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Traffic Calming in Slovenia

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ABSTRACT

Slovenia has a rather poor road traffic safety record. In the European Union as a whole there are around 100 fatalities per million inhabitants per year, but in Slovenia there are around 140. If drivers respected traffic signs we would not need traffic calming measures, but this is not the case. We have to introduce special solutions on the road network or on the roadway so that drivers are forced to respect speed limits. Based on foreign experience (Netherlands, Germany, Austria), we began to introduce traffic calming measures. Over the years, we have found that identical measures may not have the same results in different countries because of different mindsets, so we have to produce our own set of traffic calming measures. They were selected using the before – after method on different categories of road, and on the basis of effectiveness. From field results, we determined that the choice of traffic calming measures depends on the type of road, operating speed and traffic volume. Regarding this research, we prepared a table of the most effective traffic calming measures on Slovenian roads.

1.0 INTRODUCTION

The origins of traffic calming reach back to the 1960s, when angry residents of the Dutch town of Delft decided to prevent heavy freight vehicles transiting through their town and to achieve a reduction in vehicle speeds by changing the road to a “woonerf” or “living yard”.

Positive results led to the implementation of many similar projects in Europe and around the world: Odense, Malmo, Groningen, Delft, Tilburg, The Hague, Amsterdam, Bologna, Parma, Zurich, Basel, Osaka, Tokyo and Nagoya, to name but a few.

In the early 1990s, the first stage of traffic-calming measures appeared on Slovenian roads.

Traffic safety on Slovenian roads is amongst the worst in the European Union. The number of traffic fatalities per 100,000 residents is the main indicator.

TABLE 1 The number of traffic fatalities per 100,000 residents in EU

United Kingdom	6
Germany	8.3
Italy	11.7
France	12.9
Spain	13.2
Slovenia	**13.8**
Portugal	16.1
Greece	19.3

The behaviour of traffic participants and respect for traffic regulations are at a very low level. This means that mere warnings on traffic signage are not enough for drivers to stick to speed limits. In certain cases, measures must be anticipated which physically prevent speeds faster than required to ensure traffic safety.

A distinction must be made between administrative measures to reduce speed (traffic signs, light signage) and traffic-calming measures, that is, physical measures on the carriageway or on the traffic network, which operate by applying physical principles. Furthermore, certain measures also operate psychologically, since drivers adjust their speed due to visual effects on the road or on the roadside.

The basic objectives of introducing traffic-calming measures are safety and reducing the negative consequences of traffic. Local residents and other regular users often complain about excessive speed on particular road sections. Traffic calming is an intervention that fundamentally changes the regime of road use. We must be aware that shortly after the measures are implemented, regular users start to complain, so measures must be planned professionally and carefully.

2.0 BASIC PRINCIPLES OF INTRODUCING TRAFFIC-CALMING MEASURES

The basic principles of introducing traffic-calming measures with broad public support should include the following components:

1. **public involvement –** residents and daily users of the road on which the traffic-calming measures are planned, involved in the first phase; their contribution is very important, particularly in identifying problems and in selecting the measure.
2. **identification of actual problem –** often the apparent problem is not the actual problem
3. **evaluating the problem –** not all problems are equal; some only happen at certain times of the day, while others are continuous
4. **use of effective measures -** those that do not require constant supervision and are effective in themselves (e.g. roundabout instead of classic crossroads with STOP signs, road humps instead of speed limit signs ...)
5. **minimising access restrictions –** in most cases local residents are more supportive of traffic-calming measures if they do not unduly restrict access to certain sections
6. **focusing on motorised traffic –** other non-motorised traffic must not be affected by traffic calming measures
7. **introducing temporary measures –** where possible, less costly temporary solutions should be attempted, with other, more expensive measures following later only if these prove ineffective
8. **monitoring –** the effectiveness of individual measures must be monitored and, where appropriate, amended or upgraded

Another important factor in planning measures is whether they involve solving isolated problems or problems in a wider region.

