Road Safety and Road Restraint Systems

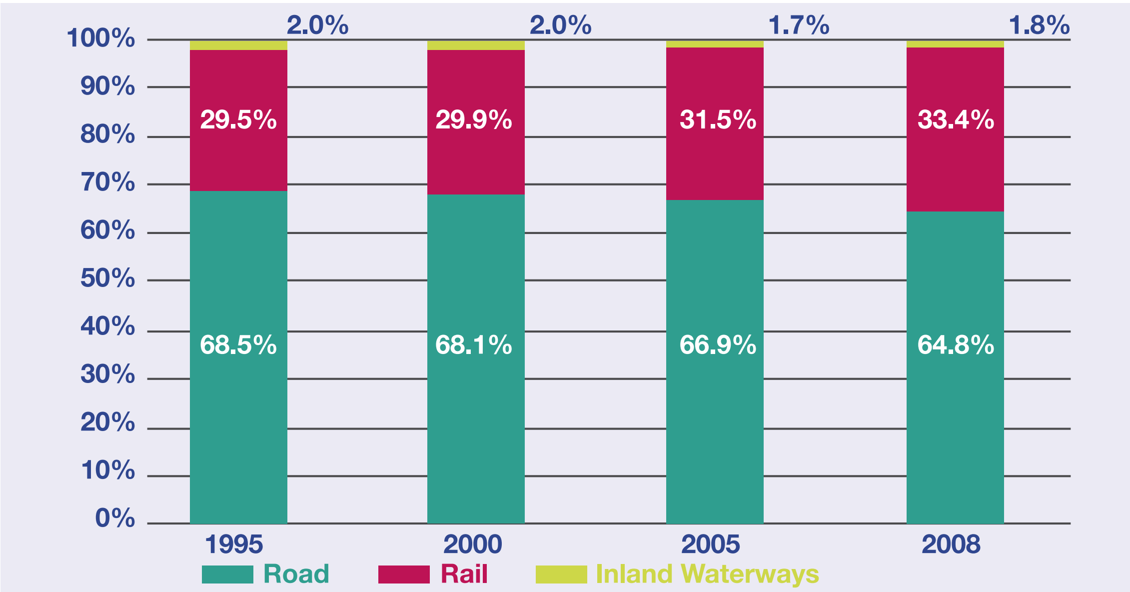
A flexible and cost-effective solution

Contents

1. Road Safety – The essential role of the infrastructure

Increasing road safety requires acting on the three pillars of the road safety triangle, i.e. the driver, the vehicle and the infrastructure

The ERF believes that, in recent years, the efforts in road safety have increasingly focussed on the vehicle and the driver, often neglecting the role of the infrastructure. Thus, while significant resources have been devoted to developing new vehicle technologies and enforcement campaigns, investment and resources for road infrastructure have steadily dwindled over the years. According to the International Transport Forum, investment in infrastructure for many Western European Countries[1], reached an all time low in 2007, a trend which most likely has not improved since the outbreak of the economic crisis in 2008 [2]. In addition to this overall decrease, road infrastructure has seen its percentage modal share decrease vis-à-vis the railways despite the fact that road remains by far the dominant mode for both commercial freight and passenger transport [3].



Transport infrastructure investment modal split in Western European Countries - Source: ITF

