Council of Ministers

ROAD TRANSPORT

SAFETY ON RURAL ROADS IN EUROPE: STRATEGIES FOR IMPROVEMENT

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1. Introduction

The aim of this report is to:

- show the scale and human cost of the road safety problem across the 41 countries of the ECMT;
- make concern with road safety an issue of national importance for politicians, roads administrators, enforcement agencies, private companies, and individual road users;
- encourage road safety policy to be part of general transport policy;
- show the benefits of a strategic approach to road safety which takes into account the vehicle, road infrastructure, and the road users as equally important parts;
- highlight the particular safety problems associated with rural roads and to present a framework for their improvement; and
- produce recommendations for improving road safety for consideration by European Ministers for Transport.

Rural roads with their particular safety problem associated with high accident risk and high severity of injury will be used as an example of the development of a framework for a strategic approach to improving road safety.

Rural roads are defined in this report as roads outside urban areas that are not motorways or unpaved roads.

The principles behind the strategy can be adapted to other areas of road safety. However, the solutions in terms of countermeasures will need to be tailored to the specific road networks or safety areas. The primary reason for choosing rural roads is that road safety problem is a very serious one that has suffered from a lack of attention compared to the safety problems on motorways and urban roads.

To illustrate our example we draw heavily on the OECD report safety strategies for rural roads (OECD 1999). The OECD report is a comprehensive documentation of the issues surrounding the lack of safety of the rural road network. It provides recommendations of how to address the inescapable conclusion that the rural road safety problem is a very serious one that has suffered from a lack of attention compared to the safety problems on motorways and urban roads. It is recommended that the OECD report be read in conjunction with the report presented here. Other sources include the IHT Guidelines for rural safety management and reports from other European Countries.

2. Road safety in Europe

2.1 The general picture

Figures 1 and 2 are important for our understanding of the road safety problem facing ECMT countries as a group. Figure 1 shows road accident trends in the Western European countries where it can be clearly seen that deaths have been falling steadily since 1970 (the reference year = 100) and by 2000 were at less than 60% of their 1970 values. In contrast accidents have increased by more then 10%, where as casualties have fallen to only about 93% of their 1970 (index =100) value and, in general, the trend for all casualties was more or less stable since 1984.
Figure 1: Road Accident Trends in Western Europe countries

Figure 2: Road Accident Trends in Eastern Europe and Baltic States

Source: ECMT
Figure 2 shows the situation for Eastern Europe and Baltic States and is in stark contrast, with the number of deaths compared with 1970, the reference year, rising rapidly during the period of independence and rapid change in the late 1980’s. The trend in deaths is starting to fall from its peak in about 1990 but it remains at about 120% of its 1970 value. The total numbers of accidents and casualties have remained fairly constant until 1984. Since 1984, the number of accidents increased to reach more than 10% of its 1970 value.

These Figures indicate that using only fatalities as a measure for road safety tends to mask the total road safety problem. Using the number of accidents and total number of casualties tends to indicate that the overall safety of European roads is not improving as rapidly as we might like to think from analysis of the number of fatal accidents. Nevertheless, traffic growth, which generally increased 2.5 times over the last three decades, should not be neglected.

Figure 3 shows the total number of deaths per million vehicles. The countries have been grouped into Western Europe, Eastern Europe and Baltic States, and other non-European OECD countries. Figure 3 clearly shows the difference between Western Europe countries and Eastern Europe plus Baltic States in terms of deaths per million vehicles. We do not know how much of this difference is due to the number of kilometres driven because information is lacking for many of the ECMT countries, nor do we know the split between urban and rural casualties.

In the remainder of this report consideration will be given to the differences between the countries of Western Europe and those of Eastern Europe plus Baltic States. The findings and recommendation of the OECD report will be discussed accordingly.
Figure 3: Total numbers of deaths per million road motor vehicles. The chart shows three
groups of countries a) Western Europe, b) Eastern Europe and Baltic States, and c) other OECD
2.2 The rural road safety problem

Despite a questionnaire being sent to all ECMT countries about their road accident situation, there is scant data available to assess the rural road safety situation and a full accounting of the serious injuries is therefore currently not possible.

Rural road safety accounts for a considerable share of the total road safety problem. Each year, nearly 100 000 people are killed on roads in ECMT countries. Table 1 shows that deaths on rural roads account for between 28% and 87% of all road fatalities. Croatia has the lowest percentage and Finland the highest, probably representing the amount of travel in those countries on rural roads. The majority of the countries shown in Figure 4 suffer about 60% of their road deaths on rural roads. The Central and Eastern European Countries tend to have a lower proportion of deaths on their rural roads. This may be due to important differences in car ownership and use between urban and rural areas between Western Europe and the other countries. The data are not readily available to assist this analysis. Further figures are given at Appendix 1.

![Mean of proportion killed on rural roads](chart.png)

**Figure 4:** Mean proportion of people killed on rural roads for Western European (WE) and Central and Eastern European (CEE) countries

The proportion of deaths that are on rural roads generally has increased between 1990 and 1998. Given the picture of reducing trends in deaths in all countries during this period (see Figures 1 and 2), we might conclude that urban road safety improvements have been successful in many countries over this period.

The economic costs of this safety problem are staggering. In the EU alone, where 43 000 people are killed each year, the costs are estimated to be of the order of €166 billion per year.

The World Health Organisation (WHO) estimates that injuries, both intentional and unintentional, accounted for about 16% of the global burden of disease in 1998. Road traffic accidents were the ninth leading cause of death globally and for adult men aged 15-44 years, is the biggest cause of ill health and premature death. The proportionate burden from road traffic accidents is predicted to rise, especially in developing countries where there is expected to be a decrease in infectious diseases and an
increase in road traffic. Injuries, especially those arising from road traffic accidents, war and violence are projected to account for a large proportion of global ill health (WHO 1999).

Injuries are responsible for one in six years lived with disability and there is evidence that the disabilities are becoming more serious. Globally, about 8 million people annually are disabled as a result of road traffic accidents.

2.3 Main contributing factors to accidents

An analysis of the main contributing factors to accidents has been undertaken in OECD countries. Given the lack of information for the majority of the CEE countries the OECD analysis has been taken as being broadly representative of the picture Europe-wide.

As many as 75% of all accidents on rural roads fall into three categories:

- single vehicle accidents, especially running off the road;
- head-on collisions; and
- collisions at intersections.

Single vehicle accidents constitute 35% or more of all fatal rural road accidents. This type of accident is the most prevalent because the three hazard elements of driver behaviour, the vehicle, and the road (infrastructure) environment, play a role in causing these accidents and increasing their severity.

Head-on collisions make up nearly 25% of all fatal accidents on rural roads. Though driver behaviour; i.e. speed, and the road environment; i.e. conflict caused by non-separation of opposing lanes, are the principal factors in these accidents, vehicle technology has the potential to lessen the severity of the accident itself.

Collisions at intersections account for about 20% of all fatal rural road accidents. Again, driver behaviour and road infrastructure are the key contributing factors to these types of accidents.

Rural road accidents are scattered over the entire rural road network, excluding some specific unsafe locations. Under these circumstances, a pressing challenge for safety professionals is to understand the causes for these rural road accidents and the contributing factors. A main conclusion from this analysis is that the rural road system itself has inherent characteristics that significantly contribute to the high number of accidents and the high risks (OECD 1999).

