

# INVESTIGATION OF SEPARATION DISTANCES BETWEEN CYCLISTS AND MOTORISTS IN CAPE TOWN

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## ABSTRACT

Road safety is a major consideration in one's decision to cycle and, there are various factors influencing safety for a cyclist. A very important factor is road space, as most roads in South Africa have not been designed and built to accommodate both motorised and non-motorised transport; the roads are built around the needs of motorized modes of transport and this has exacerbated the low modal share of cycling in South Africa.

Therefore the aims of this investigation was to find out what are the passing distances between motorists and cyclists, how do these distances compare to the recommended distances that should be given for cyclists in different driving environments and what factors influence the passing distances such as gender, weather conditions, different types of roads.

To obtain the passing distances a survey was carried out. The survey was conducted by means of collecting video footage. The footage by means of having a cyclist cycle along selected roads, and the bicycle was fitted with a GPS and video camera, therefore as the cyclist would cycle, the video camera would be recording footage of the lane in which the cyclist was travelling and all motorists passing or overtaking the cyclist were recorded too. The footage was then downloaded onto a computer and the VideoLan player used to analysis and measure the passing distances.

The findings of the survey have revealed that the passing distances were less than the recommended distances on the Pedestrian and Cyclist Facilities Design Guidelines.

This brings to question, is the fact that cycling has such a low modal share in South Africa due to the fact the road users do not feel safe to cycle on the roads.

Recommendations regarding safe passing distance legislation are made based on the findings.

*Keywords:* bicycle separation distance,

## INTRODUCTION

South Africa has a mix of first and third world traffic conditions; this has resulted in the non-motorised users, namely cyclists feeling unsafe in the mixed traffic environments.

Bicycling is one of the non-motorised modes of transport that offers greater mobility as compared to the other modes such as walking or animal drawn transport. This is due to the fact that one able to cover greater distances at higher speeds thus expanding the prism of activity for the user. However the uptake of bicycling in South Africa has been very low and this is exasperated by the fact that bicycling is seen predominantly in South Africa as, the poor man's mode of transport or as a recreational sport.

Recent trends in statistics have shown that the NMT share of road traffic fatalities is rather high, as in the case of South Africa up to half of all road fatalities are made up of the walking and cycling road users with a cycling share of 1% modal share of all trips (DoT, 2005).

Road safety has emerged as one of the main influencing factors in an individual's choice to cycle. It is therefore important to examine why there is the need for improved road safety measures for cyclists.

This paper will focus on:

- Literature review of both international and national literature on the road safety requirements and implications for cyclists with respect to separation distances,
- Case study on what the current separation distances are for cyclists.

## METHODOLOGY

One of the safety hazards is the separation distance that motorists keep when overtaking a cyclist. To investigate the effect of the separation distance on safety of cyclists, an experiment was carried out and the methodology of the experiment is as follows. The experiment methodology is based on the methodology used in a similar study carried out in the UK; "An experiment collected proximity data of motor traffic overtaking cycle traffic on roads with and without cycle lanes using an instrumented bicycle. The work enhances previous research which has considered the riding position of the cyclist and whether or not the cyclist was helmeted (Parkin and Meyers, 2010).

A Sony handycam was fitted to the rear rack of a bicycle and fed video footage into the handycam recording device. The camera was securely fitted to the rear rack of the bicycle and positioned such that the motor vehicle lane right of the cyclist could be recorded along with the footage of motorists overtaking the cyclist. The cyclist was a male cyclist, whom was familiar with the sites, which were selected for the study.

To ensure that the distances measured were accurate the video camera had to be calibrated each day and this was achieved by recording marked distances on measuring staff on the ground at a known distance from the bicycle. The video footage was viewed on VideoLan Player. To obtain the distances, a transparency was placed over the screen and was used to create a 'screen ruler' to measure the position of the motor vehicles relative to the position of the bicycle. The front wheel of the vehicle was used as the reference point for the measurement in relation to the rear wheel of the bicycle.

