MIROS Review Report
MRev No. 365

A Feasibility Study on Increasing the Speed Limit: Ayer Keroh – Simpang Ampat Section along PLUS Expressway (KM196–KM217)

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Report to the Malaysian Highway Authority

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Abstract

The Malaysian Highway Authority (MHA) has requested MIROS to commence a study on the suitability of increasing the speed limit from 90 km/h to 110 km/h. The objective of this study was to assess and to make recommendations on the feasibility of increasing the speed limit within the study area. The road section for the study is on the PLUS Expressway (E2), from KM196 – KM217 for both directions. Spot speed data was collected using the smart sensor for approximately 30 minutes at each site during off peak hours. The study covered 8 sites from the 21 km stretch, where 4 sites were located at the south bound stretch while the other were located in the north bound stretch. For each north and south bound stretch, there were two spots located within the 90 km/h speed limit stretch while the other two spots were located before and after the 90 km/h speed limit stretch. Additionally, accident data was obtained from PLUS from the year 2009 to 2012. Analysis of vehicle speeds revealed no significant difference between the mean speeds in the 90 km/h and 110 km/h zones. This shows that the 90 km/h posted speed limit did not influence the driving behavior of the road user. Further analysis also found that the speed variance between both directions was less than 2%. These provide an indication that uniformity of traffic flow exists between both zones. Next, analysis of accident data between the 90 km/h and 110 km/h zone on the 6 lane, dual carriageway from the year 2009 to September 2012 shows that the difference in the number of fatal crashes in the two speed zones are minimal. Chi square test revealed that the difference is not significant. This may be due to several factors and not due to vehicle speed factor alone. The speed limit may be increased on the condition that the road geometry and design can accommodate the new increased speed. This should be confirmed by the relevant parties. The parties are responsible to ensure of no occurrence of cross winds at the said location. Additionally, for a 60 km stretch, the total sum of accidents is 90. In the event the speed limit is to be increased, the crash rate should be monitored to track

the safety performance at this section. More effort should be invested to further reduce the current crash rate along this expressway section.

1. Background

The PLUS Expressway has been opened to the public since 1994 and it is recorded that there were 98 crashes that took place within this year resulting in 25 fatalities. In the year 1995, within the first nine months there were 155 crashes with 18 fatalities recorded along the 21 km stretch of road involving trucks and passenger vehicles which took place in the early morning and evening (Abas and Haslinda 1997)[1]**.** Due to the alarming number of crashes and fatalities, a study was conducted in 1998 by Projek Lebuhraya Utara-Selatan Berhad (PLUS) and Japan International Cooperation Agency (JICA) where several locations was determined as prone to cross wind problems. PLUS has planted trees at these locations to reduce the potential of cross wind development and installed wind socks to warn road users about the cross wind locations along the stretch. PLUS has informed that these measures are likely to reduce the possibility of cross wind occurrence along the 21 km road section. Despite the high number of crashes and cross wind problem, there are requests to increase the existing speed limit along PLUS highway.

Hence, he Malaysian Highway Authority (MHA) has requested MIROS to conduct a study in the effort of increasing the existing speed limit from 90 km/h to 110 km/h. A meeting was conducted with MHA on 15 October 2012 to discuss the issues and it was informed that the road alignment was designed based on the 120 km/h design speed. It was agreed in the meeting that MIROS will investigate matters regarding speed along this section and will produce a report addressing the issue.

[1] Abas Ab.Wahab, & Haslinda Mohamed Kamar (1997). Ciri-ciri angin lintang di lebuhraya PLUS, Kajian Kes KM212. Jumal Teknologi, Bil. 29, Dis. 1998 him. 71 - 79, Universiti Teknologi Malaysia).

2. Introduction

Based on the request from MHA, a team was formed to carry out the study. Crash data was obtained from PLUS which consists of injury and fatality data. A drive through survey was performed along the 21 km stretch and a strip map was produced. The team collected the data within two days at several locations along the 21 km stretch on the 21 and 22 October.

