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Crossroads Vertical Speed Control Devices: Suggestion from Observation

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ABSTRACT

This work focused on traffic audits and investigation of the vertical speed control devices installed at crossroads as traffic speed being controlled but rear-end accidents can still be found. The speed monitoring through 85th percentile speeds for various types of vehicles: i) passenger cars, ii) pickup trucks, iii) motorbikes, and iv) passenger buses and lorries (i.e., more than four wheels vehicles) was performed. Discussion and recommendation from the obtained results have been made. As an alternative choice to reduce crossroad rear-end collisions, this work introduced crossroad speed table.

1. Introduction

Excessive speeding of vehicles causes safety and nuisance concerned to all roadway users, especially residents in the neighborhoods. In additional to residential area, this is particular true for city-campus universities serving multi-functions. Enforcements, even though highly effective, are constrained by various factors such as police manpower, limited financial resources, and police tasks priorities (Chadda & Cross, 1985). Implementations of traffic engineering measures involving neighborhood traffic control are considered good options. Utilizing warning signs, stop signs, rumble strips, turn restrictions, one way traffic control are helpful due to their unique effectiveness (Chadda & Cross, 1985).

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Traffic calming is engineering solution for speed control. Traffic calming has so far usually been implemented through installation of highway engineering measures (such as speed hump, speed table), which do not influence the driver's 'state of mind', but physically restrict the manner in which the vehicle is driven (Department for Transport, 2007). Road safety is a top priority and traffic calming devices are helpful.

For speed deterrence and safety impacts, simple traffic management is therefore of particular interests. Application of traffic calming devices gains attention due to self-enforcement (Ewing, 1999) and easiness and cheap to install, especially speed bumps and speed humps. However, improper uses of such devices may cause specific and immediate hazards to all stakeholders as well as create pollution due to vehicle acceleration (Chadda & Cross, 1985). This work investigates the installed speed control devices at crossroads through observations made at various locations. Recommendation will be given to eliminate their drawbacks through adjustment and enhancement of the speed control devices installed at crossroads.

2. Background

Paradigm of this study took places at Thammasat University, Rangsit Campus (TU-Rs), Thailand. Traffic management within the community area of the Thammasat University is concerned with large multi-facilities zones comprising of educational complexes, sport complex, residential complexes, hospital complex, canteens, banks, and stores. Plan of Thammasat University is essentially gridiron plan (grid street plan), and there are many crossroads and T-junctions. Key transportation mode to access all facilities is by using roadways. Roadways users include pedestrians, bicycles, motorcycles, personal cars, university public buses, metropolitan buses, and employees transport buses. Some parts of roadways are two lanes with two-way driving, while the others are four lanes with two-way driving. For all the roadways, there is no type of access control. These multi-purposes roadways are therefore produced safety concerns to the university. Statistically, the most conflict points are at the intersection points where accidents are frequently occurred.

Having study on the causes of accidents, it is found that behavior of road users is the critical factor triggering more severe accidents, especially violations of speed limits signs by speedy vehicles. The TU-Rs has therefore initiated its traffic management program, focusing on self-enforcement of roadways users through the use of traffic calming devices. Speed control devices (speed bumps/humps) have been extensively installed campus-wide for more than ten years. In essence, these devices are aimed at improving safety with reduction of vehicular speeds.

Even though, speed humps have been widely employed in many countries like USA, EU countries, Australia, and others, the speed control devices utilized in TU-Rs encounter some particular concerns and problems. For example, although such devices have been installed at all legs of crossroads to delay traffic, accidents can still occasionally be found. Thus this work tries to investigate the causes of problems as well as to enhance the efficiency of the devices.

3. Vertical deflection speed control devices

With physical design techniques, speed control devices trigger physical impediments to speeding. Important vertical deflection traffic speed control devices to be discussed are speed bumps, speed humps, and speed table.

3.1 Speed bumps

Speed bumps should have height 7.6-15 cm and, travel length 30-90 cm, with vehicular passing speeds around 8 km/hr or less (Elizer Jr, 1993). Some road users are unhappy about speed bumps since they can cause immediate and specific hazard, especially for bicycles, fire trucks, and others. Noise and air pollution also can be found as vehicles accelerated after passing the devices (Chadda & Cross, 1985).

