SWOV Fact sheet

Crossing facilities for cyclists and pedestrians

Summary

More than half of all severe crashes (with deaths or in-patients) in which cyclists or pedestrians are involved occur while crossing the road. An estimated 32% of these crashes occur on crossing facilities, in spite of the huge numbers of people crossing there (data 2006). Crossing locations are, therefore, relatively safe.

There are a large number of different designs and layouts, which causes a lack of clarity among those crossing, but also among approaching drivers. What is expected of them? Crossing facilities must be understandable for everybody, especially by means of an unequivocal layout. For this reason there are provisional layout requirements for pedestrian crossing facilities according to Sustainable Safety. There should be only one rule at facilities used by both pedestrians and cyclists: both have priority, neither have priority, or both have traffic lights. Where they do have priority, this must be indicated by triangular priority marking and by extended speed bumps to ensure a low approaching speed. Crossing facilities at crossroads that are only for cyclists should be raised.

What precisely makes a crossing facility safe and understandable needs more research.

Background

In the terminology of sustainably safe road traffic, crossing the road could cause a 'lateral conflict'. These should only be allowed to happen if the speed differences are small. This is the case on access roads: separate crossing facilities are in general not necessary there. In exceptional cases, such as in the vicinity of schools or locations where a lot of the elderly cross over, crossing facilities on access roads are also desirable.

Crossing on distributor roads should only be permitted at crossroads, preferably via a crossing facility. The driving speeds of motor vehicles at that crossroads may not be faster than 30 km/h; at a roundabout this is usually the case.

The driving speeds of motor vehicles on road sections of access roads are too fast to permit crossing. If, in spite of this, there are good reasons for facilitating crossing on a road section (many or vulnerable road users crossing, long detour via crossroads), this should be done with fully-fledged crossing facility, with especially a speed inhibiting effect on motor vehicles.

This fact sheet only discusses crossing facilities. For information about pedestrians and cyclists you may consult the SWOV fact sheets Cyclists and Pedestrians.

Which requirements does Sustainable Safety make of crossing facilities?

In the meantime, provisional layout requirements have been drawn up that a sustainably safe pedestrian crossing in a road section must meet (CROW, 2000). There are as yet no so detailed requirements for cyclists. More research is needed for definite layout requirements with regard to what precisely makes a crossing facility safe and understandable for everybody.

The provisional requirements for the sustainably safe pedestrian crossing are:

- a speed reducing effect with a horizontal speed inhibitor, such as a narrowing, or a vertical speed inhibitor, such as a speed bump or a raised area;
- zebra marking (the stripes) parallel to the carriageway;
- zebra marking continued over separate parallel cycle paths;
- a road sign 'pedestrian crossing' before the zebra;
- the same road sign floodlit above the zebra on a gantry;
- a good street lighting in a different colour;
- ridged tiles on the pedestrian route to the zebra;
- studded tiles at the beginning and end of the zebra, and on sloping access curbing if the zebra is not on an extended speed bump;
- a minimum width of the zebra of 4 metres;
- an as short as possible crossover length, possibly with refuge.

An sustainably safe pedestrian crossing should only be constructed on an urban distributor road with a speed limit of 50 km/h and 2x1 lanes (in Sustainable Safety there are, in principle, no 1x2 lane roads).

The most characteristic of these requirements is the speed inhibitor; a motor vehicle would only be allowed to approach a sustainably safe pedestrian crossing at a maximum of 30 km/h.

What types of crossing facilities are there in the Netherlands?
There is practically nothing known about the current number or location of crossing facilities for cyclists and pedestrians in the Netherlands. A recent inventory (VIA, 2001) showed a great variety in their layout, and De Langen (2003) concluded that there was nothing systematic about it. She analyzed 47 different features of three types of crossing facilities (pedestrians only, cyclists only, cyclists and pedestrians) and ascertained that there was no relation between them (neither width, speed inhibitor, 24-hour traffic volume, driving speeds, signing, nor marking; to mention six).

How safe is it to cross the road and how safe are the crossing facilities?
Besides not knowing the numbers or locations, practically nothing is known about the use of crossing facilities in the Netherlands. There are undoubtedly large numbers of users, but without quantative data, nothing can be said about the *chance* of a crash on a crossing facility in comparison with such a chance at a location without facilities.
An additional limitation for a safety analysis is that crossing conflicts so described are not to be found explicitly in the crash statistics. And certainly as far as cyclist conflicts are concerned, it is not precisely coded whether a crash occurred on a crossing facility. In spite of this we attempt below to express the safety of crossing as well as are possible. In this we logically limited the conflicts to those between, on the one hand, motor vehicles and, on the other hand, what is known as 'slow traffic' (bicycles, mopeds, light-mopeds or pedestrians). The crashes that happen are usually severe.

