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RISK MANAGEMENT: A NEW APPROACH TO IMPROVING SAFETY

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1 ABSTRACT

As a result of the globalisation of markets, the European integration process and, in particular, the enlargement of the European Union to the East, freight and passenger traffic volumes in Germany will increase by 64 per cent and 20 per cent respectively by the year 2015. The fact that so many North–South and East–West transportation routes pass through the Federal Republic gives Germany's traffic safety policy a truly European dimension.

Road safety initiatives in Germany are based on the 'Programme for Improving Road Safety', which was launched in February 2001. This programme has five priorities:

- to improve Germany's highway culture,
- to protect vulnerable road users,
- to make novice drivers less prone to accidents,
- to reduce the danger posed by heavy goods vehicles, and
- to raise road safety levels on rural roads.

Thanks to this and earlier road safety programmes, the number of road accident fatalities in Germany dropped to 5,361 in 2005—the lowest number of fatalities since records began in 1953. In 1970, a combined total of over 21,000 people were killed in road accidents in what was then the Federal Republic of Germany and the German Democratic Republic. Approximately one-quarter of all personal injury accidents and 60 per cent of all fatal accidents occurred on rural roads (excluding motorways).

This is why raising road safety levels on rural roads is a national concern. The main focus of this work is on research into and the development of new guidelines for standardized road design. In future, road design will be based more on the physiological and psychological abilities and limitations of road users than has previously been the case. Other topics in this national report include the status of development of telematics systems and road tunnel safety.

2 THE GERMAN ROAD SAFETY POLICY

Mobility is an important prerequisite for progress, prosperity, growth, and employment. According to all estimates, Germany will experience considerable traffic growth in the coming years. This means that the German transport policy faces the challenge of making mobility as safe, environmentally friendly, and socially just as possible.

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- to protect vulnerable road users,
- to make novice drivers less prone to accidents,
- to reduce the danger posed by heavy goods vehicles, and
- to raise road safety levels on rural roads.

This programme makes a considerable contribution to further increasing safety levels on roads. The success of this programme is evident: while 5,842 people were killed

on German roads in 2004, this figure fell to 5,361 in 2005. This is the lowest number of road accident fatalities since records began in 1953. By way of comparison: in 1970, a combined total of over 21,000 people were killed in road accidents in what was then the Federal Republic of Germany and the German Democratic Republic. In other words, the number of road accident fatalities has decreased by approximately 75 per cent, while both traffic volume and the number of vehicles on German highways has more than tripled in the same period.

	Fatalities	Change on previous year
2000	7,503	- 3.5 %
2001	6,977	- 7.0 %
2002	6,842	- 1.9 %
2003	6,613	- 3.4 %
2004	5,842	- 11.7 %
2005	5,361	- 8.3 %

Despite these improvements, road safety work remains a task that must be tackled by society as a whole. After all, every road accident fatality is one fatality too many! Consequently, the aim of future road safety measures will remain the same, namely to make the most of the potential for reducing accidents. In doing so, the Federal Ministry of Transport, Building, and Urban Affairs (BMVBS) will not seek to meet unrealistic targets, but shall continue to work pragmatically in the interest of society in order to achieve the best possible results in the field of road safety.

In this regard, the appropriateness, justification, and social acceptance of traffic safety measures must be taken into account when defining road safety policy objectives.

If, for example, the objective were to be defined as ‘to achieve accident-free road traffic’, measures would have to be taken to avoid every last road accident. This would undoubtedly result in unjustifiably high costs to the detriment of all other private and social goals in society.

The Government’s task is to draft and implement road safety programmes containing efficient and effective measures. For five years now, this task has been fulfilled by BMVBS’s **Programme for Improving Road Safety.** At the same time, accident trends must be observed and new trends identified at the earliest possible stage in order to introduce measures that will have a positive effect. The Federal Government pledges to work towards the realisation of any sensible road safety measures and calls on all institutes and social groups involved in road safety work to support them in this regard.