The process of introducing traffic-calming measures involves four stages:

1. **review of the situation –** does the problem really require traffic calming? Review of the location and determination of critical details, consultation with affected public,
2. **estimate and determination of priority tasks –** determination of technical characteristics of the road, review of data on vehicle speeds, accidents, traffic loads;
3. **spatial planning options –** is the planned measure even feasible?
4. **implementation –** project documentation, physical implementation

In 2000, technical specification described various traffic-calming methods and measures, for the most part copied from similar solutions in other European countries. The technical specification does not specify individual details of measures, and so in practice it leads to more or less successful solutions. Project planners solve specific elements of measures based on their experience. Most often they opt for the minimum prescribed dimensions, which are inappropriate in terms of increasing traffic safety, although it does reduce implementation costs. Specifications should be upgraded with more detailed provisions regarding project tasks, lighting measures, compulsory separation of lanes, and central islands and their minimum lengths.

Planned traffic-calming measures may be implemented:

- on the road network
- on the roadway itself
- through the design of roadway and roadside areas

We must realise that the level of traffic calming also depends on the road category and on the nature of the traffic on a particular road. Traffic-calming measures are most effective on lower-grade local and distributor roads. Taking account of basic technical requirements, they can also to some extent be implemented on urban radial roads – for instance in town centres to reduce traffic speeds and volumes. However, we must be aware that such measures on urban radial roads can redirect traffic to neighbouring parallel lower-grade roads, which is also undesirable. Traffic calming is not permitted on motorways and expressways.

Figure1: Example of designing roadway and roadside areas – use of various materials, tree planting, signage – all of these influence drivers' perceptions of their surroundings

3.0 TYPES OF TRAFFIC-CALMING MEASURES

The following traffic-calming measures are most commonly used in Slovenia: optical speed bars, rumble stripes, road humps, plateaus, central islands, horizontal shifts and roundabouts.

3.1 Optical speed bars

Optical speed bars are 40 cm-wide road-surface markings perpendicular to the driving direction and crossing the whole width of the roadway. As the junction is approached, the distance between the horizontal markings reduces. The uneven gaps between the lines give drivers the feeling that they are driving at the same speed. They are always used in conjunction with speed-limit signs.

3.2 Rumble stripes

Rumble stripes are pairs of strips laid across the roadway and made of materials that do not reduce the traction coefficient. Rumble stripes, through vertical deviation from the roadway, or through texture changes, result in audio and vibratory effects that force the driver to recognise the need to change speed. Rumble stripes comprise a pair of strips 40 cm wide and 2 m apart. The purpose of rumble stripes is through audio and vibratory effects to warn and prepare drivers to reduce their speed to the limit in good time and evenly. The unequal gaps between lines and the accompanying audio and vibratory effects give drivers at unreduced speeds the feeling that they are driving ever faster. The gaps between strips are not equal, but change depending on the initial and final speed that vehicles should reach before the speed-restricted area. The parameters applicable to optical speed bars also apply to rumble stripes.

Figure 2: Rumble stripes

3.3 Speed humps

Speed humps are a suitable traffic-calming solution in residential streets, where traffic density is below 100 vehicles an hour. Road humps allow vehicles to be driven at speeds of 20-30 km/h without discomfort, shifting loads or stress. Due to the uncomfortable effects on drivers in vehicles crossing road humps at higher speeds, this is one of the most effective traffic-calming measures.

Due to the unappealing appearance and the range of problems they cause, road humps are not an ideal traffic-calming measure, and we only use them when other measures cannot be used.

Figure 3: Speed hump

3.4 Elevated platforms

Elevated platforms have a similar effect to road humps. They reduce driving speed to 25 km/h. The shape and implementation of the inclined slope are important for driveability and the desired effect. It is also important that they differ in material and where possible colour from the rest of the roadway. They are often used in combination with pedestrian and cyclist crossings.

Figure 4: Speed table

3.5 Central islands

In themselves, central islands do not lead to a great reduction in driving speeds. To enhance the effect, they must be combined with some other traffic-calming measure. Good results can be achieved with horizontal deflections, since installing a sufficiently wide central island also results in a horizontal deflection.

