

**TRAFFIC CALMING DEVICES: APPLICATIONS AND ITS
EFFECTIVENESS**

FRANKIE ANAK NAIL

This project is submitted in partial fulfillment of the requirements for degree of
Bachelor of Engineering with Honours
(Civil Engineering)

Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK
2006

ACKNOWLEDGEMENT

First of all, I would like to thank to my supervisor, Mr. Mohd. Raduan Bin Kabit for his his guides and help in making this project report. Without him, I don't think I am able to complete this report properly.

Also, I would like to express my sincere gratitude to Ir. Law Ted Min and Mr. Mohd. Fahmi, an Engineers of Council of the City of Kuching South for their very kind assistance in providing me with relevant materials related to this project.

Lastly, I would like to thank to especially Didin Jirat and all my friends who helped me a lot in the data collection and advice in the making of this project.

Demo (Visit <http://www.pdfspublisher.com>)

ABSTRACT

Speeding problem in some area especially where there are high pedestrian flows mainly school children's and elderly people has becomes a major concern to the public. Many accidents reported which involves pedestrians at such area were caused by excessive speeding vehicles. To mitigate the situations, installation of traffic calming devices were implemented by the local government. Thus, the aims of this study were to find out the effectiveness of various type traffic calming devices installed at the roadway. Also, this research will gather all the relevant information on the standard design material used for the traffic calming devices. The sites were chosen for each type of traffic calming devices implementation is yellow rumble strips at Tabuan Jaya, speed hump at Jalan song and speed table at Jalan Padungan. Spot speed studies were carried out at the selected sites to obtain the required data. Then, the normal and cumulative distribution curves were plotted based on the traffic data obtained. Further analyses by employing SPSS were carried out to find the relationship and the effectiveness of the devices. From the studies, it has found that yellow rumble strip at Jalan Tabuan Jaya to Samarahan reduce the average speed by 7.5 kph or 10.7%, the speed bump at Lorong Song 3 to BDC reduce the average speed by 6.8 kph or 14.1% and speed tables at Jalan Padungan reduce the average speed by 4.8 kph or 14.6%. From correlation analysis conducted, the entry speeds decreases very significantly as the width of traffic calming devices increases ($R^2 = 1.0$). The effect of the height of the devices also highly significant at reducing the vehicle entry speed ($R^2 = 0.9217$). Potential recommendation for a better way or guidelines for traffic calming devices installation is also addressed or presented in this report.

ABSTRAK

Isu memandu dengan laju di sesetengah lokasi terutamanya di jalan yang mempunyai bilangan pejalan kaki yang tinggi iaitu pelajar sekolah dan orang tua telah menarik perhatian orang ramai. Banyak laporan kemalangan melibatkan pejalan kaki disebabkan oleh memandu dengan laju. Bagi mengatasi masalah ini, alat-alat fizikal kawalan lalulintas telah dibina oleh pihak kerajaan tempatan. Tujuan projek ini adalah untuk mengkaji keberkesanan pelaksanaan alat-alat fizikal kawalan lalulintas. Di samping itu, projek ini juga termasuk rekabentuk standard and bahan-bahan yang digunakan untuk membuat alat kawalan lalulintas fizikal. Lokasi yang dipilih untuk kajian keberkesanan alat-alat kawalan ini iaitu Jalan Tabuan Jaya (Yellow Rumble Strip), Jalan Song (Speed Hump) dan Jalan Padungan (Speed Table). Ujian kelajuan atau “ Spot Speed Studies ” telah dijalankan di ketiga-tiga lokasi berkenaan. Selepas itu, “ Normal Distribution Curve” dan “ Cummulative Distribution Curve” dibentuk. Analysis menggunakan Microsoft Excell dan SPSS telah dilakukan untuk mengkaji keberkesanan alat kawalan lalulintas fizikal tersebut. Kajian mendapati “yellow rumble strip” di Jalan Tabuan Jaya mengurangkan “ 85th percentile speed ” kenderaan 7.5 kph atau 10.6%, “speed hump” di Jalan Song pula mengurangkan “ 85th percentile speed ” kenderaan dengan 6.8 kph atau 14.1% dan “speed table” di Jalan Padungan mengurangkan “ 85th percentile speed ” dengan 4.8 kph atau 14.6%. Melalui analysis korrelasi, kelajuan masuk berkurangan apabila lebar alat-alat kawalan fizikal bertambah ($R^2 = 1.0$). Ketinggian alat-alat kawalan fizikal ini juga memberi kesan ke atas kelajuan masuk kenderaan ($R^2 = 0.9217$). Projek ini turut merangkumi cadangan yang lebih baik sebagai panduan untuk pembinaan alat kawalan tersebut.

