**4th INTERNATIONAL SYMPOSIUM ON HIGHWAY GEOMETRIC DESIGN**
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# Country Report of ITALY

**By**


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**Abstract**

In the year 2008, there were 218,963 crashes on Italian roads. The total number of fatalities was 4,731 and the total number of injured people was 310,739. These data highlight the social costs represented by traffic accidents in Italy and justify the important effort that is currently being made to promote traffic safety. One important step to gain this goal is the improvement of the existing road network.

The paper focuses the attention on the actual regulation about the road design. In particular this regulation is formed by the "Functional and Geometric Design Standards for Road Design" published in 2001 and by the "Functional and Geometric Design Standards for Road Intersections" published in 2006" that refers to intersection and interchanges design. The respect of both these standards is mandatory for new design, whereas they are only a reference for the rehabilitation projects of existing roads for which more flexibility is allowed.

In all, this regulation is quite complex for the design of new roads even though it is characterized by a rigidity that in some condition can cause a difficulty in the insertion of the alignment in the territory. The ancient history of the Italian country influence the existing road network in terms of network layout and architectural and landscape constrains. Moreover the possibility to adopt solutions different from those led down in the standards (only for archaeological, social, economic and environmental considerations) requires an authorization process based on the safety performance of the project. The lack of a regulation for the re-design of existing roads and the necessity to demonstrate that the project solutions not consistent with the standard, enhances traffic safety, led to several researches in this field, in the attempt to develop useful tools to evaluate the safety conditions of the existing roads and the safety performance of new design proposals. In the paper an overview of National and International research projects developed by Italian researchers in the field of Geometric Design is presented.

## ROAD SAFETY IN THE EUROPEAN PERSPECTIVE

In 2001 with the White Paper "European transport policy for 2010: time to decide", the European Commission set the ambitious aim of halving the number of road traffic fatalities by 2010.

Italy agrees with this target, but nowadays, despite a significant reduction in the number of fatalities, there is still a difference between the actual result and the expected reduction (Figure 1). Referring to the last available data (1), in the year 2008, there were 218,963 crashes on Italian roads, the total number of fatalities was 4,731 and the total number of injured people was 310,739. The reduction in the number of fatalities arise the 33% with respect to the value in 2001. This reduction is significant and higher than the EU average of 28%, but the actual trend will not permit to reach the target of 50% reduction in 2010 (Figure 1).

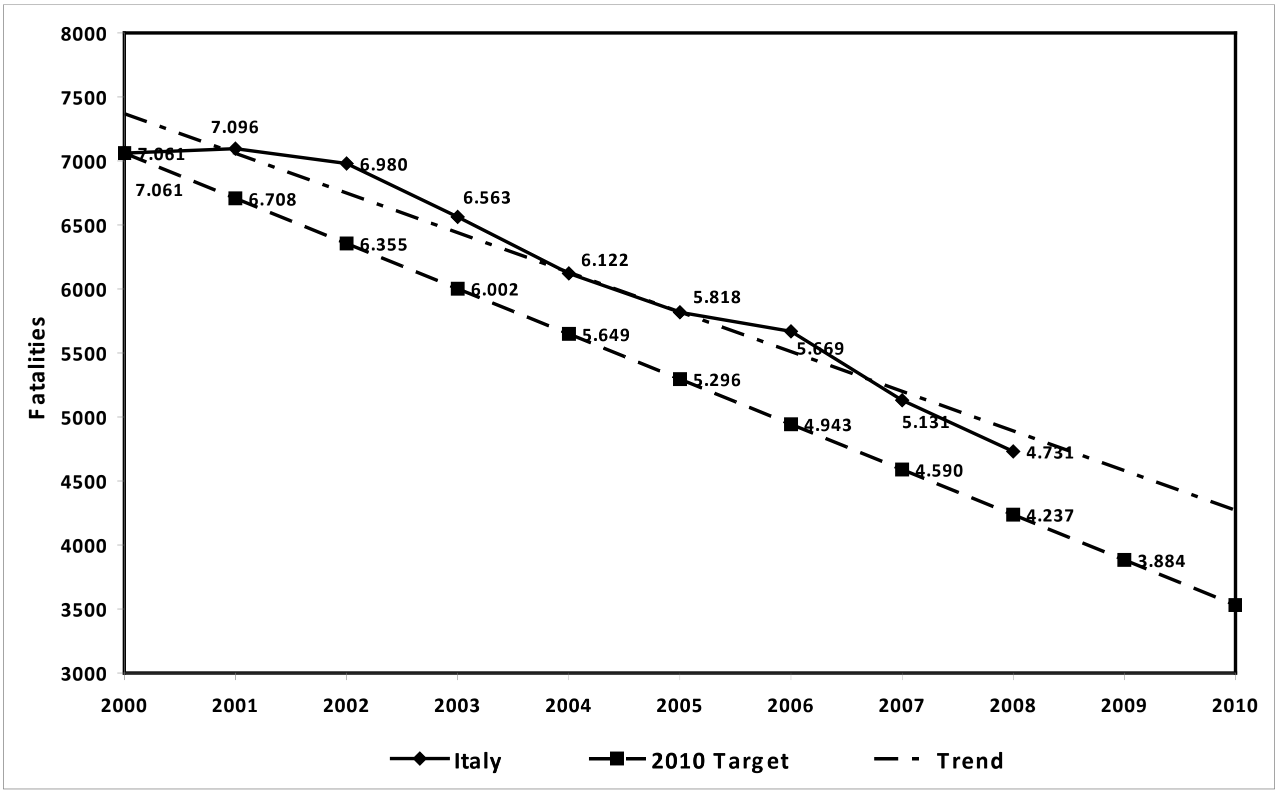


**Figure 1 - Number of road fatalities in Italy and expected trend from 2000 to 2010**

In comparison with other European countries (2), Italy with 73 fatalities per million inhabitants has a value lower than the EU mean of 78 fatalities per million inhabitants (Figure 2). Also a comparison with data from USA shows lower number of fatalities per million inhabitants in Italy and most European countries (Figure 2), but for a complete comparison between the two continents, also, a higher travel mileage of USA drivers with respect to EU ones should be considered.