2.1 Setting the Speed Limit

Speed limit is set to ensure safe operating speed on a roadway by controlling the maximum speed the road users are allowed to travel although certain countries enforce a minimum speed limit. However, this is only effective if the road users comply with the speed limit which at times is not properly set. From an engineering point of view, it is important to note the behaviour of most road users. Driving in a reasonable manner should also be considered as should setting a suitable speed limit. This is important to ensure a reasonable basis for enforcement in order to avoid unnecessary public protest against the authority. A proper speed limit is most of the time (Forbes *et al.* 2012)[2]:

i. related to crash risk;
ii. fair in the context of traffic law; and
iii. accepted as reasonable by the majority of road users.

Generally, the setting of the speed limit is carried out by considering the road geometry and road conditions and ability of the vehicle and driver. Most of the time a lower speed

[2] Forbes G. J., Gardner T., McGee H., & Srinivasan R. (2012). Methods and practices for setting speed limits: An informational report. Federal Highway Administration, Washington.

limit is required due to reasons such as changes in land use and road geometry, history of crash occurrences and high violation rates. However, in some cases it may appear that a higher speed limit is highly demanded by the public as they perceived the road to be safe to travel at a higher speed. Mostly at this location, the speed limit violation rate is high. In any case, deciding on a new speed limit requires thorough examination of the existing situation.

In Malaysia, non-compliance of the speed limit on Malaysian roads and expressways is an offence under the Road Transport Act 1987, for which a penalty or summons can be issued to the traffic offender.

Introducing speed limits is essentially a precautionary measure to guarantee road safety. There has been no consensus among road safety practitioners on the best methods and techniques to be used in setting the speed limit. However, few guidelines are available for reference on setting the speed limit. The Public Works Department has produced a guideline called 'Guideline for the Selection of Speed Limit'. This guideline is applicable to roads other than tolled roadways (Public Works Department n.d.)[3].

Expressways with closed full access allow for a higher travelling speed due to the design of the road that incorporates the highest geometric design standard which is R6/U6. The speed limit for these expressways was set to 110 km/h following the National Speed Limit Order 1989.

2.2 Location Description

i. The study location involving a 21 km stretch along the North-South Expressway between Simpang Ampat and Ayer Keroh exit (KM196 – KM217).
ii. The road stretch located at a rural area and based on the design, speed, road condition and cross section, the road can be classified as a R6 type of road. It is

[3] Public Works Department, Malaysia (JKR). Guideline for selection of speed limit.

a six-lane dual carriageway road with landscape median separating the carriageway.

iii. The vertical profile of the road could be considered flat with some mild slope uphill and downhill at some locations with some mild curves along this section.

iv. The posted speed limit along this 21 km section is 90 km/h and the traffic composition includes heavy vehicles, passenger cars and motorcycles.

3. Objective

The objective of this study is to provide an assessment and recommendation for speed limit increment along the Simpang Ampat – Ayer Keroh road section.

4. Methods

4.1 Identification of Study Sites

Eight study sites were chosen as the point for speed data collection based on the following requirements:

i. Relatively straight and flat section.
ii. Safe area for data collection.
iii. Proper area to place equipment.
iv. Proper area to conceal data collection activity from the road users.

A total of eight sites were identified in both the 90 km/h and 110 km/h zones with four sites in each direction (refer to Figure 2). Most of the study sites could not provide a good spot to 'hide' the data collection activity partly due to the size of the Smart Sensor as shown in Figure 1. The presence of signboards and trees were of little help in blocking the sight of the activity.

Figure 1 Smart Sensor used for speed data collection

4.1 Data Collection

i. Spot speeds were collected using the Smart Sensor (Figure 1) for approximately 30 minutes at each site. Speeds of every vehicle in the traffic stream were detected and stored.

ii. In order to obtain speed data which represents the driver's true behaviour of speeding, data collection was carried out only during clear weather, when the pavement was dry. Besides these measurements were taken during off-peak hours where vehicle speeds were not affected by high traffic flow.

iii. In addition, only vehicles leading a platoon (where the drivers can freely select their speeds) were considered. Therefore, only speeds of vehicles having sufficient headways were included for analysis.

iv. More than 300 vehicle speeds were included after the data cleaning process. This sample size is adequate at the 95% confidence level and considering the limit of acceptable error to be ± 2.5 km/h.

