THE EFFECTIVENESS OF ROAD CALMING DEVICES IN REDUCING VEHICLE SPEED

NIK SITI AISHAH BINTI NIK LI

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Faculty of Civil Engineering
UNIVERSITI MALAYSIA PAHANG

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ABSTRACT

This paper presents the assessment of effectiveness of traffic calming devices in reducing vehicle speed and in the same time to know the delay time when vehicle passing the traffic calming devices. Road accidents pose as a major health and social problem in this country and factors leads to accidents such as excessive speeding among the drivers. Therefore, the implementation of the traffic calming is widely used in improve road safety and to avoid negative effect. The site were chosen for each type of traffic calming devices implementation is speed hump at Jalan Perkampungan Permatang Badak and speed hump combination at Jalan Perkampungan Sungai Isap. Speeds and delay time of vehicle were collected at the selected sites to obtain the required data. Then, the data will be presented in the graph form with using Microsoft Excel 2010 and for statistical analysis to support the result using the same software. From the studies, it has found that the percentage reduction in the speed for the combination of speed hump is 55.8% and for speed hump was reduced to 49.6%. Delay time for speed hump is 5.84 seconds then followed by combination of speed hump is 6.49 seconds. This result is also proved by statistical test that shows the mean of speed reduction and delay for those two traffic calming devices are different from each other.

ABSTRAK

Laporan ini menunjukkan tentang keberkesanan pereda lalu lintas dalam mengurangkan laju kenderaan dan dalam masa yang sama untuk mengetahui masa lengah apabila kenderaan melalui pereda lalu lintas. Kemalangan jalan raya merupakan salah satu penyebab terbesar kepada kesihatan dan masalah sosial di negara ini dan faktor yang menyumbang kepada kemalangan adalah seperti memandu pada laju yang berlebihan di kalangan pemandu. Oleh itu, pelaksanaan pereda lalu lintas digunakan secara meluas dalam meningkatkan keselamatan jalan raya dan mengelakkan kesan negatif. Lokasi yang dipilih bagi setiap pereda lalu lintas adalah di Jalan Perkampungan Permatang Badak bagi bonggol dan kombinasi bonggol di Jalan Perkampungan Sungai Isap. Kelajuan dan masa lengah kenderaan dikumpul pada lokasi yang terpilih untuk mendapatkan data yang diperlukan. Kemudian, data akan dipersembahkan dalam bentuk graf dengan menggunakan Microsoft Excel 2010 dan analisis statistik untuk menyokong keputusan juga menggunakan perisian yang sama. Dari kajian, didapati bahawa peratus pengurangan dalam laju untuk kombinasi bonggol adalah 55.8% dan untuk bonggol pula berkurang kepada 49.6%. Masa lengah untuk bonggol adalah 5.84 saat diikuti oleh kombinasi bonggol adalah 6.49 saat. Hal ini juga dibuktikan melalui ujian statistik yang menunjukkan min pengurangan halaju dan masa lengah bagi kedua-dua jenis pereda lalu lintas adalah berbeza antara satu sama lain.

TABLE OF CONTENTS

CHAPTER 2 LITERATURE REVIEW

CHAPTER 3 METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Malaysia currently has modern road infrastructure and has the best road network in South East Asia. Even have the best roads, road accidents would still occur and this problem are increasing and become worst. Road accidents are currently ranked as the third principal causes of death at Malaysia (Department Of Statistic Malaysia, 2010). According to Marizwan (2009), road accidents pose as a major health and social problem in this country and there is an urgent need to implement known and effective intervention programs to reduce the number of accidents and the severity of the injuries sustained by accident victims.

Road accidents causes by many factor and situations. There are some factors leads to accidents such as excessive speeding, poor road or vehicles condition and poor geometric road design (Frankie, 2006). Among the causes to be seen as contributing to the increase in road accidents is driving speeds among drivers. This situation makes some argued that more roads are not safe for use.

Speeding issue has become a major concern in particular areas such as neighborhoods, school zones and commercial areas. High speeds can cause negative effects such as increased rate of accidents, material damage, operating cost, noise pollution and air pollution.

