

# SPEED BEHAVIOUR STUDY AT SPPEED HUMP SPEED BUMP AND RUMBLE STRIPS

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**Abstract-** Speed bumps, humps and rumble strips are used as a measure of traffic calming and reducing vehicle speed. This document shows that speed-calming measures retard speed considerably with the help of various types and designs of speed-calming measures. In this study, total of four locations are selected. Each location has two speed breakers. The speed breakers considered are speed humps, speed bump and rumble strips. Spot speed data of 40 samples for each mode i.e. 2 wheelers, 3 wheelers, small car, big car, light commercial vehicle and heavy commercial vehicle has been calculated with the help of Radar Gun at 8m, 16m, 24m distance from calming device at downstream and at 8m, 16m, 24m and 32m at the upstream side. With the help of the data collected, deceleration behavior, acceleration behavior, reduction of 85th and 50th percentile speeds at the calming devices, distribution of speed at different distances, ranking of devices will be analyzed.

**Index Terms -** Speed Hump, Speed Bump, Rumble Strips, Radar Gun, Delay

## I. INTRODUCTION

Traffic calming devices are physical design techniques that encourage or force drivers to drive slow and at constant speed. They avoid speeding of vehicles and can increase overall road safety. Traffic calming measures can also make streets more accessible and livable for other users such as cyclists, pedestrians and nearby residents. The main purpose of traffic calming measures is to reduce speed and create a safer traffic environment.

The major traffic calming measures includes:

1. Narrowing
2. Vertical Deflection
3. Horizontal Deflection
4. Block and Restrict access

The calming devices considered in this study includes speed hump, speed bump and rumble strips.

**Speed Bump:** Speed bumps are elevated portion of the pavements which spans fully or partially across the roadway, which results in forcing the rider to reduce the speed of the vehicle so that the jerk due to bump can be reduced while traversing them.

**Speed Hump:** Speed Humps are parabolic, circular or sinusoidal traffic calming devices used to slow down the vehicles at low speed, low volume roads. They are generally 0.07 – 0.1 m high and 3.65 – 4.5 m wide with a ramp length of 0.9 – 1.8 m depending on target speed.

**Rumble Strips:** A series of bumps or strips across the edge or throughout the road which changes the noise of vehicle's tyre on the surface and hence warning the rider to reduce the speed or indicating edge of the road.

Various physical parameters which must be studied for the use of these calming devices at site to get the desired results are length, height, width, profile, spacing, materials, marking and signage.

Total of four sites were selected for the study purpose, of which two were speed humps, a speed bump and a rumble strips. The sites were selected considering the point that they must be at any public buildings like school, hospital, government office.

## II. METHODOLOGY

Total of 40 readings at 8 points for each calming device were collected with the help of radar gun for each mode of vehicle which includes 2 wheelers, 3 wheelers, small car, big car, light commercial vehicle and heavy commercial vehicle. The points for the readings were separated by a distance of 8 m, so, three points were selected at upstream of device (-24 m, -16 m, -8 m), one at the device, four at the downstream of the device (+32 m, +24 m, +16 m, +8 m). So, data will be collected for a range of 56 m. The arrangement of the points is shown in fig. 1. Also age wise data of the rider of the particular vehicle was collected. The age is divided into 5 groups and will be coded as shown below:

Age Group (years)	Coding
<20	1
20 – 30	2
30 – 40	3
40 – 50	4
>50	5

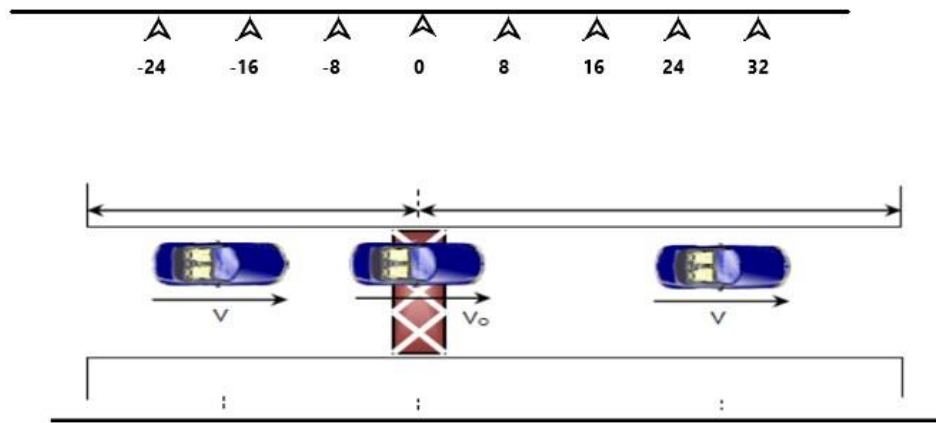


Figure 1 Arrangement of Radar Gun Points at the calming device

### III. LITERATURE REVIEW

Fifteen research had been studied regarding these calming devices, of which 7 are related to speed bumps, 6 are related to speed humps and 2 are related to rumble strips. Their studies include the evaluation of the overall area of the road stretch affected by devices, reduction of the speed, effectiveness of different profiles, delay caused due to calming devices and the psychological effect on the rides due to the structure for which the calming devices were constructed.

The studies conclude that the 85<sup>th</sup> percentile of the vehicles for bumps reduced by 10 – 12 %, for humps reduced by 7 – 8% and for rumble strips by 16 – 20 %. The speed reduction starts from 30 – 40 m upstream of the calming devices. Also the effectiveness of parabolic humps is less than that of flat topped humps.

### IV. ANALYSIS & RESULTS

#### 4.1) V C PATEL SCHOOL

Average overall speed reduction at the distance of 32 m downstream w.r.t. speed bump is 67.3% and w.r.t. 24 m upstream is 4.22%. The detailed mode wise speed profile is shown in figure 2.

It is found that the average speed over bump differs between types of vehicles. As illustrated in figure 3, higher percentage of 2W is traveling over bumps beyond a certain speed as compared to LCV and HCV. For example, about 85% of LCV pass over bump at speeds of 17.5 Kmph or below while only about 59% of 2-wheelers and 77% of small cars are in the same category.

