Reducing deaths on rural roads

- A priority for the next "Decade of action"

At least **21,500** people lost their lives on **rural roads other than motorways** in the EU last year. Rural roads are the most dangerous roads because of the risks posed by high speeds, the mix of different road users, multi-functionality, lower infrastructure safety and low enforcement levels. Rural roads contribute 55% of all road deaths across the EU, 70% for some Member States.

Yet road users are safer on rural roads today than in 2001. **Luxembourg, Portugal** and **France** achieved the highest annual reductions of more than 9% on average since 2001. **Latvia**, **Belgium**, **Israel**, **Germany**, **Spain,** the **Netherlands** and **Ireland** follow closely behind with better-than-EU average reductions. **France**, **Portugal, Latvia** and **Belgium** are countries that have achieved rapid overall reduction in road deaths over the same period. The reduction in speed has been the single most important factor in the recent French road safety success, and this has been especially marked on rural roads.

Comparison of the safety levels between countries is difficult because of the variety of rural roads and lack of detailed data on vehicle-km travelled, but measures to improve the safety on that part of the network are known. They include safe road design, safe infrastructure management, and better enforcement of traffic rules, in particular of speed limits.

The **European Commission's Road Safety Policy Orientations 2011-2020** published in July promote the application of the four relevant principles of infrastructure safety management as set out in the Infrastructure Safety Directive not only to the Trans-European Road Network but also to other rural roads where many more die.

In its Response to the EC Communication, ETSC welcomes that approach but also identifies additional actions at the EU and Member State levels and will promote them during the **European Road Safety Days** taking place this week in Brussels.

Part 1 | Country comparison

1.1 Progress in reducing road deaths outside urban areas

Road deaths on rural roads have decreased in all EU countries since 2001, with the exception of Romania and Bulgaria (Fig. 1). Best reductions have been achieved by **Luxembourg**, **Portugal** and **France**, with annual reductions of more than 9% on average. **Latvia**, **Belgium**, **Israel**, **Germany**, **Spain,** the **Netherlands** and **Ireland** follow with annual reductions of at least 6% on average.

Among the countries that achieved the highest reductions in road deaths on the rural road network are **France**, **Portugal, Latvia** and **Belgium,** which have achieved rapid overall reduction in road deaths over the same period.

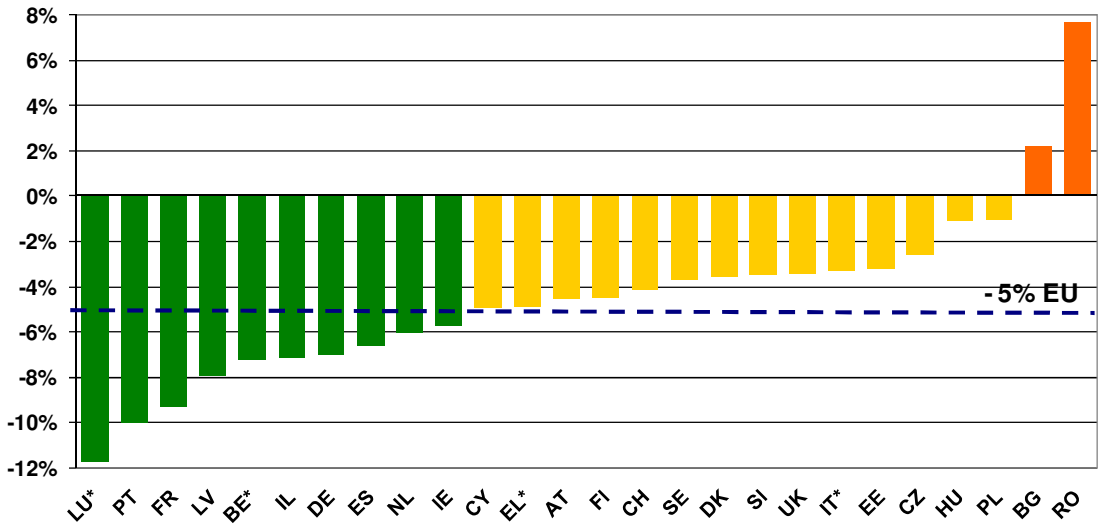


Fig.1: Average annual percentage change in deaths outside urban areas on roads other than motorways over the period 2001-2009.
**BE, EL, IT, LU (2001-2008). LI and SK have recently begun to achieve rapid reductions, but are excluded from Fig. 1 because in Slovakia deaths on rural roads are available only from 2005 and only deaths occurring within 24h after the collisions are collected, and in Lithuania, deaths on rural roads are available only from 2006.*

In **Portugal**, 365 people died on rural roads in 2009, compared to 863 in 2002. Part of this impressive reduction is due to the transfer of high speed traffic from single carriageways to newly built motorways. In parallel, an extensive high risk site removal scheme was implemented by the Portuguese authorities, in particular on rural roads. Safety at junctions was improved with the construction of roundabouts or raised junctions.

> *"The 1998 National Road Plan transferred the management of rural roads from the national level to local authorities. In return, funds were transferred to local authorities for the rehabilitation of the network to its present use and current standards. The next step is now to install safety cameras. SINCRO, our automatic speed enforcement system, similar to the French one, will hopefully be operational by the end of 2011 and help us curb speeding our Portuguese roads".* Luís Miguel Farinha, road safety expert, Portugal.

In **Germany**, road deaths on rural roads have been cut by 45% between 2001 and 2009, corresponding to a 7% annual average reduction. This steady decrease is the result of a combination of factors including active and passive vehicle safety improvements, as well as changes in infrastructure and behaviour. Major infrastructure schemes have been implemented, including the installation of roadside barriers to protect from dangerous running off (e.g. hitting trees), separate cycle lanes along cyclists' favourite routes and optimised guard rails on typical motorcycle routes. Part of the network has been upgraded to 2+1 sections offering safe overtaking (see section 2.2). Speed limits have been reduced at dangerous intersections and the entrance of villages and towns, coupled with traffic calming measures such as protective islands and roundabouts. Speed enforcement has increased but because Germany does not currently monitor mean speeds, decision-makers are deprived of important feedback on the effectiveness of their actions.

The good performance of the **Netherlands** is the consequence of the work carried out in developing an integrated approach of safe road design and traffic management, combined with speed enforcement. As a result, road deaths on rural roads have continued to decrease – by 6% per year on average since 2001.

> *"This progress has been achieved without road safety audits and road safety inspections being mandatory. We expect further reductions in road casualties as audits and inspections become mandatory starting from December 2010. Indeed, the Dutch government decided to go beyond the requirement of the EU Directive on Infrastructure Safety and implement the four instruments also on our rural network."* Peter Mak, Ministry of Transport, the Netherlands.

