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# SWOV Fact sheet

## Towards credible speed limits

### Summary

A speed limit is credible if it meets the expectations that are evoked by the road and the road environment. Credible speed limits are expected to encourage drivers to keep to the limit. A few years ago, SWOV elaborated on the concept of 'credible speed limits' in a series of studies. Photographs and animations were used to determine which characteristics of road and environment influence credibility most; a driving simulator experiment was used to study whether the driving behaviour was indeed influenced by these characteristics. The results indicated 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. Based on these findings, SWOV, together with national and international partners, developed a method that can support policy makers in the realization of safe speeds and credible speed limits.

### Background and content

The concept of 'credible speed limits' was introduced in the Netherlands in *Safe and credible speed limits; A strategic exploration* (Van Schagen, Wegman & Roszbach, 2004). Safe and credible speed limits are expected to result in drivers obeying the speed limits better. This can lead to a considerable reduction in the number of road crash casualties (see SWOV Fact sheet [Measures for speed management](#)).

In itself the idea of credible speed limits is not new. Similar terms have been used in other countries, such as 'realistic speed limits' (Fildes & Lee, 1993) and 'acceptable speed limits' (Risser & Lehner, 1998). In addition, a considerable body of literature already existed on the way speed behaviour can be influenced by elements in the environment. However, – as far as we know – it had not yet been attempted to make the terms 'realistic' and 'credible limits' concrete and applicable in practice and to bundle the available information. SWOV therefore attempted to operationalize the concept of credible limits in a number of successive studies. This Fact sheet will present 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, Wegman & Roszbach, 2004). For example, if a road has a 60 km/h limit, it should not look like a road that would normally have a limit of 80 km/h; that would not be 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 look of the road and that of its environment should make it logical and credible that the first road has a lower limit than the latter. 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 damage 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 considered to be too high or too low.

The above definition of credibility distinguishes 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. The starting point for each credible speed limit is always that it indicates a *safe* limit. Which speed can be considered safe depends on the road function and therefore on the composition of traffic and the type of conflicts that may occur (see the SWOV

Fact sheet [Measures for speed management](#)). Not until then, the question remains whether this safe limit is credible as well.

### **Which characteristics of road and environment influence credibility?**

A first step in 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. The literature indicates that various elements of the road and its surroundings may indeed influence road users' speed behaviour (see also the SWOV Fact sheet [Speed choice: the influence of man, vehicle, and road](#)). In a survey using photographs of 80 km/h roads (Goldenbeld, Van Schagen & Drupsteen, 2006) approximately 600 drivers indicated at which speed they would prefer to drive there and what they would consider a safe speed limit. They had not been informed of the actual speed limits. The (average) difference between the preferred speed or safe limit and the actual limit is considered an indication of the credibility of the actual speed limit.

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 better tuning of the speed limit to certain features of the road and its environment. 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 complexity of the situation;
- the presence or absence of buildings;
- the presence or absence of trees on the right hand side.

In the European ERASER project a similar survey was carried out using 24 pictures of rural roads (Houtenbos et al., 2011). A total of 307 drivers from Austria, Germany, the Netherlands, Great-Britain, Ireland and Sweden took part in this study. The study showed that in particular roads with two lanes per driving direction, an open road environment, and a physical barrier as separation of driving directions elicited higher speeds and lower credibility (a greater difference between reported speed and the estimated safe speed). In addition, the largest effect on speed was found to be caused by open surroundings, followed by road width.

### **Are there differences between drivers?**

The previously mentioned study of Goldenbeld, Van Schagen & Drupsteen (2006) also determined that drivers differ in the extent to which they find the limits credible. Some drivers prefer a speed which is considerably faster than the limit in force and regard a (considerably) higher limit as still being safe. Among other things, the differences depend on age (younger people find a higher limit safer than older people) and sensation seeking (people with a strong need of sensation or risk taking find a higher speed limit safer 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 to be 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 novice drivers are less influenced by road and environment features than older drivers. The presence of buildings, the road width, and the presence or absence of trees on the right hand side of the road only have an influence on older drivers; all features that influence younger drivers also influence older drivers.

### **What are the effects on driving speed?**

Credible speed limits are supposed to result in drivers obeying (safe) 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/h; 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 road markings. Variations were chosen in such a way that the final layout was in line with the current Dutch CROW guidelines.

