INFRASTRUCTURAL ACTIONS FOR THE REDUCTION OF ROAD ACCIDENTS IN URBAN SETTINGS

Fabio Fonte – Giovanni Leonardi – Francesco Scopelliti - Elisa Barbera
DIMET - Università "Mediterranea" di Reggio Calabria
email: giovanni.leonardi@unirc.it

ABSTRACT. In the last decade, road accidents have caused in our country over 72,000 deaths and 2,400,000 injures; Italy, which in the seventies was one of four European countries with the highest indexes of road safety, nowadays has become a country with medium-low safety levels.
It is therefore evident the need to intervene on the current mobility model, aiming to conditions of grater safety.
This objective can be achieved by joint and coordinated action of several public and private subjects, which can create a cultural context, technical and organizational, for a more effective management of mobility.
One of the peculiar characters in the Italian context consists in the high rate of urban accidents: in our cities, in the 2006, there were 182,177 accidents (76.5% on the total) which have caused 242,042 injures (equal to 72.7% on the total) and 2,494 deaths (44%). These values place our country in an anomalous situation in the UE panorama, in fact, the number of victims of road accidents in urban areas is significantly higher than the European average and this shows how the level of road safety in Italian cities is decidedly lacking.
This study aims to develop a methodological approach that allows to measure accidents in urban areas, especially along the major roads of access to urban areas, in order to analyse the influence that the characteristics and forms of urban space, for example, the configuration of infrastructure, public spaces, the morphology of roads and the city, and the consequent use, have on the phenomena of danger.
In order to identify appropriate intervention strategies for the improvement of safety standards through adequate planning and urban management. The research, in particular, analyzes the overall state of road in the city of Reggio Calabria, based on some project proposals for action on an area at high risk.

Keywords: *road safety, model, speed, plan, risk.*

THE PROBLEM OF ROAD ACCIDENTS IN EUROPE

In fifteen countries that constituted the European Union before the last two enlargements, road accidents occurred between 1953 and 2005, led to approximately 2.9 million deaths and 87.3 million injures; these are indicative data, based on detection methods modified several times and which only recently have reached a sufficient degree of homogeneity, but they are certainly adequate to indicate the enormous sacrifice of lives and destruction of professionalism, working ability, experience and material goods determined by road accidents in Europe.

The number of fatalities resulting from road accidents has grown constantly in all countries, except for rare exceptions, until the beginning of the '70ths, rising from 41,000 to over 81,000 deaths for year and from 1.0 to 2.1 million injures for year.

This phase of intense growth has followed, in almost all European countries, two subsequent phases of reduction (the first develops in the early '70ths and continues until the middle of '80ths, the second starts since the middle of '90ths and continues to this day), separated by a brief period of stagnation (between the late '80ths and early '90ths), this is attributable to some major socio-economic processes, such as the evolution of road network and transport system and on the qualification of government capacity. A decrease in the number of deaths characterizes the years '70 and '80, but tends to run out on the threshold of the '90ths, when the improvement of security levels, which follows the modernizing of roads and vehicles, is no longer able to offset the growth in vehicle fleet and volumes of traffic, the greatest speed of vehicles and changes in the composition of movements.

In those years, studies on road accidents started to be done, beginning to propose contrast actions, by ONU-ECE, OCSE, CEMT, European Commission and national governments of some European countries.

THE SITUATION IN ITALY

Italy's record shows a mortality rate (9.2 deaths for 100,000 habitants) slightly higher than the average of UE15 countries (8.1 deaths per 100,000 inhabitants) and considerably lower than that of the twelve countries of new entry (and of the U.S. and the Russian Federation) and significantly higher than that of the three European countries of EFTA (Iceland, Switzerland and Norway).

Therefore, our country is in an intermediate position, so if it is well away from the best statistics, where there are less than 6 deaths per 100,000 habitants, on the other hand it is equally distant from the most critical records, as in those countries where there are more than 12 deaths per 100,000 inhabitants.

Nevertheless, there are two basic reasons to believe that the Italian situation is not at all satisfactory. The first concerns the fact that the comparison with situations of excellence in numbers shows that our country has a higher casualty count of around 2,800 deaths/year, which is undoubtedly a high value. The second worrying reason regards the evolution of road safety. In fact, after a period of stagnation, between the end of the 80s and start of the 90s, which has characterized all European countries, Italy has failed to open a new phase and a consequent reduction of the number of victims of road accidents. By comparing the improvement achieved by our country, between 1990 and 2005, with the European average, we find that, while until 1990, Italian mortality rates were significantly lower than the European average, from 1991 onwards these rates have become higher, and the gap is growing in time.

