

AFRICA ON THE MOVE – BUT NOT TOO FAST

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ABSTRACT

According to the Road Traffic Management Corporation (2008) the third highest number of road fatalities (818 in 2007-08) in South Africa can be ascribed to “Failure to stop or yield”. This follows behind pedestrian and overtaking related road fatalities.

In a study of the minimum speed of vehicles through stop-controlled intersections during free-flow conditions it was found that very few drivers would come to a complete stop. Very high speeds were observed at some locations. Different types of layout were observed – such as two-way, three-way and four-way stops, with different available sight distances. At the same time a user survey was done by means of a questionnaire to determine the reasons why drivers do not stop at stop-controlled intersections.

It was observed that nearly 90 per cent of road users do not come to a complete stop while less than eight per cent said in the user survey that they would always come to a complete stop. The 85th percentile speed through these intersections was found to be 19 km/h.

The paper describes the data collection, the results and discusses the possible reasons for non compliance of the traffic rules. Different solutions to this problem will be discussed. These include the increased use of yield signs, traffic circles and improved law enforcement.

1 INTRODUCTION

The objective of this paper is to describe a study (Verlinde, 2010) of the behaviour and attitude of road users as they approach a stop-controlled intersection during free flow conditions. According to Ajzen and Fishbein’s theory of reasoned action (Ajzen, 1991), the best predictor of behaviour is the intention to behave in a certain way. Drivers failing to stop at stop-controlled intersections are a very common occurrence and most road users only slow down to what they believe to be a safe and reasonable speed. This decision made by road users is of an intentional nature. The study assessed different factors that influence road users to behave in this manner. The factors which were examined were intersection layout, available horizontal and vertical sight distance and road user behaviour at night-times, as opposed to during the day. Speed-data were collected at different intersections located in Stellenbosch and Somerset-West by means of a radar gun.

It was found that more than 95% of all accidents are caused as a direct result of a traffic offence (Arive Alive, 2009). It is common knowledge that not all road rules are abided to by all road users, be it exceeding the speed limit or as in this project’s case: failing to stop at a stop-controlled intersection. This could be because of frustration on the road users’ part due to unnecessary delays, e.g. stopping at an intersection when it would cause no

harm to merely slow down to an acceptable speed. Attempts to save as much fuel as possible or the absence of law-enforcement could also be other possible factors.

Previous research done on projects of a somewhat similar nature yielded results that stop-controlled intersections are overused, because of a tendency by traffic engineers/practitioners to make use of a higher level of control (when the road user is given less freedom to decide) over road users than is necessary, even where adequate sight distances are available (Polus, 1984). In general, a stop-controlled intersection becomes necessary when an increase of vehicle flow, an increase in approach speed or a reduction in horizontal sight distance, on all legs of an intersection, are experienced.

Earlier studies have suggested that stop-controlled intersections do not necessarily improve traffic safety (when compared to yield intersections), but that stop-controlled intersections merely increased road user costs, energy expenditure, air pollution and noise pollution (Polus, 1984).

2 METHODOLOGY

2.1 Speed observations

The main purpose of this project was to determine the factors which influence road user behaviour at stop-controlled intersections. The one method which was used for the purpose of this project was to measure the minimum speeds through various intersections. The minimum speed data was captured from behind by means of a radar gun which gives the instantaneous speed at any moment, the lowest of which was recorded. The data was analysed by means of Microsoft Office Excel 2007. One of the problems encountered during the surveys was that the available apparatus was not able to measure speeds between 0 and 16 km/h. Therefore all vehicles that did not come to a complete stop but was not measured by the apparatus were grouped together at a speed of 1–16 km/h. In the calculation of averages these vehicles were assigned a speed of 8 km/h. A minimum of 50 vehicle speeds per direction per intersection were obtained, in order to ensure a reasonably accurate representation of road user behaviour.

For the purpose of this project it is important to specify under which conditions the data were collected. Free flow conditions were of significant importance when speed-data was collected, with the purpose of obtaining uninfluenced individual road user behaviour. Free flow conditions specify that no other vehicle, on any leg of the intersection, may be present at the time of data collection, or be allowed to influence the behaviour of the road user approaching the stop line. This includes any vehicle which has already passed the stop line and exited the intersection.

