Road Safety Audit training course

Road infrastructure safety management

Best practices

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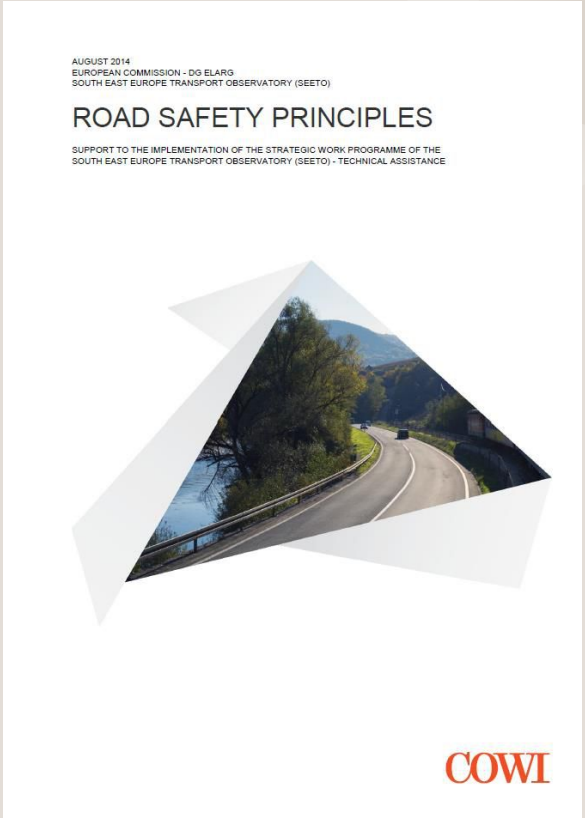
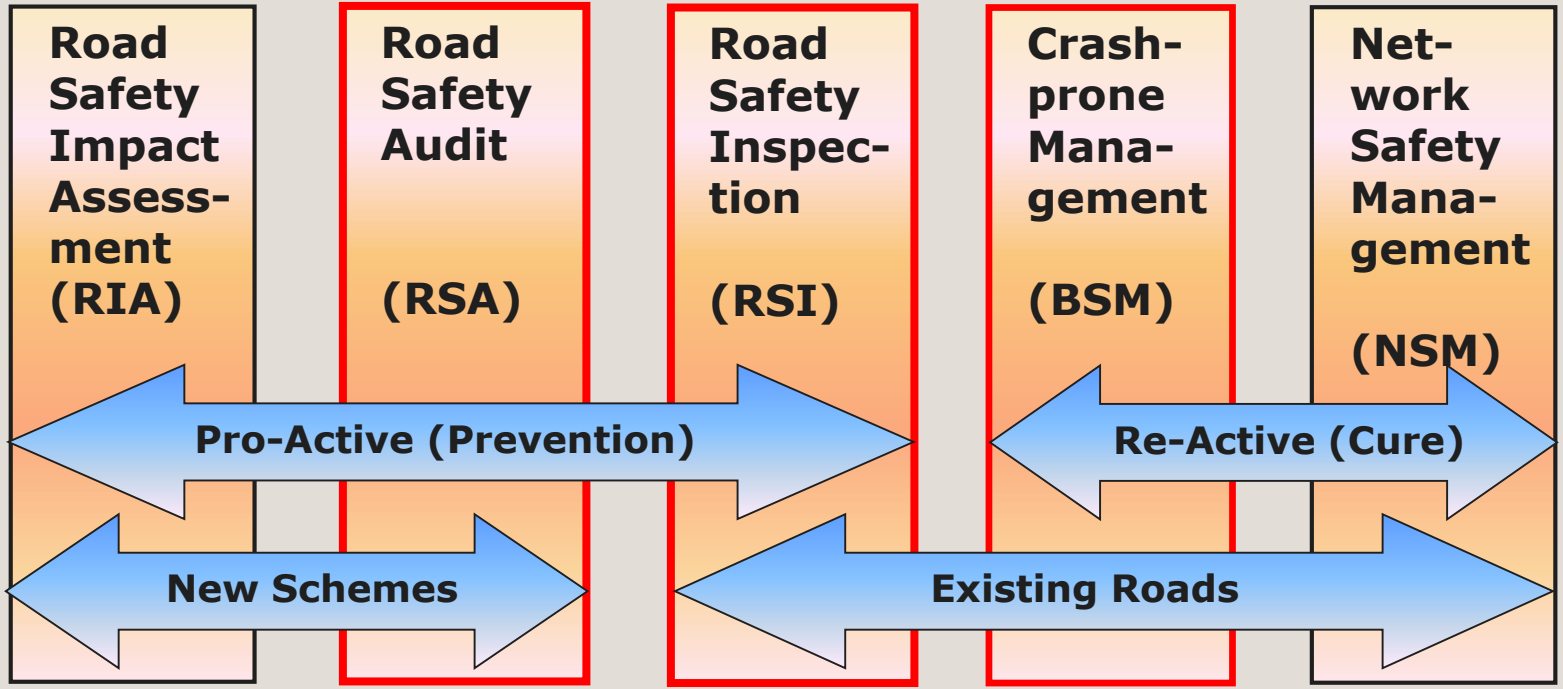
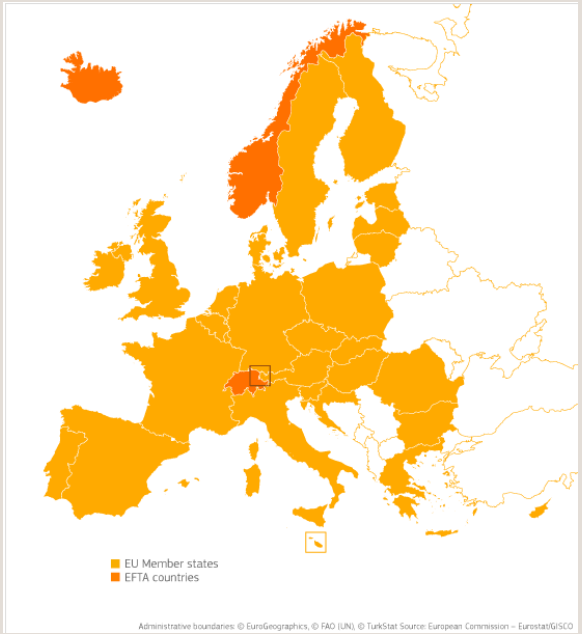