The conclusion is that from the 90s, Italy has been accumulating a delay, in comparison to the countries of UE15, which increases as years go by.

Even the latest action to contrast road mortality, represented by legislation in 2003 which introduced points on driving licenses, resulting in an intense reduction of the number of victims, was exhausted within 12 months and, as shown by the data of 2006, we have a restarting of growth of the number of accidents and the related mortality.

URBAN MOBILITY AND ITS COMPONENTS

Over 65% of victims is determined by accidents on urban roads, with reference to more recent years [ISTAT (2006)], it is significant to point out that the relative weight of urban accidentality rose from 64% in 2004 to 66% in 2005 and to 76.5% in 2006 (Table 1). These numbers show how our cities, which already in the past had higher risk rates than other European countries, in 2006 recorded a further deterioration of safety levels.

This deterioration of urban road safety compared to road safety in general is not only about the recent period, but has risen steadily since 1970.

The components of mobility that have a greater weight in the total accidents are passenger cars (66.5% of vehicles). Motorcycles are 21.4%. Therefore among vehicles involved in an accident, 1 out of 5 is a two-wheeled vehicle.

Road environment	Accidents	Deaths	Injuries	Mortality Index)	Injury index(b)
Urban Roads	182.177	2.494	242.042	1,3	132,8
Motorway	13.319	590	22.646	4,4	170,0
Other Roads	42.628	2.585	68.267	6,1	160,1
Total	**238.124**	**5.669**	**332.955**	**2,4**	**139,4**

(a) Ratio between the number of deaths and of injuries, multiplied by 100.
(b) Ratio between the number of injuries and of deaths, multiplied by 100.

Table 1 – Accidents on roads – Year 2006 (ISTAT & ACI 2007).

The 66.1% of deaths and 70.4% of injuries in road accident is suffered by drivers in involved vehicles, the transported passengers are the 20.5% of the deaths and the 23.3% of the injuries and pedestrians, which represent the “weakest link” on roads, are 6.3% of the injuries but as much as 13.4% of the deaths (Table 2).

Road User	Deaths		Injuries		Severity Index(a)
	Number	*Percentage*	*Number*	*Percentage*	
Drivers	3.748	66,1	234.476	70,4	1,6
Passengers	1.163	20,5	77.417	23,3	1,5
Pedestrians	758	13,4	21.062	6,3	3,5
Total	**5.669**	**100,0**	**332.955**	**100,0**	**1,7**

(a) Ratio between the number of deaths and the total number of deaths and injuries, multiplied 100.

Table 2 – Deaths and injuries by category of road users – year 2006.

ROAD ACIDDENTS ON THE CITY OF REGGIO CALABRIA

The territory of Reggio Calabria presents, at the administrative, infrastructural, historical and environmental level, peculiar characteristics that affect significantly on mobility of people and goods. Reggio Calabria presents a particular urban structure characterized by an urban centre with a linear morphology longitudinally developed and with strong variation in level and a remaining part of town that incorporates various districts scattered in a radius of several kilometres.

The city has a population of over 184,000 habitants, most of which employed in tertiary, commercial and industrial activities, with a density of 781 habitants/sq km, the highest in the region. The vehicular circulating park in the municipality and the Province, recorded by ACI, in the years 2002 to 2005, is characterized by an overall increase of vehicles, in particular, in the city of Reggio has risen from 101,974 cars in 2002 to 105,369 cars in 2005, with an increase of 3,395 cars (+3.3%) in the considered period. It is important to highlight the change in the percentage composition of vehicles over the years: between 2002 and 2005, in particular, a percentage decrease of passenger cars, compared with total vehicular park, and a contemporaneous rise in motorcycles, means of transport with high risk of accidents, was recorded.

TRANSPORT SUPPLY

Reggio Calabria is characterized by a series of roads parallel to the waterfront from which perpendicular roads linking the lower part with the upper part of the city depart.

The great viability is constituted by the motorway A3 Salerno-Reggio Calabria, the SS106 Jonica (Reggio Calabria - Taranto) that connects all cities in the Ionian side with the city centre, the SS18 Tirrena Inferiore (Napoli - Reggio Calabria) and by the bypass of Reggio Calabria, which crosses in Reggio suburban area linking the districts of the city by a system of fifteen junctions.

