# PEDESTRIAN CROSSING BEHAVIOUR ALONG A PRIMARY ACCESS CORRIDOR IN STELLENBOSCH

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**ABSTRACT**

The focus of this paper is the high number of pedestrian casualties on Bird Street in Stellenbosch, Western Cape. Bird Street serves as the primary route for pedestrian movement between the suburb of Kayamandi to the north of the town and the central town area of Stellenbosch. Traffic casualty data was used to establish high risk casualty areas along the road and observational studies were conducted at these locations to determine the environmental and behavioural factors contributing to the casualty problem. Pedestrian flows and patterns were also studied to determine pedestrian crossing preference and to identify informal crossing points that are of particular concern.

An initial study into pedestrian flows and patterns indicated that a major pedestrian access exists between Kayamandi and Bird Street serving pedestrians throughout the week but in particular during peak hour times on weekdays. Casualty data confirmed that the highest concentration of casualties was located at informal crossing locations for pedestrians and showed cycling casualties to contribute significantly to the total Non Motorized Transport (NMT) casualties. Observations of pedestrian road behaviour found that pedestrians engage in risky crossing behaviour in order to reach their desired location. Negative behaviour toward formal pedestrian facilities such as zebra crossings and signalised crossings was also seen to exist. Further investigation into the state of pedestrian facilities along Bird Street showed a lack of provision for the disabled and inconsistencies within formal crossing features.

## 1 INTRODUCTION

How, where and why did the pedestrian cross the road? The question may seem trivial, but could be helpful in understanding why pedestrian traffic collisions in South Africa are so high. An examination of SA road traffic casualties conducted between 2003 and 2005 showed that pedestrians constitute an average of 40% of all roadside fatalities (Botha and Van der Walt, 2006).

According to Behrens (2003), walking accounts for 36% of all road user mode choice in Cape Town. Among the population of Kayamandi, pedestrian and other non-motorized modes are most likely significantly higher than this estimate, as car ownership is extremely low and the town centre is close enough that taxi or public transport is not considered an option for most.

For the Cape Town area, historical road traffic statistics show that pedestrian collisions are higher than the national average – in 2002 63% of all fatalities in the Cape Town metropole were pedestrians (Liebenberg and Garrod, 2005). Liebenberg *et al* also noted that these pedestrian fatalities are especially prevalent in the economically active age group between 26 and 35 years.

Cape Town and its environs have seen the growth and establishment of a number of informal settlements close to larger town areas. As noted by Ribbens et al (2008), many new formal and informal settlements are established alongside the road network to allow residents easy access to transport and hence to employment. This results in a higher exposure of pedestrians to vehicular traffic and contributes to the high incidence of pedestrians we experience in the region.

Pedestrian casualties are not only a health and transport issue; they also represent an important social equity issue. As Matzopoulas et al (2007, p.75) note, "…those who do not possess motor vehicles bear a disproportionate share of road injury and risk". Identifying and understanding the underlying causes of pedestrian conflict with vehicles could contribute to creating a safer environment for these and other road users. This paper analyses the high number of pedestrian casualties occurring on a 2.2 km stretch of Bird Street, using casualty data obtained from the Stellenbosch Traffic Department to identify specific accident cluster zones. Pedestrian flows, patterns and causes of conflicts with vehicles were investigated by conducting observational studies at accident cluster locations, and a field study into the current state of pedestrian infrastructure was conducted to identify problem areas on the pedestrian route. By combining these aspects it is possible to determine the causes of pedestrian casualties on specific crossing locations along the road in study.

## 2 BACKGROUND

Stellenbosch is located in the heart of the Cape Winelands region 50km from Cape Town City Centre and 28km from Cape Town International Airport. The town, which is home to the University of Stellenbosch, has its own local municipality which falls within the Cape Winelands District Municipality zone. Figure 1 shows the location of Kayamandi to the north-west of Stellenbosch town centre, and highlights the corridor of Bird Street as the key link between the two.

Bird Street is a two lane bi-direction road and is categorized as a district distributor which connects to the primary arterial R304 located to the north as seen in Figure 1. It serves as the most direct link between Kayamandi and the CBD of the town with a distance of 2.2 km between the two destinations. The road also offers easy and direct access for pedestrians from Kayamandi with pedestrian walkways spanning both directions through the majority of the road section.

