THE ROLE OF AUTOMATIC SPEED LIMIT ENFORCEMENT IN SPEED MANAGEMENT IN PORTUGAL

João Lourenço Cardoso
Head of the Planning, Traffic and Safety Division

LNEC, Av. do Brasil 101, 1700-066 Lisbon, Portugal

ABSTRACT

Excessive speeds are a major contributing factor for road accidents. Research has shown that both accident risk and injury severity resulting from accidents vary with speed due to physical reasons and to psycho-physiological effects on road users; relations between these factors have been found at the individual and the system levels.

Most road safety plans include speed management as a tool for mitigating road crash consequences and reaching the targeted safety levels. In that perspective the Portuguese Road Safety Plan is no exception, and an integrated set of safety interventions is programmed and being implemented, including legislation update, road infrastructure improvements, information campaigns, the use of ITS and enforcement activities.

Automatic systems have been successfully used for enforcing compliance with speed limits in several countries, resulting in lower prevalence of excessive speeds and safety improvements in the vicinity of their installation sites. The investments for the implementation of these systems consistently show favourable benefit-cost ratios, provided the installation sites are carefully selected. In fact, automatic speed enforcement was identified as a road safety best practice in SUPREME, a 6th Framework European research project, in which best practices in road safety were collected, analysed and summarised. However, in some countries, social resistance to this type of devices may arise, if misunderstandings are allowed to develop about their main function.

In this paper a presentation is made of the technical criteria being applied in Portugal for the selection of eligible sites for installation of automatic speed enforcement and for monitoring its safety effects. Also, a brief description is made of the related activity being taken within the Portuguese Road Safety Plan to ensure the needed social acceptability of this safety intervention.

1. INTRODUCTION

Speed is an important factor in the safety level of a road network. The magnitude of accelerations and energy transfers on driving manoeuvres is directly related to speed, which is also a key factor in the amount of damage produced by crashes. Without speed there would be no injuries. Driver behaviour is also directly influenced by speed: at higher speeds sight distances required to timely detect dangers are longer (and at long distances, human perception capabilities is seriously diminished); available time to perceive and process relevant information is shorter; decision frequencies are higher; and the characteristics of direct and peripheral visual fields are considerably different from the prevailing ones at low speed.

Research on road safety showed significant relations between speed and accident severity and permanent trauma produced by crashes, both at the individual and the systems level. When a vehicle collides with a pedestrian, its impacting speed is a major factor in the severity of resulting injuries (Figure 1); in frontal collisions between cars or between a car and an obstacle, the probability of occupant survival diminishes almost exponentially with the increase in speed variation produced by the crash (ΔV, in Figure 2).

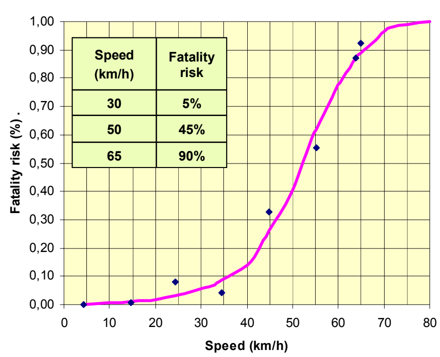

Figure 1 – Fatality in a collision with a pedestrian, as a function of the vehicle's impact speed (1)

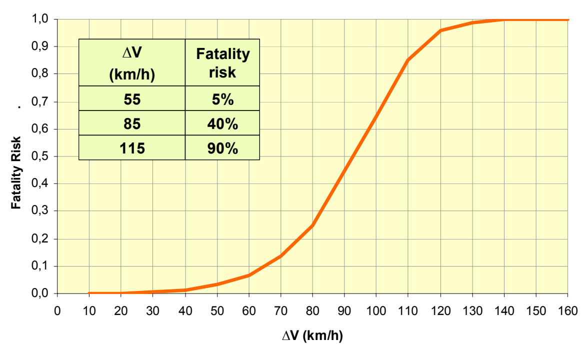

Figure 2 – Fatality risk of car occupants in a frontal collisions (2)

Research also demonstrated that speed significantly affects crash risk. Small increases in speed are associated with changes in accident risk of similar magnitude to the ones due to large increases in the blood alcohol concentration (BAC). According to McLean et al (3), an increase of 5 km/h in speed (from a 60 km/h base) generates the same growth in fatality risk as a rise of 0.50 g/l in BAC (from a 0.00 g/l base); and the rise in fatality risk due to an increase of 15 km/h is equivalent to the one expected with a BAC of 1.20 g/l.

There are several safety arguments favouring the establishment of legal boundaries to the range of travelling speeds that drivers are allowed to choose: to moderate the amount of risk imposed by a driver on other road users; to diminish the consequences of driver errors in the evaluation of prevailing traffic and roadway conditions (and the resulting choice of inappropriate speeds); to surmount driver predisposition to underestimate the effect of speed on the risk and severity of road accidents (4).