TABLE OF CONTENT

CONTENT	PAGE
TITLE PAGE	i
ACKNOWLEDGEMENT	ii
ABSTRACT	iii
TABLE OF CONTENT	v
LIST OF TABLES	ix
LIST OF FIGURES	xii
LIST OF SYMBOL	xiv

CHAPTER I INTRODUCTION

1.1	Background and Overviews	1
1.2	Problem Statement	3
1.3	Objectives	5
1.4	Scope of Studies	6
1.5	Limitation	6

CHAPTER 2 LITERATURE REVIEW

2.1	History of Traffic Calming Devices	7
2.2	Traffic Calming	8
2.3	Traffic Calming Devices	9

2.3.1	Vertical Deflection	10
2.3.2	Horizontal Deflection	17
2.3.3	Horizontal Narrowing	19
2.4	The design of traffic calming devices	21
2.4.1	Transverse Lines	21
2.4.2	Speed Hump	24
2.4.3	Speed Table	26
2.5	The Effectiveness	27

CHAPTER 3 METHODOLOGY

3.1	Site Selection	29
3.2	Study site	30
3.3	Data Collection	
3.3.1	Spot Speed Studies	36
3.3.2	Method of Counting	38
3.3.3	Sample sized requirement	40
3.3.4	Traffic Measurement Devices	44
3.3.5	Procedures of Conducting Spot Speed Studies	45
3.3	Data analysis	48

CHAPTER 4 FINDING AND DISCUSSION

4.0	Spot Speed Data Analysis	50
4.1	Analysis of Yellow Rumble Strip at Jalan Tabuan Jaya	51
4.1.1	Data of Target Radar Gun: 45 m before the Yellow Rumble Strip	51
4.1.2	Data of Target Radar Gun at Yellow Rumble Strip	53
4.1.3	Overall Analysis of Yellow Rumble Strip	55
4.2	Analysis of Speed Bump at Lrg Song 3	
4.2.1	Target of Radar Gun: 45 m Before the Speed Hump	57
4.2.2	Data of Target of Radar Gun 15 m before the Speed Hump	59
4.2.3	Overall Analysis of Speed Hump	61
4.3	Analysis of Speed Table at Jalan Padungan	
4.3.1	Target of Radar Gun: 45 m Before the Speed Tables	63
4.3.2	Target of Radar Gun: 15 m Before the Speed Tables	65
4.3.3	Overall Analysis of Speed Table	67
4.4	Regression Analysis for Relationship between Observed Speed and Distance	69
4.4.1	Analysis for Yellow Rumble Strip with SPSS	69
4.4.2	Analysis for Speed Hump with SPSS	72
4.4.3	Analysis for Speed Table with SPSS	75
4.5	Relationship between Entry Speed and Dimension	78

4.5.1	Relationship Between 85 th percentile speed and Height of Devices	79
4.5.2	Relationship Between 85 th percentile Speed and width Of Devices	80
4.6	The Effectiveness of Traffic calming Devices	
4.6.1	The Effectiveness of Yellow Rumble Strip	82
4.6.2	The Effectiveness of Speed Hump	82
4.6.3	The Effectiveness of Speed Table	83
4.6.4	Relationship between Observed speed and Distance and between 85 th percentile speed and Height and Width	84
4.7	Guidelines on Installation of Traffic Calming Devices	84
4.8	Warrants for Installation of Traffic Calming Devices	87
5.6	Recommendation	90

CHAPTER 5 SUMMARY AND CONCLUSION

5.1	Summary	91
5.2	Recommendation for Further Traffic Studies	93

REFERENCES	94
-------------------	----

APPENDIXES

APPENDIX A SPOT SPEED DATA

97

APPENDIX B PHOTO

110

Demo (Visit <http://www.pdfsplitmerger.com>)