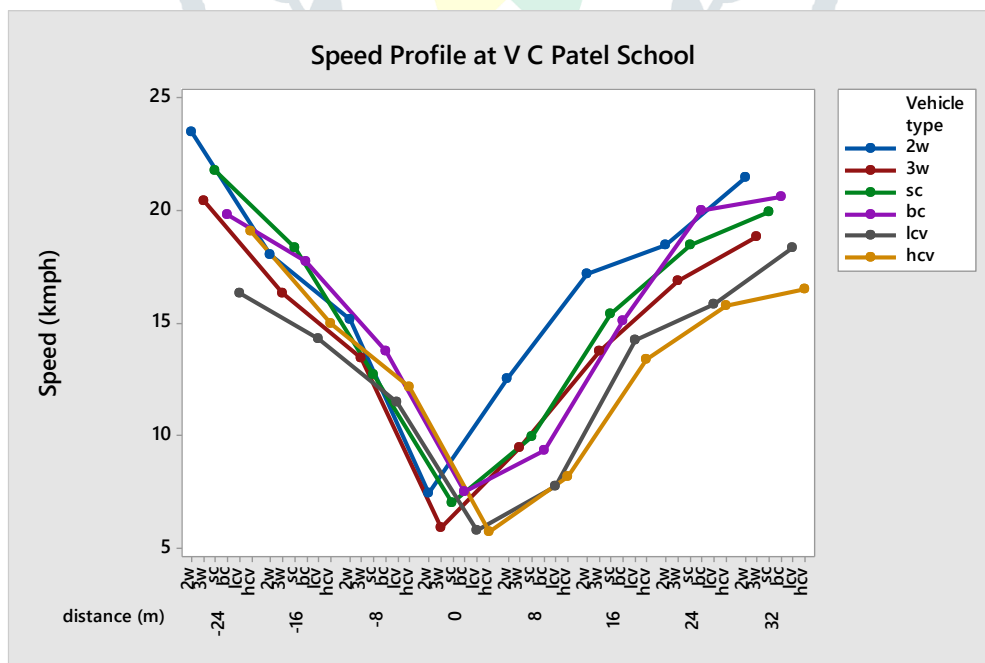


Figure 2 Mode Wise Speed Profile of V C Patel School

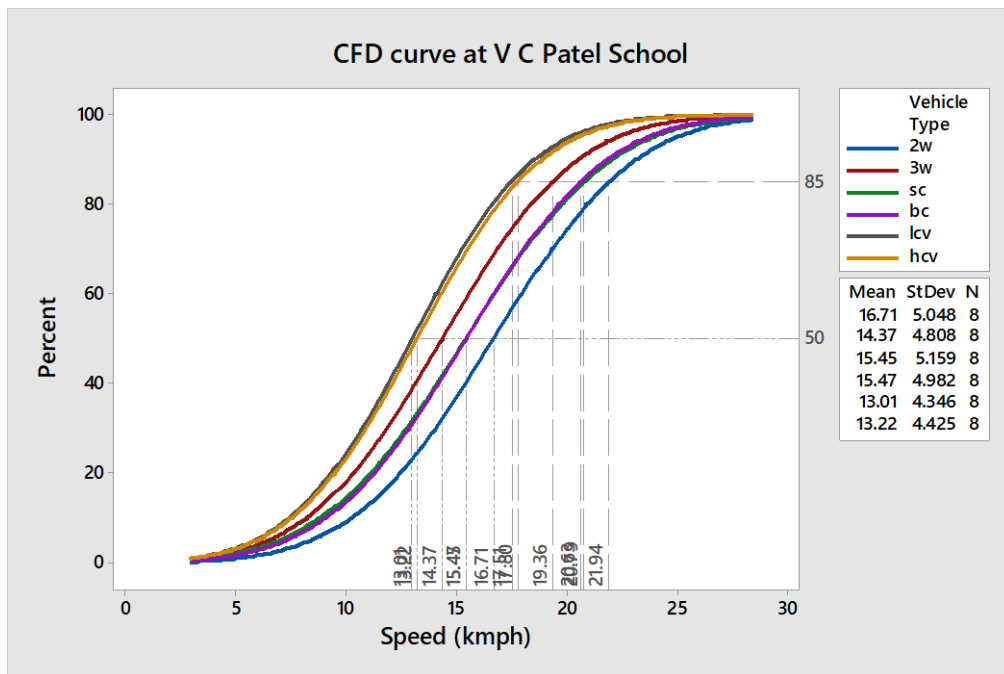


Figure 3 CFD curve at V C Patel School

4.1.1) 50<sup>th</sup> and 85<sup>th</sup> Percentile Speed Profiles

The percentile speeds for different modes is shown in Table 1. Approach speeds are varying from 15 kmph to 22 kmph on average basis. 85th percentile speeds are varying from 16 kmph to 25 kmph. The variation in average speeds is from 5 kmph to 9 kmph at the bump. In other words, the speed at bump on average is around 7 kmph.

Table 1 85th and 50th Percentile Speed at V C Patel School

Distance	Percentile Speed	2W	3W	SC	BC	LCV	HCV
-24	85 <sup>th</sup>	25.00	23.00	23.00	20.00	16.30	21.00
	50 <sup>th</sup>	22.00	20.00	21.00	16.36	15.00	18.53
-16	85 <sup>th</sup>	19.15	18.15	19.15	18.00	16.45	15.00
	50 <sup>th</sup>	16.00	16.00	16.39	16.00	14.44	13.00
-8	85 <sup>th</sup>	15.00	15.00	14.00	15.15	13.00	14.00
	50 <sup>th</sup>	12.00	11.00	10.49	13.00	10.00	12.00
0	85 <sup>th</sup>	7.00	7.00	9.00	8.15	6.00	7.00
	50 <sup>th</sup>	6.00	5.50	6.00	6.00	5.00	5.50
8	85 <sup>th</sup>	15.00	10.00	12.00	10.00	8.60	9.00
	50 <sup>th</sup>	12.00	9.00	9.81	8.00	7.00	8.00
16	85 <sup>th</sup>	19.15	16.00	19.00	19.00	16.45	15.00
	50 <sup>th</sup>	16.80	14.00	15.00	15.00	15.00	13.00
24	85 <sup>th</sup>	21.00	20.15	22.00	24.00	17.00	18.50
	50 <sup>th</sup>	18.00	18.00	19.00	22.00	15.30	16.78
32	85 <sup>th</sup>	25.00	23.00	26.15	25.00	23.15	18.75
	50 <sup>th</sup>	21.00	20.00	22.00	22.00	20.28	17.00

4.1.2) Speed Reduction Trends

Speed Reduction trends of various modes from -24 m to 0 m presented in Table 2 indicates maximum reduction by the LCV and HCV. It is not the case with 2W, 3W, SC and BC as they are entering with higher speeds compared to LCV and HCV.

