Geometric Design of Speed Control Humps in Bhubaneswar City

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***Abstract*— One of the basic requirements in traffic engineering is to control the speed of various categories of vehicles over roads for the safety of road users. Various categories of roads are designed under different situations for designated design speeds over which vehicles can travel with convenience and safety. The use of road humps in city streets is an efficient way of controlling speed of automobiles. This paper describes a study conducted to establish practical geometric design guidelines of speed control humps for the use of road engineers. A statistical relationship between geometric characteristics of speed control humps and speeds of the automobiles is developed and models have been suggested for the use of practicing engineers. This relationship can be used as a tool for designing hump geometry for a particular hump-crossing speed. One of the important features of the study is the development of a simple procedure for the road hump design.**

Keywords-speed control humps, 85th percentile hump crossing speed, hump height to width ratio, hump area to width ratio

I. Introduction

Road humps are designed to promote orderly traffic movement and improved safety. However, at certain locations such as approaches to manned & unmanned level crossings, sharp curves, accident prone locations, congested residential streets, control of speed may become necessary (1) to allow smooth flow of traffic. However in an uninterrupted flow facility, with a strong emphasis on traffic safety & management, use of road humps can't be under-estimated. Road humps, where permitted to be installed, provide visual, audible and traffic stimuli which alert drivers and cause them to slow down. These can have different heights, base widths and shape. In fact, no particular design is suitable for all the types of vehicles using the road. Though speed control humps are commonly used, well accepted design guidelines are not readily available. The design recommended herein is a compromise design to suit average Indian urban road traffic conditions and is based on field experiments on Bhubaneswar city streets and analysis.

II. BASIC CONCEPTS

A. Speed control humps

Speed breakers also known as speed control humps are commonly used across the roadway having a parabolic shape with width greater than the wheel base of most of the vehicles using the road.They are sometimes hazardous, inspite of the precautions taken in their safe design and construction. Some authorities do not favour them, especially on main roads.

B. Linear regression and corelation

The traffic engineer is commonly faced with problems of predicting whether any relationships can be established between two or more variables (2). One example is plot of a number of observations of speed and geometrics of humps. In linear regression analysis straight line is fitted to the scatter points. A measure of how good is the relation between the two variables can be had by the correlation coefficient, r. The value of correlation co-efficient varies between -1 and + 1. It is zero if both variables are independent of each other, and +1 or-1 if they fully linear dependent. The square or r, r^2 is known as the co-efficient of determination. This measure provides an estimate of the fraction of the variability. A high r^2 value nearing 1 signifies that a major proportion of the variability is explained by the regression equation.

C. 85^{th} pecentile speed

85^{th} percentile hump crossing speed is defined as the speed below which 85% of all the vehicles are driven. This speed is considered to be the value at which the motorists are tempting the safety conditions of highways and which consequently should not be exceeded. This speed is often used as the criterion in establishing an upper limit for traffic management purposes.

III. FIELD STUDY AND COLLECCTION OF DATA

Speed control humps have been used on public roads, near schools and universities in Bhubaneswar city. They have been provided where active control is needed to bring traffic speed within a desired limit (3). In the present study, only road sections that had speed control humps provided for more than one year were selected. This was to ensure that regular users of each test section would be familiar with the hump layout and thus be able to travel comfortably

