EFFECT OF TRANSVERSE RUMBLE STRIPS ON TRAFFIC FLOW FUNDAMENTAL DIAGRAM

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To my beloved mother and father and my wife

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ABSTRACT

The purpose of this research project is to determine the effect of Transverse Rumble Strips (TRS) on the traffic flow fundamental diagram. To achieve this goal, firstly segment KM14.3-14.6, Northbound PLUS Expressway E2, which connect Johor Bahru to Kuala Lumpur had been chosen as a study area, because in this place TRS was deployed on pavement. To find traffic flow fundamental diagrams before and at TRS required data which were traffic volume, speed and density had been collected before TRS with SSD distance to avoid from the effect of TRS on traffic flow characteristics and at TRS. Required data before TRS were collected by ATC method (pneumatic tubes) and data on TRS had been collected by video camera. After installing ATC, data collected for two weeks and peak period was determined. Heaviest traffic was on Friday and Saturday during 2:00pm to 5:00pm for this reason at Friday 31 August 2012 and Saturday 1 September 2012 during 3:00pm to 4:00pm required data had been collected by a video camera on TRS. In the last step fundamental diagram for both cases before and at TRS were founded and compared with each other. This study shows that TRS in speed-density and speed-flow diagrams reduces free flow speed between 4 to 5 km/hr which is significant. But about jam density and maximum flow there was not any accurate result achieved in flow-dansity and other diagrams.

ABSTRAK

Tujuan projek penyelidikan ini adalah untuk menentukan kesan Transverse Rumble Strips (TRS) pada gambarajah asas aliran trafik. Untuk mencapai matlamat ini, pertamanya segmen KM14.3 14,6, Arah Utara PLUS Expressway E2, yang menghubungkan Johor Bahru ke Kuala Lumpur telah dipilih sebagai kawasan kajian, kerana di tempat ini TRS telah dikerahkan di kaki lima. Untuk mencari gambar rajah aliran trafik ada mahupun tiada TRS data yang diperlukan adalah jumlah trafik, kelajuan dan ketumpatan telah dikumpulkan sebelum TRS dengan jarak SSD untuk mengelakkan dari kesan TRS pada ciri-ciri aliran trafik dan di TRS. Data yang diperlukan sebelum TRS telah dikumpul oleh kaedah ATC (tiub pneumatik) dan data pada TRS telah dikumpul oleh kamera video. Selepas memasang ATC, data yang dikumpul selama dua minggu dan tempoh puncak telah ditentukan. Trafik paling sesak adalah pada hari Jumaat dan Sabtu sepanjang pm 2:00 petang hingga 5:00 petang atas sebab ini pada Jumaat, 31 Ogos 2012 dan Sabtu 1 September 2012 pada 3:00 petang hingga 4:00 petang data yang diperlukan telah dikumpul oleh kamera video pada TRS. Dalam langkah terakhir gambarajah asas bagi kedua-dua kes sebelum dan pada TRS telah diasaskan dan dibandingkan antara satu sama lain.Kajian ini menunjukkan bahawa TRS dalam kelajuan kepadatan dan gambar rajah aliran kelajuan mengurangkan kelajuan aliran bebas antara 4 hingga 5 km / jam yang significanet. Tetapi tentang kepadatan jem dan aliran maksimum tidak ada apa-apa keputusan yang tepat yang dicapai dalam aliran dansity dan rajah lain.

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LIST OF SYMBOLS

AADT	Annual Average Daily Traffic
ADT	Average Daily Traffic
ATC	Automatic Traffic Count
ATR	Automatic Traffic Recorder
B	Bus
coeff	Coefficient
d_1	Total Reaction Distance
d_2	Breaking Distance
df	Degree of freedom
f	Coefficient of Longitudinal Friction
FFS	Free Flow Speed
g	Gradient
h	Headway
hr	Hour
JKR	Jabatan Kerja Raya
k	Density
K_{cr}	Critical Density (pcu/km)
k_j	Jam Density
km	Kilometer
k_o	Optimum Density
l	Distance
L	Loory
M	Motorcycle
PC	Passenger Car
PCE	Passenger Car Equivalent
PCU	Passenger Car Unit

q	Flow, Volume
q_c	Maximum Flow
q_{max}	Maximum Flow
q_s	Subordinated Flow
Se	Standard error values for the coefficient
SSD	Stopping Sight Distance
SS_{error}	Sum of Squared Error
SS_{reg}	Regression sum of square
SS_{total}	Total Sum of Squares
t	Time, reaction time
u	Speed
u_f	Free Flow Speed
u_s	Subordinated Speed
u_o	Optimum Speed
V	Van
veh	Vehicle

CHAPTER 1

INTRODUCTION

1.1. BACKGROUND OF THE STUDY

Previous studies show that TRS have a small effect on a vehicle's speed. The range of speed reduction varied from 1.6 km/h to 12.9 km/h. According to most previous study reduction in vehicle speed was statistically significant. However, it is not clear if such speed reduction impacts are practically meaningful (Kermit and Hein, 1962; Owens, 1967; Harwood, 1993; Carlson and Miles, 2003; Thompson et al., 2005).

Relatively few studies have evaluated the effectiveness of TRS in reducing crashes. Also the results of previous study are not fully compatible. The result shows that using TRS reduced crashes by 14–100% (Harwood, 1993). Traffic control devices that applied to the pavement usually provide important information for drivers and road users. With developing traffic control devices, various pavement marking materials and devices have been developed; these devices normally increase driver awareness and as a result safety on the road.

