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## **EXPERIMENTAL SURVEY TO TEST TRAFFIC CALMING MEASURES EFFECTIVENESS IN URBAN AREAS**

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*Leonardi S.*

*Researcher – D.I.C.A. – University of Catania – [s.leonardi@unict.it](mailto:s.leonardi@unict.it)*

### **ABSTRACT**

The concept of traffic calming is fundamentally concerned with reducing the adverse impact of motor vehicles on built up areas. This usually involves reducing vehicle speeds, providing more space for pedestrians and cyclists, and improving the local environment.

Traffic calming schemes generally incorporate a wide range of measures designed to complement each other in both speed reduction and environmental terms. The principle techniques used fall into four areas: vertical deflections, horizontal deflections, road narrowing, central islands.

In this paper we will study the effectiveness, in order to speed reduction, of three types of traffic calming measures: 1) speed table, 2) chicane, 3) road narrowing.

A “speed table” or “plateau” is a term used to describe a very long and broad speed hump, or a flat-topped speed hump, where sometimes a pedestrian crossing is provided in the flat portion of the speed table (see Raised Pedestrian Crossings). The speed table can either be parabolic, making it more like a speed hump, or trapezoidal, which is used more frequently in Europe. Speed tables can be used in combination with curb extensions where parking exists.

A “chicane” is a series of two or more staggered curb extensions on alternating sides of the roadway. It creates a serpentine route along the street. Drivers slow down to make the lateral movement necessary to maneuver through the chicane.

“Road narrowing” may be considered as supportive measure to vertical deflections. It cannot be considered as a speed reducing device in itself, but it can act as a reminder or encouragement to drive slowly or calmly. Narrowing the carriageway at specific locations, for example in combination with speed tables, is an effective way of combining measures to increase their effect.

The speed analyses regard a series of traffic calming measures located in urban contexts of Catania Province.

*Keywords: speed table, chicane, road narrowing*

## 1. RESEARCH OBJECTIVES

In this paper the author wants to estimate the effectiveness, in order to speed reduction, of some traffic calming measures really present in some urban contexts of the Catania city. In particular the speed profiles will be analyzed, relative to roads in which three measure types (speed table, chicane and road narrowing) are located.

The effectiveness of such measures, highlighted from results exposed in the following paragraphs, would have however to encourage a greater spread in the urban contexts.

## 2. SPEED TABLE, CHICANE AND ROAD NARROWING

Traffic calming schemes generally incorporate a wide range of measures designed to complement each other in both speed reduction and environmental terms. The principle techniques used fall into four areas: vertical deflections, horizontal deflections, road narrowing, central islands.

In this paragraph the main peculiarities of three types of traffic calming measures will be analyzed: 1) speed table, 2) chicane, 3) road narrowing (Fig. 1).

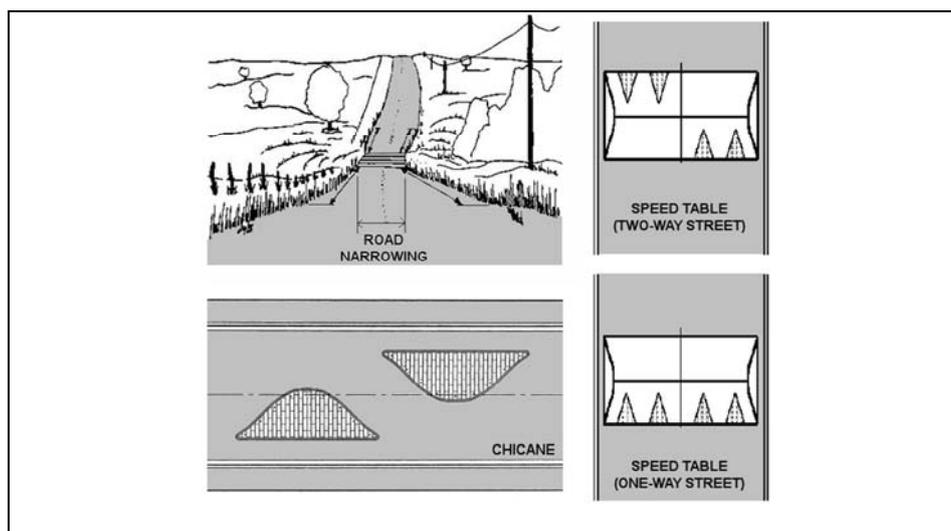


Figure 1 Examples of speed table, chicane and road narrowing

### 2.1 Speed table

Speed tables are traffic calming devices designed as long speed humps with a flat section in the middle. They are generally long enough for the entire wheelbase of a passenger car to rest on top.