5. Result

5.1 Analysis of Speeds

Speed data was collected at all the eight sites along the study location (refer to Figure 2). Four sites were located within the 90 km/h speed limit zone (two in each bound) and the other four sites were located before and after the 90 km/h zone. Table 1 and Table 2 show the speed characteristics for the study sites for each direction.

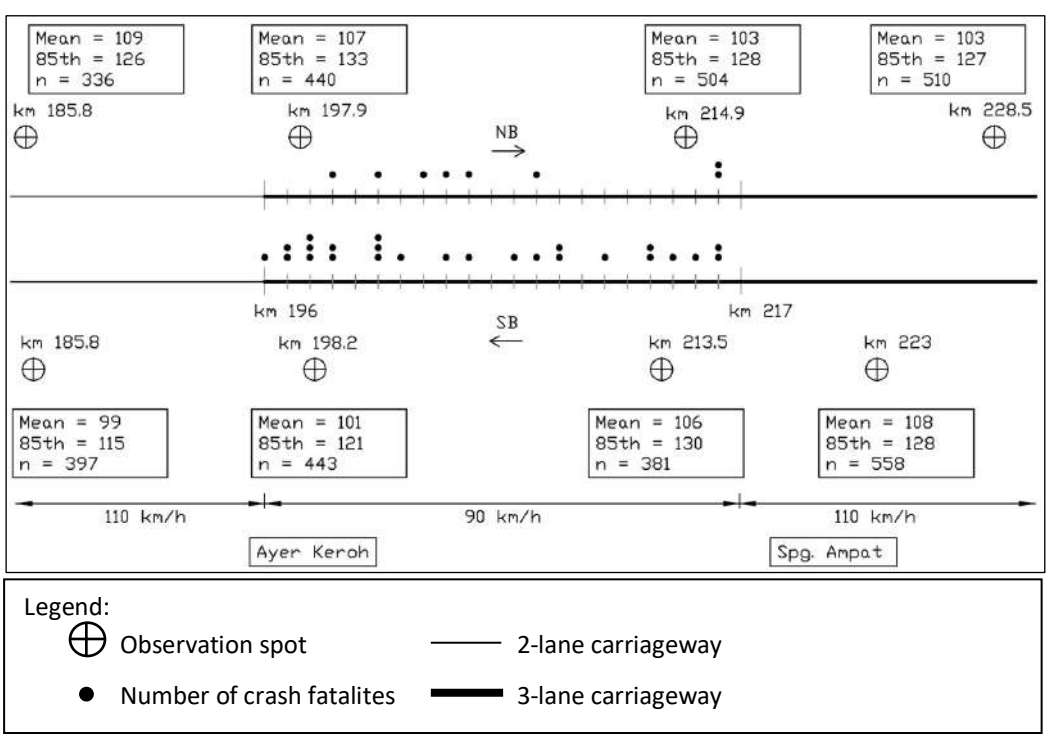

Figure 2 Strip map of study location

Table 1 Speed characteristics at study sites (southbound)

Site	KM223	KM213.5	KM198.2	KM185.8
Speed limit	110	90	90	110
Number of lanes	3	3	3	2
15th percentile speed (km/h)	87	84	82	81
Mean speed (km/h)	108	106	101	99
85th percentile speed (km/h)	128	130	121	115
Percent travelling above speed limit	40	70	67	20

Table 2 Speed characteristics at study sites (northbound)

Site	KM185.8	KM197.9	KM214.9	KM228.5
Speed limit	110	90	90	110
Number of lanes	2	3	3	3
15th percentile speed (km/h)	88	84	80	80
Mean speed (km/h)	109	108	103	103
85th percentile speed (km/h)	126	133	128	127
Percent travelling above speed limit	43	74	79	32

Analysis revealed that the mean speeds at KM223 and KM213.5 southbound do not differ significantly at the 95% confidence level, which implies that the speed limits did not influence the speed choice of the road users travelling between these sites. The 85th percentile speed indeed increase at KM213.5 southbound, indicating that most of the road users preferred to maintain their speed within this section although the speed limit was reduced by 20 km/h.