LIST OF TABLES

Table		Pages
1.1	Accident Rate at Jalan Song to BDC	1
1.2	Accident rate at Samarahan, Tabuan Jaya and 7 mile road	2
2.1	Detail Distance of Transverse Bars at Cross Walk	22
2.2	Speed Impacts of Traffic Calming Measures	27
3.1	Standard deviation of Spot-Speeds for Sample Size Determination	40
3.2	Constant Corresponding Level of Confidence	41
3.3	Constant Corresponding to Percentile Speed	41
3.4	Minimum Sample Size Determination	42
3.5	Summarized on Sample Size	43
3.6	Frequency Distribution Tables	47
4.1	Frequency Distribution Table For Traffic Volumes at 40m Before the Yellow Rumble Strip	51

4.2	Frequency Distribution Table for Traffic Volumes at the Yellow Rumble Strip	53
4.3	Summarized of Speed at Yellow Rumble Strip	55
4.4	Frequency Distribution Table for Traffic Volumes at 45 before the Speed Hump	57
4.5	Frequency Distribution Table for Traffic Volumes 10m before the speed humps.	59
4.6	Summarized of Speed at Speed Hump	61
4.7	Frequency Distribution Table for Traffic Volumes 15m before the speed table.	63
4.8	Frequency Distribution Table for Traffic Volumes 15m before the speed table.	65
4.9	Summarized on speed at Speed Table	67
4.10	Descriptive Statistics	69
4.11	Variables Entered/Removed	69
4.12	Model Summary	69
4.13	ANOVA	70
4.14	Coefficients	70
4.15	Descriptive Statistics	72
4.16	Variables Entered/Removed	72
4.17	Model Summary	72

4.18	ANOVA	73
4.19	Coefficients	73
4.20	Descriptive Statistics	75
4.21	Variables Entered/Removed	75
4.22	Model Summary	75
4.23	ANOVA	76
4.24	Coefficients	76
4.25	Table of Linear Fit of Different Entry Speed 15 m before the devices	78
4.26	Descriptive Statistics	79
4.27	Correlations	79
4.28	Descriptive Statistics	80
4.29	Correlations	80
5.1	General Warrants	87

Demo (Visit <http://www.pdfsplitmerger.com>)

LIST OF FIGURES

Figures		Pages
2.1	Photo of Transverse Bar (Yellow Rumble Strip)	11
2.2	Schematic of Speed Humps	12
2.3	Photo of Speed Hump at UNIMAS	12
2.4	Schematic of Speed Table	14
2.5	Photos of Speed Table at UNIMAS	15
2.6	Diagram of Raised Crosswalk	16
2.7	Photos of Raised Crosswalk at UNIMAS	16
2.8	Schematic of Traffic Circle	17
2.9	Photo of Traffic Circle at Samarahan	18
2.10	Photo of Roundabout	19
2.11	Photo of Neckdowns	20
2.12	Transverse Bars at Cross Walk	21
2.13	Detail A for Transverse Bar	22
2.14	Transverse Bars (Speed Breaker)	23
2.15	Transverse Bars (Section A-A)	23
2.16	Round-top Speed Hump	24
2.17	Flat -Top Speed Hump	24
2.18	Sinusoidal Speed Hump	25
2.19	Intersection Layout	26

2.20	Section A-A	26
3.1	Kuching Map	30
3.2	Site Map of Yellow Rumble Strip at Jalan Tabuan to Samarahan	31
3.3	Yellow Rumble Strip at Jalan Tabuan Jaya To Samarahan	32
3.4	Site Map of Speed Hump at Jln Song 3 to BDC	33
3.5	Photo of Speed Hump at Jalan Song 3 to BDC	33
3.6	Speed Tables at Jalan Padungan	34
3.7	Photo of Speed Table at Jalan Padungan	35
3.8	Angle of Incident	39
3.9	Radar Meter	45
3.10	Position of speed radar meter.	46
3.11	Frequency Distribution Curves	48
3.12	Cumulative Frequency Distribution Curves	48
4.1	Normal Distribution Curve for Traffic Volume at 45 m before Yellow Rumble Strip	52
4.2	Cumulative Distribution Curve for Traffic Volume at 45 m before Yellow Rumble Strip	52
4.3	Normal Distribution Curve for Traffic Volume at Yellow Rumble Strip	54
4.4	Cumulative Distribution Curve for Traffic Volume at Yellow Rumble Strip	54
4.5	Changes in speed at Yellow Rumble Strip	56
4.6	Normal Distribution Curve for Traffic Volume 45m before the speed hump	58
4.7	Cumulative Distribution Curve for Traffic Volume 45m before the speed hump	58
4.8	Distribution Curve for Traffic Volume 10m before the speed hump	60