They may be used singly for a raised crosswalk, or in a series of two or more for the purpose of speed reduction. When used as a raised crosswalk, the table should extend

all the way to the curb, possibly requiring new storm drainage construction, thus increasing cost considerably. Speed tables and humps usually taper down to street grade at the gutter, thus leaving the gutter open for normal drainage. The long length of speed tables allows long wheelbase vehicles to cross with substantially less jolting than with the humps, permitting higher speeds. Their longer profile results in higher speeds across and between the devices compared to speed humps. Thus these devices may be used on collector streets where speeds are usually higher, and which may also be emergency vehicle and bus routes. Usually, speed tables and raised crosswalks are placed midblock, but a raised crosswalk may be permitted at an intersection under certain circumstances. Speed tables can be constructed of asphalt, concrete, or rubber. While traditionally most humps were constructed of asphalt or concrete, rubber is becoming increasingly popular due to several factors. Asphalt and concrete can be difficult to construct precisely while rubber products are pre-shaped to standardized sizes and thus consistently meet industry standards. An additional advantage is ease of installation, which is particularly beneficial when a city wants to test streets before deciding where to keep the devices. The simple installation process also allows for relocation during the winter when snow is a concern, which prevents damage to the humps by snow plows. In addition, unlike concrete and asphalt, which necessitate frequent and high cost replacement, rubber products are longer lasting and thus more cost-efficient.

Because speed tables do not reduce speeds as much as speed humps, volume reduction (due to discomfort) and slower travel times are less. A series of speed tables will typically reduce volumes by about 10 percent. This minimal traffic diversion to other streets makes tables acceptable for use on collector streets. Speed reduction depends on the spacing of tables. At the closest spacing of 60 m, 85th percentile speeds average about 48-53 km/h between tables. 85th percentile speeds at the tables themselves is reduced to about 40-48 km/h. The less abrupt speed reduction of tables makes them acceptable for use on collector streets, where speeds are generally higher.

## **2.2 Chicane**

A chicane is a series of narrowings or curb extensions that alternate from one side of the road to the other forming S-shaped curves also called deviations, serpentines, reversing curves, twists, and staggering. It creates a serpentine route along the street. Drivers slow down to make the lateral movement necessary to maneuver through the chicane. On wider streets, a raised island can be added to the center of the road to prevent motorists from crossing the center line.

European manuals recommend shifts in alignment of at least one lane width, deflection angles of at least 45 degrees, and center islands to prevent drivers from taking a straight "racing line" through the feature. Normal turning radii should be accommodated, sets are to be placed 100-200 meters apart, visibility should be a key design consideration with features such as advance warning signs, reflective channelization, reflectors on curbs, and elevated landscaping.

A chicane-like effect can be achieved, at a fraction of the cost, by alternating on-street parking from one side of the street to the other. Parallel parking, angled parking, or a combination may be used. This treatment can be as simple as restriping to delineate parking bays. Or it can include landscaped curb extensions to beautify the street, screen

unsightly parking, and create protected parking bays. Even this more expensive treatment, popular now in Main Street projects, involves less curb work than a standard chicane. Combined with shuttle working (pinch-points), drivers would now have to consider the possible need to yield to the opposing stream and this is where more than one reason to slow down, as at roundabouts, starts to come into play. Lateral deflection devices may develop into useful traffic calming features, but on quiet roads the yield effect may be of limited value especially if drivers can see some distance along the road and so "size up" the situation well before negotiating the physical feature.

A research of Department for Transport of United Kingdom on approximately 150 chicanes has shown that:

- an inclination of curb extensions to 15 degrees reduces the average speed to an inferior value to 32 km/h and reduces the 85th percentile speed to an inferior value to 40 km/h; while inclinations inferior to 10 degrees concur average speeds above 40 km/h and 85th percentile speed above 48 km/h;
- the reduction of the average speed and the 85th percentile speed produced from one chicane is generally of 20 km/h;
- the speed reduction of the buses is approximately double of the speed reduction of the other vehicles.