Based on statistic from Ministry of Transport Malaysia, 2010, total road accidents by state were increased every year. From figure 1.1, the highest accident was at Selangor that are 115565 total accidents on 2010. Johor is the second higher road accidents that are 55381 then followed by Wilayah Persekutuan is 53492 accidents. On year 2010, total accident by states for Pulau Pinang is 34306, Perak is 32072, Negeri Sembilan is 19407, Kedah is 17966 and Pahang is 17315. Total accidents for another stages is 17253 for Sarawak, 16192 for Sabah, 14110 for Melaka, 10106 for Terengganu, 9707 for Kelantan and the lowest accidents is 1548 at Perlis. From that chart, obviously the rate of accident in Malaysia is at serious level and government should take action to prevent this to be more critical. Therefore, the implementation of the traffic calming is widely used in improve road safety and to avoid negative effect. Traffic calming is a practice that has been implemented primarily in developed countries. The traffic calming devices in can reduce the vehicle speed and in the same time can avoid the vehicle crush, fatalities and injuries among the road users.

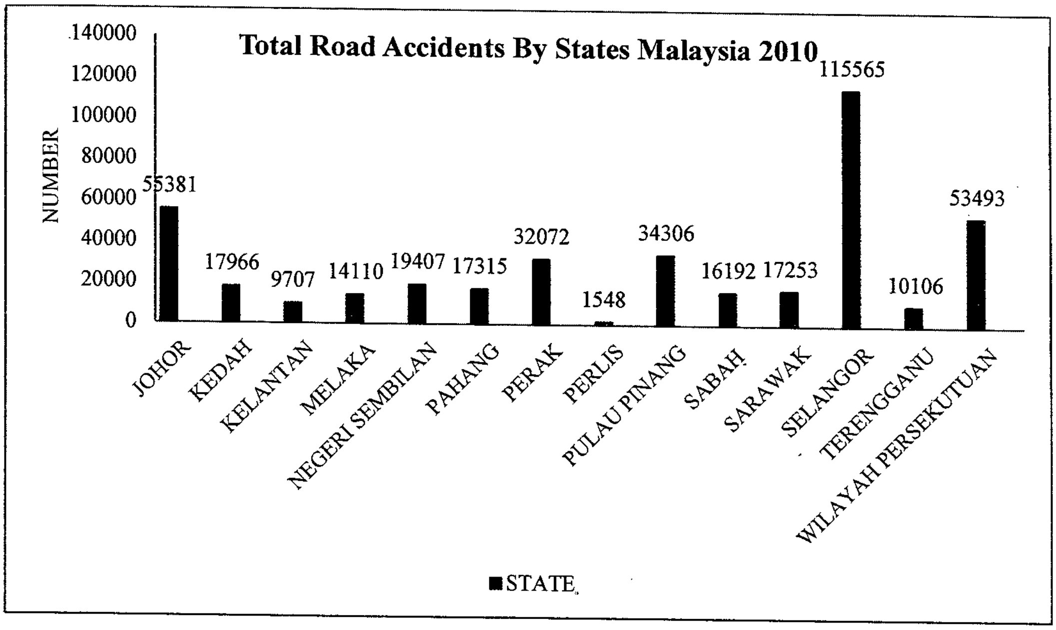


Figure 1.1: Total Road Accidents by States Malaysia, 2010
(Source: Royal Malaysian Police)

The implementation of traffic calming device such as yellow rumble strip, speed cushion, roundabout and speed hump are effective solution in reducing the vehicle speed and volumes, and sometimes, preventing particular types of vehicle travelling through an area. Traffic calming has been defined as 'the combination of mainly physical measures that reduce the negative effects of motor-vehicle use, alter driver behavior, and improve conditions for non-motorized street users, (Lockwood, 1997). Horizontal yellow rumble strips is one traffic control device used to preventing roadway departure crashes that might be caused by fatigue, drowsiness, and adverse weather conditions. The noise and vibration produced by rumble strips alert drivers when they leave the traveled way.