Inappropriate and excessive speeds are a key factor in rural road accidents because the actual speeds on rural roads are relatively high (80-120 km/h) under circumstances where these high speeds cannot be driven safely all the time and everywhere. For example, rural roads generally do not have consistent design characteristics over their total length. This is especially the case for roads that are not planned but have evolved in an historic manner. This requires constant speed adaptation to account for regularly changing situations and circumstances that increases the opportunities for human errors and leads to higher risks for accidents.

Loss of control is also a major factor as it accounts for 35% of the accidents on major rural roads and up to 60% of accidents on minor rural roads. These accidents are all the more serious when vehicles collide with an obstacle. Some 40% of fatalities in rural road accidents involve an obstacle.
Though there are many possible causes for losing control and running off the road, influencing inappropriate and excessive speeds together with a safe roadside design are key elements to improve rural road safety in this regard.

In many countries, the consumption of alcohol, especially on weekend nights by young car drivers, is an important factor. In other countries, fatigue or medicines and drugs play an important role. Though alcohol and fatigue factors are well known and their importance is thoroughly documented, there is very little information related to medicines and drugs. In spite of this, the available information does indicate that the associated road safety problems cannot be neglected.

Another striking factor that has arisen is that as much as 75 per cent of all fatal crashes in rural areas involve drivers who live in the area and 50% of vehicle occupants killed were not wearing seatbelts. This information has important implications for future rural road safety programmes.

Aside from the main areas of attention described above, certain conclusions can be made in relation to other factors relevant to the rural road safety problem.

Heavy goods vehicles and buses constitute a special problem due to the fact that these types of vehicles have a speed behaviour that is quite different from automobiles. This speed variation generates more instances of overtaking, which in turn can be a dangerous manoeuvre on rural roads. In addition, it is common to find slow moving vehicles such as agricultural vehicles, mopeds and cyclists on rural roads. When traffic such as this is using the same physical space as fast moving automobiles, high accident risks can be expected (OECD 1999).

2.4 Summary and recommendations

- The rural road safety problem is very serious and all road safety indicators (size, risk, and development over time) clearly call for decision-makers and the road safety community to give far more attention to rural road safety problems.
- The risk of being killed per kilometre driven on rural roads is generally higher than on urban roads and four to six times higher than on motorways.
- Rural road accidents are generally more severe than accidents on urban roads due to differences in operating speeds (higher on rural roads), road geometry (rural roads have evolved rather than having been designed), functionality (rural roads are multi-functional), enforcement levels (rural roads receive a lower priority) and other factors.
- There is scant data available to assess the problems of the rural road safety problem and a full accounting of the serious injuries is therefore currently not possible.
- The rural road safety problem appears to have been neglected over the years in comparison to the high level of attention that has been given to the safety problems on motorways and urban/residential roads and streets.
- There is a general lack of explicit safety policies or targets for rural roads in most countries.
- The rural road safety problem deserves a higher priority in future road safety policies, without neglecting the urban road safety problem.
- In some countries the proportion of deaths on rural roads is relatively low, thus indicating an urgent urban problem. This is where the greatest gains are to be made but this should not be undertaken at the expense of rural road safety. It is recommended that strategies for both urban and rural networks be developed.
3. **A strategy for road safety**

It is generally recognised that it is inefficient and less effective to implement road safety policies in a piecemeal manner. Here, strong political **leadership** is needed with **responsibility** for developing integrated road safety policies within overall transport policy.

In this Chapter, general elements of a strategy are presented.

3.1 **General elements of a strategic approach**

**Political commitment**: The point of departure for all successful road safety work is the political will to do something about the tragic loss of life and long term disability arising from road traffic accidents. When political guidance is given it has been shown (for example, Sweden, The Netherlands, and Great Britain) that this leads to a change in safety culture in society whereby safety is recognised as everyone’s responsibility, including private and public companies, and individual road users.

**Responsibility and leadership** - that one body, for example, the Minister for Transport, has the responsibility for creating transport policy, which should contain policies for road safety.

**Acceptance** that there is a serious road safety problem is a fundamental element of a strategy. Acceptance by Governments, Police, Road and Health Authorities that the solution to the problem is part of their responsibilities is crucial to a co-ordinated approach to road safety. However, acceptance is also required by individual road users of the existence of a problem and that they themselves have responsibility for driving safely, for taking care as a pedestrian or cyclist, etc. The overriding problem faced by those trying to improve road safety is to reduce the gap between the individual’s desire for independent mobility at all costs against the burden borne by society in terms of injury and environmental costs of such personal mobility.

**Co-ordination** of policies, strategies and plans across actors is the key to effective implementation. At the local and regional level there is a wide group of people and organisations that have responsibility for different aspects of implementation. For example:

- the highway engineer has responsibility for changes to the road network, and designs and build new roads;
- the police are responsible for surveillance and enforcement; and
- educators, behaviourists and trainers develop programmes for changing road user behaviour and attitudes.

Whilst individually all these are essential elements for a strategic approach to road safety, co-operative working across the disciplines at all stages from design to implementation is essential to develop the synergy of an holistic and strategic approach to casualty reduction and injury prevention.

One major tool to encourage co-ordination is the development of road safety plans that need to be formulated and accepted by all stakeholders.

**Road safety plans** – a national road safety plan should be created and adopted. It should then be taken and adapted by the regional and local actors to their own problems and needs.

The plan has to take an holistic view in which there is a requisite for safe vehicles to be driven by well trained drivers on well engineered roads, and when things go wrong, there needs to be efficient
emergency assistance. Taking this view means that the road, the user and the vehicle are equally important and need to be looked upon as parts of a total system.

To achieve a better road safety situation different professionals need to work together. For example:

- legislators and regulators;
- highway and vehicle engineers;
- police to improve and target surveillance and enforcement; and
- educators, trainers and communicators.

Public and private companies also have a role to play as both sectors can, through their vehicle purchasing policies, contribute to increasing demand for safe vehicles and through other policies, such as provision of advanced driving courses, can contribute to better trained road users. Limiting the availability of alcohol at public private meetings and events from which many people are expected to be driving can lead to more responsible attitudes toward drinking and driving.

**Targets** seem to be a force for focussing energy and resources towards road safety. Targets can be set both in casualty reduction terms and in operational conditions such as increased seat belt wearing and child restraint use, reduced drink driving, or speed moderation. The ECMT could set a target to reduce deaths for example by 50% by 2010.

There is growing evidence that countries that have programmes and targets are performing better in casualty reduction than those without.

### 3.2 Summary and recommendations

The institutional complexities in dealing with integrated road safety plans require a clear identification of the role of various actors on a regional basis. This institutional problem is fundamental, as a lack of tradition of co-operation has been identified in many regions and countries.

Co-operation based on the goal of jointly conceiving and implementing an integrated road safety programme in an atmosphere of “partnership” is the most promising approach. A leading organisation should induce and facilitate this partnership. The leading organisation should also play a central role in gathering and disseminating all relevant information, knowledge and expertise about rural road safety (OECD 1999).