Census data indicates that the population of the town has almost doubled, from 117,705 in 2001 to 200,527 in 2007. This increase in population could be attributed in part to the effects of urban sprawl within the boundaries of Stellenbosch.

The suburb of Kayamandi is currently home to a population of 33,000 people on 75 hectares of land, over 70% of whom live in squatter camps. Kayamandi is situated roughly 2 km from the town centre and pedestrian access to town is the most common form of transport for the

Kayamandi residents. Other forms of non-motorized transport (NMT), such as the use of bicycles, are also fairly common.

## 3 METHODOLOGY

Pedestrian casualty data for the Bird Street study area was provided by the Stellenbosch Traffic Department. Between January and August 2009 there were 63 pedestrian and cyclist casualties recorded as described in Table 1. These include 6 cases of no injury caused, 39 slight injuries, 12 serious injuries and 1 fatal injury. The locations of the injuries are shown in Figure 1 below.

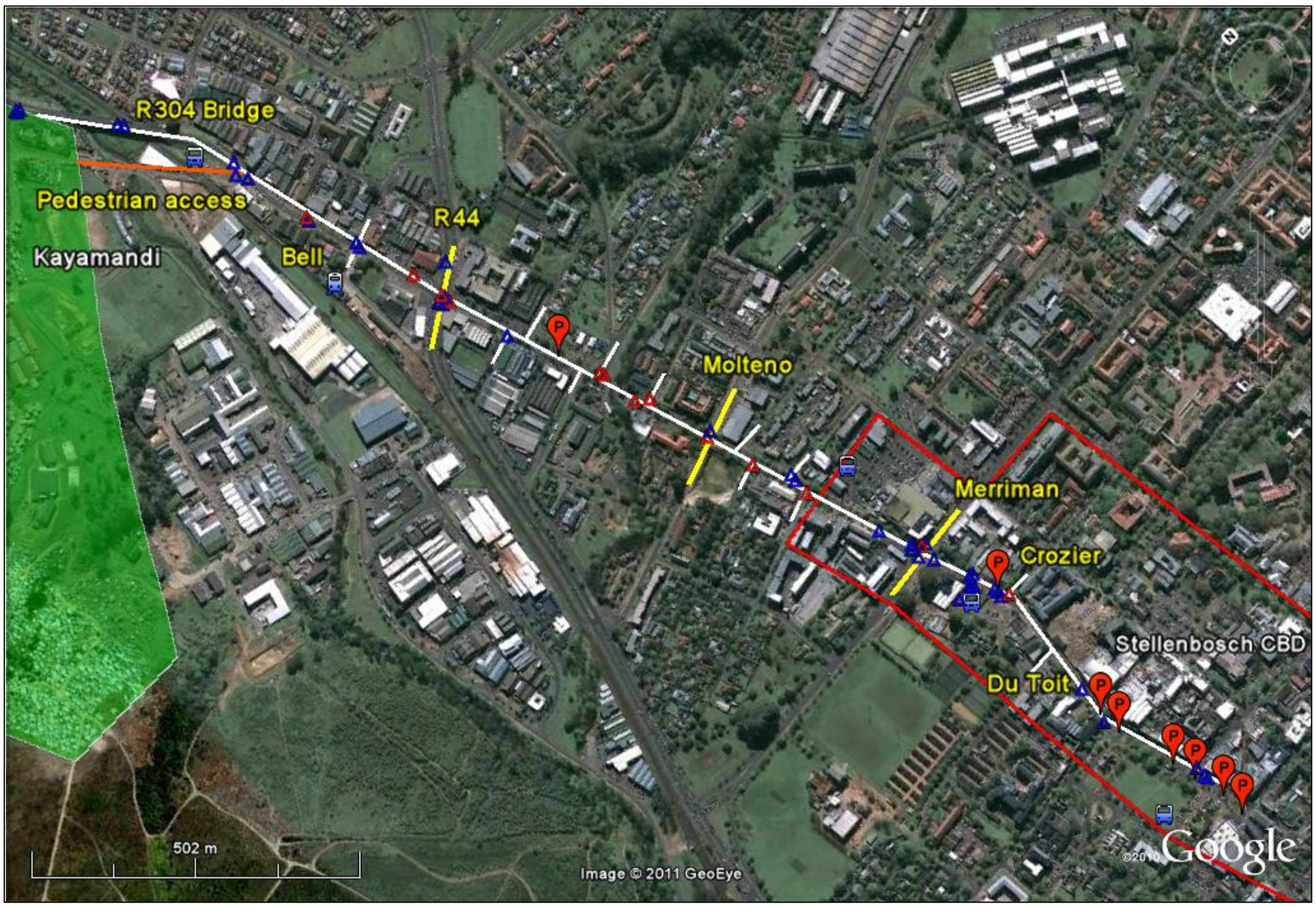


**Figure 1: Study area and casualty locations along Bird Street; blue triangles indicate pedestrian casualties and red triangles indicate cyclist casualties; yellow lines indicate signalised intersections; P signs indicate presence of formal midblock crossings**

The data was examined to pinpoint accident cluster zones along the road. Observational studies were conducted along these accident cluster zones and were accomplished by dividing it into two separate tasks. The first task involved creating log sheets to observe and log pedestrian characteristics and dangerous crossing behaviour along specified midblock and formal crossings points. These observations were conducted during weekdays with similar weather conditions and during lunch hour times (1pm to 2pm). The second task involved identifying pedestrian crossing patterns and desire lines through half-hour counts at selected intersections throughout the road on weekday peak hour times. An investigation into the surrounding environment and road infrastructure, with a focus on pedestrian facilities, formed a final component of the study.

**Table 1: Description of traffic casualty data**

| | *Cases* | *% of Total* |
|---|---|---|
| Total casualties | 63 | 100 |
| Pedestrian casualties | 47 | 75 |
| Cyclist casualties | 16 | 25 |
| Location provided | 51 | 81 |
| Time provided | 61 | 97 |
| Severity provided | 58 | 92 |

## 4 OBSERVATIONS

4.1 Midblock Crossing Locations

From the casualty data, it was determined that pedestrian casualties occur predominantly on informal midblock locations with 25 and 49% of the 51 casualties with location provided occurring on these crossings. Furthermore, it was found that casualties mostly occurred in the Northern regions adjacent to Kayamandi (39% of casualties) and within the CBD area (43% of casualties). Observational studies were conducted on three informal and two formal midblock crossing locations along the street. These are discussed by area below, beginning with crossings in the northern region adjacent to Kayamandi and then moving onto crossings in the central CBD region of Stellenbosch.