Different approaches



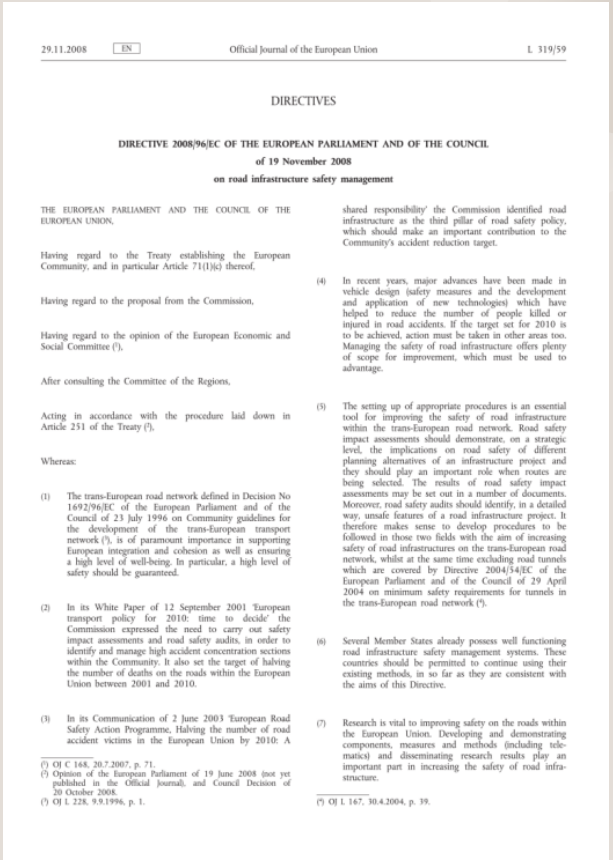
EU Directive 2008/96 on road safety

- Road safety impact assessment for infrastructure projects
- Road safety audits for infrastructure projects
- Safety ranking and management of the network in operation
- Road safety inspections
- Data management



Definition of road safety impact assessment

› Road safety impact assessment is a strategic comparative analysis of the impact of a new road or a substantial modification to the existing network influencing the safety performance of the road



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of 19 November 2008
on road infrastructure safety management

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(2) In its White Paper of 12 September 2001 'European transport policy for 2010: time to decide' the Commission expressed the need to carry out safety impact assessments and road safety audits, in order to identify and manage high accident concentration sections within the Community. It also set the target of halving the number of deaths on the roads within the European Union between 2001 and 2010.

(3) In its Communication of 2 June 2003 'European Road Safety Action Programme, Halving the number of road accident victims in the European Union by 2010: A shared responsibility' the Commission identified road infrastructure as the third pillar of road safety policy, which should make an important contribution to the Community's accident reduction target.

