety-relevant milestones in the development of the motorcycle (selection)

Sources: Department of Automotive Engineering at the Technical University of Darmstadt, DEKRA

1888

J. B. Dunlop
pneumatic tyre
(re-invention)



1894 Advertisement for the first mass-produced motorcycle in the world

1924

Chain drive
triumphs over
belt drive

1880

1885

1890

1895

1900

1905

1910

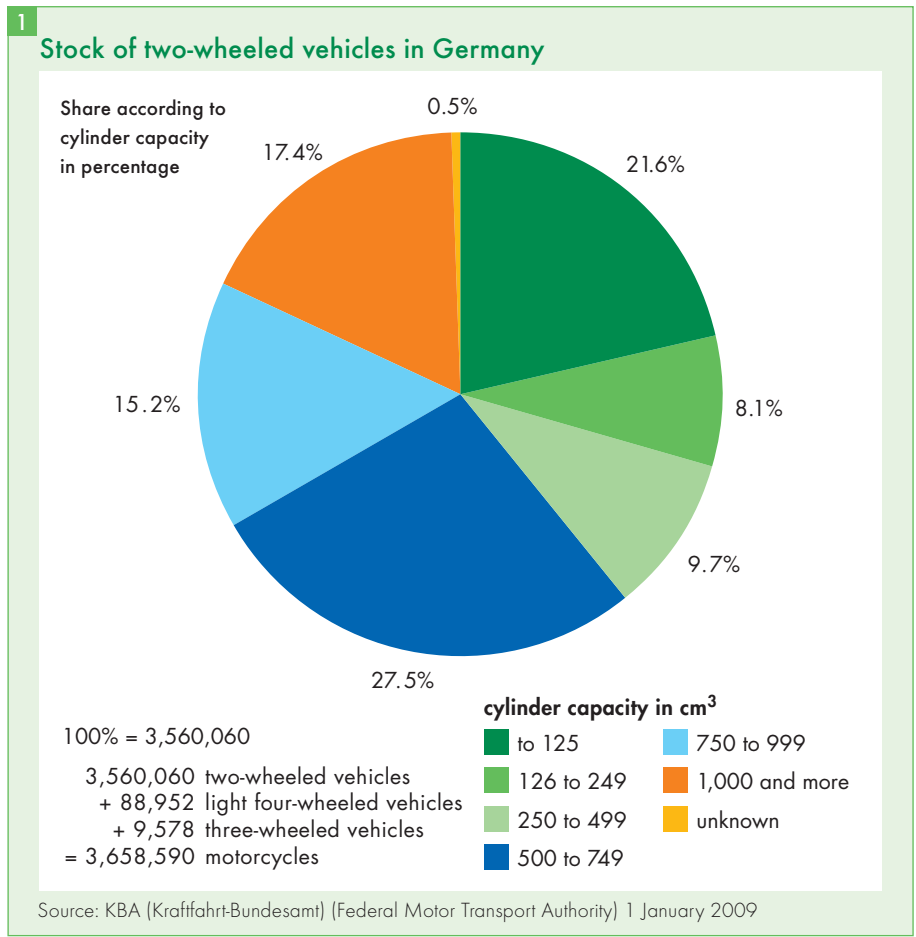
1915

1920

1925

used quite differently from passenger cars and are essentially a “recreational object”. In the first few years after purchase motorcycles are mostly ridden a great deal. With increasing age, not only does the number of vehicles fall but the annual mileage also decreases. Older motorcycles that are not put out of operation gradually acquire the status of collectors’ or classic vehicles, which are moved very little but are mostly well looked after. This does not of course apply to motorcycles that can be ridden from the age of 16 with a Category A1 driving licence. Schoolchildren and apprentices in particular use these vehicles as the only opportunity to actively participate in private motorised transport, which they do at all times of the year and in all weathers, especially in rural areas with no ÖPNV as a “genuine” alternative. Also, from the age of 18, those who cannot afford (or do not want) a passenger car travel very frequently by motorcycle every day.

Anyone who rides a motorcycle, whether for recreation or for work, is always exposed to a comparatively high risk of being involved in an accident. In the EU the mileage-related risk of being killed in a road traffic accident is 18 times higher for motorcyclists than



Better use of the traffic area

A two-wheeled motor vehicle takes up less space than a passenger car in both moving and stationary traffic. Like the passenger car, it is usually occupied by a single person. With the same transport capacity, therefore, a two-wheeled motor vehicle makes a contribution to improving how we use an increasingly dwindling traffic area. In fact, in cities like Paris and Rome, individual transportation would just not be able to function without two-wheeled motor vehicles. Nor should it be forgotten that, because of its lower weight, it uses less fuel than a passenger car.



1953
 Advertising poster for the Zündapp KS 601 (“Green Elephant”)



1969
 First mass-produced motorcycle with disk brakes (Honda CB 750 Four)

1930

1935

1940

1945

1950

1955

1960

1965

1970

1975

it is for other road users. Experience also shows that, when an accident occurs, the injuries received are often serious or even life-threatening. One reason for this is that motorcycles do not have a protective passenger compartment. In an accident,

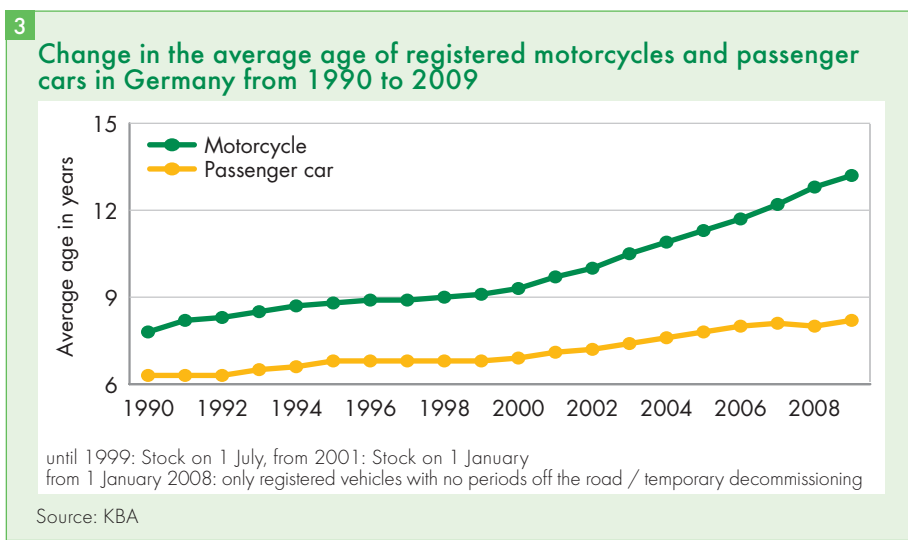
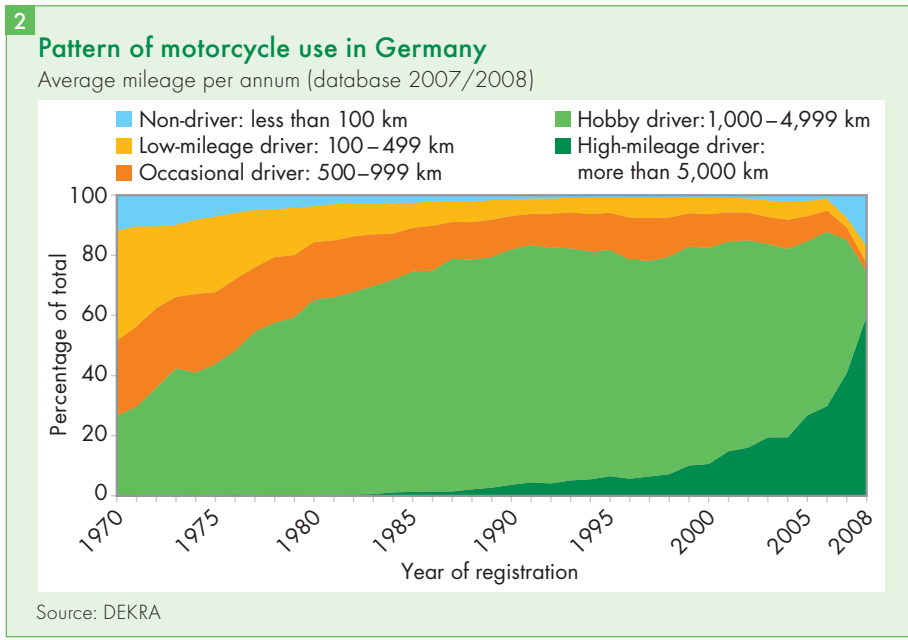
therefore, the impact forces act directly on the motorcyclist. Also, as far as dynamic handling stability is concerned, motorcyclists can reach their limits – for example in poor road conditions – much faster than a passenger car, for example.

SAFETY MOTORCYCLES AS SAFETY CELL VEHICLES?

When, at the end of the 1960s, the mobile societies in Europe, USA and Japan were no longer willing to accept the death toll of road traffic accidents, large-scale research and development programmes were initiated in order to improve vehicle and road safety. The older generation still remember the “US specifications” of passenger cars from the 1970s with concertina lateral coverings in the area behind the front bumper. These specifications represented the first standard implementation of research findings for the improvement of passenger safety, which had previously been obtained by means of crash tests with experimental safety vehicles. Research also began at that time to improve the passive safety of motorcycle occupants.

An interesting reference to more distant historical contributions to the development of motorcycle safety is to be found in the conference proceedings of the Second International Congress on Automotive Safety, which took place in July 1973 in San Francisco, one of the subjects dealt with being “motorcycles and recreational vehicles”. There have been reports that, in March 1972, the National Highway Traffic Safety (NHTSA) in the U.S.A. approached the Japan Automobile Manufacturing Association (JAMA) concerning international cooperation in the context of an experimental safety motorcycle project.

Whereupon a working group was set up to engage intensively with the subject. It was recognised that action was urgently needed and the motorcycle industry demonstrated the will to act accordingly. However, one of the fundamental discoveries was that it would be impossible to transfer the knowledge acquired at that time during the development of safety motor vehicles, especially in the area of passive safety, to the corresponding concept of a safety motorcycle. As



1980
Hydraulic anti-drive system (Japan)

1983
Motorcycle with its in-line 4-cylinder engine mounted lengthways, fuel injection and integrated leg guards (BMW K 100); also the basis for safety motorcycle studies (HUK Verband, DEKRA)



Jan Mücke,
Parliamentary State
Secretary at the
Federal Ministry of
Transport, Building
and Urban Affairs

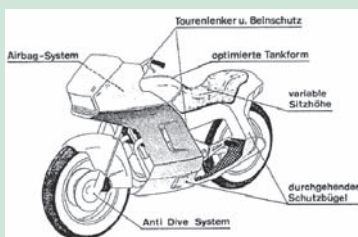


“Far too many motorcyclists are still involved in accidents, especially on rural roads. Excessive speed comes into play in 70% of cases and almost 80% of accidents occur on bends in the road. With the support of the internet, campaigns conducted by the German Traffic Safety Council or the “German Safety Tour”, under the patronage of the Federal Minister Ramsauer, and we continue to do all we can to increase motorcycling safety. In early spring in particular the Federal Ministry of Transportation launches safety campaigns, whilst also highlighting the risks to which motorcyclists are exposed at the start of the “dark season”. For many years we contributed to this by providing funding for safety training for riders of two-wheeled vehicles until such training was established in the market. That motorcyclists now drive with their lights on and are therefore easily recognised on traffic is important for their safety. That is why I am utterly opposed to compulsory daytime headlights for passenger cars and lorries, as this would lead to motorcyclists no longer standing out and to their being easily ignored. The Federal Ministry of Transport welcomes technical developments such as ABS for motorcyclists. Year after year, road signs with sharp edges cause avoidable deaths and serious injuries. I am an ardent advocate of delimitation posts made of soft plastic, which bend over when a motorcyclist involved in an accident hits them. We have urged the highway authorities of the Länder, when carrying out surfacing work, not to use any material that could cause motorcycles to skid and could be a deadly risk to motorcyclists.”

Doichi Aoki of JAMA put it: “Were one to do this, the motorcycle would mutate into a vehicle that could no longer be called a motorcycle.”

This conflict of objectives remains just as relevant today. The motorcycle is a highly individualised form of transportation. From the “easy rider”, who really wants nothing else but to ride a chopper, to the extremely sports-oriented motorcyclist, for whom there is no alternative to a high-performance racing machine (which can be used on public roads), there is a whole range of individuals with their special preferences. All have one thing in common: they travel along the roads astride a two-wheeled motor vehicle. The introduction of changes to the engineering and design of a motorcycle that do nothing more than improve safety and change the original characteristics of the preferred motorcycle type are often looked upon with scepticism or even radically rejected.

As mentioned above, the “classic” motorcyclist is not protected by any surrounding bodywork with an occupant cell, restraint systems and upholstery. In terms of accident research, therefore, he or she belongs to the group of “unprotected road users”, which includes pedestrians and cyclists. However, the fact that enormous progress has been made in the improvement of the safety of cyclists is largely due to improvements in the active safety of motorcycles, protective clothing (helmet, suit, protectors, gloves and boots), the development of road traffic legislation with restrictions on the acquisition of the motorcycle driving licence (graded motorcycle driving licence), advanced training through driving schools, improvements in transport infrastructure, improved rescue services – and, of course, the impact of continuous information and road safety campaigns, in which road users are alerted to the risks and asked to take care and give consideration to other road users.



1985
 HUK Verband
 safety motorcycle

1988
 ABS motor-
 cycle (BMW K
 100) goes into
 production



1996
 First motorcycle with
 a combined braking
 system in conjunc-
 tion with ABV and
 traction control
 (Honda ST 1100)

1988

1989

1990

1991

1992

1993

1994

1995

1996

1997



Numerous institutions also offer special motorcycle training for women.

Reiner Brendicke, General Executive Manager of the German Motorcycle Industry Association (Industrie-Verband Motorrad Deutschland e. V.)



“When it comes to the development of vehicles, manufacturers of two-wheeled motor vehicles put safety right at the top of their list of priorities. Suspension systems with exceptional tracking stability and the corresponding spring elements as well as high-tech tyres combine to create the basis for safe road use. Since Honda first introduced an electronic traction control system, numerous other companies have also addressed this issue and placed dynamic handling controls, some with intelligent brake systems, on the market. Seeing and being seen are other important aspects for riders of two-wheeled vehicles, who, because of their narrow silhouette, are more difficult to see than passenger cars. At present, motorcycle manufacturers are working intensively on vehicle-to-vehicle communication, so that safety can be improved through mutual cooperation between motorcycles and passenger cars. In addition to the development of the vehicles themselves in accordance with the relevant safety standards, it should not be forgotten that numerous innovative developments have significantly improved the level of safety in the sector of safety equipment for drivers.”

PASSIVE MOTORCYCLE SAFETY – STILL AN ISSUE FOR THE FUTURE

Improvements in the passive safety (vehicle-related measures to protect drivers and passengers in the event of an accident) of mass-produced motorcycles are hardly in evidence. It is still the case that the passive safety of motorcycles can only be achieved to a limited extent and that it is, therefore, (still) largely restricted to protective clothing and to wearing a helmet. Approaches and perspectives towards improving the passive safety of conventional two-wheel motor vehicles can be inferred from the corresponding notion of “limitation of the consequences of accidents”. In addition to the protective effect of the helmet and the suit it is important that, in a collision, the motorcyclist is not injured on his own

2000

Market launch of the first two-wheeled vehicle in the world to protect the rider with a surrounding structure (aluminum space frame technology) in the event of an accident (BMW C1)



2001

Combined braking system in conjunction with ABV and adaptive brake force distribution (BMW)

2004

Duo-lever front wheel drive and electrically adjustable shock absorber (ESA) (BMW K 1200 S)

vehicle or by his own vehicle. For this purpose, crash tests provide important findings. As with crash tests involving passenger cars, anthropometric dummies fitted with measuring equipment represent the motorcyclists. The vehicles are also fitted with the appropriate measuring equipment. The implementation and evaluation of such extensive tests was developed in the 1980s and DEKRA played an active role in this development.

Nowadays, when carrying out instrumented motorcycle crash tests, vehicle manufacturers, authorities and research institutes comply with the International Standard ISO 13232, which was first published in 1996. A financially viable approach to replicating the relevant accident situation in order to develop motorcycle safety elements is the combination of real crash tests and virtual digital simulations. For this purpose, in order to define sound engineering practice and methods, in the early 1990s the motorcycle industry began to develop the Standard ISO 13232 together with a number of research institutions with expertise in this area. The currently valid revised second edition dates from October 2005. DEKRA has worked in the competent ISO working group since 2001 and is therefore actively involved in the continuous development of this basic standard. In the last 30 years in particular a lot has been done to increase the road safety of motorcycles. However, that this is not enough is underlined by the facts and figures presented in the following sections of this report.

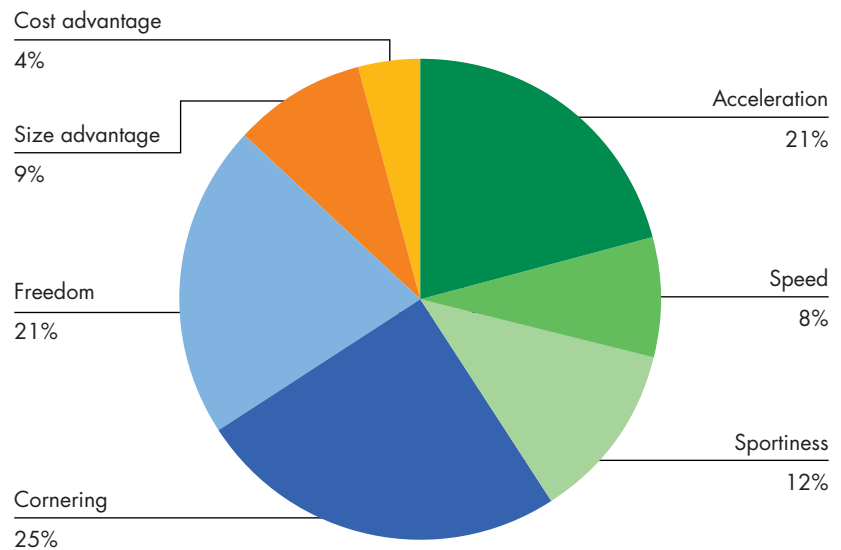
Self-assessment by motorcyclists

In 2007 the Technical University of Berlin together with the Technical University of Dresden, the German Insurance Association and the magazine "Motorrad" carried out a survey of motorcyclists as part of a research project looking into the risk of accident to which motorcyclists are exposed. According to this survey, 56.3% of the 5,297 respondents had already been involved in an accident. In 49% of accidents (details of which were provided), the police did not take any photographs or produce a report, and 69% were single-vehicle accidents. What is remarkable is the fact that, in the survey, motorcyclists at fault in an accident assessed their driving ability higher than accident-free motorcyclists. Almost half of the answers to the question why people ride motorcycles mentioned dynamic handling. Cornering and acceleration

provided further motivation. At just 8% the maximum achievable speed was of lesser importance. The freedom experienced by motorcyclists was also very important.

In order to establish a relationship between attracting attention in traffic and the frequency and/or severity of an accident, motorcyclists were also asked if they had committed any traffic violations. Of those surveyed, 1,138 said they had committed at least one traffic offence. Riders of sports bikes admitted that they were willing to take a significantly higher risk of being prosecuted for a traffic offence, such as speeding or driving too close to the vehicle in front, for example, than riders of other types of motorcycles. The majority of offences related to speeding, followed by incorrect overtaking and defective vehicles.

Motivation of motorcyclists



Source: German Insurance Association - Insurers' accident research



2006
First motorcycle airbag goes into production (Honda Gold Wing)



2009
Continuously regulating supersport ABS (Honda CBR 600/1000 RR), "brake-by-wire", activation of the brake pressure generator/electric motor plunger and ball screw, possibility or realising any number of integral functions

2004

2005

2006

2007

2008

2009

2010

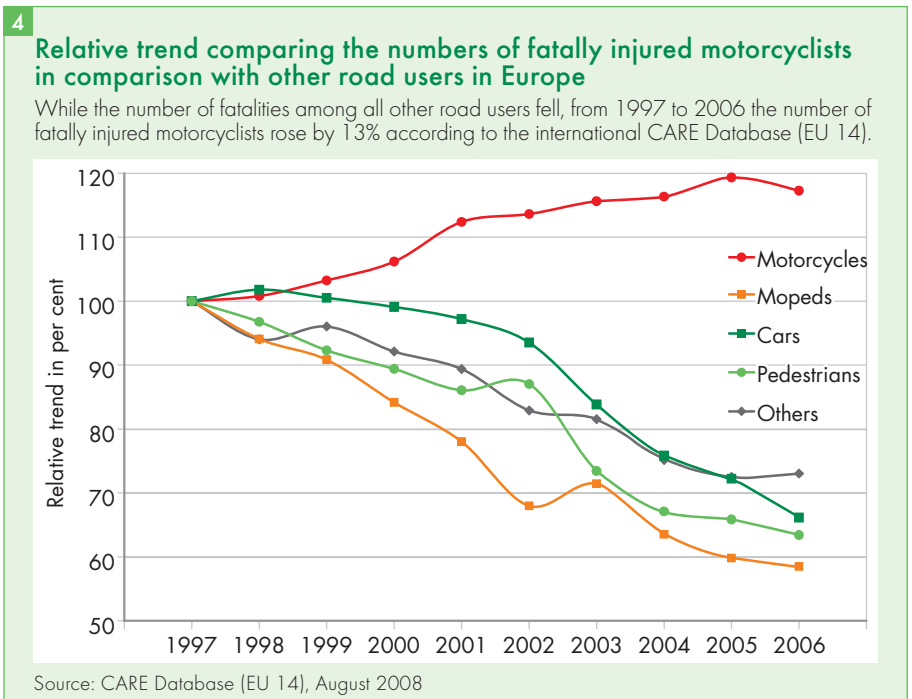


The risk of accidents remains high

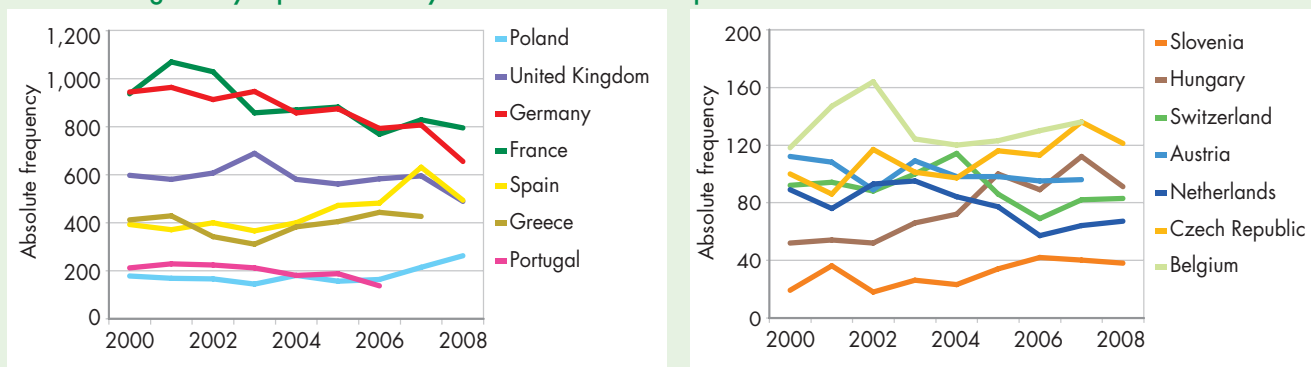
According to the most recent CARE database (EU 24), in 2008 over 5,100 motorcyclists were killed on the roads of the EU. These deaths make up 14% of a total of around 37,230 deaths on the roads of the 24 listed States, which is a relatively high proportion. Depending on the country, up to two thirds of all the motorcycle accidents involving two or more parties were caused by drivers of passenger cars. In addition to errors on the part of the motorcyclists involved, the carriageway, weather factors and the technical defects of the motorcycle were risk factors that should not be underestimated. By far the most common defects noted – during main inspections in Germany for example – were defects in the technical lighting equipment. This gives particular cause for concern, as the small silhouette, coupled with defective lighting, makes motorcycles even harder to see.