4.9	Cumulative Distribution Curve for Traffic Volume 10m Before the speed hump	60
4.10	Changes in speed at Speed Hump	62
4.11	Distribution Curve for Traffic Volume 45m before the speed table	64
4.12	Cumulative Distribution Curve for Traffic Volume 45m before the speed table	64
4.13	Distribution Curve for Traffic Volume 15m before the speed table	66
4.14	Cumulative Distribution Curve for Traffic Volume 15m before the speed table	66
4.15	Changes in speed at Speed Table	68
4.16	Normal Probability Plot for Yellow Rumble Strip	71
4.17	Normal Plot of observed speed on Speed Hump	74
4.18	Normal Plot of observed speed on Speed Hump	77
4.19	Flow chart On Implementations of Traffic Calming Devices(Current Practice by MBKS)	88
4.20	Flow Chart on Recommendation on Installation of Traffic Calming Devices	89
4.21	Recommendation on combination of removal speed hump with yellow rumble strip	90

LIST OF SYMBOLS

B	Width of physical traffic calming devices
d	Hump separation in meter
E	Permitted error
H	Height of physical traffic calming devices
K	Constant corresponding to percentile speed
N	Sample size
S	Estimated sample standard deviation
U	Constant corresponding
V	Speed vehicles
a	Angle of incident
C	Constant
α	Coefficient

Demo (Visit <http://www.pdfsplitmerger.com>)

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND AND OVERVIEWS

Speeding issues have become the major concern in certain area such as neighbourhood area, school zones and commercial area. The high speeding can cause the negative impact such as increasing of accident rate, noise pollution and air pollution. Traffic studies found that as residential street traffic speeds increase, neighborhood livability ratings decline (DKS Associates, 2002). This speeding also creates a danger environment to the pedestrians and the residents especially the children. Besides that, the loud noise from the speeding especially in the middle of night has interrupted the people life. The qualities of people life have been eroded by the high speeding and this lead to their angrier.

The implementation of traffic calming devices is one of the solutions of speeding issue. The traffic calming devices such as speed bump, speed table and yellow rumble strip and it effective in reducing the vehicles speed. By slowing traffic, eliminating conflicting movements, and sharpening drivers' attention, traffic calming

may result in fewer collisions (City of Portland, OR, February 1996). The reductions of speed are hopefully can reduce the accident rate. Fatality risk increases with vehicle speed to the fourth power; a 1% reduction in the speed of a vehicle involved in a collision provides a 2% reduction in the risk of injuries and a 4% reduction in the risk of fatalities (Stuster and Coffman, 1998). The severity of pedestrian injuries from vehicle crashes increase with the square of speed (ITE, 1997, p. 18). The probability of a pedestrian being killed in a crash is 3.5% if the vehicle is traveling at 15 mph, 37% at 31 mph and 83% at 44 mph (Limpert, 1994, p. 663).

According to Institute of Transportation Engineers, the speed bump is the most effective in reducing the speed with average 23 % decreased in the 85th percentile travel speed, while speed table are with average 18% decreased. The 12-foot speed humps decrease the accident with average 11% or from an average of 2.7 to 2.4 accidents per year .The 14-foot speed humps decrease the accident in average 41% or from an average of 4.4 to 2.6 accidents per year. The speed table and raised crosswalk are with average 45% decrease in accident or from an average of 6.7 to 3.7 accidents per year. The study from Seattle of traffic circle shows an average of 73% decrease in accident from a sample of 130 sites. The effectiveness of roundabout is with an average 29% reduction in accidents, reduction from 9.3 to 5.9 accidents per year (from a sample of 11 sites; source: Roundabouts: An Informational Guide).

1.2 PROBLEM STATEMENT

Speeding at neighborhood area has become a driver attitude especially the motorcycle. The motorcycles always speeding and produce and air noise pollution on this area. These trends have drawn the residential attention on their safety and they feel it have disturbing their life. The speeding also create a danger to the pedestrian and children safety. Beside that, the speeding problems also occur at others area such as school zone and commercial zones.

Table 1.1: Accident Rate at Jalan Song to BDC

	2004	Until Aug 2005
Normal	28	22
Killed	0	0
Total	28	22

(Sources: Police report, Kuching Traffic Police Headquarte, 2005, Kuching.)