Lithuania (-19%) and **Slovakia** (-9%) also achieved good reductions over the last few years but they have not been able to provide data to enable their average rate of reduction since 2001 to be estimated. Moreover, **Slovakia** needs to collect deaths at 30 days to allow for direct international comparison.

For **Spain** and **Estonia**, and to a lesser extent also **Sweden**, however, reductions in deaths on rural roads have not contributed their share to the good overall reductions they have achieved[1]. Overall reductions in **Estonia** and **Sweden** have stemmed rather from relatively faster progress on urban roads (Fig. 2 and 3) and in **Spain** from faster progress on motorways. Partly as a result of this, Spain, Estonia, and Sweden have a higher proportion of their road deaths occurring on rural roads than in most other EU countries (Fig. 4). Yet, rural road users in **Sweden** enjoy the lowest level of risk among the EU countries collecting data on vehicle-kms (Fig. 5).

Reductions in **Sweden** were slower earlier in the decade but have gained pace in the last two years. Investments in large infrastructure schemes, in particular the upgrade to 2+1, coupled with better setting of speed limits, have started to bear fruit (see section 2.2).

In all other countries reductions have been lower-than-average. In **Romania**, road deaths on rural roads increased from 600 in 2001 to 1,015 in 2009. This increase can only be partly explained by an increase in traffic and better reporting (Fig. 5). Enforcement to counter the main risks needs to be strengthened and high risk sites removed. Even some of the newly built roads, many funded by the EU, fall well below usual rural roads standards.

1.2. Progress in reducing speed: key to success in reducing deaths on rural roads

In **France**, road deaths on rural roads were cut from 5,400 in 2001 to 2,800 in 2009. The reduction in speed has been the single most important factor in the recent French road safety success, and this has been especially marked on rural roads. Best reductions in mean speed on rural roads in Europe have been witnessed in France (Fig. 1b), where cars and vans have slowed down by more than 10km/h from 93 to 82km/h on 90km/h roads. Most of the reduction took place between 2003 and 2007, helped greatly by the introduction of a fully automated safety camera system as part of a new strategy to "end drivers' impunity". Yet deaths on rural roads still represent 65% of all road deaths in France.

[1] ETSC (2010) 4th PIN Report, Chapter 1, Fig. 1.

Mean speeds of cars and vans on rural roads have also decreased by more than 0.5%/year in **Belgium**, **Ireland,** the **Czech Republic,** and **Latvia**, and on dual carriageways in **Great Britain** (Fig. 1b).

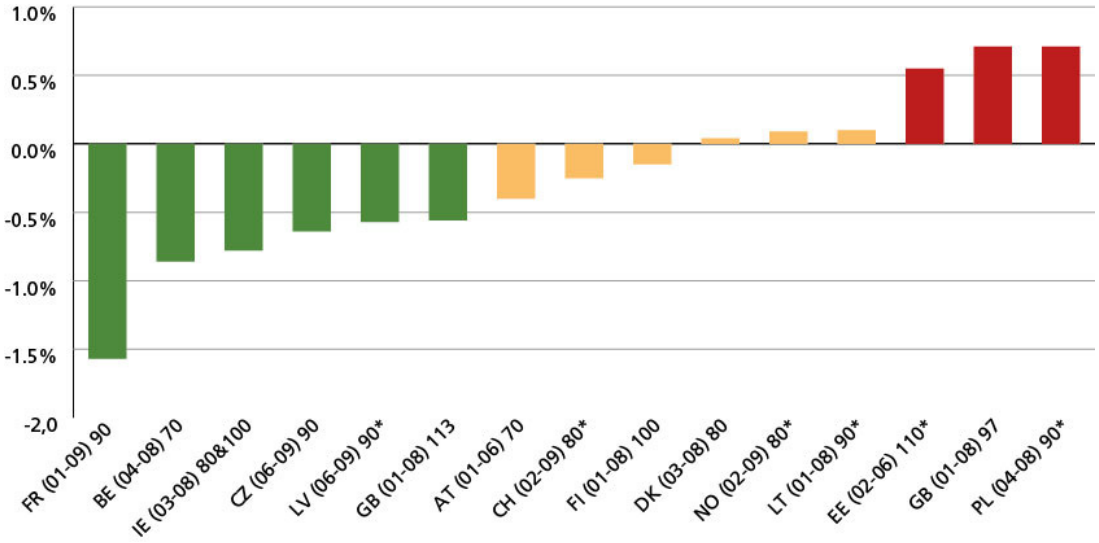


Fig. 1b: Yearly average percentage change in mean speed of cars and vans on rural roads (from earliest available baseline to latest available year)[2]. ** All traffic.*
GB 113km/h = 70miles/h (dual carriageways). GB 97km/h =60miles/h (single carriageways)

In **Poland**, **Estonia**, **Hungary** and **Slovenia**, road deaths on rural roads stagnated between 2001 and 2007, and even increased to reach a peak in 2007. In **Poland** and **Estonia**, countries that did monitor speed, mean speeds had increased over this period by 2km/h on 90km/h rural roads (Fig. 1b). In these two countries, mean speeds were above the legal limit when measurement stopped. Yet road deaths in these four countries have started to decrease in 2008 and 2009 (in 2009 only in **Poland**).

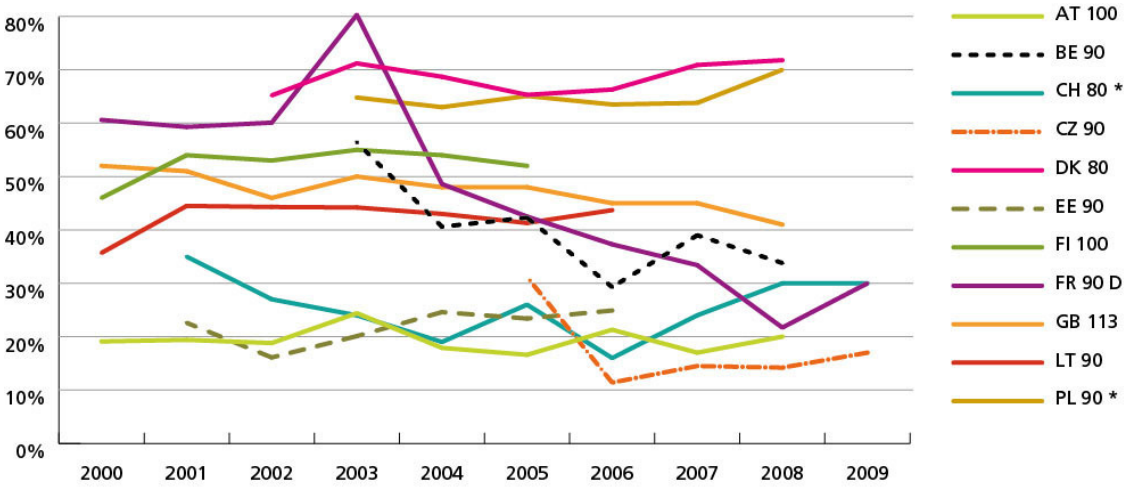


Fig. 1c: Percentages of cars and vans exceeding speed limits on rural roads. ** All traffic.*
GB 113Km/h = 70miles/h (Dual carriageways)

[2] First published in ETSC (2010), 4th Road Safety PIN Report.