Test experiences of Department for Transport has characterized some correlations between the lane width, the axis deviation, the chicane length and the consequent speed (table 1).

**Table 1 Correlations between the lane width, the axis deviation, the chicane length and the consequent speed**

Lane width	Axis deviation	Chicane length and consequent speed		
		24 km/h	32 km/h	40 km/h
3,00 m	2,00 m	6,00 m	9,00 m	14,00 m
	3,00 m	9,00 m	13,00 m	18,00 m
	4,00 m	12,00 m	16,00 m	-
3,50 m	2,50 m	-	-	11,00 m
	3,50 m	9,00 m	12,00 m	15,00 m
	4,50 m	11,00 m	15,00 m	19,00 m
4,00 m	3,00 m	-	7,00 m	9,00 m
	4,00 m	-	9,00 m	12,00 m
	5,00 m	-	11,00 m	15,00 m

### 2.3 Road narrowing

Road narrowing is a narrowing or limitation of the roadway:

- narrowing of the roadway can be done as a two-lane narrowing or as a narrowing to one lane.
- narrowing to one lane can be combined with speed hump or raised area.

Road narrowing cannot be considered as a speed reducing device in itself, but it can act as a reminder or encouragement to drive slowly or calmly. Road narrowing is reducing the width of the travel way of the road. This slows traffic by displacing the cars horizontally and narrowing the lane. People tend to drive slower on narrow roads.

If the carriageway width is reduced to a single lane by the narrowing the effectiveness of this technique in speed reduction is further increased. However, this is largely dependant on the balance of the opposing traffic flows.

On narrowed two-way roads occasional strips at the edge of the carriageway may be used to allow large vehicles to pass. If these are constructed in sets or similar materials car drivers will avoid using them. This can however cause problems for cyclists unless smooth materials are used, which in turn makes the narrowing less effective.

The extra space created by road narrowing is generally used to provide some combination of widened footways, dedicated cycleways and formalised parking bays, or to provide more space for public transport, for example by allowing the use of bus lanes.

The following design considerations can be exposed:

- cyclists should be taken into consideration for instance by establishing a cycle passage;
- two-lane narrowings can be applied on traffic roads and local roads with design speeds of up to 50 km/h;
- narrowing to one lane can be applied on stretches with design speed up to 40 km/h, and with peak hour traffic less than 300 cars per hour. This also concern narrowing to one lane combined with hump or raised area.

Road narrowing can impact parking and driveway access reduces pedestrian crossing width and increases visibility of pedestrian. It have an impact on vehicle speeds. Table 2 gives an indication of the relative speed reductions. The "before" situation refers to a road with a 48 km/h speed limit.

**Table 2 Expected speed reduction effect of road narrowing**

	Upper limit of maximum speed (km/h)		Upper limit of 85 percentile speed (km/h)		Range of average speed (km/h)	
	Before	After	Before	After	Before	After
Road narrowing to a single lane	100	65	75	45	45-65	22-35
Road narrowing to a reduced width	100	95	75	70	45-65	40-55

### 3. FIRST TRAFFIC CALMING MEASURE: SPEED TABLE

The investigation context is represented from the residential area that is developed around to the road called *Lungo Mare Pantano street*, in Riposto city (CT). In particular, on this road are two speed tables, placed to a distance between one and the other of 40 meters, realized in bituminous conglomerate and opportunely premarked (Fig. 2).

In order to adequately study the variation of the cinematic characteristics of the vehicles, for effect of the speed tables presence, have been chosen the five speed measurement sections:

- the section indicated with "A" letter, located 30 meters before the first traffic calming measure;

- the “B” section is placed 10 m before the first speed table;
- the section “C” is equidistant between the 2 speed tables;
- the “D” section is located 10 m after the second speed table;
- the “E” section is placed 30 meters after the second traffic calming measure.

The distance described from the sequence of sections A, B, C, D and E, is downhill, with longitudinal slope of 2%.



**Figure 2 Speed tables in Lungo Mare Pantano street (Riposto)**

For speed measurement, it has been used the Autovelox 104/C2, realized from the "Sodi Scientifica", based on the emission and the reception of a pair of laser beams that cross the road perpendicularly. The survey operations have been executed in the month of April 2006, and have been completed in 10 days.