Table 2 Speed Reduction Trend at V C Patel School

Vehicle Type	Average Percentage of Speed							
	Distance from Speed Breaker (m)							
	-24	-16	-8	0	8	16	24	32
2w	100	86	78	55	63	64	77	81
3w	100	90	86	52	55	62	76	79
SC	100	84	74	45	52	61	67	75
BC	100	92	75	43	48	62	76	74
LCV	100	81	72	40	44	55	65	66
HCV	100	82	79	42	52	56	63	70

#### 4.1.3) Mode-wise Relative Reduction in Speeds

Relative Reduction in speeds for 50<sup>th</sup> and 85<sup>th</sup> percentile for each mode is given in Table 3. Higher reduction values are observed with reference to 85<sup>th</sup> percentile speeds in comparison with 50<sup>th</sup> percentile speeds between the stretch of -24 m to 0 m. The values are around 50% for 85<sup>th</sup> percentile and 45% for 50<sup>th</sup> percentile. Mode-wise HCV have higher relative reduction at 85<sup>th</sup> percentile, whereas for 50<sup>th</sup> percentile value, 3W has higher value.

Table 3 Reduction in Speeds at V C Patel School

Vehicle Type	Reduction in Speed			
	85 <sup>th</sup>		50 <sup>th</sup>	
	KMPH	%	KMPH	%
2W	15.00	48.54	13.00	48.00
3W	10.30	57.61	10.85	50.68
SC	15.00	50.00	16.00	42.86
BC	15.00	46.43	11.00	47.62
LCV	15.55	36.66	14.13	33.14
HCV	9.00	59.09	10.00	50.00

Similar analysis was carried out for other three locations – I B PATEL SCHOOL, KRISHNA HOSPITAL and JILLA PANCHAYAT BHAVAN.

#### 4.2) Comparative Study of Various Speed Breakers

##### 4.2.1) Mode-wise Average Speed Comparison

The speed characteristics in terms of speed profiles, speed reductions and delay etc. are considered at micro level for each category. Now it is an attempt to assess the effectiveness of each category of speed breaker on relative speed profiles. Table 4 gives the details of speed profiles for four locations of speed breakers considered in the study. Average entry speed, and speeds at the speed breakers are shown in the Table 5.

The average traffic speed at -24 m varies from 20 kmph to 26 kmph, while it will be 7 kmph to 15 kmph at speed breaker. Mode wise average speed for differ location at -24 m and 0 m is shown in fig 4 and fig 5 respectively.

Table 4 Average Speed of Different Modes at -24m and 0 m and Reduction in Speed

Location	Type of Speed Breaker	Distance (m)	Mode					
			2W	3W	SC	BC	LCV	HCV
V C Patel School	Speed Bump	-24 m	23.46	20.40	21.78	19.80	16.30	19.08
		0 m	7.45	5.95	7.00	7.53	5.79	5.74
		Reduction (%)	16.01	14.45	14.78	12.28	10.51	13.34
Jilla Panchayat Bhavan	Speed Hump	-24 m	27.05	25.15	25.63	28.01	23.17	22.04
		0 m	18.20	14.88	14.03	14.98	12.72	13.91
		Reduction (%)	8.85	10.28	11.60	13.03	10.45	8.13
Krishna Hospital	Speed Hump	-24 m	26.07	24.35	27.92	27.00	25.75	24.17
		0 m	14.29	12.60	12.55	11.71	10.40	11.64
		Reduction (%)	11.78	11.75	15.37	15.29	15.35	12.53
I B Patel School	Rumble Strip	-24 m	22.20	20.60	21.73	23.83	22.67	22.33
		0 m	8.33	5.07	11.47	10.33	7.00	7.00
		Reduction (%)	13.87	15.53	10.27	13.50	15.67	15.33

## V. CONCLUSIONS

### 5.1) 85<sup>th</sup> and 50<sup>th</sup> Percentile Speeds

*V C Patel School* - At the bump the decrease in 85<sup>th</sup> percentile speed is uniform for 2W, 3W, SC and BC. But for LCV the speed decrease suddenly at -16 m, while for HCV the sudden decrease of speed occurs at -8 m.