In 2006, road deaths reached their lowest recorded level in the **Czech Republic**, where the percentage of cars and vans exceeding speed limits dropped following the introduction of a penalty point system and increased enforcement. Unfortunately this percentage has begun to go up again as the level of enforcement was not sustained (Fig. 1c).

Indicator box

Rural roads other than motorways are the most dangerous roads but they are difficult to compare internationally because of different definitions, the great variety of rural roads and lack of detailed data on vehicle-km travelled. Rural roads can be single or dual carriageways with one or two lanes each way, with or without median barrier, with or without side barrier, an isolated narrow mountain road limited to 70km/h or a busy four lanes bypass road limited to 110. Speed limits on rural roads vary between Member States and within Member States.[3] In most cases, the use of rural roads is not limited and the great diversity of road users travelling, riding, cycling or walking at different speeds pose serious threats to the safety of the most vulnerable ones.

To encompass the diversity of so-called 'rural roads', the terms 'outside urban areas, excluding motorways' or 'outside built-up areas excluding motorways' are being used by the scientific community. To keep it simple for our readers, we are using the most common terminology of 'rural roads'. According to CARE, deaths on rural roads are those that occurred on a road other than a motorway outside urban area boundary signs. This definition works for the majority of countries, but some, like the UK, do not have boundary signs to distinguish between urban and rural lengths of road. In the UK, the distinction is based on the boundaries of urban areas defined for planning purposes and their numbers of inhabitants, but in road safety work, roads are designated as built-up or non-built-up according to the prevailing speed limit. A road is defined as non-built-up if the speed limit is above 40miles/h, or as built-up if the speed limit is 40miles/h or lower.

This report uses as the main indicator of the safety on rural roads the annual percentage change in road deaths on rural roads since 2001 (Fig. 1). In addition, countries are compared on the difference between this change in deaths on rural roads and the corresponding change in deaths on urban roads since 2001 (Fig. 3). Austria, Estonia, Finland, Hungary, Israel, Romania, Spain, Sweden and Switzerland have estimates of vehicle-km travelled on rural roads (Fig. 5) and they use various methodologies to make the estimates. Fig. 1, 2 and 3 look at deaths among all kinds of road user taken together. The majority of killed road users on rural roads are car occupants. Powered two wheelers account for around 17% of deaths on rural roads, pedestrians for 10% and cyclists for 5% (Fig. 7). The share of vulnerable road users varies between countries (Fig. 6).

The data was retrieved from CARE when available and completed or corrected by the PIN Panellists. The full dataset is available in the Background Tables, together with national definitions as provided by Panellists on www.etsc.eu/PIN-publications.php (> PIN Flash 18).

[3] EC, Traffic rules at a glance, Standard legal speed limits, http://ec.europa.eu/transport/road_safety/observatory/doc/speed_rules.pdf

1.3 Progress on rural roads compared to urban roads

Road deaths on urban roads have decreased in all EU countries since 2001 (Fig. 2). Best reductions have been achieved by **Belgium**, **Estonia, Luxembourg, France** and **Portugal**, with annual reductions of more than 8% on average. **Sweden, Italy** and **Switzerland** follow with annual reductions over 6% on average.

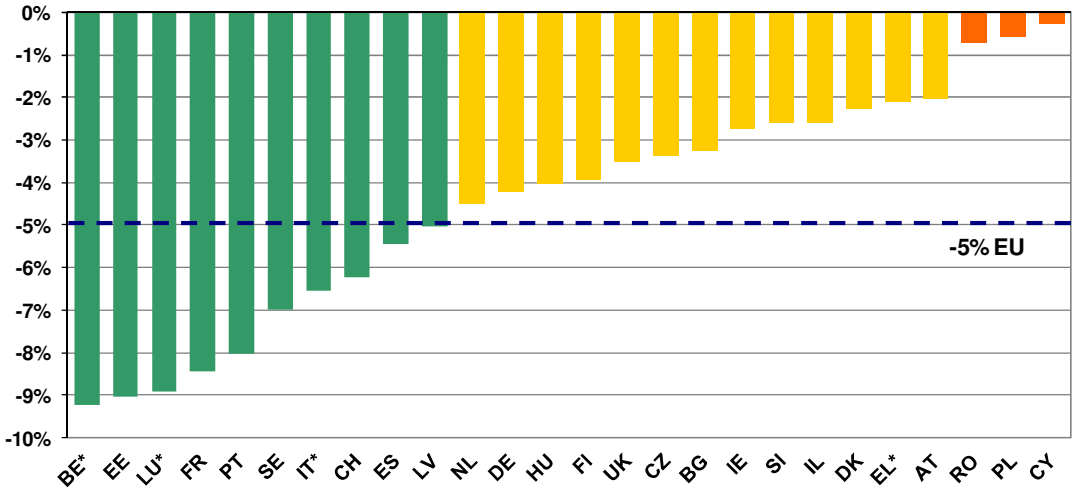


Fig. 2: Average annual percentage change in road deaths inside urban areas over the period 2001-2009.
**BE, EL, IT, LU (2001-2008). LI and SK are excluded from Fig. 2 because in Slovakia deaths on urban roads are available only from 2005 and only deaths occurring within 24h after the collisions are collected, and in Lithuania, deaths on urban roads are available only from 2006.*

Lithuania (-21%) and **Slovakia** (-10%) also achieved impressive reductions over the last few years. In **Lithuania**, road deaths on urban roads have been cut from 209 in 2006 to 89 in 2009 and in **Slovakia**, from 277 in 2005 to 136 in 2009 (24h definition).

In **Cyprus**, **Israel**, **Latvia**, **Luxembourg**, **Greece**, **Germany**, **Austria**, **Ireland** and **Portugal**, progress in reducing deaths outside urban areas exceeded by 2%/year or more progress in reducing deaths on urban areas (Fig. 3). In these countries, this extra progress on rural roads has been similar for reductions in deaths among car occupants and users of powered two-wheeled vehicles at about 3%/year on average. For pedestrians and cyclists it has been about 2%/year, and for users of goods vehicles, the extra reduction has been only about 0.6%/year.