It is important to note that all intersections under consideration are located in areas with maximum speed limits of 60 km/h.

Different intersection layouts were used to determine the effect on the behaviour of its road users. The following different layouts of stop-controlled intersection types were taken into account:

- 2-way stop intersection (one major and one minor road, with only vehicles on the minor road required to stop)
- 3-way stop intersection (T-Junction; stops on all three legs)
- T-Junction; stop on only one leg
- 4-way stop intersection

A total of 19 different intersections (two 2-way, nine 3-way (including T-junctions) and eight 4-way) were chosen for the surveys.

One of the main reasons for using a stop sign in stead of a yield sign is because of insufficient availability of sight distance. There are various ways in which to measure sight distance (NITRR, 1984), but for the purpose of this project the available horizontal shoulder sight distance was measured 5 m from the stop line, in order for the user to be able to judge whether or not a stop is necessary (depending on other road users present at other stop lines). These measurements have been done by means of a measuring wheel, starting at the stop line of one direction and measuring until the user's view is obstructed 5 m from the perpendicular intersection-legs' stop lines. This is done in all applicable directions of all intersections under examination.

2.2 Attitudinal survey

A questionnaire with two simple questions was distributed electronically to students at the University of Stellenbosch. A total of 292 out of a possible 1425 students had completed the questionnaire, which gave a relatively accurate distribution of the requested answers. The first question which was asked to students was as follows:

“How often do you come to a complete stop when you reach a stop street (when no other vehicle is present)?”

- Never
- Rarely
- Mostly
- Always

To this question a single response was required.

The second question which was asked to students was as follows:

“What mostly influences you not to stop at a stop street?”

- Lack of law-enforcement
- Waste of time
- Waste of petrol
- Safe to do so

To this question more than one reason for not stopping could be given.

3 RESULTS

3.1 Speeds

3.1.1 *All intersections*

The speed distribution of all road users observed at all the intersections are shown in Figure 1.