The *Lungo Mare Pantano street* is a road to service of an exclusively residential zone; the traffic flows, therefore, are not elevated ever, and the greater part of the vehicles is isolates. These conditions, evidently, are ideal in order to estimate the intrinsic effectiveness of any traffic calming measure; in fact the mutual conditionings between the vehicles are practically null. Therefore, it has not been adopted the traditional criterion of selection of distinctive hourly bands for the speed measurement; to the contrary, they have been executed the continuous measures, until obtaining a statistically meaningful number of speeds values relative to the isolated vehicles.

In particular, after the experimental survey, it has been obtained the speed values of 788 vehicles for the uphill distance (156 for the “A” section, 150 for the “B” section, 168 for the “C” section, 153 for the “D” section and 161 for the “E” section) and the

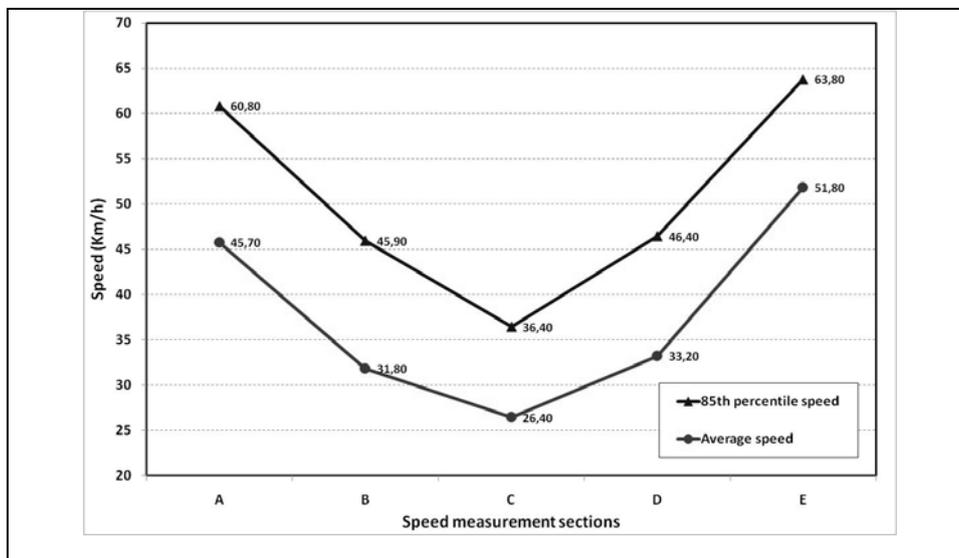
speed values of 775 vehicles for the downhill distance (148 for the “A” section To, 152 for the “B” section, 156 for the “C” section, 161 for the “D” section and 158 for the “E” section).

Subsequently the following assessments have been executed:

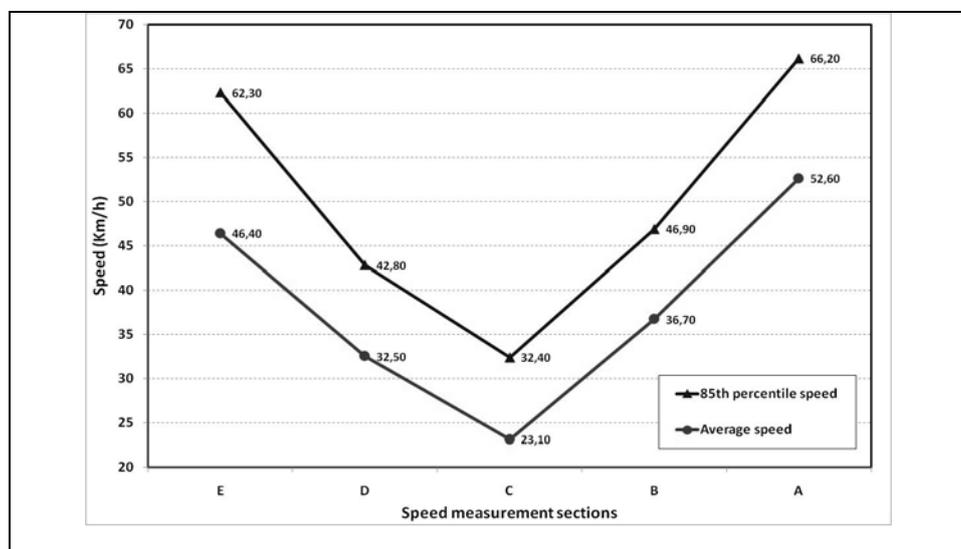
- calculation of average speed ( $S_a$ ) on all the speed measurement sections;
- calculation, for the same sections, of the 85<sup>th</sup> percentile speed ( $S_{85}$ ), that is that value of the speed that is not exceeded from 85% of the road users.