(4) In recent years, major advances have been made in vehicle design (safety measures and the development and application of new technologies) which have helped to reduce the number of people killed or injured in road accidents. If the target set for 2010 is to be achieved, action must be taken in other areas too. Managing the safety of road infrastructure offers plenty of scope for improvement, which must be used to advantage.

(5) The setting up of appropriate procedures is an essential tool for improving the safety of road infrastructure within the trans-European road network. Road safety impact assessments should demonstrate, on a strategic level, the implications on road safety of different planning alternatives of an infrastructure project and they should play an important role when routes are being selected. The results of road safety impact assessments may be set out in a number of documents. Moreover, road safety audits should identify, in a detailed way, unsafe features of a road infrastructure project. It therefore makes sense to develop procedures to be followed in those two fields with the aim of increasing safety of road infrastructures on the trans-European road network, whilst at the same time excluding road tunnels which are covered by Directive 2004/54/EC of the European Parliament and of the Council of 29 April 2004 on minimum safety requirements for tunnels in the trans-European road network (4).

(6) Several Member States already possess well functioning road infrastructure safety management systems. These countries should be permitted to continue using their existing methods, in so far as they are consistent with the aims of this Directive.

(7) Research is vital to improving safety on the roads within the European Union. Developing and demonstrating components, measures and methods (including telematics) and disseminating research results play an important part in increasing the safety of road infrastructure.

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Road safety impact assessment for infrastructure projects

- Member States shall ensure that a road safety impact assessment is carried out for all infrastructure projects
- The road safety impact assessment shall:
  - be carried out at the initial planning stage before the infrastructure project is approved
  - indicate the road safety considerations which contribute to the choice of the proposed solution
  - further provide all relevant information necessary for a cost-benefit analysis of the different options assessed

Road safety impact assessment for infrastructure projects

- Elements of road safety impact assessment:
  - problem definition
  - current situation and 'do nothing' scenario
  - road safety objectives
  - analysis of impacts on road safety of the proposed alternatives
  - comparison of the alternatives, including cost-benefit analysis
  - presentation of the range of possible solutions

- Elements to be taken into account:
  - fatalities and accidents, reduction targets against 'do nothing' scenario
  - route choice and traffic patterns
  - possible effects on the existing networks (e.g. exits, intersections, level crossings)
  - road users, including vulnerable users (e.g. pedestrians, cyclists, motorcyclists)
  - traffic (e.g. traffic volume, traffic categorisation by type)
  - seasonal and climatic conditions
  - presence of a sufficient number of safe parking areas
  - seismic activity

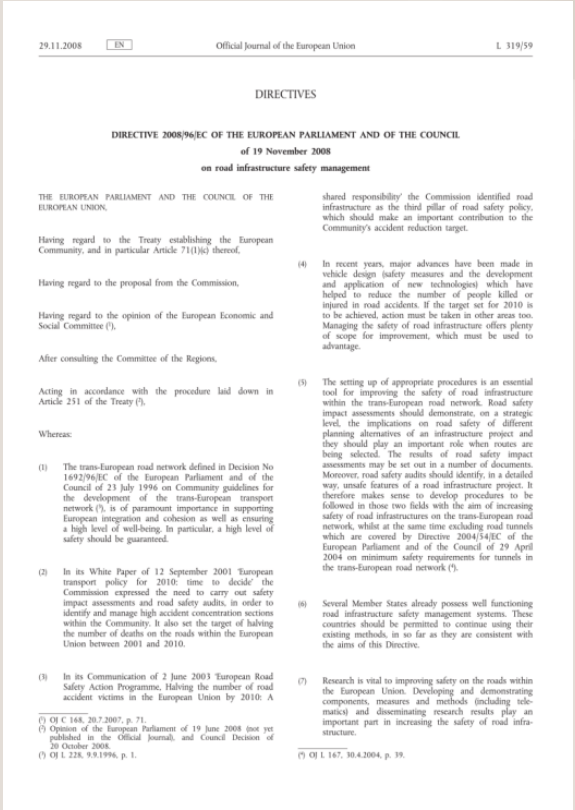
Definition of road safety audit

› **Road safety audit**
is an independent detailed systematic and technical safety check relating to the design characteristics of a road infrastructure project and covering all stages from planning to early operation

Source: EU Directive on road safety

EU directive on road safety audit

- Part of the design process for infrastructure projects including the stages of:
  - draft design
  - detailed design
  - pre-opening
  - early operation
- Audits should be carried out for all infrastructure projects
- An audit report could be prepared for each stage of the infrastructure project



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(5) The setting up of appropriate procedures is an essential tool for improving the safety of road infrastructure within the trans-European road network. Road safety impact assessments should demonstrate, on a strategic level, the implications on road safety of different planning alternatives of an infrastructure project and they should play an important role when routes are being selected. The results of road safety impact assessments may be set out in a number of documents. Moreover, road safety audits should identify, in a detailed way, unsafe features of a road infrastructure project. It therefore makes sense to develop procedures to be followed in those two fields with the aim of increasing safety of road infrastructures on the trans-European road network, whilst at the same time excluding road tunnels which are covered by Directive 2004/54/EC of the European Parliament and of the Council of 29 April 2004 on minimum safety requirements for tunnels in the trans-European road network (4).