Figure 5: Set paving strip in the area of the central line, which visually acts as an island

Figure 6: Central island

Figure 7: Very emphasised central island

3.6 Horizontal deflections

Through horizontal deflection, we introduce a minor horizontal element to the roadway that vehicles can pass at reduced speeds. We thus physically prevent higher speeds and force drivers to drive more carefully and especially slower.

Figure 8: Horizontal deflection

3.7 Roundabouts

Roundabouts contribute two important factors in traffic calming:

- Due to horizontal deflection, they markedly reduce driving speeds and increase driver attention.
- At roundabouts, the radius of the roundabout forces drivers to use lower speeds.

The size of a roundabout depends on the actual and anticipated traffic load and on traffic structure. Roundabouts are also an urban-planning element that – with their characteristic form and where possible through landscaped islands – give a specific appearance to an area, which also influences driver behaviour and thereby helps improve traffic safety. They may be implemented on roads within or outside settlements. A feasibility study must be carried out before implementation, since roundabouts represent a significant financial investment.

Figure 9: Roundabout

In using roundabouts an assessment must be made of the justification of the roundabout based on the following criteria:

- Functional criteria,
- Spatial-planning criteria,
- Permeability criteria,
- Traffic-technical criteria,
- Traffic-safety criteria, and
- Economic criteria.

We must anticipate the primary role of the roundabout, whether there is sufficient space available, whether the solution will allow adequate traffic flow even at the end of the planning period, the circumstances of the particular site, whether this is a safe traffic solution, and whether it is economical.

4.0 EXPECTED EFFECTS OF TRAFFIC-CALMING MEASURES

The most effective traffic-calming measure is road humps. On average, road humps reduce speeds by 10-20 km/h. Despite such an effective result, because of the wide range of negative consequences, we prefer to avoid them, and where possible we use other types of traffic calming. As a temporary measure they are very effective, particularly on local non-transit roads with low traffic volumes.

Research on Slovenian roads shows that the 85 percentile speeds (V_{85}) fall within the following ranges:

- **Road humps - V_{85} from 20 km/h to 30 km/h**
- **Dividing islands – V_{85} from 50 km/h to 80 km/h**
- **Elevated platforms – V_{85} 20 km/h to 30 km/h**
- **Horizontal deflections – V_{85} from 15 km/h to 40 km/h**
- **Rumble stripes – v_{85} from 40 km/h to 70 km/h**
- **Roundabouts – V_{85} from 30 km/h to 35 km/h**

5.0 SYSTEM FOR INTRODUCING MEASURES

The methodology is based on four main selection criteria:

- Road category
- Location of measure
- Average daily traffic (ADT)
- Duration of measure

Under categorisation, we must distinguish two distinct meanings – on the one hand rough categorisation of the road (local, national), and on the other hand the function performed by the road. This does not just involve elimination of conflict points, but also improving living conditions (reduction of noise, emissions of exhaust gases, lower speeds etc.). Under the Danish rules, there is a very simple categorisation – roads are divided into two rough groups: regional and local.

The location of the measure determines the type of measure, since measures at junctions differ from those on sections, as well as from those on open sections outside settlements. Here it is easiest to limit ourselves to selection of speed, which gives suitable guidelines for selecting a measure.

It is sensible to distinguish three different speeds:

- >60km/h: on bypasses and transit roads, and roads outside settlements,
- 50km/h: on most urban roads
- <40km/h: on roads around sensitive areas (schools, kindergartens, residential areas, crossroads)

Average annual daily traffic is one of the important factors in the decision. Some traffic-calming measures greatly reduce traffic flow. Hazardous situations or traffic accidents occurring at a particular point may be a consequence of an occasional or periodic state at a particular place (temporary traffic diversions, operation of light-signalling devices, public events etc.).

We can divide measures into temporary, which improve the situation at least in part, and permanent solutions, which completely eliminate the conflict point.