Another traffic calming devise is speed humps. The main purpose of the road speed hump is to ensure that vehicular speed is reduced to an acceptable level at a certain location along a road. The overall operating speed of the vehicle on that road will also be low enough for the vehicle to stop safely, thus avoiding a crash.

1.2 PROBLEM STATEMENT

Excessive speed is currently one of the primary contribution factors in traffic accidents around the world. High speeds can cause negative effects such as increased rate of accidents, material damage, operating cost, noise pollution and air pollution. Therefore, the implementation of the traffic calming is widely used in improve road safety and to avoid negative effect. So, this research is to study the effectiveness of traffic calming devices in reducing the vehicle speed and in the same time can avoid the vehicle crush, fatalities and injuries among the road users. Beside that, this study also to estimate delay time when vehicle passing the traffic calming devices.

1.3 OBJECTIVES

i) To determine the percentage of vehicle speed when passing the traffic calming devices.
ii) To estimate the delay time when vehicle passing the traffic calming devices.

1.4 SCOPE OF THE STUDY

The scope of this project is to determine the percentage of vehicle speed when passing the traffic calming devices and also to estimate the delay time when vehicle passing the traffic calming devices. From the speed data, analysis shall then be conducted to find out the influences of traffic calming devices in reducing speed. To achieve the objective, this study will cover the mostly widely traffic calming devices applied in Kuantan road where are combination of speed hump and speed hump only.

1.5 EXPECTED OUTCOME

The traffic calming devices are effective in reducing vehicle speed among drivers and know delay time of the vehicle when passing the traffic calming devices.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Traffic calming refers to a variety of physical measures intended to reduces the effect of vehicle and it is the most effective way to reduce speeding on residential streets, avoid traffic accidents and prevent fatalities. Institute of Transportation Engineers (ITE) in 1997 defines traffic calming as a combination of physical measures that reduce the negative effects of motor use, changes of driver behavior and improve conditions of road users who are do not use a motor vehicle (Lockwood, 1997). According to Litman (1999), Voctoria Transport Policy Institute defines traffic calming as some design features and strategies to reduce the speed and volume of vehicles on the road. Tim murphy (2003) states that traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use alter driver behavior and improve conditions for no motorized road users. Traffic calming can be installed as a retrofit improvement to an existing neighborhood or in newly constructed neighborhoods as a design feature.

2.2 HISTORY OF TRAFFIC CALMING DEVICES

Traffic calming already used effectively in Europe for decades, traffic calming is becoming more and more increasingly popular in Europe since 30 to 40 years ago. Traffic calming started in the Netherlands, late 1960s in an effort to change driver behavior in order to make the roads safe for children, pedestrians and cyclists. The Europeans was very disappointed with the attitude of drivers like overtaking and make the roads unsafe (Bunte, 2000). The first traffic calming solution, called Woonerven, it slowed traffic and lessened volume with the placement of tables, benches, sand boxes, and parking bays extending into the streets. Woonerven were endorsed by the government nearly a decade later in 1976. In the following years, the idea spread to other countries around the world such as Austria, Denmark, Germany, Israel, Sweden, and Switzerland. According to South Central Regional Council of Governments (2008), the traffic calming alternative involving humps and other physical measures was endorsed in 1983. Again other nations followed this lead to also achieve reduction in speeds and accidents and a better quality of life for their streets. In the United States, the use of street closures and traffic diverters dates back to the late 1940's early 1950's and the first area-wide traffic calming planning was conducted by Seattle, Washington in the early 1970's.

2.3 PREVIOUS STUDY ABOUT TRAFFIC CALMING DEVICES

By slowing speed are hopefully can reduce the accident rate. Stuster and Coffman (1998) state that 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 4% reduction in the risk of fatalities. Most previous studies have evaluated the effectiveness of transverse rumble strips in improving road safety and speed reduction. Pan Liu (2010) states that transverse rumble strip may reduce expected crash frequency at pedestrian crosswalks by 25% on rural roads in China. The road hump has the merit of producing the lowest operating speed of all traffic calming devices (Ewing,1999: Daniel,2011). Norsarwani (2010) writes that transverse bar gives least reduction on speed which is 6.57%, followed by hump about 68.94% and 69.63% for combination of hump and transverse bar. From that result it proved that traffic calming devices can reduce speed among vehicles drivers.