Similarly there was no significant change in the mean speeds at KM198.2 and KM185.8 although the 85th percentile speed decreased by 6 km/h. Despite a higher speed limit, a reduction in the operating speed might be due to reduction in the number of lanes. Nevertheless, the operating speed was still recorded above the speed limit (20% of the road users were observed to travel above the speed limit).

The mean speeds for northbound traffic were also found to be consistent (no significant change), and were recorded to be above 90 km/h. The 85th percentile speeds at sites with three lanes were slightly higher as in the case for the southbound traffic. Again this indicates that the driving behaviour is not influenced by the lower speed limit.

Table 3 shows the summary of the speed characteristics by speed limit zones. The analysis showed that the mean speeds on both zones were above 90 km/h for both directions. Statistical tests revealed the mean speeds on both zones for southbound direction do not differ significantly at the 95% confidence level.

In order to ascertain if the desired speeds of the majority of drivers in the two zones vary to an extent that safety might be jeopardized, the 85th percentile speed is used. The results showed that the differences of the 85th percentile speeds between the two zones are less than 10 km/h for both directions. This indicates that the road design of both zones allows drivers to travel at a relatively consistent speed. In other words, large speed differential does not exist between the zones.

Further analysis showed that the percentages of vehicles travelling above the speed limit in the 90 km/h zone are approximately twice the figure for the 110 km/h zone. This somehow indicates that most (about two thirds) of the road users feel comfortable travelling above 90 km/h under the existing road environment in which the road geometrics were designed based on a design speed of 120 km/h. In addition, the 15th percentile speed which indicates the measure of slow driving was found to be above 80 km/h. Therefore the 90 km/h speed limit in this context does not seem to be of relevance to the road users.

The coefficient of variation which measures the relative dispersion between vehicles was determined as the ratio of the standard deviation to the mean speed (Mussa 2005)[4]. The results showed that the differences of coefficient of variations between both zones for each direction were small. It further strengthens the indication that the dispersion

[4] R. Mussa. (2005). 60 kph minimum speed limit on rural interstate freeways: Is it relevant? Safety and Security Engineering, vol 82.

of vehicle speeds between both zones is relatively small, which provides evidence that sufficient uniformity of traffic flow exists in these sections.

Table 3 Overall speed characteristics at study sites

	Southbound		Northbound	
Speed limit zone	**90**	**110**	**90**	**110**
15th percentile speed (km/h)	83	84	81	83
Mean speed (km/h)	103	104	105	105
85th percentile speed (km/h)	125	123	130	126
Standard deviation (km/h)	22	21	24	22
Coefficient of variation	0.214	0.202	0.229	0.210
Percent travelling above speed limit	68	32	69	36

5.2 Analysis of Accident Data

Accident data for the year 2009 to September 2012 was obtained from PLUS for sections between KM176 and KM237. Detailed data showing the time and exact accident locations were only provided for KM196 to KM216, in which the 90 km/h speed limit zone is posted. Figure 3 and Figure 4 show the distribution of fatal crashes between KM196 and KM216. For the northbound carriageway, the highest recorded count was two which occurred at section 216. While on the southbound carriageway, section 198 and 201 recorded three fatal crashes which are the highest in this section. There was also a higher number of crashes occurring on the southbound carriageway (25) compared to eight crashes on the northbound carriageway.