The whole city, in the bottom and, especially, in the central area, is characterized by a very dense road network that is interrupted by avenues and roads linking districts.

In recent years, new infrastructures were built to reduce the problems of crossing of all the central area. In particular, the rivers within the city were covered, which were fracture element relatively to mobility, and a series of improvements to existing infrastructure have been implemented.

The study of General Plan Urban Traffic (PGTU). has shown, firstly, that there isn't a clear functional hierarchy of the network and a lack of adequate connecting or transit elements between local and crossing roads.

This situation generates points of discontinuity and creates disturbances in the system of movement of each infrastructure that significantly increases the risk of accidents, because there isn't a clear separation or regulation of different type of displacement. The second consideration that emerges is the practice of wild stop, strongly opposed by the Local Administration; either with sanctions measures that with the establishment of numerous parking lots, but still practiced. This drastically reduces the capacity of roads and determines conditions of chaotic congestion; witch reduces road safety, because it induces users, especially drivers of cars or motorcycles, to hazardous and/or prohibited manoeuvres.

The municipal Administration, to reduce private traffic in the city centre, and encourage the movement of pedestrians and the use of public transport, has established a low-traffic area (ZTL).

ACCIDENTALITY

The results of surveys conducted in the urban areas [Progetto SICUR (2005)] show that the road sections with the largest volume of daily traffic flow and maximum hourly flow are the section of Via Matteotti with a number of approximately 16,500 vehicles per day and a maximum flow of over 1,000 vehicles for hour, measured in the time between 21.30 and 22.30, and the section of Bretella Argine sinistro Calopinace, with 14,500 vehicles per day and a maximum hourly flow over 1,100 vehicles for hour, measured in the time between 19.30 and 20.30.

The most loaded road, during the 24 hours, is the circular highway (bypass), which bears the greatest volume, especially in the direction of entry from the north of the city, ranged from 2,500 to 1,500 vehicles/h. In the urban area, always in reference to 24 hours, the roads affected by major traffic flows are: via G. Matteotti, Corso Vittorio Emanuele III, the Bretella Argine sinistro and Argine destro Calopinace, with traffic volumes between 2,500 and 1,000 vehicles/h. Viale Europa, Viale Calabria, Viale Aldo Moro follow with traffic volumes between 1,000 and 500 vehicles/h.

With reference to the period 1995 - 2005, the temporal evolution of the phenomenon of road accidents on the city of Reggio Calabria was reviewed (Figure 1). From 1995 to 2005, inside the territory of the municipality of Reggio Calabria, there were 6470 traffic accidents, with 92 deaths and 9,350 injuries of varying severity.

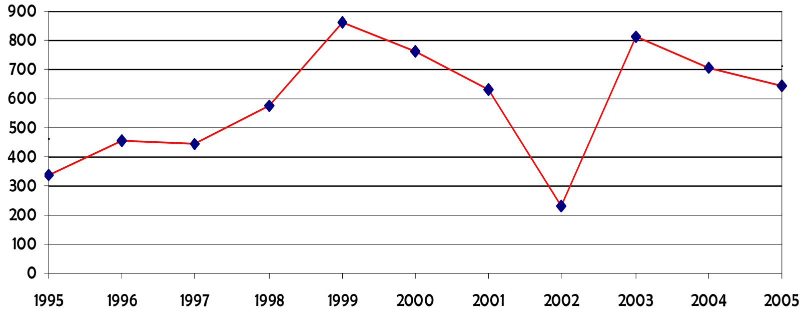


Figure 1 – Number of accidents in Municipality of Reggio Calabria.

After 2003, also for the municipality of Reggio Calabria, we have a decrease in the total values of accidents, presumably due to the implementation of a series of measures introduced by the new Road Code.

In the period from 01/01/2005 and 15/12/2006, the local police noticed over 1,791 accidents, of which 782 with only material damage, 1,004 with 1,317 people injured and 5 mortal accidents which caused 5 deaths.

By analyzing data of the streets affected by more than 15 accidents in the biennium 2005-2006, the highest number of accidents was noted on Viale Calabria (53), while the highest damage index was in Via Italia (1,00).

By comparing the accidentality data with the volumes of traffic, we can get useful information. For example, we can see that the roads with a high damage index are the same ones that were crossed by large flows and characterized by high speeds, in particular Viale Europa, Corso Matteotti, Via Bretella Argine DX Calopinace and Viale Calabria, affected by daily flows exceeding 6,000 vehicles.