Institute of Transportation Engineers (1999) stated that the speed bump and speed table work effectively in reducing the speed. According to Jianhe Du, the installations of traffic calming devices are suitable for local street and arterial road only not for major road. With installing traffic-calming devices will effectively slow down traffic while making the community safe and livable. Barbosa (2000) stated that the effect of different types of traffic calming measures on speeds has shown differences by type of measure. The effectiveness of speed humps was investigated at12 streets in Salt Lake City, Utah and for the summary the 78% of the sites experienced a decrease in the mean speed, a decrease in the 85th percentile speed, or an increase in speed limit compliance (Wayne,2006). Results from US Department Researches indicate that Transverse rumble strips may be effective in reducing severe injury crashes at minor road stop-controlled intersections.

Worldwide studies also show an average of 18 % reduction in traffic volumes and an average of 13 % reduction in collisions along the stretch of the road where speed humps are installed appropriately (Sirim, 2009). Frankie (2006) 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 table at Jalan Padungan reduce the average speed by 4.8 kph or 14.6%. According to Tim murphy (2003), the overall objectives of implementation of traffic calming are to;

i. Achieving slower speeds for motor vehicles
ii. Reducing crash frequency and severity
iii. Increasing safety for non-motorized users of the road
iv. Reducing the need for police enforcement
v. Enhancing the road environment
vi. Increasing access to all modes of transportation,
vii. Reducing through motor vehicle traffic.

2.4 TYPES OF TRAFFIC CALMING DEVICES

The influence of traffic calming devices on the speed and delay time of vehicle has been conduct by using various combinations of traffic calming devices. The study was focusing on two traffic calming devices that cause a vertical deflection of the vehicle. Vertical shift in the roadway are the most effective and reliable for speed reduction. Types of traffic calming devices were used in this study are speed hump and combination of speed hump. Combination of speed hump consist 2 types of traffic calming devices that are speed hump and yellow rumble strip.

2.4.1 Speed Hump

Speed hump is a raised pavement area across a roadway with a rounded top of 3.70 m to 4.25 m width and vertical rise of 75 mm to 100 mm which can generally slow down vehicles gently to speeds of 15km/h to 30km/h (Sirim, 2009). Speed humps are constructed of asphalt, concrete, or rubber but mostly humps were constructed of asphalt or concrete. According to Board of Engineers Malaysia (2006) speed humps when constructed in asphalt should be installed in minimum two layers. Two templates may be used to ensure the integrity of the speed hump profile. Any other method of construction which can improve accuracy and shape conformity may be used. It is also a requirement that the area of pavement to be covered by the speed hump be roughened, heated or tack coated with bitumen to improve adhesion throughout the entire underside of the hump and to avoid deformation at the edges. A construction tolerance of ±3 mm is recommended for the final height of the speed hump.

The length and height of the speed humps determine the speed at which traffic will travel over the devices. Shorter lengths and greater heights of speed hump can slow cars most drastically. Different types of speed humps are built for different purposes and environments. Generally speed hump are designed and built to standards with yellow and black colored pattern. Speed hump are obviously installed to prevent people speeding in place of high foot traffic, but should have signs indicating the speed humps and a suggested speed or a speed limit on that property. If the humps are too high, try driving over the humps at the suggested speed or just under the speed limit. If over the speed limit, the impact is too great and can possibly cause damage to a standard vehicle. According to Basil, speed reduction brought about by road humps can be attributed to the drop in discomfort levels as vehicle speeds are lowered. Based on Sirim (2009), the physical characteristics of a speed hump are as follows:

i. rounded raised areas of pavement
ii. typically 3.70 to 4.25 m in length and span across the width of the road
iii. hump heights range between 75 m to 100 mm with a construction tolerance of ± 3 mm
iv. common speed hump shapes are parabolic, circular and sinusoidal
v. typically has pavement markings to enhance visibility (suggested to be of yellow zebra)
vi. tapered to the edge near curbs to allow a gap for drainage
vii. some have speed advisories for bicyclists and motorcyclists (prefer that it does not cover or cross the bicycle or motorcycle lane)