To this end, BMVBS works with all relevant bodies in society and provides over € 11 million of federal funding for information and educational campaigns that seek to reduce traffic accidents.

These funds are allocated as follows: every year renowned traffic safety work associations, the German traffic safety council (Deutsche Verkehrssicherheitsrat e.V.) and its members, and the German Traffic Patrol (Deutsche Verkehrswacht e.V.) receive over € 5.6 million in funding, while a further € 6.1 million of Federal money is spent on information campaigns targeting the general public.

Germany in Europe
In view of the fact that Europe is moving towards an ever-closer union, it is important that road safety programmes do not stop at national borders. For this reason, Germany welcomes all measures that seem conducive to further increasing safety levels on Europe's roads. The European Union continues to spearhead developments in this regard. Its 3rd European Road Safety Action Plan aims to halve the number of people killed in road accidents in the EU by 2010. The mid-term review of the 3rd Action Programme published by the EU Commission in February 2006 highlighted Germany's successful track record in road safety work. According to this review, Germany is one of a number of countries to have achieved a greater reduction in road accident fatalities (-14 per cent) than the EU average (-5 per cent) in the years 2001-2004.

Germany will continue to work intensively with its partners in the European community and the European Union to improve road traffic safety.

3 RAISING ROAD SAFETY LEVELS ON RURAL ROADS

In 2005, approximately two-thirds of all personal injury accidents (67 per cent) occurred in built up areas (64 per cent in 1991). Approximately one-quarter (27 per cent) of all personal injury accidents and 60 per cent of all fatal accidents occurred on rural roads (rural roads excluding motorways). This explains why the fifth priority of the German road safety programme is to raise road safety levels on rural roads. It is not surprising that this issue is one of the themes of a World Road Congress. I would like, therefore, to examine this issue in more detail.

3.1 Financial measures

In 2005, 662 people were killed on Germany's **motorways**. This figure is much lower than the one relating to fatalities on both urban and rural roads, despite the fact that the vehicle-kilometres travelled on motorways are much higher.