*4.1.1 Northern Bird Street*:

Along Bird Street, there are no formal crossings in the northern Kayamandi section of the road between the R304 bridge exit and R44 to accommodate pedestrians. This stretch is also the location of a pedestrian access connecting Kayamandi to Bird Street (Figure 2) which sees increased pedestrian crossing movement into and out of the area. This lack of crossing points is in stark contrast to the southern CBD section of the road between Alexander and Church Street which incorporates a total of six formal pedestrian crossings as located in Figure 1.

**Figure 2: Pedestrian access into Bird Street**

**Figure 3: R304 Bridge entrance adjacent to pedestrian access**

**Figure 4: Child pedestrian waiting midway to cross the road**

As a result of the high volume of vehicles entering and exiting Bird Street from the R304 bridge (Figure 3) , pedestrians were observed having to wait significant periods of time to find sufficient gaps to cross the road, resulting in pedestrians running across the road and/or waiting midway for traffic breaks. The dangers of pedestrians running over the road were exacerbated by the pedestrian committing him/herself to making the crossing manoeuvre with less time to pick up all visual information. Crossing behaviour was observed on two midblock sections in the region and showed running to occur on 17 of 65 crossings observed on the Bell// R44 midblock and 22 of the 115 crossings observed on the R44 Bridge exit midblock crossing. Running had been identified as a factor in 13% or eight casualty collisions involving pedestrians on this section of road, which underlines the risks associated with this behaviour.

Pedestrians stopping midway between two flows of traffic find themselves in close proximity to incoming vehicles as can be seen in Figure 4, especially heavy vehicles. This crossing behaviour is prevalent on the road of study and was observed to occur on 25% (16 cases) of the crossings observed on the Bell// R44 midblock. At certain times, lower volumes of traffic created opportunities for pedestrians to cross diagonally over the road directly to their desired location and also specifically to and from the access walkway into Kayamandi. This diagonal crossing manoeuvre exposes the pedestrian to traffic for extended periods of time with his/her back to incoming traffic. A higher incidence of diagonal crossing was seen to occur across the pedestrian access area in Kayamandi, with 21 and 18% of pedestrians observed taking the shortest route to their destination.