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EU directive on road safety audit

- At detailed design stage audit should according to EU directive include where relevant:
  - layout
  - coherent road signs and markings
  - lighting of lit roads and intersections
  - roadside equipment
  - roadside environment including vegetation
  - fixed obstacles at the roadside
  - provision of safe parking areas
  - vulnerable road users (e.g. pedestrians, cyclists, motorcyclists)
  - user-friendly adaptation of road restraint systems (central reservations and crash barriers to prevent hazards to vulnerable users)
- Criteria includes assessment of road safety in light of actual behaviour of users
- There are also checklists for draft design and pre-opening

EU directive on road safety audit

- Highlight critical safety problems in the design and provide recommendations from a safety point of view
- The road owner should ensure that a team of auditors is appointed to carry out the audit of the design
- The auditor appointed should be in compliance with the following requirements:
  - experience or training in road design, road safety engineering and accident analysis
  - road safety audits shall only be undertaken by auditors or teams to which auditors belong, meeting the following requirements:
    - road safety auditors should undergo an initial training resulting in the award of a certificate of competence, and take part in periodic further training courses
    - the auditor should be independent of the infrastructure project thus not have been involved in the project
- At least one member of the team should hold a certificate of competence
- For appointing and training of auditors training curricula for road safety auditors should be provided
- Reasons shall be stated by the competent entity when recommendations are not accepted

Definition of safety ranking and management of the network in operation

- **Ranking of high accident concentration sections**
  is a method to identify, analyse and rank sections of the road network which have been in operation for more than three years and upon which a large number of fatal accidents in proportion to the traffic flow have occurred

- **Network safety ranking**
  is a method for identifying, analysing and classifying parts of the existing road network according to their potential for safety development and accident cost savings

Safety ranking and management of the network in operation. Member states shall ensure that:

- Ranking is based on reviews, at least every three years, of the operation of the road network
- High ranked road sections are evaluated by expert teams through site visits
- Remedial treatment is targeted on road sections focusing on those with highest benefit-cost ratio
- Appropriate signs should be in place to warn road users of road infrastructure undergoing repairs and which may thus jeopardise the safety of road users
  - signs should be visible during both day and night time and set up at a safe distance, and shall comply with the provisions of the Vienna Convention on Road Signs and Signals of 1968.
- Users are informed of the existence of a high accident concentration section by appropriate measures
  - If a Member State decides to use signposting, this shall comply with the provisions of the Vienna convention on Road Signs and Signals of 1968

Ranking of high accident concentration sections and network safety ranking

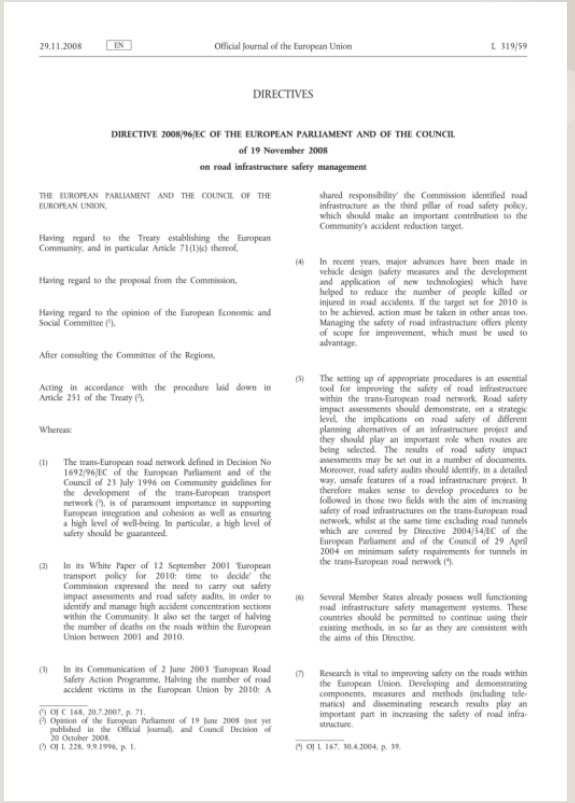
- Identification of road sections with a high accident concentration
  - at least the number of fatal accidents that have occurred in previous years per unit of road length in relation to the volume of traffic
  - in case of intersections, the number of such accidents per location of intersections.
- Identification of sections for analysis in network safety ranking by road categories
  - Potential savings in accident costs
  - For each category of roads
    - road sections shall be analysed and ranked according to safety-related factors, such as accidents concentration, traffic volume and traffic typology
    - network safety ranking shall result in a priority list of road sections where an improvement of the infrastructure is expected to be highly effective