2.4.2 Detailed Design of Speed Hump

There are four main types of design profile for speed humps in use in countries around the world. These are Circular, Sinusoidal and Parabolic. According to the Canadian Guide to Neighbourhood Traffic Calming a sinusoidal speed hump of 4.0m in length and 100mm height is recommended on streets with a traffic volume of 1,000 – 5,000 vehicles per day. A second hump design of 4.0m in length and 70mm in height is recommended for higher volume streets of 3,000-8,000 vehicles per day. The overlap in traffic volume would allow some flexibility for individual case. It is anticipated that speed humps of 100mm high will result in vehicle crossing speeds of approximately 25 km/hr and that the 70mm high humps will give vehicle crossing speeds of approximately 35 km/hr (Board of Engineers Malaysia, 2006) .Figure 2.1 shows the common shape of speed hump and Figure 2.2 shows the specification of speed humps.

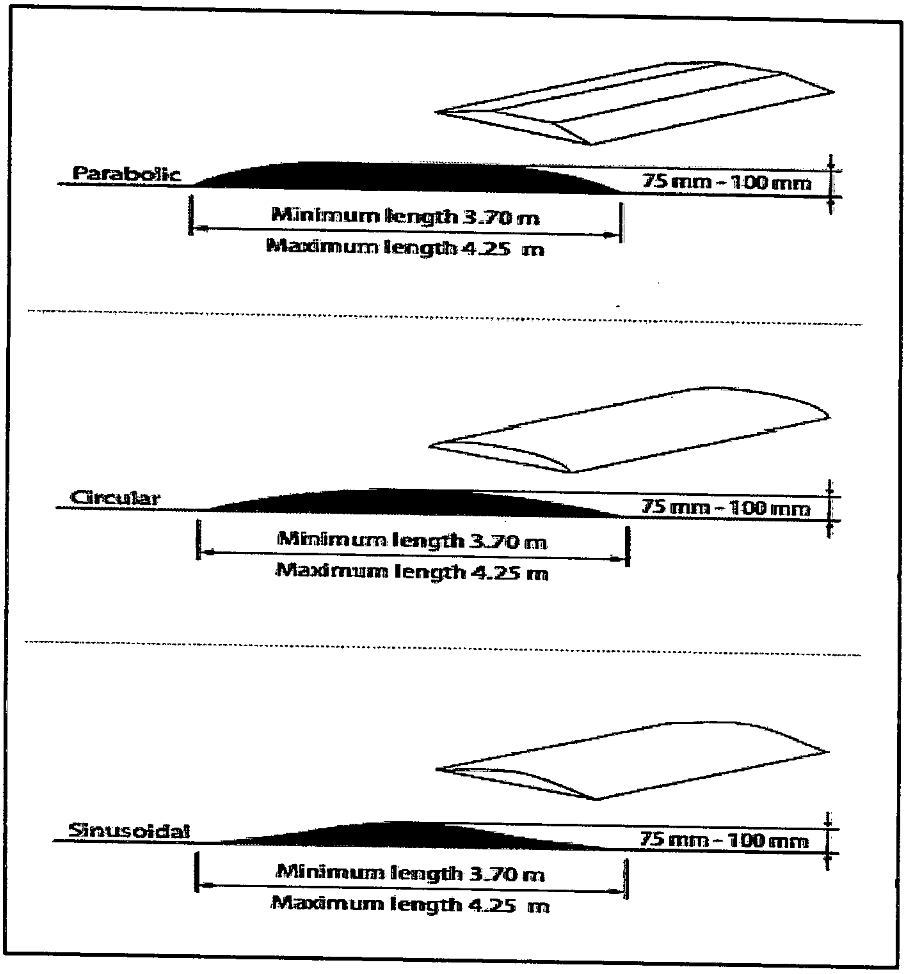


Figure 2.1: Common shapes of speed hump

(Source: Sirim Standards and Quality News)