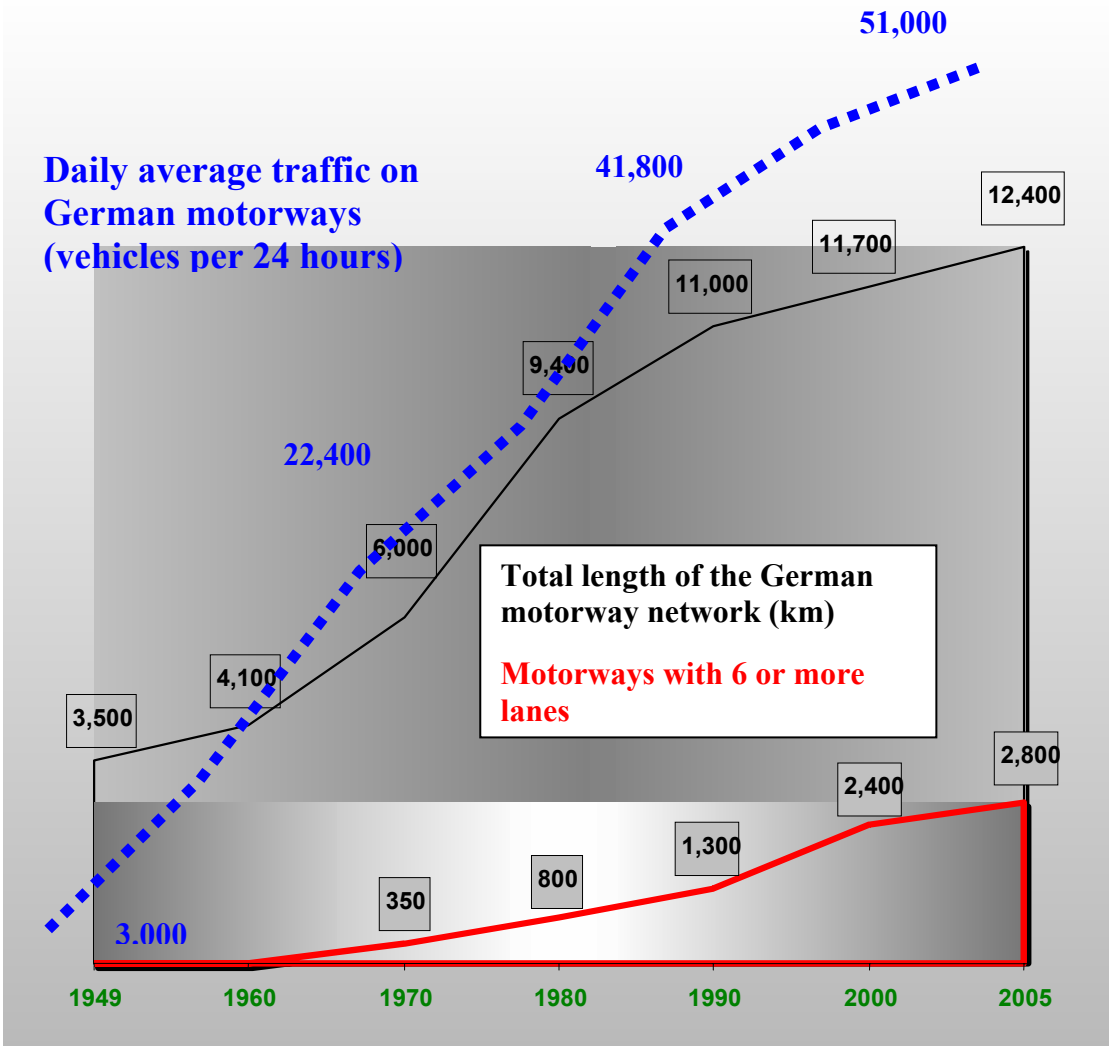


Figure 1 - Development of the German motorway network and the traffic volume thereon

When compared with statistics for the previous year, the number of fatalities per billion vehicle-kilometres in Germany dropped from 3.17 to 3.03. This proves that, as is the case in other countries, German motorways are the safest roads in the country. This result is an affirmation of our post-reunification investment policy of giving priority to developing the motorway network in the eastern part of the country and to closing significant gaps in the network.

Figure 2 - German Unity Transport Projects

Between 1991 and 2005, 1,200 km of new motorway was constructed at a cost of approximately € 14.3 billion and a further 1,500 km was widened to six or more lanes at a cost of approximately € 11.8 billion. Germany's motorway network is now roughly 12,400 km long, some 2,800 km of which have six lanes or more.

The Requirement Plan for the Federal Trunk Road Network considers the most pressing projects for the period starting 2006 to be the construction of a further 1,200 km of motorway and the widening of 1,800 km of motorway.

In terms of federal trunk roads, a total of € 12.2 billion was invested in new-build and widening projects and 430 by-passes between 1991 and 2005. The total length of four-lane federal highways increased by 800 km to 3,800 km. Once the pressing projects indicated in the Requirement Plan for the Federal Trunk Road Network are completed, this network will have grown to 4,500 km.

The Requirement Plan also considers the construction of a further 680 bypasses to be a priority.

Approximately € 37.3 billion was invested in the construction of new trunk roads and the widening of existing trunk roads in Germany between 1991 and 2005 (some € 2.5 billion per annum).

Segregating cycle traffic and motorised traffic on busy roads by means of constructing **cycle ways** serves a dual purpose, namely the prevention of accidents involving bicycles and a reduction in motorised personal transport. The continual development of the network of cycle ways along trunk roads is also in line with the wishes of the German parliament. In 2004, approximately 400 km of cycle ways were completed at a cost of roughly € 80 million and in 2005, approximately 380 km of cycle ways were completed at a cost of roughly € 79 million.

Central traffic islands are regularly constructed at the entries to villages and towns to serve as a refuge to pedestrians and cyclists crossing the road and to reduce speeds (see Fig. 3).

Figure 3 - Segregation of non-motorised traffic featuring a central traffic island

Considerable funding made available by the Financing of Local Transport Act has been used for the construction of municipal cycle ways.