In figures 3 and 4 there are the speed profiles (for average speed and for 85<sup>th</sup> percentile speed) relative to the measurement sections. From the analysis of such diagrams, it is possible to make the following considerations:

- the speed profiles for  $S_a$  and for  $S_{85}$  show an attended result: both for the uphill road and for downhill road, has lowest speed in correspondence of road portion comprised between the speed tables;
- from the comparison between the  $S_{85}$  values associates to the measurement sections farther from the speed tables sequence and those relative to the intermediate sections between the two traffic calming measures, it has deduced an average reduction of 25 km/h approximately (correspondent to a variation percentage of 40%) in the case of downhill road, and an average reduction of 30 km/h approximately (equal to 48%) in the case of uphill road;
- from the comparison between the  $S_a$  values associates to the measurement sections farther from the speed tables sequence and those relative to the intermediate sections between the two traffic calming measures, it has deduced an average reduction of 19 km/h approximately (correspondent to a variation percentage of 42%) in the case of downhill road, and an average reduction of 23 km/h approximately (equal to 50%) in the case of uphill road.



**Figure 3 Speed profiles (downhill road) relative to speed tables**



**Figure 4 Speed profiles (uphill road) relative to speed tables**

#### 4. SECOND TRAFFIC CALMING MEASURE: CHICANE

The traffic calming measure analyzed is a chicane. The chicane is located in *Anastasi street* (road to only direction) in the urban centre of Catania city, and is realized through two vehicle parking lines disposed alternatively on the left margin and on the right margin of the road (Fig. 5).

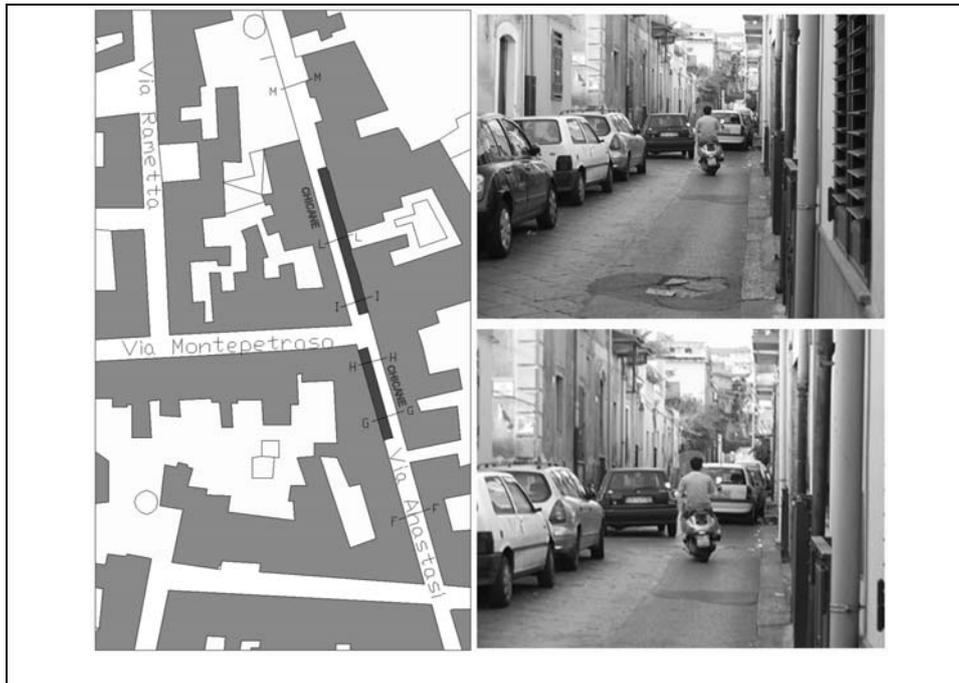
For the experimental survey, six speed measurement sections have been choices:

- the section indicated with “F” letter, located 30 meters before the vehicle parking line on the left margin of the road;
- the “G” section, placed 5 meters after the beginning of vehicle parking line on the left margin of the road;
- the “H” section, located 20 meters after the beginning of vehicle parking line on the left margin of the road;
- the “I” section, placed 5 meters after the beginning of vehicle parking line on the right margin of the road;
- the “L” section, located 20 meters after the beginning of vehicle parking line on the right margin of the road;
- the section indicated with “M” letter, located 30 meters after the vehicle parking line on the right margin of the road.