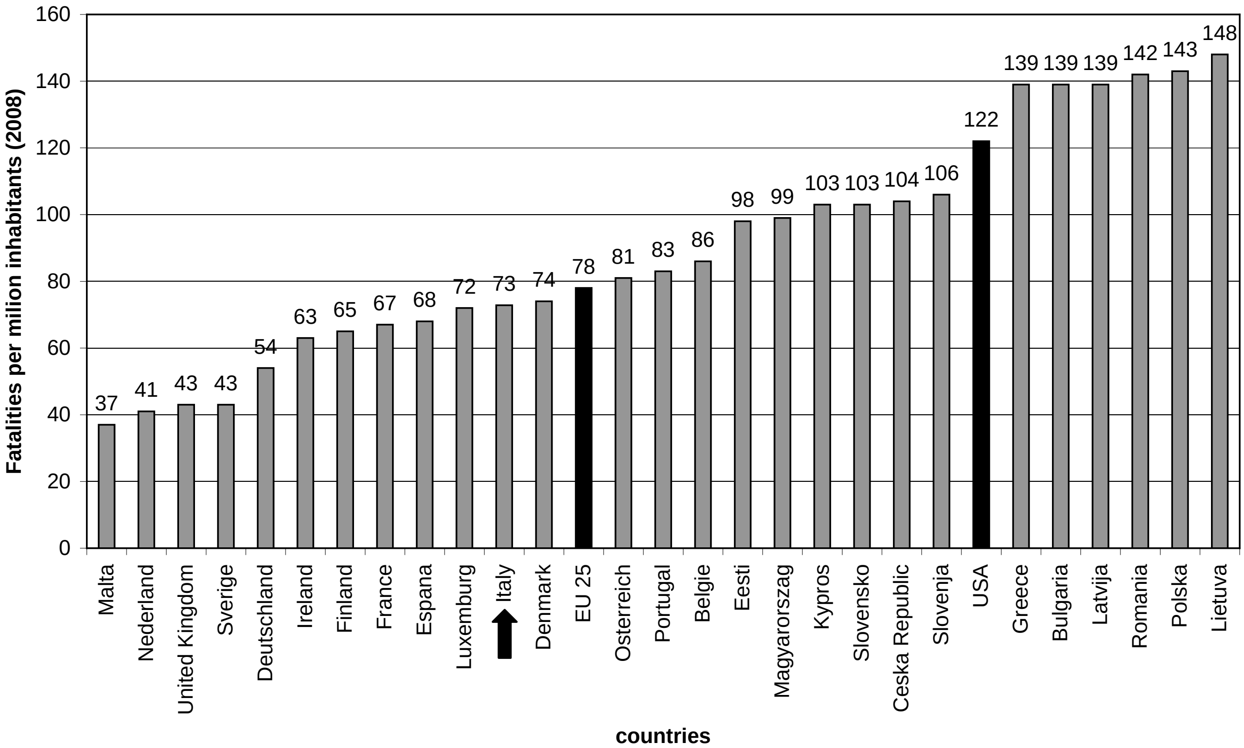


**Figure 2 - Fatalities per million inhabitants, EU – 25 (2008)**

In general, a simple comparison of the number of accidents doesn't lie to significant results due to the variability among the various countries in terms of exposure (vehicle fleet, travelled kilometers). Instead, the proportions of the occurrence of different typology of crashes are not influenced by the sample dimension and can be used to compare the characteristics of crashes between Italy and a reference of 14 (EU14) of the 15 European countries that joined EU from 1995 (data from Germany are not full available).

Italy has a percentage of fatalities in motorway (10.4%) and on urban street (44%) significantly higher than the EU 13 values (Figure 3).

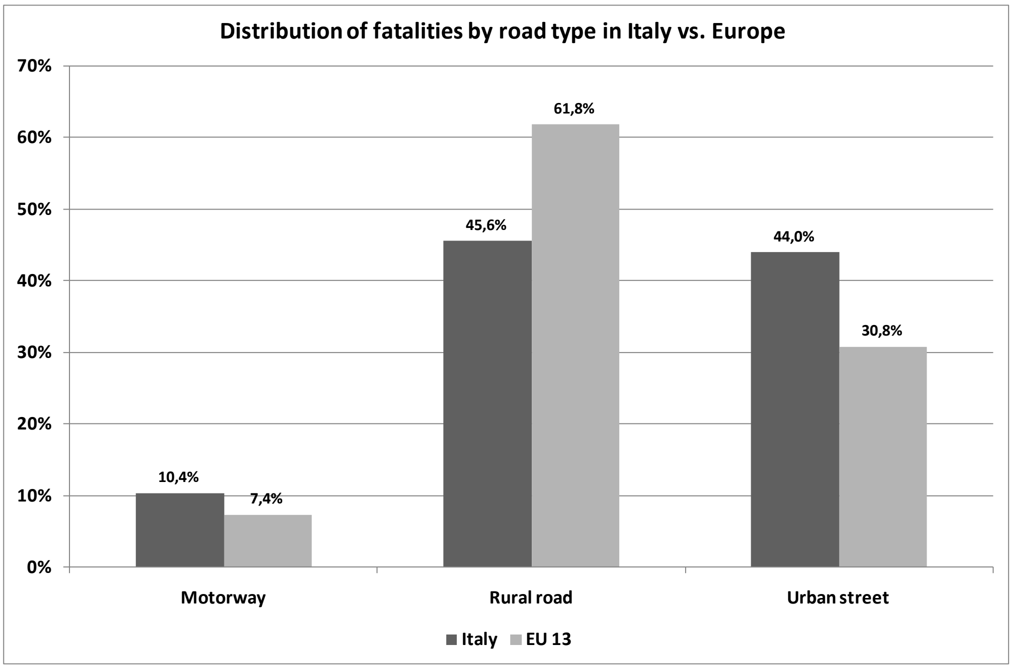


**Figure 3 Distribution of fatalities by road type in Italy vs. Europe**

The higher percentage of fatalities happens at not junction (70.8%), but in Italy the percentage of fatalities at junction is higher than EU14 mean value (Figure 4).