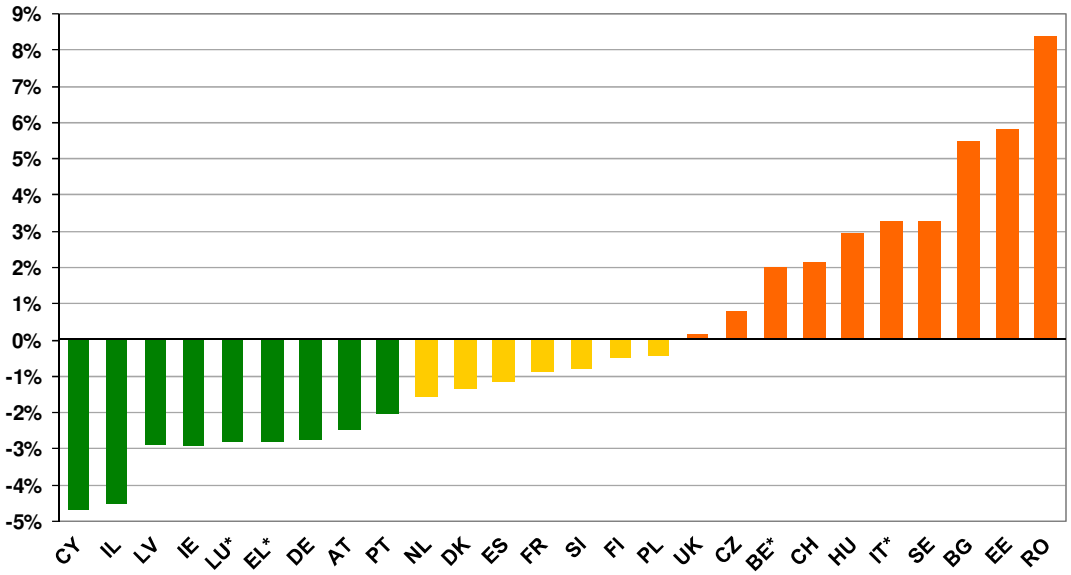


Fig. 3: Difference between the average annual percentage reduction in the number of deaths on rural roads and the corresponding reduction in number of deaths on urban roads over the period 2001-2009. **BE, CZ, EL, IE, IT, LU, UK (2001-2008)*
Note: Fig. 3 presents for each country the difference between progress on rural roads and on urban roads, regardless of the absolute levels of progress. Fig. 3 should therefore be read in conjunction with Fig. 1 and Fig. 2, and not in isolation.

In **Romania**, **Estonia**, **Sweden**, **Italy**, **Switzerland**, **Belgium**, the **UK** and the **Czech Republic**, on the contrary, progress in reducing deaths outside urban areas was slower than inside urban areas. In those countries, the reductions in car occupant deaths have been slower outside urban areas by about 3%/year on average. For pedestrians and cyclists, progress has been about 0.8%/year slower, and for users of goods vehicles about 5%/year. For users of powered two-wheeled vehicles, there has been little progress in urban areas, about 0.2%/year, whilst on rural roads the number of deaths has increased in these countries by about 1.5%/year on average.

1.4 More than 55% of all road deaths occur on rural roads

Across the EU, around **56**% of all road deaths occur on rural roads (Fig. 4). More than 70% of all deaths occur on the network outside urban areas including motorways in **Spain**, **Sweden, Finland, Austria, Ireland, Estonia, Belgium, Germany, Lithuania** and **France** and in **Finland, Ireland** and **Estonia** more than 70% occur on rural roads other than motorways. This can be partly explained by a higher share of rural roads among the different road types[4]. Only in **Romania** (and Cyprus) are more people being killed in urban areas than on rural roads, in particular pedestrians.

[4] ERF (2010), European Road Statistics 2010, p. 15. The reader should bear in mind that the definition of road types varies from country to country, thus the data are not comparable.

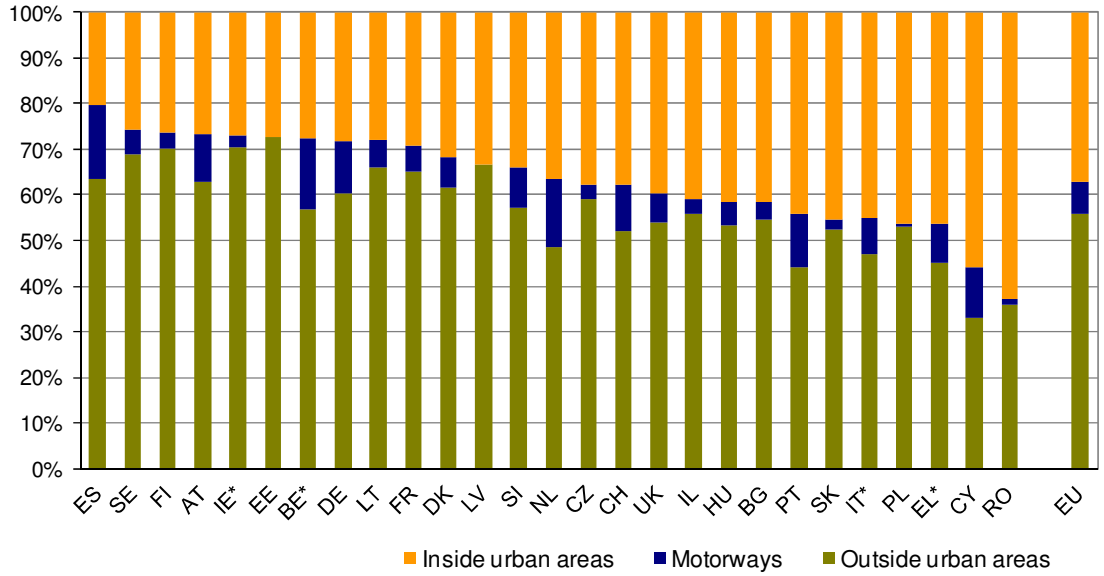


Fig. 4: Percentage share of road deaths per road type (2007-2009 average) ranked by the percentage share of road deaths on rural roads and motorways taken together.
**BE, EL, IE, IT (2001-2008). ** ES: motorways include motorways and Autovia*

A higher share of road deaths occurs on motorways in **Spain**, **Belgium** and the **Netherlands** compared to the other EU countries, and to a lesser extent also in **Germany, Portugal Austria, Switzerland, Slovenia, Cyprus, Italy** and **Greece**. For some of those countries, this can be partly explained as they have higher traffic volumes on motorways (*eg* in transit countries and countries with a longer motorway network). But for others, although there are sections where the safety quality is good, other sections fall below usual motorway standard (**Belgium**, **Italy** or **Greece**).