At first glance, the national statistics for accidents involving motorcycles in some countries of the EU, such as Germany, the Netherlands, Austria and the UK, where the number of fatally injured motorcyclists has been falling for years, reflect a positive development. But in virtually half of EU Member States, including Italy, Greece, Spain, Finland and Sweden, the number of fatally injured motorcyclists has risen since 2001. And even in countries where the number of fatally injured motorcyclists has fallen, this downward trend is not as positive as in the case of fatally injured passenger car occupants (Figures 4 and 5).

Overall, in the EU motorcycles are still the most dangerous form of transport. In 2008, 5,126 motorcyclists were killed (CARE database, EU 24) which is a high figure, given that two-wheeled motor vehicles account for just 2% of all road users. In the EU, therefore, the mileage-related risk of being killed in a road traffic accident is 18 times higher for motorcyclists than it is for



Trend among fatally injured motorcyclists in selected European countries



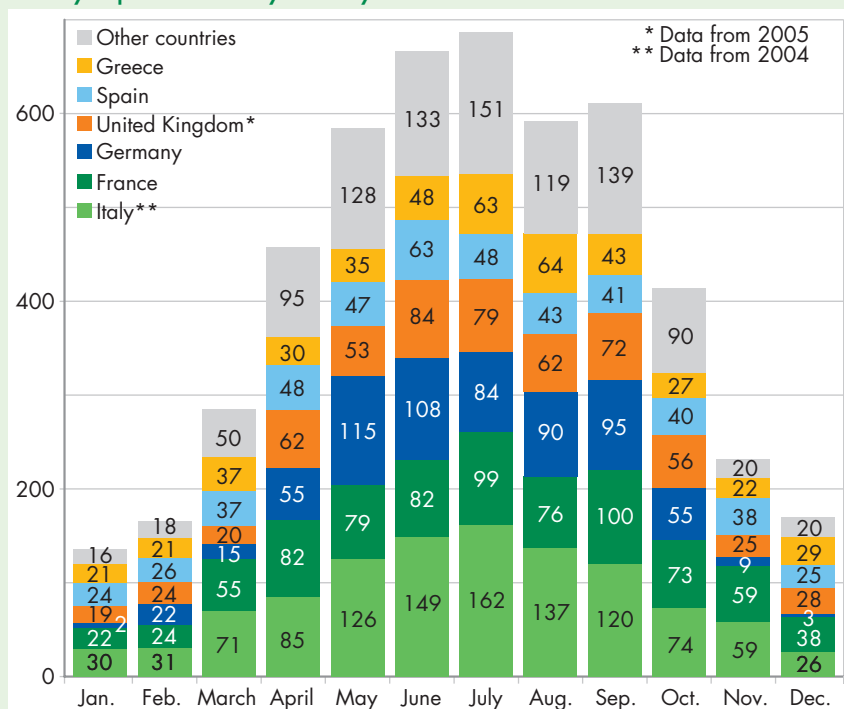
Source: CARE Database

passenger car drivers. Approximately one in three road casualties is under 25 years of age but, again, the accident rate among motorcyclists of average age is much higher than among passenger car drivers. Most motorcycle accidents happen during the warmer months of the year, from April/ May to September/October (Figure 6).

SIGNIFICANT INCREASE IN THE NUMBER OF FATALLY INJURED MOTORCYCLISTS IN SOUTHERN EUROPE

According to the most recent database of CARE (EU 24), in Germany the number of fatally injured motorcyclists fell by around 32% from 964 to 656 between 2001 and 2008. In the same period the number of fatally injured car occupants fell by slightly more than 41% from 4,023 to 2,368. In France, the situation is as follows: while the number of fatally injured car occupants fell by approximately 58% from 5,283 to 2,205 between 2001 and 2008, the number of fatally injured motorcyclists fell by „only“ around 25% from 1,092 to 817 over the same period. In 2008, motorcyclists accounted for 19% of all 4,275 road traffic fatalities in France, while in 2001 (8.160 road traffic fatalities) the figure was 13.4%. The situation in Italy is quite different: here the number of fatally injured car occupants fell by 45% from 3,847 to 2,116 between 2001 and 2008 while the number of fatally injured motorcyclists rose by 28% from 848 to 1,086. This accounts for 23% of all 4,731 road traffic fatalities. There has also been a significant increase in fatally injured motorcyclists since 2001 in, among other countries, Romania, Spain and Greece, even though the numbers fell slightly in the last two countries in 2008. The same is also true according to the Annual Report 2009 of the IRTAD (International Road Traffic and Accident Database) for Slovenia. From 2007 to 2008 the number of fatally

Fatally injured motorcyclists by month



Source: CARE Database (EU 24), August 2008, and Federal Statistical Office

injured motorcyclists fell from 40 to 38, but, compared to 19 fatally injured motorcyclists in 2000, this is a rise of 100%. Looking beyond the borders of the EU to the USA, it is interesting to note that the number of fatally injured car occupants fell by just short of 30% from 20,699 to 14,587 between 2000 and 2008, while the number of fatally injured motorcyclists rose by 83% from 2,897 to 5,290.

POSITIVE TREND IN GERMANY

A detailed look at Germany reveals that, according to the latest report by the Federal Statistical Office, in 2008 a total of

413,524 people, including 30,640 motorcyclists, were involved in road traffic accidents. In 2008, 4,477 people, including 656 motorcyclists, lost their lives in road traffic accidents in Germany. Of these, 596 were male (= 91%) and 60 were female (= 9%). A similar difference between the numbers of seriously injured male and female motorcyclists (8,396 compared to 1,106) and slightly injured male and female motorcyclists (17,450 compared to 3,018) was also noted. 491 motorcyclists died outside built-up areas while 145 died inside built-up areas. In 2008, 616,741 people, including 30,419 motorcyclists, were involved in accidents resulting in

7 Road traffic accidents in Germany from 2005 to 2008 with particular regard to the motorcycles concerned

Facts	2005	2006	2007	2008	Percentage change in 2008 compared to 2005
Total number of casualties including motorcycle riders and passengers	438,804	427,428	436,368	413,524	-5.8
Total number of fatalities including motorcycle riders and passengers	5,361	5,091	4,949	4,477	-16.5
Fatalities outside built-up areas including motorcycle riders and passengers	3,890	3,707	3,614	3,216	-17.3
Total number of persons involved in accidents resulting in personal injury including motorcycle riders	652,487	634,947	648,796	616,741	-5.5
Main cause of accidents resulting in personal injury including motorcycle riders	336,619	327,984	335,845	320,614	-4.8
Inappropriate behaviour of persons involved in accidents resulting in personal injury including motorcycle riders	434,330	423,973	409,529	388,201	-10.6
including	21,746	20,958	21,157	18,791	-13.6
excessive speed	7,444	7,139	7,108	6,314	-15.2
overtaking	2,469	2,384	2,274	1,911	-22.6
distance	2,307	2,241	2,288	2,139	-7.3
incorrect road use	1,257	1,175	1,085	952	-24.3
the influence of alcohol	882	846	796	694	-21.3

Source: Federal Statistical Office, November 2009

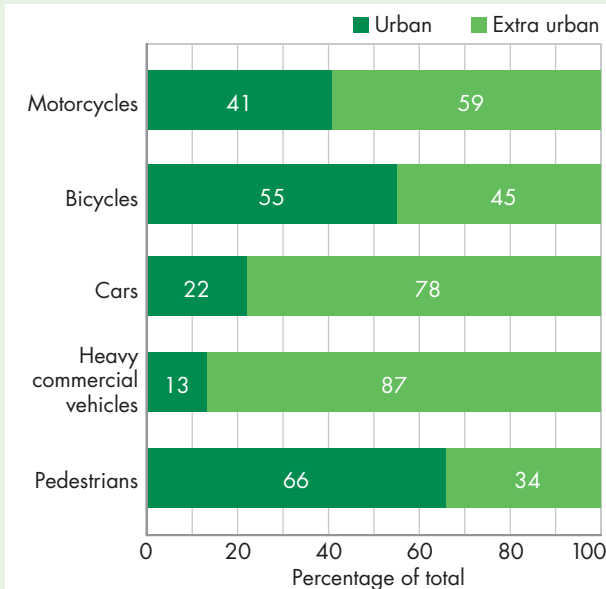
personal injury. In comparison with 2007, the number of casualties among motorcycle users fell by 12%, while the number of fatally injured motorcyclists fell by almost 19% (Figures 7, 8, 9 and 10).

The positive trend described here is essentially characterized by the figures for 2008. Before then, the decline was much less and, in some cases, numbers even rose. According to the latest projections by the Federal Highway Research Institute (Bundesanstalt für Straßenwesen BAST), the positive trend set in 2008 did not continue into 2009. The figures are also highly dependent on the weather – they are higher in years with long, dry summers than in rainy summers. The weather during the many “long” spring weekends when there are public holidays also plays an important role.

To determine and comparatively assess the risk of being involved in an accident, the number of accidents involving a specific group of vehicles can be based on the registered vehicles in this group. This approach is common practice and the Federal Statistical Office, among others, publishes relevant comparative figures in its annual report. According to these figures, in Germany, with 859 casualties per 100,000 vehicles, the users of motorcycles were at much greater risk than car occupants (582 casualties). For every 100,000 vehicles, 18 motorcyclists died while, among car occupants, the number of fatalities was 7 per 100,000 vehicles.

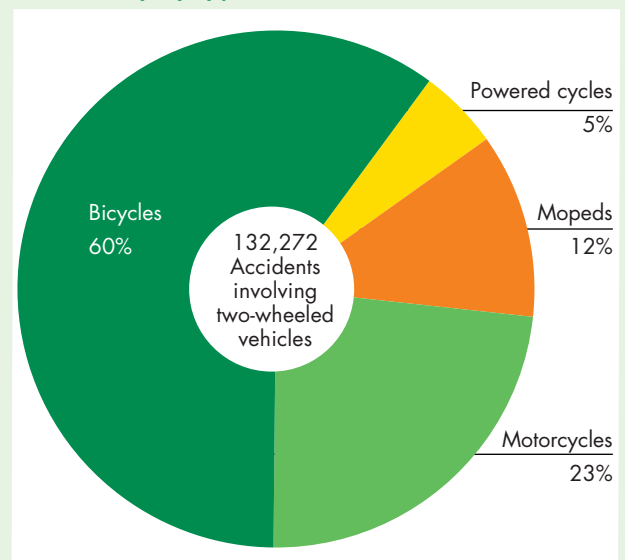
The difference is even more dramatic when the number of kilometres travelled is taken as the basis of comparison. For every

8 Fatally injured motorcyclists by location in Europe



Source: CARE Database (EU 19), July 2008

9 Casualties among riders of two-wheeled vehicles in Germany by type of road use 2008



Source: Federal Statistical Office, 2008



billion kilometres travelled 2,760 users of motorcycles were involved in accidents while, among car occupants, the figure was “only” 599. For every billion kilometres travelled, 59 motorcyclists died while “only” 6 car occupants died. In France this contrast is even greater. According to the figures of the “Observatoire National Interministériel de la Sécurité Routière” in 2008, for every billion kilometres travelled, 143 motorcyclists died while “only” 6 car occupants died on French roads. In France, the risk of being killed in a road

traffic accident is 24 times higher for motorcyclists than it is for car occupants. Of special interest in this regard are road traffic accident figures published by the Statistisches Landesamt Baden-Württemberg (Statistical Office of Baden-Württemberg), according to which, in purely statistical terms, a motorcycle can expect to be involved in an accident resulting in serious damage to property or personal injury for every 290,000 kilometres travelled. A passenger car would need to travel 2.6 million kilometres.



10

Fatalities in 2008 by type of road use and light conditions in Germany



Source: Federal Statistical Office, 2008

Road safety of motorcycles in France



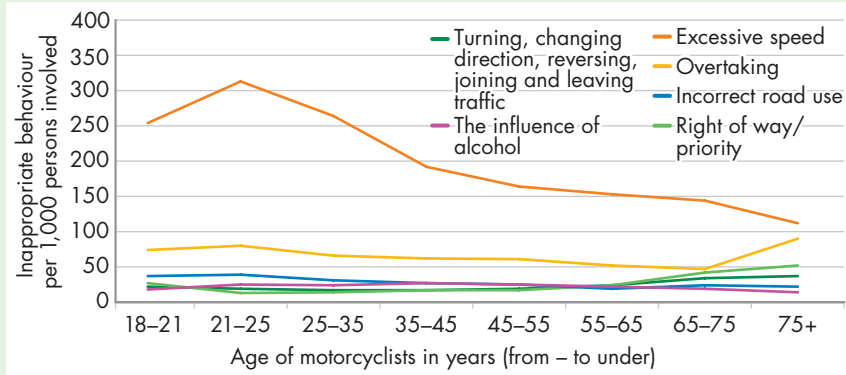
“The safety of motorcyclists is accorded high priority in France in terms of road safety. The number of motorcyclists has been increasing rapidly for many years. But the number of motorcyclists killed in accidents is also increasing. In 2008, 26% of all road accident fatalities were riders of two-wheeled motor vehicles, even though they make up just 2% of all road users. In 2009, the number of motorcyclists killed in accidents rise even further. In addition to young road users, the victims also included people who use two-wheeled motor vehicles to travel to work. Against this background, the French Prime Minister, François Fillon, announced at the latest “Comité Interministériel de la Sécurité Routière” in February 2010 important measures to increase the road safety of users of two-wheeled motor vehicles. Under these measures, the “souping up” of mopeds and powered cycles will be subject to tougher law enforcement and the their condition will

be checked every two years in the context of technical vehicle monitoring. In addition, holders of a Category B driving licence (cars) will undergo seven hours of extensive training to enable them to ride a light motorcycle. These measures mark the start of a plan to improve the road safety of users of two-wheeled motor vehicles, which was drawn up in June 2009. We are working hard to achieve harmonious co-existence on the road. Everyone must be able to move freely; this only works through peaceful and respectful behaviour towards all road users.”

Michèle Merli, Interministerial Delegate for Road Safety in the Ministry of Ecology, Energy, Sustainable Development and the Sea

11

Inappropriate behaviour of motorcyclists per 1,000 persons involved in accidents resulting in personal injury in 2008 in Germany



Source: Federal Statistical Office, 2008

COMPARATIVELY HIGH ACCIDENT FIGURES AMONG THE MIDDLE-AGED GROUPS

As far as motorcyclists involved in accidents resulting in personal injury in Germany are concerned (30,419 motorcyclists in total), in 2008 riders of machines from 500 cm³ cylinder capacity (7,661 motorcyclists), 750 cm³ cylinder capacity (9,245 motorcyclists) as well as between 81 cm³ and 125 cm³ cylinder capacity (7,677 motorcyclists) were predominant. Among riders of less powerful machines of between 81 cm³ and 125 cm³ cylinder capacity, the majority of motorcyclists involved in accidents resulting in personal injury were under 18 (2,668 motorcyclists). Among riders of more powerful machines of more than 500 cm³ and 750 cm³ cylinder capacity, the majority of motorcyclists involved in accidents resulting in personal injury were between 35 and 55 years of age.

Most motorcyclists killed in accidents were in the age groups 21 to 25 years of age (96 fatalities out of a total of 656) and 40 to 50 years of age (175 fatalities). Among seriously injured motorcyclists the age group 40 to 50 years of age (2,480 seriously injured out of a total of 9,502) dominated. Among slightly injured motorcyclists the age group 15 to 18 years of age (2,564 slightly injured out of a total of 20,468) dominated, as did, once again, the age group 40 to 50 (5,040 slightly injured).

Road safety of motorcycles in Poland



"In 2008, passenger car drivers in Poland caused 29,475 road traffic accidents while motorcyclists caused 1,195 accidents. Given the huge difference in vehicle stock (just short of 14.6 million cars and approximately 825,000 motorcycles) as well as the fact that motorcycles are mainly ridden during warmer months and their mileage is much lower than that of cars, motorcyclists have caused far more accidents than passenger car drivers. In 2008, a total of 2,762 passenger car drivers lost their lives on Poland's roads while acci-

dents claimed the lives of 184 motorcyclists. Exceeding the speed limit, which motorcyclists frequently do, constitutes a high accident risk, one of the reasons being that, because of the high speed, they are seen too late by passenger car drivers in their rear-view mirrors."

Inspector Mag.-Ing. Wojciech Pasieczny, Council of the Department for Road Traffic in the Police Headquarters of Warsaw

Road safety of motorcycles in Italy



"With 1,086 fatalities in 2008, motorcyclists accounted for 23% of all 4,731 road deaths in Italy. By way of comparison, in Italy, in 2001, road accidents claimed the lives of 7,096 people, 848 of whom - i.e. approximately 12% - were motorcyclists. Within the EU, Italy is one of the countries that has seen the biggest increase in the number of fatally injured motorcyclists in recent years. In 2008, for every 100 motorcycle accidents approximately two motorcyclists lost their lives. For every 100 car accidents, 0.8% of passenger car drivers lost their lives. As regards the number of injured, 99.6% of motorcycle accidents resulted in injury while 65.1% of car accidents resulted in injury. In 2008, the highest proportion of fatally injured motorcyclists occurred in the 25 to 44 age group."

Source: Istituto Nazionale di Statistica



Inappropriate behaviour is most frequently found among motorcyclists in the 25 to 55 age group. In first place is excessive speed, followed by driving too closely to the vehicle in front and dangerous passing manoeuvres (Figure 11). By way of comparison, in the case of passenger cars, most fatally injured, seriously injured and slightly injured drivers were in the 18 to 30 age group, while inappropriate behaviour was most common by far among drivers aged between 25 and 45.

The frequency of accidents involving motorcycles is heavily influenced by seasonal factors. Poor road and weather conditions during the six months of winter often deter many motorcyclists from taking to the road. That is why, during the six months of summer, they take to the road much more frequently. During 2008 approximately 50 per cent of car occupants came to harm in the months of April to September; the figure among motorcyclists was 76%.

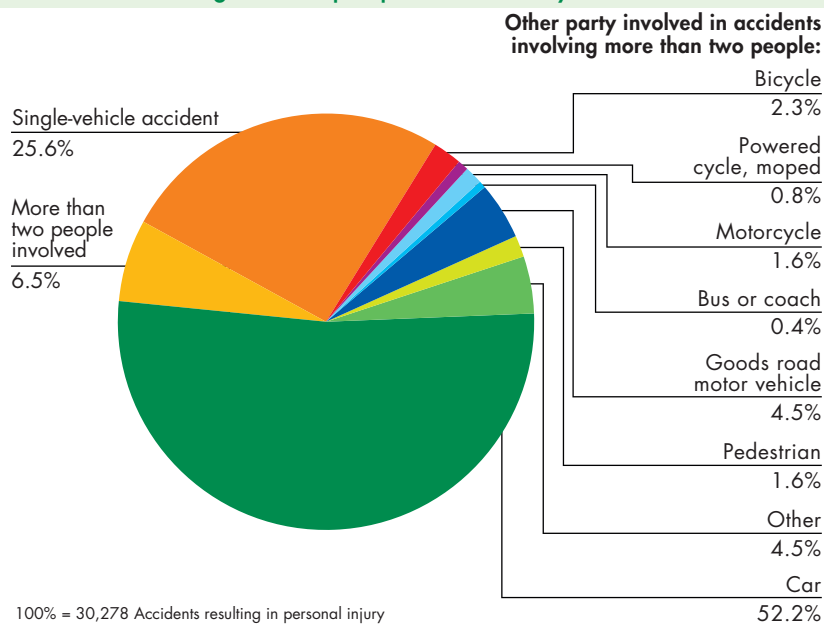
PASSENGER CAR DRIVERS ARE THE MAIN PARTIES RESPONSIBLE FOR MOTORCYCLE ACCIDENTS INVOLVING TWO OR MORE PARTIES

Irrespective of EU Member State, up to two thirds of all motorcycle accidents involving two or more parties are not caused by the motorcyclists themselves (Figure 12). A passenger car driver fails to see a motorcyclist or misjudges their



Police roadside checks contribute to greater road safety.

12 Single-vehicle accidents resulting in personal injury and motorcycle accidents involving several people in Germany in 2008



Source: Federal Statistical Office, 2009

Road safety of motorcycles in the Czech Republic

"In 2009, two-wheeled motor vehicles caused a total of 1,762 accidents, claiming the lives of 88 riders of two-wheeled motor vehicles (= 10.6% of all 832 fatalities). Motorcyclists, with 80 fatalities, accounted for 91%. With 38 fatalities for every 1,000 accidents, motorcyclists also occupied the inglorious top spot ahead of other vehicles. By way of comparison, for every 1,000 car accidents, 13 people lost their lives. The majority of accidents involved vehicles with a cylinder capacity of between 460 cm³ and 850 cm³ and the highest number of fatalities involved vehicles with a cylinder capacity of between 860 cm³ and 1250 cm³. The majority of fatally injured motorcyclists were aged between 25 and 44."

First Lieutenant Josef Tesaik, Traffic Police Directorate of the Police Headquarters of the Czech Republic

Road safety of motorcycles in Spain

"In 2009, the accident rate among motorcycles in Spain fell by "just" 7.8% compared to 2008. This means that, even though, in 2009, there were 24 fewer fatalities than in 2008, in comparison to the fall in the overall accident rate, the figures are still alarming - with 283 fatalities and a share of 14.9% of the total number of accidents and an increase of 1.5% in relation to the total number of fatal road traffic accidents in 2008.

Impact against support posts in particular caused often serious or often fatal injuries.

A number of autonomous regions, such as Madrid and Andalusia, however, have now begun to encase the dangerous support posts in foam and plastic in order to reduce the effects of accidents.

One further piece of good news must be emphasised: the use of helmets has increased significantly. In 2002, 11% of motorcyclists and passengers who lost their lives in an accident were not wearing a helmet; in 2009 the figure was just 3%."

DEKRA Expert Spain

speed. These are the main reasons why so many motorcycle accidents are caused by passenger car drivers. The majority of accidents happen when a passenger car driver crosses a road junction, makes a turn, changes direction or reverses. This is also reflected in the figures for Germany, where, in 2008, 27% of motorcyclists involved in an accident and 31% of motorcyclists or motorcycle passengers fatally injured in an accident came to harm in accidents in which no other vehicles or pedestrians were involved. In 80% of accidents in which motorcycles collided with another road user, the latter was a passenger car. In 15,817 collisions of this kind,

1,606 passenger car occupants and 16,548 motorcyclists or motorcycle passengers were injured. Therefore, 91% of accident victims were motorcyclists or motorcycle passengers, while 72% of these accidents were caused by passenger car drivers.





REPRESENTATIVE SCENARIOS OF MOTORCYCLE ACCIDENTS IN EUROPE

A current and comprehensive view of accidents on Europe's roads (EU-14) is provided by the integrated research project TRACE (Traffic Accident Causation in Europe), which is promoted by the EU Commission. Using the available statistics

it was established that 17% of all fatally injured road users in Europe were riders or passengers of two-wheel motor vehicles – so-called powered two-wheelers (PTW). At 12.2%, motorcyclists form the largest group. At just 4.8%, moped riders form a much smaller group.

With more in-depth case-by-case analyses of motorcycle accidents in the UK, Spain, Italy, Greece, the Czech Republic and Germany, it was possible to identify four representative scenarios for accidents involving motorcycles (Figure 13). Together, these account for 50% of the motorcycle accidents resulting in fatal and serious injuries that were investigated. The

13 Most common situations in which motorcycle accidents occur

Share *	Accident constellation	Description	Significant influencing factors
27%		Single-vehicle motorcycle accident on roads outside built-up areas: leaving the road, rollover on the carriageway, collisions with safety barriers	Inappropriate reactions/errors, risky/unsafe driving, too high/excessive speed on the part of the motorcyclist
13%		Motorcycle/car collision Front/side, Side/front At road junctions inside and outside built-up areas	Inattentiveness/errors, unsafe/risky driving on the part of the passenger car driver Unsafe/risky way of driving on the part of the motorcyclist
5%		Motorcycle/car collision Side/side in traffic moving along a carriageway on roads inside and outside built-up areas	Inattentiveness of the passenger car driver Unsafe/risky way of driving on the part of the motorcyclist
5%		Motorcycle/car collision Rear/front, front/rear in traffic moving along a carriageway on roads inside and outside built-up areas	Inattentiveness of the motorcyclist Inattentiveness of the passenger car driver

* Share in all motorcycle accidents in Great Britain, France, Spain, Italy, Greece, the Czech Republic and Germany investigated in the TRACE project

Source: TRACE (Traffic Accident Causation in Europe) 2006

14 Overview: Periodic technical inspection of motorcycles in Europe

Country	Compulsory
Austria	Yes
Belgium	No
Czech Republic	Yes
Denmark	Yes
Estonia	Yes
Finland	No
France	No
Germany	Yes
Greece	No
Hungary	Yes
Italy	Yes
Latvia	Yes
Luxembourg	Yes
Netherlands	No
Poland	Yes
Portugal	No
Slovakia	Yes
Slovenia	Yes
Spain	Yes
Sweden	Yes
Switzerland	No
United Kingdom	Yes

Source: ACEM (Association des Constructeurs Européens de Motocycles)



exceptional diversity of accidents involving motorcycles is clearly in evidence.