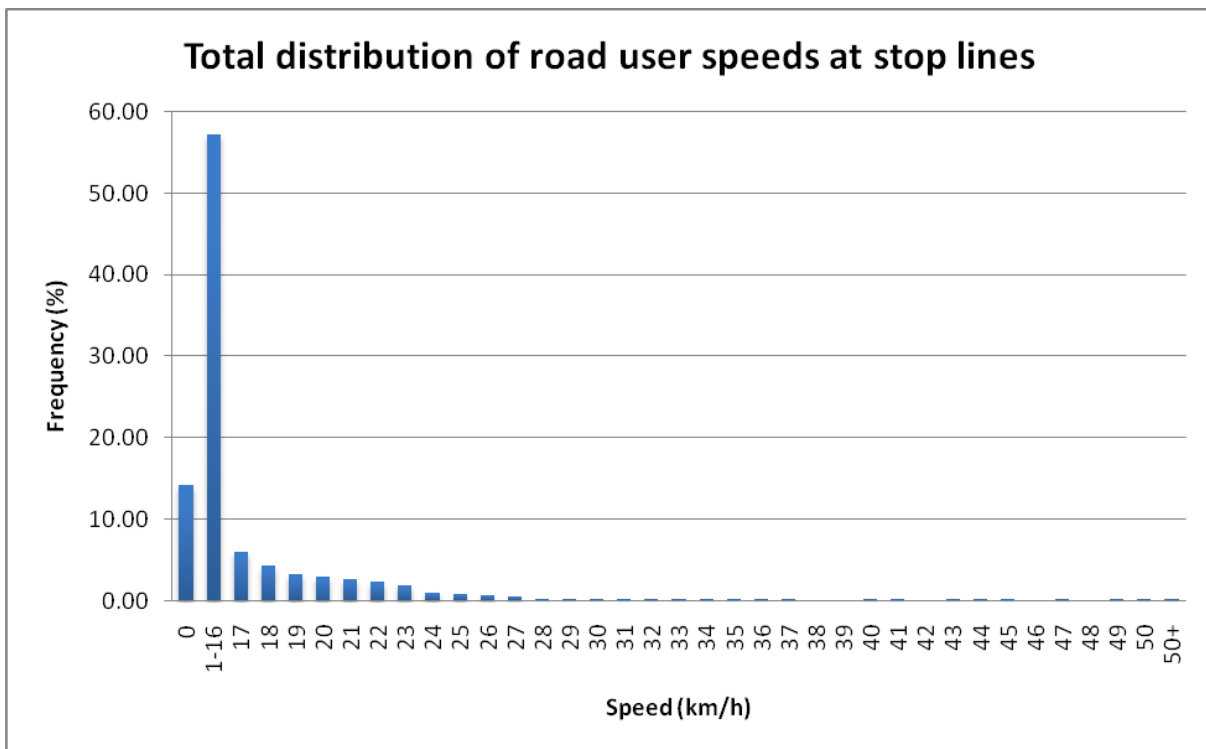


Figure 1: Speed distribution of all road users at all intersections

The important statistics are an average of 10.5 km/h, an 85th percentile of 19.0 km/h and a maximum speed of more than 50km/h. It is also important to note that only 14.2% of the users actually stopped at these intersections.

3.1.2 Speeds by layout of intersection

The speed statistics for the different intersection layouts are given in Table 1 and shown in Figure 2.

Table 1: Speed statistics of different layouts of intersection

Intersection Layout	Average speed (km/h)	85 th Percentile speed (km/h)
2-way stops	7.3	16.2
T-intersection: one stop	8.2	19.8
T-intersection: three stops	14.7	21.9
T-intersection: all	11.3	21.0
4-way stops	10.5	18.4