Implementation of the German National Cycling Plan began in 2002. The aim of this plan is to increase significantly the ratio of cycle traffic to total traffic by the year 2012 and to improve traffic safety. Some € 2 million per annum has been earmarked for non-investive activities that will further the implementation of the German National Cycling Plan. Such activities include research projects and pilot projects that seek to increase safety levels for cyclists (e.g. an investigation of the influence of intersection design on blind spot accidents involving cyclists).

Most accidents on rural roads involving fatalities and serious injuries occur when travelling along carriageways in the direction of traffic flow. Such accidents account for over 30 per cent of all accidents. Traffic safety can be increased considerably by promoting the upgrading of two-lane roads to three-lane roads, whereby traffic travelling in both directions alternately use the third lane for overtaking (see Fig. 4). The accident cost per 1,000 vehicle-kilometres on three-lane rural roads is 30 per cent lower than on two-lane rural roads.

Figure 4 - A modern three-lane federal highway featuring the segregation of slow traffic

The sustainable reduction in serious accidents involving fatalities in Eastern Germany (from over 30 road accident fatalities per 100,000 inhabitants in 1991 to less than 10 in 2005) is primarily the result of such upgrading projects and improvements made to the road infrastructure (see Fig. 5).

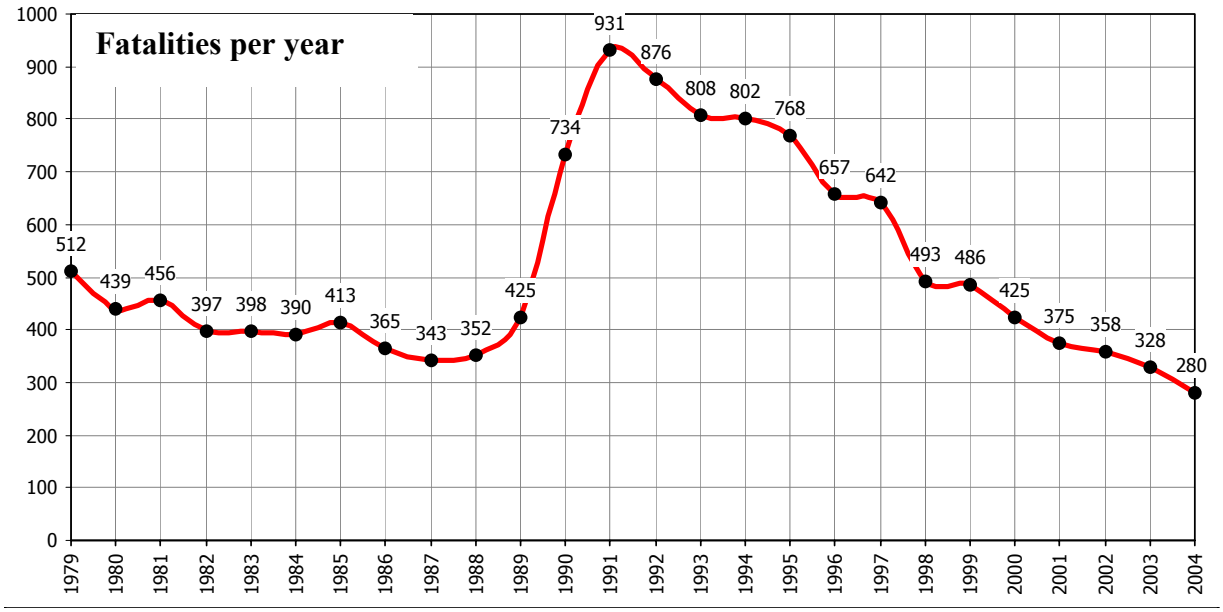


Figure 5 - Road accident fatalities in eastern Germany

3.2 Design measures

In view of the fact that accidents on rural roads continue to be out of proportion to accidents on other roads, particular efforts in this area are justified. Both a programme of investment and a professional approach to the identification and elimination of hazards are necessary if safety levels on rural roads are to be increased. Identifying and eliminating high-risk sites (black spots) is a continuing task that necessitates a systematic, computer-assisted evaluation of accident data.

