SWOV Fact sheet

Towards credible speed limits

Summary
SWOV has elaborated the concept of 'credible speed limits' in a number of studies. A speed limit is credible if it meets the expectations that are aroused by the road and the road environment. For 80 km/hour roads SWOV carried out a photograph study, followed by an experiment in a driving simulator. The photograph study was used to determine which characteristics of the road and surroundings influence the credibility the most; in the driving simulator experiment we studied whether the driving behaviour was indeed influenced by these characteristics. The results showed that it is possible to choose a speed limit that is more credible for everybody; improving the credibility of the speed limit can be achieved by either adapting the speed limit itself or the road layout.

Background
The concept of 'credible speed limits' was first introduced in the Netherlands in *Safe and credible speed limits; A strategic exploration* (Van Schagen et al., 2004). Safe, credible speed limits are expected to result in motorists obeying the speed limits better. This can lead to a considerable reduction in the number of road crash casualties (see the SWOV Fact sheet *Measures for speed management*).
In itself the idea of credible speed limits is not new. Comparable terms have been used abroad, such as 'realistic speed limits' (Fildes & Lee, 1993) and 'acceptable speed limits' (Risser & Lehner, 1998). However, until now – as far as we know – it has not yet been attempted to make these terms concrete and applicable in practice. SWOV has tried to do so in a number of successive studies. This Fact sheet presents the most important results of these studies.

What is a credible speed limit?
A credible speed limit is defined as a speed limit that matches the image that is evoked by the road and the traffic situation (Van Schagen et al., 2004). For example, if a road has a 60 km/h limit, it must not look like a road that would normally have a limit of 80 km/h; that is not credible. It is equally implausible if a road looks like a 60 km/h road but is actually an 80 km/h road. Both the road and its environment must make it logical and credible that on the one road there is a lower limit than on the other. If a limit is not credible, drivers will be more inclined to choose their own speed. If limits are experienced as being incredible too often, it will also harm the trust in the speed limit system as a whole. In addition, it is important to realize that the credibility of a limit is not an absolute measure. Credibility is a sliding scale that varies from 'very credible' to 'very incredible'. A speed limit can be incredible either because the limit is judged as being too high or as being too low.

In the above definition of credibility we make a distinction between the 'road image' and 'the situation image'. The 'road image' is formed by the static features of the road and its environment, such as the lining and markings, bends, buildings, and vegetation; the 'situation image' is created by the dynamic features of the traffic situation such as weather conditions and the amount of traffic. The dynamic features are particularly relevant for dynamic speed limits, i.e. limits that are being tuned to the current circumstances. At present, the Netherlands mainly has static limits, meaning that the degree of credibility is mainly determined by the static features.

Which characteristics of road and environment influence credibility?
A first step for converting the concept of credibility into practical applications is to answer the question whether the degree of credibility can be attributed to specific features of the road or its environment. In a survey using photographs of 80 km/h roads (Goldenbeld et al., 2006) approximately 600 motorists indicated their preferred and safe driving speeds for 27 road situations –without being informed of the actual speed limit. The difference between the preferred speed or safe limit and the current limit can be considered an indication of the credibility of the speed limit in force.
The photograph study showed that the credibility of a speed limit is indeed influenced by specific features of the road and the environment. This means that it is possible to improve the credibility of the

limit by tuning the speed limit and certain features of the road and its environment to each other better. According to the photograph study the following features influence the credibility of the limit on 80 km/h roads:

- the road width;
- the presence or absence of a bend;
- the view ahead;
- the view to the right;
- the clarity of the situation;
- the presence or absence of buildings;
- the presence or absence of trees on the right hand side.

Are there differences between motorists?

The previously mentioned study of Goldenbeld et al. (2006) also examined whether drivers differ in the extent to which they find the limits credible. The results showed that this is the case. Some motorists want to drive considerably faster and regard a (considerably) higher limit as still being safe. Among other things, the differences depend on age (younger people find a higher limit safe than older people) and sensation seeking (people with a strong need of sensation or risk taking find a higher speed limit safe than those with a lesser need of sensation seeking). There also seems to be a relation between the number of speeding fines and the extent to which a higher limit is still considered as being safe. Unfortunately, these personal differences make it impossible to determine a speed limit that is equally credible for everybody.

Fortunately, it seems possible to determine a speed limit that is *more* credible for everyone. There are only few differences between drivers in the way in which they are influenced by the road and environment features. The features that influence everybody are the presence or absence of a bend, the clarity of the situation, the view ahead, and the view to the right. However, young motorists are less influenced by road and environment features than older ones. The presence of buildings, the road width, and the presence or absence of trees on the right hand side of the road only had an influence on older drivers; all features that influenced younger drivers also influenced older motorists.

What are the effects on driving speed?