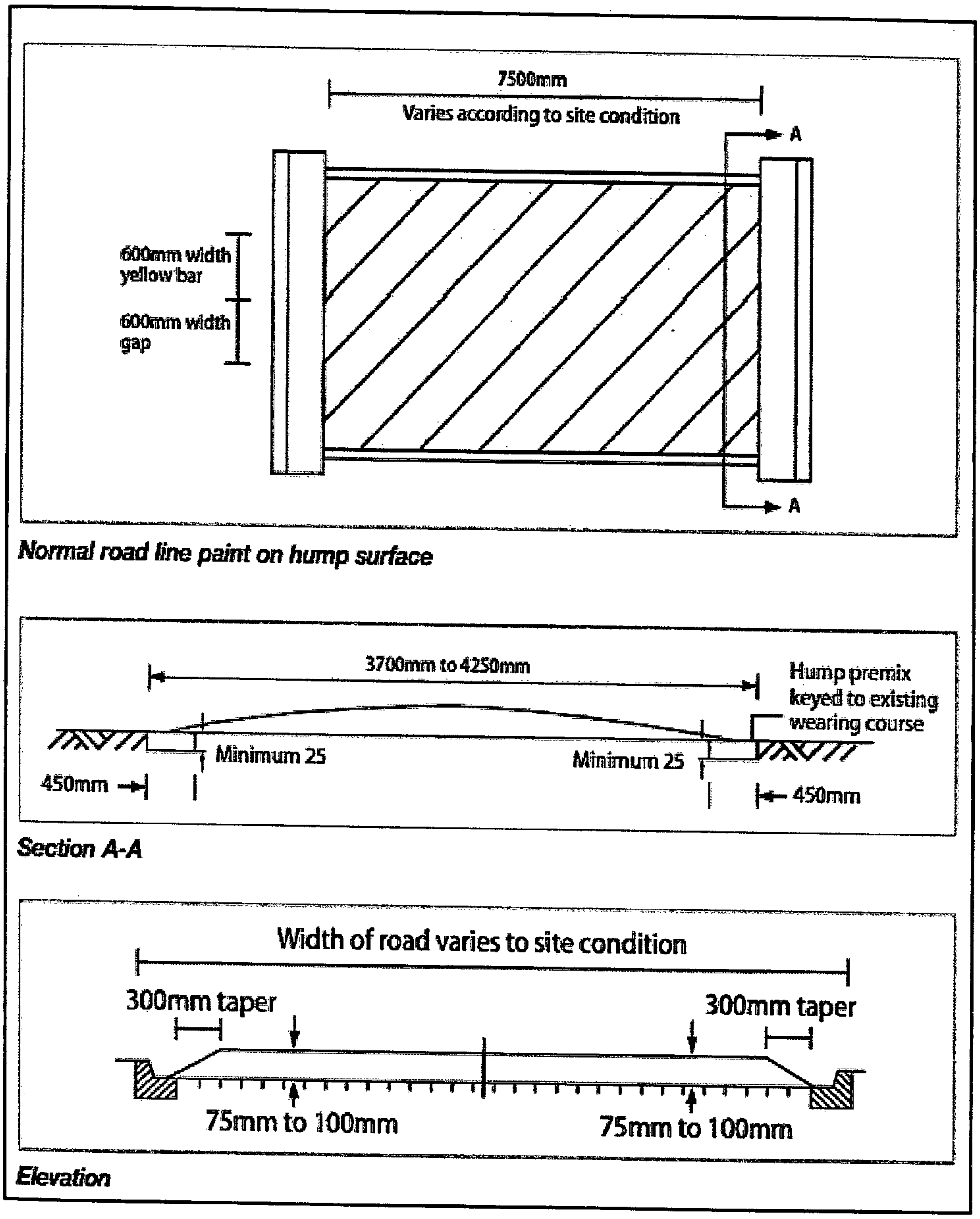


Figure 2.2 : The specification of speed humps.

