

SAFETY EFFECTS OF BICYCLE FACILITIES; THE DUTCH EXPERIENCE

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## 1. INTRODUCTION

The Netherlands is a country of bicyclists: 14.5 million inhabitants own 11.5 million bicycles, i.e. almost 8 out of 10 Dutch own a bike (Figure 1). In the early seventies there were 7 million bicycles. The number of mopeds (< 50 cc) is some 600.000 now, in comparison to almost two million in 1970. In the last few years the number of bicycles and mopeds has remained stable.

The Dutch travelled a total of 158.8 thousand million kilometres in 1986. Private cars did 74%, public transport 11%, bicycles 7% and mopeds over 1% of this.

The most important motive to ride a bike appears to be recreational and sport (24%), commuting to work (18%), to school (18%) and shopping (18%). For the moped it is different: 27% commuting to work, 24% to school and 15% recreational.

Dutch traffic is relatively safe with a mortality rate of some of 10 deaths per 100.000 inhabitants. Approximately 22% of the traffic fatalities are cyclists and 8% moped riders. These percentages have remained more or less constant in the last few years. Some 25% of the in-patients are bicyclists, 20% moped riders. If passenger cars have an accident rate (deaths per kilometre) of 1, then that of cyclists is 4.5 and that of moped riders 11.

70% of all moped fatalities are concentrated in the 16-24 year old age group, while the cyclists have two peaks: some 20% in the 10-20 year old age group and 40% in the group of the elderly (over 65).

The Netherlands is a country of facilities for bicyclists (Figure 2). Along a total length of the (paved) road network of 97,189 kilometres there are 13,422 kilometres of cycle paths and 1064 kilometres of cycle lanes. This means that almost 15% of the network has facilities for bicycles, most of them to be used by mopeds too.

We distinguish different kinds of facilities for bicycles:

- cycle paths separated from the road by a verge;
- cycle lanes, which are only separated from the road by a marking line; they have the same surface as the road;
- cycle tracks with their own marked out route.

The facilities for bicycles along the side of a road can be built on one side or both sides of the road. A question frequently asked is then which solution is to be preferred from the traffic safety point of view. And, what is the influence on traffic safety of certain design features?

In this contribution questions will be answered on the basis of Dutch research and experiences. First an outline will be given of government policy in the Netherlands regarding bicycles and mopeds.

## 2. AN OUTLINE OF THE TRAFFIC SAFETY POLICY REGARDING CYCLISTS AND MOPED RIDERS

In spite of the boom in mass-motorization, the ownership and use of bicycles has grown in recent years. Many municipalities and provinces implemented plans for cycle paths. Within seven years the length of the Dutch cycle paths increased by 55% and that of lanes by more than 70%. The aim of all the plans is to stimulate the use of the bicycle by offering attractive facilities for the cyclists, consisting of paths of high quality separated from the motorized traffic, of direct connections, and of special green phases in traffic lights for cyclists.

Besides this aim directed at use and comfort there always is the aim of safety for cyclists: to reduce the number of casualties and the accident rate. Sometimes it is also stipulated that this cyclist-friendly policy must lead to a reduction in car use.

The position of the moped is not always clear. Mopeds inside built-up areas are allowed a maximum speed of 30 km/h and outside these areas of 40 km/h. The riders ignore these maxima in mass and cause inconvenience and nuisance.

It can not be said that the Dutch authorities carry out a moped-friendly policy and from the traffic-safety point of view this may be right regarding the actual "tuning-up" of mopeds. Without additional measures an increased use of mopeds by people who ride a bicycle or travel by public transport, will lead to more casualties.

The National Government subsidised a number of "experimental" facilities and evaluated the effects. Two of them are of particular interest:

### Urban bicycle routes in The Hague and Tilburg

They were built in the years 1976 - 1978. Both routes are of a high quality (Figure 3). They could be used in both directions and linked living areas with the centre of town. An evaluation report was drawn up in 1981. The main conclusion was that one single route does not change modal-split in favour of the bicycle. The routes do attract cyclists, but only those who do not (or hardly) have to make a detour. The construction of the routes did not change traffic safety. There were more casualties among slow traffic because of accidents amongst one another, but a drop in accidents between slow traffic and motorized traffic. There were also more accidents with slow traffic on the routes, coming from the "unexpected" direction. These projects made it clear that the area influenced by such a route is not large and that even routes of such high quality do not really bring in new cyclists. This fact and the fact that cyclists do not make a detour brought about a new project.