SAFETY ON THE ROAD WITH SAFE MOTORCYCLES

Across the whole of Europe, the available statistics confirm that the overwhelming majority of accidents involving motorcycles can be attributed to the human factor. Other risk factors are road conditions, weather conditions, obstacles and others. That technical defects can also be jointly responsible for a substantial number of accidents is demonstrated by the analyses conducted by DEKRA. According to these analyses, 23.6% of motorcycles inspected following accidents in the years 2002 to 2009 exhibited defects, 33.9% of which were of relevance for the accident. All the more reason, therefore, to inspect motorcycles at regular intervals to ensure that they are safe.

A register compiled by the European motorcycle manufacturers' association, ACEM, shows that such vehicle monitoring is the rule in many countries, for example in Germany, Denmark, Austria, Spain and the UK. However, EU-wide standard vehicle monitoring is still a long way off (Figure 14). Nevertheless, discussions are underway in the EU Commission about extending Directive 2009/40/EC on roadworthiness tests for motor vehicles and their trailers to motorcycles.

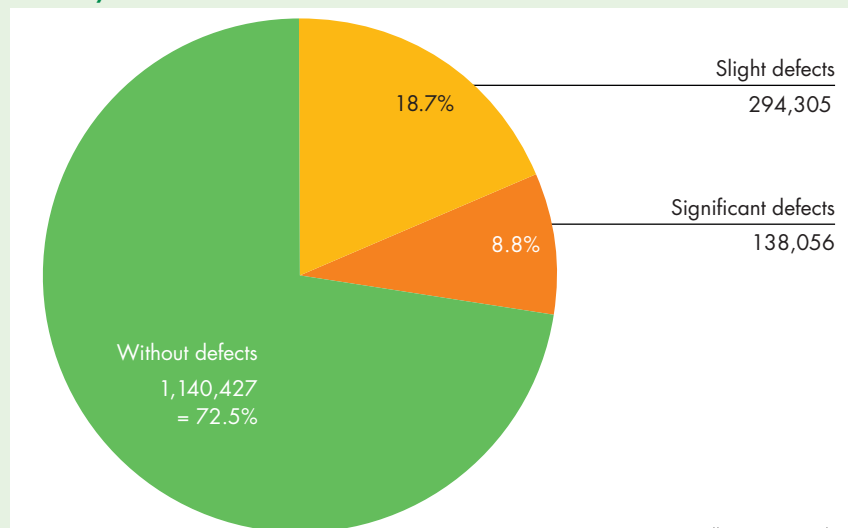
This issue, amongst others, is currently being discussed in France against the background of more motorcyclists once again losing their lives in 2009, after years of decreasing numbers of motorcyclists being killed. It should also be noted that, in 38% of accidents involving motorcycles, the motorcyclists themselves were responsible for the accident. In the opinion of DEKRA France, the regular technical inspection of motorcycles

Jacques Compagne, Secretary General of the European motorcycle manufacturers' association ACEM (Association des Constructeurs Européens de Motocycles)



"A vehicle must undergo regular maintenance and repair in order to continue to meet the initial construction requirements. The majority of Member States have introduced regular inspections for two-wheeled motor vehicles – on safety and, to an ever increasing extent, on environmental, grounds. The MAIDS study confirms that lack of vehicle maintenance is a decisive factor in accidents involving two-wheeled motor vehicles and accounts for 5% of all accident factors as far as two-wheeled motor vehicles are concerned. Regular inspections reduce the frequency of safety-relevant defects in tyres, brakes and lights. This especially concerns defects that are not noticed by the owner of the vehicle. At the same time, the inspections most likely deter the manipulation of mopeds. The ACEM therefore supports the inclusion of two-wheeled motor vehicles in the scope of Directive 96/96/EC of the European Parliament and of the Council of 20 December 1996 on the approximation of the laws of the Member States relating to roadworthiness tests for motor vehicles and their trailers as well as Council Directive 2009/40/EC of the European Parliament and of the Council of 6 May 2009 on roadworthiness tests for motor vehicles and their trailers."

15 Motorcycle test results



Source: Krafffahr-Bundesamt (KBA, Federal Motor Transport Authority) 2008. Data from Germany



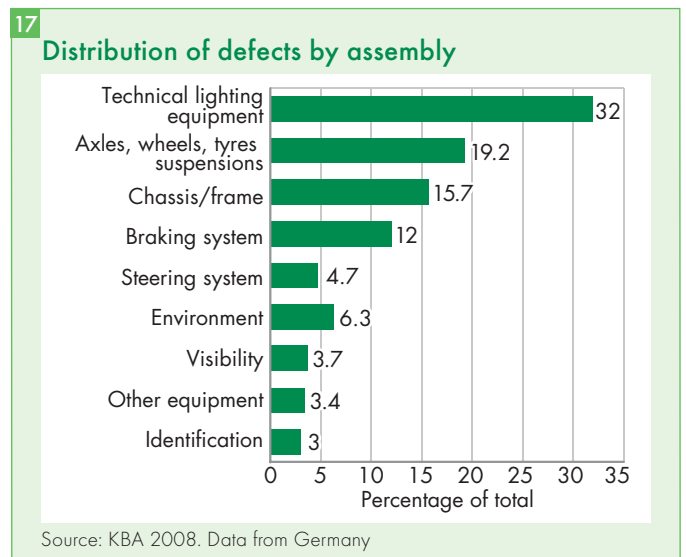
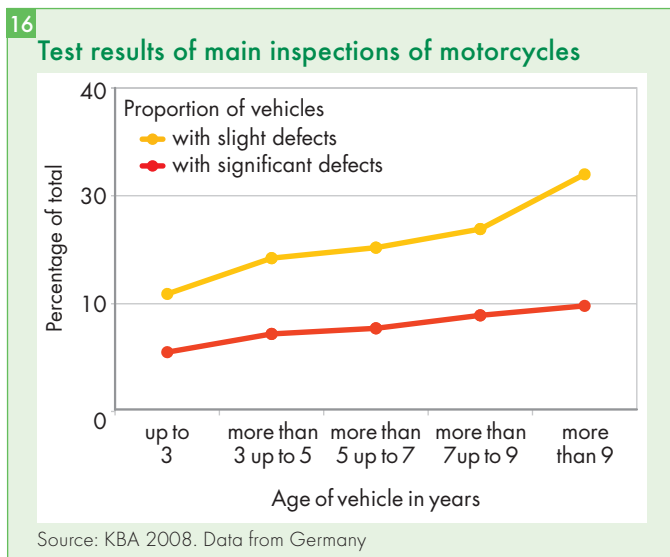
would doubtless improve the technical condition of these vehicles, as was the case following the introduction of obligatory testing for cars and commercial vehicles.

TECHNICAL LIGHTING EQUIPMENT AND TYRES HEAD THE LIST OF DEFECTS

Overall, in 2008, the majority of motorcycles that were examined in detail during

general inspections were in good technical condition. According to figures released by Germany's Federal Motor Transport Authority, 72.5% of the more than 1.5 million motorcycles examined did not have any defects, 18.7% had slight defects and 8.8% had substantial defects (Figures 15 and 16). The motorcycles examined by DEKRA had an average age of slightly more than 12 and the average mileage was 3,000 kilometres.

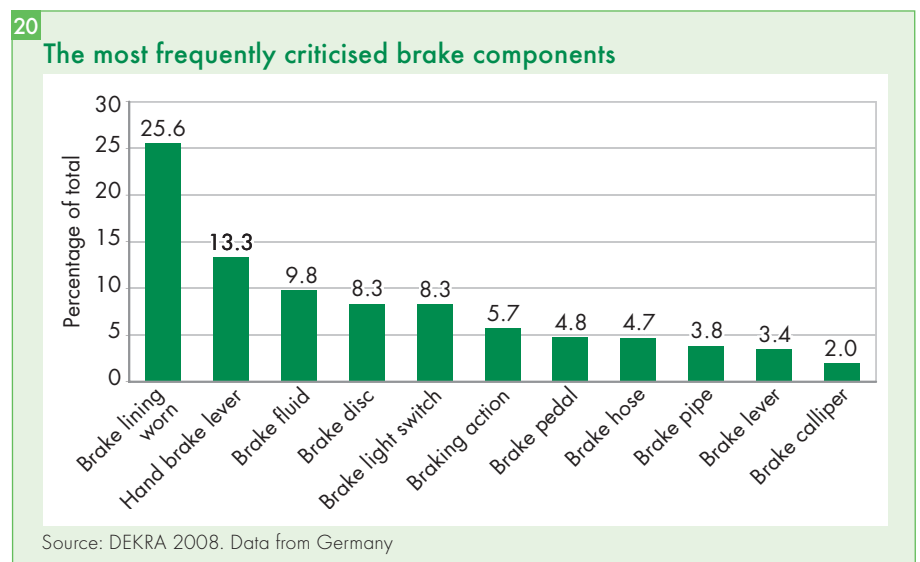
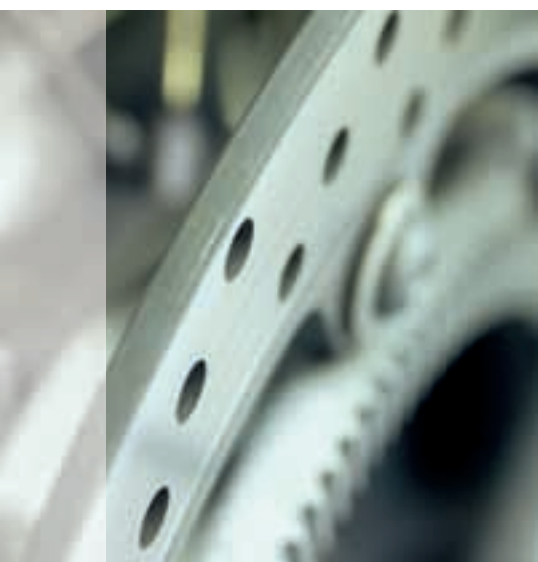
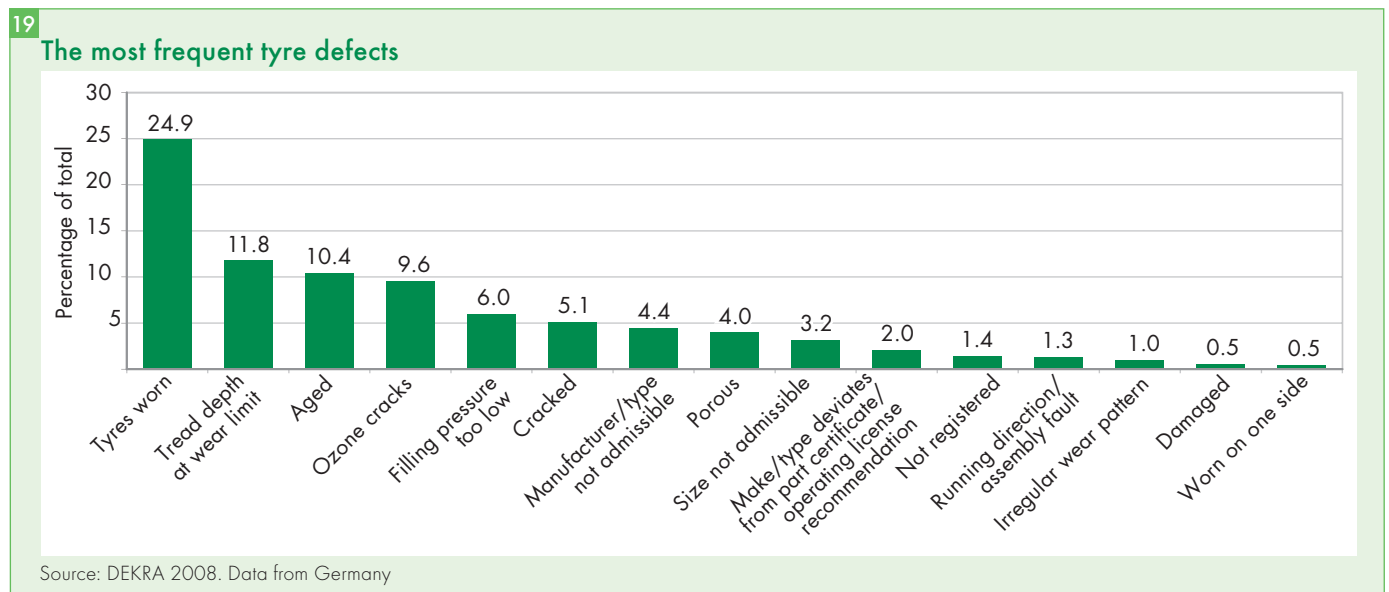
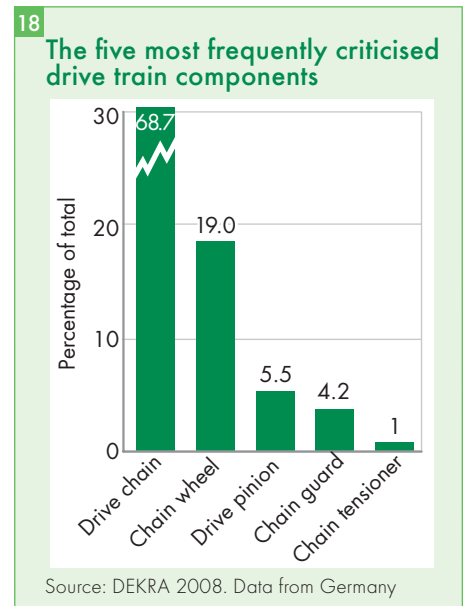
The most striking result was that, during the period of intensive use (vehicle age up to 20 years), the percentage of motorcycles identified during the general inspection as having slight or substantial defects at first continued to rise. From the age of 20 years, the percentage of motorcycles with slight or substantial defects fell slightly as a result of better care and lower mileage, but then remained at this level.



As far as defects in the assemblies are concerned (Figure 17), technical lighting equipment heads the list of defects at more than 30%. In almost one in five motorcycles with defects the assembly consisting of axles/wheels/tyres/suspensions were found to be at fault, followed by chassis/frames at 16% and brakes at 12%. Of the 30 components most commonly criticised by DEKRA during the main inspection, tyres, drive chains, brake pads and rear retro-reflectors have the greatest impact. These components belong to the wheels/tyres, drive train, brake and lights assemblies. In the wheels/tyres assembly (Figure 19), at just under 25% worn tyres dominated and, for just under 12% of motorcycles with defects, the tread depth was at the wear limit. At around 10%, aged tyres account for a relatively high proportion of defects.

As regards the drive train (Figure 18), in more than 68% of cases the drive chain was to blame. In 30% of cases the tension of the drive chain was too low, and in 17% of cases the drive chain was worn. Both defects represent a high safety risk, the reason being that too low tension can cause the chain to drop off and to become entangled in the rear wheel, thereby blocking the wheel. If the drive chain is worn, it may break, with similar effects as with too low tension. In the brake assembly (Figure 20), at more than 25% the brake pads have the highest proportion of defects, followed by the hand brake lever with 13% of defects. As regards the technical lighting equipment (Figure 21), the rear reflector was criticised the most, with more than 19% of defects.

Also of interest is the issue of tuning, where thoughts generally turn im-

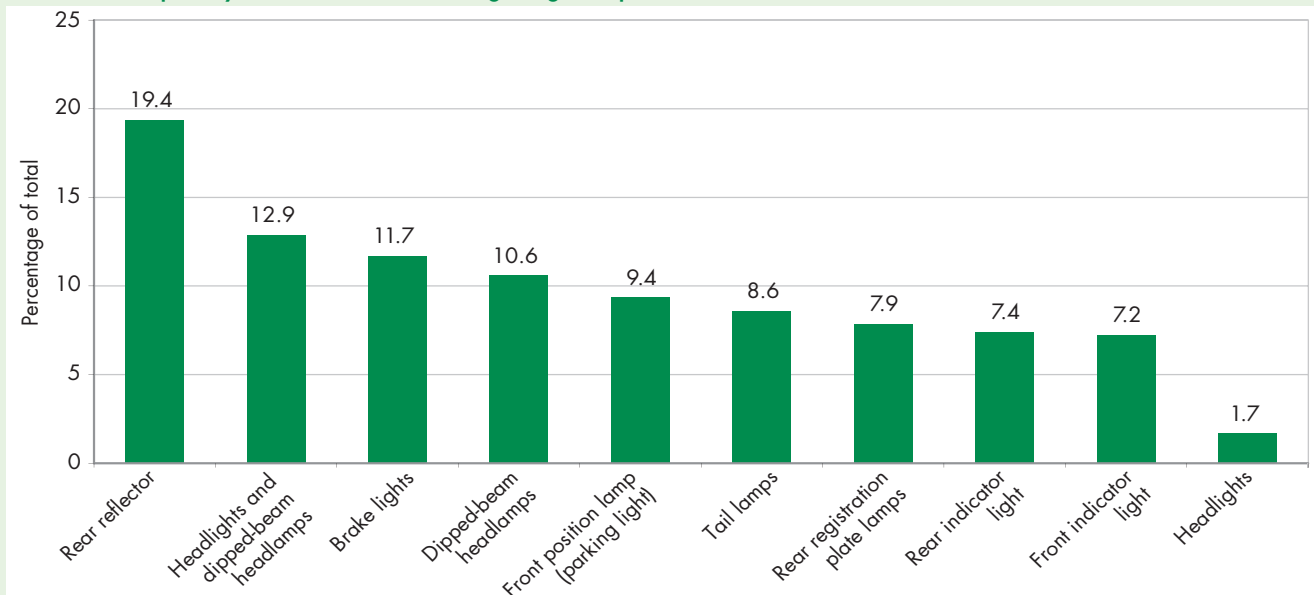




mediately to illegal performance-enhancing type modifications. However, no components relating to performance enhancement occupy the top places in the list of type modifications most frequently complained of (Figure 22). Rather, most type modifications are made to improve appearance rather than performance. An example is the removal of a mud flap together with the reflector. The allegedly better appearance is, however, to the detriment of the rider's safety. The second most frequently criticised point (handlebars) is often due to the fact that the owner of the vehicle does not know that type modifications to handlebars must be registered. The reason for this is to ensure that handlebars are not mounted that, for example, have an inadequate steering angle thus compromising the driver's safety. In principle, any modification that is carried out on an assembly can have a negative impact on road handling and modifications to several assemblies can influence each other and further increase the risk of an accident.

The test results from the technical monitoring of motorcycles from other European countries are not available or are only partially available. In Italy for example few details of the results are recorded. Nonetheless, the results should be more or less comparable with those from Germany. A look at the technical inspections carried out in Slovenia confirms this. In 2008, approximately 3.5% of motorcycles had to undergo a subsequent inspection by DEKRA Slovenia either because they exhibited significant defects or because were not road-worthy. The majority of vehicles exhibit

21 The most frequently criticised technical lighting components

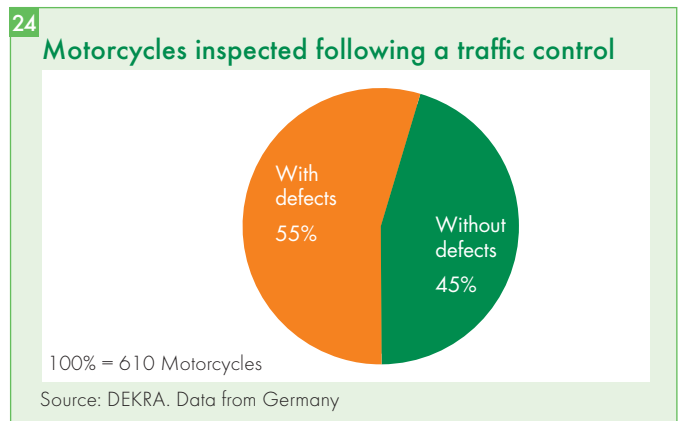
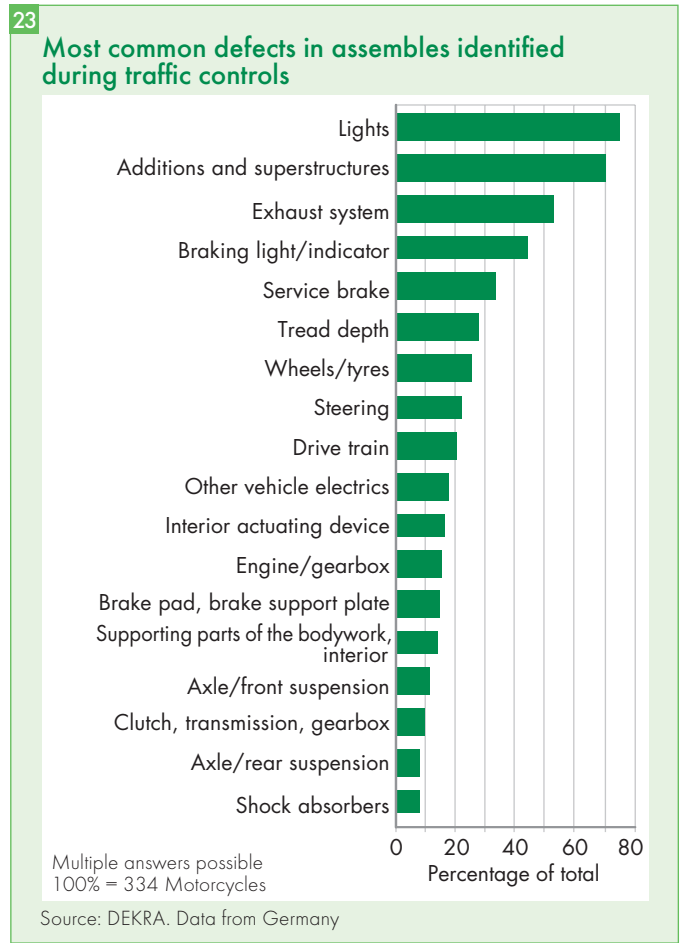
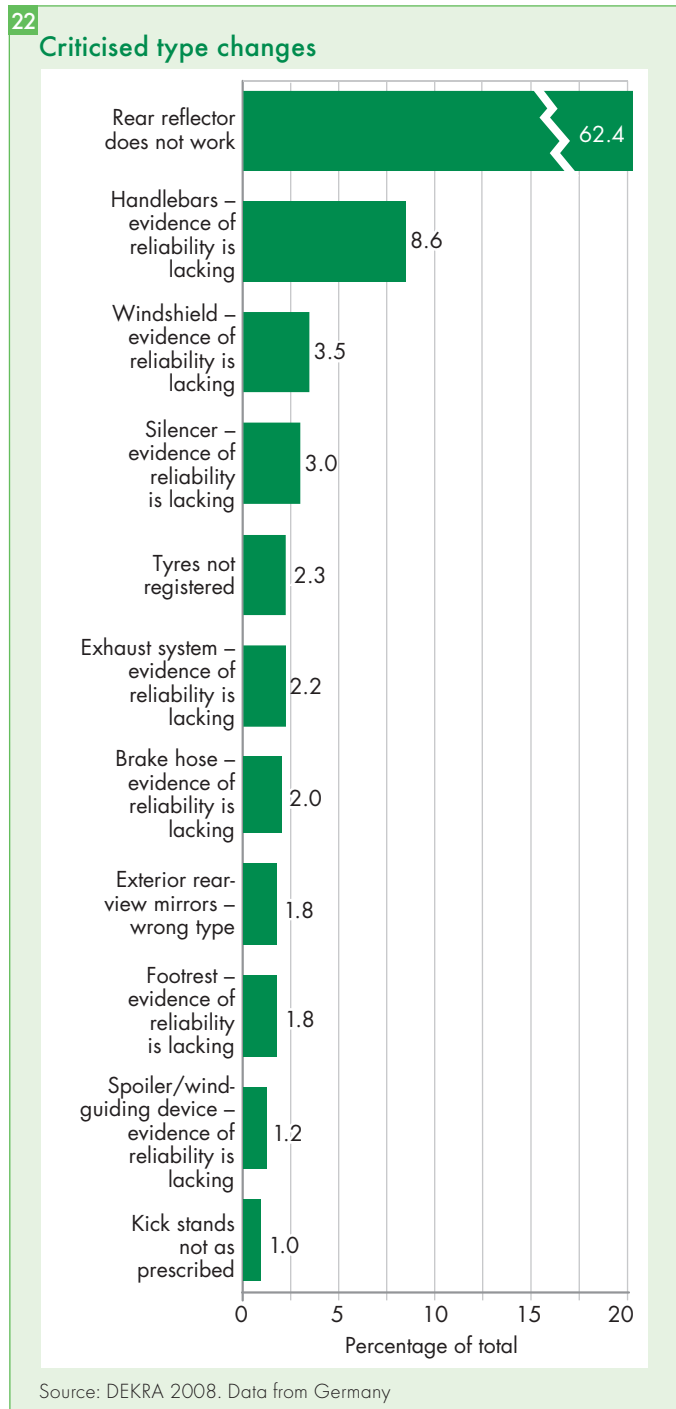


Source: DEKRA 2008. Data from Germany

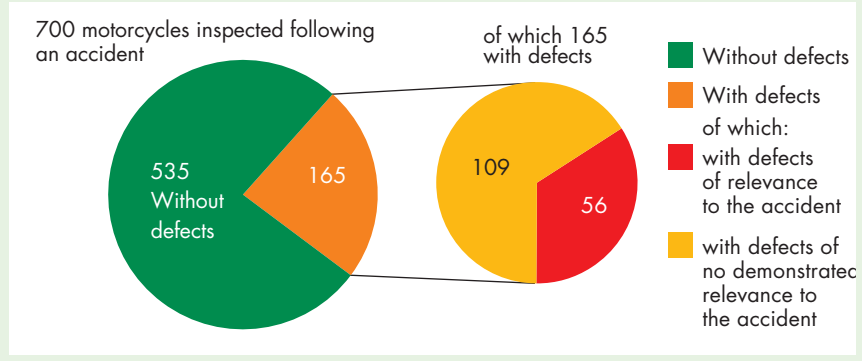
significant defects had faulty technical lighting equipment whilst those that were not roadworthy had faulty tyres.