Experience from best performing countries in road safety shows that best practice in dealing with the speed problem involves the application of speed management, which implies an integrated set of interventions at various levels – legislation, road infrastructure, enforcement, information campaigns, education and intelligent transport systems (ITS). The objective of speed management is not the reduction in travel speeds, but the mitigation of prevailing inappropriate (dangerous) speeds (5).

2. SPEED LIMIT ENFORCEMENT

2.1. Background

Road traffic law enforcement is the result of a chain of procedures for the detection of traffic offenders, their identification and their punishment. Usually the first procedure is carried out by traffic police forces; the last two procedures are essentially juridical. The preventive effect of enforcement depends on the efficiency of each one of these procedures, and deficiencies in one of them may undermine the overall efficiency of enforcement activities.

According to the ETSC enforcement influences driver behaviour in two ways: by general deterrence, which is a consequence of the overall perception of being detected and punished for violating traffic rules; and by specific deterrence, which results from the experience of identified violators with the punishment procedures initiated by the detection of their violations (5). Usually, specific deterrence is especially directed towards repeating violators.

2.2. Automatic speed cameras

Automatic speed cameras – also called safety cameras (SC) – were developed to fully automate most tasks in speed enforcement procedures: detection of speeding vehicles; identification of the vehicle owner, who is responsible for identifying the actual violator; and production of an official notification of the detected violation, for payment of fine and other punishments. When adequately installed, SC enable an integral assessment of the running speed of all vehicles passing at the measurement section.

Safety cameras are intended to convey to drivers the requirement for strict compliance with the established speed limits, thus helping to increase the overall deterrence, even though only at the restricted space neighbouring the cameras.

Recent technical developments in detection devices, transmission technology and information systems processing have greatly improved the effectiveness of speed cameras. Several technologies may be used for vehicle detection and speed measurement: inductive loops, piezoelectric cables, magnetic sensors installed on the pavement; and video cameras with real time digital processing, laser, radar and infrared sensors installed on the roadside, near the carriageway (6). If correctly installed and calibrated, all these types of sensors are able to detect, classify and measure the speed of vehicles passing at predefined road sections. Several sensors may be used to count the number of axles and measure motorcycle speeds; some devices can measure the average speeds over long sections (250 m to 5 km).

The length of road influenced by SC depends on the type of equipment and its operating conditions: for average speed cameras, the whole road stretch used for measurement is affected; for other types of cameras, the length varies between 0.5 and 2 km. In France and the UK, no increase in accidents due to sudden braking at the vicinity of SC was observed (7, 8).

2.3. Results from international experience with safety cameras

Automatic systems have been successfully used for enforcing compliance with speed limits in several countries, resulting in lower prevalence of excessive speeds and safety improvements in the vicinity of their installation sites.

Speed cameras were installed in 1980 on a dangerous motorway section in Germany, resulting in major reductions in speeds (less 20 km/h in the average speed for cars) and accidents, the yearly number of fatalities being reduced from 8 to 1 (9). The UK, Norway, France, Victoria State (Australia), Austria, and The Netherlands, have successfully tested the use of SC, with reductions in speed ranging from 5 km/h to 20 km/h and decreases in accident frequency between 14% and 65% (6). Overall, most reports agree on the effectiveness of these systems to achieve significant reductions on both speeds and accidents. According to Elvik's meta-analysis of several interventions involving SC, they originate a 17% reduction in the number of injury accidents (with a 95% confidence interval between -19% and -16%) (10).

Implementation of these systems consistently shows favourable benefit-cost ratios, provided the installation sites are carefully selected. In fact, automatic speed enforcement was identified as a road safety best practice in SUPREME, a European research project, in which best practices in road safety were collected, analysed and summarised.

It is recommended to assess the effectiveness of each individual installed SC, as there are references to cases where undesirable effects on speed distribution patterns were detected. Also, evidence gathered may be used to counter public misperception about their main function.

3. CRITERIA ADOPTED IN PORTUGAL FOR THE INSTALLATION OF SAFETY CAMERAS

As a general policy, in Portugal safety cameras may be installed at: **i)** high traffic volume road sites (or stretches) where there is high expected accident frequency due to excessive speed, and no suitable cost efficient infrastructure redesign is available; **ii)** where traditional visible enforcement is unsafe or inefficient due to traffic or roadside conditions; **iii)** work zones; **iv)** at the vicinity of schools and other public spaces, generating high volumes of pedestrian traffic conflicting with motorized traffic.

Warrants for the installation of speed cameras in Portuguese roads include three types of criteria: **a)** the expected number of accidents; **b)** the type of registered accidents and speed distribution characteristics; and **c)** the severity of potential accidents.