1.5 Deaths per vehicle-km travelled

Only few countries collect separate data on vehicle-km driven on rural roads (Fig. 5). Rural road users in **Israel**, **Sweden**, **Finland** and **Switzerland** enjoy a lower level of risk than users in other countries collecting data on vehicle-km travelled. In **Estonia** and **Israel**, deaths per billion vehicle-km were more than halved between 2001 and 2009. Yet comparison is difficult because of the differences in methods of collecting data on vehicle-km travelled on rural roads.

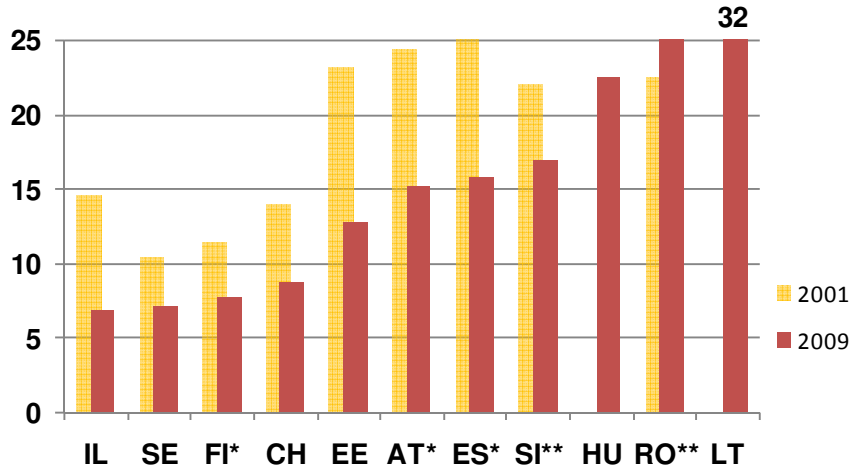


Fig. 5: Road deaths outside urban areas excluding motorways per billion km driven in 2009 (and in 2001 for comparison) for countries for which data on vehicle-km is available. **2001-2008. **2005-2009.*

1.6 There are also vulnerable road users on rural roads!

In the EU, around 32% of people killed on rural roads are vulnerable road users: 10% pedestrians, 5% cyclists and 17% riders of mopeds or motorcycles. Their share varies between countries (Fig. 6). In **Switzerland**, **Luxembourg**, **Italy**, **Slovenia**, **France**, **Austria**, the **UK, Greece, Cyprus, Germany** and **Spain**, the share of PTW deaths is higher than in other countries and can only be partly explained by a higher share of motorcyclist riders. In the **Netherlands**, and to a lesser extent also in **Belgium**, the share of cyclists is higher than in other EU countries.

Since 2001, deaths have been falling in all categories of road users, except for motorcyclists (Fig. 8).

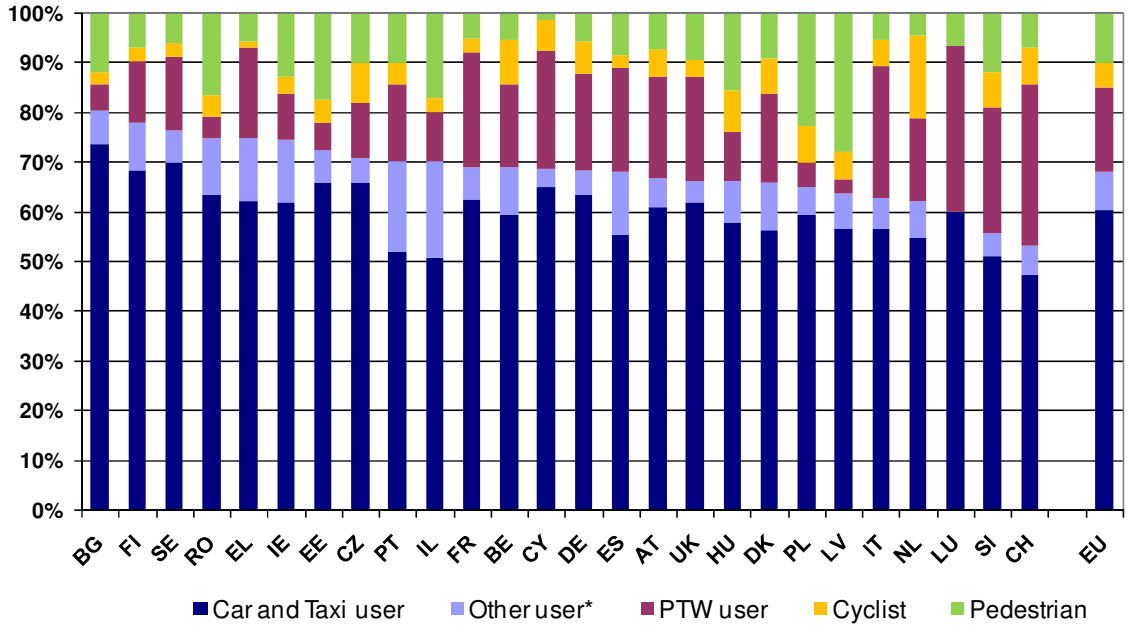


Fig. 6: Percentage share of road deaths by road user group on rural roads ranked by the percentage share of road deaths on rural roads and motorways taken together. (2007-2009 average).

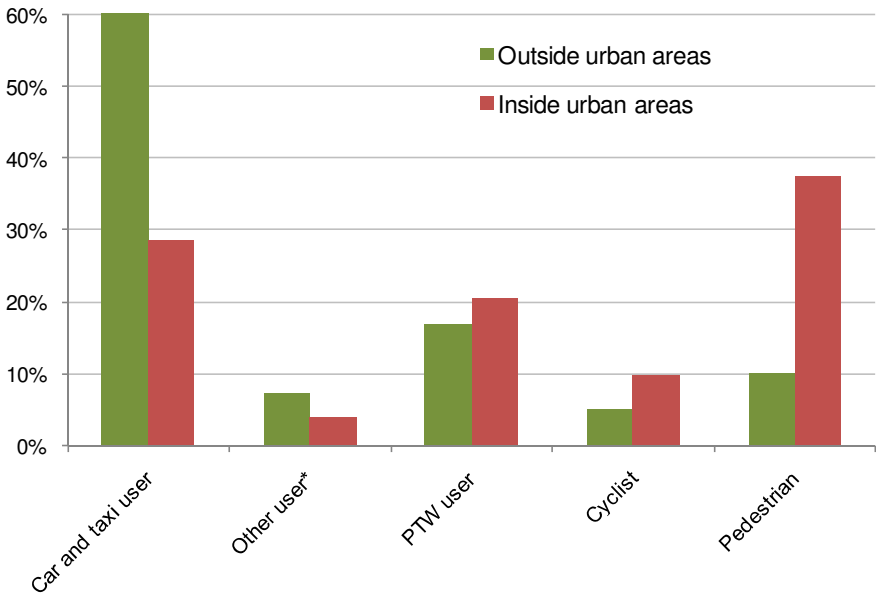


Fig. 7: Percentage share of road deaths by road user group on rural roads (with urban roads for comparison) in the EU
**Others include HGVs, lorries under 3.5t, agricultural tractors, bus and coaches, other vehicles and unknown.*