Elements of evaluation for expert teams' site visits:

- A description of the road section
- A reference to possible previous reports on the same road section
- The analysis of possible accident reports
- The number of accidents, of fatalities and of severely injured persons in the three previous years
- A set of potential remedial measures for realisation

Definition of road safety inspection

› Safety inspection
is an ordinary periodical verification of the characteristics and defects that require safety improvement



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Road safety inspections - Member States shall:

- Ensure that safety inspections are undertaken of the roads in operation in order to identify the road safety related features and prevent accidents
- Comprise periodic inspections of the road network and surveys on the possible impact of roadworks on the safety of the traffic flow
- Ensure that periodic inspections are undertaken by the competent entity
  - be sufficiently frequent to safeguard adequate safety levels for the road infrastructure in question

Data management

Member States:

- Shall ensure that for each fatal accident an accident report is drawn up by the competent entity
- Shall calculate the average social cost of a:
  - fatal accident
  - severe accident occurring in its territory
- May choose to further differentiate the cost rates, which shall be updated at least every five years

Accident reports should include the following elements:

- As precise location as possible of the accident
- Pictures and/or diagrams of the accident site
- Date and hour of accident
- Information on the road such as:
  - area type, road type, junction type incl. signalling, number of lanes, markings, road surface, lighting and weather conditions, speed limit, roadside obstacles
- Accident severity:
  - including number of fatalities and injured persons, if possible according to common criteria
- Characteristics of the persons involved such as:
  - age, sex, nationality, alcohol level, use of safety equipment or not
- Data on the vehicles involved:
  - type, age, country, safety equipment if any, date of last periodical technical check according to applicable legislation
- Accident data such as:
  - accident type, collision type, vehicle and driver manoeuvre
- Whenever possible, information on the time elapsed between the time of the accident and the recording of the accident, or the arrival of the emergency services

Exchange of best practices and continuous improvement of safety management practices

The Commission shall:

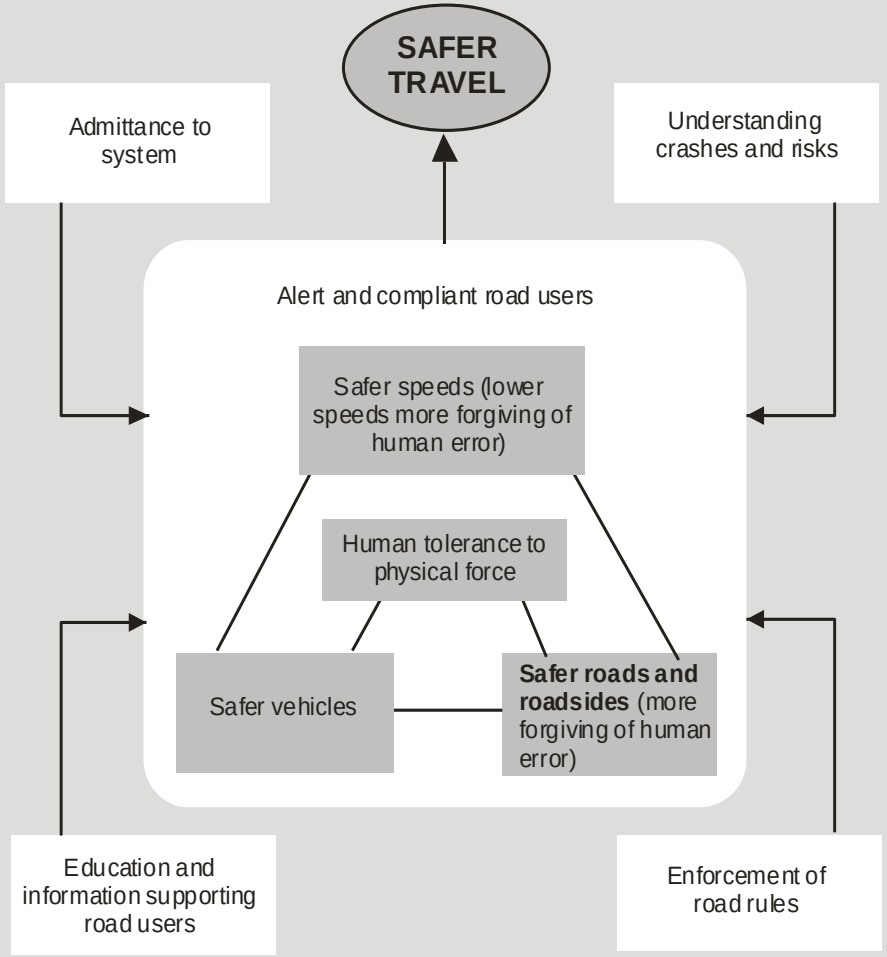
- Establish a coherent system for the exchange of best practices between the Member States
  - covering, inter alia, existing road infrastructure safety projects and proven road safety technology
  - to improve the safety of roads within the European Union that are not part of the trans-European road network
- Facilitate and structure the exchange of knowledge and best practices between Member States
  - through experience gained in existing relevant international forums
  - to achieve continuous improvement of road safety management practices in the European Union

