SWOV Fact sheet

Speed cameras: how they work and what effect they have

Summary
Much research has been carried out into the effects of speed cameras, and the research shows consistently positive results. International review studies report that speed cameras produce a reduction of approximately 20% in personal injury crashes on road sections where cameras are used. In the Netherlands, research also indicates positive effects on speed behaviour and road safety. Dutch drivers find speed cameras in fixed pole-mounted positions more acceptable than cameras in hidden police cars.

Background and content
This Fact sheet is about how speed cameras work and the effect they have. Speed cameras are used to register speeding offences and to identify vehicle owners based on the vehicle registration number. The cameras are usually linked to radar or induction loop detectors in the road surface with which speeds are measured. Speed cameras can be installed in pole-mounted positions (fixed speed cameras), or in police cars (mobile speed cameras). They can also be mounted on gantries above the road. Speed cameras can perform measurements at a fixed position or average speed measurements. Cameras with Automatic Number Plate Recognition (ANPR) are used for average speed measurements. This Fact sheet focuses on fixed and mobile speed cameras taking fixed-speed measurements. Other methods of speed enforcement, such as average speed measurement, laser guns, stopping drivers (on-the-spot fine), and video surveillance are not discussed in this Fact sheet. More information about these methods can be found in the SWOV Fact sheet *Police enforcement and driving speed*.

How do speed cameras fit into Dutch road safety policy?
Speed is an important factor in road crashes (see SWOV Fact sheet *The relation between speed and crashes*). Speed limits are often violated in the Netherlands. In 2010, measurements at 30 and 50 km/h roads in the province of South-Holland showed that 70% of the passing vehicles violated the speed limit at 30 km/h roads, half of which violated the limit by more than 10 km/h. At the 50 km/h roads that were monitored, around 35% violated the speed limit, of which around a third violated the limit by more than 10 km/h (Van Schagen et al., 2010). Many measures contained in the Sustainable Safety programme (30 km/h areas, 60 km/h areas, roundabouts), are aimed at reducing speed at and are close to locations with a lot of potential traffic conflicts. However, measures along the road (or in the vehicle) cannot always be realized at short notice, sometimes because they cost a lot of money and sometimes because the physical space for a new measure is lacking. Moreover, a small group of road users deliberately violates the speed limits despite these measures. For this reason, police enforcement is a supplementary measure used to manage driving speed and improve road safety.

When and where are speed cameras used?
Different parties – the road authority, the police, the Public Prosecution Service (OM), and the Traffic Enforcement Team of the National Public Prosecutor's Office – discuss suitable locations for speed cameras in a steering committee. The formal final decision on whether the cameras are to be used is made by the Public Prosecutor's Office. The following guidelines are generally followed as criteria regarding the question of whether and where speed cameras are allowed to be used:
1. at places/on roads with a relatively high number of road crashes[1];
2. where there is an apparent, or plausible, connection between crashes and speed;
3. where there is a relatively high percentage of speed offenders.

In addition to these general criteria, more specific considerations also play a role per location and method, such as visibility, accessibility, and the possible effect on traffic flow. Policy regarding the

[1] This concerns absolute numbers of crashes and not high crash-rate roads (number of crashes per vehicle kilometre).

approach to regional traffic hazards, and therefore also policy regarding infrastructural measures and the use of traffic law enforcement, is determined within the said steering committee. A policy evaluation is undertaken every two to three years, when the use of enforcement (fixed position and mobile speed cameras) is reconsidered.

Concerning fixed speed cameras specifically, the Traffic Enforcement Team has introduced guidelines for placement and usage, as well as for replacement of analog fixed cameras by digital ones (Hofstra et al., 2012).
In short, the following basic rules are applied for the usage of speed cameras:

- Speed cameras are only used at locations on the basis of criteria for road safety previously formulated.
- Speed cameras are always deployed in combination with accompanying communication.
- New speed cameras that are to be placed contain pronounced police striping at the cases.
- Speed cameras are only deployed as a final measure after influencing behaviour and adjusting the infrastructure.
- Digital cameras are permanently in use.
- Red light cameras always enforce speed as well.
- Speed cameras preferably cover all lanes, or, where that is not possible, the most dangerous lanes.
- Minimum distances between two speed cameras are adhered to at road sections without sideways, intersections, roundabouts etcetera.
- The enforcement through fixed speed cameras is evaluated every three years, because of the possibility of continuing the enforcement.