In the past, the planning of roads and road networks was centred on traffic, space, and environmental considerations The publication of the Recommendations for the Analysis of Safety on Road Networks (ESN) provided a tool that allowed traffic safety considerations to be systematically taken into account when planning roads. The procedure described in the ESN allows safety deficits on the road network to be identified and analysed with a view to ensuring that optimum use is made of available means in terms of increasing road safety levels (see Fig. 6).

< € 1,000 per km and year

€ 1,000-50,000 per km and year

> € 100,000 per km and year

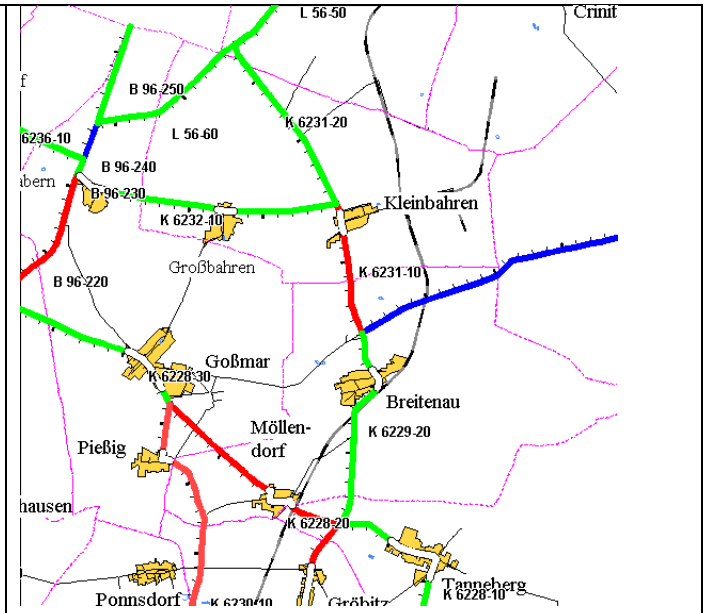


Figure 6 - Network safety management

Naturally this does not tell us anything about the types of safety deficits on our infrastructure or the factors that regularly cause driving errors. Consequently, we await with interest the World Road Association's recommendations on conducting **road safety inspections** (RSI) and hope that they will provide a systematic yet simple tool for identifying safety deficits on the road network. We would hope that such a tool could be successfully used by our **accident commissions**. These accident commissions were established by law 30 years ago and exist in every administrative district and every city that constitutes an administrative district in its own right. They institutionalise the co-operation between road administrations, transport authorities, and police stations.

The RSI's sister procedure, the road safety audit (RSA), was presented to the international roads community at the PIARC World Road Congress in Kuala Lumpur in 1999. Since then, it has been introduced in many countries.

Although road safety considerations are included in the technical standards and specifications governing the planning, construction, and maintenance of road infrastructure, road construction measures are frequently planned and implemented without making the most of safe road design opportunities. These safety deficits are generally the result of two factors: firstly, priority is given to other considerations (e.g. cost pressure, resistance put up by third parties, avoidance of land acquisition) to the detriment of road safety, and secondly, the infringement of applicable standards, specifications, guidelines etc. (e.g. non-observance of minimum requirements).

In order to ensure that as many authorities as possible conduct road safety audits, support was provided during the period under review for the duration of the practical pilot project, the conducting of road safety audits on rural and urban roads, and the training of road administration staff to road safety auditors. In addition, findings and progress reports were published and discussed at expert meetings. By 2005, road safety audits had either been introduced or pilot projects launched in a total of 13

German *Länder*.
Road safety audits are closely related to the latest findings regarding the relevance of road design guidelines to road safety. The procedure involved in changing such guidelines is generally a lengthy one. Auditors must therefore keep one step ahead of this development and be involved in research and development.

3.3 Research and development

These considerations bring me to the next important pillar of Germany's road safety work: research and development.