Many countries have adopted safe system approach – and e.g. World Bank advocates for the system

- Examples of early safe system approaches are Sustainable Safety and Vision Zero of the Netherlands and Sweden respectively
  - more countries have followed or are inspired
- The Guidelines on Road Safety Management Capacity Reviews and Safe System Projects prepared by the World Bank

Safe system approach

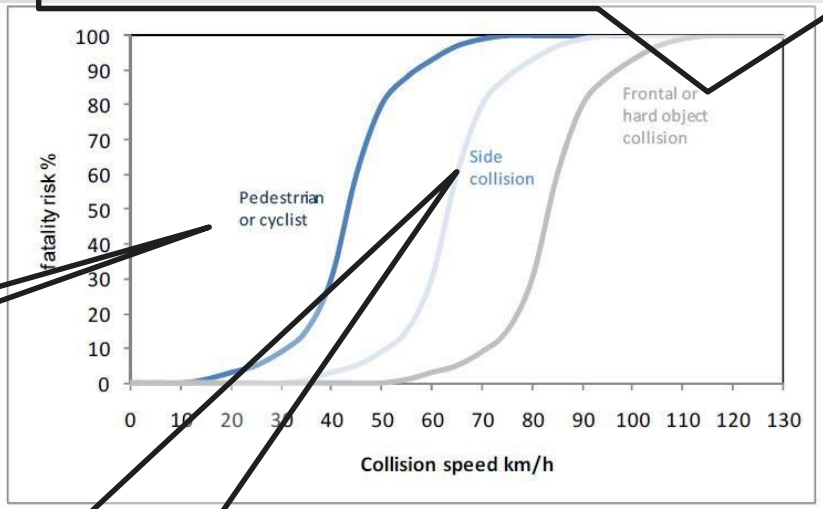
- Recognises that road user errors will happen and crashes will occur
- Joint responsibility:
  - those involved in the design of the road transport system need to accept and share responsibility for the safety of the system
  - that users of the system need to accept responsibility for complying with the rules and constraints of the system
- Aligns safety management decisions with broader transport and planning decisions
- Shapes interventions to meet the long term goal - elimination of all deaths and serious injuries



Basic strategy of Safe System approach is to ensure that in the event of a crash, the impact energies remain below the threshold likely to produce either death or serious injury

- Threshold will vary from crash scenario to crash scenario, depending upon the level of protection offered to the road users involved
- Fatality risk – the chances of survival for:

a properly restrained motor vehicle occupant the critical impact speed is 70 km/h (for head-on crashes).



Source: Wramborg, P. (2005). *A New Approach to a Safe and Sustainable Road Structure and Street Design for Urban Areas.* Paper presented at Road Safety on Four Continents Conference, Warsaw Poland.