Rumble strips are raised or grooved marking or devices, that when the tires of vehicles passing from them, they produce vibration and audible noise for drivers. Rumble strips usually are used in different situation and location through the

roadway, to announcing drivers to various changes in the environment of the roadway ahead. Common categories of rumble strips are Centerline rumble strips (CRSs), Edge line rumble strips (ERSs) or shoulder rumble strips (SRSs), Laneline rumble strips (LRSs) and Transverse rumble strips (TRSs) (Melisa, 2005).

1.2. PROBLEM STATEMENT

Accident can occur by vehicles leaving the travel lane and then hitting roadside objects or overturned. Speed is a very significant element in single vehicle accidents; greater speed has more potential to the fatal accident. Transverse rumble strips are not traffic calming devices and should not be used as a traffic calming device. Speed control measures such as speed bumps and speed humps should be used for traffic calming (Liu, 2011).

How rumble strips decrease number of accidents. Do they caution drivers by increasing their awareness? Or force drivers to reduce their speed when they approach to that particular area, such as a crosswalk, a school zone, a curve or an intersection (Cheng, 1994). TRS individually should not have an effect either on speed or flow of vehicle on the road section. In this study, purpose is to determine the effect of transverse rumble strips on traffic flow fundamental diagrams.

1.3. OBJECTIVES OF THE STUDY

The objectives are:

- To determine the volume, density and speed of vehicles on road section before TRS.
- To determine the volume, density and speed of vehicles on TRS.
- To determine the maximum traffic flow, jam density and free flow speed in both situations.
- To compare traffic flow fundamental diagrams and identify the effect of TRS on traffic flow fundamental diagram.

1.4. SIGNIFICANCE OF THE STUDY

TRS shall not be used as a traffic calming measure. The long-term success of TRS as a traffic control enhancement lies in their very select and limited application. Transverse rumble strips should not be used as the standard treatment for alerting motorists to conditions ahead. Overuse of TRS will degrade their impact on road users thereby reducing their effectiveness as a safety tool. In addition, many factors except than speed limit may also affect the effectiveness of transverse rumble strips in engineering applications. One of the major factors is the design of transverse rumble strips, which includes the location, size and the number of transverse rumble strips deployed. These issues have not been considered in this study. Also installation of new transverse rumble strips is out of the scope of this study.

1.5. SCOPE OF THE STUDY

The current study determines the effect of transverse rumble strips on traffic flow fundamental diagram in segment KM14.3-14.6, Northbound PLUS Expressway E2, which connected Johor Bahru to Kuala Lumpur. In this study by collecting needed data which were the volume, average speed, and density on this particular expressway, traffic flow fundamental diagrams were found. The first part of data were collected 270 meters before TRS and the second part of data were collected in middle of TRS. Figure 1-1 shows the satellite map of road segment.

Figure 1-1 Satellite Map

There are 33 transverse rumble strips were deployed in this place. The space between each pair of them was around 3.1 meters. The average mean speed of the vehicles was measured between band 15 and 17. Figure 1-2 shows site map.

Figure 1-2 Site Map

Data was collected at two points, the first point was 270 meters before TRS to avoid of the effects of sight distance. The data at this point were collected by ATC which was an automatic traffic counter device. The second point was in middle of TRS, data at this point were collected by video camera. Figure 1-3 shows the location of ATC and video camera on the site.

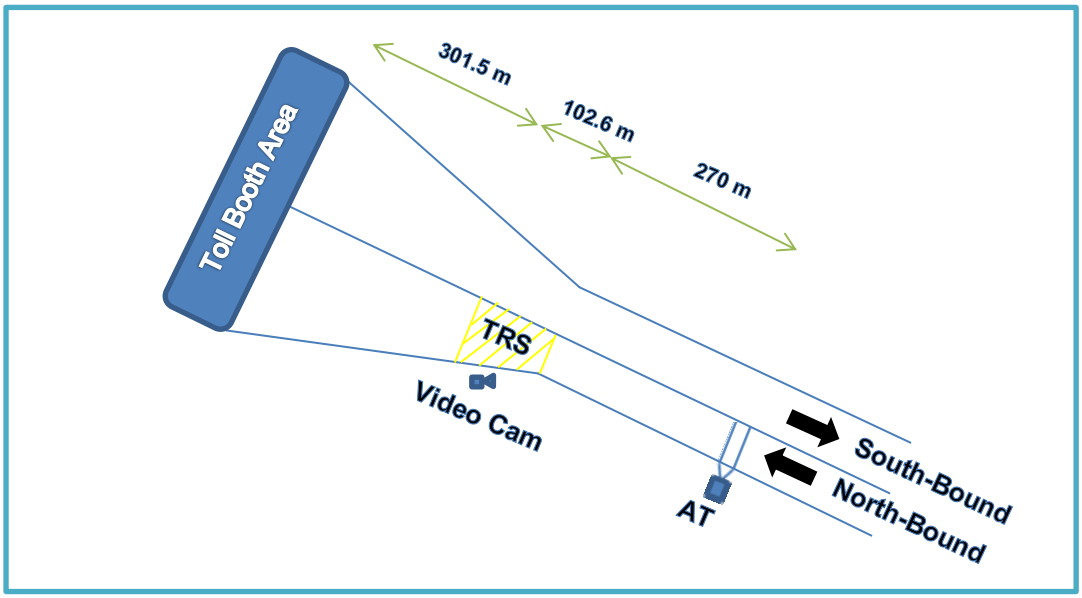

Figure 1-3 Road sketch

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