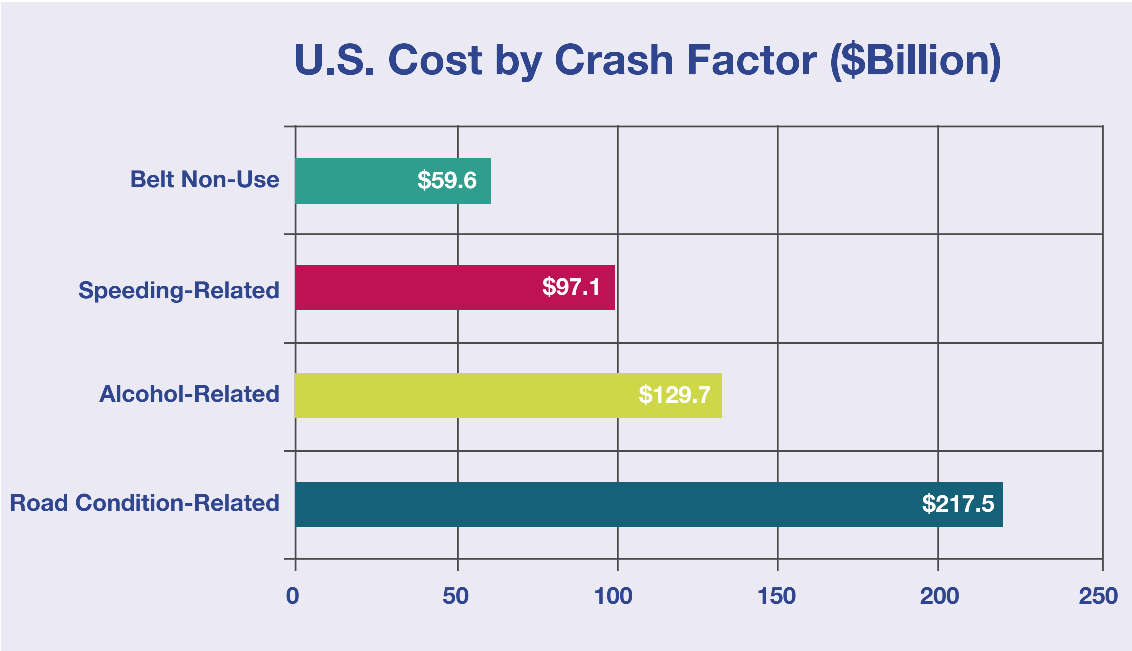
While acting on the driver and on the vehicle surely has its role to play, the ERF believes that investing in road infrastructure can offer fast and cost-effective solutions that can reduce fatalities and related health care costs.

1 Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Spain, Sweden, United Kingdom
2 Investment in transport infrastructure 1995-2007, Summary of aggregate trends
http://www.internationaltransportforum.org/statistics/investment/Overview.pdf
3 In 2009, road accounted for 83.7% of total passenger transport and 73.8% of inland freight transport: Source: EU Transport in Figures: Statistical Pocket 2011, European Commission

In the Netherlands, the Institute for Road Safety Research (SWOV) produced a report entitled 'The Balance Struck: Sustainable Safety in the Netherlands 1998-2007', that evaluated the national road safety programme's success. During this period, the number of accidents decreased in total by 30%, decreasing, in total numbers, from 1149 to 791 and resulting in more than 1700 lives saved as result of the new measures. This reduction was achieved by an annual investment of approximately € 530 M spent for road safety measures, € 350 M of which on road infrastructure. Assessing the cost-benefit ratio of measures, the report concludes that measures were socially cost-effective, assessing the cost-benefit ratio at 4:1[4].

If investing on road infrastructure measures is a cost-effective solution for improving road safety and saving lives, then, it can be naturally assumed that failing to do so can have major consequences, not only in terms of lives, but also in terms of the cost of accidents, which are significant.

According to a study recently published in the USA by the Pacific Institute of Research and Evaluation entitled 'On a crash course: dangers and healthcare costs and deficient roadway conditions', more than half of U.S. highway fatalities are related to deficient roadway conditions – a substantially more lethal factor than drunk driving, speeding or non-use of safety belts. Furthermore, the study concluded that the cost of deficient roadway conditions was significantly higher than the costs of other safety factors.



