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Speed spot study by comparing time mean speed and space mean speed: A case study

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Abstract
Objective: Speed being an important factor in terms of safety, comfort, time and economics as we generally carries out the speed spot studies for the determination of speed percentiles and speed distribution of a free flowing traffic stream at a particular location. As the data we collect or gather will be evaluated and are then used for determine the speed limits usually two main percentiles are often used i.e. (50th and 85th).which can be further analyzed for making important speed related decisions. The Aim of doing speed spot studies is to have a look at speed character. which are already existing on the road system as we know that traffic engineering generally involves collection of the data upon that factors the design speed is formed or posted for a particular road system as spot speed study is done for being an important traffic studies tool as it gives us idea about the traffic flow conditions under prevailing condition. As we know that usually the finial resource decrease with increasing population and due to increase in the traffic volume it has posed a challenge for the engineers to think about the situation and to handle large amount of traffic. As the data gathered from traffic theory are the important tools regarding the planning, designing and operational use of a road system due to rapid increase in the traffic volume it becomes very much difficult to maintain the design speed for a road system. Which results in the delay for reaching the destination or target point generally three parameters are to be used in the traffic theory are Volume, capacity and speed. The relation between these parameters has a great impact on traffic regulation and simulation. Speed data is collected on the mid-section of the 4 lane road stretch Rama-Mandi to Hoshiarpur in Punjab, India**.** In this study we have calculated the Space mean speed and Time mean speed and proven the relationship between the two i.e. VT>VS. This paper represents the traffic conditions on the road stretch Rama-Mandi to Hoshiarpur (NH3) and tries to analysis the results obtained from the speed spot study during off-peak hours. From this paper we come to know about the recommendation for improvement in the existing road system to provide good level of service and to come up with the appropriate speed limits.

Keywords: speed, volume, percentile speed, speed distribution, level of service (LOS), time mean speed (VT), space mean speed (VS)

Introduction

Road network plays substantial part in social & economic program of a Country. Transportation sector is a dynamic element related with almost all activities of life. Road accidents are becoming serious problem in current situation all over the world. Road accidents due to traffic flow are the primary cause of death by injuries and overall 10th primary cause all over world according to W.H.O:

- 1.2 million people die in road accident annually
- Total Number of victims that are injured or gets disabled in road accidents every year are about 50 million

Speed as being an important factor as it is concerned with the time, comfort, safety and economics as well. The quality of level and safety can be achieved by the speed on a given road system. We can define speed as the rate of movement of vehicle in a given distance per unit time. The typical speed units are kilometer per hour (km.ph) or miles per hour (mph). Time mean speed and space mean speed are the two types of speed. The Space mean speed can be defined as the average time taken by the various vehicles over the specific section or on the length of the section which are passing over that section. The Time mean speed or spot speed is the average speed at the spot of various vehicles at a given stretch. Spot study is carried out see the distribution of flow pattern under the prevailing conditions. Which are very useful in making many speed related decisions. Speed includes spot speed, journey speed and running speed? The main purpose of spot speed studies is to record speed characteristics under existing traffic conditions at a specific location along a roadway. Speed spot studies is an important element toward the engineering use as it provides the benchmarking of the speed percentiles which are further used in many speed related decisions like speed design, managing of the traffic volume and posting of the speed limits.as we know that speed gets effected by no. of factors which include traffic volume and the type of road.as it can be observed that it is higher in case of express ways and highways and bit lower in the collectors and the street ways speed is also effected by the lane width and the sight distance As we know that Speed decreases with an increase in traffic volumes. Traffic volume may be defined as the number of vehicles that passes a point along a roadway or traffic lane per unit time.

- It becomes compulsory to understand traffic speed characteristics as it is important requirement in the field of traffic engineering. As speed generally indicates the quality of service experienced by the traffic stream. To have knowledge of speed is an essential component of traffic engineering and projects related to geometric design of roads, regulation and control of traffic operations and

improvements, accident analysis, before-and–after studies of road improvement schemes, assessing journey times, congestion along roads and in correlating capacity with speeds.