Due to geometric nature of roads vehicles (both motorised and cycles) there is variation on their position with respect to horizontal and vertical characteristics, which result in the variation of the position of vehicles as they drive along. The need to limit to variation of the cyclist was achieved by means of ensuring the cyclist rode along at a constant distance from the kerb and for this study the cyclist rode along the gutter of the road.

The sites selected for the study were located in the southern suburbs of Cape Town. The sites presented a range of geographical and operational conditions present on roads in South Africa furthermore; they are roads which have been named in the City of Cape Town Bicycle Master Plan.

The sites selected included:

1. Main Road (Primary Arterial)
2. Liesbeek Parkway (Primary Arterial)
3. Albert Road (Primary Arterial)
4. Malta Road (Primary Arterial)
5. Newlands Avenue (Primary Arterial)
6. Lansdowne Road (Secondary Arterial)
7. Campground Road (Primary Arterial)
8. Belvedere Road (Primary Arterial)
9. Durban Road (Secondary Arterial)
10. Milner Road (Primary Arterial)
11. Park Road (Primary Arterial)
12. Belmont road (Secondary Arterial)
13. Dean Street (Secondary Arterial)
14. Sawkins Road and (Secondary Arterial)
15. Raapenburg Road (Primary Arterial)
16. Klipfontein Road (Primary Arterial)
17. Prince George Drive (Expressway).

Majority of the roads do not have on-street cycle lanes which means that a comparison of overtaking distances on roads with and roads without on-street cycle lanes could be not done.



**Figure 1: Map of study site**

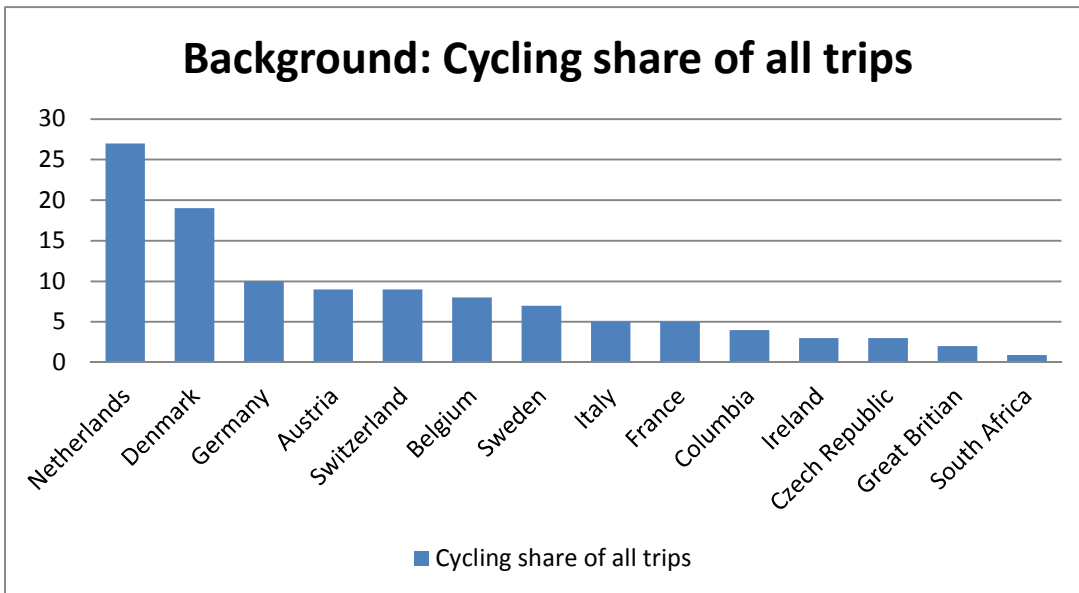
The geometric and operational characteristics ranged across the 14 sites. Streets with on-street parking were included to examine the effect of on-street parking on the separation distance kept by passing vehicles relative to the cyclist.