4 "De balans opgemaakt: Duurzaam Veilig 1998-2007" (The balance struck: sustainable Safety in the Netherlands 1998-2007), SWOV, 2009 http://www.swov.nl/rapport/Balans_10_jaar_DV.pdf

2. Road Restraint Systems – A cost-effective solution

Road Restraint Systems are an essential component of a modern road infrastructure and constitute one of the most important life-saving devices available to public authorities and road operators. They represent an immediately available solution that can, in addition to saving lives, significantly reduce the accident related health care cost.

Road restraint systems can be also considered as the most "flexible safety device" possible: they are designed to withstand a crash from different kind of vehicles in different conditions: according to their containment level, they are tested both for a small city car or a large family car; small to heavy truck or coach, with the possibility to equip it with a motorcyclist protection system (MPS) to further extend this protection to a particularly affected class of vulnerable road users.

An example of the effectiveness of those solutions is the analysis carried out by the German Land of Hesse: the erection of a median and a road side barrier in two identified 'black spots' in its road network resulted in a decrease in accidents with injuries by 65% and 91% respectively, while, at the same time, reducing the annual accident costs by 70% and 88%, thus leading to a global yearly saving of € 1.214.000[5].

5 The calculation methodology can be found in Annex 1 on page 17

Effectiveness Analysis

Installation of a median barrier on B 49

Place:	Braunfels/Lahn-Dill-Kreis	
Project Management:	Amt für Straßen-und Verkehrswesen Dillenburg	
Problem:	Heavy accidents due to driving faults and overtaking	
Solution:	Installation of a median barrier	
Realisation:	1996	
Result:	Reduction of accidents with injuries by 65%	

Evaluation relating to national economy (in euro):

Accidents Costs $_{before}$: 518.000

Accidents Costs $_{after}$: 153.000

Constant 2000 Price Level

Road Safety and Road Restraint Systems - A flexible and cost-effective solution

Effectiveness Analysis

Installation of a median barrier on B 49

Location within the road network

Situation after Installation

Effectiveness Analysis

Installation of a crash barrier on L 3140

Place:	BSchiltz/Vogelberg-kreis	
Project Management:	Amt für Straßen- und Verkehrswesen Schotten	

Problem:	High frequency of tree impacts
Solution:	Installation of a crash barrier on road edge
Realisation:	2001
Result:	Reduction of accidents with injuries by 91%

Evaluation rela ting to national economy (in euro):

Accidents Costs $_{\text{before}}$: 969.000

Accidents Costs $_{\text{after}}$: 120.000

Constant 2000 Price Level

Effectiveness Analysis

Installation of a crash barrier on L 3140

Location within the road network

Situation after Installation

Further evidence of the effectiveness of road restraint systems in reducing accidents can be found in the 2009 Annual Road Safety Report in France published by the 'National Inter-Ministerial Observatory on Road Safety'. According to the data available in the report, the existence of protective barriers on road can reduce fatalities up to a factor of 4 when compared to collisions against other road obstacles[6]. Actually, the presence of a road restraint system appears to offer the highest level of protection compared to accidents against obstacles in non–urban environments.

ACCIDENT AGAINST FIXED OBSTACLES

Mainland France	Vehicles involved		Persons Killed		Gravity (fatalities/ 100 vehicles involved)
	Number	%	Number	%	
Barriers	2811	17,9	185	11	6,6
Trees	1830	11,6	513	30,4	28
Walls, bridge piers, parapets	1533	9,7	212	12,6	13,8
Parapets	142	0,9	18	1,1	12,7
Posts	1302	8,3	202	12	15,5
Ditches, slopes, rocky road sides	2249	14,3	316	18,7	14,1
Signs – street furniture	740	4,7	52	3,1	7
Urban obstacles (calming islands, stationed vehicles, other obstacles on the road side or pavement)	5156	32,9	208	12,2	4
Totality of fixed obstacles	15721	1000	1688	100	10,7

6 "La sécurité routière en France: Bilan de l'année 2009", Observatoire National Interministériel de Sécurité Routière. Figures as published in the report
http://www2.securiteroutiere.gouv.fr/ressources/bilan/2009/sources/index.htm

3. Road Safety, Road Restraint Systems and the EN 1317

In a single market where goods and people flow freely, standardisation can often play an important role in improving safety standards. The case of road restraint systems is no exception.