In the decision to remove analog speed cameras or possibly replace them by digital speed cameras, a fixed checklist is used containing questions about a possible road reconstruction, decrease of the road use intensity, previous use of analog cameras, violations, etcetera.

What effects do speed cameras have?
Various studies have been carried out regarding the effects of speed cameras. Although the exact results vary per study, almost all the studies have observed a reduction in speed and in the number of crashes at locations with camera surveillance. However, the effects are limited over both distance and time. This is called a limited 'distance halo' (the distance travelled after passing the camera at which there still is an effect on the driving speed, for example 2 or 3 km after the camera location) and a limited 'time halo' (the period after ending the speed enforcement at which there still is an effect on the driving speed, for example 2 hours or a day after it has ended). A review of the European road safety project DaCoTa[2] shows that the effects of speed cameras generally radiate from just a few kilometres to approximately ten kilometres past the camera location (DaCoTa, 2012). When the cameras are easily visible, this distance halo is larger. A combination of visible fixed cameras and hidden mobile cameras can also increase the distance halo. The largest effects are observed in the immediate vicinity of the camera. If camera surveillance is stopped, the effects disappear within a few days.

Although the individual effects of the speed cameras are limited as to time and distance, when combined over various locations and a number of years, they can have a substantial road safety effect. This is because there is a very strong link between driving speed and road safety. We will enlarge upon the safety effects of speed cameras below, where we will separately discuss the results of international review articles and the results of Dutch research.

International reviews
The international research into the effects of speed cameras is primarily concerned with before-after comparisons between the number of crashes on road sections with cameras and road sections without cameras. Often this concerns a road section of around 0.5-1.5 km in front of and behind the camera location, but greater distances were used as well (especially in the case of mobile cameras that can be placed at different locations at the side of a road). In addition, there are modelled comparisons between the crash trend of road sections with cameras and the general national trend. In the three review studies, various research results have been tested and combined with each other.

[2] DaCoTa refers to Road Safety Data, Collection, Transfer and Analysis.

In the first review study, only the effects of fixed cameras were examined. It shows that the number of personal injury crashes on road sections where cameras were used was reduced by 20 to 25% (Thomas et al., 2008).

The second review is a meta-analysis of studies on various types of traffic law enforcement, among which are speed cameras (Ercke, Goldenbeld & Vaa, 2009). This review found that the effect is greater for fatal crashes than for personal injury crashes. For all methods of speed enforcement together, researchers found a reduction of 29% in fatal crashes versus 14% in personal injury crashes; with speed camera enforcement they find a 33% reduction in fatal crashes versus 22% in personal injury crashes. This difference in effects is in line with the general knowledge on speed control measurements.

Furthermore, Erke, Goldenbeld & Vaa (2009) make a distinction between the effects for mobile and for fixed cameras: for fixed cameras they found a reduction in the number of personal injury crashes of 35% and for mobile cameras they found a reduction of 14%. A possible explanation for this difference is that fixed cameras are used more frequently than mobile ones at locations inside built-up areas with heavy traffic and a high concentration of crashes. If the initial situation is less safe, then the effect of a camera will by definition also be higher. It must be noted that a review of mostly Australian and New Zealand enforcement projects (Delaney, Diamantopoulou & Cameron, 2003) shows that the effects of hidden mobile cameras radiate cover a larger area than the effects of fixed cameras. Hence, although fixed cameras may often have a greater safety effect per specific location, hidden mobile cameras can be effective in a larger area.

The third review is by Wilson et al. (2010). They have examined 28 studies from various parts of the world, which qualify as poor or as reasonably good. Because of the great heterogeneity in results, the authors did not separate the effects for fixed and mobile cameras. Based on these studies, Wilson et al. concluded that the number of serious injury crashes (leading to deaths or hospitalisation) on roads and in areas with fixed or mobile cameras decreased by 11% to 44% compared to similar roads or areas without cameras. Research on the effects of cameras in larger areas finds reductions of 17% to 58%, in which most reduction is found between 30 and 40%. Studies measuring the effects over a longer period of time show that the positive trend remains or even becomes stronger over time. Wilson et al. conclude that the consistency of the results shows a positive effect of cameras on road safety.