A strategy for integration and implementation is the way forward to a safer road system for all road users. The essential elements of a **strategic** approach to road safety are:

- strong political **commitment** arising from **acceptance** of the road safety problem;
- development of a safety culture within society where it is recognised that road safety is the responsibility of each of individually;
- **co-ordination** between all the actors involved, at whatever level;
- setting road death and injury reduction **targets**; and
- developing and implementing **road safety plans**.
4. A plan for road safety

4.1 General elements of a road safety plan

After formulating a strategy it needs to be translated into a road safety plan which should contain a programme for implementation, and monitoring and evaluation. Evaluation of the process as well as the outcome is essential to learning by experience at all stages. The results from the evaluation provide feedback by which policy, strategy, and the road safety plan may all be improved.

The characteristics of the network that need to be considered when developing a road safety plan are given below. This Section draws heavily on the OECD report, which sets out very clearly the requirements for a framework to improve rural road safety. It presents a good example to illustrate the strategic approach described in Section 3.1 as applied to road safety in rural areas. It is based on a set of characteristics of the rural road safety problem, as follows:

1. The rural road network is very long and much of it has grown unplanned over several centuries, where function, road type, design and usage are not always clearly defined.
2. The network can be characterised by free flow and high speeds while, at the same time, the road user is confronted with a wide diversity of circumstances including a lack of standardisation and unpredictability of the course of the road, especially at bends, on approaches to junctions, and crests of hills.
3. The majority of accidents on rural roads fall into three categories with inappropriate speed as a dominant factor:
   - run off the road;
   - head-on and
   - intersection
4. Only limited financial means are available for maintaining and expanding the rural road network, especially in relation to its length and the low traffic volumes carried.
5. Many different actors, but primarily road authorities, and police are in charge of preventive action.
6. It is important to develop a rural road safety plan, or improvement strategy, and each country should develop short, short/medium and long-term programmes that are based on a sound analysis of the problems. Such plans should pay special attention to raising awareness about rural road safety both within the general public and within the organisations of all key actors: government, road, police, health and highway authorities, and public and private companies.
7. In short-term plans, programmes should include the development and implementation of a speed management strategy in which speed limit setting and speed enforcement (combined with publicity campaigns) are key components.
8. An emergency assistance management system could be installed in the short term in most countries.

In the short- and medium-term programmes, traditional infrastructure measures have to be chosen that emphasise investment to improve the quality of the rural road infrastructure.

- low-cost, effective and efficient infrastructure measures should be selected that preferably fit into existing road maintenance programmes. Among the infrastructure measures that are chosen, measures for bends, junctions and safe roadside design are critical elements.
- long-term programmes could include ITS applications among other measures.

Many examples of low-cost and effective infrastructure measure are given at Appendix 2.
4.2  A rural road safety plan

In Section 2.2, we have seen that single vehicle accidents, head on collisions, and collisions at junctions are the main safety issues for rural roads. For each country, region or local area, an analysis of the accident data is required to establish the national, regional or local problems that will not necessarily be the same as the composite picture for Europe. Section 2.3 discusses the main factors contributing to the accidents on rural roads and highlights road user behaviour, the road infrastructure, and the vehicle.

The next step is to match the problem to possible improvements that may be implemented to bring about a reduction in the number and severity of crashes on the rural road network. It has been estimated that improving road user behaviour, especially through speed adaptation, will contribute substantially to reductions in single vehicle, head on collisions, and collisions at junctions. Improving the infrastructure, especially the road, will bring large reductions in fatalities and injuries. Estimates of the contribution of improvements to vehicles are varied but all agree that, whilst not as large as the estimates for behaviour and the road, they are still significant. New technology in the form of intelligent transportation systems (ITS) have been estimated to bring about very large reductions in casualties -- between 30 and 50 per cent in some cases. It is recognised that many of these systems are for the future when institutional, behavioural adaptation and legal aspects have been agreed.

Whatever the relative contributions of the various measures are estimated to be, they need to be applied in a strategic way both nationally and regionally within Europe. Several countries have recognised the need for systematic introduction of interventions for urban roads and now the attention is turning to rural roads.

The rural road system itself has inherent characteristics that significantly contribute to the high number of accidents and the high risks. Inappropriate and excessive speed on rural roads are readily identified problems, especially as rural roads tend to be of older, historic design and have inconsistent design characteristics along their lengths. Drivers need to adapt regularly their speed to the constantly changing conditions. Key elements of any rural road safety strategy should be to reduce excessive and inappropriate speed together with improving road and roadside design. Another important element is to reduce variation in speed between vehicles within a stream due mainly to slower vehicles such as buses, heavy goods and agricultural vehicles, mopeds, and bicyclists.

4.2.1 Influencing road user behaviour

For rural roads to become safer, driver behaviour needs to be influenced and changed. The most powerful way to achieve these changes is through the integrated efforts of highway engineering, enforcement, and road user education.

Excessive and inappropriate speed has been identified as a significant problem on the European rural road network. This manifests itself in unsafe overtaking leading to head-on collisions, fast approach speeds at bends leading to run-off road and head-on collisions, and fast approach speeds at junctions leading to perceptual misjudgements by drivers on both major and minor roads.

Driving speed is affected by several factors, such as the speed of others, opinions of significant others, emotions and moods, and personal characteristics. People often feel that it is difficult to control their own driving speed and they tend to overestimate their own ability to control the consequences of speed (Levett 1998). This makes it difficult to persuade drivers to adopt slower speeds unless the message is targeted more directly at individuals such as in vehicle activated signs, by engineering measures to encourage slower speeds (see Section 4.1.2), or by enforcement.
Speed is not the only factor and impairment has also been identified:

- drink-driving in rural areas;
- driving whilst under the influence of drugs;
- medications prescribed by doctors; and
- fatigue.

There is evidence from accident studies that young drivers are more likely to accept more risky gaps than older drivers and be involved in accidents when they are driving too fast, especially when they are overtaking. There are many lessons for young drivers to learn about safe driving on rural roads and new driver training and assessment procedures already in use in some European countries (e.g. Sweden, Netherlands, Britain).

Older drivers try to avoid situations they find difficult, such as driving at night and at busy periods but they still have problems with turning out of minor roads onto major roads. They find it difficult to judge speed and distance of oncoming traffic. Training packages aimed at the older driver can help to alert them to this deficiency but introduction of engineering measure to reduce speed on the approach should also help (see Appendix 2).

4.2.2 Infrastructure

Evidence from across Europe has shown that an integrated approach to road safety in urban areas has paid dividends with improvements in road safety being demonstrated. Such a strategic approach is now starting to be implemented in rural areas. The key to a strategic approach is the defining of a road hierarchy by function. The principle of Sustainable Safety in the Netherlands has embraced this approach and there the road have been designated by function as either a) rural motorways and express roads of near motorway standard, b) distributor roads, or c) access roads. Each tier of roads has its own speed limit associated with it. 110/100 km/h for the motorways/express roads, 80 km/h for the distributor roads, and 60 km/h for the access roads. Three important safety principles are defined: functionality, homogeneity, and predictability.

It is hypothesised that drivers have a mental representation of a type of road that is shaped by previous experience. For example, motorways have wide lanes, ‘hard shoulders’, central barriers -- grade-separated junctions -- and generally high speeds. Many non-motorways are being improved and are gaining some motorway attributes, which may encourage higher speeds. However, when a driver encounters part of the road environment that doesn’t conform to their expectations (e.g. an unimproved section of dual carriageway that has at grade intersections) we might expect problems to arise and crashes to occur.

Some individual measures and their use to help encourage good design are given in Appendix 2.