The European Norm 1317 for Road Restraint Systems was created in 1998 and lays down common requirements for the testing and certification of road restraint systems in all countries of the CEN, i.e. the 27 Member States of the European Union as well as Croatia, Iceland, Norway, Switzerland and Turkey.

As of 1 January 2011, all Road Restraint Systems sold within the EU need to be certified with a CE Marking[7]. This is an obligation stemming from provisions of the European Constructions Products Regulation (305/2011/EU-CPD) as stipulated in Annex ZA of EN 1317-5. The entry into force of the Regulation puts an end to the three year transition period during which the EN 1317 and respective national norms co-existed.

The introduction of EN 1317 represents a significant change in terms of safety and quality for European drivers insofar that it establishes an EU market based on performance, replacing previous 'prescriptive based systems based on empirical experience'. In practical terms, this means first, that new barriers placed on European roads can offer guaranteed levels of safety and secondly, that the level of guarantee is the same across the whole of the EU, i.e. a single market for safety barriers.


7 Some countries, e.g. the United Kingdom have a derogation until 2013

4. Road Restraint Systems - Challenges Ahead

a) National Containment Levels across the Trans-European Network

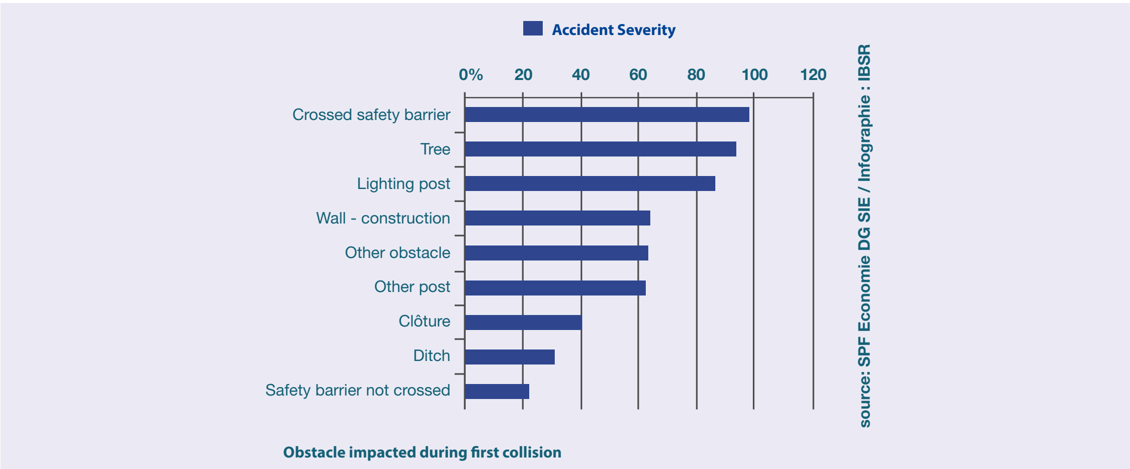
While the EN 1317 for Road Restraint Systems guarantees common testing methods for road restraint systems across EU Member States, it is up to national governments to decide the level of protection on their road network. As a result, European drivers are confronted with varying levels of road restraint systems protection on the European motorway network despite the fact that speed limits and driving conditions are very similar.

Research with the ERF Working Group on Road Restraint Systems has revealed striking differences between countries. The following tables provide a brief graphical representation of the different containment levels as well as an overview of the situation in selected European countries[8].

Taking into account that certain sections of the TEN-T serve as major freight corridors for goods in Europe and thus, have a high frequency of Heavy Good Vehicles (HGV) weighing up to 44 tonnes, the current containment levels chosen by national administrations are clearly insufficient to protect against a serious accident involving such a vehicle.