TECHNICAL DEFECTS AS A CAUSE OF MOTORCYCLE ACCIDENTS

The results of the main inspections of motorcycles carried out by DEKRA are reflected in the analyses undertaken by DEKRA Accident Research. They are also confirmed by the results of inspections of motorcycles in which defects were found during roadside checks carried out by the police between 2002 and

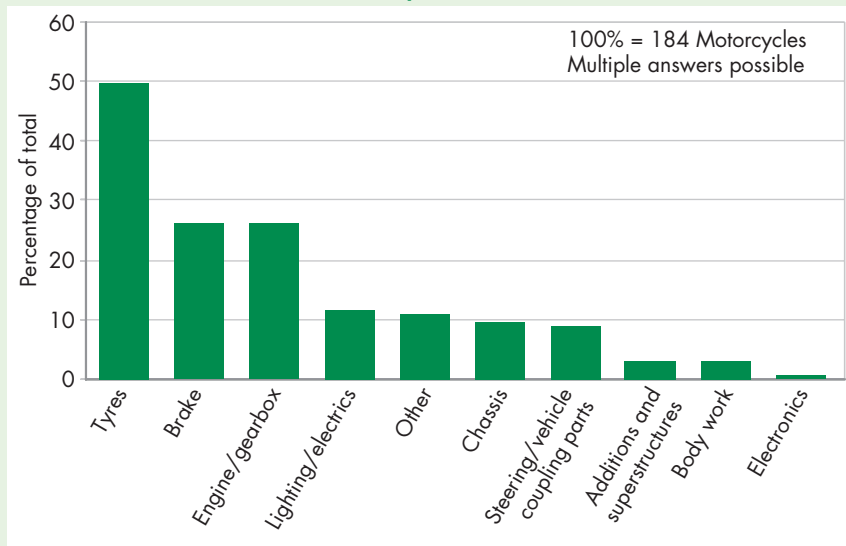


25 Defects in motorcycles involved in accidents



Source: DEKRA 2002 - 2009. Data from Germany

26 Assemblies with defects in motorcycles involved in accidents



Source: DEKRA 2002 - 2009. Data from Germany

2009 (Figures 23 and 24). A total of 610 motorcycles were inspected, a targeted selection of which is assumed for present purposes (inspection following initial suspicions or as a result of obvious defects). The suspicion of defects was confirmed in 334 of the 610 motorcycles, with 254 motorcycles exhibiting defective lights. Further down the list of defects were, among others, additions and superstructures (235 motorcycles), exhaust systems (179 motorcycles), braking lights/indicators (147 motorcycles), service brakes (113 motorcycles), tread depth (93 motorcycles) as well as wheels/tyres (85 motorcycles).

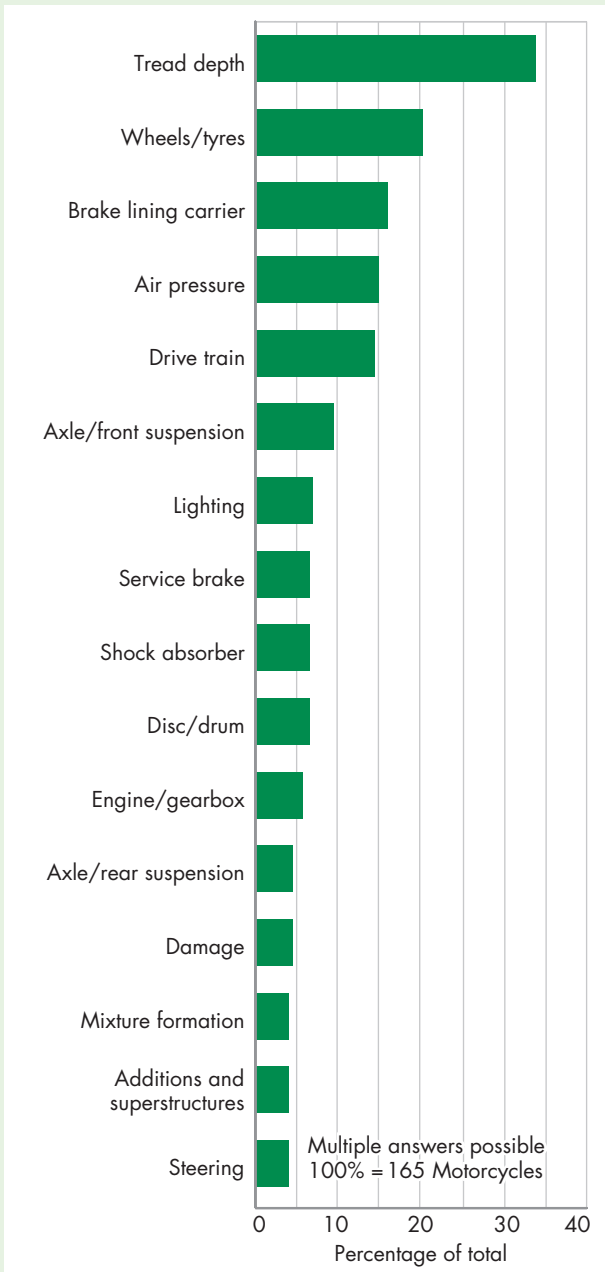
In addition, between 2002 and 2009 a total of 700 motorcycles were inspected by DEKRA following accidents (Figures 25 to 28). Of these 700 motorcycles, 165 motorcycles, i.e. 23.6%, were defective. Of these 165 motorcycles, 56 motorcycles, i.e. 33.9%, exhibited defects that were of relevance to the accident. Again, in 56 of these 165 motorcycles the tread depth of the tyres was too shallow, 34 motorcycles had defective wheels or tyres, 27 motorcycles were being ridden with inadequate tyre pressure, in 25 motorcycles the brake linings were worn, in 24 motorcycles the drive train was faulty and 16 motorcycles had defective lights. As far as the technical defects of relevance to an accident are concerned, air pressure, lights and tread depth accounted for almost 30%, that is to say three individual defects that are clearly visible to and detectable by every driver. The majority of technical defects of relevance to an accident related to tyres, brakes, engine/gear box, lights and chassis.

The examples of accidents given on the following pages show the fatal impact defects in motorcycles can have on road safety.



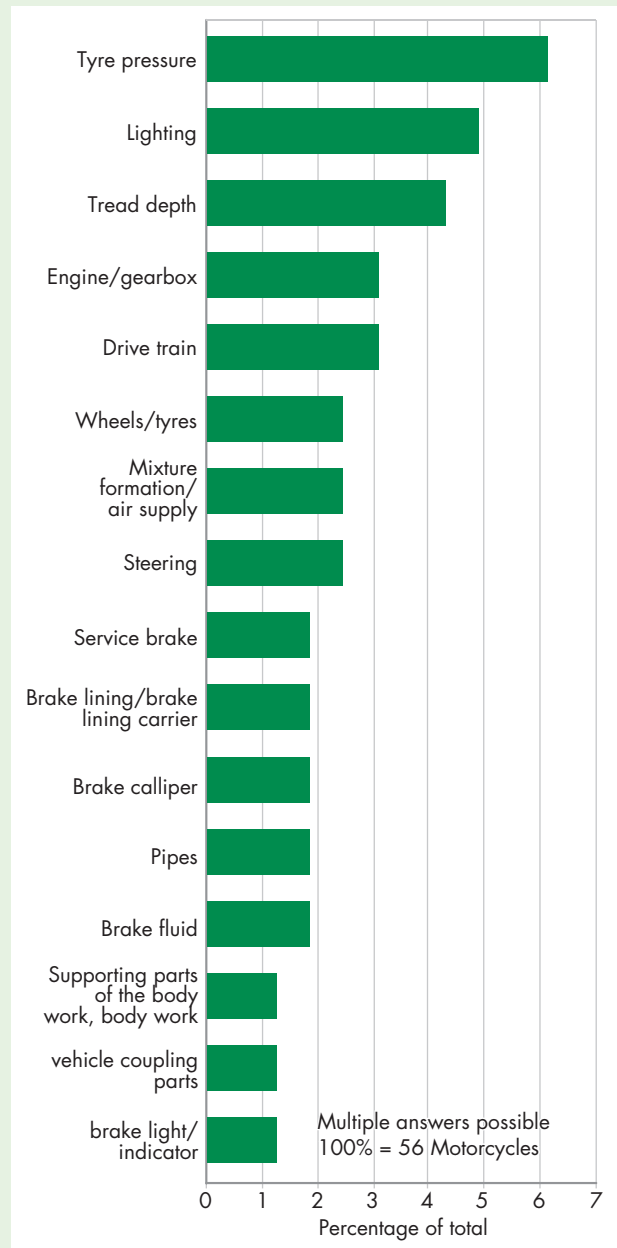


27 The most common defects and assemblies with defects in motorcycles involved in accidents



Source: DEKRA 2002 - 2009. Data from Germany

28 The most common defects of relevance to an accident and defective assemblies in motorcycles involved in an accident



Source: DEKRA 2002 - 2009. Data from Germany

Striking examples of accidents in detail

The human factor as well as technical defects and lack of safety features are the main causes of motorcycle accidents. The following examples strongly emphasise this.



1 Final resting positions of the vehicles involved in the accident

2 Left front axle deformation caused by the impact of the motorcycle

3 Mangled motorcycle in its final resting position

4 Damage to the rim of the front wheel



Example 1

MOTORCYCLE OVERTAKES AS TRACTOR WITH TRAILERS TURNS ABRUPTLY

Sequence of events leading up to the accident:

An agricultural vehicle, consisting of an agricultural tractor and two trailers, was being driven along a district road. The driver wanted to turn left. As he did so, he collided with a motorcycle, which was travelling along the district road in the same direction and was overtaking the agricultural vehicle at that very moment.

Vehicles involved:

Agricultural tractor Steyr VT 150 with two trailers, motorcycle KTM 690 SMC.

Consequences of the accident/injuries:

The driver of the agricultural tractor was uninjured. The motorcyclist was fatally injured. On the agricultural tractor the left suspension, the engine, the radiator and the exhaust system were heavily damaged. The front of the motorcycle was totally destroyed.

Causes of the problem:

The motorcyclist had initiated an overtaking manoeuvre during which several vehicles behind the agricultural tractor and the agricultural tractor itself were to be overtaken. The motorcyclist, when he realised that the agricultural tractor was turning, tried to brake his vehicle before colliding with the agricultural tractor (skid marks 12.9 metres to the point of impact).

Avoidance possibilities/ approach to road safety measures:

Reaction of the motorcyclist approx. 80 to 85 metres before the collision corresponds to approx. 2.5 seconds before the collision. Because the overtaking manoeuvre had already been underway for some time, the motorcycle would have been visible to the driver of the agricultural tractor if the latter had been attentive and complied with the obligation to look behind and the turning manoeuvre could have been delayed.

Other characteristics of the accident:

Collision speed of the motorcycle: approx. 110–120 km/h.

Speed prior to evasive braking: approx. 120–130 km/h.

Collision speed of the agricultural tractor: approx. 10–15 km/h.

Permissible maximum speed: 100 km/h.

Time of accident and characteristics of the road: summer, 5 p.m. District road with traffic in both directions, one lane in either direction, direction of traffic separated by a continuous white line. Dry road condition.

Example 2

CAR TURNS OUTSIDE A BUILT-UP AREA, MOTORCYCLE BRAKES AND SKIDS INTO THE TURNING CAR

Sequence of events leading up to the accident:

A motorcyclist was travelling along a road and collided with a car, which suddenly turned in front him.

Vehicles involved:

Car Honda CR-V, motorcycle Honda VTR Firestone.

Consequences of the accident/injuries:

The motorcyclist was seriously injured (head and leg injuries). The occupants of the car sustained slight injuries and shock. The car was damaged in the area of the rear left side wall and the rear left wheel as well as in the area of the rear left floor assembly. There were traces on the side of and beneath the vehicle where the motorcyclist, having slid under the vehicle, had made contact. The motorcycle collided with the vehicle head-on. Before colliding with the car, the motorcycle toppled over to the left. The motorcyclist's helmet was scratched and deformed. At the time of the accident it was being worn and had been properly fastened.

Causes of the problem:

Failure to keep an eye on following traffic on the part of the car driver and excessive speed on the part of the motorcyclist.

Avoidance possibilities/ approach to road safety measures:

By reacting sooner and braking harder the motorcyclist would have been able to prevent the accident. However, it cannot be ruled out that the motorcycle would still not have succeeded in stopping before colliding with the car. If the passenger car driver had paid careful attention to following traffic and had complied with the obligation to look behind twice he would have seen the motorcyclist and been able to delay the turning manoeuvre. The collision could have been prevented by equipping the motorcycle with an ABS brake. Emergency braking may have led to greater deceleration and hence a lower collision speed thereby mitigating the consequences of the accident.

Other characteristics of the accident:

Collision speed of the car: approx. 10 km/h.

Collision speed of the motorcycle: approx. 60–70 km/h.

Speed of the motorcycle prior to braking:
approx. 85–95 km/h.

Permissible maximum speed: 70 km/h.

Time of accident and characteristics of the road: middle of November at approx. 6.30 p.m. It was dark. Where the accident happened there was no street lighting or other fixed source of light. The road was flat and, when the accident happened, it was dry.



1 Final resting positions of the vehicles after the accident and tracks
2 Damage to the turning car

3 Final resting position of the motorcycle
4 Fork deformation on the motorcycle



- 1 Photograph showing skid marks
- 2 Final resting position of the motorcycle
- 3 Impact marks on the post of the safety barrier
- 4 Pressureless tyre on the front wheel
- 5 Used damaged valve
- 6 Valve caps compared
- 7 Some of the protective clothing worn

Example 3
TECHNICAL DEFECT IN THE TYRE VALVE

Sequence of events leading up to the accident:
A motorcycle with two occupants was travelling along a main road when it toppled over. The motorcyclist was flung under the safety barrier and the passenger lay on the ground close to the motorcycle. The front wheel did not show any signs of impact but there was no air pressure in the tyre.

Vehicle involved:
Motorrad Yamaha XV 1100 Virago (chopper).

Consequences of the accident/injuries:
The motorcyclist was fatally injured in the impact against a safety barrier post. The passenger suffered serious injuries as a result of the fall. The motorcycle sustained damage.

Causes of the problem:
The tracks at the scene of the accident indicated that the motorcycle went out of control and toppled over due to a loss of air pressure in the front tyre. Other reasons for the motorcycle to topple over cannot be deduced from the findings at the scene of the accident. A laboratory test carried out on the tubeless front tyre, which had been fitted shortly before the accident, together with the wheel rim, showed that the valve was old and had ozone cracks. It had been incorrectly fitted over a long period of time and was set at an angle. In addition, a heavy metal valve cap had been fitted which, in conjunction with the sloping position, placed additional pressure on the valve. Under static pressure load the valve was not air tight, which quickly led to drop in tyre pressure during dynamic movement.

Avoidance possibilities/ approach to road safety measures:
When the front tyre was replaced the valve should also have been replaced. Downstand beams supporting the safety barrier could have protected the motorcyclist, having been flung from his motorcycle, from impacting against the safety barrier posts.

Other characteristics of the accident:
Speed of the motorcycle prior to toppling over: approx. 60–65
Both motorcycle passengers were wearing helmets and appropriate attire with boots and gloves.

Example 4
SINGLE-VEHICLE ACCIDENT CAUSED BY EXCESSIVE SPEED AND INADEQUATE TREAD DEPTH

Sequence of events leading up to the accident:
 A motorcyclist was travelling along a winding road outside a built-up area. Following a depression in the road, the motorcycle became unstable and crashed into the right-hand safety barrier. It was raining heavily at the time of the accident.

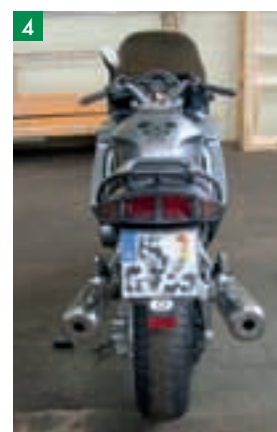
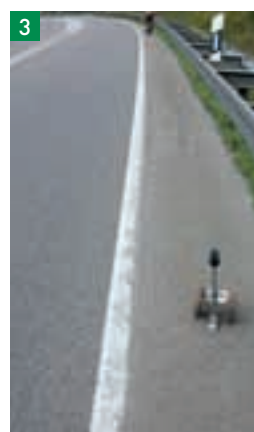
Vehicle involved:
 Yamaha FR 1300.

Consequences of the accident/injuries:
 The motorcyclist was hurled beneath the safety barrier and sustained serious head and chest injuries, to which he succumbed at the scene of the accident.

Causes of the problem:
 Before the motorcycle became unstable, it had negotiated a depression in the road on a right-hand bend. The rear wheel tyre had a tread depth of 0.5 mm in the centre and a tread depth of 1.6 mm at the edge of the tread section. With the appropriate amount of water on the carriageway in conjunction with the reconstructed speed, the bank of the curve and the inadequate tread depth of the rear wheel tyre, the cause of the accident can be explained by the handling of the motorcycle and the technical deficiency of the tyre.

Avoidance possibilities/ approach to road safety measures:
 Instability as the cause of the accident could have been avoided if the speed limit had not been exceeded (especially considering the heavy rain!) and, in particular, the rear wheel tyre had had adequate tread depth. The fact that protectors were not fitted to the safety barrier posts at the time of the accident did not have a negative effect in this case, as the motorcyclist did not impact against the safety barrier posts. The motorcyclist's injuries were caused by the impact on the carriageway or by the impact of the motorcycle against the motorcyclist.

Other characteristics of the accident:
 Initial speed of the motorcycle before it became unstable: approx. 120–130 km/h.
 Speed of impact against the safety barrier: 105–110 km/h.
 Permissible maximum speed in the area where the accident happened: 80 km/h.



- 1 Shape of the curve before the site of the accident
- 2 Vertical post coverings not fitted at the time of the accident
- 3 Marks on the carriageway
- 4 Rear tyre worn to below the minimum tread depth
- 5 Marks on the safety barrier
- 6 Motorcycle involved in the accident
- 7 Impact marks on the safety barrier
- 8 Stress marks and skid marks



The human being: a risk factor in road traffic

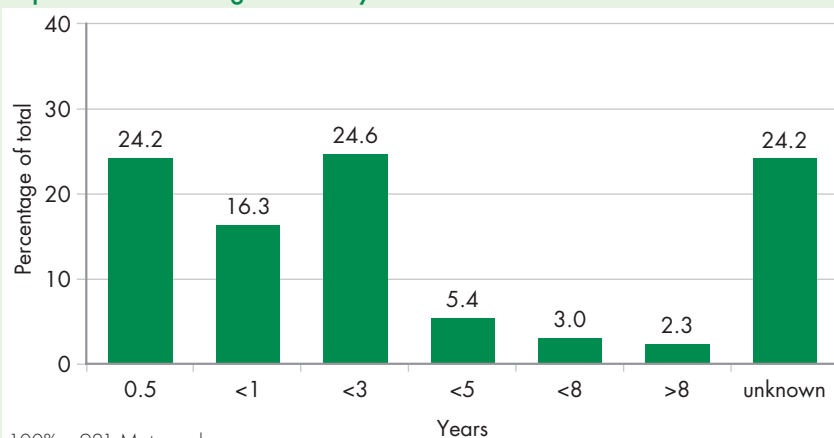
Inappropriate speed, too low a safety distance, disregard for the right of way, errors when overtaking and when turning, driving under the influence of alcohol, as with accidents involving passenger cars and lorries, motorcycle accidents are frequently attributable to human error. Appropriate and anticipatory driving behaviour is therefore the be-all and end-all when it comes to motorcycling and would prevent not only collisions with other vehicles but also many single-vehicle accidents. A sound awareness of risk is based on a solid training for drivers. Driving safety training at regular intervals is also recommended once the driving licence has been obtained. Last, but not least, it is important to rigorously monitor compliance with the applicable road traffic regulations.

Motorcycling is extremely popular among all age groups. Also, for seasonal reasons, temporary motorcycle permits are issued from April to October. In April, due to a lack of driving practice, motorcyclists are somewhat unprepared for influencing the traffic situation, and therefore they expose themselves and other road users to increased risks. From April, the number of motorcycle accidents increases significantly. The latest report by the Federal Statistical Office on accidents involving two-wheeled vehicles bears this out, as do statistical analyses carried out in other EU countries.

The MAIDS Analysis (MAIDS = Motorcycle Accidents in Depth Study) of over 900 motorcycle accidents in Europe, which was carried out on behalf of the

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Experience of riding a motorcycle



Source: MAIDS Study

European motorcycle manufacturers' association ACEM in association with the OECD, showed that almost 90% of motorcycle accidents can be attributed to the human factor at the man-machine interface (Figures 29 and 30). This applies both to the motorcyclists themselves and the drivers of vehicles that may be involved in a collision. For example, passenger car drivers often become aware of motorcycles too late. This provides an initial impulse to the taking of targeted measures to improve the mutual awareness of road users, to which attention should be paid when all road users learn to drive.

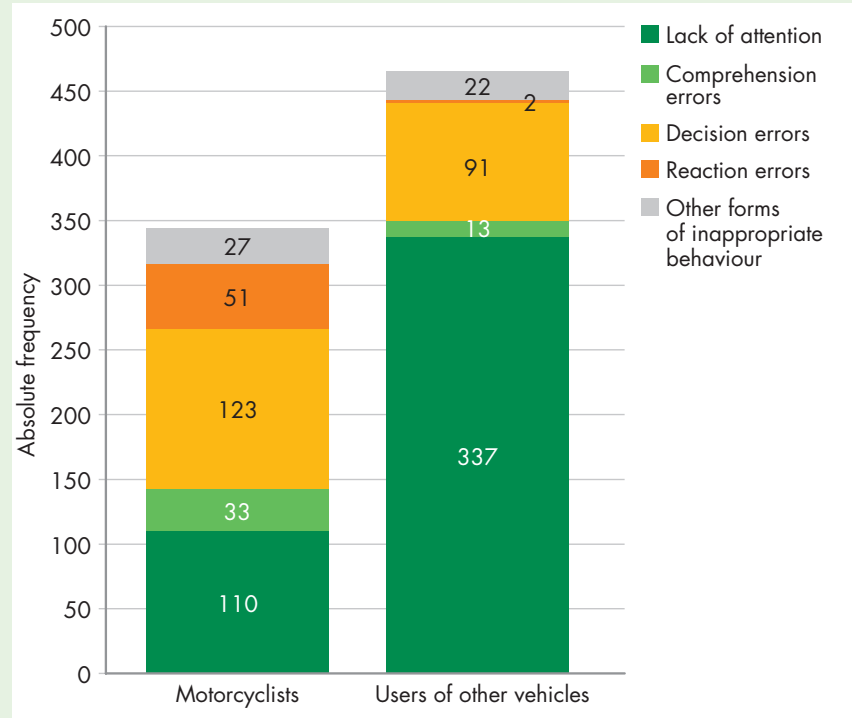
NON-AGGRESSIVE DRIVING IS THE BEST SAFETY STRATEGY

During training, special emphasis must be placed on training future motorcyclists to take personal responsibility for ensuring that they are seen (light, brightly-coloured clothing, safety distances, attention to blind spots, etc.). Passenger car drivers, on the other hand, should pay special attention to users of two-wheeled vehicles by driving with anticipation and constantly checking their rear-view mirror. This applies in particular during turning and lane-changing manoeuvres. As a further measure when riding a motorcycle, non-aggressive driving is the best safety strategy whereby many accidents motorcyclists themselves are responsible for and less serious collisions can be prevented.