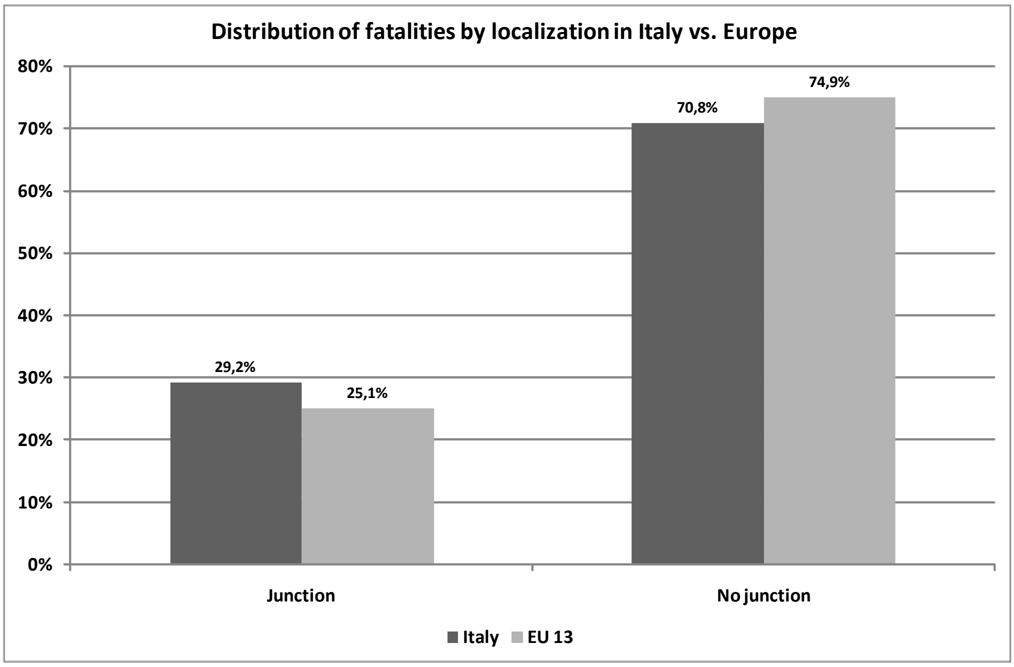


**Figure 4 Distribution of fatalities by localization in Italy vs. Europe**

Referring to the mode of road transport, fatalities in bicycle (3.9%), in moped (5.1%), in motorcycle (14.0%) and in car (57.4%) are more relevant in Italy than in the European average used as reference (Figure 5).

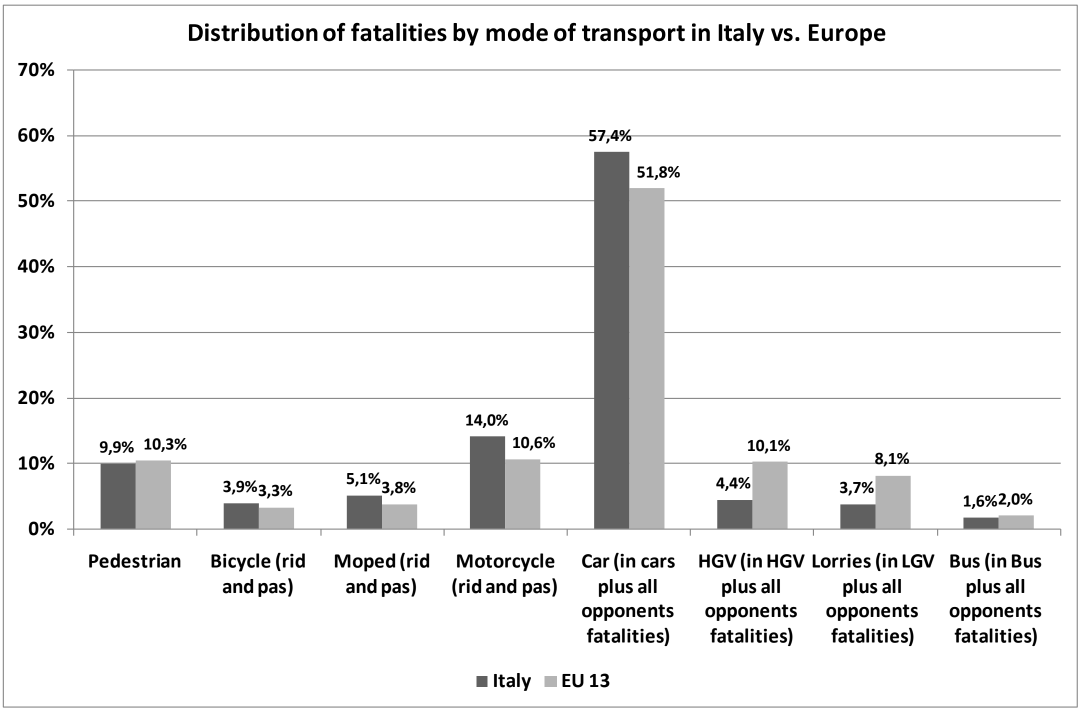


**Figure 5 Distribution of fatalities by mode of transport in Italy vs. Europe (EU13)**

Relevant is the increase in the percentage of fatalities in the powered two wheelers (PTW) users. This result is typical of other euro-mediterranean countries and reflect the large use of this type of mode of transport. Considering that the people involved in PTW crashes is composed above all by young ones, the consideration of PTW as particular component of traffic flow in road design with training and education for young people are considered one of the priorities for the next European Road Safety Action Programma 2011-2020.