While such accidents are fortunately rare, they tend nevertheless to be extremely severe when they do happen. Such an accident occurred in Italy, on the A4 motorway (Milan to Venice) at the Cessalto's exit, when a HGV vehicle ran off and smashed through the median barrier, ending up in the opposite traffic lane and resulting in 7 deaths.

Actually, research from the Road Safety Observatory in Belgium concluded that the severity of accidents involving a 'crossed' barrier on motorways is actually higher than a run-off accident against a tree and 5 times higher compared to incidents where the barrier has managed to contain the vehicle[9].



The ERF calls on the European Commission and the public authorities in the Member States to examine this issue and declares itself ready to act as a dialogue partner should they wish to consider some level of harmonisation at European level.

8 This work has been carried out by ERF Secretariat and the members of the Road Restraints Systems Working Group. Given the extreme complexity of the European Norms, the values should be seen as approximate.
9 "Statistiques de sécurité routière 2008", Observatoire pour la sécurité routière, p.109
http://bivvweb.ipower.be/Observ/FR/Statistiques%20de%20securite%20routiere%202008_FR.pdf

Table 1:

Containment Level :
European Standard EN 1317

Defining Containment Levels

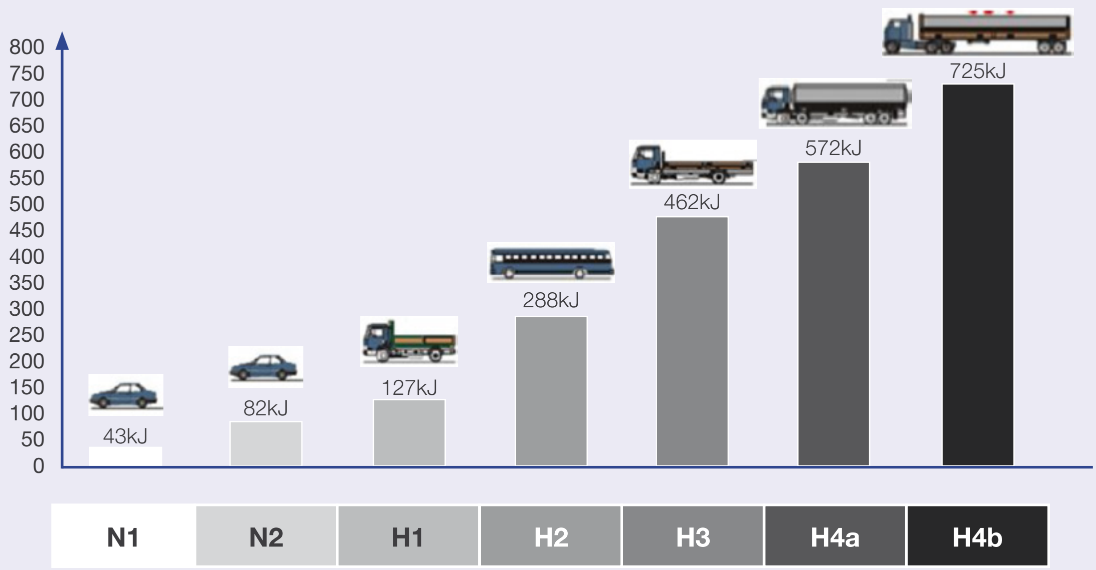
N1	*N2*	*H1*	*H2*	*H3*	*H4b*

1.500 kg	*1.500 kg*	*10. 000 kg*	*16. 000 kg*	*13. 000 kg*	*38. 000 kg*
80 km/h	*110 km/h*	*70 km/h*	*80 km/h*	*70 km/h*	*65 km/h*

→ *Higher class barrier = Higher impact energy*

Table 2:

The norm EN 1317:
Containment Level



Normal Level **High Level** **Very High Level**

Table 3:

Situation in the EU countries :
*Minimum legal requirements on motorways**

	Side Barrier	Central Barrier	Bridge Barrier
Austria	H2	H3	H3
Belgium	H2	H2	H4b
Bulgaria	H1	H2	H1
Czech Republic	H1	H2	H1
Denmark	H1	H2	H3
Finland	N2	N2	H2
France	N2	H1	H2
Germany	H1	H2	H1
Ireland	N2	H2	H2
Italy	H2	H3	H4b
Holland	H2	H2	H2
Norway	N2	H2	H2
Poland	H1	H2	H1
Spain	N2	H1	H3
United Kingdom	N2	H1	H1

* Updated version 23 March 2012

b) Motorcycle Protection System

As for cars, roadside obstacles represent a high danger for motorcycles as well: an impact against a tree, or a fall from a cliff, is dangerous for the 4-wheel vehicle as well as for the 2-wheel ones. Additionally, standard road restraint systems are designed to redirect cars and trucks and thus, are not designed to prevent the impact of motorcyclists against obstacles. On the contrary, they represent an obstacle in themselves.

For more than 20 years, road restraint systems manufacturers have invested and carried out research and development on dedicated products in order to increase the safety also of motorcyclists, and since 2008, CEN (European Committee for Standardization) and its members have been working on the development of a European standard for the testing of those products, which has now been approved as a Technical Specification (TS 1317) and will be published in early 2012.

While motorcycle riders often advocate the removal of standard safety barriers, the fact is that such a decision would increase the risk of serious collisions for all users, given that their drivers would be unprotected against roadside obstacles. In the view of the ERF, the use of high protection (HIC<650) TS 1317 - part 8 tested products would be the best solution to guarantee a higher motorcyclist safety, and to maintain the existing safety level for 4 wheel vehicles.

c) Acting on the secondary network

While placing better performing barriers on Europe's motorways can undoubtedly improve driver safety, the potential safety gains by acting on Europe's rural roads can be said to be substantial given that 56% of Europe's fatalities occur on rural roads compared to only 6% on motorways, which can be attributed also to the existence of guard rails.

As the previous examples of 'black spot management' have demonstrated, placing barriers on secondary/rural roads can have impressive results at a relatively low cost. These findings are also supported by the European Road Assessment Programme, which found that a median barrier on a rural road can help reduce the kinetic energy of a run-off crash, thus decreasing the risk factor by approximately a factor of 3[10].



10 "Star rating roads for safety – The Eurorap methodology" pp 14-15, Eurorap,
http://www.eurorap.org/library/pdfs/20091201_StarRatingMethodology.pdf

Table 4: Car occupant risk and protection from death or serious injury on a rural road

Safety barriers help reduce the kinetic energy of a run-off road crash for car occupants (risk factor = 1.75)

Steep embankments represent a severe roadside hazard for car occupants involved in a run-off road crash (risk factor = 5.00)

The ERF believes that, at a time of economic constraint, acting on passive safety solutions that are already available can represent one of the most cost-effective solutions for public authorities and citizens alike. In this respect, it welcomes the European Parliament's Transport Committee's Report on European Road Safety Programme 2011-2020 and the paragraph 26, which 'calls on the Member States to take prompt action (including replacing the existing guard rails) to refit dangerous stretches of road with rails with upper and lower elements as well as with other alternative road barrier systems, in accordance with Standard EN 1317, in order to lessen the repercussions of accidents for all road users'.

Annex 1 - Methodology for Calculating Accidents[11]

Accident costs represent the avoidable economic losses from road traffic accidents. They estimate the costs that could have been avoided if accidents had not happened, i.e, if there was no damage and no deaths or injuries. Here, resource-failure cost (reduction or loss of work force) as well are taken into account as direct and indirect costs of reproduction such as medical rehabilitation or administrative costs of the police. Damages take into account the direct and indirect cost of repair and the administrative costs of the corresponding institutes (police, ambulance, road authority etc. including overhead costs).