In order to provide scientifically proven aids that allow decision-makers to address political and technical questions raised by the Programme for Improving Road Safety, the Federal Highway Research Institute (BASt) has on behalf of the Federal Ministry of Transport, Building, and Urban Affairs planned over 30 research projects as part of its road safety research programme. Work on most of these projects has already begun.

The Road and Transportation Research Association (FGSV) will co-ordinate, manage, and integrate most of these research projects into guidelines, which will be discussed and agreed with the relevant users.

For many years now, the Federal Ministry of Education and Research has been promoting research and development projects relating to improved road safety in conjunction with the Federal Ministry of Transport, Building, and Urban Affairs. In accordance with the type of research involved, the results—which are generally made available in the form of new procedures and scientific findings—generally find their way indirectly into products and standards etc. In 2002 and 2003 such research projects were financed to the tune of approximately € 5.844 million. Project results are generally evaluated in the form of scientific secondary studies.

New guidelines are being drafted in order to increase safety levels on new or upgraded roads. To this end, currently applicable design guidelines have been reviewed and the knowledge contained in these guidelines enhanced by new research findings and experience gained in conducting road safety audits. One major aspect of such amendments is the focus on increasing road safety levels by advancing the standardisation of road types.

3.4 Requirements regarding standardised roads

Before we define standardised roads—a subject so closely related to the issue of sustainable road safety—we must define our requirements in this regard. This is particularly important because it is a question of adapting the technical features of the road system (vehicle, road, and road user) at the human-road interface to suit the physiological and psychological abilities and limitations of road users.

From Germany's point of view, this relates to the following axioms:

1. Where possible, mixed functions and forms of traffic (motorised and non-motorised) should be avoided.

‘Where possible, avoid mixed functions!’ would be a good international rule of thumb for road planners.

2. The road must steer and guide the road user clearly and must not give rise to any confusion regarding either the course of the road or the right of way.
   ‘Never mislead the driver!’ is the maxim in this case.

3. Road users must never be taken by surprise by sudden changes in either the course of the road or the type of traffic on it. ‘Never surprise the driver!’ is the golden role here.

4. Avoid overwhelming inexperienced road users in particular along the course of the road (vertical and horizontal alignment) and at intersections. Road users tend to be overwhelmed when they have to register several pieces of information simultaneously and process them within a short space of time. Examples of such cases include more than two different traffic signs in one place, complex intersections with a high number of conflict points, or a quick succession of different road features such as bends, intersections, bus stops, level crossings etc. Consequently: ‘Never overwhelm the driver!’

5. From the road users’ point of view, there should be no contradictions in either the design of the road infrastructure or the traffic rules.
   Therefore: ‘Avoid contradictions!’

6. Finally, it must be said that standardised roads cannot prevent all driving errors or prevent run-off accidents. Consequently, forgiving road sides remain a highly significant principle of road safety.

3.5 Status of implementation of these axioms

1. The unambiguous identification of a road category begins with the clear differentiation between rural roads and built-up roads. It is this differentiation that makes it possible to develop specific design guidelines. The fact that rural roads may not be built-up is not as clearly stipulated in road laws and building codes in other countries as it has been in Germany for many decades. This means that access to rural highways are almost never possible and only permissible on minor roads that are used to reach agricultural land. For this reason, the development of so-called linear settlements was blocked in Germany as early as 1930.

   As already mentioned, Germany’s guidelines for the most varied road categories are currently being revised and restructured with regard to road safety. Instead of having separate guidelines for alignment and intersections—as was the case in the past—Germany is now moving towards guidelines for the design of motorways (RAA), of rural roads (RAL), and of urban roads (RASt), each of which will contain all relevant design elements. To this end, specific cross-sections have already been allocated to different motorway types (see Figs. 5 to 7).