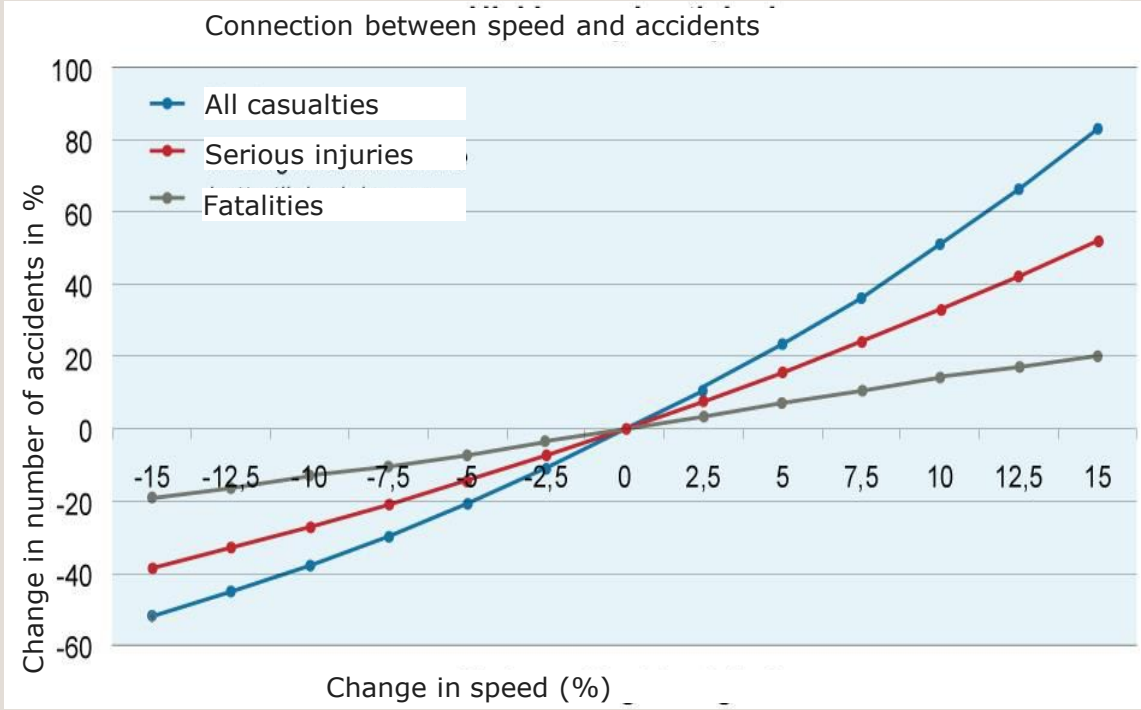
an unprotected pedestrian hit by a vehicle diminish rapidly at speeds greater than 30km/h

- stoppet[1].rv

a properly restrained motor vehicle occupant the critical impact speed is 50km/h (for side collisions)

Speed

- The connection between speed, and number of accidents and the severity is well documented
- Connection between the speed of vehicles and the number of serious accidents with casualties, e.g. a 5% increase in speed means a 20% increase in number serious injured
- Apart from average speed also the variation in speed is important. The more similar speed the fewer and less serious accidents



Safety principles

- The key to a sustainable safe traffic system is the consistent and systematic application of safety principles
- The starting point must be the road user – in particular their limitations and capabilities
- The system must allow for human error without leading to death or serious injury
- This is called the 'safe systems' approach

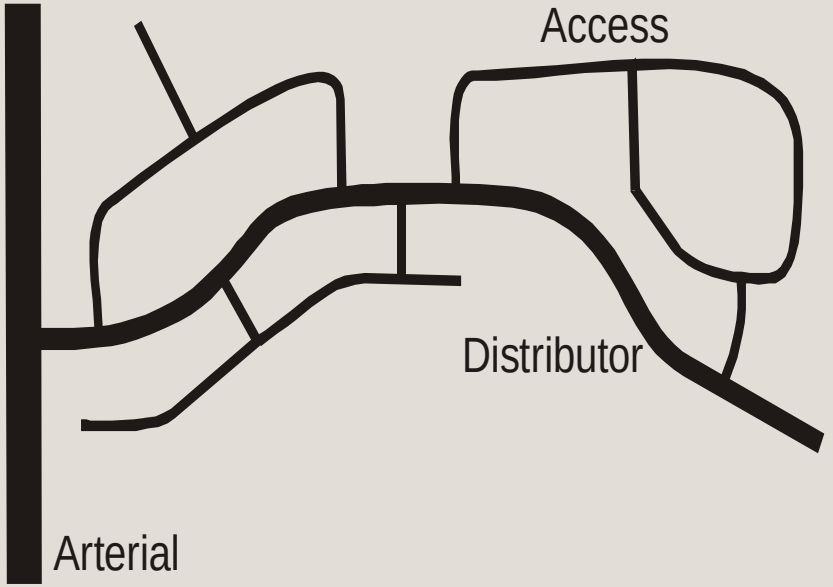
Following on from this are three more safety principles:

- Functionality – different roads for different functions
- Homogeneity – keep traffic of the same type together and avoid conflicts
- Predictability – roads should give a consistent, clear message to drivers

Safety principles

There are basically three functional categories:

- Flow function – rapid vehicle movement – arterial (through) roads
- Distributor function - distribution and collection of traffic from different areas – distributor (collector) roads
- Access function – access to individual plots – access roads



Safety principles

Homogeneity

- Keep traffic of the same type together and avoid conflicts
- Avoiding differences in speed, driving direction and type of vehicles
- The design should minimise conflicts, especially conflicts between different traffic streams.