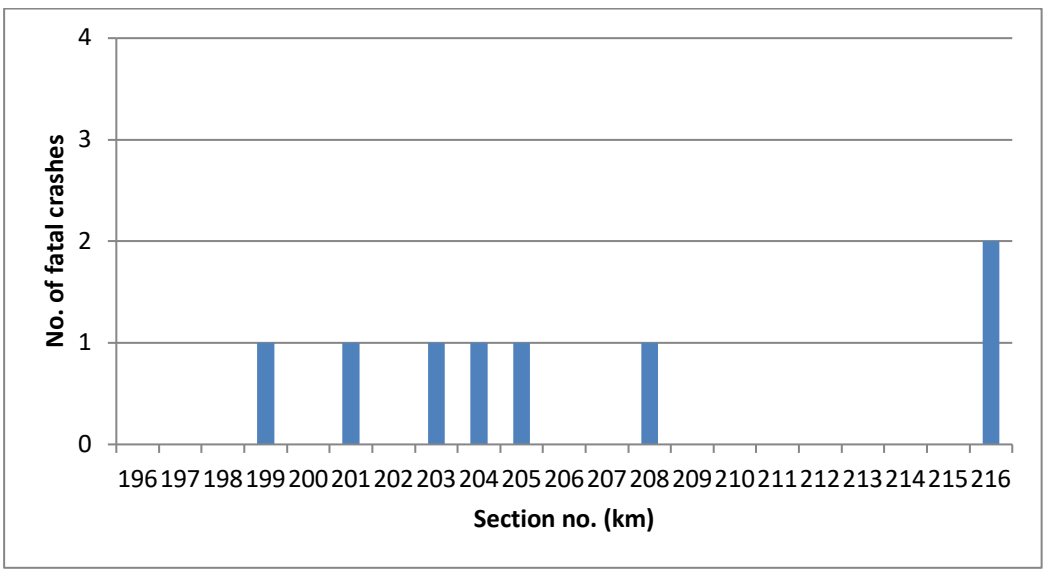

Figure 3 Number of fatal crashes from 2009 to 2012 (northbound)

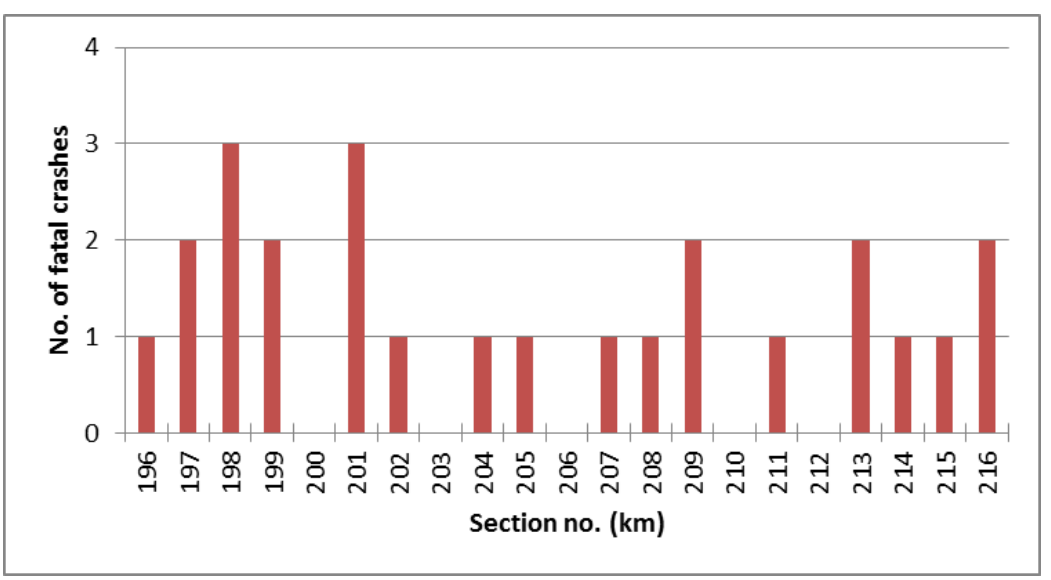

Figure 4 Number of fatal crashes from 2009 to 2012 (southbound)

Figure 5 and Figure 6 shows the number of all types of crashes occurring in the 90 km/h zone. For the northbound carriageway, the highest number occurred at section 216 with 27 crashes. While on the southbound carriageway, the highest number occurred at section 212 with 55 crashes.

The southbound carriageway recorded more number of crashes (461) compared to northbound carriageway with 294 cases.