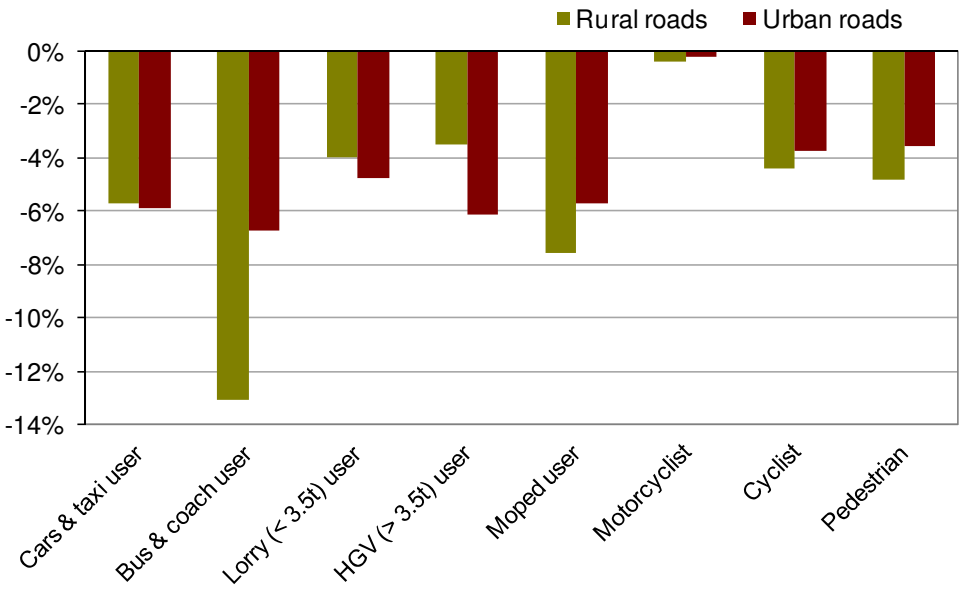


Fig. 8: Reductions in road deaths on rural roads by road user group (with urban roads for comparison) between 2001 and 2009

Part 2 | Room for improvement

Experience from the fast progressing and best performing countries show that deaths can be prevented through a combination of well-known and cost effective measures including safe road design, safe infrastructure management and increased enforcement - particularly speed enforcement. Of course, other factors such as vehicle fleet and mobility patterns play a role too, but these are harder to quantify.

2.1 Reduce illegal and inappropriate speeds

Exceeding the speed limit is widespread on rural roads. Addressing illegal speeding therefore requires a large number of non-compliers to change their behaviour. Experience shows that there is not one single measure to reduce speed. It rather takes a combination of measures including credible speed limits, enforcement and education, combined with 'self-explaining' roads and 'self-complying' vehicles.

On most rural roads in a majority of EU countries the speed limit is 90km/h or lower. In Austria, Germany, Ireland and the UK, however, the general speed limit is set 100km/h or lower. Only in Denmark is the speed limit 80km/h or lower. According to Vision Zero and the Sustainable Safety approach, the speed limits should be determined by the road characteristics so that the forces in collisions do not exceed the level that the human body can tolerate. The speed limit should not exceed 70km/h on roads without median barrier and 100km/h on roads with median and side barriers[5].

[5] Wegman, F.; Aarts, L. (2006), Advancing sustainable safety, National Road Safety Outlook for 2005-2020. Based on Tingvall, C., Haworth, N (1999) Vision Zero, An ethical approach to safety and mobility.

In approving Swedish Transport Administration's recommendations in 2007 for a new speed limit classification, the Government of **Sweden** has stated recently that road safety needs to be at the core of decisions on the setting of speed limits. The new speed limits (limits in 10 incremental bands in the range 30km/h – 120km/h) are set to match the road design.

> "*We are currently running a campaign addressing speeding on rural roads in Denmark. The campaign has been informed by new results from a survey in which 6 out of 10 people living along rural roads said that they feel insecure because of speeding and 9 out of 10 said they are bothered by speeding"*. Jesper Sølund, Danish Road Safety Council

Unfortunately, enforcement levels in most EU countries are low on rural roads partly because of the extent of the network and low traffic density. The perception by the drivers of the subjective risk of being caught – in particular speeding – needs to be increased on rural roads by increased police enforcement and a combination of fixed and mobile safety cameras as recommended by the 2004 EC Recommendation on enforcement of traffic laws.

Applying the "Power Model" to current numbers of deaths indicates that **if every driver slowed down by only 1km/h, more than 1,000 road deaths per year could be prevented on rural roads** (1,100 on urban roads and 100 on motorways).

ETSC (2010), 4th Road Safety PIN Report, Chapter 3, p. 50.

2.2 Better infrastructure safety management

Present road designs result from many decades of construction and maintenance in times when safety issues were not considered to the same extent. Today, road features on many roads no longer meet the latest safety requirements. Moreover, traffic conditions may have changed since the road was designed and built. Knowledge about safe design and effective risk management are not fully applied even in the best performing countries.

Against this background, the EU adopted a **Directive on road infrastructure safety management**. The Directive requires Member States to apply the following four instruments on the Trans-European Road Network (TERN) by December 2010:

- Road safety impact assessments: demonstrate the road safety implications of different planning alternatives for a road project, whether construction of new infrastructure or rehabilitation of existing infrastructure, as in the case of environmental impact assessment
- Road safety audits: an independent technical check aiming at identifying unsafe features of a road project, including proposals for remedy
- Network safety management targeting remedial measures to parts of the network with high concentrations of accidents (high-risk road sections) and/or a high potential to avoid accidents in the future.
- Safety inspections: as part of regular road maintenance, enable the detection and hence reduction of accident risk in a preventive way through low cost measures.

These procedures already exist and are applied to varying degrees in some Member States. The aim of this Directive is therefore to extend the above-mentioned measures to

the whole of the EU, leaving the Member States free to keep already existing procedures if they have them in place or to introduce procedures in their own way if not[6].

The EU project ROSEBUD estimated that the application of the four procedures to the Trans-European roads would reduce the number of deaths by more than 600 and injuries by 7,000 every year. ROSEBUD also estimated that 700 additional lives per year could be saved if the safety management was also applied to what the project called 'main' roads.

A new step has recently been that the European Commission has committed to make sure that European funds will only be granted to infrastructure compliant with the road safety and tunnel safety Directives[7]. Every year between 1.5 and 2 billion EUR of EU funds are spent on building roads in the EU, it is the EU's duty to ensure that these roads are built safely. The Commission also promised to explore the extension of this principle to external aid.