- The study we are conducting based on speed spot study so Spot speed is the speed or instantaneous speed of a particular vehicle when it passes a section over a given period of time. Spot speed is measured by the calculating the time taken by the vehicle to cross the section at a particular spot. These Spot speed studies are generally carried out to frame out the distribution curve for the road system and to analyses the median speed over the specific location on the cumulative frequency graph. Spot speed is generally measured by an enoscope, radar and timing procedures (stop watch method).Manually the speed spot study has been performed in order to carry out the whole process for our data and the data has been analyzed.

Literature review

Highways are generally built for the society. They are not movable but they provide the service to the transport sector in turn which provides service to the humans for comfort.one of the main thing is the speed limit on Highways which are built by society for their comfort (Winch 1963). As one of the case study that is speed data from Ontario by using the institute of transportation. They suggested that the speed limits on the highway should be increased by using the method of 85^{th} percentile as the main asset according to that 85% of the drivers drive at the same speed under the free flow condition The method used is based on the 85th Speed percentile. This is the speed at which or below which 85 percent of drivers travel. It was observed that the speed limits posted on the specific location were not followed the site namely (401) the speed limit posted is 100 km/h but in real conditions it should be between 110-130 km/h and the other site that is (401) the speed limit should be increased from 105-110 km/h as on the existing ONTARIO highway

As we know that traffic engineering involves the use of different engineering methods to achieve the safe and efficient movement of goods and people along the road. Traffic flow is generally concerned with the safe and the efficient flow of traffic and in turn it is indirectly attached with the traffic flow pattern or distribution basically three parameters are prevailing in the traffic distribution that is volume, speed and capacity. In order to deal with the future needs the traffic management and planning to overcome needs the future needs of traffic related is to be done. Due to change in the economic conditions the traffic volume has increased significantly and movement of the people towards city area for rapid growth of industrialization. Along with which the concern about speed have been rising for a long time. This work by A Arib *et al* provided the traffic speed distribution in the city of Dhaka at a particular junction.

In order to have a scientific planning of road system, it is important to have a proper data base of existing traffic parameters on the road system. The different traffic parameters have been observed and later evaluated on selected urban road, connecting Samarkhachokdi to Anand new bus station by DK Thakor. Traffic volume study and spot-speed study have been conducted at both the ends of road system and analysis has been carried out.

Experimental setup/methodology

Stop watch method

It is one of the easy way to find out the speed spot study in stop watch method is generally used for small sample size which is taken over a short section on high way for a small period of time. This method is quick and inexpensive for the collection of data stopwatch method is a quick and Inexpensive method for collecting speed data

Key steps in stop watch method

- Acquire suitable length for study.
- Choice appropriate site and its layout.
- Recording the observations from stop watch observations on stopwatch.
- Determine the vehicle speed
- Create frequency distribution tables from the data gathered and determine the speed percentiles from the data table

Procedure

- Two observers are at the starting point one holding stop watch and other one with pen and the sheet to write down the readings
- The third observer is having a flag in his hand at the end point of the section to indicate the vehicle has crossed the section
- As the vehicle enters the section the stop watch is started as soon as the front wheels touches the reference line
- The third observer standing at the end point raises the flag to indicate the vehicle has crossed the section
- As soon as the flag is raised the stop watch is stopped and the elapsed time taken by the vehicle is noted down on the sheets
- This procedure is simultaneous carried out for different group of vehicles
- Sample size of usually 50(10 trucks, 10 buses, 10 four wheelers, 10 three wheelers and 10 two wheelers) is generally carried out on the site to yield good results
- After analyzing the time elapsed by individual vehicle the vehicle speed is calculated for every vehicle to cross the section
- After calculating the speed, normal distribution and cumulative frequency distribution are carried out to find out the speed percentiles
- Usually (50^{th} and 85^{th}) percentiles are carried out to find out the desired speed limits on particular road system
- Bar charts and the graphs are made on the excel sheets to carry out the further requirements for speed percentiles
- Time mean speed and space mean speed are analyzed and their relationship is to be analyzed for the particular road system

Results and discussion

Table 1: Speed data collection (speed spot study)