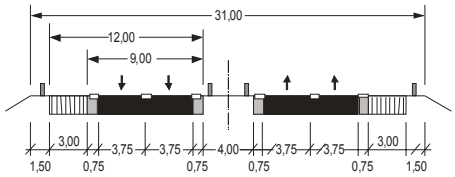
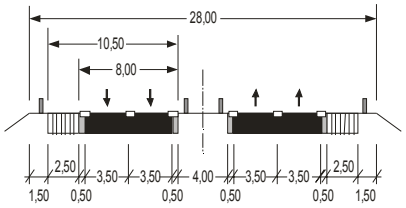
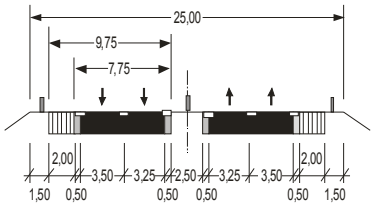
	Cross-sections of long-distance motorways
Motorways will be designed as either **long-distance motorways** (design class motorway EKA1),	RQ 31 
as **motorway-like roads** (design class motorway EKA2),	RQ 28 
or as **urban motorways** (design class motorway EKA 3).	RQ 25 

Figure 7 - Regular motorway cross-sections

2. Never mislead the driver! The design and layout of the road, the design of intersections, and the choice of traffic signs must all be addressed in order to avoid misleading the road user. The following example illustrates this point:
Y junctions, particularly those on older roads, are a frequent cause of road accidents in Germany, especially in cases such as the one illustrated in Fig. 10, where the main road does not follow the optical alignment of the road. This is particularly misleading for inexperienced drivers or drivers who are not familiar with the route. Replacing such junctions on rural roads with small roundabouts reduces accident costs by up to 85 per cent and is, therefore, increasingly being implemented by the authorities responsible for construction.

Fig. 10: Black spots at Y junctions

Small roundabouts are a safer solution

3. Never surprise the driver! Road users react faster to changes and incidents when they are prepared for them. For this reason, it is absolutely imperative to ensure sufficient visibility so that they can see what is coming or to make sure that they are warned by traffic signs in good time. This is why road administrations in Germany attach great importance to the design of transitions in bends and transitions from rural roads to intersections, cross-town links, and pedestrian and cyclist crossings (see Fig. 3).

4. Never overwhelm the driver! A joint working group set up by the Federal Government and the *Länder* conducted a critical survey of the number of traffic signs used and the reasons for their use. The group's findings will result in a comprehensive amendment to the German Road Traffic Regulations (StVO) and the associated General Administrative Provisions (VwV).
   The intention is to follow the maxim 'as many traffic signs as necessary; as few traffic signs as possible' in order to limit the amount of information road users have to process and to counteract the excess of traffic signs on Germany's highways. The new regulations are expected to enter into force in the course of 2007.

5. Forgiving roadsides are a highly contentious issue in northern Germany in particular. The problem here is that the preservation of tree-lined roads, which are protected by environmental laws, is in contradiction with the dramatic effect such roads have on traffic safety. Collisions with trees are particularly frequent and serious on these tree-lined roads. 'Recommendations regarding the Prevention of Accidents Involving Collisions with Trees' (ESAB) have recently been introduced. The ESAB provides:

   - opportunities for identifying conspicuous trends relating to accidents involving trees,
   - ways of improving such trends, and
   - information regarding factors that must be taken into account when planting young trees on existing roads.

In terms of nature conservation and landscaping, the ESAB recommends felling trees only when all other possibilities (e.g. crash barriers) have been exhausted. In view of

the close proximity of such barriers to the trees, special energy-absorbing systems have been developed (see Fig. 11).

Figure 11 - Energy-absorbing crash barriers protecting trees

Motorcycle accidents are particularly problematic in this regard because a collision with a crash barrier often aggravates the injuries sustained. It is hoped that this problem can be addressed by the development of additional components for steel crash barriers, which would both significantly reduce the risk of injuries for motorcyclists and ensure the safety of passenger car occupants.

4 RELATED TOPICS

4.1 Telematics

The long-term objective is to have a network of self-explanatory roads. However, the self-explanatory road layout can only have a limited effect on acute traffic situations. Telematics and driver assistance systems must in future be used to enhance the effect of such road layouts, thereby helping to bring about a significant reduction in accident rates.