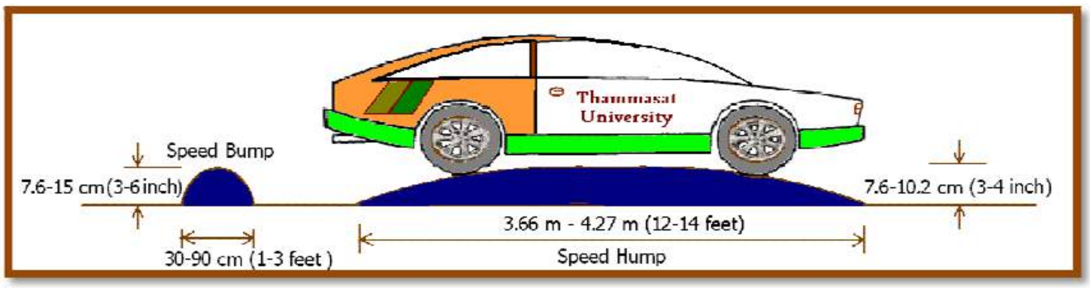

Figure 1: Sizes and shapes of speed control devices.

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3.2 Speed humps

Being widespread used by EU countries, USA, and many others (Elizer Jr, 1993), the popular Watt profile speed humps developed by the Britain's Transport and Road Research Laboratory (TRRL) should have height 7.6-10.2 cm and, travel length 3.66-4.27 m (Chadda & Cross, 1985) (Ewing, 1999), with vehicular passing speeds around 24 km/hr or less. Speed between a series of humps is about 40-48 km/hr, depending on size and shape of the humps. Comparing the profiles with bumps as given in Figure 1, humps are more relatively gradual than bumps, thus produce less driver discomfort, and less damage to vehicles. In addition, humps cause less pollution and noise due mainly to not as much of vehicular acceleration after passing the devices.

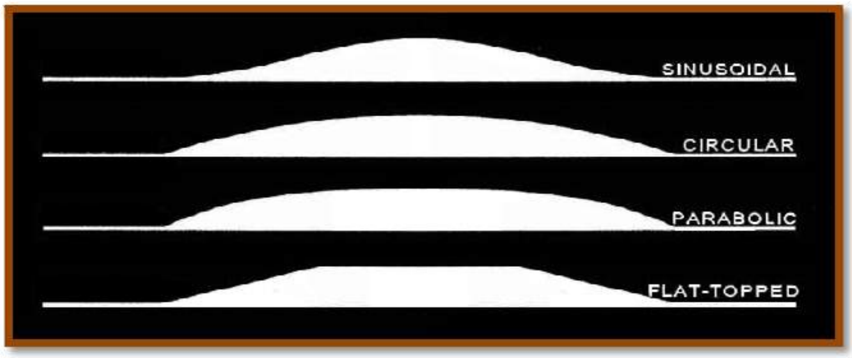

Figure 2: Speed hump longitudinal profiles.

Profiles of speed hump may be sinusoidal (a sine wave), circular (a segment of a circle), parabolic, or flat-topped as portrayed in Figure 2. Sinusoidal profile provides the shallowest initial rise, thus giving a more comfortable ride at about 40 km/hr (County of Hawaii, 2007). Regardless of profile, recommended height of road hump should be less than 7.6 cm (Department for Transport, 2007).

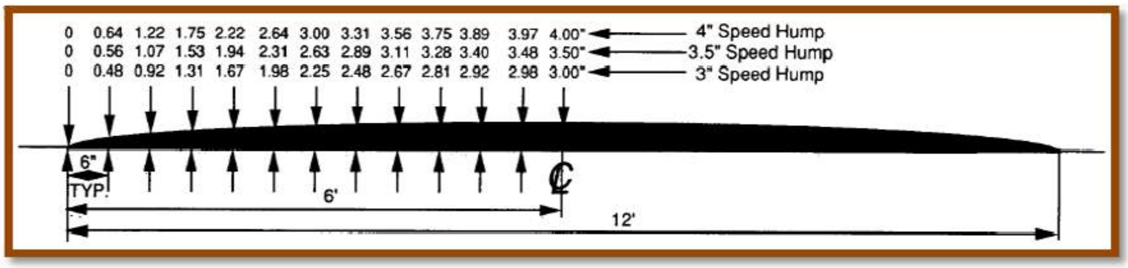

Figure 3. Dimensions of typical speed hump parabolic shape (Elizer Jr, 1993)