*4.1.2 Southern part of Bird Street*.

This section of the road is located within the CBD and maintains high volumes of pedestrians and vehicles throughout the day. Observational studies were conducted on the Merrian// Crozier midblock section that is located along a formal taxi rank, the Bergzight Taxi Rank, and low cost retail centres (Figure 5 and 6). This midblock section was identified as having the highest number of casualties with 17%, (or ten) of reported casualties having occurred here.

**Figure 5: Pedestrians crossing to formal taxi rank**

**Figure 6: Retail centres along midblock section**

Similar crossing behaviour witnessed in the northern region was seen to take place within these midblock crossing locations. These include running, midway stopping and diagonal crossing occurring frequently. As in the northern section long waiting times for pedestrians crossing the road were observed. From Figure 7 it can be seen that midway stopping was most prevalent in this area, occurring on 63 of the 224 crossing observed. An interesting distinction here was that where, in the northern section, pedestrians crossed individually or in small groups, in the southern section bigger groups of pedestrians (up to ten) were seen to cross at the same time, resulting in clusters of pedestrians waiting midway for traffic to pass before proceeding to enter the taxi bus entrance for the taxi rank as shown in Figure 5.

Four casualties were located at the entrance and parking bay of the taxi rank where taxis enter the taxi rank. The concentration of casualties here could well be the result of unsafe pedestrian entrances to the taxi rank and short barrier walls being placed adjacent to the taxi bus entrance, blocking alternative access into the area.

This midblock section also provides parking spaces on the side of the road as shown in Figure 6, which, when occupied by parked vehicles, were seen to obstruct the drivers' view of pedestrians crossing in front of or behind them.

Longer crossing times were witnessed when elderly and or disabled pedestrians crossed the road and 5% (twelve) of the 224 crossing pedestrians observed in the study period were elderly and/or disabled. Woman carrying young children were also observed frequently and were seen to have protracted crossing times compared with other adults.

Figure 7 below illustrate the predominant types and frequency of behaviour witnessed on three key informal crossing locations within similar weekday conditions.

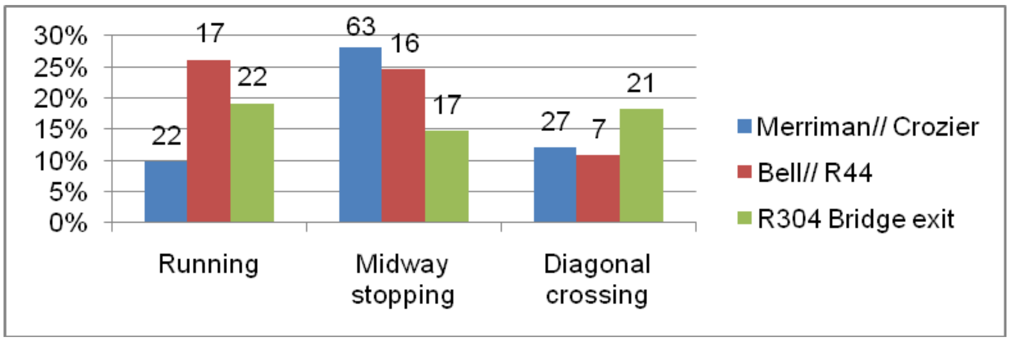


**Figure 7: Crossing behaviour at informal midblock crossings**

4.2 Formal versus informal crossings

In total, 8% of the 51 casualties with site specific information were located on formal crossing locations throughout Bird Street, compared with 49% which occurred at informal crossings. Comparing pedestrian crossings between informal midblock crossings and formal crossings within the same midblock section revealed that the majority of pedestrians prefer to cross at informal crossings than walk the short distance to the formal pedestrian crossing. Two such studies within the CBD showed 224 informal vs. 127 formal crossings (64% informal crossing preference) at the Merriman// Crozier crossing (Figure 8) and 152 informal vs. 68 formal crossings (69% informal crossing preference) at the Eikestad mall crossing (Figure 9) to occur within similar weekday conditions and times.