However, minor flows, less than 4,000 vehicles for day, cross Via Sbarre Centrali and Via Torrione, both characterized by a damage index lower form the previous ones. The only exception is represented by Via Italia, which, although it is crossed by not very large flows, presents a high index of damage.

Regarding the accident distribution in the territory for 2005 and 2006, we see that the larger amount of accidents is concentrated along a central strip of the city that runs parallel to the coast, while in the area suburban the phenomenon is more modest and numerically insignificant.

By splitting the territory into three zones, namely “southern”, “central” and “northern”, it is possible to develop the following considerations relating to accidents of the last biennium. In the southern area, the roads characterized by highest values of accidents are Viale Calabria (53), the Vie Argine Destro and Sinistro Calopinace (23), Viale Europa (32) and the Via Sbarre Centrali (19); in particular, Viale Calabria is the one with the highest number of accidents.

Another point where there is a significant concentration of accidents is the roundabout where the Viale Europa converges.

In central area the record of accidents is of Via Matteotti (45), while the road with the greatest kilometrical frequency, i. e. the number of times with which the phenomenon is repeated along the same road, belongs to Corso Vittorio Emanuele I.

Also, we marked an elevated concentration of accidents at the area identified by the roads Via Vollaro, Via Colombo and Corso Giuseppe Garibaldi (25). In the south area the accidentality has values much lower, with maximum values in Via XXV Luglio and the Via Cardinale Portanova, both with a number of accidents equal to 8.

Another significant datum about the urban accidentality is represented by trunks critical sections of the network or those sections with a frequency of accidents for km significantly high.

The road that have the highest values are: the Viale Calabria (5,09 Inc/100mt), the Via Sbarre Inferiori (4,97), the Viale Europa (3,63), the Corso Garibaldi (5,28), the Via Matteotti (8,94), the via Torrione (4,02), the via Aschenez (5,53), but also streets with fewer accidents but that, compared to their modest extension, are particularly critical, such as the via S. Anna (6,49), the Via Giulia (3,22), the Via S. Francesco da Paola (3,54), the Via Missori (3,24), the Viale Roma (3,24).

We can developed the same analysis for road intersections, comparing the number of accidents with the number of deaths and injuries (damage index), the highest values are found in the intersection between the Via Itria e la Via Sila (damage ind. = 2,75), probably due to the high speed at which this intersection is often crossed, the intersection between the via XXI Agosto and the Via S. Francesco da Paola (1,50), the intersection between Viale Roma and Via G. De Nava (1.25), the intersection between the Via Vittorio Veneto and Via XXV Luglio (1.25) and the intersection between Corso G. Matteotti and the Via Plebiscito (1,25).

The hardest consequences for the involved vehicles are those relating to weak users and two-wheeled vehicles, which are the classes clearly with the highest number of injured in relation to the number of accidents (Table 3).

Analyzing the distribution of the phenomenon on the territory is possible, therefore, to identify weaknesses in the urban road system.

In particular, we found that accidents are more concentrated in correspondence with the intersections of the complex Argine DX and SX Calopinace and along the network of roads located in the central part of the urban area, overlooking Corso Vittorio Emanuele I, Via Vollaro, Via Matteotti and Corso Garibaldi.

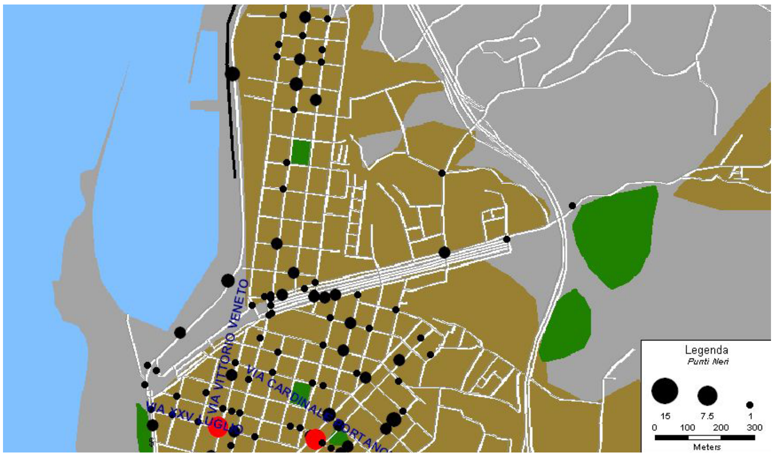


Figure 2 – Black spots in the northern zone of Reggio Calabria.