The selected sites were cycled at various times of the day namely; 08:00, 10:00, 12:00 and 14:00 hours. The reason for the different times of cycling was to observe if there are indeed any variations in the overtaking distances for the different periods of observation.

## PREVIOUS RESEARCH

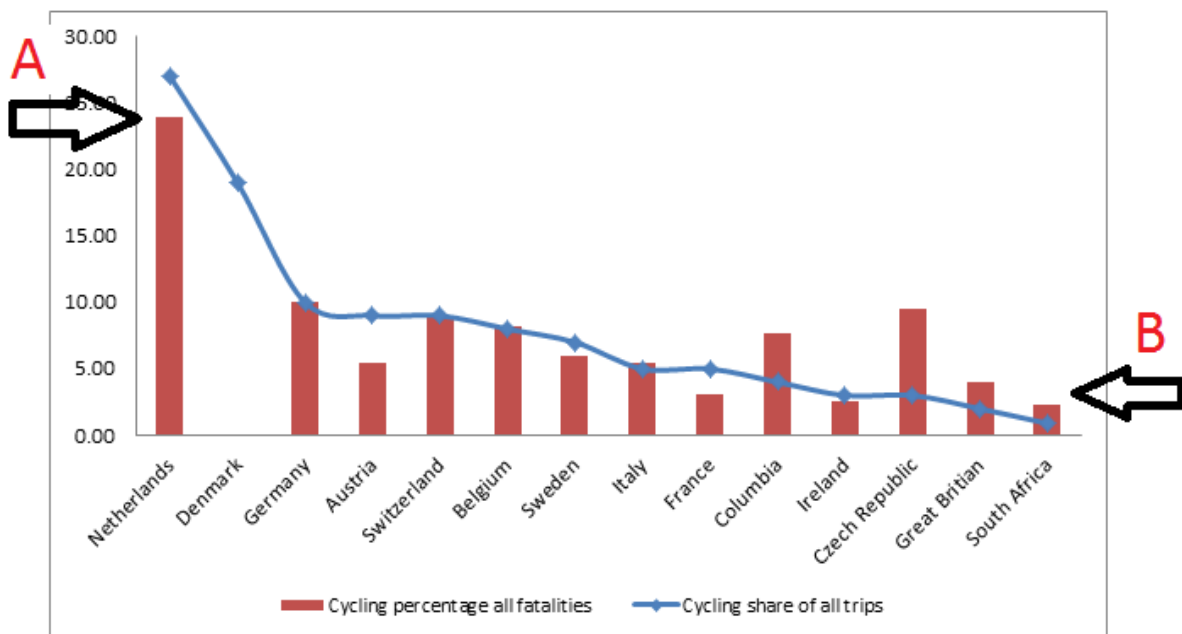
The South African National Household Travel Survey found that 30% of respondents either walk or cycle as their main modes of commuting; this highlights the role of NMT in trip making in South Africa. Furthermore, despite the growth in motorized transport in South Africa, a large portion of the population still depends upon the NMT modes of transport (DoT, 2008). This therefore highlights the great potential to increase the cycling share of trips in South Africa through a comprehensive approach which aims to address and meet the shortcomings and needs of cyclists. (DoT, 2005)

According to both international and national statistics, the cycling share of all trips can be seen below for various countries such as the Netherlands, Denmark and Germany who have the highest percentage of cycling trips as compared to South Africa on the other end of the scale with a cycling share of 1%.



**Figure 2: Cycling share of trips (Source: OECD)**

Trend analysis also shows that pedestrians and cyclists make up the greater part of road fatalities. In Figure 3 overleaf a comparison of cycling trip percentage versus cycling fatalities of respective countries could be done. From the graph it is interesting to note that the Netherlands has the highest number of fatalities. However, it is not an accurate depiction as the high cycling share of trips that the Dutch have versus the South African case which therefore means that the numbers of fatalities in South Africa are much higher due to the low number of cycling trips for the number of fatalities. Therefore, there has been an increasing recognition for the need to improve cyclist safety.