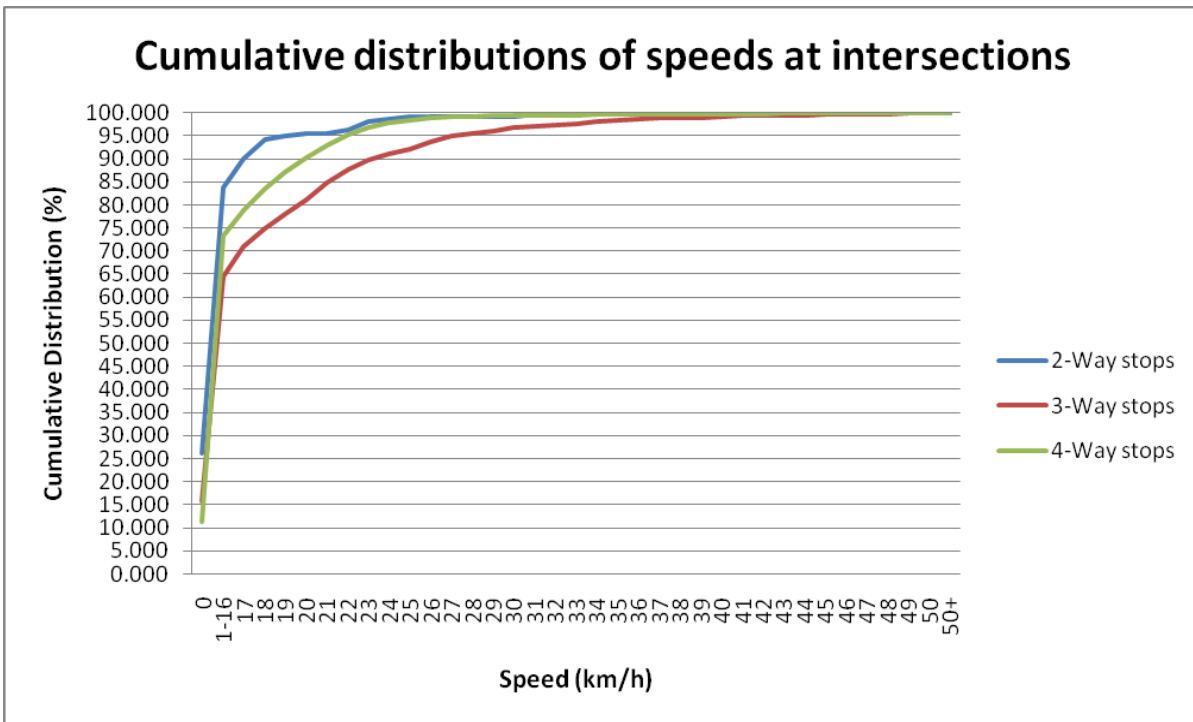


Figure 2: Cumulative speed distributions at different layouts of intersection

From this figure and the table it is clear that the users of two-way stops generally drive slower than those at three- and four-way stops. Also, more vehicles at two-way stops (26.2%) come to a complete stop than at four-way stops (15.7%) and three-way stops (11.2%).

3.1.3 The effect of sight distance

It was only at the two-way stop intersections that a definite trend between the average speed and the available sight distance was observed. This is shown in Figure 3. At three- and four-way stop intersections no clear pattern was found.

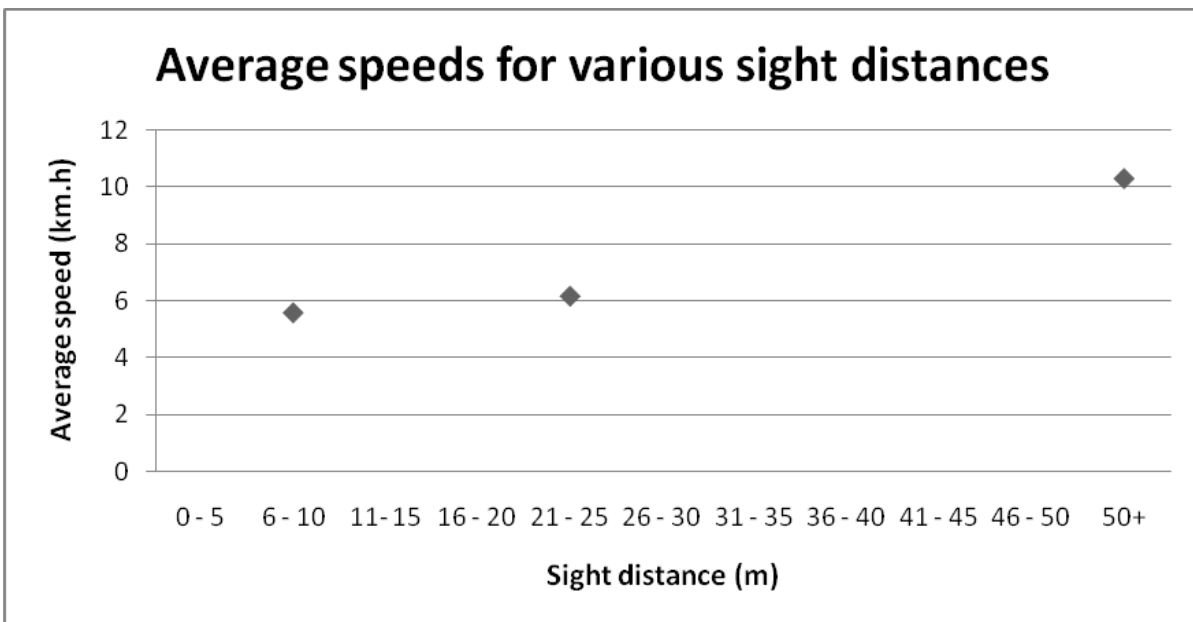


Figure 3: Speeds through two-way stop intersections versus sight distance

3.1.4 The effect of day vs night

At one specific four-way stop intersection the speed surveys were conducted during the day as well as during the night. The results are shown in Figure 4.