The **UK** has a long experience with road safety audits. They have been compulsory since 1991 for all new national roads and improvements on existing ones. The British Road Safety Foundation is running annual surveys of the GB road network on behalf of EuroRAP, the largest analysis of its type anywhere in the world, covering 28,000 miles. Topping the list of the UK's 10 most improved roads is the A40 Llandovery-Carmarthen, where junctions have been upgraded, new road markings introduced and extensive resurfacing carried out, including anti-skid treatments, saving 20 fatal and serious collisions between 2006 and 2008[8].

Cost-effective approach to infrastructure safety management

A methodology known as Network Safety Management (NSM) has been developed jointly by the Federal Highway Research Institute (BAST) in Germany and the Technical Department for Transport, Road and Bridge Engineering and Road Safety of the French Ministry for Ecology (SETRA). NSM is a tool for road administrators to help them in identifying road sections to be treated with high priority. In NSM, the key parameter to assess the safety performance of road sections is the so-called safety potential. The safety potential describes the potential savings in accident costs that could be reached by remedial measures. It is defined as the amount by which accident costs per km length of road would be reduced if a road section had a best practice design.

The advantage of the safety potential compared to the classic accident parameters is that it allows different road types and roads with different traffic volumes to be assessed at the same time. Furthermore, as the safety potential is given in terms of accident cost, it can be related to the cost of the improvement measures. Since resources are limited, those sections where improvements can be expected to have the highest benefit-cost ratio have to be treated first[9].

[6] Directive 2008/96/EC of 19 November 2008 on road infrastructure safety management http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0096:EN:NOT
[7] European Commission, Policy Orientations on road safety 2011-2020, Objective 3, p. 7.
[8] http://www.eurorap.org/gb2010
[9] Ganneau F. and Lemke K., Network Safety Management – From case study to application, http://www.setra.equipement.gouv.fr/IMG/pdf/ip304-e.pdf

Safe design of roads in the Dutch Sustainable Safety Vision

A fine example of the principles governing safe infrastructure design can be found in the Dutch 'Sustainable Safety' approach, according to which a road network should integrate these core principles:

- Functionality

A sustainably safe road network has a functional layout, based on three main road types. 'Through' roads for dispersion of traffic, 'access' roads for access to final destinations, and 'distributor' roads for a good link between these types.

- Homogeneity

Wherever possible, roads should ensure the homogeneity in mass, speed, and direction of vehicles. Vehicles with large differences in mass, speed, and direction must be physically separated from each other. Opposing traffic should be separated by middle barrier and vulnerable road users should have separate paths. When physical separation is not possible, for example at junctions at grade level, the speed must be reduced and infrastructure adapted (e.g. by use of roundabouts or raised junctions).

- Recognisability or 'self explaining' roads



Road users should know which driving behaviour is expected from them and what they can expect from others. People need to recognise the road type and drive accordingly, in particular at the appropriate speed. This must apply to the whole road network which should also be predictable, as should others' driving behaviour.

® Wegman, F.; Aarts, L. (2006).
Example of a gate construction entrance to a rural access road.

- Forgivingness

Road design should be such that any collision will end with as little injury as possible. A vehicle that goes off the road should not hit any rigid obstacles or other fixed objects. Forgivingness in Sustainable Safety also has a social meaning. The more experienced drivers should offer room to the less experienced drivers by displaying anticipatory behaviour. This prevents mistakes by the inexperienced being 'punished' by a collision.[10]

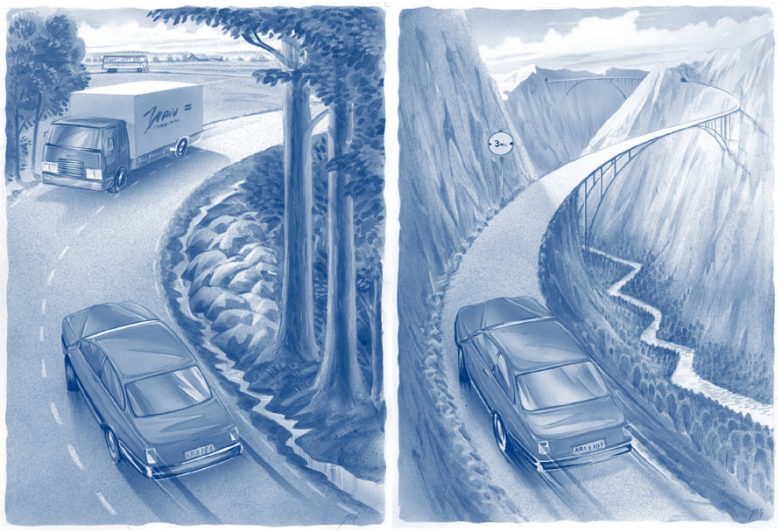
In **Germany**, from 2011 onwards, new guidelines will apply for rural road design promoting the concept of "self-explaining roads". Roads will be designed or re-designed in such a way that the user knows how to behave and which speed limit is appropriate[11].

[10] Wegman, F.; Aarts, L. (2006).
[11] These guidelines have been developed by the German Research Association for Road Transport and Traffic issues, www.fgsv.de/landstrassen.html

The experience of '2+1 roads' in Sweden

Sweden has pioneered new safe designs for roads which are not motorways and has committed to upgrade safety equipment on all significant single carriageways by 2025. Since 1998, there has been a large programme of installation of median cable barriers to address the problem of fatal head-on collisions. When possible, the traditional 13 meter wide roads were converted into so called '2+1 roads'. A 2+1 road consists of two lanes in one direction of travel and one lane in the opposite direction. The two-lane section, which provides a safe overtaking zone, alternates with a one-lane section at intervals of 2km approximately. Vehicles travelling in opposite directions are separated by a safety barrier system, which prevents overtaking manoeuvres on the one-lane section[12]. This provides the model for all countries where traffic is too light to upgrade major routes to motorway. 4200km of road have now separated traffic flow (covering around 40 % of traffic flow on national roads (mainly rural), 2140km of which are on 2+1 roads. 2+1 roads have been implemented in other countries, such as Germany, with great success. In addition, speed limits have been reduced on almost 18,000km of rural road.

Carlsson's evaluation study (2009) showed impressive reductions in deaths of up to 76 % following the upgrade to 2+1 roads.[13] The risk of being killed per vehicle-km travelled on '2+1 roads' is about the same that on motorways limited to 110km/h. Carlsson's study also showed that, in contrast to what motorcyclists feared, there was no increase in collisions involving motorcyclists. On the contrary, the risk of death per vehicle-km travelled for motorcyclists decreased, in part because median barriers prevented motorcyclists from colliding with opposing traffic. The Swedish Transport Administration strategic plan for 2008-2017 indicates that this work is set to continue.