4.2.2.1 Consistent vertical and horizontal alignment is an important feature of a consistent road environment to encourage appropriate speeds with relatively small differentials (variance) in speed between vehicles.

The Danish Road Directorate has made proposals to improve rural road safety – these include:

- speed reduction measures
- improvement of roadside verges to reduce loss of control once vehicle has left the road
• measure to improve perception of curves (effective and uniform signing and marking)
• increased distances from carriageway to roadside obstacles
• measures to avoid overtaking on road stretches where the sight lines are insufficient.

The ERSF (European Road Safety Federation) gives good design principles for intersections in that they should be:

• conspicuous from all approaches to allow safe speed adaptation and lane choice;
• meet sight requirements to enable safe crossing from a waiting position;
• simple and understandable;
• driveable;
• if possible, designed to reduce speeds and conflicting angles between vehicle path; and enable mutual co-ordination between drivers and vulnerable road users.

4.2.2.2 At bends

Run-off road accidents are common at bends, so too are head-on collisions. The bends which have the worst accident records are isolated bends, or those which occur as first in a series of bends after a straight section.

OECD reports two main inter-related causes:

• inappropriate approach speed leading to negotiating the bend too fast resulting loss of control and running-off the road or head-on into opposing traffic
• limited sight distances on approach and on bend itself leading to incorrect positioning and inappropriate speed

4.2.2.3 Along the open road – roadside hazards, crossing places for vulnerable road users

Whilst clearing the roadside of obstacles and hazards may not prevent run-off road accidents from happening, it is often the collision with the roadside object that causes the injury. Roadside obstacles include trees, ditches, rocks, walls, bridge supports, poles for affixing signs and utility poles.

A Swedish study of collisions with lighting poles (Nilsson and Wenall) recommended the following measures:

• provide frangible (break-away) lighting columns on new roads and place on the inside of bends;
• replace solid lighting columns with frangible ones on existing roads where there is sufficient width;
• use fewer poles with multiple light sources;
• replace poles with suspended lighting where possible or attach to buildings;
• replace roadside poles with central reservation lighting if room on a divided road.

In addition, poles should be placed behind safety fences where possible.

Many countries have obstacle-free zones along the road in places where obstacles can be removed or a policy of placing safety fencing at locations where the obstacles are fixed, for example, bridge supports or important trees. The size of the zone varies from country to country and by road type.
and speed of traffic. French guidelines are for 4m for existing roads and 7m for new roads. In the Netherlands, it varies from 4.5 m for 80 km/h design speed single-carriageway rural roads to 10m for motorways.

Soft planting, for example bushes and shrubs with thin trunks may be used by the roadside for aesthetic and ecological reasons as an alternative to planting trees.

Steep drops into drainage gullies and ditches, and rises onto embankments are also roadside hazards for the vehicle that has lost control, and good design can help to prevent the vehicle rolling over. This is a design issue not under the control of the safety engineers but a thorough safety audit of new roads at the design stage should highlight areas where changes may be made to reduce the steepness of the slopes. In many cases the introduction of safety fencing, especially at steep drops is recommended.

4.2.2.4 Other measures for road and roadside

Designing for the safety of vulnerable road users on high-speed rural roads is difficult and, where possible, grade separated crossings should be provided. Where this is not practicable, the ERSF recommends three safety principles:

- reduce speed of traffic;
- reduce road width to be crossed; and
- enhance mutual visibility between drivers and other road users.

4.2.2.5 At transition zones on approaches to villages

Where main roads pass through villages and other small communities, it is important to alert drivers to the change in characteristics of use of the road and to introduce sufficient measures to moderate speed behaviour to acceptable and safe levels. One alternative is to build a by-pass but, besides being very expensive, this does not resolve the problem entirely because traffic that does not use the by-pass can still travel too fast through the village without the necessary speed modification changes being made.

The most common treatment for transition zones to villages is to warn the drivers by changing the road layout on the approach to the village entrance where a gateway is provided to alert them that they are about to enter a different type of environment.

4.2.3 The vehicle

There is great potential for reducing the number of accidents and injuries through improved design of all types of vehicle from motorcycles through to buses and heavy goods vehicles. In Chapter I we have seen how the severity of injuries is increasing on the rural road network in European countries. Against this background there have been improvements in vehicle design and the greater use of EURO-NCAP crash test programmes has demonstrated that European drivers and manufacturers are becoming more safety conscious and creating a market force for safety. However, there are still improvements to be made both in primary safety -- preventing the accident from happening, and in secondary safety -- minimising the injury consequences once an impact has occurred.

Many of the improvements will require legislative changes by the EU, and Governments of other European countries, and this can take time. Most decisions on vehicle design standards are taken by the EU and not by individual member countries. The prime motivator for such decision making powers is to
reduce trade barriers but the harmonisation of standards is one important way in which all European
countries, EU and non-EU can work together to improve vehicle safety. However, those European
countries not part of the EU will still have local jurisdiction on such matters.

4.2.4 Police enforcement

Police enforcement is an effective symbol to show that road safety is as important as other types
of crimes and misdemeanours. This is especially important given the contribution of inappropriate speed
and excessive speed in rural road crashes. Effective enforcement can serve as a general deterrent factor that
can bring about long-term behaviour changes in drivers if it is coupled with other firm actions including
appropriate penalties and sufficient driver training. However, due to the great length of the network,
enforcement by conventional means is very limited and one cannot rely only on strategies based on
deploying police manpower alongside the road.

Publicity campaigns associated with targeted enforcement can increase the enforcement effects
and contribute to a change in driving norms. Also, repeated enforcement creates longer halo effects, in
terms of either time or distance, in contrast to “blitz” campaigns. By introducing a random enforcement
element, enforcement effectiveness can also be increased and introducing a random enforcement element
will produce longer halo effects. Automated enforcement technologies that target the causes of the
principal rural road accidents should be considered. Finally, funds generated by traffic enforcement should,
where possible, be earmarked for rural road safety to ensure that these important safety problems are
addressed to the fullest extent possible (OECD 1999).

4.2.5 Intelligent transportation systems (ITS)

As discussed in Section 2.2 the problem of accidents on rural bends is a European wide issue and
various road-engineering measures with good signs, markings, and high friction surfacing will all
contribute to a reduction in crashes. Nevertheless, some drivers will still make mistakes either with too
high approach speeds or with misjudgement of the geometry of the bend. Many problem bends have
substandard design or engineering features but, in many cases, it is not possible to realign them to bring
them nearer to good practice standards. The research in this area of rural bend safety indicates that
providing relevant, timely and accurate information to the driver is of paramount importance and the
effectiveness of this information is enhanced if there is some suggestion of enforcement (Compte and

This is an area where intelligent transportation systems (ITS) can help, either by proving in-car or
roadside information about approach speeds to hazards, or by taking control of the car through a fully
automated speed control system. Compte and Jamson evaluated different systems as part of the MASTER
(MAnaging Speeds of Traffic on European Roads) project. They concluded that providing advice to drivers
does result in reduced approach speeds and, as expected, optimal performance is attained under an
automatic system but there is much research needed to evaluate long term benefits and behavioural
adaptation issues.

