

## Essential safety elements concerning infrastructure of cycle paths; a risk based approach in cycling safety

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### 1 INTRODUCTION

In 2022 in total 737 road deaths were registered in The Netherlands [1]. Most fatalities occurred among cyclists (39%; n=287). In 2021 about 5000 cyclists were seriously injured (MAIS3+) due to crashes. Among these about 80% are crashes without involvement of motorized traffic [2]. The number of cycling fatalities and serious injuries is increasing in the past years [1,2]. This requires more attention in order to reach the Dutch policy aims to reduce the number of road deaths and injuries with an ambition of zero casualties in 2050.

In 2018, the Dutch Ministry of Infrastructure and Water Management together with the boards of regional and local authorities launched the Strategic Road Safety Plan 2030. The Ministry established the Knowledge Network for the Strategic Road Safety<sup>1</sup>, which is a cooperation between the Dutch knowledge center directed at infrastructure, traffic, and safety (CROW) and the Dutch institute for road safety research (SWOV).

One of the key elements in this initiative is the implementation of a 'risk-based' approach, which means that crash statistics are not the primary source for road safety policy, but indicators that provide information on hazards in road traffic: the risk-indicators, also known as road Safety Performance Indicators (SPIs) [3]. One of these SPIs is focused on improving the safety of infrastructure; including cycling infrastructure. The SPI for cycling infrastructure is defined as the proportion of cyclists that cycle on infrastructure that is qualified as sufficiently safe. As a first part of the operationalization of what is called 'sufficiently safe' cycling infrastructure, SWOV selected essential safety elements of a specific part of the cycling infrastructure, namely the cycle paths (not including intersections).

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1. <https://www.kennisnetwerkspv.nl/>

**2 ESSENTIAL SAFETY ELEMENTS OF CYCLE PATHS**

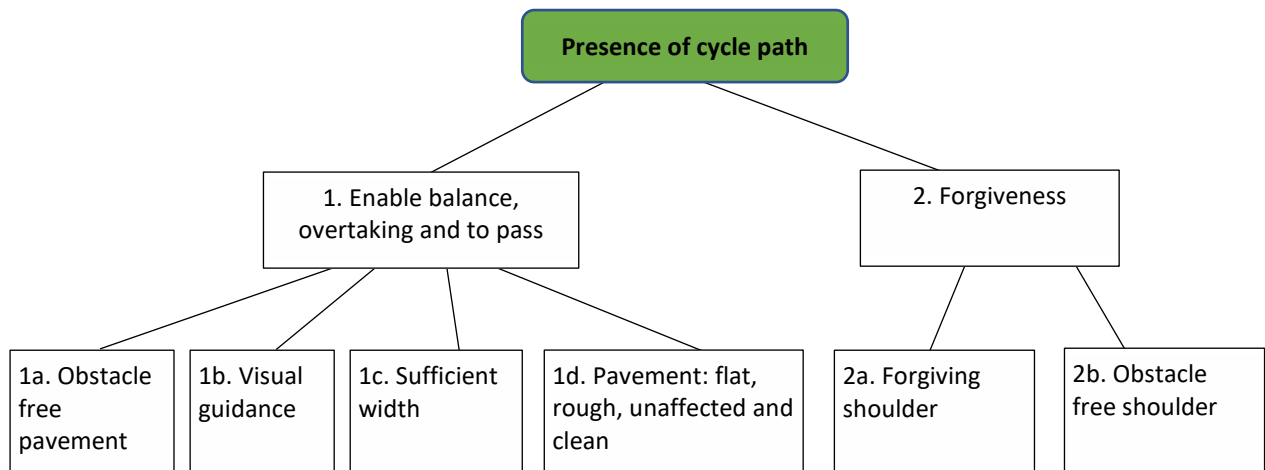
The essential safety elements of cycle paths are defined as those elements for which evidence is available that they have impact of level of safety of the cycling infrastructure. SWOV conducted a review on international literature in order to identify those elements that appeared to have an impact on crash risk. Most of the literature was based on Dutch studies and reports.