### The network of bicycle routes in Delft

In Delft a great number of measures was taken, leading to a fine-meshed network of cycle tracks, built in a hierarchical structure (Figure 4). The measures consisted of the construction of bridges, tunnels, cycle paths and lanes, but also smaller facilities of a more modest nature. The feeling is now that the maximum has been done in Delft regarding facilities for cyclists.

As a result of these measures there is an increase in bicycle use of 6-8% (corrected for trend and other factors). The share of the bicycle has grown from 40 to 43%.

The second aim of this project, i.e. to reduce car use by encouraging bicycle use, cannot be proven to have been reached, but it is probably the case because a reduction has been observed inside the town of Delft of car movements. The measures caused considerable changes in route choice. Moreover, it was found e.g. that 35% of the bicycle kilometres were travelled on the bicycle tracks (was 30%) and 40% amidst other traffic (previously 45%). The accident study has not been completed yet, but the researchers expect a favourable effect on the safety from this change of the choice of routes. This conclusion should not be made too lightly, as will be apparent from the next chapter.

### 3. BICYCLE FACILITIES AND THEIR SAFETY EFFECTS

#### 3.1. Inside built-up areas

SWOV carried out a research to the safety effects of various facilities relating to the infrastructure for cyclists and moped riders: no special facility, bicycle lanes and bicycle paths (Figure 5). The results are summarized in Figure 6.

The research has proven that:

- stretches of road (incl. minor junctions) with cycle paths are safer for cyclists than those without, or those with lanes; it is safer to have no facilities than to have lanes;
- junctions are safer for cyclists if the connecting stretch of road has no facility or bicycle lanes.

This can be explained by the fact that (turning) traffic is confronted too suddenly with cyclists, because they were not "seen" on the previous stretch of road. Another explanation may be that the car speed is higher when cyclists have separate facilities. From the afore mentioned research comes the indication that the seriousness of the accidents of cyclists was higher if there were lanes or paths for cyclists.

Finally there is a slight indication that the presence of lanes on the connecting roads hardly leads to less accidents than if there is no facility at all. This unexpected (unfavourable) effect of the bicycle lane needs some explanation, especially because it is known from observations that motorized traffic sticks more to the axis of the road if there is a lane than if there is not. Further research would have to give a decisive answer. This research should verify whether bicycle lanes would indeed induce a higher speed. The influence of the width of lanes would also have to be investigated.

Observed behaviour has suggested that lanes are often too narrow. A lane should have a minimum width of 1.80 meters. Many lanes (50% in the above-mentioned research) are too narrow in this respect. This means that if cyclists (and moped riders) pass each other or with parked cars they leave the lane and ride on the road, which car drivers perhaps do not expect: (too) small is less safe.

In this research young cyclists in particular would have to be studied. Young children appear not to keep sufficiently to the right and have problems with course holding.

For moped riders, lanes on a stretch of road appear to be as safe as if there is no facility, but safer than paths. The same applies for junctions. On cycle paths moped riders have relatively many accidents with cyclists and pedestrians.

On stretches of road without facilities moped riders and motorized traffic are accident partners to the same extent as they are if there is a facility.

This result necessitates a (re)consideration on the use of cycle paths by moped riders. Moped riders, riding either on the bicycle lane or among motorized traffic are equally safe probably, but cyclists and pedestrians will be safer without the mopeds. If for moped riders it would be as safe to ride on a lane as to ride on the road with no facility and for cyclists it would be safer without a lane on a stretch of road and for junctions it is uncertain, then it would perhaps improve traffic safety to remove the lanes. Further research might give a more definite answer to this question.