Credible speed limits are supposed to lead to motorists obeying speed limits better. In a driving simulator, SWOV studied whether this was really the case (Van Nes et al., 2007b). In a simulator, a total of 20 subjects drove the same rural route twice along roads with a limit of 60, 80, or 100 km/hour; these were access roads, distributor roads, and through roads respectively. The credibility of these limits was manipulated beforehand by varying a number of features known to be relevant: the road width, the presence or absence of buildings, the presence or absence of vegetation, the number of lanes, and the lines/markings. Variations were chosen in such a way that the final layout met the current Dutch guidelines.

In the first experimental drive the speed limit was not shown. The credibility of the existing speed limit was then determined for each road by comparing the speed that was driven intuitively with the intended limit. The credibility deviated from the optimum credibility in two directions: not or less credible because the intended limit was too high (in that case the intuitive speed was lower than the intended speed limit) or because the limit was too low (in that case the intuitive speed was higher than the intended speed limit).

In the second experimental drive the speed limits were shown on traffic signs. During this drive the degree of credibility did indeed influence the driving speed. More credible limits resulted in an average driving speed that was closer to the limit. When the limit was experienced as being too low, the average speed was a considerably higher than the limit; for limits that were experienced as being too high, the average speed was lower than the limit. There are indications that drivers older than 50 are more influenced by the credibility of limits than younger ones; gender and sensation seeking have no influence here.

In the driving simulator study the effects on speeding offences and speed differences were also measured. In accordance with the expectations, on average less time was spent speeding when the limit was credible than when the limit was considered as being too low. The effect on speed differences was less obvious, but there were indications that there were fewer large differences

between drivers when the limits were credible than when they were experienced as being too high or too low.

Will the credibility of speed limits still be relevant after the introduction of ISA?
Intelligent Speed Assistance (ISA) is on the rise. We expect that the more informative and warning variations will be first on sale (see the SWOV Fact sheet *Intelligent Speed Assistance*). The question is whether the concept of 'credible speed limits' still makes much sense if ISA is being used. To answer this question, 21 subjects in the driving simulator study described above made the drive with a warning type of ISA. This ISA substantially reduced the driving speed, particularly in the case of incredible limits that were regarded as being *too low*. In these cases, speeds were much higher than the limit without ISA; with ISA they were equal to or just below the limit. The effect of ISA was smaller for incredible limits that were regarded as being *too high*. In these cases, just like when no ISA was used, speeds were (far) below the limit; with ISA the speeds were only slightly lower (see *Figure 1*).

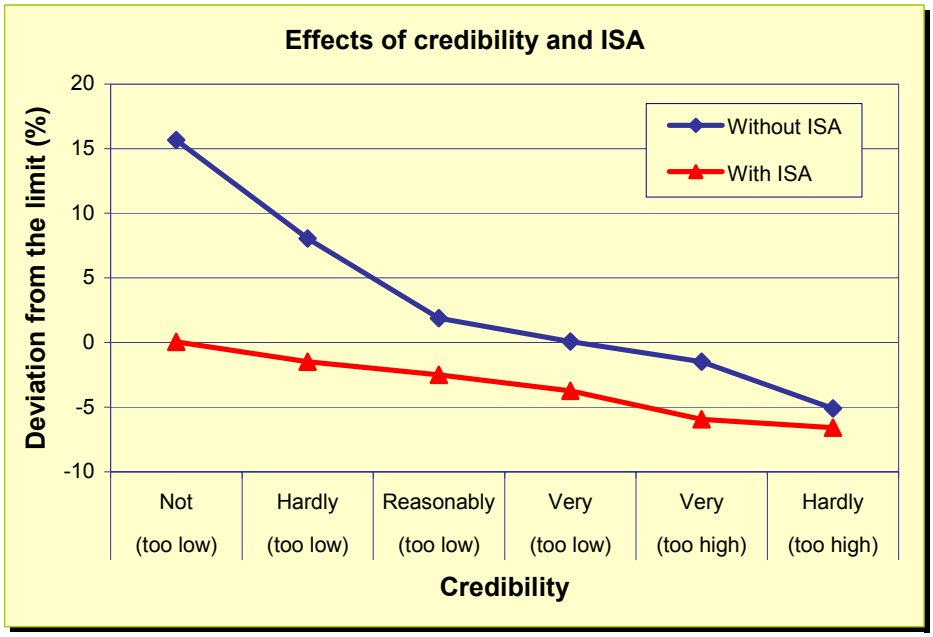

Figure 1. *Effect of credibility and ISA on the average percentage deviation of the speed limit.*

In any case, this experiment gave no indications that, under certain circumstances, people will drive faster with ISA than they would have done without it. This means that motorists are apparently not inclined to drive at exactly the speed of the limit. Furthermore, this study also showed that with ISA, the degree of credibility of the speed limit is no longer important, at least not when the aim is an average speed that is not faster than the limit. With ISA, the average speed never is above the limit, not even if the limit is regarded as being too low. However, we must realize that the ISA variant used in this experiment was a very strict one. The ISA already warned if the driving speed was 1 km/hour above the limit and the audible warning was repeated every 10 seconds in an insistent way. With a less strict ISA variant, the credibility of limits probably does play a role. It may also be possible that the credibility of limits will influence the acceptance of ISA. However, this aspect was not studied.