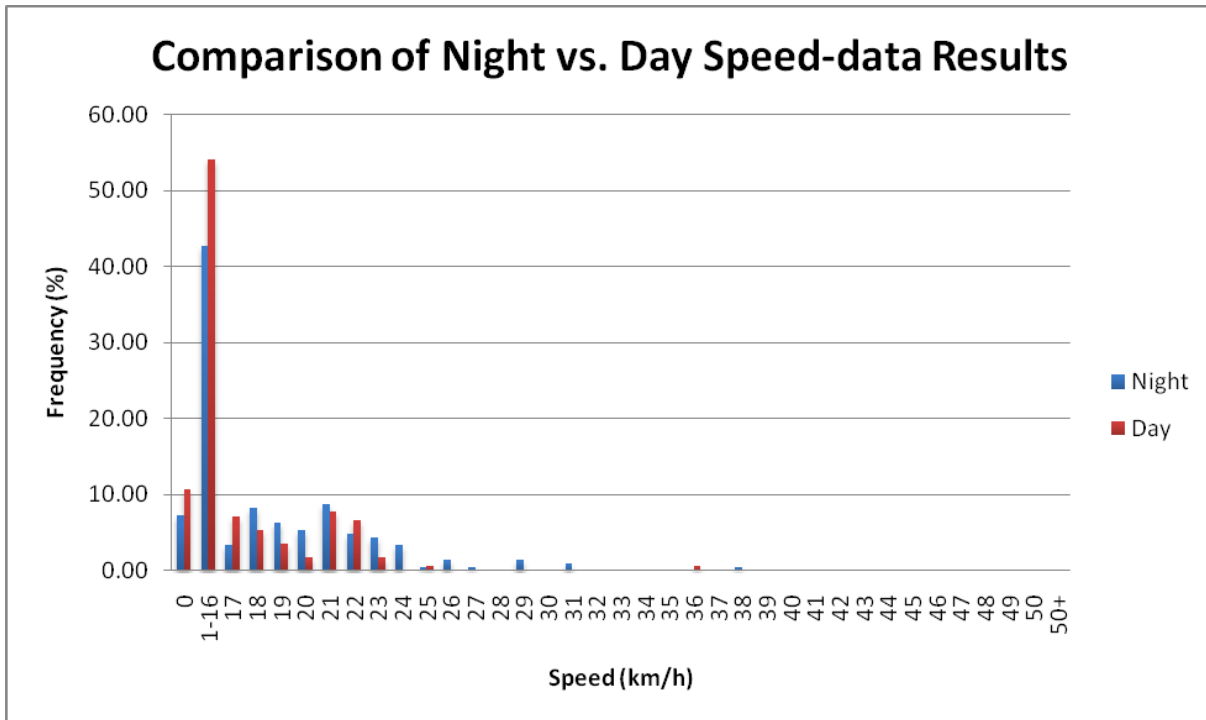


Figure 4: Day versus nighttime speeds

From this figure it is clear that the daytime speeds are lower (more travel at the slower speeds). The average speed during the day was 11.4 km/h as against the 14.0 km/h during the night. More road users (10.7%) came to a complete stop during the day as compared to the percentage (7.3%) during the night.

3.2 Questionnaire results

The results from the first question on how often the respondent comes to a complete stop when no other vehicles are present (free flow) are given in Figure 5.