TABLE 2 The use of traffic calming measures on Slovenian roads

	TYPE OF ROAD		SPEED BEFORE THE TC MEASURE [km/h]			AADT [veh/day]	
	REGIONAL ROAD	LOCAL ROAD	>60	50	<40	>2500	<2500
SPEED HUMPS		X			X		X
ELEVATED PLATFORMS		X			X		X
ROUNDABOUTS	X	X	X	X		X	X
STREET NARROWINGS	X	X	X	X		X	X
CHICANES		X		X	X	X	X

6.0 EXAMPLE OF IMPLEMENTATION

The initial state in the crossroads had the following characteristics:

- Pedestrian crossing used by children going to school
- Fatality – child while crossing the road at the pedestrian crossing
- Despite additional signs, the crossing is still not well known
- Vehicle speeds are high due to the extended route

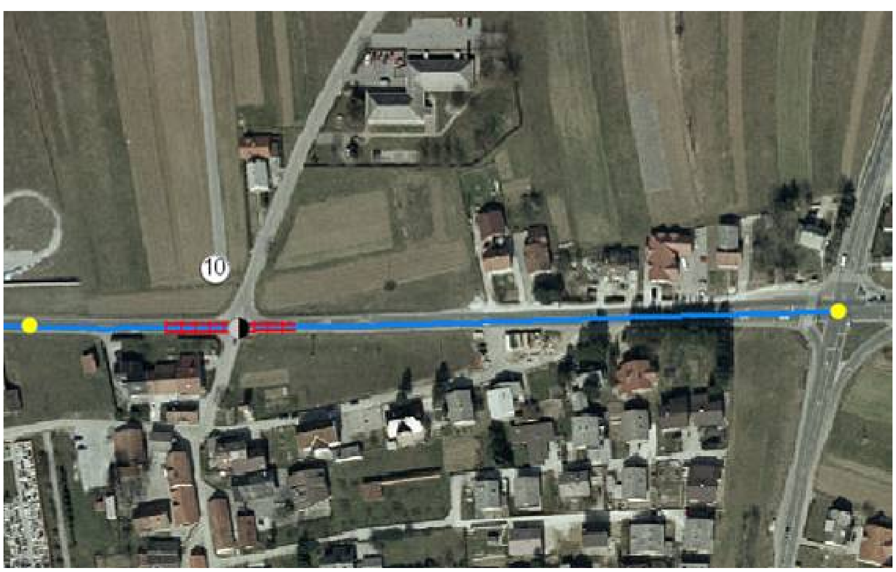


Figure 10: Position of the crossroads

The roadway was more than 6 m wide, while the crossroads was not well known. This was most probably the reason why drivers did not stick to the speed limit, which is 50 km/h on this section.

Police statistics going back several years do not show any serious traffic accidents in the immediate vicinity of this crossroads, but in March 2004 a terrible accident resulted in the death of a child on the way to school. This was the reason that – in addition to the normal horizontal and vertical signage marking the pedestrian crossing, another, even more distinct sign, III-6 was added with flashing lights, although during the day at least it has not significantly increased awareness.

Two radars were also installed before the crossroads, notifying drivers of their speed. The average number of vehicles exceeding the speed limit has fallen, but this does not mean that traffic safety has improved accordingly. In approaching the crossroads, drivers paid too much attention to the radar and the speedometer, while they paid less attention to other participants (pedestrians and vehicles on Kraljeva Cesta).

As a temporary solution, rumble stripes were installed, which initially effectively reduced speed. However, they also had a range of major drawbacks, particularly noise, caused mainly by heavy goods vehicles and the fact that many vehicles attempted to avoid this measure and drove along the shoulder or even surrounding gardens.

Two possibilities were suggested for the decision on the final solution:

- Traffic lights, or
- Construction of a traffic-calming device.

Installing traffic lights at pedestrian crossings outside densely built-up areas is not the best solution in terms of traffic safety. There is a strong possibility that drivers who do not expect traffic lights on the open road may not notice the lights until it is too late, despite the prescribed vertical warning sign (sign I-20). In such instances, their reaction depends on the speed (often higher than the speed limit) and on the situation at the traffic light.