Contrary to what we might expect, the more numerous accidents do not occur at the intersections (26% of the total in the biennium 2005-2006), but along the road arches.

In fact the intersection with the highest number of accidents is formed by Via Vittorio Veneto and Via XXV Luglio (Figure 2), with 8 accidents, while 16 occurred on a stretch of Via Matteotti between Via 2 Settembre and Via XXIV Luglio.

Table 3 shows a particularly important datum; i. e. the five deaths occurred in Reggio Calabria from 1 January 2005 to 15 December 2006, affected only pedestrians.

Vehicle class	*accidents*	*injured*	*deaths*	*Damage rate*	*Death rate*
Pedestrians	161	146	5	90,7%	3,1%
Car	1574	611	0	38,8%	0%
HGV	212	28	0	13,2%	0%
motorcycles	572	532	0	93,%	0%
other	42	2	0	4,8%	0%

Table 3 - Accidents for vehicle class (01/01/2005 al 15/12/2006).

INFRASTRUCTURAL ACTIONS FOR SAFETY IMPROVEMENT

To identify the most effective operational strategies for the improvement of safety standards is necessary to develop a Safety Plan for an adequate planning and management of operations.

The contents of a safety Plan (SP) for local mobility can be schematized as shown in the following flowchart:

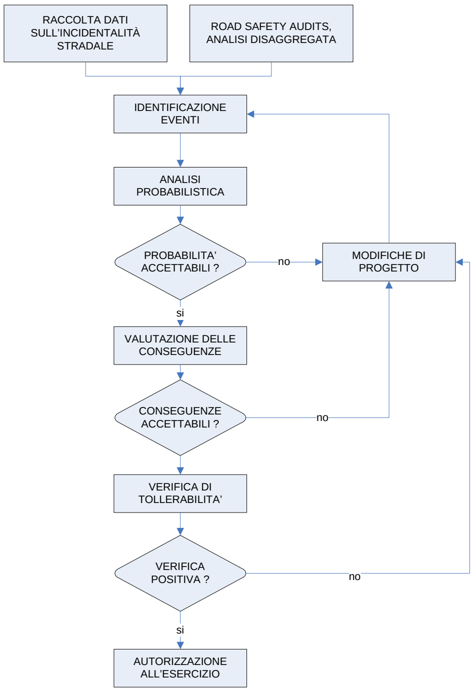


Figure 3 – Framework of urban Safety Plan [Galatola (2006)].

As shown in Figure 3, we can summarize the main operational steps for the elaboration a Safety Plan:

Analysis Phase and Identification of Events

At this stage, it is necessary to define a framework allowing the information timely detection of accidents on urban roads and the identification of systematic highest risk situations. This must be achieved through the identification of situations (intersections, roads, areas formed by a grouping of roads, types of mobility, etc.). At highest risk, characterized by mortality rates and higher injury and recursive.

Within such a database on urban accidents, we must specifically identify the information on the categories of users who have the highest rates of specific risk.

At this stage, it is necessary to define a framework allowing the information for the timely detection of accidents on urban roads and the systematic identification of highest risk situations.

This must be achieved through the identification of situations (intersections, roads, areas formed by a grouping of roads, types of mobility, etc.) with highest risk, characterized by mortality and injury higher and recursive rates.

Dividing the urban area into areas bounded by barriers such as railway lines, rivers etc, may be useful at this stage. It may also be useful to consider where different parts of the urban area have very different housing types or land use.

The aim of the analysis phase is to assess how the road network is currently used, its suitability for the various functions required of it and what are the safety and mobility problems.

Accident data is analysed under various headings such as:

- by road user type
- by accident type
- by vehicle type
- by road type
- by time of day
- by road condition

This allows for common types of accidents to be identified, and measures designed to affect and reduce them. It is often useful to look at all motor vehicle casualties on the various road categories and consider pedestrian casualties and two wheeler casualties separately. The analysis should show which areas have the highest accident rates where measures might be considered first. It is very useful to produce accident maps for the road network so that an immediate visual impression of accident density can be gained, perhaps by type of accident.

Ideally the map should also show vehicle and pedestrian flows. The data analysed should ideally cover a period of at least the past three years so that trends and variability can be studied, and any underlying pattern can become apparent.

