# SWOV Fact sheet

## Edge strips on rural access roads

**Summary**
In a sustainably safe traffic system, uniformity of traffic facilities is a point of special interest. Uniformity ensures recognizability and predictability of (critical) traffic situations. The uniformity of rural access roads can be increased by applying edge strips on both sides of the road; this creates a narrow single lane for motorised vehicles in the middle of the carriageway: a marked driving lane. Edge strips are marked with broken lines. The edge strips on either side of the marked driving lane can be used by cyclists if they are sufficiently wide. Studies indicate that this type of marking slightly increases road safety.

**Background and content**
When redesigning rural roads according to the Sustainable Safety guidelines, 80 km/h roads with a minor traffic function in rural residential areas are converted into rural access roads. This road category is intended for use by all transport modes and has a speed limit of 60 km/h.

In a sustainably safe traffic system, uniformity of traffic facilities is a point of special interest. Uniformity is a way of ensuring recognizability and predictability of (critical) traffic situations (see also the SWOV Fact sheet *Recognizable road design*). The uniformity of rural access roads can be increased by applying edge strips; this leaves a marked driving lane for motorized vehicles in the middle of the carriageway (see *Figure 1*). The present Fact sheet will discuss the requirements for the different types of edge strips on rural access road and the effects on traffic behaviour and road safety.

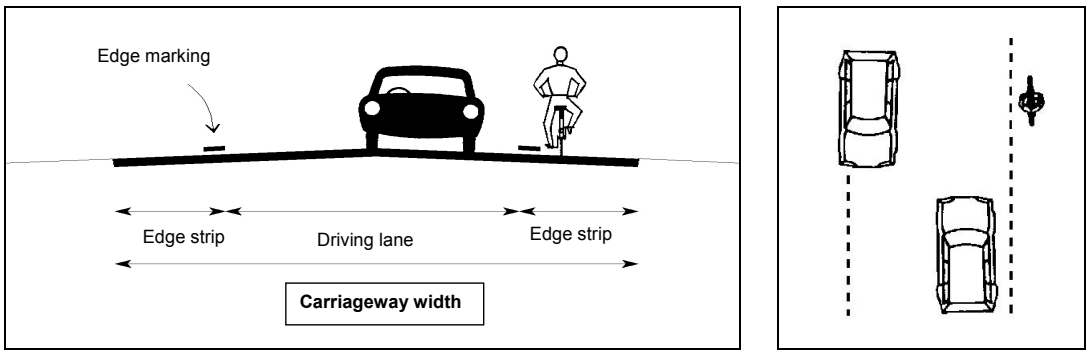


Figure 1. *Marked driving lane with edge strips; cross section (left) and view from above (right).*

**How many casualties on road sections of 60 km/h access roads?**
*Table 1* shows that in 1998 there were 8 registered fatalities and 24 serious road injuries[1] on road sections of Dutch 60 km/h rural access roads. In 2009 there were 63 fatalities and 231 serious injuries; an increase in fatalities by a factor of 8. This amounts to an increase from about 1% of all registered road deaths in the Netherlands in the late 1990s to about 10% one decade later. The number of serious road injuries has increased by a factor of 10. These increases seem to be almost entirely due to the increase in 60 km/h roads. In 1998, there was an estimated 2,100 km of 60 km/h access roads; in 2008 this was approximately 35,400 km (Weijermars & Van Schagen, 2009), an increase by a factor of 17. This means that the casualty density, here the number of road fatalities on road sections per 1,000 kilometres road length, was more than halved from 3.8 in 1998 to 1.4 in 2008. The crash risk (serious injuries per motorized vehicle kilometre) should also decrease if the traffic volumes remain the same; however, since too little reliable data is available about the traffic volumes on these roads, no statements can be made about the crash rate (see also SWOV fact sheet *Risk in traffic*).