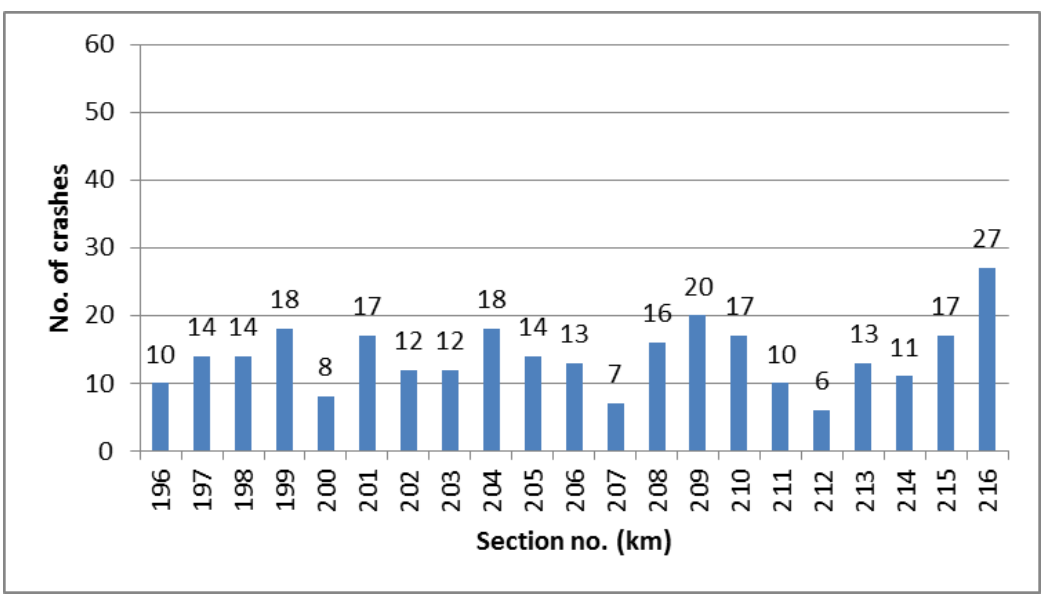

Figure 5 Number of all types of crashes from 2009 to 2012 (northbound)

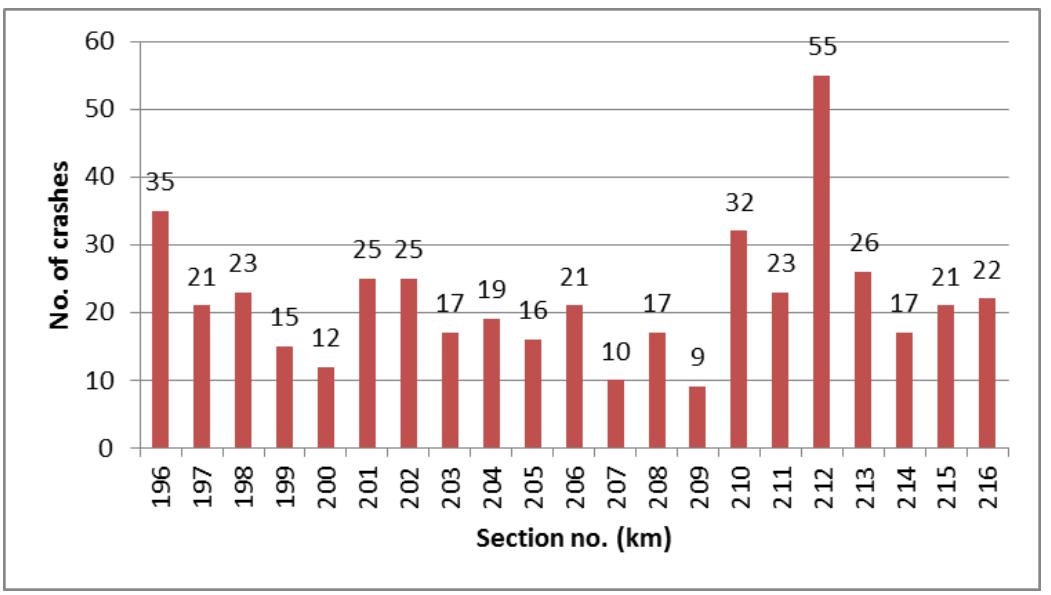

Figure 6 Number of all types of crashes from 2009 to 2012 (southbound)

Figure 7 and Figure 8 show the distribution of fatal crashes within a 24-hour period. On the section of southbound traffic, the highest number of fatal crashes occurred during the period 5:00 p.m. to 5:59 p.m. with four cases. No fatal crash was recorded during the period of 0:00 (midnight) to 0:59 a.m., 10:00 a.m. to 12:59 p.m., 2:00 p.m. to 2:59 p.m. and 10:00 p.m. to 10:59 p.m.