**Figure 3: Cycling Share and Fatality Statistics (Source: OECD)**

Previous research shows that there are several factors which increase the probability of a fatal crash between a cyclist and driver; which are greater vehicle speeds, presence of heavy vehicles, intoxication of the driver and or the cyclist, cyclist age, inclement weather, poor lighting conditions and accident characteristics. (Kim et al, 2007)

The South African Pedestrian and Bicycle Facilities Design Guidelines recommend that a minimum of 1.2 m be kept between cyclists and motorists. This space requirement is governed by the need for space in which cyclists have enough room to clear any obstacles, keep enough space between them and any other vehicles and enough space to carry out maneuvers (CSIR, 2003). This space is called the dynamic envelope.

Furthermore, previous research has shown that motor vehicles passing a cyclist exert a lateral force on the cyclists because of the air turbulence created (Parkin and Meyer, 2009). To lessen the impact of the lateral force on a cyclist, the Federal Highway Administration (FHWA) recommends that motor vehicles are to pass at a minimum space of 1.2 m which is dependent on the speed of the vehicle. (Parkin and Meyer, 2009)

The FHWA reviewed cycling accident data and found that accidents in which a motorist was overtaking a cyclist accounted for 4.7% of all accidents involving accidents. (Tan, 1996).

Unfortunately, research has been unable to establish any empirical link between separation distances and cycling accident rates. (Knoetze and Venter, 2013) Furthermore, a study conducted in the UK found that the installation of bike lanes lessened the variability in separation distances. (Kroll and Ramey, 1977)

(Walker, 2006) carried out a study in which he collected objective measures of motorists passing behavior with respect to the riding position, helmet use, vehicle type and gender on separation distances when a motorist overtook a cyclists. The work suggests that; female cyclists were given more space, drivers passed much closer to cyclists who were wearing helmets, drivers of larger vehicles passed much closer than drivers of smaller vehicles and finally based on a quadratic trend, in general drivers passed much closer earlier in the day.

Passing behavior can furthermore be expected to be related to not only to the geometric and traffic conditions prevalent at the time, but also factors such as weather conditions and visibility for the road users. (Knoetze and Venter, 2013)

Research by (Basford et al, 2002) found that the provision of bike lanes appears to have the effect of increased driver confidence and thus they exhibited much more risky behavior by passing closer.

In the absence of reliable data researchers have been forced to look to others ways of studying road safety for cyclists and thus have identified three types of safety and they are; Actual safety, which is based upon accident data and statistics, Perceived safety, which is based on the opinion and perception of safety of the cyclist and lastly, is inferred safety which is related to the behavior of other road users, most notably in mixed traffic environments. (Schramm, A and Rakotonirainy, A, 2009)

A lot can be taken away by learning from the successes and failure of countries such as the Netherlands on how they have achieved such great success in establishing cycling as a mode of transport. (Cycling Academic Network, 2010), (Braakman et al, 2009) and (Buis, 2009).

## RESULTS AND DISCUSSION

Analysis of the video footage was carried out using the VideoLan computer software. The computer program enabled the author to record the distances between the motorists and the cyclist.

The recorded distances were then captured in excel, using excel the mean distance and the standard deviation could be computed for each vehicle category. The results were then plotted on a column graph. The column graph allowed for the spotting any trends in the results with respect to any variations or similarities amongst the different road users and on the different roads.