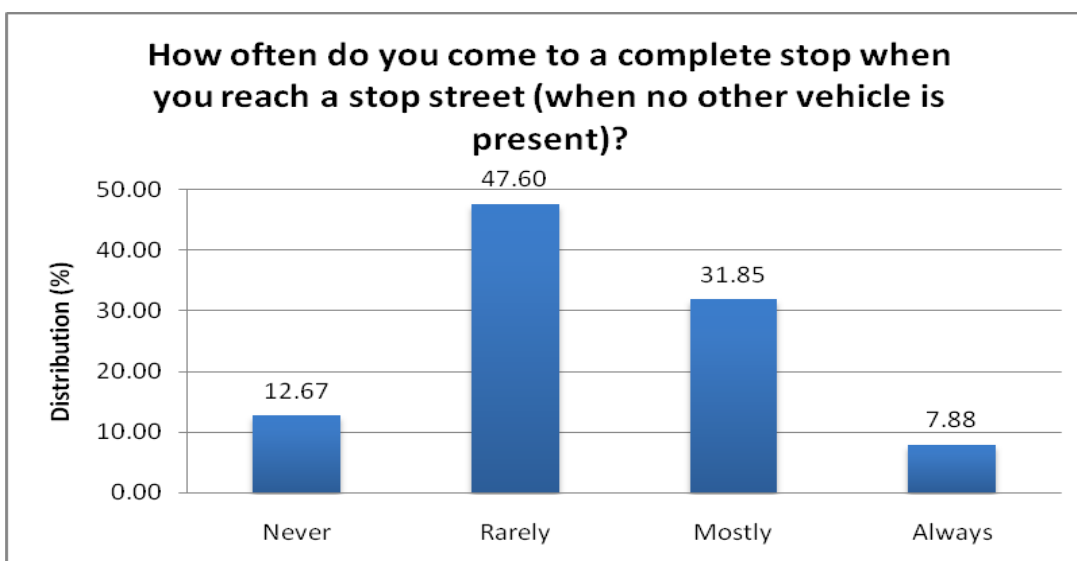


Figure 5: Questionnaire: Question 1

The results from the second question is shown in Figure 6.

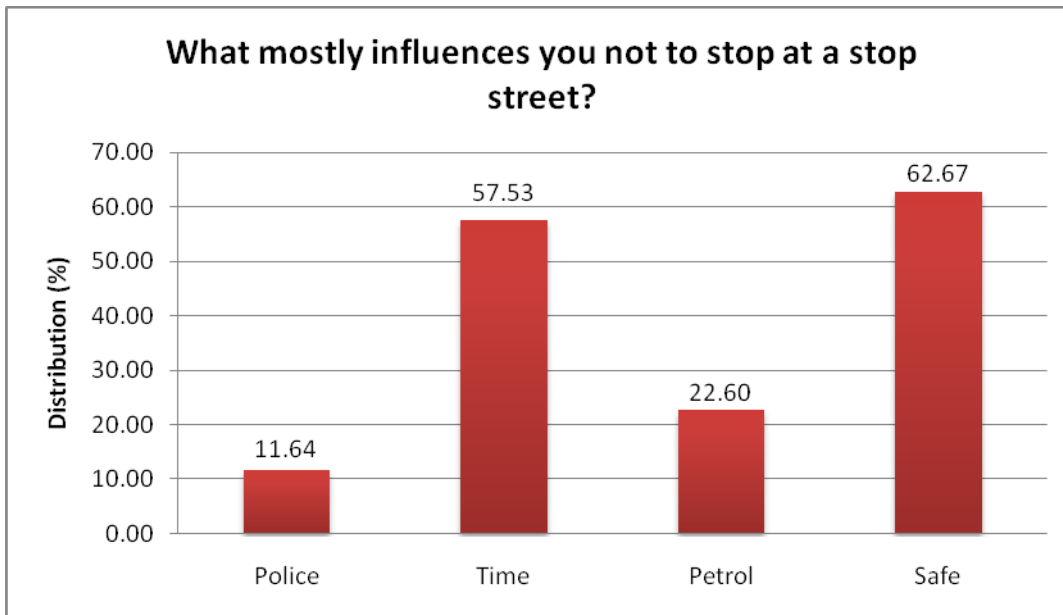


Figure 6: Questionnaire: Question 2 (Multiple answers were allowed)

From these two figures it is clear that the majority of users rarely or never stop and it is because they feel it is safe to do so and it will save them time. They are clearly not concerned about fuel consumption or law enforcement.

4 DISCUSSION

4.1 Speeds

4.1.1 *General*

The behaviour of road users at stop controlled intersections is quite alarming when it is considered that 85.8% of those observed during this project did not conform to the requirements of the road traffic act. This is much higher than the percentage (30.7) of vehicles exceeding the speed limit (Botha, 2006) which is usually given as an example of the disregard for traffic rules. It can be seen as part of a general tendency towards lawlessness in South Africa (Botha, 2006), but also as an opportunity to reconsider the use of this type of control at intersections.

In the guidelines for setting speed limits the 85th percentile speed is used as an input. If the same principle is applied at intersections many of the stop signs could be replaced by yield signs. There just need to be a new definition and/or sign for an all-way yield.