Speed spot study							
Date:21/22.11.2016				Start Time: 12PM, End Time: 2 PM			
Location: NH-3 (Rama Mandi-Hoshairpur Road) Wheather: Sunny							
Trucks				Buses			
Dist. M	Time Sec.	Speed m/s	Speed km/hr.	Dist. m	Time Sec.	Speed m/s	Speed km/hr.
60	4.8	12.5	45	60	4	15	54
60	4.5	13.3	48	60	3.2	18.8	67.5
60	4.2	14.3	51.43	60	3.1	19.4	69.68
60	5.3	11.3	40.75	60	3	20	72
60	5.2	11.5	41.54	60	4.2	14.3	51.43
60	5.5	10.9	39.27	60	4.1	14.6	52.68
60	4.1	14.6	52.68	60	3.2	18.8	67.5
60	4	15	54	60	3	20	72
60	4.2	14.3	51.43	60	3	20	72
60	5	12	43.2	60	3.2	18.8	67.5

Formula for calculating the speed $V = \frac{D}{1.47*T}$

Where,
V = spot speed (mph),
D = length (feet), and
T = elapsed time (seconds). In the equation,
1.47 is a constant that converts units of feet per second into miles per hour.

Table1 represents the spot speed of trucks and buses, table 2 represents the speed percentile of trucks and the calculation of the speed percentile is given in table 3 and the comparison between the time mean speed and the space mean speed is proven in table 4 which states (VT>VS) with respect to the particular class here we have taken truck in the excel sheet their bar charts and cumulative percentile graphs are drawn in (fig.1, fig.2) and alternately fig 3 shows the percentile speed on the graph for the trucks by drawing the perpendicular lines cores ponding to the 50th, 85th and 98th percentile (fig.3)order to show the relationship, further this the time mean speed and space mean speed is being monitored on the given section for separate classes and their relationship is proven (VT>VS) which is shown in the excel sheet in (fig.4, fig.5)

Table 2: speed percentile of trucks

Trucks				
Speed (km/hr)	frequency	Cumulative frequency	Cumulative Percentage	Speed Percentile
30-35	0	0	0	
35-40	1	1	10	
40-45	4	5	50	
45-50	1	6	60	
50-55	4	10	100	

Table 3: calculation of the speed percentiles graphically

Percentile	Trucks	Buses	Four wheelers	Three wheelers	Two wheelers
98th	49.75	69.5	87	37.5	54.5
85th	48	67.5	58	35.5	52.75
50th	40	62.5	30	32.5	49

Table 4: comparison between time mean speed and space mean speed

Speed	Trucks	Buses	Four wheelers	Three Wheelers	Two Wheelers
Time mean Speed	48	65	54	35	53
Space mean Speed	31.479	64.068	50.024	34.99	52.659