[1] A serious injury is a casualty assessed with an injury severity of MAIS 2 or higher . The registered number of serious injuries is known for the years 1993 up to and including 2009. A serious crash involves at least one fatality or serious injury.

| Road sections 60 km/h | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fatalities | 8 (1%) | 8 (1%) | 19 (2%) | 18 (2%) | 21 (2%) | 23 (2%) | 30 (4%) | 45 (6%) | 42 (6%) | 51 (7%) | 49 7%) | 63 (10%) | 41 (8%) | 33 (6%) |
| Serious road injuries | 24 (<1%) | 34 (<1%) | 59 (1%) | 93 (1%) | 122 (2%) | 173 (2%) | 153 (2%) | 186 (3%) | 203 (4%) | 210 (1%) | 255 (5%) | 231 (5%) | N.b* | N.b* |

Table 1. *Registered numbers of fatalities and serious road injuries on road sections of 60 km/h rural roads in the period 1998-2011 in the Netherlands, and the percentage of the total number of fatalities and serious road injuries on all roads. *Note: not yet known. Source: Dutch Ministry of Infrastructure and the Environment, DHD.*

**What are the guidelines for access roads with edge strips?**

According to the Dutch guidelines, the rural access roads can be subdivided into roads of type I (carriageway width of 4.50-6.20 m) and type II (carriageway width of 2.50-4.50 m) (*Table 2*). From the Sustainable Safety point of view, the 60 km/h speed limit on rural access roads is in fact too high for the mixing of different transport modes. For safe mixing the maximum speed should not be higher than 30 km/h. To make the situation as safe as possible, applying a single marked driving lane for car traffic in both directions in the middle of the carriageway on type I access roads is recommended (CROW, 2002; see also *Figure 1*). Such a visual narrowing is intended to make motor vehicles drive slower and more in the middle of the carriageway. The marked driving lane is marked by broken lines. The spaces between the marked driving lane and the edge of the carriageway on either side are called edge strips. Edge strips provide more room to correct steering errors, thus reducing the risk of going off the road. We expect that this will reduce the damage to road shoulders, which, in its turn, can substantially lower the maintenance costs. To prevent damage to road shoulders, the maximally acceptable traffic volume is 350 motorized vehicles (mv) per 24-hour period for roads with a 3 m surface width; 1,000 mv per 24 hours for roads with a 4.5 m surface width; and ca. 5,400 mv per 24 hours for roads with a 6.2 m surface width.The width of the edge strip and the type of edge marking determine the name that is used for the edge strip(CROW, 2004, 2006):

- Diverging lane, intended for motorized vehicles when overtaking or when passing oncoming traffic (marked with broken line in a ratio of 1 m line – 3 m open, width of 0.25-0.40 m);
- Non-designated bicycle lane, intended for use by bicycles (marked with broken line in a ratio of 1 m line – 1 m open, width of 1.25-1.50 m);
- Bicycle lane (marked with broken line in a ratio of 1 m line – 1 m open, width of 1.50-2.00 m, with a bicycle symbol. .

| Characteristic* | Rural access road type I | Rural access road type II |
|---|---|---|
| Speed limit | 60 km/h | 60 km/h |
| Number of lanes | One | One |
| Carriageway width | 4.50 – 6.20 m | <4.50 m |
| Width of marked driving lane | 3.00 – 4.50 m | Same as carriageway width |
| Marking | Broken edge marking (10*-15** cm wide)<br>1 m line – 3 m open (diverging lane)<br>1 m line – 1 m open (non-designated bicycle lane)<br>1 m line – 1 m open + red pavement (bicyle lane) | No marking |
| Width of edge strip | 0.25 – 0.40 m (diverging lane)<br>1.25* – 1.50** m (non-designated bicycle lane)<br>1,50 – 2,00 m (bicycle lane) | n.a. |

Table 4. *Dutch Guidelines for rural access roads. CROW, 2002; 2004 (*);2006 (**).*