Parabolic profile hump for height 3, 3.5, and 4 inches has been developed by TRRL in Great Britain as given in Figure 3 (Elizer Jr, 1993). For parabolic hump profile for height 3 inches, the longer base length (from 3.66 m to 4.27 m) yields slightly increased speed (from 32 km/hr to 37 km/hr), thus provides a more comfortable drive.

3.3 Speed tables

Speed table, the so-called *trapezoidal humps* or *speed platforms*, is in fact speed hump with flat-topped. Popular speed table is Seminole profile, designed by Seminole County of Florida, as demonstrated in Figure 4. Speed table normally has travel length 6.7m (22 ft) with height 7.6-9.2 cm with straight or parabolic approaches. Bricks or some special texture materials may be applied at flat-topped area. Considering 85th percentile speed for speed table, traversing speed is in a range 40-48 km/hr. Comparing to speed humps, speed tables thus yield much gentler drives (Ewing, 1999).

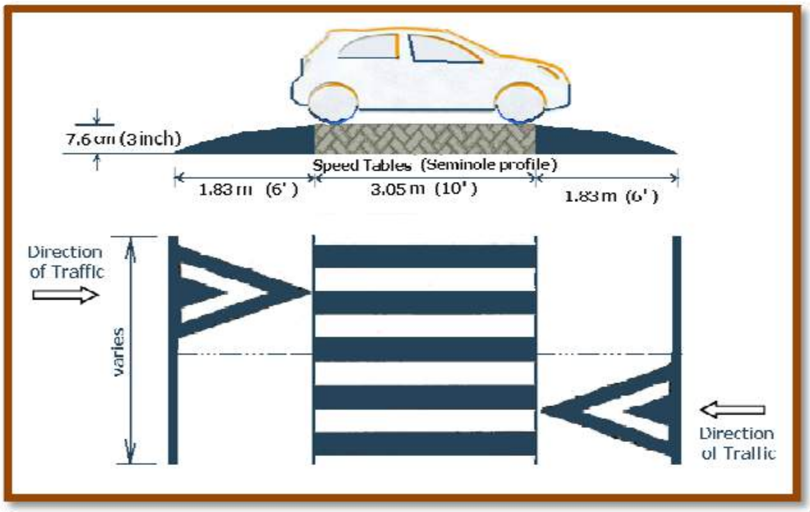

Figure 4: Typical profile and pavement marking for Seminole speed table.

If marking for pedestrian crossing, speed tables are called *raised crosswalks* or *raised crossings*. Many parts of the US have shift from speed humps to speed table. The reasons are 1) to accommodate public transports such as fire vehicles, 2) to represent attempts to move beyond local streets to collectors and arterials, where standard speed humps cannot accommodate high volumes and speeds, and 3) to serve as raised crosswalks (Ewing, 1999).

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4. Auditing of crossroad installed vertical deflection speed control devices

Vertical deflection speed control devices have been installed at TU-Rs more than 60 locations campuswide. However, this work focused on the investigation related to appropriateness and effectiveness of the devices installed at a crossroad, at TU-Rs. Total three crossroads were studied, but only one is reported as similar results were obtained.

4.1 Profiles of the installed devices

Since about 1998, sizes and shapes of the TU-Rs devices have been altered from bumps closer to humps, thus providing less awkward drive. Even though with such continuous development, the devices were still have some adverse characteristics, as evident by scratches on the devices. In addition, it was noticed from observation that when vehicles passing the device there were body-shakes impact due to front and rear wheels jostling the devices. This gave rather nuisance experiences, even with speed 25 km/hr or less.

4.2 Location of the installed devices

The devices have been placed all legs of crossroads. However, the devices are not at the corners of crossroad, but at various distances about 10 m, 20 m, and 30 m.