From literature it appears that a large majority of cycling crashes resulting in serious injuries happen without involvement of motor vehicles [4,5]. They may collide with other cyclists, pedestrians or mopeds on the cycle paths, but also with infrastructure elements like obstacles on, or near the pavement [4,5]. Loosing balance and falling due to for instance swerving or strong breaking may also result in serious injuries [6]. It is estimated that in about 50% of these cycling crashes infrastructural factors play a role [4,5]. Amongst them, the following scenarios were reported, for instance slippery surface (29%), curbs (23%), unsafe shoulder (12%), fixed obstacles on the pavement (12%) and bumps, pits and clutter on the pavement (10%).

Following from these crash scenario’s, two general design principles for sufficiently safe cycle paths are formulated (Figure 1). These cycle paths should:

1. enable cyclists to maintain their balance and be wide enough to enable cyclists to overtake or pass other cyclists;
2. be provided with forgiving shoulders.

In order to give substance to these design principles the following elements of cycle path infrastructure were identified from literature that appeared to have an evidence based safety impact; the essential safety elements 1a-d, 2a,b; Figure 1.



*Figure 1: Design principles and essential safety elements for sufficiently safe cycle paths*

### **1a Obstacle free pavement**

Putting obstacles on the pavement of the cyclepath is generally seen as an unsafe element for cyclists [7,8]. Fixed obstacles on the pavement were involved in 12% of cycling crashes involving infrastructure elements [4,5].

### **1b Visual guidance**

Safe passing of vehicles at high speeds requires a high level of visual guidance. Especially older cyclists and people with visual limitations report a higher experienced safety when clear visual guidance is present [10]. In depth studies showed that at cycling crash locations visual guidance of the edge of the cycle path was deteriorated [9]. In an experimental study [10] it was found that steering behaviour of cyclists deteriorates as the visual guidance of edges of the cyclepath and obstacles is less clear.

### **1c. Sufficient width**

The design of a cyclepath should accommodate safe overtaking and passing of cyclists. In a recent study [11], van Weelderen found an increased risk of cycling crashes on cycle paths with lower widths.

De Goede [12] found a reduction in serious traffic conflicts between cyclists as the width of a cyclepath increased.

### **1d. Pavement: flat, rough, unaffected and clean**

In about 40% of all cycling crashes involving infrastructure elements [4,5] slippery surface or bumps, pits and clutter on the pavement were involved.

### **2a. Forgiving shoulder**

In general, cyclists keep a distance of one meter to the curb if it concerns a substantial difference in level [13,14]. Nevertheless it appears that almost 25% of all cycling crashes involving infrastructure elements involves a crash with a curb [4,5]. This might be the result of for instance an evasive action of a cyclist requiring more space than is available. If the shoulder appears to have a level difference the cyclist will be brought out of balance and fall.

### **2b Obstacle free shoulder**

In a recent study [11], van Weelderen found an increased risk of cycling crashes on cycle paths by increased number of obstacles per 100 meters in the shoulder of the cyclepath. The distance of the relevant obstacles to the edge of the cycle path surface was less than two meters.

The six essential infrastructure elements of safe cycle paths are formulated as follows:

A cycle path is qualified as sufficiently safe as each of the following essential elements are present:

1. The pavement is obstacle free;
2. Visual guidance is available;
3. The width of the cyclepath is according to the design guide cycling infrastructure 2016 [8];
4. The pavement of the cycle path is flat, rough, unaffected and clean;
5. The shoulder is forgiving (no vertical difference in level);
6. The shoulder is free of obstacles.

The level of safety of the cycle path is in accordance with the number of essential elements that are present per unit of length.

### 3 INTENDED USE OF ESSENTIAL SAFETY ELEMENTS

The intention is that for each cyclepath in The Netherlands the level of safety will be established based on the the number of essential elements that are present. These safety level scores will be an important indicator for setting priorities for improving the safety of cyclepaths.

The Knowledge Network for the Strategic Road Safety enhances the processes to obtain the required data and to monitor future improvements of the safety of cycle paths. The data that are obtained will be made available for all policymakers (central, regional and local) and other stakeholders by means of a national dashboard.

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