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Driver-related accident factors

Of 921 motorcycle accidents analysed on behalf of the European motorcycle manufacturers' association ACEM in association with the OECD 87.9% can be attributed to the human factor. Of these, 37.4% (= 344 accidents) are accounted for by motorcyclists and 50.5% (= 465 accidents) by users of other vehicles. While, among motorcyclists, lack of attention and a decision taken that was inappropriate to the traffic situation led to the accident concerned too much the same extent, among users of other vehicles by far the most common cause of accidents was lack of attention.



Source: MAIDS



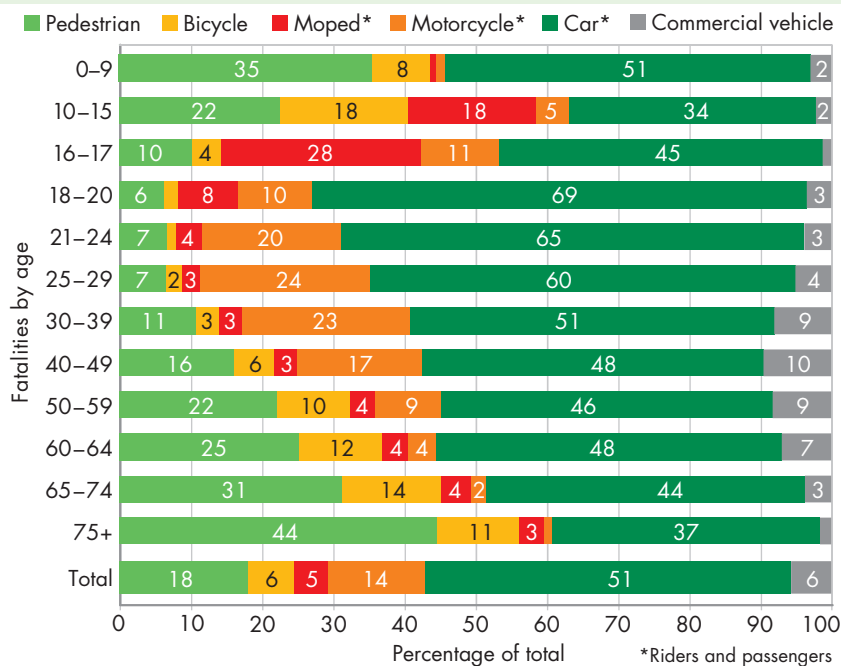
Prof. Dr rer. nat.
Wolfgang Schubert,
First Chairman of the
Board of the Deutsche
Gesellschaft für
Verkehrspsychologie
e. V. (German Society
for Transport Psychology)



"The human factor plays a central role in preventing motorcycle accidents. Knowledge-based, educational, vehicle technology-based, infrastructural as well as medical and psychological measures are required to reduce serious injuries amongst motorcyclists. It is also important that these measures are effective, economical and that they can be implemented."

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Fatalities by age and type of road use in Europe



Source: CARE Database (EU-19), July 2008

Training courses in safe driving for motorcyclists

Safe driving pleasure requires control over the motorcycle. In addition to basic training, regular training in safe driving under the professional guidance of specially trained instructors is recommended for this. The safe driving courses set up, for example by DEKRA, in accordance with the guidelines of the German Traffic Safety Council include steering momentum techniques, optimal braking, navigating a slalom course, and emergency manoeuvres among the areas of focus. The method consists of training in the correct sequences of movements, and also in the experiencing of the limits set by driving physics. Recognising and avoiding dangers in good time is the overriding learning aim of the

training. Of course, participants also learn how to take control of dangerous situations unharmed. The instructors always take care to ensure that theory and practice complement each other. The contents of the training courses are worked out jointly and take account of the driving needs and issues of the participants.

The motorcycle curve lean training programmes launched and offered on request by DEKRA also contribute to greater safety. These training programmes safely show participants what leaning positions are possible and how they can be controlled – an experience that can save lives during the next evasive manoeuvre or at a seemingly too high cornering speed.

The EU project “PROMISING” (Promotion of Measures for Vulnerable Road Users) has shown, among other things, that infrastructure to accommodate motorcycles (road surfaces, bumps, the layout of road junctions, coloured markings, etc.) offers motorcyclists further potential for preventing accidents. As regards technical improvements to vehicles, there are measures that also contribute to significant safety gains – by fitting motorcycles with anti-blocking brakes as standard, for example. Another way of preventing injuries, particularly slight to moderate injuries, would be for motorcyclists to wear colourful, highly contrasting protective clothing to make them more noticeable. More detailed information about infrastructure, automotive engineering and clothing will be given in the next section.

TRAINING ON MACHINES THAT ARE ADAPTED FOR USE UNDER PRACTICAL CONDITIONS

The foundations of driving skills specific to motorcycles must be developed and maintained through initial training as well as through relevant advanced training later on. Training courses in safe driving, such as those offered, among other things, by DEKRA (see the box on the left), are to be recommended. Another area of focus for increasing road safety is the monitoring of road traffic by the police with the aim of ensuring compliance with the relevant legislation. In this connection, motorcyclists should receive direct “feedback”, for example in the form of appropriate sanctions, for inappropriate behaviour called into question during traffic controls, in order for the corresponding lessons to be learnt.

A special area of focus in the training of motorcyclists consists in ensuring that there is an adequate link between the





The driver training of motorcyclists is very important for road safety.

“competence” complex (theoretical and practical driver training) and the physical and mental conditions to be met, which must take account of the medical aspects (vision, a sense of balance, general health considerations, illnesses, etc.) and the

psychological and performance-related aspects (psycho-functional performance, attention, responsiveness, concentration, coordination, etc.). It is important to ensure that training is carried out on machines that are adapted for use under

practical conditions and that have a similar capacity to those that will be used later as starter machines. Anyone who wishes to ride more powerful machines later on should undergo further training and provide a relevant certificate of competence.

The driving licence regulations in Germany at a glance

Type of vehicle	Technical provisions	Driving licence		Minimum age of the driver	
		Category old / new	or alternative category		
Powered cycle	Bicycle with an auxiliary engine up to 25 km/h bbH (bauartbedingte Höchstgeschwindigkeit (maximum design speed)) maximum permissible engine speed up to 4,800 rev/min., single-seated	none	Test certificate required, if driver 15 years of age after 01.04.1980 15 or does not yet have a driving licence	15	
Moped	Two-wheeled vehicle up to 50 cm ³ cylinder capacity and not more than 60 km/h bbH	4	M	1, 1a, 1b, 2 or 3; category 5, if issued before 01.04.1980	16
Small cubic capacity motorcycle	125 cm ³ cylinder capacity and not more than 80 km/h bbH and a nominal power of not more than 11 kW	1b	A1	1 or 1a; category 2, 3 or 4, if issued before 01.04.1980	16
	Two-wheeled vehicle up to 125 cm ³ cylinder capacity, open final speed and a nominal power of not more than 11 kW				18
Motorcycle/motor scooter (also with sidecar)	Motorcycles of category 1, but with a nominal power of not more than 25 kW and a power-to-unladen weight ratio of not more than 0.16 kW/kg	1a	A limited	All motorcycles can be ridden 2 years after issue	18
	Two-wheeled vehicle with more than 50 cm ³ cylinder capacity and more than 50 km/h bbH	1	A unlimited	Holders of the old category 1a must have their driving licence converted, if they want to ride unrestricted motorcycles.	25

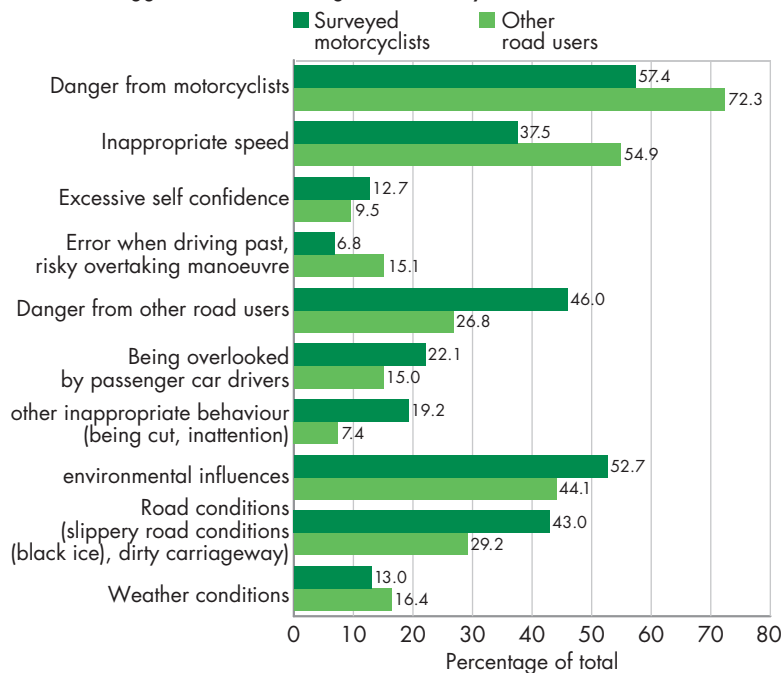
Source: Federal Statistical Office, Motorcycle Accidents, 2008



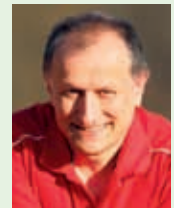
Motorcyclists – dangerous or endangered?

Passenger car drivers underestimate the danger that motorcyclists are threatened with from other road users. This emerged from a representative survey of 2,000 road users conducted on behalf of the German Traffic Safety Council (Deutsche Verkehrssicherheitsrat (DVR)). While 72.3% of passenger car drivers believe that the biggest source of danger for motorcyclists lies in the behaviour of the motorcyclists themselves, 57.4% of motorcyclists believe this to be the case. Almost one in two motorcyclists (46%) are of the opinion that hazardous situations for users of two-wheeled vehicles are also brought about by the behaviour of other road users. Yet only approximately one in four (26.8%) of drivers of other vehicles see this danger. That bikers are better than their reputation seems to suggest is shown by the latest report of the Federal Statistical Office on motorcycle accidents in Germany: of all accidents resulting in personal injury in which motorcyclists were involved in 2008, more than 52% were not caused by motorcyclists but by other road users.

What are the biggest sources of danger for motorcyclists?



Source: DVR



Michael Pfeiffer,
editor-in-chief of
the magazine
MOTORRAD

“No other vehicle develops such a dynamic as a motorcycle. It is controlled exclusively by a human being. The human factor is therefore absolutely crucial. Controlling a motorcycle requires practice. Not enough attention is given, to two-wheeled motor vehicles, particularly on public roads. So there is no alternative but to be prepared for all eventualities, such as cars ignoring the right of way, difficult bend combinations, or bitumen-contaminated patchwork quilt roads. We motorcyclists must simply be better than other road users. We must be able to react more quickly, drive more carefully, and develop a seventh sense for danger. Training is therefore important; we must be fit and also composed. And that is down to us personally. Like pilots of a passenger aircraft we should feel sympathy for the most important passenger in the world: yourself. That is why, at the start of the season, we should undergo safety training and not just drive off when we see the first ray of sunlight. Then things will work out.”



It is often the case that accidents between passenger car drivers and motorcyclists can be attributed to lack of mutual consideration.

Passenger car drivers: watch out!

Passenger car drivers bear a great deal of responsibility for preventing accidents with motorcycles. Greater partnership and consideration between passenger car drivers and motorcyclists is necessary. Here are a few safety tips for passenger car drivers:

- Specially delicate situations are turning and changing direction (making a U-turn), changing lanes and continuing straight on over road junctions. In these situations, special attention is needed.
- Be careful. Sometimes there is more than what the eye can see at a particular moment. Bear in mind that the view of the driver can be obstructed by passengers, headrests, roof spars and door posts.
- When you start to overtake or to change lane, always consider the possibility that

there may be a motorcycle in the blind spot of your car.

- Beware. Motorcycles are often concealed by lorries or cars. So do not simply concentrate on cars; actively and consciously look for motorcycles. In principle, passenger car drivers should be trained appropriately when receiving driving instruction.
- Even if you cannot see the motorcyclist, he can probably see you. So always use the indicator to inform motorcyclists of your intentions.
- Do not underestimate the acceleration capacity and speed of motorcycles. Consider carefully whether you really want to turn in front of the approaching motorcycle or whether there is not enough time. It is risky for motorcyclists if they have to brake suddenly.

CONSIDERATION AND SELF-CONTROL

Further accident-prevention potential lies in the presence of behavioural characteristics and personality traits representing compensatory opportunities, all of which are based on human conduct. These include non-aggressive driving, mutual consideration and the adequate evaluation of traffic conditions,

as well as the faculty to be self-critical, the ability exercise restraint or self-control.

It will not be possible, and it will probably not be necessary, to regularly test all road users with regard to the qualities mentioned above. However, special attention should be paid to further developing the system of event-related medical and psychological examinations of motorcyclists

who have already been brought to the attention of the authorities. A particular aim of this is to enable driving licence authorities to support those drivers who are unable to meet road traffic requirements or consistently and repeatedly flout the law, and to enable them to change their behaviour through training and to retain or regain their driving licence.

Behaviour and safety tips for motorcyclists

Motorcyclists live more dangerously than passenger car drivers. Yet the risks can be minimised through the correct behaviour, the right clothing, the appropriate and, particularly, roadworthy motorcycle as well as regular training. Most important of all, always factor in that extra bit of safety – never go to your limits.

Healthy scepticism towards other road users

- Always expect other road users to make mistakes and try to anticipate their (inappropriate) behaviour.
- A great deal of care is needed when vehicles are turning or at road junctions. This is where most accidents happen.
- When you overtake a vehicle pay attention to its front wheels. This is how can most quickly see if the vehicle is going to swing out. Keep out of the blind spot if possible and overtake the vehicle quickly.

Training – for beginners and experienced riders

- Undergo driver safety training regularly – the best time would be at the beginning of each season.

- Consciously practice braking – even if your motorcycle has been fitted with an anti-blocking system (ABS). Even experienced motorcyclists often do not manage to achieve optimum control of braking performance in emergencies.
- When you ride your motorcycle, accustom yourself slowly to the change in the behaviour of the motorcycle. Avoid braking and changing direction suddenly and accelerating aggressively.

Protective clothing and helmets

- Always wear full protective clothing, even on short journeys.
- Only buy a helmet bearing the ECE-R 22-05 mark. Full face helmets offer the greatest protection.
- Make sure that the helmet sits firmly on your head and that the chin strap is fastened.

Be visible – at all costs

- When buying your helmet and clothes go for clearly visible, bright, vivid, contrasting colours.
- This also goes for the motorcycle itself.
- Always keep your lights switched on.

Treacherous carriageway

- Always keep an eye on the carriageway. Motorcyclists can easily skid on sand, leaves, dirt, grit, oil and diesel spills. Wet, snow-covered or icy roads can also be tricky of course.
- Bitumen, which is often used for road repairs, is particularly treacherous. Especially when the bitumen is wet, the motorcycle's grip on the patches of bitumen is strongly diminished. This is also true for road markings.
- Watch out for manhole covers, tram lines, wheel ruts and longitudinal joints on motorways!
- Current safety barriers pose a special risk. When they fall, motorcyclists often slide under the barrier or collide with the posts. The risk of injury is significant. So ride carefully at tricky places where there are protective barriers.

Keep your motorcycle well maintained ... and you are halfway there

- It is especially important to regularly check the air pressure and the condition of the tyres and valves.
- Make sure that the tread depth of the tyres is adequate and that the brakes and lights are working.



Increasing active and passive safety

The data and information assembled in this report clearly show that, contrary to the general trend of falling numbers of fatalities and seriously injured road users in Europe, among motorcyclists these numbers have stagnated at a relatively high level for a number of years. There is potential for optimisation: in terms of the motorcycle, in matters of protective clothing, as regards road infrastructure and, last but not least, the road users themselves. Numerous EU road safety projects show this to be the case.

In contrast to passenger car drivers, motorcyclists are exposed to a much higher risk in road traffic. This is due to the different driving physics, the always delicate state of equilibrium, and the special physical and psychological strain that motorcyclists are under. At the same time, motorcyclists are much more sensitive to climatic influences and other disruptive factors, such as road conditions and unforeseeable traffic situations. In addition, a motorcycle does not have any protective bodywork. So motorcyclists are unprotected when they collide or fall, even if they are wearing protective clothing. And, more importantly, serious accidents often prove fatal.

Therefore, there is urgent need for action – each injured or fatally injured motorcyclist is one too many. For decades there have been intensive efforts at all levels with regard to increased road safety for motorcyclists. The European Commission has introduced, and is still introducing, new projects aimed at improving the systems of active and passive safety. An example of such a project is “APROSYS” (Advanced PROtection SYStems), which involved 46 partners (universities, research institutions, suppliers and manufacturers) from twelve European countries. One such partner was DEKRA. The “Integrated Project on

Improved Protection Systems” concerned itself with scientific and technological developments in the domain of passive safety – focusing on human biomechanics, the crash performance of vehicles and infrastructure, and on protection systems for vehicle occupants, motorcyclists and other road users.

Measures and strategies for two-wheeled motor vehicles were included in the scope of subproject 4 (SP 4), which dealt with motorcycle accidents. The aim of this subproject was to reduce the number and severity of the injuries suffered by road users in accidents involving two-wheeled motor vehicles for the most



There is a wide variety of safety helmets for motorcyclists. The integral, full-face helmet offers the best protection. However, with the classic jet helmet, the chin is unprotected.

important types of accidents. To this end, accidents that had actually happened in various EU states were analysed in depth and the injuries resulting from the different impact velocities were examined, with interest being focused on “forgiving” road design and layout as well as protective systems for motorcyclists.

PROTECTIVE SYSTEMS THAT LEAVE MUCH TO BE DESIRED

The aforementioned accident scenarios confirmed the results of earlier studies, which found that motorcycle and/or car accidents can often be attributed to errors in perception. The most common types of accident are head-on collisions between motorcycles and cars as well as the lateral impact of a motorcyclist against a car. Avoidance measures taken by motorcyclists, such as braking or swerving, are often unsuccessful. Where injuries sustained by riders of two-wheeled motor vehicles were caused by contact with a car, these injuries were usually serious or fatal. Where riders of two-wheeled motor vehicles collided with infrastructural facilities, the majority of obstacles – especially in accidents with serious consequences – were trees, pillars, and safety barriers. Other impact objects were posts as well as the carriageway itself. The initial impact was often against an infrastructural facility. Impact against safety barriers in particular frequently led to serious injuries. Collisions with obstacles led, with particular frequency, to head injuries, with injuries to the lower extremities being almost as common.

In order to determine the effectiveness of safety devices for drivers of two-wheeled motor vehicles, crash tests and paired comparisons between dummies with and without protective equip-

ment were carried out in four protection stages as part of the APROSYS project. The impact velocities chosen for this purpose were 0 to 35 km/h, 36 to 70 km/h and more than 70 km/h. Even at speeds of up to 35 km/h the loads acting on the dummy indicated a risk of serious, critical or life-threatening injuries to the head, chest, pelvis and upper extremities. An analysis of the loads acting on the spinal column attested to the effectiveness of protective clothing in reducing both the severity of the injuries and the number of injuries resulting from accidents in all speed ranges.

HELMET AND CHEST PROTECTOR

One of the results of the APROSYS project is the conclusion that the protection provided by currently available,

very safe helmets can be optimised even further. At the moment, helmets have to pass a series of impact tests in accordance with the applicable regulations, especially ECE Regulation 22 as amended by the 05 series of amendments (ECE-R 22-05). However, this standard only takes partial account of specific violations on the basis of turning and acceleration effects. Therefore, the Centre for Innovation and Safety at the University of Florence (CISAP) developed a prototype helmet with a moving, thermoplastic and reinforced fibreglass chin part, which is supported by means of a honeycomb structure on the left and right of the helmet shell and therefore acts like a crash box. On impact, the head acceleration and the forces acting on the chin straps could therefore be reduced. In the opinion of the CISAP,



The German Road Traffic Act (StVO) prescribes the wearing of a suitable helmet. DEKRA explicitly recommends that, when buying a new helmet, motorcyclists should ensure that it has passed the ECE-R 22-05 test. The relevant marking can be found on the interior padding and the chinstrap.

these findings should therefore have an influence on the ECE-R 22-05 motorcycle helmet safety standard in the future.

The scientific analysis of accidents also highlights the fact that motorcyclists time and again suffer serious injuries in the chest region due to impact. Therefore, a study was carried out within the APROSYS to develop suitable protection for this region of the body. The Italian manufacturer Dainese and the Ludwig Maximilian University in Munich collaborated on the development of such protection, a special chest protector. Several

Airbag prototype for mid-range touring motorcycle

A big touring motorcycle like the Honda Gold Wing offers plenty of room for the installation of a large airbag. According to currently published information, this has a volume of 150 litres. Honda was therefore able to adopt the relatively low-risk approach of restraining a rider and bringing him or her to a complete standstill by means of a fully inflated airbag. This purely restraint-based protective effect can be observed in the crash tests carried out at an impact speed of 48 km/h in accordance with ISO 13232.

To present the protective effect of a small motorcycle airbag, between 2001 and 2004 DEKRA developed a motorcycle airbag with a volume of 60 litres to be mounted on a mid-range touring motorcycle. Four real-world crash tests were carried out in accordance with ISO 13232, during which the motorcycle crashed into the side of stationary and moving passenger cars. The paired comparisons demonstrated that the impact against the opposing vehicle was significantly lessened by the airbag compared to the tests without the use of an airbag. Once again, this shows that, even for smaller touring motorcycles, which are manufactured and sold in large numbers, the airbag can be a promising protective measure for the improvement of passive safety. However, there is a risk of injury during the continued movement of the motorcyclist following the much lessened initial impact against the airbag until the second impact on the road. Further extensive research and development work in this area is necessary.

simulations to determine the effectiveness of the protector showed that it distributed the forces exerted during impact better, thereby preventing dangerous, inwardly directed rib fractures. The system consists of a polypropylene helmet shell, into which a honeycomb structure made from aluminium, which cushions the impact, is integrated. Its protection is greatest during head-on impacts. The development of the chest protector took account not only of passive safety aspects but also of ergonomic aspects in terms of active safety. Attention was also paid to maximum freedom of movement during the wearing of the protector to enable the rider to control the motorcycle and avoid dangerous situations.

Running partly in parallel with APROSYS, the EU follow-up project "Safety in Motion" (SIM), a safety concept again involving several partners, including DEKRA, investigated elements of active and passive safety as well as prevention. The project focussed on motorcycle traction control, a semi-active damping system, lift-off protection for the rear wheel, an airbag, inflatable protective jackets and a fully integrated ABS. The research platform was provided by the three-wheeled motor scooter MP3, which was launched onto the market by Piaggio in 2006, and with which a promising safety concept was implemented.



The chest protector contributes to the prevention of dangerous rib injuries.



In the Crash Test Center in Neumünster DEKRA also regularly carries out crash tests with two-wheeled motor vehicles.



In 2006 the Honda Gold Wing was the first motorcycle with an airbag fitted as standard.