The distance described from the sequence of sections F, G, H, I, L, M is almost in plain.

The experimental survey has been carried out in the month of April 2006 for a period of 2 weeks. In order to estimate the real effect of the chicane like a traffic calming measure, it have been selected three hour bands representative of three hours "of soft", that is temporal periods in which the conditionings for the road users derive

mostly from the traffic calming measures presence than from the interactions with the other vehicles. The hour intervals for experimental survey, therefore, they have been: 10.00-11.00, 15.00-16.00, 16.00-17.00.



**Figure 5 Chicane in Anastasi street (Catania)**

After all, for all the six sections, have been organized three series of surveys (everyone of the duration of an hour).

After the experimental survey, finally, has been obtained the speed values of 969 vehicles (161 for the “F” section, 167 for the “G” section, 171 for the “H” section, 159 for the “I” section, 148 for the “L” section and 163 for the “M” section).

In figure 6 there are the speed profiles (for average speed and for 85th percentile speed) relative to the measurement sections. From the analysis of such diagrams, it is possible to make the following considerations:

- the speed profiles for  $S_a$  and for  $S_{85}$  evidence remarkable speed reductions during the run on the chicane;
- from the comparison between the  $S_{85}$  values associates to the measurement sections farther from the chicane and those relative to the intermediate sections between the two vehicle parking lines (“H” and “I” sections), it has deduced an average reduction of 22 km/h approximately (correspondent to a variation percentage of 50%);
- from the comparison between the average speed values ( $S_a$ ) associates to the measurement sections farther from the chicane and those relative to the

intermediate sections between the two vehicle parking lines (“H” and “I” sections), it has deduced an average reduction of 20 km/h approximately (correspondent to a variation percentage of 42%).

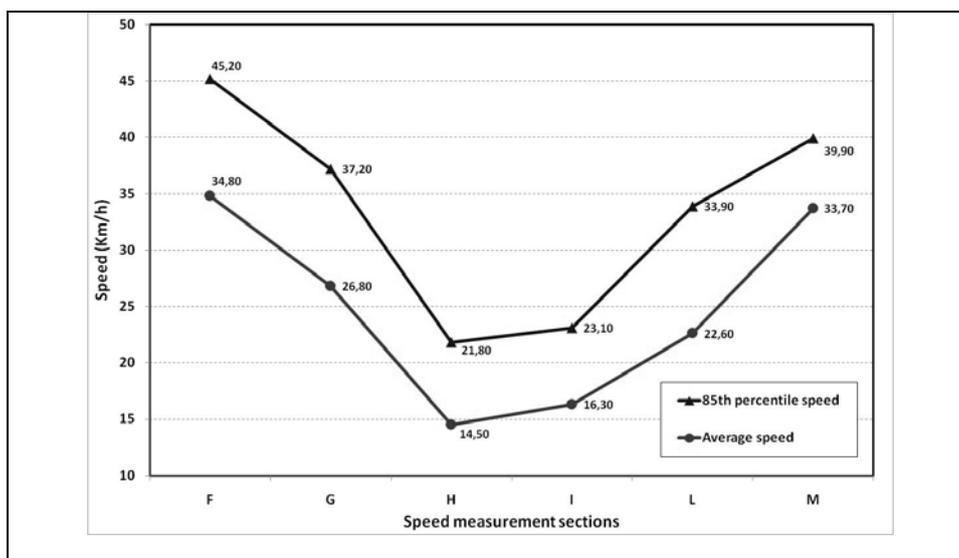


Figure 6 Speed profiles relative to chicane

## 5. THIRD TRAFFIC CALMING MEASURE: ROAD NARROWING

The third measure of traffic calming analyzed is a road narrowing. Such road narrowing has not been realized “voluntarily” but is consequent to urban configuration due to the urbanization conditions and to the territory morphology (presence of substantial rocky formations). The road narrowing is located in *Mandrà street* (road to only direction) in the urban centre of Catania city (Fig. 7). The road has initially the width of 8 m and subsequently it is shrunk abruptly until the minimal value of 3,10 m (after around 5 meters from the beginning of the narrowing, there is a subsequent narrowing of the road section up to the attainment of the total width of 2,60 m).