In road safety terms there are several possible systems that could help drivers make appropriate
speed choices on approach to hazards. These systems, in principle, are suited to rural roads where it is very
difficult to make engineering changes to vertical or horizontal alignment in order to influence speed or
alert drivers.
ITS can also be used to set interlocks to prevent the vehicle being driven if the driver is sensed to have been consuming alcohol or has been disqualified from driving. Another use is to provide warning to the driver and passengers that seatbelts are not secured, or to provide information to emergency services in the event of a crash (Mayday systems).

The introduction of ITS is more complex than is the introduction of more physical changes to the vehicle to enhance safety. ITS needs to work across borders and the countries of Europe need to work together to agree common standards and legislation. Specific actions recommended to the European Union are made by ETSC (1999) and if any systems are to work more broadly across continental Europe -- these principles should be extended to and embraced by all countries.

4.2.6 Emergency assistance in rural areas

Identifying an accident is one of the key problems in responding to rural road crashes. There are several options that can improve the situation, including:

- improving road and kilometre/mile identification schemes;
- expanding the use of GPS;
- exploring possibilities for automated accident detection, and
- adopting a uniform emergency number (112) in all ECMT countries

Several communications technologies should also contribute to improving rural road safety. Among available technologies, cellular telephones are viewed as an extremely positive advance as they can shorten arrival time and improve the overall information available about an accident situation. There is a role for publicity campaigns in conjunction with more widespread first aid training to improve trauma treatment at the scene of a rural road accident. Also recommend and describe common guidelines and standard procedures that local hospitals could adopt to improve trauma treatment (OECD 1999).

4.3 Summary and Recommendations

Improving the safety of rural roads is one of the main challenges in European road safety as we progress through the first years of the new millennium. Over the final decades of the 20th Century significant progress was made in improving the safety of urban roads, and of vehicles to help occupants withstand impact. Compared with urban areas, there are relatively few proven accident remedial measures for rural roads and more emphasis is needed by all countries of Europe to bring together information on what works and what remedial measures are acceptable to people who live in rural areas.

The theme of this report is the holistic approach to road safety where the goal is to have safe drivers on safe roads with safe vehicles. Elements that should be included in a road safety plan are given starting with the need to influence behaviour. Police surveillance and enforcement is necessary for a well-regulated traffic system.

Measures that have been shown to work are divided into those that assist drivers at bends and junctions. Along lengths of road, measures are listed to reduce the possibility of head-on collisions and others reduce the likelihood, or severity of injury when vehicles leave the road by removing or softening roadside hazards. Measures are also given for helping vulnerable road users cross the different types of road.
Improvements to the vehicle have been listed together with the need for further development and acceptance of intelligent transport systems (ITS). There is still a great potential for improving vehicle safety as not all countries, especially some of those outside the European Union, have assimilated currently available improvements into their vehicle fleets. This takes time to trickle through as older cars are replaced with newer ones incorporating safety features.

5. Implementation

To give focus and strength to the implementation process and to ensure that road safety policy, strategy, plans, and programmes will be implemented, there are several prerequisites that have to be in place. First of all, there has to be a demand for improved road safety in the whole society. Secondly, strong institutional structures need to be developed and systems for knowledge transfer need to be put in place. There are specific methods and measures that can be used to strengthen the implementation process, for example, benchmarking and safety audit are tools, which can be used to increase the incentive to implement safety measures.

5.1 Institutional development

The demand by professionals and society for road safety is perhaps the most important way to strengthen the implementation process but after this, it is to develop institutional structures in ways which:

- allow organisations to work together so that the road administration can work closely with the police authority, health and education sectors, and public and private companies;
- develop a well-trained and motivated workforce with the right skills and knowledge and equipped with the resources to carry out their tasks.

5.2 Knowledge transfer

Knowledge transfer between professionals, within and between countries, is a key element in the support of this institutional development. One important example being undertaken by the ECMT is the Peer Review of road safety work. In this process, the host country invites experts to share knowledge and expertise with professionals who may then participate in exchange visits to further expand their knowledge and expertise.

Knowledge transfer is not only important for institutional development. It is obvious that knowledge transfer in all matters is essential in the work for a safer road transport system.

- There is insufficient data available to assess fully the extent of the rural road safety problem. To develop road safety policies, strategies, programmes and to the implementations of measures requires a unified method both within countries and, preferably, across the ECMT countries for collecting and reporting accident data, identifying exposure measures, monitoring and evaluating countermeasures and estimating their cost-effectiveness.
- There are large differences in the number of deaths per million vehicles across Europe and there is a substantial difference between the best countries and the rest. These differences need to be reduced by better dissemination of information about what works to reduce rural accidents and by better and closer co-operation between countries with the best safety records and other countries.
It is quite evident that the current knowledge and expertise about how to improve rural road safety is not sufficient. For instance, there is insufficient understanding about why road users make errors that sometimes lead to accidents or why, on a massive scale, they do not obey speed limits.

Knowledge is also limited regarding how to influence human behaviour effectively and efficiently.

Knowledge transfer can be maximised by giving explicit attention to safety as a basic design element in university-level road engineering courses.

5.3 Developing a rural road hierarchy

The key to strategic development of a safer rural network is the assignment of roads to a place in a hierarchy whereby roads having similar functions and used by similar types of traffic are allocated to the same place in the hierarchy. In this way quiet single-track lanes providing access to farms and properties are distinguished from distributor roads that carry a greater mix and volume of traffic, which in turn are distinguished from the main inter-urban long-distance routes carrying faster traffic. Once a road is in its position in this functional hierarchy, specific interventions, including measures to adapt behaviour, safer design and engineering, and speed management, can be applied in a systematic way. For example:

- **main roads** where motorised transport predominates, a whole route approach is desirable with the aim of harmonising the design, road markings, signs and features for ease of travel;
- **distributor roads** are also used by non-motorised modes as well as by agricultural traffic. This mixed use needs to be catered for in terms of speed management and sympathetic design of remedial treatments, signs and markings;
- **access roads – country lanes**; it is common to find pedestrians, bicyclists and equestrians on these roads therefore speed management and design of remedial measures should take account of the slower speeds and mix of use.

Within these hierarchy levels will be roads that have a good safety record and those that have a poor safety record. This is often related to the quality of the road, for example, new roads tend to be safer than older historic ones. It is recommended that within each level roads be further categorised by road quality as defined by a safety standard such as number of casualties per unit length or by casualty rate.

5.4 Benchmarking

A specific method to strengthen the implementation phase is to use benchmarking between countries in a public and transparent way. One inspiring example is the OECD lead in producing league tables of economic development. Benchmarking can also be used within a country to compare and contrast different regions.

The most important part in the development of a benchmarking process is to decide which safety objective to benchmark and how to measure it. In the case of road safety it could be the number of casualties, number of well-maintained and safe cars in use, or the quality of the roads. The indicator has to be carefully chosen as it is of utmost importance for measuring the output of the benchmarking exercise.

As a method, benchmarking is an important tool for encouraging learning from each other. It can be used between or within, countries at different stages of development of their road safety policy, strategies, and plans thus helping to strengthen and speed up the implementation process. As stated earlier, benchmarking can be used to compare different measures (volume, flow or quality) or different conditions such as number of speeding offences or casualties per 100 000 inhabitants.
Following is an example of benchmarking, in which quality of a product (the road) is combined with an operational condition (speed) and an outcome (number of casualties per 100 000 inhabitants). The basic assumption in this example is that speed has a direct and crucial influence on the number of casualties.