Crossing on the edges and diagonally over the formal pedestrian crossing located within the CBD resulted in vehicles stopping over the designated stopping line before the crossing. This had the effect of obstructing other pedestrians trying to cross on the designated crossing - this occurred on 9% (eleven) of the 127 crossing observed. Fifteen percent or 18 pedestrians were seen waiting for vehicles not stopping for pedestrians at the foot of the crossing. This in return caused a number of pedestrians to run over the crossing. Running over the formal crossing was witnessed on 9 (7%) occasions

4.3 Crossing design

Formal crossings along Bird Street differ in their appearance and design with three types of crossings found within 280m of the road section within the CBD as can be seen in Figure 8, 9 and 10. This adds to further confusion to the purpose or use of the facilities for both motorist and pedestrians.

**Figure 8: Merriman// Crozier midblock formal crossing**

**Figure 9: Raised and signalised crossing within CBD**

**Figure 10: Zebra crossing within CBD**

The formal crossing near the taxi rank (Fig.7) experienced a high number of peripheral use (pedestrians crossing outside its boundaries and also diagonally). Pedestrians were also seen to dawdle, causing frustration for motorists. Vehicles were observed frequently not stopping for pedestrians waiting to cross. The signalised crossing at Eikestad mall (Fig. 9) evidenced confusion over the right of way, with vehicles often not stopping when the green man was green, and pedestrians crossing when it was red. There appeared to be a high degree of confusion as to whether this was a demand stop of whether pedestrians always had right of way. Little diagonal or peripheral crossing was observed.

The midblock Eikestad mall crossing was well marked and the highest level of pedestrian compliance was observed here.

4.4 Other environmental factors

Traffic behaviour and characteristics at crossing points contributes to a large extent to the safety of pedestrians. Variations in the speed of incoming vehicles was observed to influence the behaviour of the pedestrian with higher approach speed resulting in pedestrians running over an crossing and slower approach speeds resulting in diagonal crossing. Midblock sections with higher volumes were observed to cause pedestrians to stop midway between traffic flows for a chance to cross.

Heavy vehicles were prevalent throughout the road in study, mostly crossing Bird Street from the R44 intersection.. The wider axle of the heavy vehicle puts pedestrians waiting midway on the road in closer proximity to these vehicles. The only documented fatality from the casualty data was with a pedestrian colliding with a heavy vehicle on the R44 intersection. This fatality also occurred in the presence of rainy and wet conditions. Rainy and wet conditions were documented during 21% (13) of the total casualties and are thus an environmental factor which appears to contribute to the safety of pedestrians on the road.

Night time conditions did not show significant increases in pedestrian casualties, although 18% (11) of casualties did occur between 18:00 and 19:00 (Figure 11). This time of day sees high volumes of pedestrians traversing home from the CBD - reduced visibility in the evening could compromise the visibility of pedestrians for drivers.

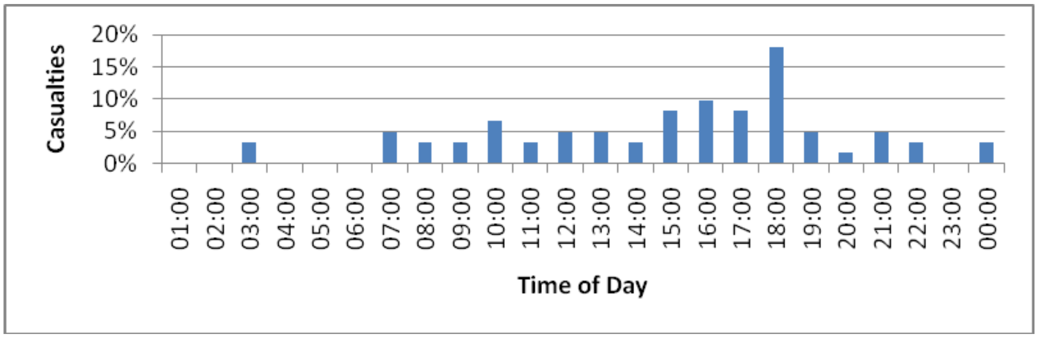


**Figure 11: Time of casualties**

4.5 Intersection Crossing Locations

Three four-way signalised intersections and eleven stop street T-intersections are located along Bird Street between Kayamandi and the CBD. From the casualty data, it was determined that 14 (27%) pedestrian casualties occurred on signal intersections. The two major signalised intersections - the regional road R44 intersection to the north and the Merriman street intersection further south in the CBD accounted for six (12%) casualties each and was the subject of further investigation. The two intersections are similar in design except for the R44 intersection that features a median within the R44 road (Figure 12). Both these intersections provide marked walkways for pedestrians but neither facilitates smooth access for cyclist and wheelchair use.