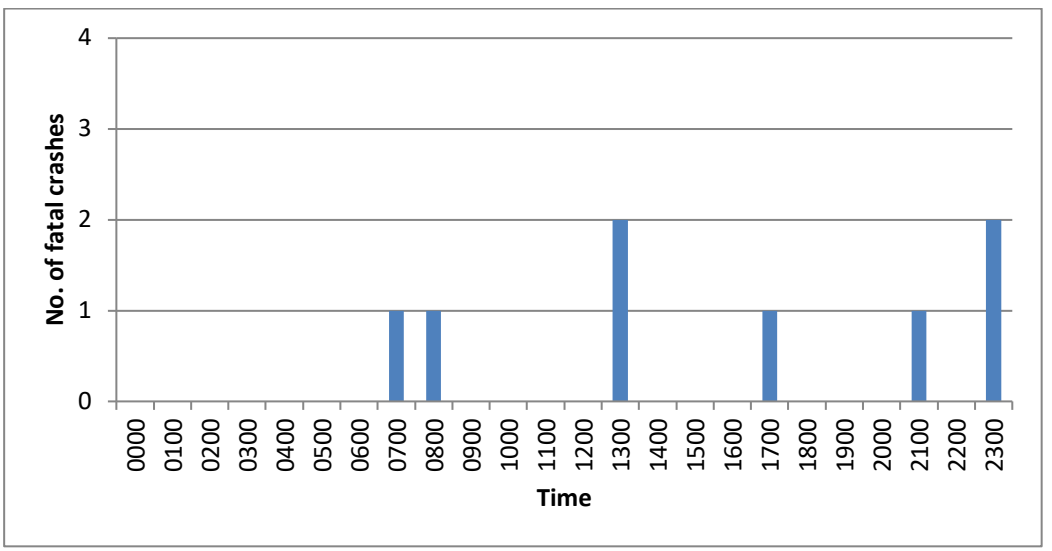

Figure 7 Number of fatal crashes by time (northbound)

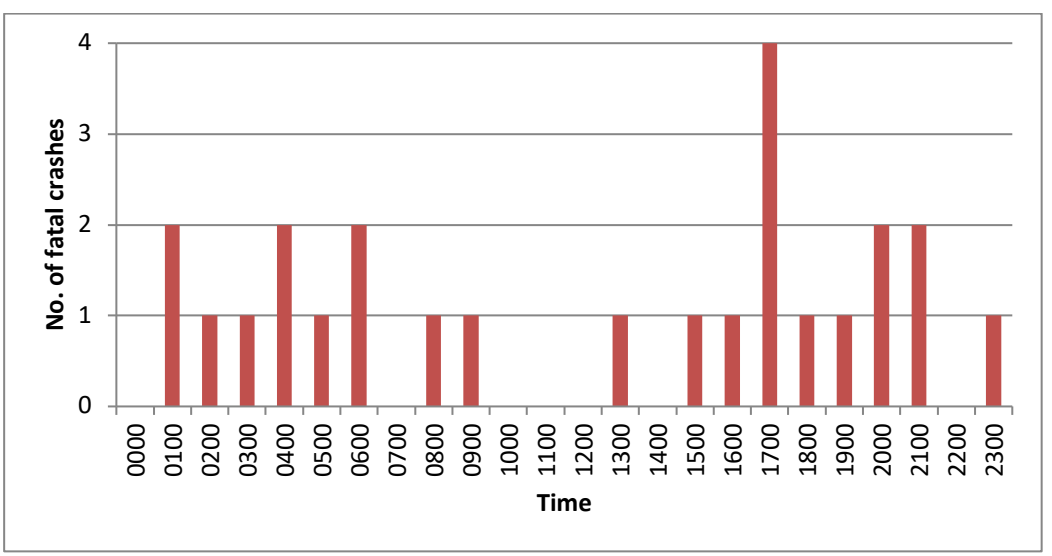

Figure 8 Number of fatal crashes by time (southbound)

Table 4 shows the number of all crashes occurring from KM176 to KM196 (Area 1), KM196 to KM216 (Area 2) and KM216 to KM237 (Area 3) for both directions. Area 3 recorded the highest occurrence of crashes while the lowest number of crashes was recorded in Area 1. A similar pattern is also observed for the number of fatal crashes. Comparison of these figures is illustrated in Figure 9.