## GEOMETRIC DESIGN STANDARD

The New Road Code (3), published in 1992, required the issuing of a new road design standard (art. 13) to substitute the existing road design guidelines then in operation (4,5). The Minister of Public Works consulted the Public Works Council and the National Council for Scientific Research for the drafting of these design standards and, finally, published the standard as ministerial decree in 2002 (6). This standard concerns the geometric features of alignment and cross section of the urban and rural roads (with the exception of mountain roads in territories with specific morphologic features which in general do not enable the observance of the design standards). The decree introduced the principle of the obligatory nature of its application for all projects both of new and existing roads. The decree accepted that design solutions different from those led down in the standard were adopted on existing roads for archaeological, social, economic and environmental reasons if they were supported by specific safety analyses and were authorized by the public administration.
The difficulty in the application of this standard to the project of existing roads caused the publication of a new decree in 2004 (7) that established that the respect of the standard is obligatory only for projects of new roads and it has to be considered as reference at which the design should aim for the projects of existing roads. However, in this last case the designer must submit a report that demonstrates that the project enhances traffic safety. Finally, in the year 2006 the standard for the design of intersections was also published as a ministerial decree (8). Also in this case the respect of the standard is obligatory for the projects of new intersections, whereas it is a reference for the projects of existing intersections.

*Functional classification of the roads*

The standards, both for highways and junctions, are based on the functional classification of the roads that is provided by the New Road Code (3). This classification makes it possible the definition of a precise hierarchical classification of all the roads based on the identification of their role within the territorial framework and the overall system of road infrastructures. The standard (6) specifies the characteristics and function of all the different categories provided by the New Road Code. The fundamental factors that identify a specific road from a functional point of view, thus making it possible to rank each network are precisely described in the guideline:

- kind of travel movements (main movement, distribution, collection, terminal access);
- distance travelled (average distance travelled by vehicles);
- function played by the road network (national, inter-regional, provincial, local connection);
- traffic composition and related categories (light vehicles, heavy vehicles, ptw, pedestrians).

With reference to the four above-mentioned fundamental factors, four network levels (primary network, main network, secondary network, local network) are identified by the standard in the overall system of road infrastructures. The eight categories of roads reported in the standard match these four network levels. It should be noted that another ministerial decree, also published in 2002 (9) requires to create the road cadastre and, in particular, requires to classify all the existing roads according to the functional classification of the roads that is provided by the New Road Code.

*Cross Section*

Each road category is characterized in the standard by the cross section and by a “design speed interval” that is used to indicate the range of values according to which the characteristics of the various road elements (tangent, circular curve, spiral curve) have to be defined. The interval upper limit is the reference speed for designing the less binding road elements given the characteristics of the road cross section. This reference speed is at least equivalent to the maximum speed tolerated by the Rules of the Road for the various road categories (general speed limits). The interval lower limit is the reference speed for designing the horizontal and vertical geometric elements which are binding for a road of a given cross section. The transition from one element with a certain speed design to another with a considerably different speed design will have to take place on the basis of the relation criteria contained in the standard. Table 1 shows the possible composition of the carriageway (number of lanes in both directions) and the limits of the design speed interval for each road category and for any possible related service road. The number of elements and their size depend on the traffic volume and the upper limit of the design speed interval respectively. The standard requires that the size of the cross section is kept unchanged for the whole length of the road, also in case of artificial structures (tunnel, grade-separation structure, bridge, viaduct, etc.).

| STANDARD CATEGORIES FOR ROADS | | TERRITORIAL AREA | | SPEED LIMIT [km/h] | Number of lanes for each way | Design speed range | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower limit [km/h] | Upper limit [km/h] |
| FREEWAY | A | RURAL | primary road | 130 | 2 or more | 90 | 140 |
| | | | eventual service road | 90 | 1 or more | 40 | 100 |
| | | URBAN | primary road | 130 | 2 or more | 80 | 140 |
| | | | eventual service road | 50 | 1 or more | 40 | 60 |
| HIGHWAY | B | RURAL | primary road | 110 | 2 or more | 70 | 120 |
| | | | eventual service road | 90 | 1 or more | 40 | 100 |
| RURAL ROAD | C | RURAL | C1 | 90 | 1 | 60 | 100 |
| | | | C2 | 90 | 1 | 60 | 100 |
| URBAN EXPRESSWAY | D | URBAN | primary road | 70 | 2 or more | 50 | 80 |
| | | | eventual service road | 50 | 1 or more | 25 | 60 |
| URBAN WARD ROAD | E | URBAN | | 50 | 1 or more | 40 | 60 |
| LOCAL ROAD | F | RURAL | | 90 | 1 | 40 | 100 |
| | | URBAN | | 50 | 1 | 25 | 60 |

**Table 1 Composition of carriageway (number of lanes in both directions) and limits of design speed intervals.**

*Sight Distance*

Appropriate sight distances are an absolute prerequisite for traffic safety. The sight distance along the road required by the standard are:

- Stopping sight distance, corresponding to the minimum distance necessary for a driver to safely stop a vehicle in front of an unexpected obstacle (to guarantee along the full length of all the roads).
- Passing sight distance, corresponding to the road stretch which is necessary to safely complete a passing manoeuvre, when the arrival of a vehicle from the opposite direction cannot be excluded (to guarantee along a suitable percentage length of two-lane roads, according to the traffic flow served at the assigned level of service).
- Changing lane sight distance, corresponding to the road stretch which is necessary to change lanes in the deviation manoeuvre in correspondence of special points (intersections, turning roadways, etc) along roads that have more than one lane for each traffic direction.

It should be noted that the standard requires also the verification of the availability, in correspondence of the beginning of the deceleration, of a sight distance longer than the transition distance calculated in the design speed profile to ensure that a curve that requires a speed reduction can be perceived in time to decelerate.