Data on speed is also important and will often need to be collected for both planning and monitoring purposes. It is important to collect data on a range of roads.

The identification of events can be conducted through appropriate methodological tools, among these it is possible to identify the Road Safety Audits and disaggregated analyses. The Road Safety Audit is conducted by an interdisciplinary team that identifies the issues related to a critical question with the technical audit routine.

For the disaggregated analysis of accidents various methodologies have been proposed. The traditional methodology uses the “diagram of a collision”. A more recent methodology is the “accident scenarios”.

One “accident scenario” can be defined as “a prototype development corresponding to a group of accidents which have a set similarity in the overall sequence of events and causal relationships, within the different steps leading to the collision”. The methodology for analysis by scenarios consists in the aggregation of the accidents occurring in a black point in groups with common characteristics: for example we can consider the groups of accidents involving pedestrians, those resulting from loss of vehicle control, etc..

The general methodology is articulated in the following steps:

1) every accident is subject to detailed analysis to study the evolution, which consists in the following phases:
   - driving, before occurrence of event;
   - braking (event of non-return);
   - emergency, immediately before impact;
   - shock and impact;
2) the cases of accidents are grouped according to the similarities by statistical techniques (such as cluster analysis);
3) each group is associated with an existing accident scenario or a new accident scenario as much as possible independent from the path of analysis.

Identification of probability of occurrence

The evaluation of probabilities can be completed reconstructing the risk using techniques such as the construction of fault trees and of events.

However, in road safety assessment this is not generally done considering that the analysis can always be made only at statistics level.

In fact, precisely the objective of quantifying risk analysis should push to define the probability of accidents at forecast level.

Therefore, it is desirable to develop appropriate forecast models that will rebuild the level of accidentality of a road according to the flows, geometry and behaviours, calibrating the model on existing statistical data.

Such models have been developed in the accidental analysis of collisions between ships and between vehicular transporting dangerous goods and they would be useful to help to choose the most appropriate and effective solutions to reduce accidents at the desired levels taking into account the available resources. In the absence of ad hoc models the probabilistic forecast analysis can be fully carried on the historical basis.

Design phase: engineering solutions and simulation the effectiveness of interventions

The aim of a SP should be to integrate all activities affecting safety and produce a “strategy”. The strategy will form a long-term framework for action. Out of the strategy will come the safety objectives which will be achieved by either safety schemes or other actions. There are two main elements in the application of the engineering element to a road network. They are:

- managing traffic to achieve a safer distribution
- managing speed to achieve a safer circulation.

The strategy will have identified a number of safety objectives for which measures to achieve these objectives need to be designed.

There are a variety of measures that can be used to reduce the number of road traffic accidents, and improve road safety. Although, priority goes to prevention actions, that is the infrastructural works which suppress the problem.

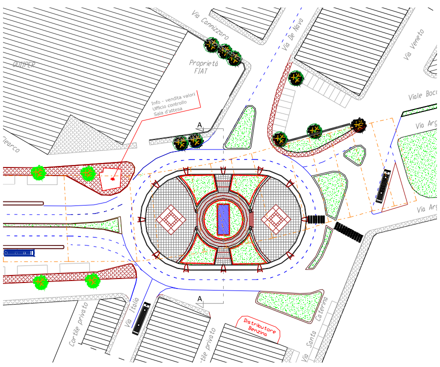
Innovative redesign of public road space to give a better quality of urban environment should be considered as a long term aim but in the interim a number of low-cost engineering measures appropriate for area-wide schemes have been developed. These include road humps, mini-roundabouts, ghost islands, central hatching, gateways, chicanes, pinch points, cycle lanes, central refuges, road side build-outs, 30 km/h zones, home zones, mixed priority route treatment etc.

As example, we show in Figure 4 two infrastructural interventions carried out in the city of Reggio Calabria, in particular, several roundabouts at the intersections of one of the main axes of access (v.le Annunziata and v.le della Libertà) in the north area of the municipality are introduced.

A database of the projects has to be developed, to be consulted to define actions for the different range considered. Once agreed, the designs of possible countermeasures must be selected or developed to achieve the aims of the strategy.

Assessment phase: assessment of consequences and impact simulation

Accident and casualty numbers are clearly the major indicators of the success or otherwise of SP. But it is also important to measure the effect on other aspects of mobility such as accessibility, the speeds and flows of motor traffic, and the amount of walking and cycling to gain a better understanding of how the various measures work. It is also useful to measure environmental effects such as noise and air quality as these can be potential sources of concern to the public.