*Jilla Panchayat Bhavan* - At the hump the reduction of 85<sup>th</sup> percentile speed is uniform for 2W, 3W, BC, LCV and HCV, but for SC the reduction appears sudden at -8 m. Also the speed is maximum for this location compare to other locations.

*Krishna Hospital* - The reduction in 85<sup>th</sup> percentile speed is uniform at the hump for all types of vehicles.

*I B Patel School* - At the rumble strips the reduction of the 85<sup>th</sup> percentile speed is uniform for all modes, but the speed of the 2W is almost constant for distance of 8m in upstream side. Also the speed recovery is almost 90% at the 32 m distance from rumble strip at downstream side.

### 5.2) Speed Distributions

*V C Patel School* - For the speed bump at -24 m from the bump it is observed that the maximum mean value is observed for small cars whereas minimum value is for LCV's. Mean values at the bump level is in the range of 7 kmph to 10 kmph.

*Jilla Panchayat Bhavan* - The mean values at -24 m is maximum for 2W and minimum for HCV. While at the speed hump it is in the range of 13 kmph to 19 kmph. Also the maximum mean value at hump is for small car.

*Krishna Hospital* - The mean speed for the hump at -24 m is maximum for small car and minimum for HCV. The mean speed ranges from 11 kmph to 17 kmph at hump.

*I B Patel School* - At rumble strips it is observed that maximum mean speed is for big cars and the minimum is for small cars and HCV. The mean speed varies from 6 kmph to 15 kmph. Also all the small cars are travelling at 7 kmph or more speed at rumble speed while the maximum speed of 3W is 8 kmph.

### 5.3) Speed Reduction Trends

*V C Patel School* - The maximum reduction of speed at bump is observed as 60% for LCV. Also the average reduction of speed at 32 m upstream for all modes is 4.22%.

*Jilla Panchayat Bhavan* - The maximum reduction of speed at hump is observed as 47% for BC. Also the average reduction of speed at 32 m upstream for all modes is 12.84%.

*Krishna Hospital* - The maximum reduction of speed at bump is observed as 60% for LCV. Also the average reduction of speed at 32 m upstream for all modes is 25.77%.

*I B Patel School* - The maximum reduction of speed at bump is observed as 75% for 3W. Also the average reduction of speed at 32 m upstream for all modes is 14.94%.

### REFERENCES

- [1] A.Hakan Lav, Ertugrul Bilgin, A. Hilmi Lav, "A fundamental experimental approach for optimal design of speed bumps", Accident Analysis and Prevention, 2017.
- [2] Ali Abdi Kordani, Saeed Monajjem, Amirarsalan Mehrara Molan, Eazaz Sadeghvaziri, "Simulation Modelling of Dynamic Response of Vehicles to Different Types of Speed Control Humps", Journal of Transportation Engineering, 2014.
- [3] Boris Antic, Dalibor Pešić, Milan Vujanic, Krsto Lipovac, "The influence of speed bumps heights to the decrease of the vehicle speed – Belgrade experience" Safety Science 57- 303-312, 2013.
- [4] Hernán Gonzalo-Orden Marta Rojo, Heriberto Pérez-Acebo, Alaitz Linares, "Traffic calming measures and their effect on the variation of speed", Transportation Research Procedia 18 (2016) 349 – 356, 2016.
- [5] Massimiliano Pau, Silvano Angius, "Do speed bumps really decrease traffic speed? An Italian experience", Accident Analysis and Prevention 33 (2001) 585–597, 2000.
- [6] Pan Liu, Jia Huang, Wei Wang, Chengcheng Xu, "Effects of transverse rumble strips on safety of pedestrian crosswalks on rural Roads in China" Accident Analysis and Prevention 43 - 1947– 1954, 2011.
- [7] Yang YANG, Xiaoduan SUN, Yulong HE, "Effectiveness of Rumble Strips on Freeways", Journal of Transportation Engineering, 2010.