Next to the three review studies mentioned, results of (individual) studies in Great Britain, France and China deserve some attention. One long term evaluation in Great Britain (Gains et al., 2005) made a distinction between fixed and mobile cameras. Here, as well, a (somewhat) larger effect on safety was found for the fixed speed cameras than for the mobile cameras: a reduction of 24% was found where fixed cameras were used, and a reduction of 21% was found where mobile cameras were used. Recent national review studies on the use of speed cameras in France and China confirm the picture of beneficial safety effects. A French review study estimated that more than 15,000 road crash fatalities and more than 62,000 injuries were prevented in France in the period 2003-2010 due to the use of fixed and mobile speed cameras (Carnis & Blais 2013). In 2003 the first speed cameras were used in France: since then, around 500 have been added yearly, resulting in a number of more than 2,700 speed cameras in 2010. An overview of data on camera enforcement in China also shows beneficial safety effects on motorways, provincial roads and city roads (He et al., 2013).

Dutch research

In the Netherlands, the effect of mobile speed cameras was examined in the province of Friesland (Goldenbeld & Van Schagen, 2005). The study included 28 roads with a speed limit of 80 km/h and with a high number of crashes. During the period 1998-2002, mobile cameras were deployed at different locations along these roads. This research compared the developments in speed behaviour and the number of crashes on these roads with the developments on 28 similar roads without speed enforcement. There was a reduction of the average speed from 82.6 to 78.6 km/h on the roads with extra mobile speed enforcement, and a decrease in the percentage of offenders from 27.4% to 15.6%. The safety effect was comparable to that in Great Britain, namely a reduction of 21% of personal injury crashes involving motorized traffic. In spite of the long research period, the question of regression to the mean may apply here. In this case this means that roads that were selected for their above average crash rate in a previous period, might also have shown a lower, more average number of crashes in the period afterwards without the intervention. Perhaps the real effect is therefore somewhat smaller.

Do speed cameras have adverse effects?

According to some, speed cameras can also have an adverse effect. In the first place, they refer to the supposed kangaroo effect. A kangaroo effect is created when drivers decelerate suddenly when they notice a speed camera, and then quickly accelerate again. This is thought to have an adverse effect on traffic flow and the environment, as well as road safety. However, no research has been carried out regarding the extent to which this phenomenon occurs in reality, or what its effects are (DaCoTa, 2012). It is also sometimes claimed that due to more intensive camera surveillance, the road safety hazard shifts from one location to another (crash migration). However, a recent study of the safety effects of mobile cameras on rural roads (Jones, Sauerzapf & Haynes, 2008), has tested these claims and has found no evidence to support them. Yet Thomas et al. (2008) do not rule out the possibility that the kangaroo effects and crash migration could affect road safety. For this reason, they recommend that this sort of undesirable behaviour should be monitored and prevented if this is needed.

Is camera enforcement accepted in the Netherlands?

In 2011 half of all traffic participants of 15 years and older (51%) were in favour of placing more speed cameras, 38% were against and 11% were neutral on the topic. This was shown in a large-scale survey among around 12,000 traffic participants in the Netherlands (Duijm et al., 2010). These percentages were almost identical to those of 2009.

The average Dutch person is critical about the presence of the police in traffic, and the use of automated enforcement methods (Berkhout, 2008). However, their criticism seems to be aimed more at the way enforcement is carried out, than at the desirability of speed and camera surveillance (Goldenbeld, 2008). Less visible forms of speed enforcement are especially criticized. In 2010, a survey among around 6,000 Dutch drivers showed that a majority of drivers find speed cameras (73%), average speed checks (69%) and stopping drivers (77%) acceptable to very acceptable. Less than half of all drivers considers hidden police cars (44%) and the use of laser guns (43%) acceptable methods of enforcement (Intomart Gfk, 2010).

One method to increase public acceptance of speed enforcement is to provide information about surveillance and traffic laws. This can also increase the effectiveness of enforcement (Erke, Goldenbeld & Vaa, 2009). The Traffic Enforcement Team therefore uses the motto ‘No enforcement without communication, and no communication without enforcement’.