**Figure 12: Pedestrians using median at R44 intersection**

**Figure 13: Pedestrians crossing Du Toit street T-intersection**

Figure 14 shows predominant dangerous crossing behaviour and frequency witnessed to occur on the two major signalised intersections crossing Bird Street within similar time and weekday conditions.

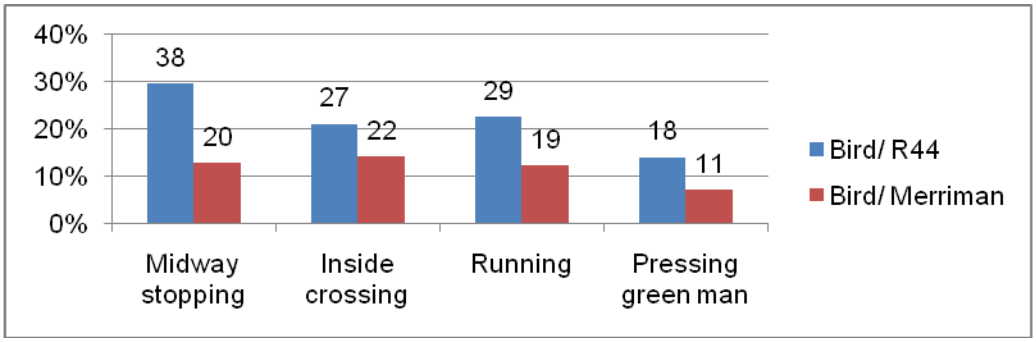


**Figure 14: Crossing behaviour at signalised intersections**

Similar dangerous crossing behaviour as associated with midblock crossings (such as running and midway stopping) was seen to occur on signalised intersections. Midway stopping was more prevalent over the R44 intersection with 30% of the 128 pedestrians observed stopping midway on the raised median compared with 13% of the 155 pedestrians observed stopping midway on the Merriman intersection (with no raised median). The R44 median is, however, too narrow for groups of pedestrians and does not stretch over the designated pedestrian walkway in front of stopping vehicles (Figure 12). This in turn could explain the higher occurrence of pedestrians crossing within the road (21% vs. 14%) and up to ten meters behind the designated walkway lines. When pedestrians cross outside the designated walkway lines provided at signalised intersections, they become vulnerable to the same dangers associated with informal midblock crossing locations and could also catch oncoming vehicles of guard.

It was found that there is a generally negative attitude towards the use of the green man walking button with only 14% of pedestrians on the R44 intersection and 7% of pedestrians on the Merriman intersection observed using it. Some pedestrians who did press the green man button were seen crossing before the green man signal appeared when traffic conditions allowed for safe crossing. The green man signal does not allow for pedestrian priority crossing, allowing vehicles to turn into the pedestrian crossing area.

Vehicles crossing incoming traffic to enter an intersection are more likely to cause conflict with pedestrians since they commit themselves to turning into the intersection to avoid incoming traffic and tend to fail to notice pedestrians in the vicinity. Furthermore, it was observed that pedestrians generally fail to look for incoming vehicles turning into their path especially when they believe they have right of way i.e. when crossing on the greenman signal. This type of behaviour at signalised junctions could be contributed to two of the casualties in the database. ‘Not looking’ was also witnessed within stop street T-intersections and can lead to what is formally described as side-swipe collisions.