In the Dutch *Design manual for bicycle traffic* (CROW, 2006), the width of the auxiliary lane intended for bicycles has been reduced to 1.5 m and markings must have a line width of 15 cm; previously these measures were 1.25 m and 10cm (CROW, 2004). The auxiliary lane for bicycles has no legal status as a traffic facility; therefore motor vehicles may use it, stop on it, and park on it. The auxiliary

lane for bicycles was sometimes given extra emphasis by giving it a red colour. However, in the *Design manual for bicycle traffic* this red colour is strictly reserved for the bicycle lane. Bicycle lanes are further distinguished from non-compulsory bicycle lanes by a bicycle symbol on the road surface approximately every 500 metres and after every intersection. Bicycle lanes do have the legal status of a bicycle facility. Motor vehicles and mopeds are permitted to use the bicycle lane, for example to diverge because of an oncoming vehicle, but they are not allowed to use it for halting or parking on or next to it. The *Design manual for bicycle traffic* advises against positioning parking spaces next to the bicycle lane.

Separate bicycle and moped tracks do not contribute to the recognizability of the access road which has mixing of all transport modes as one of its important Sustainable Safety features. Only if the daily traffic volume exceeds 2,000 to 3,000 motor vehicles per day, does CROW (2006) recommend a separate bicycle track. When redesigning the current situation (with a smaller traffic volume), the bicycle and moped tracks can be converted into (non-compulsory) bicycle tracks, with mopeds on the carriageway.

According to the recommendations in the *Road design manual (CROW, 2002)*, access roads of type II are too narrow (< 4.5 m) for a marked driving lane and therefore have no edge markings. A broken edge marking can be applied here, in the ratio of 3 metres line, 1 metre open, in dangerous bends or when vehicles often go off the road.

On both types of access road, a centre line marking may only be applied in exceptional cases: only in a bend for safety reasons and only on short stretches.

**What proportion of the access roads have been fitted withedge strips?**
To improve its insight in the layout of roads in the Netherlands, SWOV in early 2009 held a survey among the Dutch road authorities (Weijermars & Van Schagen, 2009). This showed that in 2008, 35,400 km (63%) of the approximately 56,000 km of non-urban roads categorized as access roads indeed had a 60 km/h speed limit. The speed limit on the remaining roads generally (still) was 80 km/h. According to the road authorities approximately three-quarters of the access roads with a 60 km/h limit had markings according to the Dutch Essential Recognizability Characteristics (CROW, 2004), which means that roads wider than 4.5 m had broken edge markings. The exact road length involved is not known.

**How do edge strips affect the number of road casualties?**
To assess the 60 km/h projects a crash study (with before-and-after data plus reference areas)was performed in twenty zones with an 850 km total road length (Beenker, 2004). At road sections, the number of casualties (fatalities, serious road injuries and slightly injured) appears to have decreased significantly by almost one-fifth (Jaarsma et al., 2011). The carriageway width of the roads included in this study varied between 3 and 5 m. Only those roads with a surface width of between 4.5 en 5 m were likely to have been fitted with edge strips. Therefore it is not absolutely certain for which share of the casualty reduction these roads with edge strips are responsible. It should be noted that the number of fatalities and serious injuries at road sections and intersections together even decreased by slightly less than one-third. At intersections, the number of fatalities and serious injuries even decreased by slightly more than 50%, probably as a result of the construction of raised intersections at hazardous locations. Although this evaluation study indicates that changing an 80 km/h road into a 60 km/h access road has a positive effect on the number of road casualties, it is not possible to make any statement about the specific contribution of edge strip and marked driving lane.

**How do edge strips influence driving behaviour?**
SWOV performed two observation studies at road sections with and without edge strips, so that a little is known about the effects on the behaviour of both drivers and cyclists. It should be noted that in both studies the investigated edge strips were intended for use by cyclists – and were therefore wider than a diverging lane – but that they were too narrow for a non-compulsory lane according to the present definition in the guidelines.

The first study (Van der Kooi & Heidstra, 1999) compared roads with and roads without edge strips. On average, cars on roads *with* edge strips appeared to drive somewhat slower than cars on roads without edge strips. At the same time, however, it was shown that the space between cyclists and passing cars was slightly smaller on roads with edge strips, than on those without.