### 3.2. Outside built-up areas

At the beginning of 1987, the "provisional guidelines for the construction of cycle paths along (parts of) roads outside built-up areas" were drawn up in the Netherlands. The research on which the guidelines was based brought about the following conclusions (see also Figure 7):

- roads without cycle paths are less safe than those with (with a traffic intensity of more than 1500 in 24 hours, upon a lower intensity no conclusions could be drawn);
- cycle paths with oncoming traffic are less safe than those used in one direction;
- the safety of cyclists on narrow roads is hardly different from that on wider roads;
- wide cycle paths (> 2.20 m for one directional and > 2.70 m for two directional paths) are safer than narrower paths; the influence of the width of the separation is stronger than that of the width of the path;
- with an increase of the number of exits the safety on the path decreases;
- higher intensities (of motorized traffic and of bicycle traffic) reduce safety.

On the basis of this last conclusion criteria have been developed for the construction of cycle paths (Figure 8).

With an intensity of more than 2500 motorized vehicles in 24 hours, separate cycle paths are safer. With an intensity of more than 500 bicycles in 24 hours separate cycle paths would already be safer with a 1000 motorized vehicles.

It is remarkable that this study shows that there are no data for effects of facilities on junctions, the more so if the results for built-up areas are considered. Nowadays the point of view most often held in the Netherlands is to move cycle paths further from the road at junctions and then to take away the right of way from the cyclists.

The cycle paths should not be moved too far because then crossing traffic would not expect the path yet and turning traffic would not expect it anymore.

More research should be done on cycle facilities for junctions.

#### 4. CONCLUSIONS AND RECOMMENDATIONS

1. At present the bicycle in the Netherlands is used more than some years ago. The number of deaths among cyclists has decreased, which cannot be explained unambiguously. The use of the moped has decreased and equally so the number of fatalities.

2. Many municipalities and provinces implemented plans for cycle paths in the last couple of years. By the construction of facilities for bicycles cycling was to be promoted, made safer and more comfortable. The network of cycle paths increased by 50% in 7 years; there are 15 kilometres of cycle paths now for every 100 kilometres of road.

3. The construction of cycle paths within built-up areas leads to an increase of the safety of cyclists on stretches of road. Before a junction a cycle path has to be ended. The marking of lanes to improve traffic safety should be queried. Further research (on accidents and behaviour) is needed on facilities for junctions and on lanes for bicycles.

4. The construction of cycle paths within built-up areas does not result in greater safety for moped riders. It is approximately equally safe if there are lanes or if there is no special facility (and safer than paths). It should be considered to remove moped riders from bicycle paths in built-up areas.

5. The construction of cycle paths outside built-up areas improves the safety of cyclists and moped riders on stretches of roads. No figures are available on the effects on traffic safety of the various facilities for junctions.