Data was collected over a one hour period for 121 crossing pedestrians on the Du Toit Street T-intersection located within the CBD (Figure 13). This intersection makes use of a stop control for vehicles crossing into Bird Street and has no formal pedestrian facilities. The percentage of pedestrians looking backwards for turning vehicles crossing in both directions is comparable with 47% of the pedestrians looking backward for turning vehicles when crossing from the left to right lane and 41% looking backwards walking from the right to left lane. In total, four near conflict situations were observed between vehicle and pedestrian as a result of the side swipe action from turning vehicles

4.6 Cycling

Cyclists contribute to 25% (16) of the 63 NMT casualties on Bird Street, yet they constitute a very low percentage of total NMT use. A morning peak half hour count of pedestrians and cyclist entering Bird Street from Kayamandi found that cyclist only constituted 2.5% of the total NMT for that period. This may be as a result of various factors such as the lack of infrastructure for cyclists on Bird Street.

**Figure 15: Gutter on side of road along Bird Street**

Walkways on both sides of the road are too narrow for safe cyclist and pedestrian use and the road offers minimal shoulder width for cyclist to ride on. Furthermore, the presence of wide gutter and scarce refuge zones (Figure 15) makes the journey only more hazardous. Further investigation into the casualty data found that the majority - nine of the sixteen cyclist casualties – had been a result of side swipe action with a turning vehicle with eight of these side swipe casualties occurring on T-intersections.

Observations at unsignalised T-intersections saw cyclists pass the intersection without checking for turning vehicles and behaving as if they were part of vehicle flow. Cycling Casualties on the three signal intersections was the location of four (25%) casualties. At signalised intersections, their crossing behaviour was seen to be part-pedestrian and part-vehicle, crossing on a red light when the opportunity arises, and crossing over the green light with the flow of traffic.

## 5 CONCLUSION

From the casualty data it was clear that the highest number of casualties occur at informal crossing locations for pedestrians. Following observation and analysis of pedestrian behaviour, the high number of casualties at these crossing locations is believed to have resulted from a combination of risky crossing behaviour and certain environmental conditions.

Dangerous crossing manoeuvres observed included:

- Running over midblock and intersection crossings
- Stopping midway between two flows of traffic at intersection and midblock crossings
- Diagonal crossing at midblock road sections - with or without formal crossings
- Not checking for turning vehicles while crossing intersections
- Not pressing and waiting for green man signal before crossing signalised crossing
- Preference to cross informally when in close distance to formal crossing

Environmental factors influencing casualties included high volumes of heavy vehicles and poorly designed pedestrian refuges at midblock and intersections. Inconsistent formal crossing design features, parked vehicles at sides of midblock crossings, vehicles given priority on green man signals at intersections and lack of infrastructure for disabled pedestrians were all contributory factors.

Cyclists were overrepresented in the total casualty numbers on this road. The analysis showed that side swipe collisions at intersections were the leading cause of cyclist casualties. Cyclist crossing behaviour was seen to be part-pedestrian and part-vehicle at intersections leading to confusion with vehicles crossing their path. Further contributing to the dangerous cycling environment is the lack of cycle paths and poor carriageway conditions.

Botha *et al* (2006) noted that the present approach to the traffic safety problem in South Africa focuses less on engineering strategies and more on safety awareness campaigns and stricter implications of traffic law enforcement. He noted that road authorities must urgently adopt a new and proactive approach in identifying hazardous pedestrian locations on the road. This research has attempted to do just that, and to throw new light on the relationship between pedestrian behaviour and road environment along the Bird Street corridor.

## REFERENCES

Botha, G. & Van der Walt, H. 2006, "Fatal road crashes, contributory factors and the level of lawlessness", *25th Annual Southern African Transport Conference, South Africa*SATC,, pp. 10.
Behrens, R. 2003. Cited in the Metropolitan Spatial Development Framework for Cape Town, 2003: 62. City of Cape Town.

Liebenberg, K. & Garrod, K. 2005, "Alleviation of the pedestrian safety crisis in the city of Cape Town", *24th Annual Southern African Transport Conference, SATC 2005: Transport Challenges for 2010, July 11, 2005 - July 13*Document Transformation Technologies cc, Pretoria, South Africa, pp. 537.

Ribbens, H., Everitt, P. & Noah, M. 2008, "Impact of an adequate road environment on the safety of non-motorised road users", *Crime, violence and injury prevention in South Africa: data to action,* pp. 48-69.

Matzopoulos, R.; Mathews, S.; Bowman, B and Myers, J.; Western Cape Burden of Disease Reduction Study 2007 Volume 5, Injury due to interpersonal violence and traffic.