First, roads in different levels of the hierarchy are classified into different safety standards according to the number of casualties. Thereafter certain criteria for speed limits are defined within these different safety standards. With the use of different interventions and measures the aim is to minimise the number of speed offences. Useful measures are police enforcement, speed cameras, intelligent transport systems (ITS), and education and public campaigns. The aim is to achieve average speeds at almost the same level as the speed limit set from the safety standard of the road. The country that is best at defining safe road standards and best at developing criteria for speed limits according to these safety standards, and most successful in minimising speed offences will also have the lowest casualty rate per inhabitants. The benchmark is then used to compare different casualty rates per 100 000 inhabitants between different countries or regions. The aim of this benchmarking is, by introducing a comparative element into the process gives impetus to the implementation of efficient road safety standards.

A new benchmarking programme for road safety is being developed. The European Road Assessment programme (EuroRAP) has been set up which is a co-operative project between Great Britain, the Netherlands and Sweden. EuroRAP is a pilot study for developing methods for safety rating of each section of the European road network. Vital to the EuroRAP programme are two new test protocols. The first introduces a standard for road inspection covering safety features. The second standard measures and maps the rate at which people are being killed and seriously injured on the road. The aim of EuroRAP is to supply the consumers, authorities and engineers with powerful and new information. The road standards can rise towards “best practice” once what is best and what is worst is measured, understood and communicated across Europe.

Once a benchmarking exercise has been undertaken an appropriate level for intervention needs to be set so that the worst roads are treated first and the worst locations along these roads are identified. Here the concept of intervention levels is very useful. Several countries have developed intervention levels for different types of roads, including rural roads (see for example, Barker et al 1999). In contrast to urban roads, where accidents are often clustered at hazardous sites making identification and treatment more obvious, accidents less often cluster at sites on the rural network. Intervention levels are set by reference to accident rates estimated to be typical of those occurring nationally. When rates higher than these are found along a section of rural road, remedial treatments should be considered. In rural areas, interventions are often on a route basis, treating in similar ways all the substandard bends and the isolated junctions so that the driver is given, as far as possible, a consistent image of the road along its length.

Once the decision to improve the safety of a road or section of a road has been made them the highway engineers have at their disposal for implementation the range of measures detailed in Appendix 2.

Several countries of the European Union are co-operating within the EuroRAP programme to set intervention levels for European roads. This potentially is a very useful system for benchmarking and remedial action across a broad set of roads. The wide variety of principles and implementation practices used in road classification schemes hampers and obscures a correct representation of the size and nature of the rural road safety problems and makes it difficult to compare rural road safety between countries.
5.5 Safety audit

Old roads can be assigned retrospectively to any newly defined rural hierarchy to help administrators in their task of deciding intervention levels, type of intervention, and speed management plans. New roads are designed to modern standards; however, new roads can still be opened for use with substantial safety problems. To try to prevent this from happening, more countries are adopting safety audit of new roads, which starts at the design stage and follows through right up until opening to traffic, and sometimes just afterwards. The procedure needs to be formalised with the design team taking on board the safety issues highlighted by the audit team. These can range from alignment to positioning of signs and markings. Besides improving safety of an actual new road, audit serves to bring greater awareness of road safety principles to design engineers, who should then be able to incorporate them into future designs. A useful practical text is *What goes wrong in highway design and how to put it right* (TMS and AA 1999).

5.6 Summary and recommendations

Policies, strategies and plans are not worth anything if they are not implemented. Whilst this is self-evident, it is not always the case. Documents are produced but they stay on the bookshelf without any effect on the real world. In other words they are not implemented.

In order to improve the implementation process ECMT has made following observations and recommendations:

- Develop institutional structures in ways, which allow organisations to work together so that the road administration can work closely with the police authority, health and education sectors, and public and private companies. Develop a well-trained and motivated workforce with the right skills and knowledge and equipped with the resources to carry out their tasks.
- Pay attention to knowledge transfer between professionals within and between countries as one important part of succeeding in this institutional development. Knowledge transfer concerns not only institutional development. It is obvious that knowledge transfer in all matters is essential in the work for a safer road transport system.
- To develop road safety policies, strategies, plans and the implementation of measures it requires a unified method for collecting and reporting accident data, identifying exposure measures, monitoring and evaluating countermeasures and estimating their cost-effectiveness.
- There are large differences in the number of deaths per million vehicles across Europe and there is a substantial difference between the best countries and the rest. These differences need to be reduced by better dissemination of information about what works to reduce rural accidents and by better and closer co-operation between countries with the best safety records and other countries.
- A specific method to strengthen the implementation phase is to use benchmarking between countries in a public and transparent way. Benchmarking can also be used within a country to compare and contrast different regions. As a method it primarily encourages learning from each other so it can be used between or within countries at different stages of development of their road safety policy, strategies, plans and in these case to strengthen speed up the implementations process.
- Within the framework of ECMT a benchmarking system needs to be developed based on the quality of the road, speed and number of casualties. It would be beneficial to use experience from the pilot study EuroRAP.
- Several countries of the European Union are co-operating to set intervention levels for European roads. This potentially is a very useful system for benchmarking and remedial action across a broad set of roads. More countries need to adopt safety audit of new roads, which starts at the design stage and follows through right up until opening to traffic, and sometimes just afterwards.
6. References.


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Nilsson G., and Wenäll J (1997) Collisions with lamp posts and other hard objects in the road environment VTI Meddalande 825, Swedish National Road and Transport Research Institute, Linköping


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http://www.who.int
APPENDIX 1: PROPORTION OF DEATHS ON RURAL ROADS

Figure A1: Range of proportions of deaths on rural roads in Central and Eastern European Countries

Figure A2: Range of proportions of deaths on rural roads in Western European Countries
APPENDIX 2: ROAD SAFETY MEASURES

Although a holistic approach is required and recommended in this report, there is a clear understanding that individual low-cost measures can contribute substantially to the safety of the rural road network. Therefore, each of the following sections provides a summary of measures.

A2.1 Infrastructure

Safety measures that address infrastructure offer the most plentiful opportunities for safety enhancement on rural roads and those that are low-cost and have high benefit-cost ratios have the greatest potential for widespread use. However, even though safety is understood to be an important criterion in road design, it is still too often of secondary importance.

Safety should receive explicit attention at every level of the process, from the decision to build or rebuild a road to the planning and design stages, through construction and during operation and maintenance. The basis of a safe road design is a consistent, hierarchical road network, in which each road category has a particular function to fulfil. The design characteristics of a road need to be in accordance with its function and provide “Positive Guidance” for road users. Rural roads should be assigned a specific function rather than trying to cater to a varying mix of functions. As well, the design of the road should be consistent with the function and in accordance with the lowest functional use of the road (OECD 1999).

The ultimate level of safety on a road depends on the consistency of the design in all of its aspects. For instance, a series of relatively wide curves should not be followed by a very narrow one without extensive warning and/or physical speed reducing measures. Furthermore, it must be possible to negotiate an isolated curve or the first in a series at a speed that is not excessively below the speed that is maintained on the straight section preceding it. Whereas there is a general trend that accident rates increase as a curve becomes narrower, from a safety point of view the consistency between curves along the road is at least as important.

Also, the planning process should be used to minimise direct access to major rural roads and/or not allowing access at bends, hill crests, and at or near intersections should be a minimum requirement for ensuring safe road infrastructure.