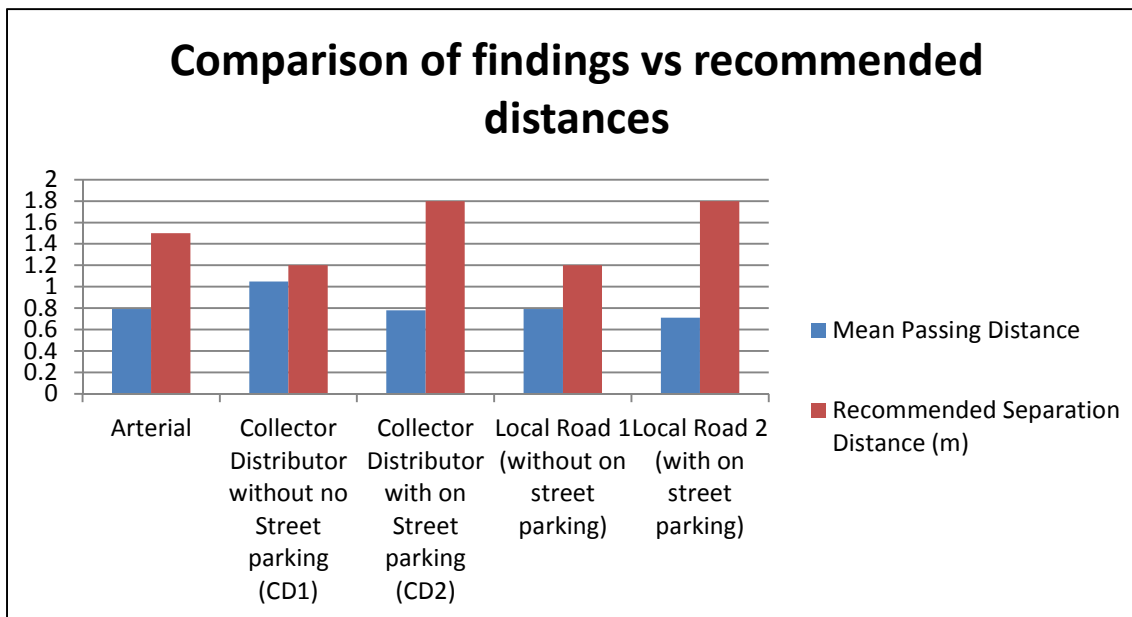
**Table 1: Recorded distances**

Road Type	Average distance (m)	Minimum Passing (m)	Maximum distance (m)	Recommended Distance (m)
Arterial	0.79	0.6	0.92	1.5
Collector Distributor without on Street parking (CD 1)	1.05	0.8	1.4	1.2
Collector Distributor with on Street parking (CD 2)	0.78	0.79	0.85	1.8
Local Road (L 1) (without on street parking)	0.79	0.58	0.85	1.2
Local Road (L 2) (with on street parking)	0.71	0.45	1.2	1.8

In Table 2 it can be seen that for the different types of roads, the average distance recorded did not compare well to the distances recommended in the Pedestrian and Cycling Facilities Design Guidelines.

In addition, it can then be seen that there are notable differences in the minimum and maximum distance for the C-D 1 and C-D 2 (road classes) of more than 0.5 m; which is the same case for the Local 1 Local 2 (road classes). The arterial road class could not be compared to any other road class as the geometric conditions on an arterial differ significantly to that on collector roads and local roads.

A comparison of the average distance and the recommended distance shows that the CD 1 road class the average distance is closest to the recommended distance. However for the other road classes, there was a notable difference between the average distance and recommended distance.



**Figure 4: Mean Separation Distances versus the Recommended Separation Distances**

Figure 4 is a column plot of the average distance for the different road classes. It can be seen that the average distance did not compare well to the distances recommended. Taking note of the results, the only road class on which the average distances was close to that which the guidelines recommend, was the Collector Distributor road without on street parking facilities. For the Arterial, C-D 2, Local 1 and Local 2 road classes all recorded average distances were well below the recommended distances.

