Transportation Research Procedia

Volume 15, 2016, Pages 122–136

ISEHP 2016. International Symposium on Enhancing Highway Performance

# Capacity and Behaviour on One-way Cycle Tracks of Different Widths

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**Abstract**
The main objective of this study is to examine how widths of cycle tracks influence the behaviour, flow and capacity of bicycle traffic. Empirical data has been collected by video observations at 8 different one-way cycle tracks of varying widths (1.85 m-2.85 m excl. kerb between cycle track and carriageway). The locations are characterised by high bicycle traffic volumes on the track, no traffic lights / junctions / bus stops / zebra crossing nearby, and no dividing verge between cycle track and carriageway. Speed and lateral positions has been measured for 8,925 cyclists. The average speed is 21.6 km/h but differs slightly between locations. Women ride 2-3 km/h slower than men but also with a smaller dispersion. The traffic volume does not affect average speed, but dispersion decrease with increasing bicycle traffic volumes. At narrow cycle tracks cyclists are riding closer to the footpath and closer to each other during overtaking compared to cycle tracks of a larger width. Car parking in the road side next to the cycle track reduces "the effective width" of cycle track with about 10-15 cm. High bicycle traffic volumes are only observed in short time spans and it seems like the capacity limit is not reached. Flows as high as 20 bicycles per 10 sec are observed at a 2-lane cycle track (width: 2.35 m) and still with an average speed of about 21 km/h. Controlling factors are used when calculating capacity from short time spans, and the hourly capacity of a 2-lane cycle track has been estimated to about 3,000 bicycles/h. The width does not affect the capacity much unless the number of lanes are reduced or increased. A cargo bike has an average speed of 16.3 km/h and its headway is 1.3 times as big as the headway of a traditional bicycle. Due to the speed and the size of a cargo bike it reduces capacity equally to 3-4 traditional bicycles. Based on the data recommended widths of bicycle tracks are found in order to ensure a safe and efficient traffic operation for cyclists.

*Keywords:* cycle track, path design, speed, capacity, bicycles

## 1 Introduction

Bicycle traffic has increased in the large cities in Denmark over the last 10-15 years. Moreover, politicians wish to continue the growth making bicycling account for an even larger share of the urban

 Selection and peer-review under responsibility of the Scientific Programme Committee of ISEHP 2016

doi:10.1016/j.trpro.2016.06.011

area transportation. Similar objectives are found in many other countries, which also invest in a better cycling infrastructure. One of the measures taken in Denmark and elsewhere is the construction of cycle tracks in urban areas, which provide the necessary space for bicycle traffic and decrease perceived risk among cyclists.

At the same time, in Denmark the national objective is to reduce deaths and injuries in traffic, where cyclists currently account for approximately 20% of the total number of injuries reported by the police.

To achieve these objectives on increased safe cycling, a well-functioning and well-developed infrastructure for bicycle traffic is required.

In urban areas, junctions very often constitute a bottleneck in relation to cyclist passability. At the same time, the vast majority of accidents involving cyclists in urban areas occur in junctions. However, it should be noted that accidents on cycle tracks are underreported, because these accidents often are single accidents or accidents between cyclists and typically less severe than accidents between cyclists and vehicles.

Nevertheless, cycle tracks between junctions are also important in relation to cyclist safety and passability. An increase in the bicycle traffic volume will put a larger pressure on the most busy cycle tracks during rush hours, which may require an increase in the capacity of some of these cycle tracks. Meanwhile, the number of cargo bikes is growing, and these are characterised by other dimensions and driving behaviour, which may affect the capacity and safety of the cycle tracks.

Supported by the Ministry of Transport, Trafitec has conducted a study (Buch and Greibe, 2014) to examine the issue. The main results are presented in this paper.

## 1.1 Objective

The main objective of this study is to examine how widths of one-way cycle tracks in urban areas influence the behaviour, flow and capacity of bicycle traffic. Traffic safety has not been a part of the project but is of course a direct offshoot of the subject. Sections with one-way tracks along a road are the primary focus. Based on new empirical studies, we wish to assess the width of the cycle track in relation to cyclist behaviour (lateral position and speed) and capacity in order to provide guidance on widths of cycle tracks allowing safe and efficient bicycle traffic. To illustrate this, cyclist behaviour at different flow volumes and during overtaking has been studied. Furthermore, it has been examined how cargo bikes affect bicycle traffic.

## 1.2 Current knowledge

Existing studies from Denmark and other countries have been reviewed in order to examine recommended widths of one-way cycle tracks, cyclists' speed and one-way cycle track capacities (Buch and Greibe, 2014). One literature study (Allen et al., 1998) from 1998 found a capacity of 1,500-5,000 cyclists per hour and traveling speed around 12-20 km/h. Another literature study (Navin, 1994) found a capacity of 2,000-10,000 cyclists per hour for a 2.5 m wide cycle track depending on the level of service. A Chinese study based on behaviour models for passing manoeuvres estimated a capacity of 5,500 cyclists per hour for 2-3 m wide tracks (Li et al., 2013).

A recent Danish study based in micro simulation (Rambøll, 2012) suggests a capacity of 5,900 cyclists per hour for a 2.2 m wide track. The study uses a width of 0.8 m per cyclist. The capacity at a higher level of service is estimated to 3,200 cyclists per hour. The Danish Capacity Manual (Danish Road Standard Committee, 2010) indicates a capacity of 2,000 cyclists per hour for a 2 lane cycle track. However, the recommendation is based on data from the 1940s.

The width of regular cyclists is around 0.70-0.75 m (CROW, 2007), and 0.8-0.9 m for cargo bikes (Buch and Greibe, 2014). The Dutch Road Standards suggest 1.0 m per cyclists/lane and in Denmark the recommended widths of one way cycle tracks is 2.2 m (Danish Road Standard Committee, 2000) leaving space for safe overtaking.