As the main rural road accident type, single vehicle run-off accidents occur most often on horizontal curves rather than on adjacent tangent sections. This is also the case for many head-on accidents. Flattening horizontal curves is an effective accident reduction measure. However, reconstructing existing curves is expensive and probably only cost-effective on higher volume roads. There are several less expensive measures such as removal or protection of roadside hazards, flattening side slopes, improving road surface skid resistance, increasing the super-elevation, paving the shoulders and eliminating road surface edge drops.

Other typical low cost measures include upgrading the edge line and centre line in some situations, adding raised reflective markers or upgrading the advance warning. Rumble devices along longitudinal sections can also be effective in reducing run-off accidents. The installation of roadside markings to guide drivers through a curve or a bridge is also beneficial for safety.

A forgiving roadside and roadside improvements in general are important because they can significantly reduce the severity of accidents. There is very high potential for improving overall safety by treating or removing roadside obstacles such as trees, ditches, rocks, utility poles and steep slopes.
Obstacle free zones of between 4 and 10 meters are desirable if the road geometry and right-of-way will allow it.

Knowledge transfer and training in the area of roadside safety as a key action area that can contribute to better and more timely treatment of roadside hazards.

In relation to head-on collisions, prevention can be accomplished by (physically) separating opposing traffic. A new approach that is being adopted in Sweden on rural roads is narrow physical separation by means of a steel or concrete barrier. In order to reduce head-on collisions caused by overtaking manoeuvres, the provision of conflict-free overtaking opportunities -- i.e. regular overtaking lanes or climbing lane installations with good forewarning -- can have many advantages. In addition, a combination of increasing lane width and shoulder width is the most effective approach for preventing a variety of accident types, including head-on collisions.

For collisions at intersections, roundabouts have a very good safety record in comparison to three and four-way intersections. Roundabouts should be considered for their safety record.

In addressing the issue of speed variance on rural roads, separating slow and fast traffic will contribute to the overall safety of rural roads.

Combining remedial programmes at hazardous locations or along lengths of road, that target specific problem sites and areas with preventive safety impact assessments and safety audits, as appropriate, when planning, designing, (re) building or maintaining roads. The aim is to prevent accidents rather than respond to those that happened. The widespread use of these practices at the local and regional level is recommended (OECD 1999).
At junctions

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflectorised marker posts</td>
<td>Increase conspicuity of junction especially at night</td>
</tr>
<tr>
<td>Edge of carriageway road markings</td>
<td>On major road and round corner onto minor road to increase conspicuity from a distance</td>
</tr>
<tr>
<td>Junction warning signs</td>
<td>Benefit all road users if appropriately sited in relation to actual speeds</td>
</tr>
<tr>
<td>Facilities for turning traffic</td>
<td>Turning bays or ghost islands may be introduced if sufficient road width. Road markings give better forward visibility of junction.</td>
</tr>
<tr>
<td>Deceleration lanes</td>
<td>Enable leaving traffic to decelerate without interfering with high speed through traffic</td>
</tr>
<tr>
<td>Junction widening</td>
<td>Provide a passing bay for straight ahead traffic</td>
</tr>
<tr>
<td>Anti-skid surfacing</td>
<td>High friction surfacing helps bring drivers to a halt before impact</td>
</tr>
<tr>
<td>Transverse bar lines</td>
<td>Useful for alerting road users to junction ahead. The decreasing spacing gives illusion of increasing speed and encourages small reduction in speed</td>
</tr>
<tr>
<td>Improved visibility splays</td>
<td>Improve visibility on minor road assists all road users. Includes cutting hedges, cutting back overhanging branches of trees, high grass etc.</td>
</tr>
<tr>
<td>Bicycle crossing at slip roads</td>
<td>Provide crossing points across slip roads to reduce exposure to traffic of cycling along the length of the merge. Useful where there is no segregated bicycle lane</td>
</tr>
<tr>
<td>Conversion of crossroads (four-way intersections)</td>
<td>Conversion to roundabouts or staggered t-junctions are effective in preventing minor road traffic crossing major roads without stopping</td>
</tr>
</tbody>
</table>

Source IHT 1999.

Measures to reduce head-on collisions on two-lane rural roads

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separating opposing traffic streams with cable or concrete barriers</td>
<td>Rarely practicable on two lane rural roads although some experimentation has taken place in Sweden and Denmark.</td>
</tr>
<tr>
<td>Continuous ladder markings in the carriageway centre</td>
<td>A softer solution used to discourage, but not prevent, overtaking.</td>
</tr>
<tr>
<td>Construction of overtaking lanes</td>
<td>Provides more opportunity to overtake safely, especially on hills</td>
</tr>
<tr>
<td>Double centre lines giving overtaking priority in each direction alternately</td>
<td>A controlled three-lane system with the middle lane alternately assigned to one direction</td>
</tr>
<tr>
<td>Increase shoulder width with solid edgelining</td>
<td>Wider shoulders give opportunity for slower vehicles to move over to let faster vehicle pass</td>
</tr>
<tr>
<td>Separate slow and fast moving traffic</td>
<td>Reduces large speed differentials, mainly provision of separate bicycle/pedestrian/ equestrian path/road, separate lane or parallel road for slow (agricultural) traffic</td>
</tr>
</tbody>
</table>
At bends

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflectorised marker posts</td>
<td>Installed on both sides of the carriageway to improve detection, perception and negotiation of bends</td>
</tr>
<tr>
<td>Chevron signs</td>
<td>Installed to improve detection, perception and negotiation of bends</td>
</tr>
<tr>
<td>Improved edgemarking</td>
<td>Installed to give clear guidance about geometry of bend</td>
</tr>
<tr>
<td>Channelisation marking</td>
<td>Centre hatching between solid lines where space permits to emphasise geometry of bend and encourage separation between oncoming vehicles</td>
</tr>
<tr>
<td>Transverse bar markings and rumble strips</td>
<td>Devices to alert speeding drivers on approach to bends</td>
</tr>
<tr>
<td>Speed advisory signs</td>
<td>Useful extra information to drivers when bend has unusual characteristics or otherwise departs from standard</td>
</tr>
<tr>
<td>Vehicle activated warning signs</td>
<td>Use on approach to bends. Have a pre-set trigger speed which vehicles exceeding cause an appropriate message to be displayed. Good for alerting drivers to hazard</td>
</tr>
<tr>
<td>Road studs</td>
<td>Reflecting road studs useful for defining road layout, especially at night</td>
</tr>
<tr>
<td>Anti-skid surfacing</td>
<td>High friction surfacing on approach and bend helps reduce loss of control, especially at high speeds or in the wet</td>
</tr>
<tr>
<td>Straightening bends</td>
<td>An effective but expensive measure</td>
</tr>
<tr>
<td>Removal or protection of roadside hazards</td>
<td>Reduces the likelihood of striking a solid object if control is lost</td>
</tr>
</tbody>
</table>