Table 4 Number of all crashes by area for year 2009 to September 2012

Year	Area*	Accident severity				Total crashes
		Fatal	Serious	Slight	Damaged only	
2009	1	6	16	24	80	126
	2	7	37	27	131	202
	3	9	36	35	171	251
2010	1	3	19	21	99	142
	2	12	34	43	126	215
	3	14	37	42	143	236
2011	1	6	28	25	90	149
	2	7	35	41	129	212
	3	6	31	22	139	198
2012	1	5	17	22	51	95
	2	7	22	22	75	126
	3	8	31	29	91	159

**** Legend:*** *Area 1: KM176 – KM196; Area 2: KM196 – KM216; Area 3: KM217 – KM237*

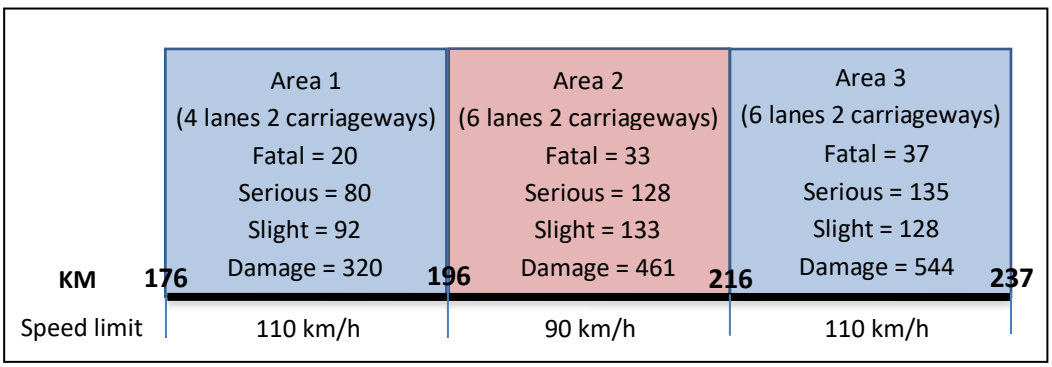

Figure 9 Comparison of number of all crashes by area

6. Conclusions

Analysis of vehicle speeds revealed no significant difference between the mean speeds in the 90 km/h and 110 km/h zones. The 85th percentile speeds in the 90 km/h zone for both directions were recorded to be slightly higher but the differences were less than 5 km/h. Further analysis found that the speed variance between both zones for both directions were less than 2%. These provide an indication that uniformity of traffic flow exists between both zones.

There is also no conclusive evidence that shows the effect of the posted speed limit on speed behaviour. It is because the mean speed and 85th percentile were found to be of no significant difference between the 90 km/h and 110 km/h zones. In other words, the 90 km/h posted speed limit did not influence the driving behaviour of the road user within this section. Hence, the road users do not comply with the 90 km/h speed limit.

Analysis of crash comparison between the 90 km/h zone and 110 km/h zone on the six lanes two carriageways from the year 2009 to September 2012 shows that the difference in the number of fatal crashes is minimal. Chi-square test revealed that the difference is not significant. This may be due to several factors and not due to vehicle speed factor alone.

The speed limit may be increased on the condition that the road geometric was designed to accommodate the particular new increased speed. This should be confirmed by the relevant parties. The parties responsible should ensure no occurrence of cross winds at the said location.

For a 60-km stretch the total fatal accident rate sums up to 90, thus with a minimum of 90 deaths in four years. In the event the speed limit is to be increased, the crash rate

should be monitored to track the safety performance at this section. More effort should be put into to further reduce the current crash rate along the expressway network.

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