AIRBAG PROTECTS HEAD, NECK AND CHEST

The airbag in particular could become increasingly important as an element of passive safety in the future. In 2006 Honda launched the first motorcycle with an airbag fitted as standard onto the market. Admittedly, research in this area had begun well before then. Reports on trials and prototypes have been coming out worldwide since 1973 and DEKRA Accident Research has been working intensively on the motorcycle airbag since 1987. In 2002 the first full-scale trials with a prototype airbag developed in-house for a medium-sized touring motorcycle were conducted in the DEKRA Crash Test Center in Neumünster. The series of tests continued in early 2004.

The airbag did not become the focus of attention of accident researchers and motorcycle manufacturers without good reason and it is based on the detailed description of accidents presented in this road safety report. The other party most frequently involved in accidents with two-wheeled motor vehicles both inside and outside built-up areas is the motorcar. Different analyses of the regions of the

body sustaining injuries indicate that the head is most in danger when it comes to serious and fatal injuries, even when a helmet is worn. There is also a wide variety of injured regions of the body, including the upper and lower extremities, depending on the type of accident and the impact constellation of the motorcycle.

One type of accident with an often fatal outcome for the motorcyclist involved the motorcyclist's head impacting against the side roof edge of a passenger car. Accident investigations carried out by the Medical University of Hanover, on the other hand, have shown that, in general, impact at an angle against the front and rear side of the car, occurs more frequently. In the case of particularly serious accidents, however, the importance of the head striking against the side roof edge of the car was confirmed. The frequency of injuries to head, neck and chest was particularly high. The decelerations of the head upon impact with the roof edge, the decelerations of the chest, the forces exerted on the neck and the bending moments of the neck are critical, life-threatening or even fatal.

The priority action in the case of accidents between motorcycles and passenger cars is the protection of the motorcyclists'



head, neck and chest. The impact of the head against the passenger car must be completely prevented, or its effects must be significantly alleviated. This means that, at the start of the collision, the kinetic energy of the occupant of the motorcycle sliding forward and then impacting against the opposing vehicle must first be reduced to the lowest level possible. Any kinetic energy remaining after the initial impact against the opposing vehicle can then be used to introduce an upwards movement of the occupant. At high impact speeds, the occupant can overfly or slide over the roof of an impacted passenger car.



Crash test not with a dummy, but with a stunt man.

It is just these requirements that the motorcycle airbag fulfils when a motorcycle collides head-on with a passenger car. At the same time, a motorcycle airbag can reduce the risk of injury when a motorcyclist impacts against the tank of his or her motorcycle or gets caught on the handlebars. The series of tests carried out by DEKRA on the basis of the regulations of ISO 13232 (international standard specifying, among other things, the simulation of impact accidents with motorcycles) emphatically underpin this.

REDUCING THE MEASURED LOADS

A series of tests of the type moving/stationary – the collision partner of the moving motorcycle was a stationary passenger car – with the collision occurring at right angles showed that the direct impact of the motorcyclist's head against the roof edge of a passenger car can be prevented. After the initial impact, in the subsequent motion sequence, with its trunk and upper body against the airbag the dummy (represent-

ing the motorcyclist) glided upwards and its head, avoiding the roof edge, was able to escape the danger zone. All the loads exerted on the dummy during the test with the airbag were much lower than the corresponding values when the same test was carried out without an airbag and were also well below the biomechanical limit values. A hybrid III 50th percentile male dummy was used in the initial series of tests. A second series of tests of the type moving/moving – the moving motorcycle impacts against the side of an, also,



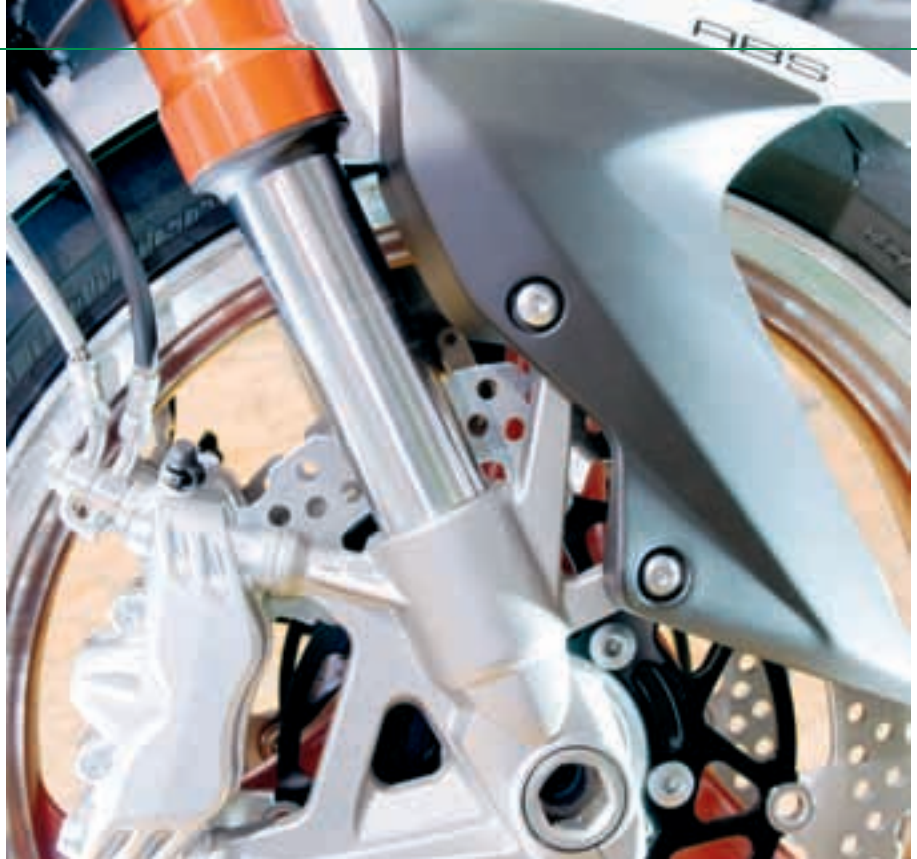
moving passenger car – showed, in some ways similar, positive but also differentiated results. For the first time, in tests it financed itself, DEKRA used the special MATD dummy as described in ISO 13232. This very lavishly instrumented dummy was designed specially for the multiple directions of motion and loads experienced during motorcycle impacts. The load values determined using the MATD enable a complete risk-benefit analysis to be carried out in accordance with ISO 13232, which is ultimately the central result of a complete series of tests with supplementary digital simulations.

In this second series of tests, a very different motion sequence resulting from the pre-collision movement of the impacted car presented itself. Once again, the airbag was able to prevent head impacts but, because of the distinct lateral movement of the crossing motorcar, the dummy did not slide onto its roof. Here too, all the measured values produced by the dummy were below the biomechanical limit value. Apart from the neck bending moment and the neck pressure force, the measured loads were significantly reduced in all other cases.

PROTECTION FOR CAR PASSENGERS DURING SIDE-ON COLLISIONS

The airbag is also important in view of the fact that the trend among car buyers is for ever taller vehicles such as SUVs and vans. The problem is that, when a motorcyclist collides with a high-sided vehicle, his or her head and upper body directly impact against the vehicle structure. If the motorcyclist is flung against the lateral front section of the vehicle he or she has no chance of gliding over the hood, as would happen in the case of a passenger car with a lower, flatter front. Steep, high vehicle fronts impede the trajectory of the motorcyclist and therefore increase his or her risk of being injured.

The fatal consequences were underpinned in a crash test carried out by DEKRA and AXA Winterthur Versicherung in 2004 in Wildhaus, Switzerland. The crash test also showed that, when a motorcycle crashes into the side of a passenger car, the passengers in the car are exposed to a considerable risk. During the test, the impacting motorcycle penetrated the vehicle to such an extent that the head and upper body of the passengers sitting in the area of the impact were at risk. Under certain circumstances, side airbags fitted in a passenger car cannot realise their full protective potential,



Motorcycle manufacturers offer their customers more and more models with ABS.

as the release mechanism is primarily designed to react to an impact from a car. It is worth noting that an occupant in the aforementioned passenger car is at risk of being injured during a lateral collision with a motorcycle. The motorcyclist is not lifted over the vehicle and may penetrate the glass of the side window. A motorcycle airbag may remedy this by initially restraining the motorcyclist when the crash occurs and then possibly pushing him or her upwards and raising him or her over the danger zone, i.e. the roof of the passenger car. A motorcycle airbag can, in such case, reduce the risk of injury not only of the motorcyclist but also of the occupants of the passenger car.

ABS HELPS TO PREVENT ACCIDENTS

There is no doubt that, in the future, the focus will shift more and more to active safety systems. Compared with a passenger car, there are fewer possibilities for incorporating passive safety elements into motorcycles. Therefore, the importance of the use of active safety for motorcyclists cannot be overstated. The availability of active safety systems is still, however, very limited. Although anti-lock braking systems (ABS) and wheel slip control systems for motorcycles exist, other marketable technical solutions for stabilising motorcycles do not. And there is another problem: the existing safety systems are installed as standard in very few models.



In the majority of cases, they have to be purchased as extras. Although the number of motorcyclists who are prepared to dig somewhat deeper into their pockets for these extras is increasing, the bottom line is that the number is still far too low. A common reason for the lack of acceptance is that numerous motorcyclists are convinced that only inexperienced bikers need an ABS.

There is no question that the investment is worthwhile. Many accidents can be prevented and the severity of impacts can be reduced through the use of an ABS or a technical assisted braking system. This is one of the conclusions reached by



a simulation study carried out by DEKRA Accident Research on the basis of 87 well document motorcycle accidents. The scientists undertaking the research showed that, if the motorcycles had been fitted with an ABS 25 up to 35% of the accidents analysed would have been prevented. The perfect technical solution would have been a combination of ABS with an integral brake and a technical assisted braking system, which is currently still in the development phase. This would have prevented almost twice as many accidents (50% to 60%), as such systems react much more quickly than conventional braking systems in dangerous situations.

The background to this is that, in dangerous situations, motorcyclists often do not exploit braking performance to the full, fearing that this will lock the front wheel, and so settle for a braking distance extended by a few crucial metres. In such situations, ABS and modern combination braking systems, which optimally distribute the braking force between front and rear wheel, could demonstrate their full potential, especially on wet roads. Thanks to ABS, deceleration values of up to 8 m/s^2 and more can now be achieved, even on wet roads (Figure 32). ABS stabilises braking, reduces braking distance and inhibits overbraking at the front wheel, thereby

preventing falls during braking. ABS also reduces the strain placed on the motorcyclist during braking, especially in crisis situations and emergencies.

The Allianz Zentrum für Technik (AZT) (Allianz Centre for Technology) worked intensively on ABS, analysing 200 particularly serious motorcycle accidents. Approximately 90 accidents were filtered out as being of relevance to ABS, as they clearly exhibited braking in the “pre-crash” phase. It was found that ABS-

relevant cases increased by 69% in non-built up areas. The majority of opposing vehicles were passenger cars and tractors (59% and 13% respectively).

POSITIVE COST-BENEFIT ANALYSIS FOR ABS

Of the 90 ABS-relevant cases, adequate documentation on the length of the skid mark, the length of the scratch mark and possible other traces was available in 48



With the BMW C1, the rider is protected by an enveloping yoke structure.

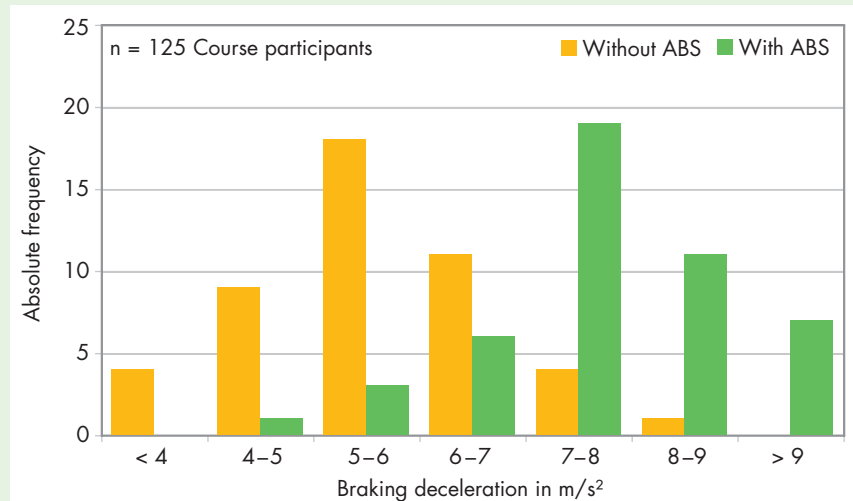
accident files. This allowed the initial braking speed and the collision speed to be reconstructed relatively accurately. The detailed analysis of all 48 reconstructable cases showed that, with ABS, eight cases would have been “probably preventable” and a further ten cases would have been “possibly preventable”. With regard to the 90 ABS-relevant cases the proportion of “probably/possibly preventable” cases was between 17% and 38%. With regard to all 200 particularly serious accidents, the AZT found that ABS would have been effective in between 8% and 17% of cases. Extrapolating this to Germany alone, if all motorcycles were equipped with ABS, approximately 100 lives would be saved every year. There would be a four-digit fall in the number of seriously and slightly injured motorcyclists every year.

The result of the AZT study also prompted Allianz Versicherung to send a signal. Since 2005 it has granted a discount of 10% on civil liability insurance for motor vehicles fitted with ABS as a standard or optional feature. This measure supports the idea of the Federal Ministry of Transport to provide incentives to promote safe behaviour on the road. The ADAC expressed the reservation, however, that ABS must not lure motorcyclists into adopting a more risky driving style. The aim of the system is simply to reduce the high risks attendant upon emergency and hard braking while the motorcycle is travelling in a straight line. Anti-lock braking systems fitted to motorcycles are only of limited suitability for cornering and when the motorcyclist is in a leaning position. In addition, not all ABS versions have a function to protect the motorcycle from overturning at very high deceleration speeds. Braking with ABS should therefore be practised regularly on non-public roads



32

Braking deceleration measurement for motorcycles with and without ABS



Source: Austrian Road Safety Board

under professional guidance as part of a driver safety training programme for the motorcyclist to take full advantage of the safety advantages in an emergency.

That ABS “adds up” for motorcyclists economically was highlighted in a cost-benefit analysis carried out in 2007 by the University of Cologne’s Institute of Transportation Economics on behalf of the Federal Highway Research Institute (Bundesanstalt für Straßenwesen BASt). The scope of the analysis included the years 2015 and 2020; the accident and inventory figures were extrapolated for each of these years.

Essentially, the major benefit of ABS and other assisted braking systems lies in reducing the frequency of accidents and hence the costs of personal injury and material damage incurred as a result of an accident. The costs of assisted braking systems consist of procurement and maintenance costs. Assisted braking systems are macroeconomically profitable if the cost-benefit ratio is greater than 1. The cost-benefit ratio of ABS for motorcycles was between 4.6 and 4.9. This means that each euro that is invested in assisted braking systems creates a benefit of between 4.6 and 4.9 euros.

Finally, a break-even analysis explained from what price or from what annual mileage ABS is worthwhile for the user. This analysis came to the conclusion that ABS is also economically viable for the user. Market prices of 701 euros for 2015 and 622 euros for 2020 were assumed, which makes ABS good economic sense for the individual motorcyclists if they travel more than 2,200 kilometres per annum (for 2015) and more than 1,900

kilometres per annum (for 2020). On average, motorcyclists travel 3,900 kilometres per annum, which means that ABS is also worthwhile for most motorcyclists in purely economic terms.

INCREASED ABS EFFECTIVENESS POSSIBLE IN COMBINATION WITH OTHER SYSTEMS

A perfectly sensible complement to the now established braking control systems is a wheel slip control system, such as the ASC (= Automatic Stability Control). This is a system that supports motorcyclists during acceleration, particularly on roads with changing and reduced friction coefficients. It limits the transferred driving torque of the engine within specific physical limits depending on the condition of the road, preventing the uncontrolled spinning of the rear wheel to a large extent. The system is also able to prevent the front wheel from lifting up as a result of strong acceleration. Risky driving should, however, be avoided at all costs, even with ASC fitted, and accelerating in an inclined position should be adapted to the circumstances.

Other conceivable extensions of the ABS system are brake assist systems. The background to this is that achieving the maximum deceleration with the help of the ABS is only possible if the rider resolutely brakes adequately. In practice, however, this is rarely the case. In most cases, actuating the brake is a reflex action and takes place quickly – but this is seldom strong enough to achieve high deceleration values. The solution appears to be brake assist systems that can



Safe cornering with sloping-position training by DEKRA.

recognise dangerous situations and are able to introduce full braking pressure despite weak actuation of the brake.

A further reason for longer stopping distances is the long period of time every human needs to react to dangers. To reduce the reaction times of approximately 0.8 to 1.2 second identified for an averagely gifted rider in normal situations, in the future systems such as the Predictive Brake Assist can be used, which recognise dangers in good time with the help of environment sensors and react by automatically increasing braking pressure in the reaction phase.

In fact, were ABS systems to be extended by means of a brake assist function, a further reduction in the stopping distance would be highly likely. For one thing, the maximum braking pressure would be introduced at the start of deceleration and, for another, the threshold times of the braking system would be demonstrably shortened. The use of the Predictive Brake Assist would make it possible to reduce the speed of the motorcycle in the rider's basic reaction phase. The threshold time of the braking system would also be shortened, as there would be low braking pressure in the hydraulic lines right from the start of the braking action. Statistical analyses have shown that the number of very seriously injured road users could be

reduced by 32% and the number of critically injured road users 21% through the widespread use of such a system (Figure 33). Admittedly, this prognosis contains a relatively high uncertainty factor. Experiential data from actual accidents is not yet available. However, it should not be forgotten that a single-track motorcycle is far less stable than a four-wheeled passenger car.

A research project undertaken by the BAST in association with the Department of Automotive Engineering of the Technical University of Darmstadt investigated whether and which innovative dynamic handling controls for motorcycles (ESP and similar systems for example) are technically feasible and whether they could contribute to reducing the number of motorcycle accidents. An accident analysis identified accidents resulting from lateral acceleration during cornering being exceeded, without the use of brakes, and from friction coefficient jumps (as a result of flat road sections, sand, oil, bitumen and suchlike, for example) as relevant types of accidents for future dynamic handling controls and were used as main scenarios for potential dynamic handling control systems. A central result of the investigation, however, was that the potential of innovative dynamic handling controls as regards the prevention of accidents



Prof. Dr rer. nat. Hermann Winner, the Chair of Automotive Engineering at the Technical University Darmstadt



"In the long term, I see huge potential in vehicle communication, i.e. in driver assistance systems that enable data to be exchanged between motorcycles, other vehicles and vehicle infrastructure via wireless communication, with the protective effect extending beyond the individual motorcycle. But several more years will pass before a successful market launch and acceptable market penetration. In the medium term, the further development and networking of existing control systems (such as ABS, ASR, semi-active suspension and steering dampers, for example) still offer many opportunities to increase safety when riding a motorcycle. Research is currently being carried out into different technical measures to enable braking to be easily controlled during cornering, especially in threatening situations."

At the "International Technical Conference on the Enhanced Safety of Vehicles", which was held in 2009 in Stuttgart, BMW finally presented a further four assistance concepts: the bad weather warning (optical information or voice announcement on a stretch of road with poor weather conditions), the obstacle warning (information for example on a vehicle left at the side of the road, an accident, a slippery patch of road or a traffic jam), the emergency vehicle warning (information that an emergency vehicle is approaching from behind) and the electronic brake light (communicating information to following traffic through braking).

INTEGRATED SAFETY

Combining active and passive safety into so-called integrated safety, using available sensors for other applications, and the future networking of vehicles to create a cooperative transport system based on wireless vehicle communications also promise additional safety. An ongoing project, which is being conducted by the

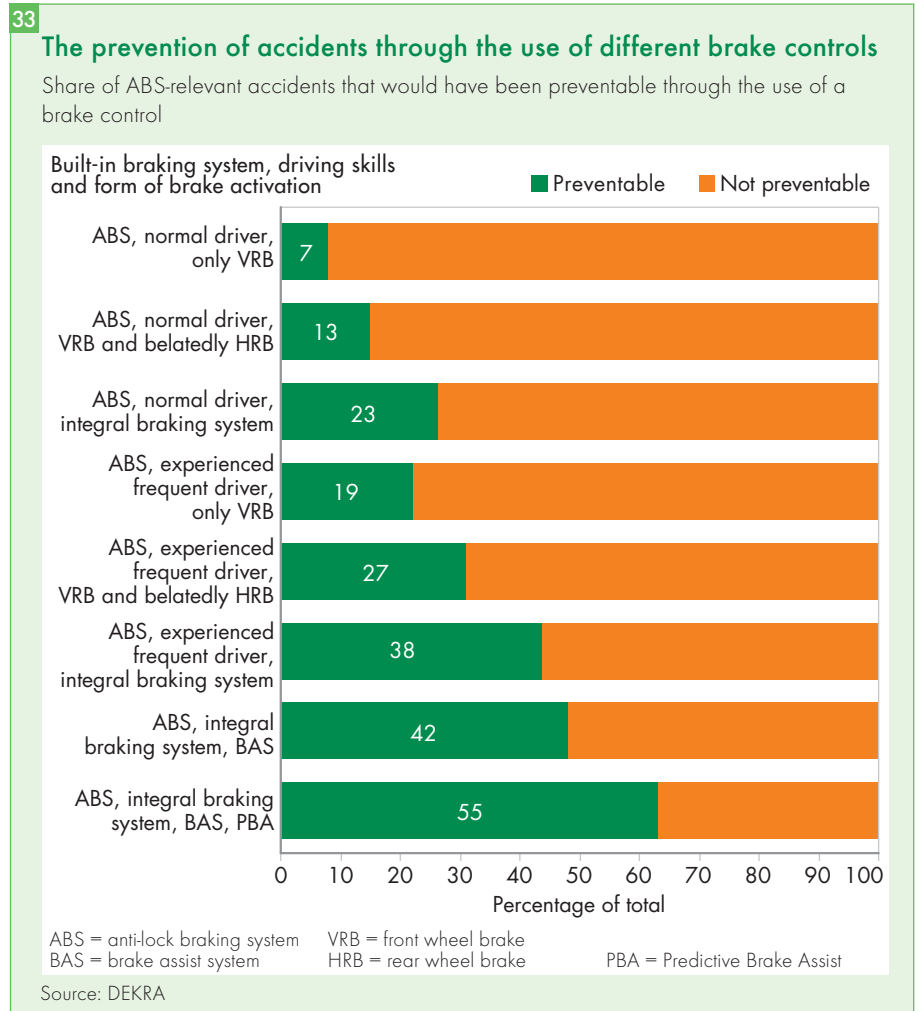
is considered to be relatively low. Those involved in the project were of the opinion that future research should therefore focus on extending existing control systems for motorcycles (ABS, ASR) and, especially, on transversal dynamics.

driver reaches the junction and the driver does not slow down, the driver receives this information early enough to brake gently. As the driver approaches the lights, a recommendation can also be given of the speed at which a road junction can be reached when the lights are green.

ACTIVE SAFETY SYSTEMS

That active safety has still has enormous potential for bringing down accident numbers is increasingly demonstrated by the fact that motorcycle manufacturers are working intensively on other assistance systems. To increase safety at road junctions the engineers of BMW, for example, are developing a system mounted in passenger cars and motorcycles for the prevention of accidents at road junctions within the context of a research project. This "Intersection Assistant" has been designed as an anticipatory system. Using information gathered by radio, it analyses the current positions and movements of road users equipped with this system as they approach a road junction, the situation regarding the right of way as well as the probability of collision and assesses the behaviour of passenger car drivers who have to wait. If such a driver does not react appropriately, he or she is warned of the risk of collision in stages optically, acoustically and haptically inside the motor vehicle. On the motorcycle, as the risk of an accident increases, the headlight gradually modulates, the intensity of the headlight increases, and additional LED warning lights on the side of the motorcycle are activated to broaden the silhouette. If the risk of collision is acute the motorcycle's horn sounds.

BMW is also developing a traffic light phase assistant, which enables the traffic light installation to communicate with the vehicle. If the traffic lights are red when the



Department of Automotive Engineering of the Technical University of Darmstadt in association with the company carhls. communication, is to be seen in this light. The project is entitled “MoLife” and consists in developing an integrated communication and warning system for motorcycles, which provides timely warning of danger spots by means of wireless communication.