Casualties on 50 km/h and 80 km/h roads
We first examined the data of crashes at locations with a speed limit of 50 km/h or 80 km/h (*Tables 1 and 2*). These road types are the most relevant for the category distributor roads. In 2006, 27% of all 730 road deaths and 27% of all 9,051 in-patients occurred in a conflict between a motor vehicle and slow traffic.
In general, less casualties of this conflict type occur on 80 km/h roads than on 50 km/h roads. On 80 km/h roads the conflicts are severer; there are relatively more deaths.
In conflicts between a *pedestrian* and motor vehicle, most of the deaths and in-patients on 80 km/h roads are on road sections and not at crossroads. This also applies to 50 km/h roads but to a lesser extent. In crashes between *bicycle* or *(light-)moped* and motor vehicle on both 50 km/h and 80 km/h roads, more of the casualties are in crossroad crashes than road section crashes.

Motor vehicle crashes with:	50 km/h speed limit				80 km/h speed limit				Total	
	Road section		Crossroads		Road section		Crossroads			
	N	%	N	%	N	%	N	%	N	%
Pedestrian	18	*3*	15	*2*	11	*2*	2	*0.3*	46	*6*
Bicycle	23	*3*	64	*9*	8	*1*	21	*3*	116	*16*
Moped/Sloped	6	*0.8*	10	*1*	3	*0.4*	13	*2*	32	*4*
Total	47	*6*	89	*12*	22	*3*	36	*5*	194	*27*

Table 1. *Number of* ***deaths*** *at locations with 50 km/h speed limit and 80 km/h speed limit from crashes between a) motor vehicles and b) pedestrians, cyclists, or (light-)moped riders: absolute numbers and percentages of total number of deaths in 2006 (730). (Source: TRC/SWOV).*

Motor vehicle crashes with:	50 km/h speed limit				80 km/h speed limit				Total	
	Road section		Crossroads		Road section		Crossroads			
	N	%	N	%	N	%	N	%	N	%
Pedestrian	206	*2*	124	*1*	22	*0.3*	9	*0.1*	361	*4*
Bicycle	280	*3*	824	*9*	63	*0.7*	115	*1*	1.282	*14*
Moped/Sloped	181	*2*	431	*5*	46	*0.5*	99	*1*	757	*8*
Total	667	*7*	1,379	*15*	131	*2*	223	*3*	2,400	*27*

Table 2*. Number of registered **in-patients** at locations with 50 km/h speed limit and 80 km/h speed limit from crashes between a) motor vehicles and b) pedestrians, cyclists, or (light-)moped riders: absolute numbers and percentages of total number of in-patients in 2006 (9,051; TRC/SWOV).*

Crashes with 'intersecting' or 'crossing'
In the crash statistics, crossing conflicts are only to be found in pedestrian crashes with 'crossing' as manoeuvre type. The safety of crossing the road for the cyclists and (light-)moped riders can be derived from crashes with the manoeuvre type 'intersecting with or without turning off'. These last ones are not always 'pure' crossing crashes. For conflicts between motor vehicles and slow traffic, a distinction is made between these manoeuvres in *Tables 3 and 4*.
More than half of all severe crashes involving pedestrians, cyclists, or (light) moped riders are of the manoeuvre type 'intersecting' or 'crossing'. This share is 53-76% in severe crashes between pedestrians, *cyclists* or *(light) moped riders* and motor vehicles. The crashes of this manoeuvre type are more often severer for *pedestrian and cyclist conflicts* than those with *(light-)moped riders*. Cyclists are the largest group of slow traffic in conflict with motor vehicles and 'intersecting' or 'crossing' manoeuvres.

Motor vehicle crashes with:	All manoeuvre types		Manoeuvre intersecting (with and without turning off) or crossing		
	A	%	B	%	% of A
Pedestrian	50	*8*	36	*15*	*72*
Bicycle	151	*25*	114	*46*	*76*
Moped/Sloped	38	*6*	26	*11*	*68*
Total (all conflicts)	678	*100*	272	*100*	*40*

Table 3. *Number of **fatal crashes** between a) motor vehicle and b) pedestrians, cyclists, or (light-)moped riders by manoeuvre type. All manoeuvre types and manoeuvre types 'intersecting (with or without turning off)' or 'crossing' during conflicts in 2006 (Source: TRC/SWOV).*