Predictability

- Roads should give a consistent, clear message to drivers
- Roads should be designed so as to make it obvious to drivers what they are meant to do (self-explaining roads)
- Not only signs and markings – the cross-section and alignment must reinforce the message
- A wide carriageway encourages drivers to drive fast.
- A narrow carriageway forces drivers to slow down

Design speed

- Design speed depends on:
  - road function, traffic flow, terrain, and the design parameters of sight distance and curvature to ensure that a driver is presented with a reasonably consistent speed environment
- Not too big or many changes in design standards
- In build-up areas where VRU are present - 50 km/h or less

Design elements - interurban roads and motorways

- Alignment of section (horizontal and vertical)
- Design of intersections and interchanges
- Cross section.

Alignment of section (horizontal and vertical)

Some typical safety deficiencies affecting the alignment of interurban roads (highways and motorways) are:

- Horizontal alignment including:
  - inconsistent radius sequence (speed differentials), usage of small radii in sections with high speed, sudden changes of alignment standards without any transition
- Vertical alignment:
  - small crest curves with sight restrictions, missing climbing lanes for trucks in the case of steep gradients on fast roads, optical illusions like “Hidden-dips”
- Insufficient sight conditions:
  - stopping sight, orientation sight and overtaking sight (especially on roads with only single carriageway).

Design of intersections and interchanges

Typical deficiencies are:

- Lack of correlation between alignment and intersection type, e.g. providing split level interchanges on high speed roads such as motorways
- Intersections are not visible for the drivers
- Sight conditions are insufficient and visibility may be obstructed by road equipment, bushes, houses etc.
- Unsafe geometry like Y and 4 –leg types
- Lack of left-turning lanes on major roads
- Lack of traffic signalisation on road sections with high traffic volume
- Unsafe crossing facilities for pedestrians and bicyclists.

Cross section

Typical deficiencies on cross sections are:

- The selected lane widths are not according to the function of the road
  - Lanes generally does not need to be wider than 3.5 m
  - Wider lanes are not proven to improve road safety
- Wide hard shoulders on single carriageway highways with a total width of the paved cross section between 11 to 12 m may lead to usage of the road as a 3 lane road with high accident risks
- Insufficient cross fall on straight road sections (should normally be 2.5 %)
- Lack of safety zone (no fixed objects near the road side) or "forgiving roadsides" (e.g. crash friendly poles, guardrails)
- Lack of sufficient superelevation in curves
- Insufficient or lack of drainage on sections with change in direction of crossfall during transition from left hand to right hand curves, too small gutter gradient on curbed sections
- Lack of strong and stable edges
- Four lane roads without physical separation with medians etc.
- Missing, insufficient or incorrect guardrail along the road and on medians of roads with two carriageways and motorways
- Missing or insufficient separate pedestrian and cyclist facilities

Through road sections and major urban roads

Typical safety deficiencies affecting the design of through road sections and major urban roads are:

- The selected speed is inappropriate - higher than 50 km/h without special separation
- The design is similar on build-up and interurban sections not showing the driver clearly the change in characteristics on the through road section
- There are no facilities to support the speed limits physically
- No facilities for pedestrians and cyclists along the road and at intersections
- Traffic signal control that does not consider the needs of all road users, including lack of protection for left-turning movements or excessive delays for pedestrians and cyclists
- Lack of facilities for pedestrians and cyclists crossing on open sections of the road
- Width of cross sections not appropriate, e.g. too wide lanes on through road sections leading to high speeding - 3.25 m are often sufficient
- Inappropriate parking and loading facilities including bus stops

Implications for SEETO Regional Participants

- Many countries often work reactive
- Important to also work proactive – especially with rapid development of road infrastructure
- Be inspired and introduce thinking from safe system design – it follows the law of physics

Safety in the ToR for design contracts

It is recommended that the ToR for design contracts require the consultant to:

- Produce a design that will keep crash costs (crash frequency and severity) as low as reasonably practical
- Undertake a study of crashes on the road in the last 5 years and identify the main causes
- Include a section in the Design Report that describes the past and potential future safety problems and explains how the design will avoid or mitigate them
- Employ an experinced road safety engineer
- Arrange for the design to be audited by an independent road safety auditor

Issues to consider:

How does your country work with road safety pro-active or reactive? how?

How do you work with speed management in your country?

Is safe system approach used in your country? if yes how?