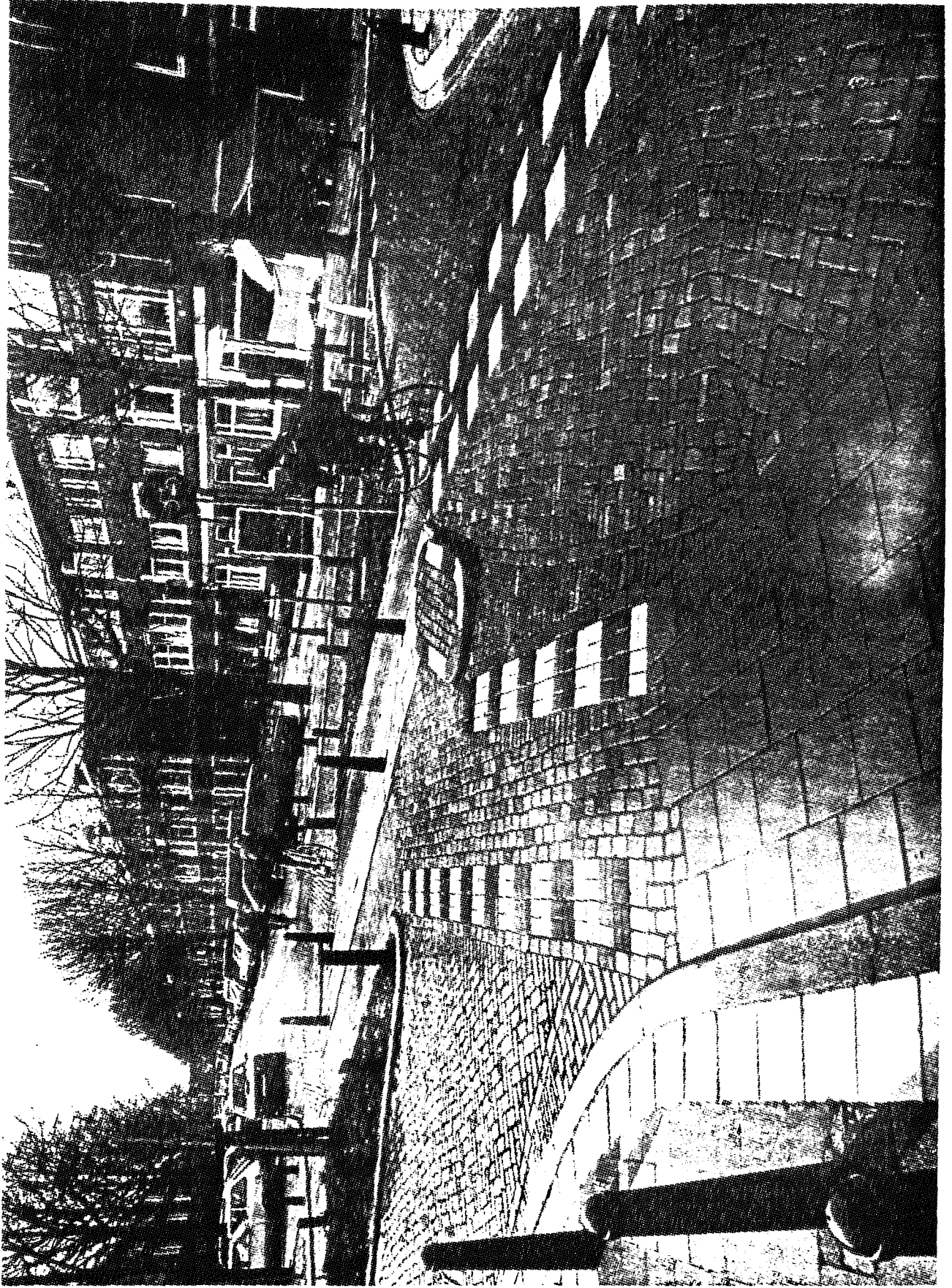


Figure 1. The Netherlands is a country of facilities for bicyclists.



Figure 2. The Netherlands is a country for bicyclists.



Figure 3. The bicycle route in The Hague.