Motor vehicle crashes with:	All manoeuvre types		Manoeuvre intersecting (with and without turning off) or crossing		
	A	%	B	%	% of A
Pedestrian	446	*6*	238	*9*	*53*
Bicycle	1,566	*21*	1,101	*41*	*70*
Moped/Sloped	992	*14*	587	*22*	*59*
Total (all conflicts)	8,039	*100*	2,988	*100*	*37*

Table 4. *Number of **in-patient crashes** between a) motor vehicle and b) pedestrians, cyclists, or (light-)moped riders by manoeuvre type. All manoeuvre types and manoeuvre types 'intersecting (with or without turning off)' or 'crossing' during conflicts in 2006 (Source: TRC/SWOV).*

Crashes at crossing facilities
We made an analysis of crashes with the manoeuvre 'intersecting' or 'crossing' (columns B in *Tables 3 and 4*) to see how many conflicts occur on a (pedestrian) crossing, i.e. as far as this was coded as such in the crash data processing. Of all bicycle conflicts with this manoeuvre (1215), approximately 28% of the fatal and 31% of the in-patient crashes happened on a crossing facility (32 and 337 crashes respectively).We estimate that, of all pedestrian crashes with this manoeuvre (274), 33% of all

fatal crashes and 42% of all in-patient pedestrian crashes took place on crossing facilities (12 and 100 crashes respectively). All in all, 32% of the serious 'crossing' conflicts happen on a crossing facility. Furthermore, the registration showed that nearly all pedestrian conflicts happened at crossing facility locations with a speed limit of 50 km/h. This is most probably because there are many more crossing facilities on 50 km/h roads than on roads with other speed limits.

How safe are the various types of crossing facilities?
In the 1980s in the Netherlands, extensive experiments were made with various types of *pedestrian crossing facilities* on road sections and crossroads of major roads. SWOV assessed some of these facilities (Bos & Dijkstra, in Dijkstra, 2000).
The total number of injury crashes on all types of crossing facilities declined by 6% (corrected for control areas) because of the measures. However, the number of crashes with pedestrians increased by 23% (also corrected). The number of killed and injured pedestrians even increased by 34%. If we look at the studied types separately, we see the bad scores especially on the crossing facilities along road sections. Three of these, in the meantime, no longer appear (and justly so) in the ASVV 1996 (CROW, 1996).

A Swedish study (Gårder et al., 1998) describes the effects of *raised cyclist crossings* on six urban crossroads. The cyclist crash reduction was 33% (corrected for other influences such as an increase in the number of passing cyclists). Nielsen et al., (1996) reported the results of constructing urban *cycle lanes* in Denmark. These lanes cross 217 side streets; traffic from a side street must give priority to traffic (including cyclists) on the main road. Based on the developments at 227 control locations (comparable crossroads), it was expected that the number of injury crashes with cyclists would increase from 7 to 10 if the lanes had not had any effect. The actual number increased to 26. The total number of injury crashes also increased considerably, from 24 to 55 (and not as expected to 25). Anyway, the effect of these lanes on road sections is completely different: the number of injury crashes involving cyclists declined by about 35% (Herrstedt et al., 1994).

Schnüll et al. (1992) compared various types of *cyclist crossing facilities*. The research material consisted of 575 crossroad branches without traffic lights on which 375 crashes with cyclists going straight ahead were registered. An intersecting cycle path with only marking had, irrespective of the number of passing cyclists, the largest crash frequency (number of crashes per crossroad branch per year). The further from the carriageway the cycle path is situated, the greater the crash frequency. A raised cycle path at the crossroads had a much lower crash frequency. The crash frequencies for cyclist facilities on a lane or on the carriageway were the lowest, irrespective of the number of passing cyclists. In a comparative Netherlands study (Welleman & Dijkstra, 1988), the crash rates (number of crashes per passing cyclist) were studied at crossroad branches where the cyclist crosses the side street over a lane, a path, or the carriageway. In this study, the cycle lanes had the largest bicycle crash rate, and cycle paths and bicycles on the carriageway did not differ from each other. The results were different for the moped crashes: cycle paths had the largest moped crash rate, and lanes and mopeds on the carriageway had the same crash rates

De Langen (2003) collected data from 121 *crossing facilities only for cyclists, only for pedestrians*, and *for both groups*. The selected crossing facilities had a wide variety of features: layout, signing and marking, and use. On crossing facilities for both cyclists and pedestrians, the use of the priority regulation was sometimes different: e.g. pedestrians do and cyclists do not have priority, or pedestrians have traffic lights and cyclists do not. This is very confusing for both those crossing as well as the approaching motor vehicle drivers.
De Langen (2003) studied the priority behaviour on crossing facilities that had a sustainably safe layout and on those that did not. She concluded that pedestrians at a sustainably safe pedestrian crossing have less confidence in being correctly given priority than pedestrians at a non-sustainably safe pedestrian crossing. On the other hand, this also results in fewer potential conflict situations. No explanation can be given for this unexpected result. She also ascertained that the approach speed at a sustainably safe pedestrian crossing was slower than at a non-sustainably safe pedestrian crossing, which leads to a safer situation. The speed at a sustainably safe pedestrian crossing is still faster than 30 km/h, the speed at which the mixing of traffic types is permitted.