(Source: Sirim Standards and Quality News)

In the US, there are several typical designs with a height of 80mm at center and extend the full width of the road with height tapering near the road edge to allow drainage and unimpeded bicycle travel. Figure 2.3 shows the US typical designs of speed humps.

US Speed Hump Type	Design Speed	Comments
3.70m Round Top (12-feet)	24-32 km/hr (15-20mph)	For Local Roads
4.30m Round Top (14-feet)	32-40 km/hr (20-25mph)	For Local Roads
6.70m Flat-topped (22-feet)	40-48 km/hr (25-30mph)	For Collector Roads More suitable for larger vehicles such as buses, trailers and fire engines

Figure 2.3: US typical designs of speed humps.

(Source: Board of Engineers Malaysia)

2.4.3 Speed Hump Signage and Road Markings

An advisory sign should always be placed at the entrance to the street with warning signs at each hump location. Individual signs at each hump will identify the hump locations to driver and emergency services drivers (Board of Engineers Malaysia, 2006). A typical Type A Sign show in Figure 2.4(a) shall be positioned at 110m before the location of a speed hump. This signage shall be followed by the placement of a Type B Sign and a Type C Sign show in Figure 2.4 (b). Type C Sign place at midpoint of speed hump and Type B Sign place at distances 60m after Type C Sign. Figure 2.5 show the road markings for speed hump.

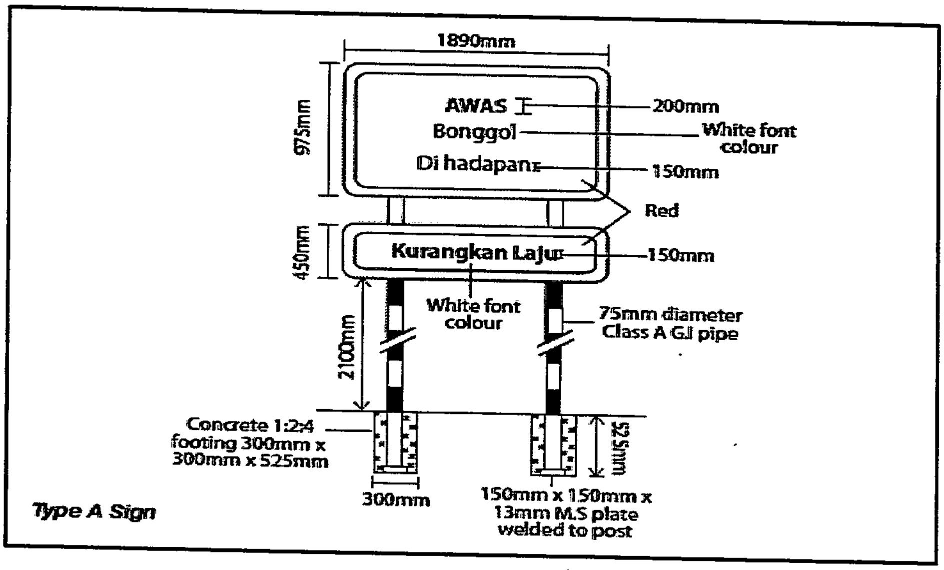


Figure 2.4(a): Typical type A sign

(Source: Sirim Standards and Quality News)