*Horizontal and vertical alignment*

The horizontal alignment is composed by tangent sections, circular curves and transition curves. A spiral curve has to be always inserted between two elements with a constant radius (two circular curves or a tangent and a circular curve) to ensure a gradual increase of the superelevation and, when necessary, of the lane width. For each road category the standard specifies the values of the minimum radius Rmin to which the maximum superelevation rate of 7% is associated; in case of a radius exceeding Rmin two diagrams (one is shown as an example in Figure 6) are used to calculate the superelevation. Minimum superelevation rate can't fall below 2.5%. Speed increases with the radius (and the superelevations is constant equal to the maximum rate) until the maximum value of the design speed interval is reached. For further increase in the radius of curvature, design speed remains constant and the superelevation rate drops.

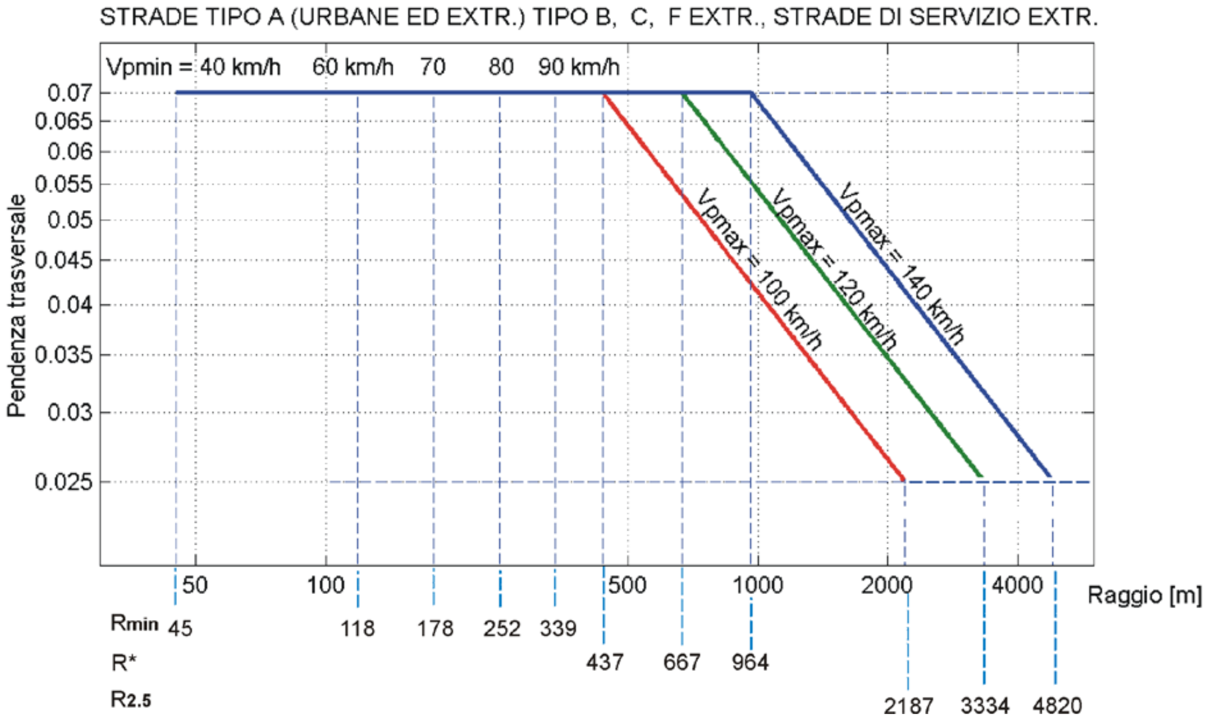

**Figure 6 Diagram to calculate cross fall and design speed vs. curve radius (Vp ≡ Vdesign)**

The maximum longitudinal gradient admitted for the various road categories is between 5 and 10%. As regards vertical curves, the standard prescribes concave and convex parabolic vertical curves. Their radii have to be selected on the basis of the sight distance, of the vertical acceleration and of the vehicle inscription.

*Consistency Check*

To avoid design inconsistency both relation design and operating speed checks are introduced. The standard requires that the radii of two adjacent curves respect a diagram that ensures a well-balanced relationship. For the sequence tangent to curve the standard requires a minimum curve radius in function of the tangent length. Moreover, the standard requires the construction of the design speed-profile. To guarantee that the horizontal alignment does not present speed inconsistencies in both traffic directions, specific limits, which depend on the road category, have to be met for the speed differences between adjacent elements. The design speed-profile is also used to calculate the sight distance since it shows the speed on each point of the alignment.

*Intersections and Interchanges*

The standard for the design of intersections and interchanges was recently published as a ministerial decree in 2006 (8). It is also based on the functional classification of the roads that is provided by the New Road Code since their functional and geometric characteristics have to be consistent with those of the related roads. Based on the road classification, the nodes can be represented as elements of a symmetric matrix (8x8), as shown in Figure 7, where all possible junctions between two roads (or symbolic points) can be seen.

The matrix shows homogeneous nodes connecting similar roads and not homogeneous nodes connecting roads belonging to different categories. In case of homogeneous nodes, connections to transfer the traffic flow from one road to another are always allowed, while in case of not homogeneous nodes connections are not always permitted because of safety and operational reasons. Therefore some nodes, when there is a considerable difference in the hierarchical classification of intersecting roads, are considered not admissible. In case of admissible connections, there are different kinds of nodes which show a different number of crossing conflicting points. In case of a node where all the intersecting roads have divided carriageways, crossing conflicting points are not admitted and an interchange (grade separated junctions) will guarantee the connection (node type 1).