Left, driving on a single carriageway road with oncoming traffic.
Right, a similarly dangerous activity. *® Lie, 2003.*

In 2004, **Sweden** was the first country to begin the classification of roads according to the EuroRAP rating score. To date, more than 10,000km of the existing rural road network has been assessed by EuroRAP. Of the assessed roads, 31% meet the four-star rating, which corresponds to a safe road. Updating and monitoring of the status of the evaluated roads is underway. Centrelines rumble strips to provide a warning to drivers when they are inadvertently crossing the road centreline is to be implemented as a standard for the non-divided part of the rural network.

[12] Breen, J.et al. (2008), An independent review of road safety in Sweden.
[13] Carlsson, A. (2009) Evaluation of 2+1 roads with cable barrier. VTI Report 636 A.
English summary available www.vti.se/templates/Report 2797.aspx?reportid=10916

SUPREME best practices on infrastructure safety

Rumble strips milled into the asphalt surface of a road shoulder or between lanes in opposite directions was promoted as one of the best practice measures in infrastructure safety by the EU funded project SUPREME. Research from different countries has shown that the number of injury crashes can be reduced by over 30% by shoulder rumble strips and by over 10% by centreline rumble strips.

Other practices relevant for rural roads were identified by the SUPREME project as:
- "Best practices": winter speed limits and winter maintenance, road safety audits, road safety inspections and roundabouts,
- "Good practices": High risk site management, Variable message signs and the hierarchical mono-functional road network in the Netherlands
- "Promising practices" measures: measures against tree collisions in France[14].

http://ec.europa.eu/transport/road_safety/pdf/projects/supreme.pdf

EuroRAP

EuroRAP was created following the success of EuroNCAP in raising the safety standard of the typical new car from two to five stars. EuroRAP has been able to bring together all the stakeholders– motoring and touring clubs, road authorities and manufacturers - and create a common international system to measure the safety of roads independent of national or proprietary standards. EuroRAP provides three protocols that can be applied to any country:

- Risk Rate Mapping: the numbers of killed and seriously injured road users per billion vehicle-km are shown on a colour-coded road map.
- Performance Tracking: Identifies whether fewer people are being killed or seriously injured on a road over time and identifies the countermeasures that are most effective.
- Road Protection Scores (RPS): assesses how much or how little protection a road environment will provide for the occupants of a car in the event of a crash. On the basis of this score, each road is given a star rating varying from 1 to 4, with 4-star representing a road which is engineered to minimise the likelihood of a crash resulting in a fatal injury to car occupants. RPS provides information that is not readily available through accidents histories. Accidents are always random and accident rates subject to statistical fluctuation. Over time as accident numbers decrease, identification of higher risk sites through variations in observed accident numbers will become more difficult. The RPS aims to provide a consistent assessment of the potential long term risk of a given road design.

EuroRAP latest report maps safety on Trans-European Roads and provides a first comprehensive safety analysis of EU Trans-European road network[15]. It shows that,

[14] Many other reports could be quoted as references, among them: Oxley J. et al (2003) Cost-effective infrastructure measures on rural roads, Monash University Accident Research Centre and Elvik et al. (2009), The handbook of road safety measures, 2nd edition.
[15] EuroRAP's report (2010), How Safe are you on Europe's Trade Routes? Measuring and mapping the safety of the TEN-T road network. The report is based on a sample which covers around half of the entire TEN-T road network spread across 15 countries in the EU and immediate neighbours. http://www.eurorap.org/news_item?search=y&ID=360.

among the network surveyed, 15% of TEN-T road network has unacceptably high safety risk and that just 31% of the network are 4-star roads. Of the 15 countries analysed in depth, Sweden, Netherlands, Great Britain and Switzerland top the league when it comes to achieving 'best possible' safety levels on the TEN-T network. Even in those countries, some sections are overdue for treatment.

The most remarkable country in the survey is **Slovenia** with its newly engineered network which is now outperforming most others. Nearly half is awarded best possible rating, but away from the new TEN-T motorway network, road risk rates are commonly ten times higher. The **Czech Republic** is making some progress and getting close to Belgium in performance with 15% at best possible levels. Poland and Slovakia have major challenges: only 5% or less of the networks achieved best possible rating and their networks contained the most sections with high risk ratings.

> *"Some road engineers, like some vehicle engineers before EuroNCAP hit its stride, are not getting enough support to apply what they know from research should be done. Crashes and their severity can be cut drastically by applying known road engineering measures at relatively little cost. And we need them on a grand scale where their benefits multiply - a 'big fix' to make our roads safe. This 'mass action' approach would initially aim to fix the safety performance of high-risk, single carriageway roads on which large numbers are dying*". John Dawson, Chairman of EuroRAP

ETSC recommendations to Member States and local authorities

- Implement the Infrastructure Safety Directive on all roads.
- Investigate all fatal and serious injury collisions and implement best practices in high-risk site management.
- Improve infrastructure safety on the whole network, applying the concepts of "self-explaining roads" and "forgiving roadsides".
- Undertake systematic and periodic road safety inspections for the detection of high risk sites. Complete EuroRAP or Network Safety Management assessment of rural network and review findings regularly for action.
- When possible, separate traffic in opposite directions by a median barrier and install side barriers. If there is a need for cycle and pedestrian facilities, separate paths along the roadway are recommended.
- When possible, build safe overtaking areas for two lane roads (following the concept of 2+1 roads as in Sweden and other countries).
- Replace dangerous intersections by roundabouts. Other intersections with or without traffic signals should provide protection for vehicles turning across the path of opposing traffic.
- Match road and vehicle design standards to safe speed limits.
- Increase enforcement of traffic law, in particular enforcement of speed limit, with fixed and mobile safety cameras, drink driving and seat belt use.
- Develop digital mapping for Intelligent Speed Assistance systems and promote their market penetration.
- Improve accident data collection by the implementation of GPS based reports and ID numbers.

ETSC recommendations to the EC

- Support the implementation by all Member States of the Infrastructure Safety Directive principles to all roads.
- Make sure that the principle of conditionality of EU funds for road safety is guaranteed by all DGs and EU Agencies (TEN-T Agency, DG REGIO). Extend this principle to EU external aid.
- Draw up technical guidelines concerning the harmonised management of high risk sites by means of low cost measures.
- Draft guidelines and promote their implementation by Member States on best practice in traffic calming measures.
- Publish Member States' reports foreseen in the Infrastructure Safety Directive.
- Invest in high quality infrastructure features such as road markings and road signs to enable Advanced Driver Assistance Systems such as Lane Departure Warning to work in proper synergy.

Recommendations to navigation systems providers

- Offer the possibility to use safe routes as a selection criterion (using for example EuroRAP star rating information).

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