In the first intuitive drive, the credibility deviated from the intended speed limit in two directions: the limit was either not or less credible because it 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 indicated and the degree of credibility was indeed found to influence the driving speed. More credible limits resulted in an average driving speed that was closer to the limit and on average, less time was spent speeding. In addition, the results indicated smaller differences between drivers. When the limit was experienced as being too low, the average speed was 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 young drivers; gender and sensation seeking were found to have no influence here.

### 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 the environment. In case of the first option, adapting the speed limit, this must not be done at the expense of road safety. 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 SWOV Fact sheet [Measures for speed management](#)). Finally, the possibility remains that for certain reasons neither the speed limit nor the road image can be changed when the limit is not credible. An example is the 80 km/h 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'). It goes without saying that the reason given should also be credible.

### What practical use is there for credible speed limits?

All things considered, the concept of credible speed limits has sufficient potential to be translated into actual practical applications, and a first step has been taken towards drawing up a 'credibility' checklist (Van Nes et al., 2007a). In a simplified way, the checklist has divided credibility into a limited number of separate elements that can be assessed easily.

However, it is important to be aware that credibility involves an overall picture. The starting point for drawing up the checklist was that the road layout was already in accordance with the Dutch guidelines for different road categories. Furthermore, five accelerators or decelerators were identified (see *Table 1*). Accelerators are elements of the road or environment that intuitively, independent of the limit, elicit a higher speed. Decelerators are elements of the road or environment that intuitively, independent of the limit, elicit a lower speed.

Next, a distinction was made between primary and secondary accelerators and decelerators. Short road sections and physical speed limiters literally force drivers to drive at a lower speed. On long tangents and when physical speed limiters are absent, the physical obstacles to prevent high speeds are missing. These two elements have been called primary accelerators and decelerators.

	Accelerators	Decelerators
1. Tangents	Long tangents	Short tangents (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*

The other three elements are secondary accelerators and decelerators: an open/closed environment, road width, and road surface. An *open road environment* offers a driver an unobstructed view, both left and right and thus will generally elicit acceleration. In a closed environment the view is obstructed, for example by buildings or vegetation which generally will elicit deceleration – as long as there is not too

much of a tunnel effect. 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. Finally, the road surface has an influence on credibility. A smooth road surface, e.g. asphalt, will elicit higher speeds whereas a rough road surface like bricks or bumpy asphalt, will elicit lower speeds.

### **Towards a decision support tool for road authorities**

Together with several Dutch provinces, the Directorate-General for Public Works and Water Management (Rijkswaterstaat), and a consultancy firm (VIA.nl), SWOV developed a method that supports policy makers in the realization of safe speeds and credible speed limits (VSGS; see Aarts & Van Nes, 2007; in English: SaCredSpeed – Safe and Credible Speeds; see Aarts et al., 2009). VIA.nl has developed the 'VIAstat' tool based on this method. The method – which would benefit from further development – is not only intended to assist in the analysis of problems in the area of safe and credible speeds, it also intends to help in the decision making process concerning measures that could be taken. These measures relate to 1) adapting the speed limit, 2) adapting the road layout and elements of the road environment, or 3) supplementary police enforcement. The method was tested on the regional road networks in the Provinces of Fryslân and Zeeland and on the road network of the city region Parkstad in the Province of Limburg (see Aarts et al., 2010; Dijkstra, Louwerse & Aarts, 2010). Around 70% of the road network turned out not to have a credible speed limit. Sometimes the limit was higher than deemed credible, which was mostly the case at trunk roads with a limit of 100 km/h and a relatively narrow profile. Limits that were lower than deemed credible were mainly found on 30 or 60 km/h roads, and the causes were mostly a lack of physical decelerating measures, long tangents and a smooth road surface. Building on the VSGS method, a European version has been developed within the scope of the ERASER-project (Aarts et al., 2011) which has been made available on <http://www.swov.nl/enquete/Eraser/Tool.php>.

### **Conclusion**

This Fact sheet discusses 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 indicate 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 drivers; it is, however, possible to determine a limit that is *more* credible for all. After all, the studies show that drivers 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 the practical application of credible speed limits. 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, there are still many research questions to be answered. For example, the credibility of speed limits is determined by a combination of various factors, of which only a few have been investigated. 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 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 much effort and development.

### **Publications and sources**

**(SWOV reports in Dutch have a summary in English)**

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