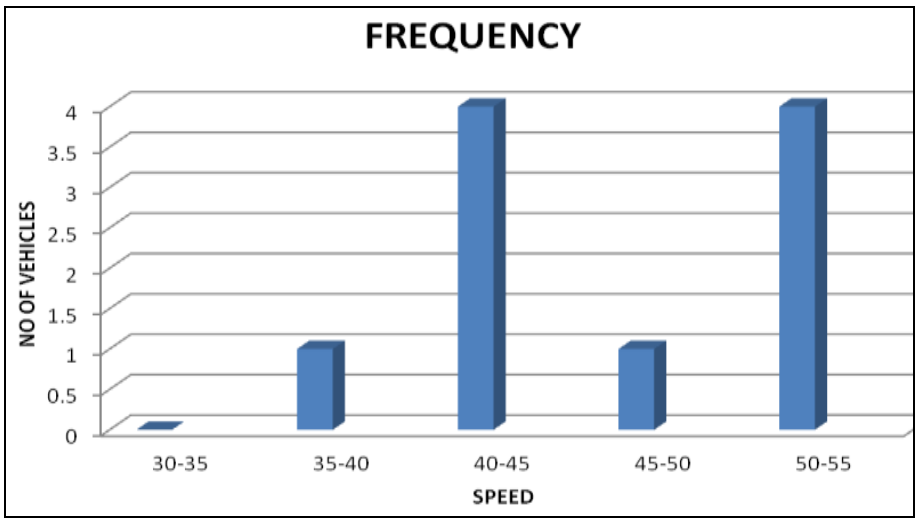

Fig 1: histogram for trucks

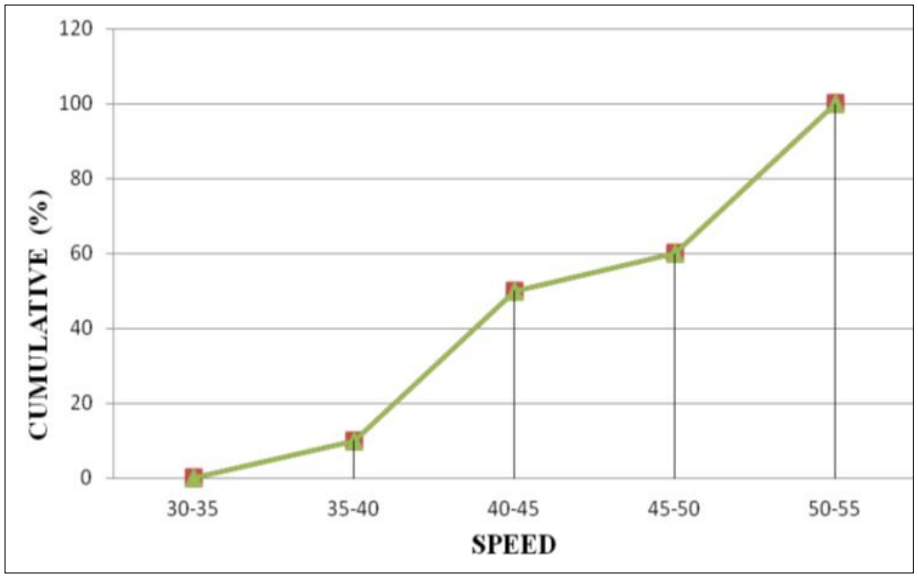

Fig 2: cumulative frequency graph for trucks

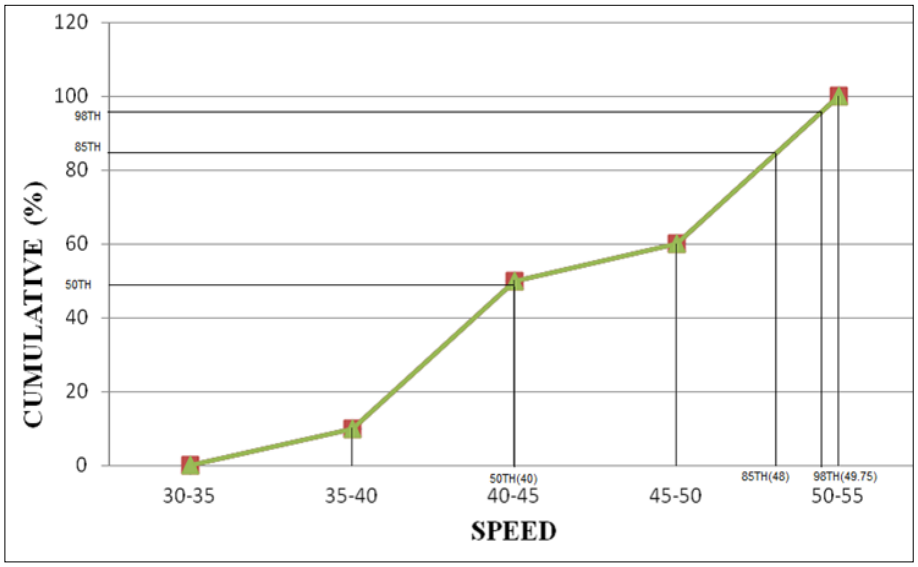

Fig 3: lines representing percentile speed on graph for trucks

	A	B	C	D	E	F	G	H	I	J	K	L
1	speed mid value (v)	volume of trucks (qt)	volume of buses (qb)	volume of 4 wheeler (qs)	volume of 3 wheeler (qt)	volume of 2 wheeler (qc)	trucks (qt.v)	buses (qb.v)	4 wheeler (qs.v)	3 wheeler (qt.v)	2 wheeler (qc.v)	
5	15	0	0	0	0	0	0	0	0	0	0	
6	25	0	0	0	0	0	0	0	0	0	0	
7	35	1	0	1	10	0	35	0	35	350	0	
8	45	5	0	5	0	2	225	0	225	0	90	
9	55	4	3	2	0	8	220	165	110	0	440	
10	65	0	4	0	0	0	0	260	0	0	0	
11	75	0	3	1	0	0	0	225	75	0	0	
12	85	0	0	0	0	0	0	0	0	0	0	
13	95	10	0	1	0	0	950	0	95	0	0	
14	Total q	10	10	10	10	10						
15	Total q.v						480	650	540	350	530	
16												
17	Time mean speed vt= total (q.v)/ total (q)											
18												
19												
20												
21												
22							48	65	54	35	53	