The expected number of accidents in 250 m length road stretches is used for selecting promising sites for installation of SC on single carriageway roads (500 m stretches are considered at dual carriageway roads). An empirical Bayes approach, similar to the one already used to detect accident black spots in the National Road Network, is used to estimate the expected accident frequency and rate on each stretch of each road class in the network. These estimated values are compared with the corresponding triggering values for that road class: if one of them is above, the stretch is selected for further consideration. For instance, the triggering values for a dual carriageway road (four lanes) on the North Region are 8 expected accidents and 0.99 expected accidents per million vehicle×km (three years period).

Safety cameras may also be installed near schools and buildings generating high pedestrian traffic volumes (namely children and elderly), as a result of community concerns as regards the severity of potential accidents, even if no accident data is available. The same applies to selected work zones in high speed roads, tunnels and viaducts passing over environmental, industrial or residential vulnerable areas.

The procedure for the selection of sites comprises the following eight steps:

1. Promising sites selection, based on the expected number of accidents, using an empirical Bayes approach.
2. Safety analysis of the detected promising sites, to identify those where excessive speeds play a major role in registered accidents.
3. On-site inspection of sites selected in step 2, to verify if the speed limit is adequate and to check that no cost effective infrastructure intervention (such as low-cost engineering measures) would improve the safety level at the site.
4. Selection of the SC sites, taking into account the available budget.
5. Speed measurement under low traffic volume conditions, to confirm that the 85th percentile of speed distribution is above the maximum speed limit, as defined in step 3, above.
6. Final selection of the SC sites.
7. Signing improvement, to ensure that proper information is provided on the prevailing speed limit and the strict enforcement applied, followed by SC installation and operation.
8. Monitoring of results, with on site speed measurements and before-after evaluation of effects both on speed and on accident occurrence.

4. CONCLUDING REMARKS

Enforcement with safety cameras – by applying strict formal rules – is substantially different from traditional speed enforcement, where informal rules – less severe – may be applied, due to human interference in sanctioning procedures. Furthermore, the number of detected violations and corresponding fines will be important, even at sites where speed limit compliance is high. As a result, there is a considerable risk that public support to SC may decline quickly, once the system is running normally. Therefore, installation of SC should be parsimonious, subject to transparent and rational warrants, integrated in

national and local speed management strategies. Furthermore, their effects on safety should be regularly assessed and communicated to the public.
The installation of SC on Portuguese roads is one of the safety interventions foreseen in the new National Road Safety Strategy (2008-2015) that has recently been approved. Therefore, it is expected that the installation of this system will be accompanied by a set of complementary measures, promoted at national and local levels, ranging from information campaigns on the safety consequences of inappropriate speeds to infrastructure interventions on the enforced road stretches and on the neighbouring road networks.

Drivers will be informed about the location of SC, by means of adequate signing, which will be adapted to the type of relevant SC. In case of average speed control over stretches longer than 1 km, it is expected to install variable message signs to remind drivers of the existing enforcement system and the prevailing speed limit.

The results obtained through the safety effects assessments will be used to improve the efficiency of the system (egg. removing cameras from unsuitable sites) and to disseminate to the public the information on the merits of the system, thereby ensuring sustainable public support to these devices, and contributing to the reduction of dangerous excessive speeds.

REFERENCES

(1) Ashton, S.J., Mackay. G.M. (1979). Some characteristics of the population who suffer trauma as pedestrians when hit by cars and some resulting implications. 4th IRCOBI International Conference. Gothenburg.
(2) Hobbs, C.A., Mills, P.J. (1984). Injury probability for car occupants in frontal and side impacts. TRRL Report 1224, TRRL, Crowthorne.
(3) McLean, J.; Kloeden, C. (2002). Alcohol, travelling speed and the risk of crash involvment. 16th Int. Conference on Alcohol, Drugs and Traffic Safety. Montréal.
(4) TRB (1998). Managing speed. Review of current practice for setting and enforcing speed limit. Special Report 254. TRB, Washington D.C.
(5) European Road Safety Observatory (2006). Speed enforcement. Bruxelles.
(6) LNEC (2008). Technical warrants for the installation of systems for automatic enforcement of speed limits (in Portuguese). LNEC, NPTS, Lisboa (2008)
(7) Mountain, L., Hirst, W., and Maher, M. (2004). Costing lives or saving lives: a detailed evaluation of the impact of speed cameras. Traffic Engineering & Control, 45(8).
(8) Chapelon, J.; Boyer, S.; Sibi, P. (2006). Impact du contrôle sanction automatisé sur la sécurité routière (2003-2005). ONISR, Paris, França.
(9) Lamm, R., Kloeckner, J.H. (1984). Increase of traffic safety by surveillance of speed limits with automatic radar devices on a dangerous section of a German Autobahn: a long-term investigation. TRR nº. 974, pp 8-16. TRB, Washington D.C., USA.
(10) Elvik, R., Vaa, T. (2004). The handbook of road safety measures. Elsevier, Amsterdam.