How does the effectiveness of speed cameras relate to other measures?

The positive effects of speed cameras do not automatically mean that the use of cameras is also always and in all situations the most obvious and most cost effective speed enforcement measure. Particularly in built-up areas, infrastructural measures can be more effective than speed cameras. For example, Mountain, Hirst & Maher (2005) conclude that infrastructural measures at 30mph roads (48 km/h roads) could reduce twice as many personal injury crashes in Great Britain as speed cameras could.

Wegman & Aarts (2006) advocate a systematic and step-by-step approach to the speed problem (see also the SWOV Fact sheet *Measures for speed management*).

- The first priority is to make speed limits safe and credible.
- Then road users must be informed as well as possible about the speed limit in force via signboards, road markings and information systems.
- Next, extra infrastructural measures at specific locations and roads can ensure that the desired speed is actually achieved.
- Finally, as a last step, speed enforcement will be required for the group of road users who still persist in violating the speed limits, including the use of speed cameras.

Furthermore, the ideas behind deploying speed cameras, and with that also the set-up and use of camera systems, turn out to be different in different counties. Belin et al. (2010) examined the policy vision behind the deployment of speed cameras in the Victoria (Australia) and Sweden. In Sweden, the idea is that there is a conflict between the road design and the speed of the road user, and that camera programs should be limited only to dangerous locations and should contribute to creating a social norm amongst road users that it is easier and safer to keep to the speed limit. Australia, on the other hand, works from the thought that continuous and intentional violation of the speed limit by

drivers is the problem. Through increasing the objective chance of being caught and intensive information campaigns, road users should get the idea that they can be checked for speed at any time and at any location. Sweden attempts to convince road users through providing information on safe speed limits; Australia attempts to influence road users more through mechanisms of general and specific deterrence.

Rules of thumb for successful use of speed enforcement

DaCoTa (2012) formulated ten golden rules for setting up successful speed enforcement through cameras (as well as stopping drivers):

1. Focus on speeding where it is related to road safety.
2. Speed cameras must be part of a larger policy focused on speed.
3. Camera surveillance is more effective if prioritization of roads, areas and points in time has taken place.
4. Credibility is an important aspect of surveillance.
5. Camera enforcement is especially recommended for roads with much traffic and at which many crashes take place.
6. Speed enforcement should be coupled with safe and credible limits, publicity, and suitable penalties.
7. Serious attention is needed for the development of supplementary new penalties, such as warning letters, educational measures and speed limiting devices.
8. Speed surveillance becomes increasingly effective when goals and criteria of success have been formulated and when results are being monitored.
9. Cooperation between police, the municipality and data experts offers the best guarantee for good enforcement.
10. New technology in or outside of vehicles creates opportunities to monitor and catch extreme or repeat speed offenders.

These ten rules concern specific speed surveillance; the steps of Wegman & Aarts mentioned earlier concern the full approach to speed control, so they actually precede these ten rules. In other words: before thinking of speed or camera enforcement, the road itself should be given a credible limit and the road user should be provided with clear information about this.

Conclusion

The use of fixed and mobile speed cameras has been found to provide positive safety effects worldwide. Recent reviews of international studies (both from 2008), estimate an average decrease in personal injury crashes of approximately 20% on road sections where cameras were used. A recent overview of 2010 finds a decrease in serious personal injuries of 11-44% near camera locations, and of 30-40% for larger areas where camera activities are used. Dutch research also points to the positive effects of speed cameras.

Dutch drivers find clearly visible speed cameras at fixed positions more acceptable than hidden mobile speed cameras. Little research has been done on the undesirable side effects of speed cameras, such as sudden deceleration and acceleration in the vicinity of cameras, and the migration of crashes to other locations. However, the possibility that such effects may occur cannot be excluded. It is therefore important to include an evaluation of possible side effects when planning camera projects. The positive effects of speed cameras do not automatically mean that cameras are also always the most effective measure for speed management and road safety improvement. A credible speed limit and clear information on this towards the road user should be arranged correctly before we can think about speed surveillance using cameras. In built-up areas in particular, infrastructural measures can be considerably more effective than speed cameras.

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