Under this solution, pedestrians could cross the road in stages – first one lane, then the next – while the central dividing area would allow them to wait for a few moments if traffic conditions did not allow immediate crossing of the road. The crossing is implemented in phases, and a fence is added to prevent crossing the road elsewhere. Installation of suitable traffic signage and road furniture, illumination of the area of the crossing and regulation (construction) of a footpath along the right edge of the road were envisaged. This solution was implemented on the ground.

Figure 11: Situation before

Figure 12 Intermediate situation - rumble stripes

Figure 13: Final solution – central island

The solution operates appropriately in terms of both traffic and aesthetics. Greater effectiveness would require a wider central island and a combination of two traffic-calming measures – narrowing the roadway with a central island and horizontal deflections, but such a solution would require more space.

FIGURE 1 Speeds before introduction of the measure

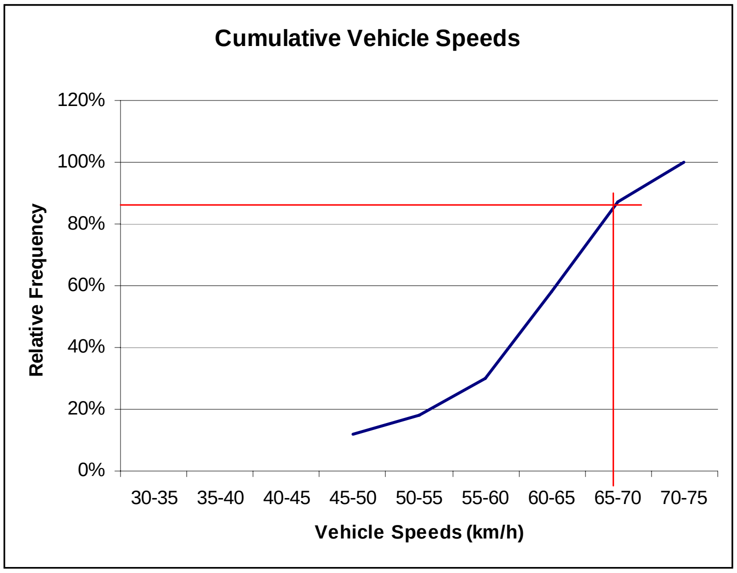
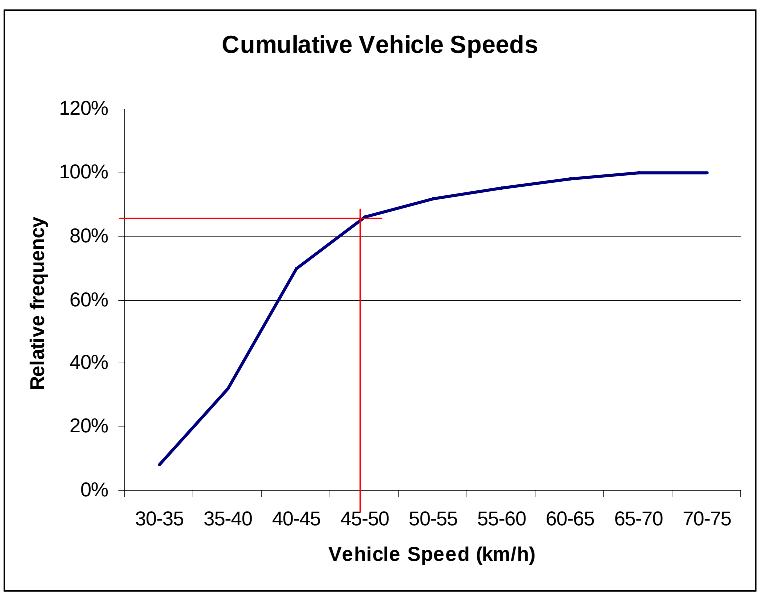


FIGURE 2 Speeds after introduction of the measure



7.0 CONCLUSIONS

In Slovenia we know that there are no universal solutions in traffic calming. We have to investigate each problem singly. The traffic calming measure should be introduced gradually and if possible in phases. It is necessary to introduce monitoring to find out if the measure is effective. If not we have to make corrections. Monitoring is also important for planning similar measures on other locations

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