Providing road users with targeted information at an early stage reduces the element of surprise and puts them in a position to adjust and prepare themselves for the traffic situation up ahead. This also helps increase road safety levels.

Users get such information from traffic management systems and in-vehicle information and communication systems that use telematics to help drivers fulfil their driving responsibilities (e.g. navigation systems and driver assistance systems).

Traffic management systems have helped considerably reduce the risk of accidents and congestion on particularly accident-prone sections of the motorway network. Traffic management systems that impose situation-specific speed limits and provide warnings on specific sections of the motorway have already helped reduce personal injury accidents by an average 20 to 30 per cent. Their positive effect on multi-vehicle accidents—in fog conditions, for example—is even greater.

Because of further increases in traffic and the positive experience gained with these systems to date, great importance will be attached to the use and development of modern traffic control technology in Germany in the future. Activities to date will be continued as part of the current traffic management programme for motorways (2002 to 2007). Other modern systems that will manage individual motorways and/or the entire network, control access, and temporarily open the hard shoulder to traffic are either under construction or already in operation on the motorway network.

Noticeable technical developments and the increasing interest in using flexible (dynamic) traffic management and information systems on federal trunk roads have also led to the addition of a dynamic signposting system with integrated congestion information to the tried and tested range of traffic management systems.

Some € 200 million of federal funds has been earmarked for the implementation of such measures for the period 2002–07.

The Federal Government supports the development of the European satellite navigation system, Galileo. It is hoped that Galileo will give Europe its own civil satellite navigation system that will vastly improve the quality and reliability of navigation services, thereby improving road traffic safety.

Research into driver assistance systems (DAS) is a prerequisite for the creation of safety standards. The interaction of innovations and legal questions is currently being investigated in a comprehensive European project (RESPONSE) to which Germany is making a significant contribution.

The BASt has dedicated a research project to defining requirements for DAS in terms of road safety and investigating whether drivers need support functions. To this end the BASt is conducting an in-depth analysis of accident reports. This will determine what kinds of human error actually cause accidents. Initial results show that accidents at intersections are generally caused by the driver not registering important information (see section 3.4, subsection 4).

Accidents caused by driver errors (single-vehicle accidents), on the other hand, are generally caused by poor driver decisions. In such cases, accidents can usually only be prevented by the active intervention of a driver assistance system. Another research project is focussing on the identification of and proposals for the prevention of the potential for misuse and abuse of such systems.

A sub-project on DAS (driver assistance systems, active safety) seeks to come up with new concepts for congestion assistance, anticipatory active safety, registration of the immediate environment, and the human-machine interface. Traffic consequences, legal issues, and the matter of acceptance are also being investigated.

4.2 Tunnel safety

No national report on road safety would be complete without addressing the issue of road tunnel safety. As we all know, EU Directive 2004/54/EC was introduced in order to increase safety in road tunnels. This Directive was applied in Germany in the form of an amendment of the Guidelines for the Equipment and Operation of Road Tunnels (RABT 2006), which applies to all tunnels on the federal trunk road network and for road tunnels owned and operated by the *Länder*.

Naturally, it already applies to the construction of new tunnels such as the Tiergarten Tunnel in Berlin (see Fig. 12).

Figure 12 - Tunnel safety equipment in the Tiergarten Tunnel in Berlin

Safety in road tunnels that are not part of the Trans-European Road Network and do not fall within the scope of application of the EU Directive is assured by similar provisions.

Other initiatives have also been taken in order to increase user safety. Such initiatives include the publication of standards based on the EU Directive regarding the standardised design and implementation of rescue facilities such as escape route markings with emergency lighting in the event of fire, guidance equipment, markings on and colours of emergency exits, and the colouring of emergency telephone facilities. These measures are expected to enhance safety levels by making it easier for tunnel users to rescue themselves in the event of an incident. By meeting increased safety requirements both in the planning and construction phase as well as in the retro-fitting of existing tunnels, a uniform level of safety is expected to be achieved by 2010.