For the experimental survey, three speed measurement sections have been choices:

- the section indicated with “N” letter, located 30 meters before the beginning of the abrupt narrowing;
- the “O” section, placed 10 meters before the beginning of the narrowing;
- the “P” section, placed 10 meters after the beginning of the narrowing.

The distance described from the sequence of sections N, O and P is uphill, with longitudinal slope of 1,5%.

The experimental survey has been carried out in the month of May 2006 for a period of 1 week. In order to estimate the real effect of the road narrowing like a traffic calming measure, they have been selected three hour bands representative of three hours

"of soft", that is temporal periods in which the conditionings for the road users derive mostly from the traffic calming measures presence than from the interactions with the other vehicles. The hour intervals for experimental survey, therefore, they have been: 10.00-11.00, 15.00-16.00, 16.00-17.00.



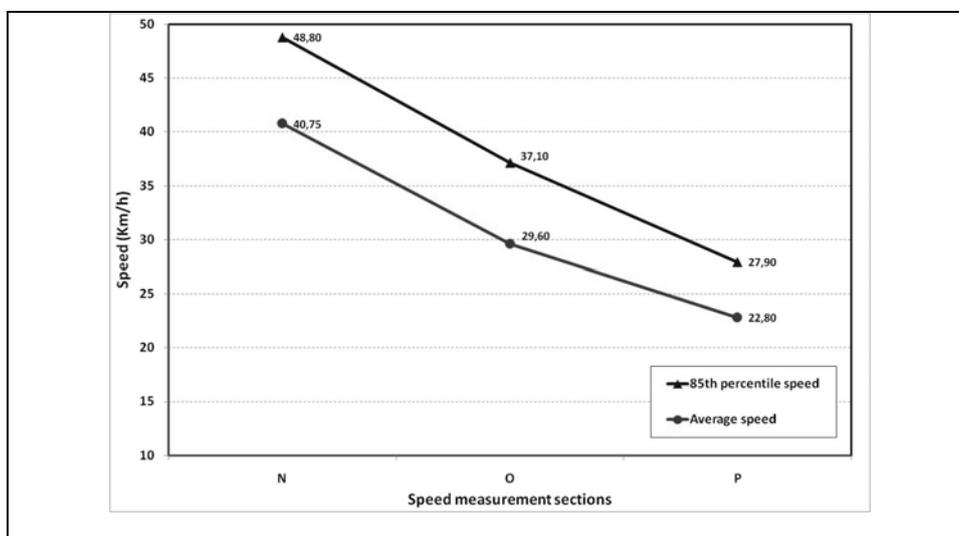
**Figure 7 Road narrowing in Mandrà street (Catania)**

After all, for all the three sections, have been organized three series of surveys (everyone of the duration of an hour).

After the experimental survey, finally, has been obtained the speed values of 462 vehicles (148 for the "N" section, 152 for the "O" section and 162 for the "P" section).

In figure 8 there are the speed profiles (for average speed and for 85th percentile speed) relative to the measurement sections. From the analysis of such diagrams, it is possible to make the following considerations:

- the speed profiles for  $S_a$  and for  $S_{85}$  evidence remarkable speed reductions during the run on the road narrowing;
- from the comparison between the  $S_{85}$  values associates to the measurement section farther from the narrowing and those relative to the two sections nearer the road narrowing, it has deduced an average reduction of 17 km/h approximately (correspondent to a variation percentage of 35%);
- from the comparison between the  $S_a$  values associates to the measurement section farther from the narrowing and those relative to the two sections nearer the road narrowing, it has deduced an average reduction of 16 km/h approximately (correspondent to a variation percentage of 38%).



**Figure 8 Speed profiles relative to road narrowing**

## 6. CONCLUSIONS

The urban accidents represent approximately 70% of those altogether relative to the national road net.

In this paper, the author has been able to demonstrate the concrete possibility “to force” the road users to reduce the speed.

If the traffic calming measures were distributed warily and systematically on all the urban road net, it could be obtained, with a little investment, a result of great importance both in terms of safety and, more in general terms, in terms of ethicality.

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