A study of the AA Foundation (1994) determined how often *pedestrians* walk along various urban road types) *main road, distributor road, and residential street*), how often they crossed over the road there, and at what types of crossing facilities they did this. With this exposure data they then calculated the

casualty rate (number of pedestrian casualties per distance walked or per crossing). The number of pedestrian casualties (killed, severely injured, slightly injured) per 100 million pedestrian kilometres on distributor roads was three times larger and on main roads six times larger than on residential streets. The number of pedestrian casualties per crossing on distributor roads was nearly five times larger, and on main roads more than 9 times larger than on residential streets.
The number of pedestrian casualties per crossing on a zebra crossing was (irrespective of road type) half of the number at locations where there are no crossing facilities. On main roads in particular, this ratio was much larger: there the zebra crossing was 100 times safer than at locations without crossing facilities.
In general, there are nearly four times as many pedestrian casualties per crossing at locations with pedestrian traffic lights of the Pelican type (Pedestrian light controlled crossing i.e. a regulated crossing location) than at locations without crossing facilities. However, on main roads it is striking that at a Pelican crossing there are half the pedestrian casualties per crossing than at locations without crossing facilities. Pedestrian facilities evidently have a positive safety effect on crossing busy (main) roads.

Zegeer et al. (2001) studied a safety difference between 1,000 *marked pedestrian crossing facilities* (various marking types including zebras) and 1,000 locations without any marking but where pedestrians cross the road.
The safety level (number of crashes per million crossing pedestrians) of both location types was the same when the 24-hour traffic volume is less than 10,000 motor vehicles. When the traffic volume is larger than this, locations without markings were *safer!* Zegeer et al. (2000) assume that this result is because motorists hardly react to a marked crossing facility and because pedestrians wrongly assume that this facility offers extra safety. They base these assumptions on a number of detailed behavioural studies that had already been carried out within the framework of this study.
In contrast to those in the United Kingdom (AA Foundation, 1994), marked crossing facilities in the United States (Zegeer et al., 2001) evidently do not have a positive effect on busy/busier roads. There is as yet no explanation for this.

How much do crossing facilities cost?
The only thing that is known about the costs is that published by Infopunt DV (2001). This mentions that pedestrian crossing facilities on a road section of an 80 km/h distributor road cost €5,500 each (price level 2001). An extended speed bump on a 50 km/h distributor road costs €16,000.

Conclusions and recommendations

More cyclist crashes occur at locations where cycle lanes cross side streets than where there are no cyclist facilities. Raised cyclist crossing facilities at crossroads have a positive safety effect; 33% fewer cyclist crashes in Sweden (Gårder et al., 1998).
Crossing facilities at crossroads have a more positive effect on the number of crashes involving pedestrians than crossing facilities on road sections. Crossing locations with traffic lights on main roads are twice as safe, per crossing pedestrian, as locations without any facilities. Other types of crossing locations (zebras) are also safer than locations without any facilities. The Netherlands crash data also shows that crossing locations are in general relatively safe. About 32% of severe crossing crashes involving cyclists or pedestrians take place on a crossing facility in spite of the large numbers of people crossing there. An estimated 41% of severe crashes involving pedestrians take place at a crossing location.

It is important to introduce a greater uniformity in pedestrian crossing facilities by using the (provisional) Sustainable Safety implementation requirements. In addition, further research is necessary of how a crossing facility can be made safe and understandable for everybody. This is important because a) a considerable share (41%) of severe pedestrian crashes still occurs at crossing facilities, b) there is often no correct priority giving, and c) there is an enormous diversity of crossing facilities. This diversity also makes it less clear what is expected from those crossing and the approaching drivers.

We also recommend that there must be only one rule at facilities used by both pedestrians and cyclists: either both have priority, neither have priority, or both have traffic lights. Where they do have priority, this can be indicated by triangular priority marking just in front of the crossing facility, combined with an extended speed bump to ensure a low approaching speed. A quite long speed

bump would slightly increase motorists' comfort because they can position the whole vehicle on the speed bump just in front of the crossing facility.
Crossing facilities at crossroads that are only for cyclists had best be raised.

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

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