4.1.2 *Layout of the intersection*

The lowest speeds (and highest number of drivers stopping) were found at the two-way stops where those on the minor road know that the drivers on the main road will not stop. At the all-way stop intersections there is a probability (although small) that other drivers will stop or at least drive at a low speed. The second lowest speeds were recorded at T-intersections where only those on the stem of the T have to stop. The slightly higher speeds than at the two-way stops can be ascribed to the lower number of conflict points at a T-intersection. The second highest speeds were found at the four-way stops and the highest speeds (and lowest number of drivers stopping) at the T-intersections where

everybody has to stop. The latter difference again as a result of the lower complexity of the layout at the T-intersection.

4.1.3 *The effect of sight distance*

It is logical that the speeds at which drivers cross the stop line will increase when conflicting vehicles can be detected at an earlier stage. This was clearly the case for two-way stop intersections. It seems, however, that for the all-way stops the driver is only concerned with conflicting vehicles closer to the intersection than his own in which case he will reduce his speed further and even stop but in some cases accelerate to reach the stop line before the conflicting vehicle. For this a sight distance of 5 m would be sufficient. The proof will be shown in Section 4.2.

4.1.4 *The effect of day versus night*

There are four possible reasons why vehicle speeds through stop-controlled intersections are higher during darkness than during daylight hours:

- The headlight glare of conflicting vehicles can be seen at an earlier stage;
- Drivers are aware that law enforcement activities during the night are even less than during the day (also see perceptions of users);
- Drivers and especially those of the female gender may be afraid of crime. This reason is often given for red light running at night; and

4.2 Road users' reactions and perceptions

From the survey sample it is clear that the majority of road users (60%) do not see the need to stop at stop controlled intersections while only 7.9% said that they would always do so. The reasons given are mainly because they feel it is safe to do so and that they would like to save time. As far as safety is concerned the following assumptions would be reasonable:

- 85% of drivers will decrease the speed of their vehicle to 19 km/h when approaching a stop-controlled intersection;
- While decelerating from 60 km/h they will have their foot on the break pedal when they reach a point 5 m from the stop line;
- If, at that point, there is a conflicting vehicle closer to any of the other stop lines and this would be possible to determine in the majority of cases (sight distance is greater than 5 m) it would be possible to bring the vehicle to a stop before the stop line is reached by decelerating at 2.8 m/s^2 . If there were no conflicting vehicles closer to the stop line the driver can proceed through the intersection at 19 km/h.

A deceleration rate of 2.8 m/s^2 can be described as comfortable as against an emergency rate of 7.3 m/s^2 (Papacostas, 2005). It is therefore clear that a speed of 19 km/h through an all-way stop intersection under free-flow conditions can be safe. It should be noted that these assumptions do not hold true for two-way stops or for the single stop at a T-intersection.

As far as the waste of time is concerned it can be shown that about three seconds can be saved by driving through the intersection at 19 km/h rather than by coming to a complete stop.

5 CONCLUSIONS

It is clear from the results that the vast majority of road users in Stellenbosch and Somerset West do not stop at stop-controlled intersections unless it is necessary. It is highly likely to be a problem throughout South Africa. Also, a survey amongst students confirmed that the vast majority of them would not stop when there are no other vehicles present. The problem is worse at night and at all-way stops. The main reasons are the perception that it is safe and that time can be saved. It was also indicated that the current level of law enforcement is not a deterrent to this behaviour.

The main problem arising from the results of this project is that the integrity of the stop sign is being compromised and traffic officials are not doing much to stop it. It can be stated that the use of the all-way stop as a control measure can partly be blamed for this situation. It is therefore time to reconsider this way of controlling traffic at intersections.

6 RECOMMENDATIONS

The current situation at stop-controlled intersections is unacceptable and should not be allowed to continue. It is recommended that all-way stops be replaced by traffic circles or another types of control where it would not be necessary for all users to come to a complete stop. It may even be considered to introduce a four-way yield intersection with the necessary legislation. We may even follow the British example of requiring special permission to erect a stop sign. At the same time there should be a vigorous campaign to restore the integrity of the stop sign at two-way stops and railway crossings by means of law enforcement.

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