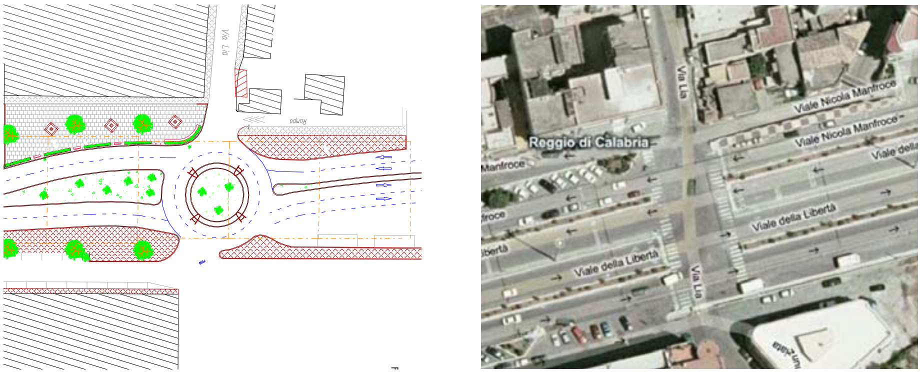


Figure 4 – Examples of infrastrucutural designs using roundabouts – Piazza della Libertà & V.le della Libertà – Via Lia - Reggio Calabria.

Any changes in public awareness and opinions are also important in being able to judge the acceptability of SP to the local citizens. These can be measured by interview surveys or focus groups but it is important to get a good cross section of public opinion. Relying only on letters of objection can give a misleading impression of the community's views.

Verification of tolerability

Regarding to road safety, we prefer to analyse the tolerable risk for section, or for unit of length [Lord *et al.* (2004), Galatola (2006)].

To reconstruct the risk we must make the sum of couples FN (frequency/number of deaths) of the various events, where the frequency $F_{g,k}$ of accidental final event k, on the section g can be estimated by:

$$F_{g,k} = T \cdot R_k \cdot A_g \cdot P_k \qquad (1)$$

and the corresponding number of fatalities $N_{g,i,k}$ (number of deaths as a result of final accidental k, caused by the scenery i on the section g) by:

$$N_{gk} = VC_{g,k} \cdot PV_g \cdot PF_k \qquad (2)$$

where:

T = number of trips for year;

A_g = accident rate for km of g-th section;

R_k = probability that checks the i-th accidental event happens;

P_k = probability of incidental event k;

$VC_{g,k}$ = vehicles involved in the accidental event k on section g;

PV_g = number of occupants for vehicle on the segment g;

$P\ F_k$ = probability of fatalities as a result of event k.

If the level of risk found is not tolerable [Galatola (2006)] both quantitatively according to the criteria set above described, but also in qualitative similarity with similar situations) it is necessary to intervene with techniques of mitigation or of prevention.

CONCLUTIONS

In this paper, we analysed the problem of road accidents in urban areas to assess the influence that the characteristics and forms of urban space, such as the configuration of infrastructure, public spaces, the morphology of the network road and the city, and the consequent use, have on the levels of security. The research, in particular, analysed the overall state of road in the municipality of Reggio Calabria, dwelling on some planning proposals on a main roads of access to the city.

Finally, a methodological approach for the identification of more effective operational strategies for development of an organic Safety Plan of local mobility and for proper planning of infrastructure was proposed.

REFERENCES

[1] Department for Transport, (2003). *Urban safety management guidelines, Road safety strategies for urban communities*. Printed in the UK, September 2003.

[2] Dipartimento di Idraulica, Trasporti e Strade, Università degli Studi di Roma La Sapienza, Amministrazione Comunale Reggio Calabria, (2006). *Analisi dell'incidentalità stradale all'interno del territorio comunale - Progetto SICUR.*
[3] Galatola E., (2006). *L'applicazione delle tecniche di analisi di rischio industriale alla sicurezza dei trasporti ed alla sicurezza stradale in particolare.*
[4] ISTAT-ACI, (2006). *Statistica degli incidenti stradali Anno 2006* - Roma 2007
[5] Lord D., N. Bhagwant, (2004). *Estimating the safety performance of urban road transportation networks*, Accident Analysis and Prevention 36, 609–620.