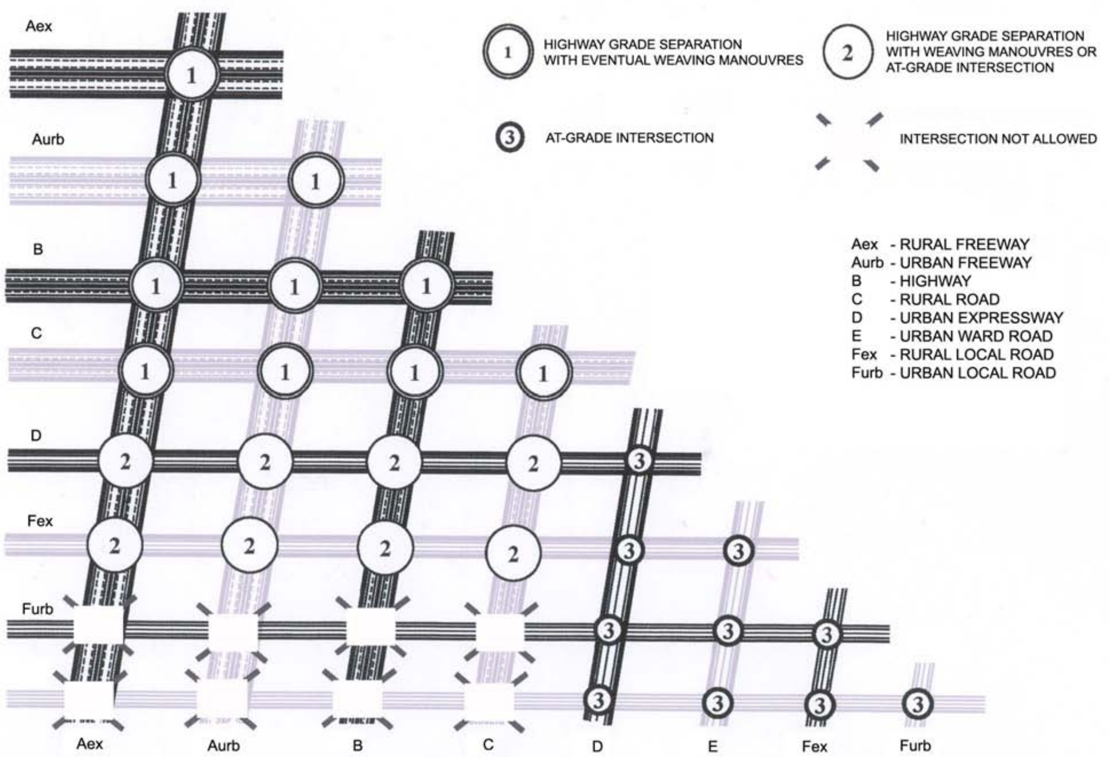


**Figure 7 Admissible types of junction between different road categories**

In case one of the intersecting roads of the node has its cross section planned with one single carriageway, cross traffic movements are admitted on this road; the intersection must be grade-separated to avoid conflicts (node type 2) if the other road have divided carriageway. In case of two roads the cross section of which is planned with one single carriageway, the node is an at-grade intersection (node type 3). The different nodes identified in Figure 7 can be associated with varied appropriate geometric solutions according to the category of intersecting roads at the node.

**ROAD SAFETY AUDIT OF DESIGN PROJECT**

Nowadays, Road Safety Audits –RSAs if referred to the design level or Road Safety Audit Review – RSARs, Road Safety Inspections - RSIs, if referred to the existing roads, have shown their effectiveness in improving the road design with respect to safety. These methodologies foresee the proactive evaluation of roads safety conditions, both at a design level and for existing highways tends to establish worldwide. Specifically, due to the complexity of the road design, the simple observance to guidelines and design standard is not sufficient to achieve level of safety for all traffic conditions (day, night, good weather, rain, fog…) and for all users (cars, heavy vehicles, two-wheels, bycicles, pedestrians, old drivers, young drivers…).

First applications of Safety Audit started in the ’80s in the United Kingdom referring to the railway engineering experience yet settled and they become mandatory for National road network since 1990. At the beginning, the systematic employ of the procedures spread in Australia and in New Zealand, while its use in the last decade gradually propagates in several Europian countries, in North America, in Japan and in South Africa.

In Italy, the formalization of the road safety audit (RSA) of both design and existing roads was introduced by the Circular no.3699/2001 “Guidelines for Road Safety Audits” (10), promulgated by the Ministry of Public Works. The RSA is defined as *” the formal safety examination of a road project, a traffic plan, an existing road or a project interacting with road users, in which an independent and qualified analysis team reports on potential crash risk and on road safety performances”*. The application of road safety audit to road project in not mandatory in Italy. From the publication of the Guidelines only few audits were carried out on voluntary base or in the field of pilot project promoted by the National Road Safety Plan.
Recently, the Directive 2008/96/EC of the European Parliament of 19 November 2008 on “Road Infrastructure Safety Management” (11), strengthens the value of the systematic application of Safety Audit and Safety Inspection Procedures. The EU Directive will became in force for all the European countries in December 2010. Even though the Directive shall apply to roads which are part of the to trans-European road network (TERN), Member States are invited to apply the provisions of the Directive, as a set of good practices, to national road transport infrastructures not included in the trans-European road network. Nowadays the application of RSA and RSAR to all the road network is diffused in Europe and Italy but it is above all conducted on voluntary base because the requirements are not mandatory (Figure 8).