4.3 Traffic sign

Traffic signs are important as to inform motorists to be aware of the devices installed ahead. From field measurement, distances from installed traffic signs to devices are in ranges between 10-30m. Examples of traffic signs are displayed in Figure 5. The leftmost sign was partially obstructed by tree. The middle sign and the crossroad was too far from the installed device.

Figure 5: Bump (hump) and crossroad signs.

4.4 Pavement marking

Pavement marking provides another important visual warning for motorists preparing to slow down vehicular speeds. Alternating yellow and white paint pattern has been implemented as portrayed Figure 6. The paint has been partially peeled off.

Figure 6: Installed speed hump near crossroad.

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5. Speed monitoring

Speed monitoring field survey was performed as before and after vehicles passing the devices installed at crossroads. A video camera was setup to record movement of passing vehicles. For each straight line observation along crossroads, total 16 marks were made on the ground with 10m interval. There were five portions (50m) before vehicle approaching the first device and another five portions after vehicle leaving the second devices, as detailed in Figure 8.

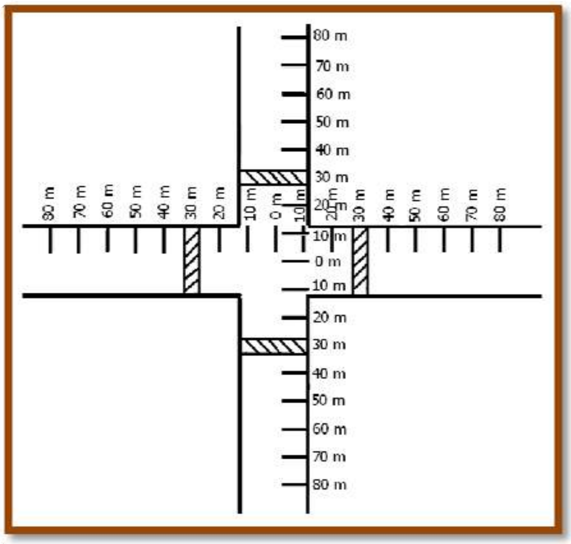

Figure 8: Speed monitoring marking scheme 10m-interval at the crossroad.

In this study, speeds of motorists driving behavior had been observed. In order to clearly examine speed behaviors, vehicles are classified into four groups: i) passenger cars, ii) pickup trucks, iii) motorbikes, and iv) passenger buses and lorries (i.e., more than four wheels vehicles). Such groupings were done according to engine powers as well as dimensions of the vehicles.

6. Study result and discussion

6.1 Result and discussion of vehicular speed

From the investigation, the devices seemed to working effectively, specially at distance about 20m before and after passing the device, as given in Figure 9. Vehicular 85th percentile speeds of all kinds of vehicles were about 20 km/hr. However, speed at the intersection area went higher to 30 km/hr or more, where in fact low speed is required. This was due to that the vehicles needed to get through as fast as possible. The true objective of installing of the device thus cannot be wholly fulfilled. Another important aspect is that after the vehicles already passed the intersection area vehicles need to speed down again in order to pass the second device. This can sometimes cause rear end accidents, as the following vehicles speeding up to pass the intersection area.