The Accident Costs summarise the number and severity of accidents and allow comparisons of traffic safety at different spots. The calculation is done using accident cost rates, which are dependent on the categories of accidents and that of roads.

Standard Accident Cost Rates (2000 price level in euro)

Accident Category		Road Category	
		Highways	Rural Road
1	Accident with heavy personal damage	300.000	270.000
2	Accident with slight personal damage	31.000	18.000
3	Accident with personal damage	105.000	110.000
4	Accident with heavy property damage	18.500	13.000
5	Accident with slight property damage	8.000	6.000
6	Accident with property damage	10.500	7.000

The Accident Categories represent the different statistics available in Germany and are not to be understood as an order (eg. Category 3 contains also C1 and C2 accidents).

The Standard Accident Cost Rates are lump-sums, determined based on the average nationwide casualty structure and the estimated absolute costs for personal and property damages.

The absolute costs for injuries are estimated as follows (in euro)

Killed Person	1.250.000
Heavily injured person	85.000
Slightly injured person	3.750

11 Online-Kompendium Strassenentwurf, Bewertung der Verkehrssicherheit, http://strassenentwurf.elcms.de/content/e603/e912/e926/index_ger.html

Costs for accidents with injuries also contain property damage costs, which are estimated as follows (in euro):

Category	Highways	Rural Road
Accident causing fatality or serious injury	45.500	17.000
Accident with slightly injured person(s)	25.500	13.000
Accident causing personal damage	31.000	14.500

The actual calculation of the Cost Rates is done like in the following example:

Average accident with heavy personal damage (Category 1) on highways (in euros)

0,12 persons killed = 1.250.000 x 0,12 = 150.000
1,20 persons heavily injured = 85.000 x 1,20 = 102.000
0,66 persons slightly injured = 3.750 x 0,66 = 2.475
Total costs for personal damages 254.475
Total costs of property damages: 45.500

Standard Accident Cost Rate: ≈ 300.000



Bibliography

1. ITF Investment in Transport Infrastructure, Transport Infrastructure Investment Modal Split Western European Countries
   http://www.internationaltransportforum.org/statistics/GlobalTrends/Investment.pdf

2. EU Transport in Figures: Statistical Pocket 2011, European Commission
   http://ec.europa.eu/transport/publications/statistics/pocketbook-2011_en.htm

3. "De balans opgemaakt: Duurzaam Veilig 1998-2007" (The balance struck: sustainable Safety in the Netherlands 1998-2007), SWOV, 2009,
   http://www.swov.nl/rapport/Balans_10_jaar_DV.pdf

4. "On a crash course: dangers and healthcare costs and deficient roadway conditions", Pacific Institute of Research and Evaluation, 2009
   http://www.pire.org/documents/PireStudyLowRes.pdf

5. "La sécurité routière en France: Bilan de l'année 2009", Observatoire National Interministériel de Sécurité Routière',
   http://www2.securiteroutiere.gouv.fr/ressources/bilan/2009/sources/index.htm

6. "Statistiques de sécurité routière 2008", Observatoire pour la sécurité routière,
   http://bivvweb.ipower.be/Observ/FR/Statistiques%20de%20securite%20routiere%202008_FR.pdf,

7. "Star rating roads for safety – The Eurorap methodology" pp 14-15, Eurorap,
   http://www.eurorap.org/library/pdfs/20091201_StarRatingMethodology.pdf

8. European Parliament resolution of 27 September 2011 on European road safety 2011-2020
   http://www.europarl.europa.eu/sides/getDoc.do?type=TA&language=EN&reference=P7-TA-2011-0408

9. Online-Kompendium Strassenentwurf, Bewertung der Verkehrssicherheit
   http://strassenentwurf.elcms.de/content/e603/e912/e926/index_ger.html

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