Sl No	Location	H/W	A/w(m)	V85(Car)Kmph	V85(TW)Kmph
1	OUAT Campus	0.097	0.1134	9.25	9.32
2	Siripur Market	0.1	0.16	9.12	8.32
3	CAET Gate	0.111	0.2	8.08	11.5
4	Jagamohan Nagar	0.094	0.1134	9.08	9.1
5	Rajadhani College	0.043	0.08	11.32	12.76
6	ITER Road1	0.147	0.0734	10.44	14.4
7	ITER Road2	0.1167	0.0467	12.96	17.8
8	Gandamunda Road-1	0.4	0.16	10.44	8.2
9	Gandamunda Road-2	0.138	0.06	12.16	15.196
10	Gandamunda Road-3	0.083	0.067	11.52	18.62
11	CRPF SQUARE-1	0.075	0.08	10.84	15.12
12	CRPF SQUARE-2	0.055	0.09	10.44	12
13	CRPF SQUARE-3	0.045	0.06	11.5	18.36
14	CRPF SQUARE-4	0.052	0.073	8.8	16.6
15	IRC Village	0.09	0.093	9.68	13.2
16	JAYADEV BIHAR-1	0.055	0.07	11.16	18
17	JAYADEV BIHAR-2	0.056	0.086	10.52	15.04
18	Acharya Vihar	0.075	0.08	11.16	15.84
19	VaniVihar-1	0.067	0.053	13.032	15.88
20	VaniVihar-2	0.062	0.05	13.651	15.5
21	Cuttack Puri Road-1	0.1	0.06	13.68	15.131
22	Cuttack Puri Road-2	0.087	0.047	14.4	19.8
23	Cuttack Puri Road-3	0.057	0.053	12.52	18.9
24	OMC House	0.1	0.026	11.5	19.8
25	Secretariate Road	0.093	0.01	14.08	11.52
26	Rajabhavan Pump House-1	0.185	0.033	15.64	19.1
27	Rajabhavan Pump House-2	0.12	0.04	13.845	20.24
28	Rajabhavan Pump House-3	0.133	0.026	17.08	21.6
29	Rajabhavan Pump House-4	0.125	0.033	15.02	21.12
30	Kalyani Mandap,Unit-8	0.1	0.046	12.32	18.16

Table-1

across those humps. A total of 30 humps (Table1) were studied. For each hump, measurement of height, base width and shape were made. Hump crossing speeds of vehicles were computed from measurements of travel time over a distance of 10m width with the crown of the hump located at the mid-point for each of the hump selected. Experiments were conducted during off-peak periods to avoid platoon traffic conditions. At least 50 numbers of speed data were recorded for four wheelers and two wheelers at each site.

I. ANALYSIS AND DESIGN

A. Analysis based on height to width ratio

The procedure of selecting only hump width and height can be examined by studying the relationship between hump-crossing speed and H/W ratio of the hump. From the experimental data Fig. 1:a and Fig.2:a show the relationship between the 85^{th} percentile speeds of two wheelers and passengers respectively with the H/W ratio No statistically significant relationships could be established between H/W ratio and the speed measurements, which signifies that specifying only the width and height of a hump does not sufficiently enable the design engineers to effectively control the desired hump-crossing speed of traffic. The practice in hump construction of specifying only hump width and height is therefore is therefore insufficient in this regard.

A. Analysis based on area to width ratio

An alternative quantitative indicator that can be utilized to characterize hump geometry is the area-to width ratio A/W, which can be seen as a measure of the average height provided over the base of a hump(3). In the Fig.2a and Fig2b 85th hump crossing speed data for two wheelers and passenger cars respectively are plotted against the A/W ratio. Statistically significant relationships are now developed between the A/W ratio and thee speed measurements. Lower hump-crossing speeds are found to associate with higher A/W ratios. The following linear regression relationships can be obtained for the 85th percentile (V_{85}) hump-crossing speeds in kilometer per hour.

V_{85} (Two wheelers) = 24.365- 121.951 (A/W)

R^2 =0.555 (1)

V_{85} (Cars) = 16.649 - 66.225 (A/W)

R^2 =0.6003 (2)

Where A/W is expressed in m; and R^2 = statistical coefficient of simple determination.

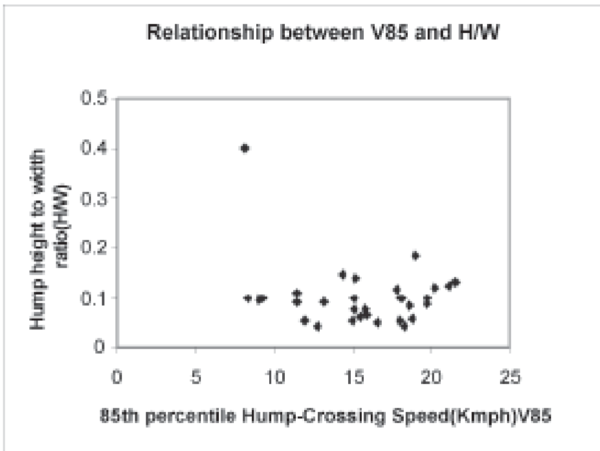

Fig-1a, Relationship between Hump height to width ratio and 85th percentile speed of Two Wheelers