Fig 4: Time mean speed excel sheet

	A	B	C	D	E	F	G	H	I	J	K	L
1	speed mid value (v)	volume of trucks (qt)	volume of buses (qb)	volume of 4 wheeler (qs)	volume of 3 wheeler (qt)	volume of 2 wheeler (qc)	trucks (qt/v)	buses (qb/v)	4 wheeler (qs/v)	3 wheeler (qt/v)	2 wheeler (qc/v)	
5	15	0	0	0	0	0	0	0	0	0	0	
6	25	0	0	0	0	0	0	0	0	0	0	
7	35	1	0	1	10	0	0.028571	0	0.028571	0.285714	0	
8	45	5	0	5	0	2	0.111111	0	0.111111	0	0.044444	
9	55	4	3	2	0	8	0.072727	0.054545	0.036364	0	0.145455	
10	65	0	4	0	0	0	0	0.061538	0	0	0	
11	75	0	3	1	0	0	0	0.04	0.013333	0	0	
12	85	0	0	0	0	0	0	0	0	0	0	
13	95	10	0	1	0	0	0.105263	0	0.010526	0	0	
14	Total q	10	10	10	10	10						
15	Total q/v						0.317672	0.156083	0.527181	0.285714	0.189899	
16												
17	space mean speed vs= total (q)/ total (q/v)											
18												
19												
20												
21												
22												
23							31.479	64.068	50.024	34.999	52.659	
24												

Fig 5: Space mean speed excel sheet

Hence **Time Mean Speed** is always greater than **Space Mean Speed VT>VS**

Speed percentile and how to use them Speed percentiles are the usually the speed limits that are generated to determine the effective adequate speed limits. Usually two main percentile limits are used commonly (50^{th} and 85^{th}) percentiles. The 50^{th} percentile is the average or median speed in which 50% of the vehicles tend to flow on the average speed that is 50^{th} percentile for that group of class of vehicles along the road section.85^{th} percentile is usually used to set the design speed over a road system or we can say 85% of the drivers of vehicles tends to travel at or below 85kmph or it is safe design

speed for a particular road system.it can be used in recommending or evaluating the posted speed limits.85th percentile is normally considered to be safe maximum safe speed on a particular road system or required design speed. 98th percentile speed is generally used for the design geometric purpose or to assign the design speed for the road way system

Well Speed percentiles will get affected by the obstruction posed on the road system, bad weather like in rainy time we may get other results. That is why spot speed is carried out on a sunny day traffic flow should be free, there should not be any sort of obstructions that may affect the driver's behavior Speed percentile is calculated by this formula

$$SD = \frac{\text{PD}-\text{Pmin}(\text{Smax}-\text{Smin})+\text{Smin}}{\text{Pmax}-\text{Pmin}}$$

Where,
SD= speed at PD
PD= percentile desired
P max= higher cumulative percent
P min= lower cumulative percent
S max= higher speed
S min= lower speed.

Conclusion

1. The road surface are not maintained properly speed limits board along the road surface is missing.so the drivers are not aware of the speed limit.
2. The design speed is usually followed under the circumstances but the thing to instant growth of the vehicles over the years
3. The median on the carriage way should be of proper width as we have seen there where road section where the maiden is totally absent which can results in accidents.
4. Traffic engineering tools like traffic signs, signals and markings are not present on the road surface
5. Private sector vehicles are given preference over the public which results in the growth rate of vehicles Therefore comprehensive measures must be taken to have a check on the growing populations
6. Speed as being an important asset in terms for transportation usually people of age limits have different speedy behavior on the road system
7. 98th percentile is used for design speed for the roads
8. 85th percentile may be used for designing speed limits
9. 50th percentile is the average speed of the vehicles that are travelling on the road section

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