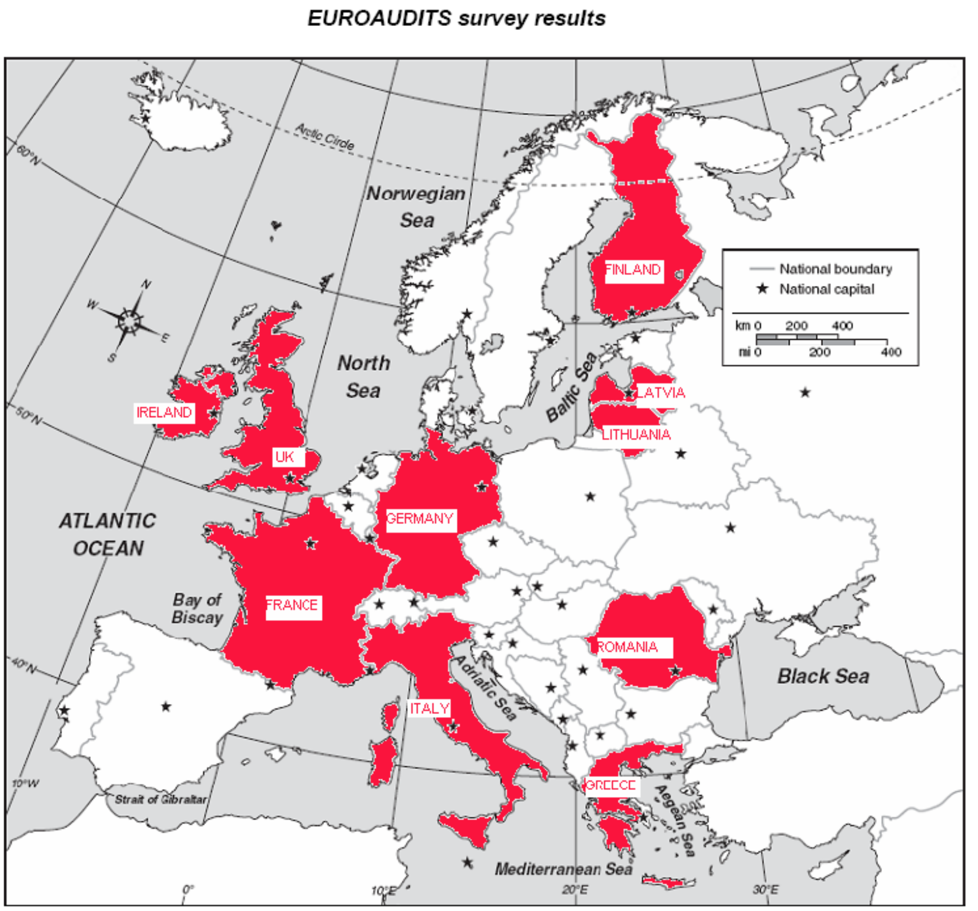


**Figure 8 Countries with requirements to carry out RSA on all part of their road network (EUROAUDITS Survey Results, 2007).**

The European Directive requires the establishment and implementation of procedures relating to the planning phase (road safety impact assessment), to the design level (road safety audit), and to the

management stage (the management of road network safety and safety inspections) by the Member States.
The Directive introduces a complete and coordinate system of road safety management specifically referring to the following four procedures:

1) Road safety impact assessment for infrastructure projects
   A road safety impact assessment shall be carried out at the initial planning stage before the infrastructure project is approved.
2) Road Safety Audit
   Road safety audits shall form an integral part of the design process of the infrastructure project at the stage of draft design, detailed design, pre-opening and early operation.
3) Safety ranking and management of the road network in operation
   Member States shall ensure that the ranking of high accident concentration sections and the network safety ranking are carried out on the basis of reviews, at least every three years, of the operation of the road network. Member States shall ensure that road sections showing higher priority according to the results of the ranking of high accident concentration sections and from network safety ranking are evaluated by expert teams by means of site visits.
4) Safety Inspections

   Member States shall ensure that periodic safety inspections are undertaken by the competent entity in respect of the roads in operation in order to identify the road safety related features and prevent accidents. Such inspections shall be sufficiently frequent to safeguard adequate safety levels for the road infrastructure in question.

The European Commission estimates a yearly reduction of 600 fatalities per year due to the application of this directive to the TERN. This value shall grow of further 400 fatalities if extended to all European freeways and of further 900 fatalities if applied to two-lane National rural roads.
Specifically articles 2 and 4 of the European directive refer to the application of RSA to infrastructure projects as 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*".

The basic criteria for RSA, reported in Annex II of the Directive, are similar to those of the Italian Circular 3699/2001. They investigate the potential interactions among road users behaviours and geometrical and operational characteristics of road environment:

1. Criteria at the draft design stage:

(a) geographical location (e.g. exposure to landslides, flooding, avalanches), seasonal and climatic conditions and seismic activity;

(b) types of and distance between junctions;

(c) number and type of lanes;

(d) kinds of traffic admissible to the new road;

(e) functionality of the road in the network;

(f) meteorological conditions;

(g) driving speeds;

(h) cross-sections (e.g. width of carriageway, cycle tracks, foot paths);

(i) horizontal and vertical alignments;

(j) visibility;

(k) junctions layout;

(l) public transport and infrastructures;

(m) road/rail level crossings.

2. Criteria for the detailed design stage:

(a) layout;

(b) coherent road signs and markings;

(c) lighting of lit roads and intersections;

(d) roadside equipment;

(e) roadside environment including vegetation;

(f) fixed obstacles at the roadside;

(g) provision of safe parking areas;

(h) vulnerable road users (e.g. pedestrians, cyclists, motorcyclists);

(i) user-friendly adaptation of road restraint systems (central reservations and crash barriers to prevent hazards to vulnerable users).

3. Criteria for the pre-opening stage:

(a) safety of road users and visibility under different conditions such as darkness and under normal weather conditions;

(b) readability of road signs and markings;

(c) condition of pavements.

4. Criteria for early operation: assessment of road safety in the light of actual behaviour of users.

Audits at any stage may involve the need to reconsider criteria from previous stages.

The auditor is appointed by the 'competent entity', i.e. by any public or private organisation set up at national, regional or local level, involved in the implementation of the Directive by reason of its competences, on the basis of main requisites of qualification and independence.

The Italian Circular recommends the following requisites: multi-disciplinary abilities and experience in road planning, traffic engineering, road engineering, crash investigation and prevention, and, more generally, a deep knowledge of the road safety principles. The EC Directive decrees that the auditor hold a certificate of competence issued by a reliable organization.

Both for the Directive and the Circular 3699/2001, a peculiar feature is the independence of auditors team by the design, construction and management process of the infrastructure.

## RESEARCH IN THE FIELD OF GEOMETRIC DESIGN

This paragraph of the country report would give to the international readers a synthetic overview of the most significant researches in the field of geometric design investigated in Italy. This presentation can't be considered exhaustive of all the studies carried out in Italy also because uses as primary reference international conferences organized by TRB and SIIV (Italian Society of Transport Infrastructures) in the last 3 years.