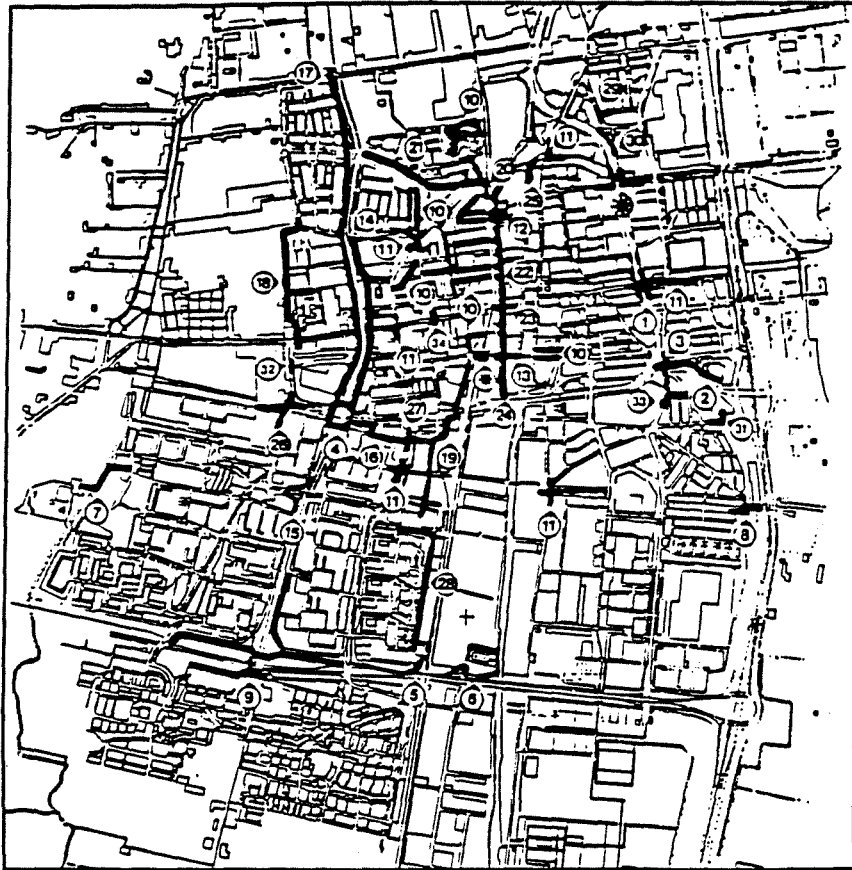


Figure 4. The Delft bicycle network.

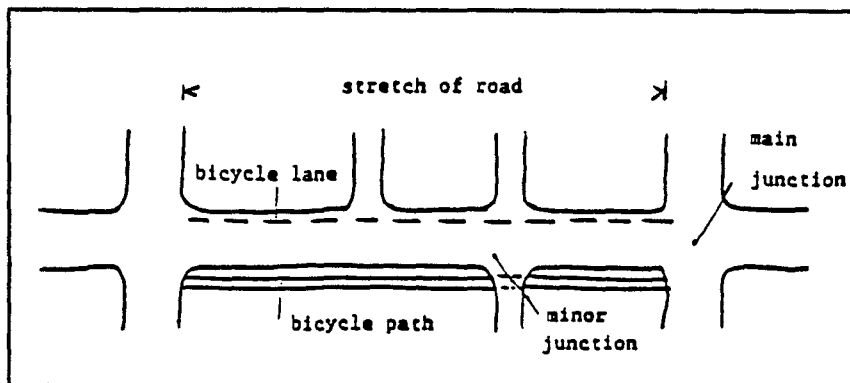


Figure 5. Bicycle facilities along urban traffic arterials.

	no facility	cycle lane	cycle path
stretches of road (incl. minor junctions).			
cyclists	1	1.36	0.76
moped riders	1	1	1.28
junctions (major)			
cyclists	1	0.81	1.32
moped riders	1	1	1.66

Figure 6. Differences in accident rates for cyclists and moped riders for different bicycle facilities (no facility = 1).

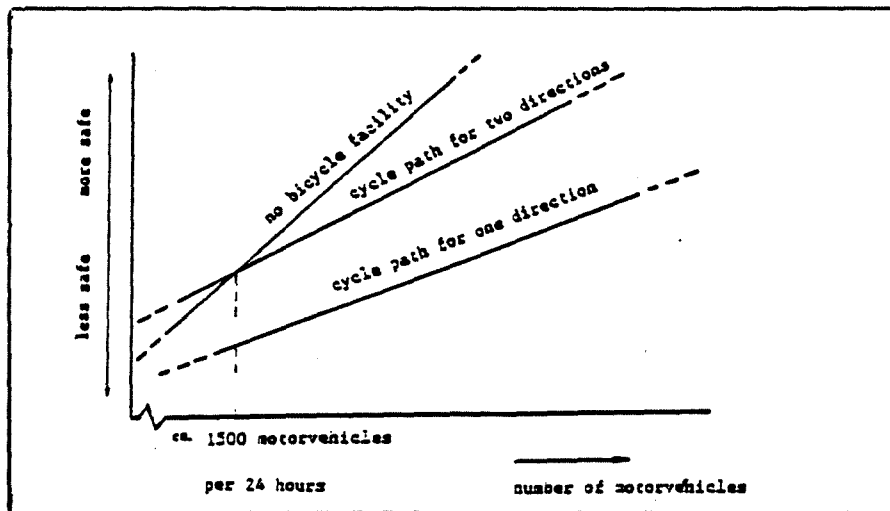


Figure 7. Safety effects of bicycle facilities outside built-up areas.