In order to identify such danger spots, in addition to technical vehicle-dynamics sensors, the driver is involved as an active “sensor”. Besides developing, or further developing, sensor-based danger spot detection methods, the challenge is to design control and warning elements that neither alarm nor distract the driver. After all, motorcyclists are exposed to greater stresses than passenger car drivers and small errors on the part of the driver can have fatal consequences. Therefore, MoLife is not only developing danger spot detection; it is also evaluation various man-machine interface concepts to meet the aforementioned requirements so as to ensure that the driver is warned effectively, with no adverse effect on driving safety.

DESPITE ASSISTANCE SYSTEMS, THE MOTORCYCLIST'S ATTENTION MUST NOT DIMINISH

What active safety systems will one day supplement the existing systems remains to be seen. One of the issues current being addressed by an EU road safety project named “Saferider” is what driver assistance systems already used in passenger cars and commercial vehicles are transferable to motorcycles. The project is focuss-

ing on four systems which, as concerns the safety of motorcycles on the road, have great potential benefits: systems that warn against exceeding the speed limit, excessive cornering speed, obstacles and being too close to the vehicle in front, as well as road junctions and other dangerous stretches of road.

The “Pisa Project” (“Powered Two-Wheeler Integrated Safety”) is also attempting to define driver assistance systems to address the current motorcycle accident situation. Essential systems with great potential for reducing the number of motorcycle accidents are: active emergency braking, collision warning, braking assistant, ABS, integral brake, Adaptive Cruise Control (ACC) and improving visibility. Particularly with regard to environment sensor systems, close examination of the advantages and disadvantages is required before they can be fitted as standard. Particularly with regard to systems that support the driver in driving situations encountered every day and hence convey a feeling of security, there is always the danger that drivers will be less attentive to the situation on the road and may cause preventable accidents due to an increased willingness to take risks.

HELMET AND PROTECTIVE CLOTHING ARE INDISPENSABLE

The issue of protective clothing has already been addressed during the discussion of the EU Project APROSYS. Indeed, protective helmets, protective clothing and protectors make a substantial contribution to significantly reducing the severity of injuries sustained in an acci-

dent. Their main benefit lies, for example, in providing protection against extensive abrasions, cuts and puncture wounds as well as burns caused by friction heat. The importance of the helmet as an essential item of protective equipment is reflected in the generally high rate of use. The BAST reported that, in Germany, 97% of drivers and 98% of passengers of two-wheeled motor vehicles wore a protective helmet in 2008. The proportion of drivers of two-wheeled motor vehicles who also wore protective clothing as well as a helmet was 51%. However, “as well as a helmet” may mean that, under certain circumstances, only gloves were worn. Only 19% of all drivers of two-wheeled motor vehicles wore full protective clothing. It should be noted, however, that the data pool examined (traffic monitoring) was all two-wheeled motor vehicles. The percentage of drivers of powered cycles and mopeds who wore full protective clothing in a built-up area would be interesting, as, from experience, apart from a helmet, riders in this group seldom wear other protective clothing. The 19% mentioned above must also be relativised. 35% of passengers of two-wheeled motor vehicles wore other protective clothing as well as a helmet, 22% of passengers wore full protective clothing.

High rates of helmet wearing of over 90% are also shown by the MAIDS analysis (MAIDS = Motorcycle Accidents in Depth Study) of over 900 motorcycle accidents in Europe carried out on behalf of the motorcycle manufacturers' association ACEM in association with the OECD. On the other hand, the EU project “COST 327” (Motorcycle Safety Helmets) showed





that 67% of helmet-wearing motorcyclists nonetheless suffered head injuries. Head injuries account for 81% of serious or fatal injuries. Although a helmet cannot prevent all head injuries, it can nonetheless reduce their severity. And, according to COST, 50% of fatal injuries can be prevented through the wearing of a helmet.

COMPLIANCE WITH EUROPEAN STANDARDS

In the choice of helmet, it is important to ensure that it complies with the current ECE standard R 22-05. If this is the case, compliance with the standard is also indicated on the helmet itself. According to the Institute for Motorcycle Safety (Institut für Zweiradsicherheit), the greatest protection is provided by an integral, full-face helmet with an integrated chin guard. Modern flip-up helmets, which have a chin part that can be opened upwards by means of a hinge, nowadays achieve good values. They are especially preferred by spectacle wearers because they make it much easier for them to put on and take off their spectacles. On the other hand, cross helmets and jet helmets offer very limited protection, even though they bear the current test marking. It is especially important that the helmet sits firmly on the head. Only then can it have its full protective effect. According to the MAIDS study, almost 10% of accident victims lose their helmet

at some time during the accident. In most cases, the chin strap was not fastened or had even been removed.

As far as protective clothing is concerned, the basic equipment consists of a classic leather outfit or an appropriate leather suit, suitable gloves and sturdy shoes. To provide optimum protection, the materials should be weatherproof, tear proof and abrasion proof. They must also be light reflecting, as this increases visibility at night and in bad weather. It

is important that the protectors, whether separate or integrated into the clothing, have been tested in accordance with the European standard EN 1621-1 or EN 1621-2. For all items of clothing, it is important that the rider is able to feel the vehicle, as the special driving physics of the motorcycle calls for constant control of the entire system consisting of motorcycle and rider. This control system cannot be maintained without adequate feedback on the current driving state.

Dr med. Rainer Zinser, surgery, trauma surgery and emergency medicine specialist at the St. Elisabeth Hospital in Ravensburg



“While head injuries sustained during motorcycle accidents have always been a problem, in the last few years the number of motorcyclists, who have been involved in accidents, being admitted to our clinic with serious leg and pelvic injuries has increased enormously. Therefore the wearing of appropriate protective clothing and protectors is, from a medical point of view, absolutely essential. The same is true of course for helmets. Although injuries to the skull and brain, in some cases serious, stemming from excessive speed, among other things, cannot be prevented by wearing a helmet, without a helmet the motorcyclists would have lost their lives. Integral helmets provide much better protection than half-shell helmets, especially since the latter are frequently wrenched from the head during an accident if incorrectly fastened and are therefore unable to offer any further protection. On the other hand, it is encouraging that neurological rehabilitation sometimes achieves miracles even in the case of serious skull and brain injuries. But motorcyclists shouldn't bank on this, but should ride more carefully.”

NEW AIRBAG SYSTEM IN THE HELMET AND ON THE BACK

It is clear that the issue of helmets and protective clothing is moving forward. One of the more recent examples is the airbag system called the “D-Air Racing System”, which was developed by Dainese and presented in 2007. The system is mounted on the shoulders and back of the rider and functions entirely independently of the motorcycle. When the rider crashes, the airbag is activated by means of a system of acceleration and gyro sensors. Before this, an integrated microprocessor constantly monitors the rider’s seating position. The appropriate signals are evaluated by a data computation algorithm, which causes the airbag to inflate if necessary. The airbag wraps around the neck, shoulders and collarbone like a straightjacket and withstands even heavy abrasion. The rider continues to slide with the airbag around his or her neck and, on reaching his or her final resting position can simply remove the system.

In 2008, the world’s first motorcycle helmet with integrated airbag was presented at the International Fair for Motorbikes and Scooters (Intermot) in Cologne. Assembly, maintenance,

Wearable safety: The motorcycle jacket with airbag by Hit Air protects the chest, back, nape of the neck and shoulders in the event of a fall.



communication with the user and the accident detection system were developed in such a way as to offer motorcyclists protection without complicated manoeuvres. A small control device housed in the helmet compartment or under the seat processes all incoming pulses. On the basis of the results obtained, the helmet receives the command to inflate, whereupon the airbag inflates in less than 0.15 seconds. The activated airbag encircles the neck and runs down the nape of the neck to just below the seventh cervical vertebra, stabilising the neck area and cushioning blows in the upper back area during an accident. The planned market launch was preceded by numerous crash tests carried out by DEKRA in accordance with ISO 13232 DEKRA.

IMPROVED RECOGNISABILITY THROUGH DAYTIME DRIVING LIGHTS

Crashes between motorcycles and passenger cars often occur because the passenger car driver involved recognises the motorcyclist too late. Daytime driving lights could increase the safety of motorcyclists significantly. This was the conclusion of a new study carried out by the BAST on the recognition of motorcycles during the day. The obligation for motorcyclists to ride with lights on during the day was introduced in 1988 to make motorcycles easier to see and hence to reduce accidents. In Germany, on October 2005 the Federal Ministry for Transport recommended that all multi-track motor vehicles should also be driven with dipped beams or special

Court ruling: less compensation

According to the ruling of the Higher Regional Court of Brandenburg compensation for motorcyclists involved in accidents will be reduced (Ref.: 12 U 29/09). Under the German Road Traffic Act (StVO) motorcyclists are only obliged to wear an appropriate protective helmet, but, if a rider without protective clothing is involved in an accident, he and his wallet will come off worst. In the case at hand, the motorcyclist was not wearing appropriate protective on his legs and sustained injuries there. The court found the motorcyclist guilty of “fault against oneself”. In accordance with case law such fault exists if a “prudent and circumspect person” does not take the necessary care to protect himself from harm. The Higher Regional Court is of the opinion that every motorcyclist without adequate protective equipment runs a much higher risk of being injured. The injuries could have been reduced or prevented through the wearing of adequate protective clothing.



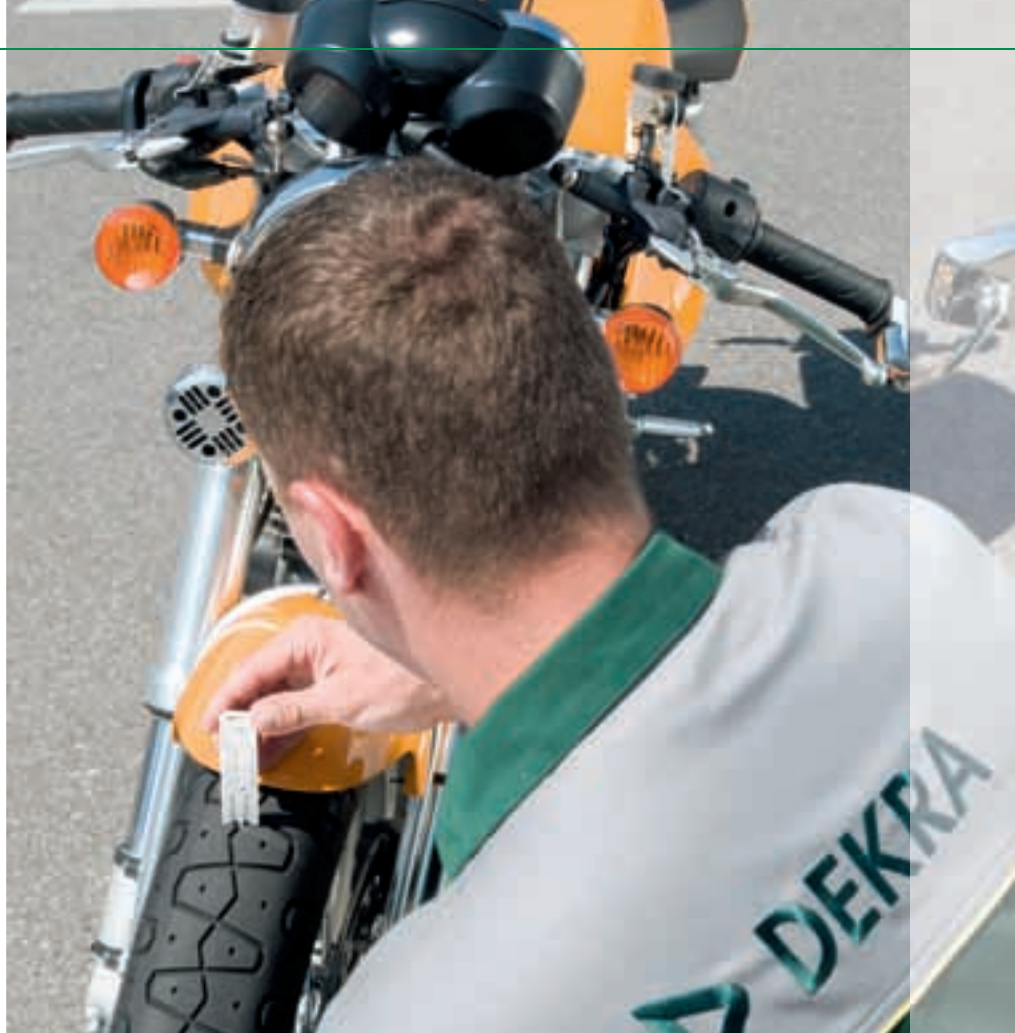
daytime driving lights during the day (in accordance with ECE-R 87).

Daytime driving lights for multi-track motor vehicles were designed specifically to improve the recognisability of motor vehicles, and their radiation characteristics are different to those of dipped beams. If daytime driving lights for multi-track motor vehicles become more widespread, it cannot be ruled out that motorcycles will become more difficult to recognise compared with the present situation, as, currently, motorcycles cannot be fitted with daytime driving lights.

That is why the BASt is investigating to what extent the recognisability of motorcycles can be increased compared with the present situation. The investigation should also clarify whether motorcycles could be less recognisable in the future with today's signal pattern during the day (dipped beam). The following configurations were therefore mounted on two different motorcycles: dipped beam, dipped beam with permanently lit front direction indicator lamps, daytime driving lights in white, selective yellow and amber, as well as white daytime driving lights as a pair or with maximum intensity. In the static test, these were then comparatively evaluated by volunteers in different real-life traffic scenarios. The most important findings were as follows:

- One daytime driving light in accordance with ECE-R 87 is more recognisable than one dipped beam.
- Two daytime driving lights are more recognisable than one daytime driving light.
- More intense daytime driving lights are more recognisable from a greater distance than less intense daytime driving lights, while differences in recognisability resulting from different colours or colour ranges decrease with increasing observation distance.
- Multi-track motor vehicles and their lights had no effect on the evaluation of the recognisability of motorcycles.

As a consequence of the findings of the investigating into the recognisability of motorcycles, according to the BASt the fitting of one or two in accordance with ECE-R 87 to motorcycles should be allowed, so that the motorcyclist can ride during the day with daytime driving lights switched on instead of a dipped beam. In this connection, mention must also be made of the EU project "2-be-safe", in which the BASt and the Technical University of Dresden are involved as German partners. The focus of the project is on improving the signal pattern of motorcycles by day and by night. One of the topics discussed will be what contribution daytime driving lights can make.



Too low tread depth greatly endangers the safety of motorcyclists on the road.

DEFECTIVE TYRES ARE A SAFETY RISK

Defective tyres and inadequate air pressure account for a significant proportion of the defects in the motorcycles inspected by DEKRA following accidents. The fact is that motorcycle tyres can suddenly or slowly lose internal pressure. As a rule and in most cases separations can occur between the belt plies in the tread centre of motorcycle tyres because of high temperatures. These separations are caused by insufficient pressure or by excessive strain as a result of high speeds. Investigations carried out by DEKRA have shown that approximately 50% of the separations were caused by insufficient air pressure which, in turn, was usually caused by holes or by leaking valves.

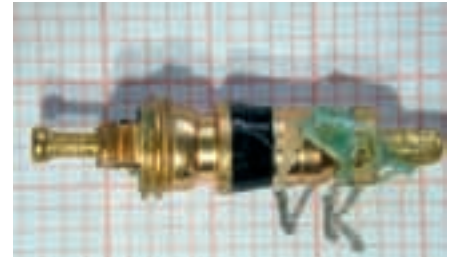
In recent years, DEKRA has been increasingly commissioned to carry out

inspections of motorcycles with refitted tyres that have been involved in accidents. Some of the crashes occurred when the motorcycles were leaving the premises of the tyre dealers or just a few 100 metres down the road. As motorcycle tyres have to transfer strong circumferential, braking and lateral forces, the adhesion and grip of the rubber mixture in the tread area is enormously important. Because of the softness of this rubber mixture, manufacturers have optimised the adhesion for warm operating temperatures. The rubber mixtures are designed so that they do not establish their optimum grip until the material has reached a temperature of 60 degrees and more. Cold motorcycle tyres exhibit a lower temperature after the start and so their adhesion is much reduced. In some cases, the manufacturer's labels are not removed from the tread area or adhe-

Tips on motorcycle tyres

- Carefully warm up cold motorcycle tyres; initially avoid extreme sloping positions and circumferential forces during acceleration and braking.
- Carefully run in new tyres – because of the separating agent – for at least 200 kilometres.
- Pay attention to the load reserves of the rear tyre when touring with a pillion passenger; there should be 50 or more kilograms of load reserve (depending in the type of motorcycle and the tyres).
- Obtain and take note of the recommendations of the tyre and motorcycle manufacturers, if only because of the optimal matching of tyres with the wheel rim.
- Check air pressure at least every two weeks or at the start of a long journey. As the checking devices at petrol stations can be out by up to 0.2 bar despite the calibration identification plate; better to put in an extra 0.2 bar. In this connection, an electronic air pressure monitoring system on the motorcycle is highly recommended.
- With tubular tyres, loosen the knurled-head screw on the valve after inflation and preferably turn it back as far as the valve cap. This way, it is possible to tell by the inclination of the valve stem whether the tyre has twisted or not. If it has there is a danger of a valve tear-off at the valve base.
- Take care when handling high-pressure cleaners, as tyres can be „burned“ by the effect of corrosion despite cold water.

Motorcycle accidents can be caused by defective or clogged valves.



sive residues remain after the labels have been removed. Also, when the labels are removed, any adhesive residues can pick up grit and dirt from the surface of the road, significantly reducing the adhesion in some parts. Another common cause is that, soon after they have been fitted, the tyres are loaded with strong braking or circumferential forces.

Furthermore, investigations have shown that the mounting paste used takes several hours to dry. Failure to take this into account leads to the tyre rotating on the rim due to the high torques on the rear wheel. This significantly impairs the ride stability of the motorcycle. Tyres with inner tubes are subject to additional hazardous torques of a valve tear-off or (slow) puncture.

SPECIAL TRAINING FOR TYRE FITTERS

As far as the tyre remaining firmly in place on the rim is concerned, it should be noted that a large number of different rim contours are used, especially in the motor-

cycle industry, such as CP rims, WM rims, MT rims, normal rims and many others.

As regards the selection and matching of the tyre to the rim, therefore, the tyre dealer must inform the purchase whether the tyre can also be used for the corresponding wheel rim. This requires the tyre dealer to read the product descriptions or ask the tyre manufacturer. The incorrect matching of tyre with rim contour may also lead to the tyre rotating on the rim, with the aforementioned additional hazardous torques in the case of tubular tyres.

Accidents have other causes. Valve caps in the form of a rifle cartridge are used, especially on Harley Davidson machines. These valve caps are much heavier than normal metal or plastic caps and lead to the deformation of the valve stem and the formation of fissures with centrifugal forces at higher speeds. Breakdown sprays (Pannensprays) must also be used with care, as the Latex in the spray may clog the valve inserts and cause them to leak. The resulting gradual loss of air leads

Crash test carried out by DEKRA to optimise safety barrier systems.





Safety integrated into the landscape: NATURE rail with underrun protection was designed especially for equipping winding biking roads. Flexible underrun protection prevents motorcyclists from sliding under the safety barrier.

to separations in the tread area through “flexing” during the rolling of the tyre. In sum, the correct choice of motorcycle tyre, working perfectly with the rim, as well as the correct choice of valve insert and valve are the responsibility of the tyre and motorcycle dealers. Specific knowledge is also required to change a motorcycle tyre, especially on the rear axle, as this involves not only fitting the tyre onto the rim but also mounting and dismounting the complete rear wheel for the different models with shaft drive or chain drive. It is all the more necessary, therefore, that motorcycle tyre fitters are specially trained.

UNDERRIDE PROTECTION ON SAFETY BARRIERS

When it comes to increasing road safety for motorcyclists, road infrastructure plays a quite central role. Safety barriers, which are designed to cushion the impact of passenger cars and commercial vehicles, pose a special problem. The space between the safety barrier and the ground exposes the motorcyclists to great risks. If a motorcyclist loses control on a bend and crashes, there is a risk that he will slip under the safety barrier or impact against one of the support posts, often resulting in extremely serious or even fatal injuries.

This problem was recognised more than 20 years ago. An initial approach to reducing the risk of injury was to install safety barrier post casings made from foam. However, these foam protectors deteriorate over time and are only practical at low impact speeds of approximately 30 km/hour. Also, the gap between the safety barrier and the ground remains, which is especially dangerous given that approximately 50% of motorcyclists who have an accident involving safety barriers slide against them

in a horizontal position. To counteract the resulting injuries, the “Euskirchen System” was developed in the context of a regional initiative of the Rheinisches Straßenbauamt Euskirchen (Euskirchen Road and Motorway Directorate of the Rhineland). This involved upgrading conventional steel guard rails by mounting a binding beam under the existing capping piece. This system was tested by the BAST in January 2003 and subsequently included in the “Guidelines for passive protection devices”. It prevents motorcyclists from sliding under the capping piece or getting caught on individual barrier components and being injured or impacting directly against a safety barrier post.

SAFETY BARRIER WITH UPPER BINDING BEAM AND LOWER BINDING BEAM

As far back as 1998 the BAST commissioned DEKRA Accident Research to undertake a research project to systematically investigate the existing risk potential and possible improvements on the basis of impact tests with motorcycles impacting against protection devices. The findings of real-world accident analyses were used to define the test conditions. The tests were carried out in the DEKRA Crash Test Center Neumünster. During the tests, motorcycles occupied by dummies were ridden into steel safety barriers and a concrete barrier in an upright position and while skidding on their side. The tested safety barriers were a standard safety barrier (einfache Schutzplanke (ESP) and a

A good safety barrier system is characterised by, amongst other things, the fact that the motorcyclist can not slide under it after impact.





Common accident situations from the motorcyclist's perspective

Accident situation	Possible road factors influencing the accident situation
Accident on bends	<p>not enough traction between wheel and carriageway (cracks, bitumen repairs, replacement of road surface, markings, objects or liquids on the carriageway, etc.)</p> <p>poor view of the road ahead (diffuse incidence of light, slopes, planting, etc.)</p> <p>discontinuous line management (sequence of radii, radii jumps inside a bend)</p> <p>adverse slope conditions (low traction between wheel and carriageway)</p>
Accident while turning	<p>poor recognisability and understanding of the nodal point</p> <p>poor view of traffic with priority</p>
Accident at a turning/ junction	<p>poor recognisability and understanding of the nodal point</p> <p>poor view of traffic with priority</p>
Accident in parallel traffic on bends	poor view of the road ahead (diffuse incidence of light, slopes, planting, etc.)
other accident	collision with obstacle (branches, shed load, etc.) on the carriageway
Source: Forschungsgesellschaft für Straßen- und Verkehrswesen e. V. (Road and Transportation Research Association), Cologne	

standard distance safety barrier (Distanzschutzplanke (EDSP)). The tested concrete barrier was designed as a single-sided system with "New Jersey profile".

Constructive proposals for improvement were elaborated on the basis of the findings of these tests. Some of these proposals were implemented in the form of a new safety barrier consisting of a Swiss box profile and a steel-binding beam. The same crash tests as those with conventional safety elements were carried out. Significant potential for improvement both in the case of impacts with the motorcycle in an upright position and while skidding on its side was demonstrated. However, the tests also showed that the costs of this system were relatively high and prevented their widespread use on the relevant stretches of road. Other crash tests with passenger cars also showed that the impact severity level increased with such safety barriers and that, as a result, the risk of injuries to the

occupants of passenger cars during impact increased.

In 2004, the BAST, in collaboration with the Federal Ministry of Transport, Building and Urban Affairs, charged DEKRA Accident Research with a follow-up project to develop and test requirements for safety elements to improve the safety of motorcyclists. The findings of the previous project and knowledge gained from practical experience were taken into account. Approaches using a safety barrier with an upper binding beam and a lower binding beam were developed, with particular emphasis being placed on costs and ease of assembly. Evaluations of adaptive safety elements already on the market provided additional findings. The Euskirchen Plus system was developed on this basis. An improved protective effect for riders of motorcycles crashing in an upright position and while skidding on their side was established. The same protective effect was also demon-

Dr-Ing. Achim Kuschefski, Director of the Institut für Zweiradsicherheit e. V. (ifz) (German Institute for Motorcycle Safety)



"Many experts talk of a safe road, some even talk of 'Vision Zero' - but no motorcyclist! It is obvious why or, rather, the answer lies in the past. The reason is that, unfortunately, too little attention has hitherto been paid to this group of unprotected road users. The reason for this probably lies less in the chronic lack of money and the resulting lack of investment in the construction of roads and more in the perspective or basic attitude of many decision-makers towards the two-wheeled motor vehicle. Most probably many of these people have never ridden a motorcycle. For this reason, I would like to be able to travel with them through Germany so as to expand their horizons to all the possible risks, such as safety barriers, masts, etc. Due to time constraints, however, this is, unfortunately, unthinkable. That is why we at ifz rely on judgement and on the effectiveness of our information campaign, which we have been operating for many years now."



strated for the occupants of passenger cars crashing into a safety barrier.