Since many years [International Symposium on Highway Geometric Design, 2005] the Italian research has shown a great interest in the operating speed ($V_{85}$, the $85^{th}$ percentile of the distribution of passenger cars speed values) as an estimator of **driver behavior** along freeways, highways and low-volume roads. $V_{85}$ may be adopted for the design of the individual geometric elements [TRR n. 1961, 2006], to check the consistency of the whole alignment and in the before/after analysis to evaluate road upgrades [TRB Annual Meeting Proceedings, 2009]. The operating speed model formulation uses the statistical methods for the interpretation of data collection, identifying the variables that are more important for the speeds. The Italian operating speed models use essentially two classes of variables: the variables associated to the element of the road and the variables referred to the general features of the alignment. The speed models on curve that also use the geometric features affected the previous site can be divided in two areas: models estimating the speed on horizontal curves as a function also of the environmental (or desired) speed [TRB Annual Meeting Proceedings, 2007] and models introducing the geometric characteristics of the previous curve as independent variables [TRB Annual Meeting Proceedings, 2008]. The speed models on tangent consider the operating speed as a function of its geometric features. When the tangent is short (or dependent from curve) the speed model is a function of the geometric characteristics of preceding curve, otherwise, in the presence of long tangent (free from the previous curve) the speed models are also a function of the homogeneous section. The improvement of the knowledge of speed variations along the transition sections is important above all in the search of the deceleration/acceleration rates approaching/departing from curves and intersections [TRB Annual Meeting Proceedings, 2010]. Obviously speed factors and prediction models are quite different for freeways, highways and low-volume roads. Further, speed prediction models were calibrated also by driving simulator experiments carried out at the CRISS research laboratory in Rome.

In literature, only marginal attention to the effect of the intersections on the speed profile has been dedicated. Indeed, the existing operating speed-profile prediction models do not take into consideration the presence of intersections along the road. To overcome this limitation, speed behaviour approaching and departing from at-grade intersections with stop control and modern roundabouts with yield control were studied and a procedure to predict the operating speed-profile along a road section characterized by the intersection presence was developed. As a result, a procedure to consider the presence of the intersection on the minor road in the operating speed-profile model was developed.
The effect of the presence of the intersections in the major road was investigated by a driving simulator experiment. The VERA dynamic-driving simulator, operating at the TEST Road Safety Laboratory located in Naples, was used. Results showed that the speed behaviour in the tangents was significantly affected by the presence of the intersection. Further, several perceptual aimed at increasing the intersection detection were tested. The treatments helped the driver to detect the intersection earlier and to slow down. The results contradict the Italian geometric design standard, which require a speed profile that does not take into account the intersections on the major roads.

Italian researches on operating speed are, also, finalized to define correlations between driver "speed errors" induced by road geometric design and safety. The excessive driving speed with respect to roadway geometry may be related to inconsistencies in the horizontal alignment, which cause the driver to be surprised by sudden changes in the road's characteristics with an increase in crash frequency. Specifically, in Italy, a significant research activity is aimed at investigating the relationship between crashes and variables related to design consistency and geometric design [TRB Annual Meeting, 2008, 2009, and 2010]. Research focused on two-lane rural highways and on rural motorways. Parameters related to design consistency and geometric design resulted significant explanatory variables in crash prediction models for both the two-lane rural highways and the motorways.
Crash prediction models, also known as safety performance functions, were calibrated using negative binomial regressions in a sample of two-lane highways. Two consistency variables and one geometric variable were significant: the standard deviation of the operating speed profile, the number of speed differentials greater than 10 km/h, and the ratio between the length of curves and the total length of the homogeneous section.
Crash prediction models were fitted for estimating the safety of the rural motorways. Separate models were developed for total crashes and severe (fatal plus all injury) crashes. Further, disaggregated models were calibrated for the following crash types: night time, day time, rainy, non rainy, run-off-road, and non run-off-road. Generalized linear modeling techniques were used to fit the models, and a negative binomial distribution error structure was assumed. The significant variables related to design consistency were: operating speed reduction, length of the tangent preceding the curve, with a positive sign; difference between friction demand and supply, second curve (curve preceded by another curve or by a tangent shorter than 250 m), with a negative sign. The significant variables related to geometric design were: curvature and square curvature, with a positive sign; deflection angle (central angle of the curve), equivalent upgrade, sight distance, and right shoulder width, with a negative sign. The most important result is that design consistency

measures significantly affect road safety not only on two-lane rural highways, as found in many studies reported in literature, but also on motorways.

The effects of design consistency were, also, evaluated by the way of naturalistic studies conducted on drivers running on two lane rural roads (TRB Annual Meeting, 2009). The maximum driving speed differential between two successive elements and between the average section speed and the minimum single element speed were identified as Driving Performance Indicators because statistically correlated with crash data.

Another more relevant research topic concerns **roundabout** design criteria. Modern roundabouts are distinguished from traffic circles by their uniform characteristics in operation and design. Special attention was recently given to the turbo-roundabouts [International Symposium on Highway Geometric Design, 2010]. European improvements in design, operations, and traffic regulations have led to safer performance in roundabouts than in conventional intersections. In Italy roundabouts have become one of the most significant traffic control measures because they are generally safer and more efficient than traditional at grade intersections. Particularly geometric design elements are important factors affecting capacity and safety. From many years studies are dedicated to the evaluation of the operating conditions of roundabout: capacity, waiting phenomena, safety and reliability [TRB Annual Meeting, 2007 and 2010].

Lastly research topic concerns **road landscape** procedures associated with, the assessment, design and management of roads as they affect the Italian landscape. The research objectives are: procedures and requirements for landscape assessment in the concept phases of road projects, design measures to achieve a better integration of roads and the landscape through which they pass, design practice and standards addressed within the landscape design phase of road projects, management considerations for the maintenance of new and existing road landscapes [TRB Annual Meeting, 2010].

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