What to do if a speed limit is not credible?
If a speed limit is not credible, there basically are two possibilities to do something about it: *either* change the limit, *or* change the layout of the road or its surroundings. If the first option is chosen, raising the speed limit must not increase the number of crashes. A safe limit remains the starting point, no matter what. The road's function, traffic composition, potential conflict types, traffic volume, etc. will always need to be considered (see also the SWOV Fact sheet *Measures for Speed Management*). Finally, the possibility remains that for certain reasons neither the speed limit nor the road layout can be changed. An example is an incredibly low speed limit on motorways for environmental reasons. In these cases it is advisable to explicitly communicate the reason for the low limit to the road user, as is done in e.g. Germany ('Umweltschutz') and France ('Pollution').

What practical use is there for credible speed limits?
As is evident from the studies discussed above, the concept of credible speed limits has sufficient potential to be translated into practical traffic applications. Based on the survey study, the simulation study, and an additional literature study in which relevant road and environment features of other than 80 km/hour roads have been identified, an initial effort has been made to draw up a checklist 'credibility' (Van Nes et al., 2007a).

In a way, a checklist for credible limits is a contradiction in terms. Credibility is a concept that involves the overall image of a road and its environment. The checklist has broken down this overall image to a limited number of separate elements that can be easily assessed. The starting point for SWOV's checklist was that the roads already fulfilled the Dutch road design guidelines. The credibility characteristics that had been identified and were not dealt with in the guidelines, were reduced to five accelerators/decelerators (see *Table 1)*. At present, the first version of a checklist is being further developed within the framework of the *Safe and credible speed limits* project in which SWOV cooperates with a number of provinces and a consultancy firm.

	Accelerators	Decelerators
1. Straight road sections	Long straight road sections	Short straight sections (many bends or intersections)
2. Physical speed limiters	Physical speed limiters not present	Physical speed limiters present
3. Openness of the situation	Open, clear road environment	Closed, inconveniently arranged road environment
4. Road width	Wide road	Narrow road
5. Road surface	Smooth road surface	Rough road surface

Table 1. *Five features of road and road environment that can function as accelerators or decelerators*

As shown in this table, we distinguish between five accelerators and decelerators. Accelerators are elements of a road or its environment that intuitively, independent of the limit, elicit a higher speed. Decelerators are elements that encourage a lower speed.

Short sections and physical speed limiters literally force motorists to drive slower. On long sections and when physical speed limiters are absent, the physical obstacles for driving fast are missing. These two elements were called primary accelerators and decelerators

In addition, we also distinguish three secondary accelerators and decelerators: an open/closed environment, road width, and road surface. In an *open road environment* a motorist has a clear view, both left and right; in a closed environment, for example because of buildings or vegetation, the view is obstructed. In a closed road environment motorists are inclined to drive slower. A closed road environment thus strengthens the 'short sections' decelerator, whereas an open road environment strengthens the 'long sections' accelerator. Road width also affects credibility. A wide road acts as an accelerator and a narrow road as a decelerator. This is the case for both the entire road width and the lane width. Finally, the *road surface* has an influence on credibility. A smooth road surface, e.g. asphalt, encourages faster driving whereas a rough road surface like bricks or bumpy asphalt, invites lower speeds.

Conclusion
This Fact sheet describes a number of SWOV studies that were carried out to make the concept of credible speed limits more concrete and applicable. The studies confirm that, in principle, this is possible. The studies show that certain specific road and environment features influence the credibility of the speed limit. It is not possible to determine a limit that is equally credible for all motorists; however, it is possible to determine a limit that is *more* credible for all. After all, the studies show that motorists are to a large extent influenced by the same road and environment features.
Furthermore, the driving simulator study has indicated that credible speed limits also have the desired effect on driving speed behaviour: a credible speed limit is obeyed better.

There are still quite a few problems in its practical application. For example, we must realize that we cannot simply increase a speed limit because it would be more credible. A safe limit always remains a primary prerequisite. The alternative – to alter the road image – can sometimes be achieved with relatively simple means, but in other cases it will be more difficult.

Furthermore, not all research questions have been answered. The credibility of speed limits is determined by a combination of a variety of factors in the road environment, of which only a few were investigated in the studies. Dynamic factors, such as the presence of other traffic and the weather conditions, have been left out. The studies also leave the question unanswered of what to do if the road environment changes within a particular road section. It is theoretically undesirable and practically impossible to alter the speed limit every 100 metres. In other words, credible speed limits are a promising point of action for speed management and, therefore for road safety. However, large scale application in practice still requires a lot of development.

Publications and sources
(SWOV reports in Dutch have a summary in English)

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