*Source IHT 1999.*

Other measures for road and roadside

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian crossing points</td>
<td>On fast, busy roads footbridges are often the only way for pedestrians to cross these roads safely</td>
</tr>
<tr>
<td>Horse crossing points</td>
<td>In some countries, horse riding trails cross-busy roads. A wide fenced area in the centre of the road needs to be provided for equestrians to wait. The provision of a traffic light to stop the traffic may be necessary</td>
</tr>
<tr>
<td>Parking/rest areas</td>
<td>Can be provided on straight sections of busier roads for drivers to pull off the road safely in order to take a rest break</td>
</tr>
<tr>
<td>Signs and markings</td>
<td>Good delineation and signing help drivers position their vehicle correctly on the road as well as giving information about upcoming hazards and substandard road layout. Too many signs may cause confusion. Good maintenance is essential.</td>
</tr>
<tr>
<td>Street lighting</td>
<td>Can be used sparingly at hazardous locations such as isolated junctions. But environmental issues such as light pollution in rural areas need to be balanced with possible accident savings</td>
</tr>
</tbody>
</table>

28
At transition zones on approaches to villages

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countdown signs</td>
<td>A sequence of signs at set intervals of 300, 200 and 100m before the gateway, effective as a warning particularly when gateway is hidden from view on approach</td>
</tr>
<tr>
<td>Vehicle-activated warning signs</td>
<td>Effective in reducing speeds on approach to villages. Speed detectors pre-set and when speeding driver approaches it shows an appropriate message</td>
</tr>
<tr>
<td>Riblines/rumble strips</td>
<td>Can reduce speed and alert drivers to hazard but are very noisy</td>
</tr>
<tr>
<td>Visual road narrowing</td>
<td>Achieved using road markings to make the road narrower at the gateway – may be over-run by wider vehicles</td>
</tr>
<tr>
<td>Physical narrowing</td>
<td>Can be used where there is sufficient road width for traffic to pass on narrow lanes or by using one at a time working where flows are low. Effective when used with vertical elements to enhance height thus reducing perceived width</td>
</tr>
<tr>
<td>Coloured or textured surfaces</td>
<td>Can be effective when used with speed reducing measures at the gateway. Care needs to be taken not to increase noise in the vicinity of dwellings</td>
</tr>
<tr>
<td>Speed limit roundels</td>
<td>These show the speed limit through the village and are placed in the centre of the lane at the gateway. For greatest impact, they should be on a coloured surface.</td>
</tr>
</tbody>
</table>

Source (IHT 1999)

A2.2 Intelligent Transport Systems (ITS)

The full potential of ITS solutions for rural road safety can be realised only if research is undertaken to obtain a better understanding of the costs of these systems, the specific technical issues, the human-machine interface, and the institutional and political constraints. As well, the extensive nature of the rural road network demands low-cost solutions.

However, there are low-cost ITS measures that are being used by some vehicle manufacturers on some of their models. These could, if more widely used, make contributions in reducing the principal accident types on rural roads and include speed control technologies such as speed advisory systems and adaptive cruise control.

Other low cost measures in use on a trial basis in some countries include systems for driver monitoring, intersection approach warning and guide lights. In the short to medium term, other low cost measures such as smart seat belts and air bags or vehicle data recorders will be broadly available and can lessen the rural road safety problem.

The introduction of ITS is more complex than is the introduction of more physical changes to the vehicle to enhance safety. ITS needs to work across borders and the countries of Europe need to work together to agree common standards and legislation. Specific actions recommended to the European Union
are made by ETSC (1999) and if any systems are to work more broadly across continental Europe – these principles should be extended to and embraced by all countries.

ETSC (1999) in their report Intelligent Transportation Systems and Road Safety give some of the most promising direct systems suitable for rural roads.

| Collision avoidance         | cruise control systems should be introduced with collision avoidance systems- there is a long way to go before such systems can be routinely fitted in vehicles but the predictions for casualty savings are good |
| Adaptive cruise control     | provide more efficient speeding detection and feedback and have been demonstrated to be effective – newer digital systems can track vehicles and compute average speed over a section of road |
| Headway adaptation systems  | speed adaptation ranges from informative systems to intervening ones. Advisory speed signs at critical locations, in-car warnings when speed limit exceeded, lowered speed limits in adverse weather conditions (fog, ice), external speed control via data transfer to vehicle engine management system about prevailing speed limit |
| Collision avoidance systems | monitoring systems to detect impairment caused by drowsiness, illness, drugs or alcohol in-vehicle monitoring systems for hgvs collect data from brakes, tyres, lights etc and can monitor load shifts and give information to driver crash data recorders for hgvs is in force but could be extended to private vehicles to improve safety |
| Automated speed enforcement | Performance indicators are based on the present system, including feedback and are not calibrated for the new system |

### A2.3 The vehicle

**The main primary safety issues are**

| Speed control                  | daytime running lights, coloured lights for motorcycle conspicuity, conspicuity of agricultural vehicles |
| Improved vision and conspicuity| reduction of jack-knife accidents, better braking systems for agricultural vehicles, anti-lock brakes, stability of on/off road vehicles, advanced electronic braking systems |
| Better braking and stability of vehicles | Performance indicators are based on the present system, including feedback and are not calibrated for the new system |
The secondary safety issues are more numerous and include

<table>
<thead>
<tr>
<th><strong>Cars</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Seat belts</td>
<td>probably the single most effective measure if wearing rates could be improved and easier use can help this- provision of lap and diagonal belts only for both front and rear seat</td>
</tr>
<tr>
<td>Child restraints</td>
<td>better design of seat and provision of strong anchorage points</td>
</tr>
<tr>
<td>Head restraints</td>
<td>fixed restraints give better protection than adjustable – need a standard height to help prevent neck injuries</td>
</tr>
<tr>
<td>Airbags</td>
<td>better standardisation of front and side airbags</td>
</tr>
<tr>
<td>Steering wheels</td>
<td>despite seatbelts, severe injuries occur from steering wheel impacting on driver’s chest. Need better design increasing use of airbags should help</td>
</tr>
<tr>
<td>Frontal crash protection, driver and passenger leg impact area</td>
<td>continued testing and development through Euroncap etc to improve crash protection, head injury is a big issue in side impacts</td>
</tr>
<tr>
<td>Seat strength</td>
<td>seats are insufficiently robust for adults in rear impacts – also need rear seats to act as a barrier to loose luggage – loading of rear seats needs standardisation to withstand better the force of seatbelt restrained passengers</td>
</tr>
<tr>
<td>Pedestrian protection</td>
<td>the development of pedestrian friendly car fronts has been an issue for many years – this would be a very beneficial car design feature</td>
</tr>
<tr>
<td>Structural compatibility between vehicles</td>
<td>collisions between vehicles of different size and mass is an issue where continued work is need to achieve structural compatibility between sides and fronts of differently sized vehicles – under-run protection is an example</td>
</tr>
<tr>
<td>Downsizing of vehicles</td>
<td>as more vehicles become smaller because of environmental considerations, there will be a bigger difference in mass between the large and the small- good secondary safety design is essential to help compensate for this difference</td>
</tr>
<tr>
<td>Fuel system</td>
<td>improvements in this area will help to reduce vehicle fires after impact</td>
</tr>
<tr>
<td>Door latches</td>
<td>locks that are burst proof on impact are a safety feature to help prevent occupant ejection</td>
</tr>
<tr>
<td><strong>Motorcycles</strong></td>
<td>better helmets will help protect head and neck</td>
</tr>
<tr>
<td><strong>Hgv/agricultural vehicle safety</strong></td>
<td>hgv under-run guards (front, rear and side) cab strength,</td>
</tr>
<tr>
<td><strong>Bus and coach safety</strong></td>
<td>seatbelt systems and other secondary devices, strength of superstructures</td>
</tr>
</tbody>
</table>