The second study (Van der Kooi & Dijkstra, 2003) was a before-and-after study. The driving speed and the lateral position of cars were observed before and after edge strips were applied. The findings broadly matched those in the previous study. A carriageway with edge stripshas been found to have a channelling effect which both drivers and cyclists seem to accept. These are positive effects. Cyclists use 'their own' strip and usually keep somewhat more distance from the road edge than they did before an edge strip had been applied. Drivers also keep slightly more distance from the road edge when edge strips are present. When passing a cyclist they often choose not to cross the edge strip on the other side of the road. At the same time, this means that when drivers overtake a cyclist on a non-compulsory bicycle lane they are often closer to the cyclist. To what extent the distance being a few centimetres narrower is dangerous is hard to say. In most cases, the average driving speed goes down by a few km/h due to the edge strips. This is a positive development that, however limited it may be, has a positive effect on nearly all crash types (see also SWOV Fact sheet *The relation between speed and crashes*).

As was mentioned earlier, the edge strips that were investigated were narrower than is now the advice for non-compulsory lanes. A slightly wider strip may perhaps have a somewhat more positive effect on both driving speed as well as distance between car and cyclist, but this would require further investigation.

Furthermore, Aarts & Davidse (2007) found that red edge strips – in their study without the bicycle marking – increase the distinction of access roads as opposed to other road categories and raise the correct expectations about the possible presence of cyclists.

Other than the studies into edge strips on 60 km/h roads, there has been much international research into the effects of line markings on driving behaviour. A meta-analysis of these types of studies (Davidse et al., 2004) shows that edge markings have a positive effect on the lateral position of cars on the road, and limit the risk of going off the road and damaging the road shoulder. An unwanted effect is that the good visual guidance of line markings encourages drivers to use a higher speed. Broken lines offer (somewhat) less visual guidance than solid lines and also give a clearer impression of the driven speed. If, like on access roads, the purpose is speed reduction, broken lines are preferred.

**Conclusion**

The uniformity and recognizability of rural access roads is increased by edge strips at both sides of the road, thus creating a single marked driving lane for motorized vehicles in the middle of the carriageway. The marking of the edge strips consists of broken lines. The two edge stripscan be used by bicycles if they are sufficiently wide. Such strips are called auxiliary lanes intended for bicycles. If the surface is marked with a bicycle symbol it is called a bicycle lane. Bicycle lanes have a legal status and are preferably carried out in red asphalt. Research findings indicate a slight road safety improvement as a result of edge markings.

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

Aarts L.T &. Davidse, R.J. (2007). *Herkenbare vormgeving van wegen; Eindrapport van de herkenbaarheidsprojecten in het SWOV-programma 2003-2006*. R-2006-18. SWOV, Leidschendam. [in Dutch]

Beenker, N.J. (2004). *Evaluatie 60 km/uur projecten; Eindrapport*. In opdracht van de Unie van Waterschappen. VIA Advies in verkeer & informatica, Vught.

CROW (2002). *Handboek wegontwerp wegen buiten de bebouwde kom: erftoegangswegen*. Publicatie 164d. CROW, Ede.

CROW (2004). *Richtlijn essentiële herkenbaarheidkenmerken van weginfrastructuur: wegwijzer voor implementatie*. Publicatie 203. CROW, Ede.

CROW (2006). *Ontwerpwijzer fietsverkeer*. Publicatie 230. CROW, Ede.

Davidse, R.J., Driel, C.J.G van & Goldenbeld, Ch. (2004). *The effect of altered road markings on speed and lateral position: a meta-analysis.* R-2003-31. SWOV, Leidschendam. [In English]

Kooi, R.M. van der & Dijkstra A. (2003). *Enkele gedragseffecten van suggestiestroken op smalle rurale wegen*. R-2003-17. SWOV, Leidschendam. [in Dutch]

Kooi, R.M. van der & Heidstra, J. (1999*). Effect van kantstroken op verkeersgedrag*. R-99-25. SWOV, Leidschendam. [in Dutch]

Weijermars, W.A.M. & Schagen, I.N.L.G. van (2009). *Tien jaar Duurzaam Veilig; Verkeersveiligheids-balans 1998-2007*. R-2009-14. SWOV. Leidschendam.