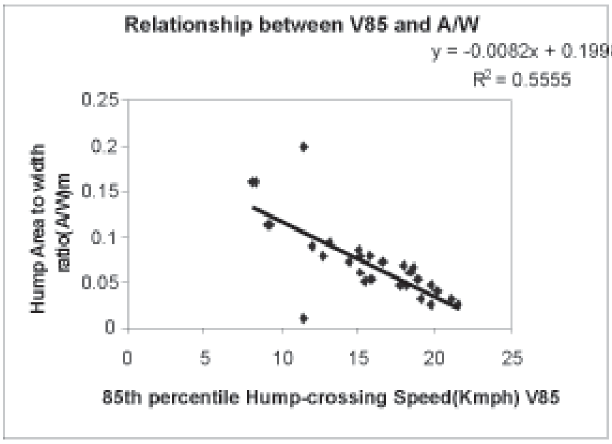

Fig-1b, Relationship between Hump area to width ratio and 85th percentile speed of Two Wheelers

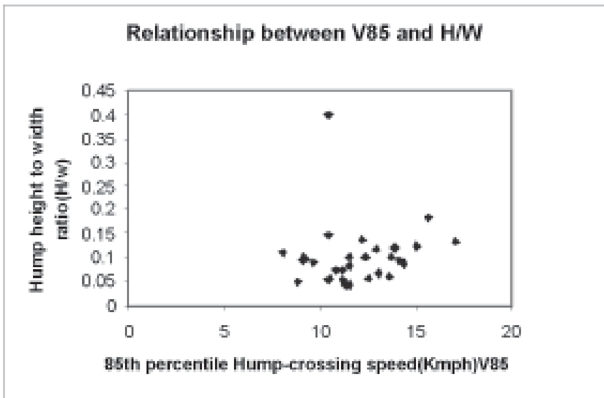

Fig-2a, Relationship between Hump height to width ratio and 85th percentile speed of Cars

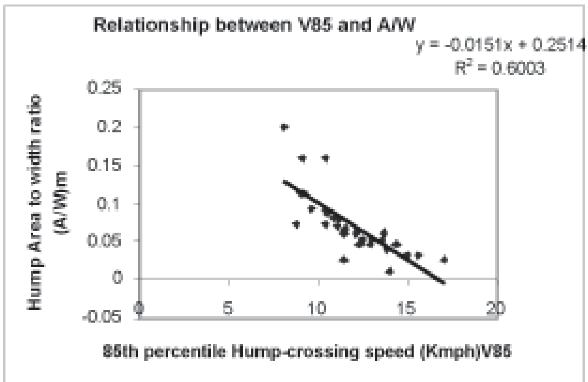

Fig-2b, Relationship between Hump area to width ratio and 85th percentile speed of Cars

A. Geometric design procedure

1. Select particular design 85^{th} percentile hump-crossing speed
2. Find out the required A/W ratio from the equation (1) or (2)
3. Choose a hump shape : circular, parabolic surface profiles have been used
4. From a hump width and compute hump height that satisfies the A/W ratio found in step 2.
5. Check whether the hump height is permissible. If not, repeat the procedure in step 4.

II. Conclusions

Based on the field experiments on hump geometry and hump-crossing speeds of two wheelers and passenger cars vehicles this investigation have shown that statistically significant regression relationships could be established between hump-crossing speeds and hump geometry characterized by area to width ratio. These relationships provide a useful tool for field engineers to design hump geometry for speed control.

References

[1] IRC: 99-1988 "Tentative guidelines on the provision of speed breakers for control of vehicular speeds on minor roads".

[2] L. R. Kadiyali, "Traffic Engineering and Transport Planning", Khanna publication (1989), 1991.

[3] T. F. Fwa, and L. S. Tan, "Geometric characterization of road humps for speed control design" ASCE Journal of Transportation Engineering , Vol.118, No.4, pp. 593-598, 1992.

[4] P. K. Sahoo, "Traffic Engineering measures for accident reduction in Bhubaneswar city" Annual journal of the Orissa Engineer's forum, cuttack , pp.31-35, 2009.