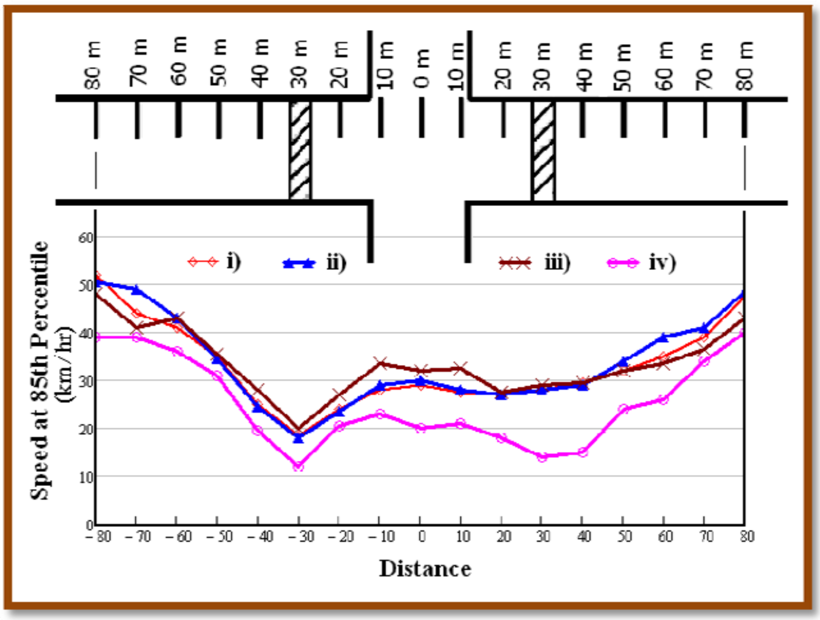

Figure 9: 85th percentile speeds for various types of vehicles: i) passenger cars, ii) pickup trucks, iii) motorbikes, and iv) passenger buses and lorries (i.e., more than four wheels vehicles)

6.2 Recommendation for adjustment and enhancement of the vertical speed control devices installed at crossroads

6.2.1 Adjustment through devices reposition

As observed from Figure 9, 85th percentile speed in the position 20 m is less than 30 km/hr are desired speed for vehicle passing the intersection area. Therefore, relocations of the installed devices are needed to accommodate this requirement. The new positions of the devices should be right at the corner of the crossroads, as illustrated in Figure 10(a), so speed will be lowest during entering the crossroads. Traffic sign should also be installed at a proper distance before approaching the devices.

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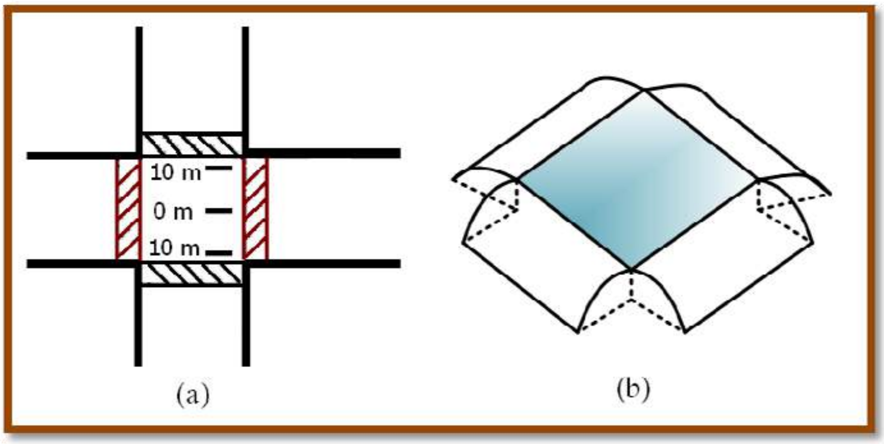

Figure 10: (a) Reposition humps to the intersection corners, (b) crossroad speed table.

6.2.2 Enhancement the devices

Profiles of the devices should be altered to provide more comfortable drives. Speed humps with sinusoidal or parabolic shapes are recommended, as discussed in section 3.2. This, together with reposition of the devices discussed in section 6.2.1, should reduce accident rates of rear-end collision to be minimal. Also, painting maintenance of the devices should be frequently performed.

6.2.3 Adjustment through the use of crossroad speed table

As from discussed above about the pros of speed table, therefore it is possible to adapt speed table to be used at crossroad, as exampled in Figure 10 (b). Crossroad speed table can provide more attentions to all stakeholders. As it elevated the vehicles, the motorists will have a better sight, other than increased awareness. In addition, there is no stop as no a second bump (hump) device, thus rear end collisions should be totally eliminated.

7. Concluding Remark

This work involved observation of the use of vertical speed control devices installed at crossroads. Having investigated on traffic speed and traffic accident, recommendation on enhancement as well as adjustment of the devices has been made. As compared to bump, speed humps provide a much smoother and more gradual flow of vehicle speeds. All the devices should be reshaped to have hump profile. The devices should also be repositioned to the intersection corners.

Crossroad speed table was introduced for traffic control with many expected advantages. However, more study about crossroad speed table is needed to confirm the effectiveness.

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