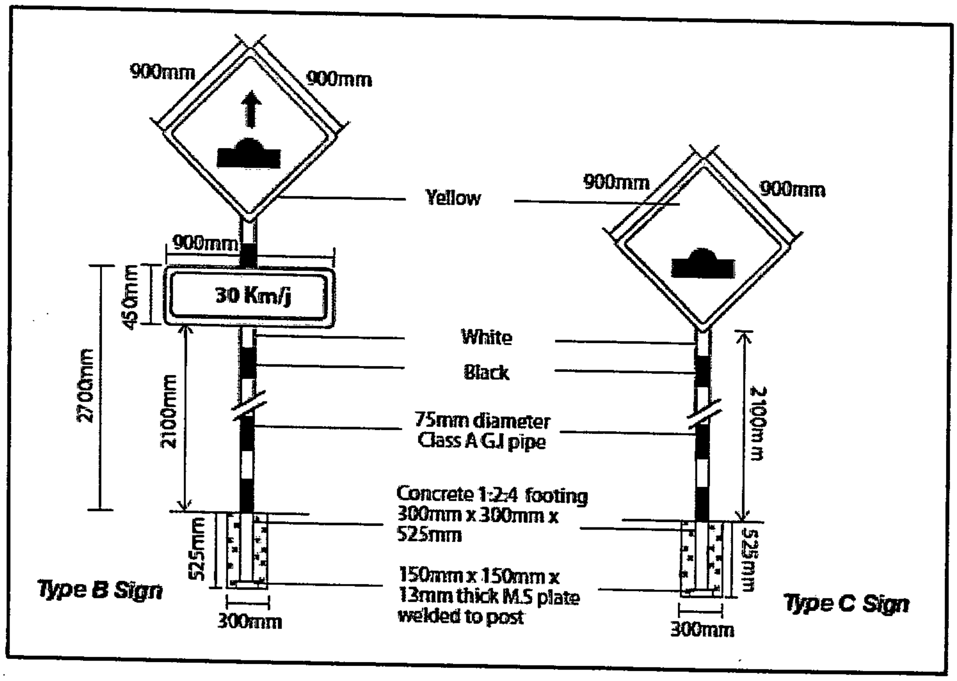
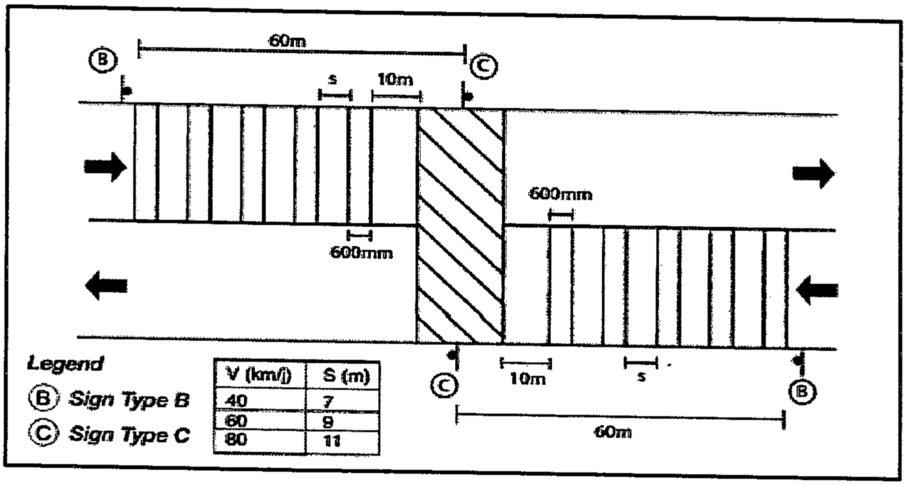


Figure 2.4(b): Typical type B and type C sign

(Source: Sirim Standards and Quality News)



V (km/j)	S (m)
40	7
60	9
80	11

Figure 2.5: Speed hump road markings (2-way traffic flow)
(Source: Sirim Standards and Quality News)

2.4.4 Rumble Strip

Transverse rumble strips is widely used in Malaysian roads and commonly developed by authorities to reduce vehicle speed and alert driver as they approach critical and danger-prone areas (Haffy, 2012). Transverse rumble strips was made with thermoplastic material that is mounted horizontally and have several strips at certain height, usually 10 to 13 mm. Rumble strips purpose is to alert the driver until the vehicle speed can be reduced in order to improve traffic safety. The availability of the rumble strips, drivers must reduce the vehicle speed or felt uncomfortable and beside that damage will be occur to the vehicle due to friction with the surface of the rumble strips. Rumble strips are raised buttons or grooves crossing the roadway surface to provide a tactile, noise, vibration and audible warning for drivers. From Draft Tanzania Standard states that the height of an individual strip shall be between 12mm and 15mm, the breadth shall be 200 $\pm$ 10 mm, the space between individual strips shall be 200mm. The length of the strip shall be equal to the width of road. Figure 2.6 shows the typical design of transverse rumble strips in Malaysia.