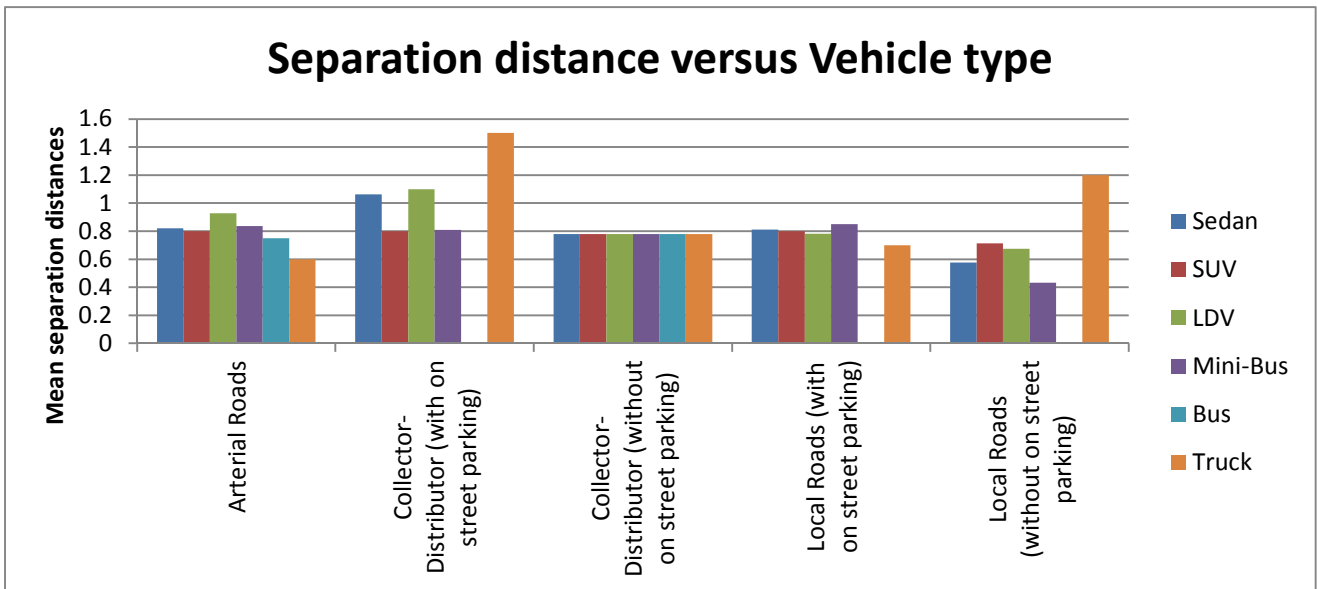
Figure 5 below is a plot of the average distances per vehicle category per road class. For the Arterial roads, as per the guidelines, a width of 1.2 – 1.5 metres is recommended, however, it can be seen, that the average distances for all the vehicle types is less than 1 metre. The greatest distance was approximately 0.92 metres and the smallest distance 0.6 metres.

Collector Distributor with on street parking, the results relate to roads which have on-street parking. Therefore, the recommended distance should be 1.8 metres. However, it can be seen that the maximum distance given is 1.4 metres and the least is 0.8 metres.

Collector Distributor without on street parking, the results relate to roads which has a paved shoulder, therefore, the recommended distance for a road of this type is 1.2 metres. However, it can be seen that the average distances are all below 0.8 metres and the average distances for the different vehicles are constant at 0.78 metres.

For a local road with on street parking, the geometry of the road is in an environment of mixed residential, retail and educational use. The road has on-street parking; therefore, the recommended distance is 1.5 metres. The average distances are below 0.9 metres





**Figure 5: Average separation distance versus vehicle type**

with the greatest distance being 0.85 metres and the smallest distance being 0.7 metres. Local Road without on street parking, the roads are most often found in residential areas whose function is that of access. Therefore, these roads can expect to have high volumes of NMT users with little or no on-street parking, as well as vehicles accessing the road from abutting properties. The recommended distance is 1.5 metres. It can be seen that the greatest distance offered is 1.2 metres and the smallest distance is approximately 0.4 metres.