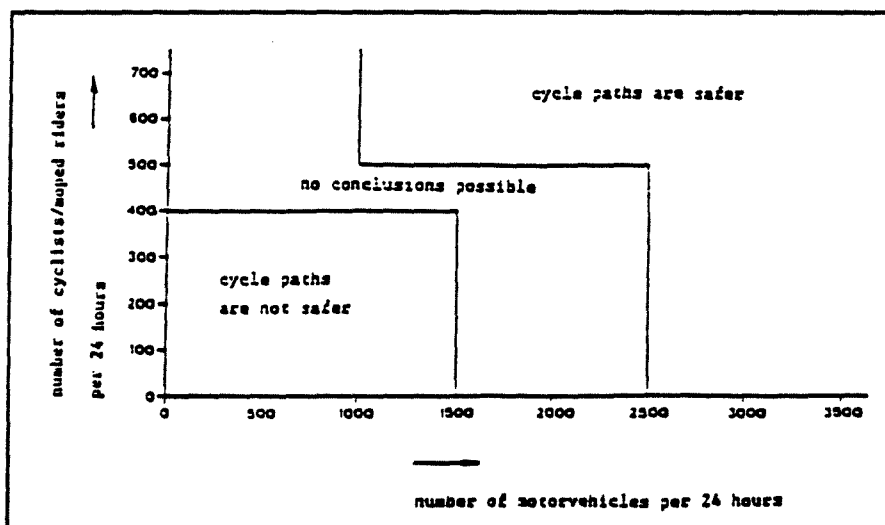


Figure 8. Safety criteria for bicycle facilities outside built-up areas.

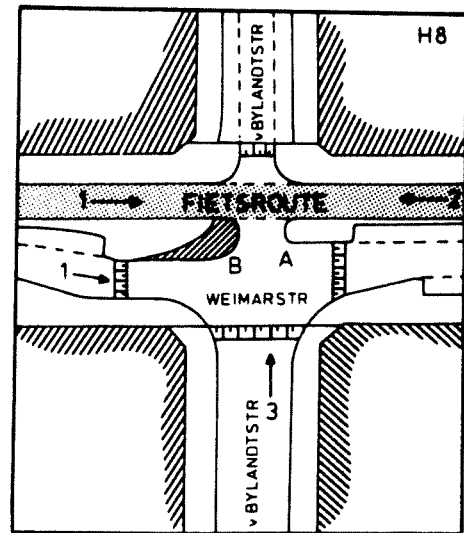
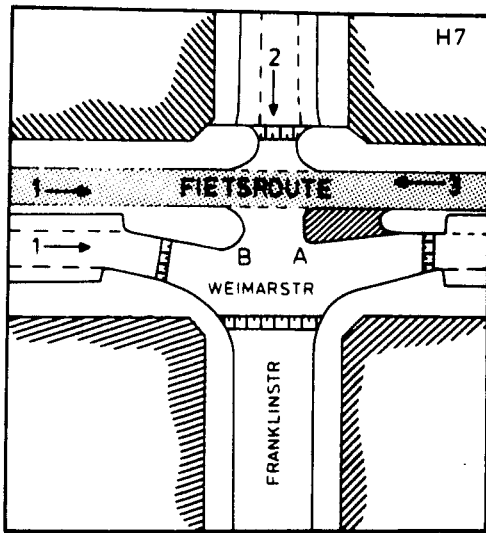


Fig. 3. The bicycle route in The Hague

Fig. 1. The Netherlands is an Country of facilities for bicyclists (Foto: Studio Verkeeren)

Fig. 2. The Netherlands is an Country for bicyclists (Foto: Studio Verkeeren)