ROAD CONSTRUCTION AUTHORITIES REACT

Additional opportunities for optimising roadside safety barriers were discussed within the aforementioned EU project APROSYS. In this connection, Hiasa, a Spanish manufacturer of road safety barriers, developed a system that strongly resembles the “Euskirchen Model” of 1998: a steel binding beam between the capping piece and the ground prevents the motorcyclist from sliding through the safety barrier and cushions the impact with its suspensions. The system proved its worth in full-scale crash tests carried out in accordance with the Spanish standard UNE 135900, and the head injuries sustained by the impacting dummies were non-critical.

The responsible road construction authorities in numerous EU countries are now aware of the issue. In Germany, for example, the local authorities are identifying more and more critical stretches of road within their area of responsibility and are retrofitting them with an underrun protective device. An example of this is the Glemseck between Leonberg, Gerlingen and Stuttgart, which is one of the best-known meeting points for motorcyclists in Baden-Württemberg. In good weather, very many bikers gather there at weekends and on public holidays.

Yet the accident figures are shocking: from 2004 to the middle of August 2009, according to the Böblingen police directorate, out of a total of 81 road traffic accidents involving motorcycles, there were 5 fatalities, 28 seriously injured and 49 slightly injured casualties. Many of the survivors suffered lasting damage to their health. Of

Dangerous signs

To increase road safety on dangerous stretches of road, the authorities specify speed limits by means of mandatory signs. In addition, road users can be made aware of danger spots by means of danger signs placed at the edge of the road and be motivated to drive especially carefully. Such signs are occasionally supplemented by poster campaigns. For motorcyclists, however, this can lead to added dangers. Every massive obstacle at the edge of the road is a possible danger for motorcyclists, who may crash and sustain extremely serious or even fatal injuries – coming off the road after a fall, for example.

The picture above shows part of a road that is very popular amongst motorcyclists. Extremely serious and even a number of fatal motorcycle accidents regularly took place here. Reducing the speed limit and erecting signs warning of the bad condi-

tion of the road alone did little to improve the situation. All the safety barriers on that stretch of the road were then retrofitted with a binding beam in an exemplary fashion. Posters specifically targeted at motorcyclists were put up. However, the danger still posed for motorcyclists continuing to crash into the posts of some of the older signs was not always taken into account. For the poster campaign, new billboards with massive stands firmly anchored into the ground on concrete foundations, were erected – some of them in areas definitely still directly reachable by motorcyclists (and also by passenger car drivers) moving at a high residual speed during accidents in which the vehicle comes off the road. Road signs are pliable – sign-carrying posts and poster stand posts are not, which is why, although the intention was good, there is still room for improvement.

these accidents, 49, i.e. 60%, were caused by the motorcyclists themselves. The activities of the police and the authorities at the Glemseck were and are immense and consist of regular speed measurements, checks on two-wheeled motor vehicles and providing motorcyclists with relevant information. In matters of passive safety, a further stretch of road was fitted with the, often life-saving, underrun protective device on existing safety barriers.

The road construction authorities are also supported by private initiatives such as MEHRSi (MEHR Sicherheit für Biker) (MORE safety for bikers). The association has devoted itself for at least five years to the task of reducing the death toll and the severity of injuries amongst motorcyclists. According to MEHRSi, 482 bend sections in Germany have been secured with 62,938 metres of underrun protection.



Further effort is required throughout Europe

Experts agree that, in order to increase the safety of motorcyclists even further, there are a number of approaches that can be adopted. ABS and airbag are, in this connection, key words, alongside protective clothing and helmets, visibility, road infrastructure and road construction measures, driver training and safety training, as well as the periodical technical inspection of motorcycles.

Year on year, fewer and fewer people are killed on the roads throughout virtually the whole of Europe. This is an extremely pleasing development, especially against the background of the EU Road Safety Charter signed by DEKRA, among others, in 2001, the declared aim of which is to halve the number of deaths on the road to 25,000 by 2010.

But there is a downside: while the number of car users killed on the roads has declined, the number of motorcyclists killed on the roads has stagnated at a comparatively high level. Although a decline has occurred in many EU States – in Germany, for example, between 2001 and 2008 from 964 to 656 (= minus 32%) or in France from 1,092 to 817 (= minus 25%), the trend in other States is upward. The rise has been particularly high in, among other places, Italy: between 2001 and 2008 the number of motorcyclists killed on the roads rose from 848 to 1,086 (= plus 28%). This shows that action is required on many fronts.

An important basis for all measures are, for a start, detailed and harmonised statistics on motorcycle accidents. The cross-national statistics provided for example by

the EU database of CARE or the annual reports of the IRTAD (International Road Traffic and Accident Database), as well as national statistics, provide much more accurate data material than a few years ago, but a clear and, above all, pan-European uniform distinction between motorcycles,

scooters, mopeds and powered cycles is still lacking. A harmonised European accident database would be important because governments can only create the framework conditions for greater road safety on the basis of detailed and accurate accident data.



PROTECTIVE CLOTHING, HELMETS AND PROTECTORS

Increasing passive and active vehicle safety offers great potential for a pan-European fall in the numbers of injured and fatally injured motorcyclists. Unlike passenger cars or lorries, motorcycles do not have a protective rigid body and so motorcyclists are directly exposed to injury during collisions or falls, with serious accidents in particular often resulting in death. The wearing of adequate tear-proof and abrasion-proof as well as clearly visible protective clothing and protectors is just as important as wearing a helmet, for the selection of which care must be taken to ensure that it complies with the current ECE standard R 22-05. Integral helmets are to be preferred over half-shell or jet helmets, the former clearly offering greater protection, especially in the chin and face area. It is of course also important that the helmet sits firmly on the head and that the chinstrap is fastened.

The scientific accident analyses show that motorcyclists still sustain serious chest injuries as a result of impacts. Within the framework of the EU project "APROSYS" (Advanced PROtection SYSTEMS), in which DEKRA, among others, was involved, a study was therefore carried out to develop appropriate protection specifically for this region of the body. Several simulations to determine the effectiveness of the chest protector showed that it distributed the forces exerted during impact better, thereby preventing dangerous, inwardly directed rib fractures.



AIRBAGS, DAYTIME DRIVING LIGHTS AND HIGH-VISIBILITY JACKETS

Another, very promising, protective element during an accident is the motorcycle airbag. Numerous crash tests, such as those carried out by DEKRA for many years, have demonstrated the effectiveness of the airbag, especially in collisions with a passenger car, which is the most common opposing vehicle in an accident. Especially when the head strikes against the side roof edge of a passenger car, the frequency of injuries to the motorcyclist's head, neck and chest is particularly high. The airbag helps to cushion or even completely eliminate head impacts. It can also reduce the risk of injury when a motorcyclist impacts against the tank of his motorcycle or gets caught on the handlebars.

Accidents between motorcycles and passenger cars often happen because passenger car drivers often become aware of motorcycles too late. Special daytime driving lights could help to alleviate this, as shown by a study carried out by the Bundesanstalt für Straßenwesen (BASt) (Federal Highway Research Institute). As a consequence of the findings of the investigation into the recognisability of motorcycles, according to the BASt the fitting of one or two in accordance with ECE-R 87 to motorcycles should be allowed, so that the motorcyclist can ride during the day with daytime driving lights switched on instead of a dipped beam. As far as the recognisability of motorcyclists is concerned, a further safety element should not be forgotten: the high-visibility jacket. In many EU States, such as France, Italy, Spain, Portugal and Austria, the wearing of these high-visibility jackets is an obligation. They must also be worn by motorcyclists outside built-up areas in case of breakdown or accident. A similar regulation could also be appropriate for Germany.

FEWER ACCIDENTS AS A RESULT OF ABS

There is no doubt that, in the future, the focus will shift more and more to active safety systems. Compared with a passenger car, there are fewer possibilities for incorporating passive safety elements into motorcycles. Therefore, the importance of the use of active safety for motorcyclists cannot be overstated. This is particularly true of anti-lock braking systems (ABS), which are being offered more frequently by manufacturers – fortunately not just in top models.





The fact is that many accidents can be prevented and the severity of impacts can be reduced through ABS. This was the conclusion reached by, among other things, a simulation study carried out by DEKRA Accident Research, in which it was demonstrated that by equipping motorcycles with 25% to 35% of the serious accidents analysed would have been preventable. Were one to combine the ABS with an integral brake and a technical assisted brake system, which is still in the development phase, almost twice as many accidents (50% to 60%) could have been prevented, as such systems respond much more quickly than conventional braking systems in dangerous situations.

The Allianz Zentrum für Technik (AZT) (Allianz Centre for Technology) has devoted a great deal of work to ABS and its effectiveness. Extrapolating the results to Germany alone, if all motorcycles were equipped with ABS, approximately 100 lives would be saved every year. There would be a four-digit fall in the number of seriously and slightly injured motorcyclists every year. To benefit fully from the safety advantages in an emergency, motorcyclists must naturally control braking with ABS. It is therefore all the more important that motorcyclists regularly undergo driver safety training. Such programmes consist of training in the correct sequences of

movements, and also in the experiencing of the limits set by driving physics. They are particularly appropriate at the start of the motorcycling season as well as for those returning to motorcycling and older beginners.

That the issue of active safety still has enormous potential for reducing accident figures is increasingly demonstrated by the fact that motorcycle manufacturers and scientific institutions are working intensively on other systems – the intersection assistant, traffic light phase assistant, obstacle warning or networking vehicles to a cooperative traffic system using wireless vehicle communications, to give just a few examples.

IMPROVING ROAD INFRASTRUCTURE

Safety barriers at the side of the road pose a significant danger to motorcyclists. Although they offer the best possible protection for drivers of passenger cars and commercial vehicles, the space between the safety barrier and the ground exposes the motorcyclists to great risks. If a motorcyclist loses control on a bend and crashes, there is a risk that he or she will slip under the safety barrier or impact against one of the support posts, often resulting in extremely serious or even fatal



injuries. Intensive research has therefore been carried out to minimise this risk. The Euskirchen^{plus} system, which was developed as a result of a project undertaken by the BAST and DEKRA Accident Research, has proved to be an efficient safety element. These safety barriers, which are fitted with a binding beam, provide better protection for motorcyclists whose motorcycles crash into them in an upright position and while skidding on their side.

Bitumen repairs on roads also pose a threat to motorcyclists. Bitumen has approximately just one third of the friction coefficient of normal asphalt surfaces. When the bitumen is wet, or with temperatures above 23°C, these values fall even further, as the repairs become soft. Road grip suffers while the motorcycle is travelling both in an upright and in an inclined position. Bitumen casting compounds should therefore not be used for road improvement works if at all possible. This is especially true for the large-scale use of this process.

TECHNICAL MONITORING OF MOTORCYCLES

The accident analyses carried out by DEKRA show that technical defects may also be responsible for motorcycle accidents. According to these analyses, 23.6% of the motorcycles inspected following an accident between 2002 and 2009 had defects, of which 33.9% were of relevance for the accident. It is therefore all the more important that motorcycles are regularly inspected as regards their safety. Such vehicle monitoring is already the rule in numerous EU Member States. As concerns the main inspections carried out by DEKRA between 2007 and 2008, technical lighting equipment headed the list of defects at over 30%. In almost one in five

motorcycles with defects the assembly consisting of axles/wheels/tyres/suspensions were found to be at fault, followed by chassis/frames at 16% and brakes at 12%. The proper functioning of all safety equipment must, in any case, be guaranteed.

One final note: regardless of any measure to increase road safety, however

efficient it may be, a non-aggressive, anticipatory driving style, especially on the part of motorcyclists, is the best safety strategy. This will prevent not only collisions with other vehicles but also single-vehicle accidents. Every motorcyclist personally lays the foundation stone for sound risk awareness: in the form of solid driver training.



The DEKRA requirements in brief

- Creation of a single pan-European accident database
- Wearing of protective clothing, including a helmet and protectors
- Improvement of passive and active safety
- Optimisation of road infrastructure
- Introduction throughout Europe of periodical technical inspections for motorcycles
- Solid driver training and regular participation in driving safety training programmes

Any questions?

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Bibliography

ACEM - Association des Constructeurs Européens de Motocycles, Market figures and statistics: Circulating park. Brüssel, Januar 2010.

ACEM - Association des Constructeurs Européens de Motocycles, Report 2010. Brüssel, Januar 2010.

Autofore, Study on the Future Options for Roadworthiness Enforcement in the European Union: WP530 - Extension of roadworthiness tests to other vehicle categories. Comité International de l'Inspection Technique Automobile, Brüssel 2007.

Bartels, O., Sander, K., Erkennbarkeit von Motorrädern am Tag - Untersuchungen zum vorderen Signalbild, Berichte der Bundesanstalt für Straßenwesen, Reihe Fahrzeugtechnik Heft F71, Bremerhaven 2009.

Baum, H., Westerkamp, U., Geißler, T., Nutzen-Kosten-Analyse für ABS bei Motorrädern, Berichte der Bundesanstalt für Straßenwesen, Reihe Fahrzeugtechnik Heft F68, Bremerhaven 2008.

Berg, A., König, J., Accident Involvement of Motorcycles - Description of the Current Situation in Germany Using Data from Federal Statistics and In-Depth-Studies. Proceedings 3rd International Conference ESAR „Expert Symposium on Accident Research“, Hannover, September 2008.

Berg, A., Rücker, P., Motorcycle airbags - an option to improve the secondary safety of powered two-wheeler riders. Proceedings XXI JUMV International Automotive Conference and Exhibition, Belgrad, April 2007.

Berg, A., Rücker, P., König, J., Schwalbe, G., Drop Tests to Study the Loads Acting on a Dummy During Ground Impacts. Proceedings ICRAISH International Crashworthiness Conference, Athen, Juni 2006.

Berg, A., Motorcycle Airbags - an Option? Proceedings 8th International symposium and Exhibition on Sophisticated Car Occupant Safety Systems (airbag 2006), Karlsruhe, Dezember 2006.

Berg, A., Rücker, P., Gärtner, M., König, J., Grzebieta, R., Zou, R., Motorcycle Impacts to Roadside Barriers - Real World Accident Studies, Crash Tests and Simulations carried out in Germany and Australia. Proceedings 19th International Technical Conference on the Enhanced Safety of Vehicles, Washington, Juni 2005.

Berg, A., Rücker, P., Bürkle, H., Mattern, R., Kallieris, D., Prüfverfahren für die passive Sicherheit motorisierter Zweiräder. Berichte der Bundesanstalt für Straßenwesen, Reihe Fahrzeugtechnik Heft F49, September 2004.

Berg, A., Rücker, P., König, J., Motorcycle Crash Tests - An overview. Proceedings International Crashworthiness Conference ICrash, San Francisco, Juli 2004. Proceedings International Journal of Crashworthiness [Crash 2005 Vol. 10 No. 4, S. 327-339.

Berg, A., König, J., Rücker, P., Profit and protection of the airbag to enhance the passive safety of motorcycles. Proceedings FISITA World Automotive Congress, Barcelona, Mai 2004.

Berg, A., Rücker, P., Airbag Prototype for a Mid-Sized Touring Motorcycle. International IRCOBI Conference on the Biomechanics of Impacts, München, September 2002, Proceedings S. 353-354.

Berg, A., Bürkle, H., Groer, M., Reproduzierbarkeit von Motorrad-Crashtests am Beispiel der Konfiguration 413 nach ISO 13232. Verkehrsunfall und Fahrzeugtechnik 39, Dezember 2001, Heft 12, S. 326-331.

Berg, A., Rücker, P., Niewöhner, W., Airbags für Güterkraftfahrzeuge und Motorräder - Erkenntnisse aus Unfallforschung und Crashtests. Tagung „Fahrzeugairbags“, München, November 2001, Tagungsband.

Berg, A., Bürkle, H., Groer, M., Reproduzierbarkeit von Motorrad-Crashtests am Beispiel der Konfiguration 413 nach ISO 13232. 3. Int.

Motorrad-Konferenz INTERMOT, München, September 2000, Tagungsband, Seite 85-100.

Bürkle, H., Berg, A., Anprallversuche mit Motorrädern an passiven Schutzeinrichtungen. Berichte der Bundesanstalt für Straßenwesen, Unterreihe Verkehrstechnik Heft V 90, Bergisch Gladbach, September 2001.

CARE - European Road Accident Database, Fatalities by transport mode in EU countries. Brüssel, Dezember 2009.

DEKRA Motorrad-Hauptuntersuchungen 2007 und 2008.

DEKRA Motorrad-Unfallgutachten und Gutachten nach Verkehrskontrollen 2002 bis 2009.

ERSO - European Road Safety Observatory, Traffic Safety Basic Facts 2008: Motorcycles and Mopeds. Brüssel, Oktober 2008.

ETSC - European Transport Safety Council, Vulnerable Riders - Safety implications of motorcycling in the European Union. Brüssel 2008.

ETSC - European Transport Safety Council, Road Safety Performance Index, Flash 7 - Reducing motorcyclist deaths in Europe. Brüssel, Dezember 2007.

Forschungsgesellschaft für Straßen- und Verkehrswesen (Arbeitsgruppe Verkehrsmanagement), Merkblatt zur Verbesserung der Verkehrssicherheit auf Motorradstrecken, Köln 2007.

IRTAD - International Traffic Safety Data & Analysis Group, Annual Report 2009. Paris, Januar 2010.

Istituto Nazionale di Statistica, Incidenti stradali 2008. Rom 2009.

König, J., Passive Sicherheit: Erkenntnisse aus dem EU-Projekt APROSYS SP4. Tagungsband des Internationalen Motorrad Symposiums der Unfallforschung der Versicherer und des Deutschen Verkehrssicherheitsrats, Berlin, September 2009, S. 24-27.

König, J., Rücker, P., Berg, A., APROSYS SP4 - erste Ergebnisse des Europäischen Projekts zur Erhöhung der passiven Sicherheit motorisierter Zweiräder. Tagungsband der 6. Internationalen Motorradkonferenz des Instituts für Zweiradsicherheit, Essen, Oktober 2006.

König, J., Berg, A., Powered Two-Wheeler Accidents - First Results of APROSYS SP4 Implied GIDAS 2002 Data. Proceedings 2nd International Conference ESAR „Expert Symposium on Accident Research“, Hannover, September 2006.

Kraftfahrtbundesamt, Fahrzeugzulassungen - Bestand an Kraftfahrzeugen und Kraftfahrzeuganhängern am 1. Januar 2009 nach Herstellern und Handelsnamen. Flensburg, Juli 2009.

Kühn, M., Unfallforschung kompakt - Analyse des Motorradunfallgeschehens. GDV/Unfallforschung der Versicherer, Berlin 2009.

Kulla, B., Untersuchung realer Motorrad-Alleinunfälle unter besonderer Berücksichtigung von Anprallen auf passiven Schutzeinrichtungen. Von DEKRA betreute Diplomarbeit, Zwickau 2003.

MAIDS (Motorcycle Accidents in Depth Study). In-depth investigations of accidents involving powered two wheelers, Brüssel 2009.

Observatoire National Interministériel de Sécurité Routière, Les grandes données de l'accidentologie 2008, Paris 2009.

Observatoire National Interministériel de Sécurité Routière, La sécurité routière en France 2008, Paris, Juni 2009.

Peldschus, S., Schuller, E., König, J., Gärtner, M., Garcia Ruiz, D., Mansilla, A., Technical Bases for the Development of a Test Standard for Impacts of Powered Two-Wheelers on Roadside Barriers. Proceedings 20th International Technical Conference on the Enhanced Safety of Vehicles, Lyon, Juni 2007.

Roll, G., Hofmann, O., König, J., Effectiveness Evaluation of Antilock Braking Systems (ABS) for Motorcycles in Real-World Accident Scenarios. Proceedings 21st International Technical Conference on the Enhanced Safety of Vehicles, Stuttgart, Juni 2009.

Rücker, P., Berg, A., Der Motorradairbag - neueste Erkenntnisse aus Full-Scale-Crash-Tests nach ISO 13232. Verkehrsunfall und Fahrzeugtechnik 43, Mai 2005, Heft 5, S. 121-128.

Rücker, P., Berg, A., Der Motorradairbag - neueste Ergebnisse aus Full-Scale-Crash-Tests nach ISO 13232. Tagungsband 5. Internationale Motorradkonferenz, September 2004.

Rücker, P., Berg, A., Beitrag zur Untersuchung des Potenzials eines Airbags zur Steigerung der passiven Sicherheit motorisierter Zweiräder. 4. Internationale Motorradkonferenz Internot, München, September 2002, Tagungsband, S. 415-440.

Santucci, D., Pieve, M., König, J., Bianco, E., Vázquez de Prada Martínez, J., Powered Two Wheelers Integrated Safety - First Results of the SIM Project. Proceedings 21st International Technical Conference on the Enhanced Safety of Vehicles, Stuttgart, Juni 2009.

Schmidt, S., Nutzenpotenzialabschätzung aktiver Sicherheitssysteme im Motorradunfallgeschehen. Von DEKRA betreute Diplomarbeit, Stuttgart 2007.

Seiniger, P., Erkennbarkeit und Vermeidbarkeit von ungebremsten Motorrad-Kurvenunfällen. Vom Lehrstuhl für Fahrzeugtechnik der Technischen Universität Darmstadt betreute Dissertation, Darmstadt 2009.

Seiniger, P., Winner, H., Objektive Erkennung kritischer Fahrsituationen von Motorrädern, Berichte der Bundesanstalt für Straßenwesen, Reihe Fahrzeugtechnik Heft F73, Bremerhaven 2009.

Spornier, A., Analyse von Motorradunfällen mit dem speziellen Fokus auf Verletzungen der unteren Extremitäten. Forschungsbericht 01/06 des Gesamtverbandes der Deutschen Versicherungswirtschaft, Berlin 2006.

Spornier, A., Neueste Ergebnisse der Unfallforschung der deutschen Autoversicherer mit speziellem Schwerpunkt: Bremsen mit Motorrädern. Tagungsband der 4. Internationalen Motorradkonferenz 2002 des Instituts für Zweiradsicherheit, S. 151-178, Essen 2002.

Spornier, A., Kramlich, T., Zusammenspiel von aktiver und passiver Sicherheit bei Motorradkollisionen. Tagungsband der 3. Internationalen Motorradkonferenz 2000 des Instituts für Zweiradsicherheit, S. 55-82, Essen 2000.

Statistisches Bundesamt, Verkehrsunfälle - Zweiradunfälle im Straßenverkehr 2008, Wiesbaden, November 2009.

Statistisches Bundesamt, Verkehr - Verkehrsunfälle 2008. Fachserie 8, Reihe 7, Wiesbaden, Juli 2009.

Statistisches Landesamt Baden-Württemberg, Straßenverkehrsunfälle in Baden-Württemberg 2008. Stuttgart 2009.

Vavryn, K., Winkelbauer, M., Bremsverzögerungsmessung bei Motorradfahrern mit und ohne ABS. Kuratorium für Verkehrssicherheit - Abteilung Fahrausbildung und Fahrzeugtechnik, Wien, Dezember 2002.

Walther, E., Cavegn, M., Scaramuzza, G., Niemann, S., Bächli-Biétrý, J., bfu-Sicherheitsdossier Nr. 05: Motorradverkehr, Bern 2009.

Weidele, A., Skriptum Motorräder 2009. Technische Universität Darmstadt - Lehrstuhl für Fahrzeugtechnik, Darmstadt 2009.

Winner, H., Hakuli, S., Wolf, G., Handbuch Fahrerassistenzsysteme - Grundlagen, Komponenten und Systeme für aktive Sicherheit und Komfort, Wiesbaden 2009.

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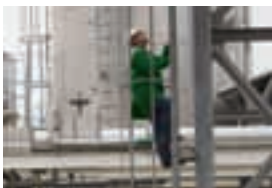


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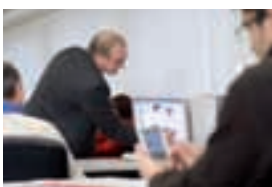


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