Using the functions in excel, the standard deviation for the different vehicle types could be calculated.

**Table 2: Standard Deviation in separation distances**

Vehicle Type	Standard Deviation
Sedan	0.155
SUV	0.034
LDV	0.147
Mini-Bus	0.156
Bus	0.015
Truck	0.340

In Table 3 above is the standard deviation for each vehicle type on all five of the roads presented in the results. It was found that the Bus and SUV vehicle types respectively have the smallest standard deviation which means that there is less variance in the passing distance recorded from the average distance whereas, inversely the LDV, Sedan and Minibus vehicle types respectively, have the larger standard deviation which means that there is greater variation in the recorded passing distances from the average distance.

The trend from the results is that drivers were seen to be passing much closer than expected and this is especially the case for drivers of larger vehicles such as buses and trucks, this could be attributed to the fact that they operate much larger vehicles and with the given widths of lanes, they have to pass closer, so as not to interfere with opposing

traffic flows. The passing distance could be influenced by the fact that the larger vehicles travel at lower speeds and thus feel safer to pass closer to the cyclist.

Drivers of smaller vehicles, namely sedans, provided the greatest passing distances, because they have more room to manoeuvre within a given lane without interfering with the flow of traffic in the opposite direction and in cases of more than one lane be available in each direction they often opted to change lanes when overtaking the cyclist.

Road class is governed by the function of the road which dictates the geometry of the road i.e. arterials, the passing distance is much larger, as the road geometry allows for larger lane widths. However, wider lanes do not have the effect of improve safety, as with larger lane widths, motorists operate at higher speeds. At higher speeds, larger passing distances are recommended because risk and severity of injury increase with speed.

According to the different types of vehicles, sedans allow for a greater degree of separation between themselves and the cyclists.

At intersections, due to the lack of bicycle lanes/paths and crossing facilities, not only do cyclists have to weave through queuing traffic (which means that the separation distance and the motor vehicles are no more than a few centimetres at certain locations) to make it through the intersection, but they also have to be alert and look for a gap in which they can safely cross the intersection.

On-street parking has the effect of forcing cyclists to cycle into the traffic lane as there is not enough room to accommodate both pedestrians and cyclists on the sidewalks, further reducing the separation distance between the cyclist and motorists.

It was noted that for the different road types, the separation distances versus the recommended separation distances. It can be seen that on all the road types, the recommended separation distance is more than the distance provided in practice. Motor vehicle drivers are passing much closer than suggested by the design guidelines (CSIR, 2003), which means that the likelihood of a crash happening is much higher.

## **CONCLUSIONS**

The availability of accident data for cyclists on South African roads is limited and, therefore, investigating the separation distances is a possible alternative solution to establishing the status quo of cycling road safety.

Further studies to Investigate the influence of speed on the passing distances which avail means to compare the operational characteristics of different vehicle types.

There are not many studies which are aimed at identifying the relationship between separation distances and accidents therefore is it hard to state that vehicles passing too closely could be cause of accidents. Internationally, there is an increasing interest in the safety of cyclists and what factors affect road safety, this trend too is picking up in South Africa which means that steps are being taken to take into consideration the needs of cyclists.

Furthermore, such studies can help planners and the relevant stakeholders identify and decide on an action plan to make South Africa a more cycling friendly nation. Moreover, such data could play a role in giving grounding and meaning to legislative policy, strategy and framework that needs to be drawn up and used to support the implementation of safe cycling, not only in Cape Town but in South Africa as a whole, and this can be complemented by shared lessons from countries that have had huge successes with cycling, such as The Netherlands, Denmark, China and Columbia (in particular Bogotá). A

further benefit to the availability of accident data is that it can be used in accident location analysis too.

## **ACKNOWLEDGEMENTS**

We would like to take this opportunity to thank the *Pedal Power Association* (South Africa) for the funding they have provided, to make this study possible.

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