Table 1 shows information on traffic accidents at Jalan Song and BDC in 2005. The accident statistics are base on measured the number and severity of accidents case reported. From the statistics it can be seen that Jalan Song to BDC has a considerable number of accidents reported. The total accidents at Jalan Song in 2004 were 28 cases and 22 cases from January until August 2005. There are some factors leads to accidents such as excessive speeding, poor road or vehicles condition

and poor geometric road design. Often, the human mistakes are the typical causes of accident especially when they are driving at exceeding the posted speed limit.

Table 1.2: Accident Rate

	2001	2002	2003	2004
Normal	97	111	171	138
Light	27	32	31	99
Fatal	29	16	27	17
Killed	12	12	4	10
total	165	171	233	264

(Sources: Police Report, Samarahan Police Headquarters, 2005, Samarahan)

From the statistics above, the accident rate at Samarahan area increase year by year. There are 165 cases reported in 2001, 171 cases in 2002, 233 cases in 2003 and 264 in 2004. The increasing numbers of accident are most probably caused by speeding. To reduce the number of accident rate, the high speeding problem need to be addressed.

The location of high accident rate at Samarahan is;

1. Batu 9, Jln Kuching Serian
2. Jalan Datuk Mohd Musa, Kota Samarahan
3. Jalan Kota Samarahan/Tabuan Jaya.

When the location of accident problem has been identified, the remedial action must be taken to reduce it. Accident problems due to high speeding had caused the government especially the city council to implement or install traffic calming devices on the roadway. The speed humps, speed table and yellow rumble strip are the most popular traffic calming devices applied in Sarawak road. According to Institute of Transportation Engineers (1999), the speed bumps and speed table work effectively in reducing the speed. The installations of these devices are suitable for local street and arterial road only not for major road.

1.3 OBJECTIVES

The objectives of the project are as follow;

- a) To determine various applications and construction materials of traffic calming devices
- b) To analyze and evaluate the effectiveness of traffic calming devices.

1.4 SCOPE OF STUDIES

With the aims mentioned, the followings are the scope of the project;

- a) The scope of this project includes the identification of the application and its construction material of traffic calming devices.

The study will cover the most widely traffic calming devices applied in Sarawak road (yellow rumble strip, speed hump and speed table).

The descriptions of traffic calming devices and their geometric design consideration / standard will be discussed.

- b) The scope of the project also covers the determination of effectiveness of traffic calming devices.

From the spot speed studies data, analysis shall then be conducted to find out the influences of traffic calming devices in reducing speed.

1.5 LIMITATION

The studies have some limitations. Due to time constraint, only one site has chosen for the most each traffic calming devices used. The equipment used in spot speed study also has it limited ability. It can only measure speed above 20 km/hr.

CHAPTER 2

LITERATURE REVIEW

2.1 History of traffic calming devices

The applications of traffic calming devices begin in late 1960's. Traffic calming devices started in Netherlands when their life disturbed by motorist speeding in residential area at night. They took up the paving stones in a road to make sure the motorist cannot speed up. Then, the Officials allowed the redesigned of paving stones and it led to the first traffic calming project. In 1970's, German planner adopted this concept and apply it in their country. Then, the traffic calming devices were widely used and accepted by many countries. Traffic calming then spread quickly at Europe and to others country such as Denmark, New Zealand, Great Britain, United Stated and Japan.

2.2 Traffic Calming

Traffic calming is fundamentally aims to reduce the adverse impact of motor vehicles on built up areas. It involves in reducing vehicle speeds, providing more space for pedestrians and improving the local environment. Although much information is now available on techniques for calming residential roads, there is less documentation available on measures suitable for main roads (T. Harvey, HETS, 2000).

Traffic calming is a set of traffic engineering measures and devices that used to solve traffic problem. Traffic calming consist of operational measures such as enhanced police enforcement, speed displays and a community speed watch program, as well as such physical measures as edge lines, chokers, chicanes, traffic circles, speed humps and raised crosswalks (Montgomery County Maryland) .According to Roess (2204), the specific goals of traffic calming are to;

- Reduces traffic volumes on local streets through the used of volumes control measures such as Full Closure, Half Closure, Diagonal Diverter and Median Barrier.
- Reduces traffic speed on local streets by speed control measures such as Speed Bumps, Speed Table, Traffic Circles and Yellow Rumble Strip.
- Reduces accidents on local streets by implementation the speed reduction devices.