Determination of Relationship Between Space Mean Speed and Actual Travel Time on the Link Between Signalised Intersections in Ahmedabad city.

Umang Patel[1], Dhruv Patel[2]

[1] Prof. Civil Department, LDRP Institute of Technology

[2]Post Graduate Student of Infrastructure Engineering, LDRP Institute of Technology

Abstract

The urban traffic congestion has become a global phenomenon. Rapid urbanization and industrialization have caused drastically growth of vehicles all over the world but problem like congestion, delay, energy consumption, environmental pollution, etc. still remain in question if traffic signals are not coordinated. For coordination actual travel time prediction is necessary between two signalized intersections. Generally, Space Mean Speed (SMS) observed by sampling survey in the mid -block section. The total travel time on that link is calculated based on this SMS. In reality, actual travel time is somewhat more or different than the travel time calculated by SMS So, it is interesting to determine the relation between travel time by SMS and actual t ravel time taken by vehicles to cross the link.

INTRODUCTION

Transportation sector plays significant role in implementing the financial development of any country. India has one of the biggest road networks in the world balanced around 3.4 million km at present. As per present calculation, total road network carries about 65% of goods and 85% of passenger traffic. Traffic on the roads is increasing at the rate of 7 to 10 % per annual. National highways are the main road which carries about 40 % of total road traffic and National highways share only2 % of total road network system. These will obviously show the traffic congestion and fall in level of service on road.

Traffic stream is the study of relation between vehicles, drivers and infrastructure (including the roadways, traffic signals, other traffic devices), with an aim to understanding and creating an optimal road network with sufficient movement traffic to control the congestion of vehicles. Traffic streams are explained by three basic parameters namely flow (Q), density (K) and speed (v) which is measured in vehicles per lane per hour, Vehicle per lane per kilometers and kilometers per hours respectively. These parameters are identified by stationary condition at each point in time and space. These basic parameters are related by Q=KV. The heavy concentration of populations in urban centers has resulted in the growth of cities in area as well as density. Increment in population and economic activities the results in increment of travel demand. Study of the basic traffic flow characteristics like traffic volume is the pre-requisites for the effective planning, designing, operation and organization of roadway system. Traffic in the developing countries like India is heterogeneous in nature containing different categories of vehicles with widely varying dimensional and operational behaviors. Under this type of condition, it becomes very hard to make all vehicles lane following. In such heterogeneous condition traffic has been converting the different category into Passenger Car Unit (PCU). The urban traffic congestion has become a global phenomenon. Rapid urbanization and industrialization have caused drastically growth of vehicles all over the world. But the difficulties like congestion, delay, and environmental pollutionetc.still remain in question if the traffic signals are not coordinated. Coordination of signals is achieved when the flow of traffic on a particular phase of movement at one junction is accommodated by a "go'' phase on its arrival at the next signalized intersection. It enhances progressive movement of traffic flow at specific speed without forced halts and reduced overall delay. It reduces the speed variations and provides smooth traffic operation, which increases capacity, decreases energy consumption and reduces air and noise pollution. Coordination of traffic signals on a road is one kind of traffic management measure.

For the coordination of traffic signals in a given urban road network, different software packages are available like, SCOOT, TRANSYT, DYNAMIT etc. These are working with the help of sensors. These are costly and may not be giving satisfactory results in Indian traffic conditions so this study is useful in the co-ordination of traffic signal in mixed traffic urban roads.

AIM OF STUDY

Determination of relationship between Space Mean Speed (SMS) and actual travel time on a link between signalized intersections.

OBJECTIVE

1. To measure the Space Mean Speed of vehicles in the mid-block of the link between signalized intersection.
2. To enumerate the actual travel time of a particular vehicle.
3. Develop a relation between the Travel time calculated by space mean speed and actual (observed) Travel time of vehicle between stop lines of two signalized intersections.

SCOPE OF STUDY

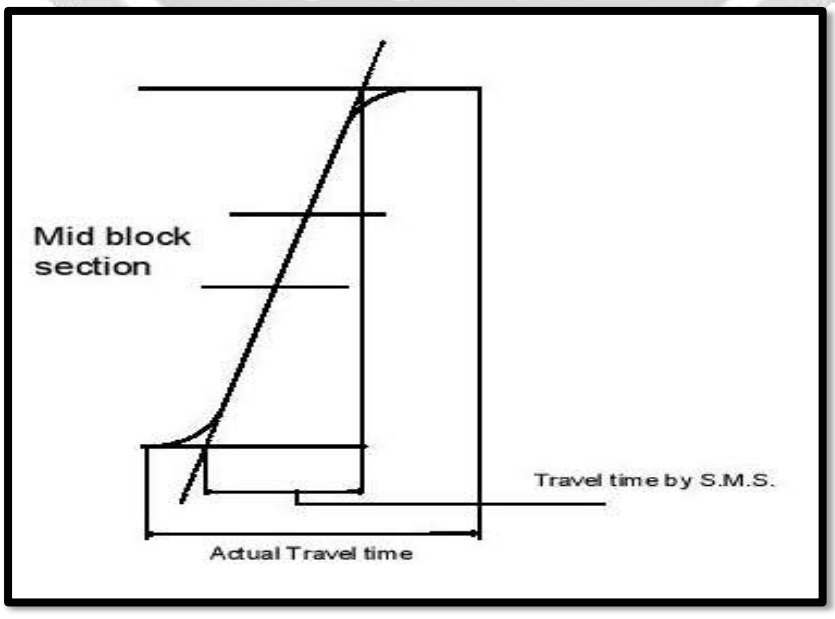
1. It involves spot speed study with an aim to develop various relationships between Traffic flow parameters (Space mean speed and actual travel time) under existing situations for study area.
2. Study is limited to observe the travel time and space mean speed on the links between 3 intersections (4 arm signalized intersection) in Indian traffic condition.
3. This study will helpful for designing coordinated signal on urban corridors.
4. This relationship can be utilized the same situation at other sites.
5. This relationship can be utilized for trip assignment procedure.

METHODOLOGY

In this chapter the complete methodology for obtaining actual travel time from videography survey has been illustrated. To calculate the actual travel time for each and every vehicle traversing from one intersection to other intersection and after negotiating the signalized intersection towards next intersection is difficult task. In this study an attempt has been made to vehicle passing from one intersection to second and third intersection (as depicted in figure) and calculating its actual travel time to passing the intersection.

5.1 Adopted Methodology

As stated the problem statement in signal co-ordination Time space diagram and Average speed of traffic stream will be considered. Average speed of traffic stream is obtained by spot speed study of mid-block section. Spot speed study gives Space Mean Speed (S.M.S.) and this S.M.S. are considered for signal co-ordination.Suppose figure is fundamental details of vehicle passing through signalized intersection and track of vehicle. SMS of the vehicle is taken at the mid-block of link and if slope of SMS is extended for that distance (mid-block distance) which gives Travel time by SMS (tt_S)In other hand actual track of vehicle is different and slope from actual track gives actual travel time of vehicle (tt_a) for that stretch.



Data Analysis sheet

Cycle no.	SMS (S) at mid- block (m/s)	Travel time by SMS $tt_s = l / s$ (sec)	Average of Actual Travel time of vehicles tt_a(sec)
1			
2			
3			
4			
Up to n			

For the n observations, relationship (linear Regression) between $tt_s$and *att* will be obtained using MS Excel (LINEST Function).

$$tt_a = a_o + b\,(tt_s) \quad \text{...} \quad (1)$$

From the above equation find the value of r^2

This type of relationship will be obtained for stopped vehicles so, relationships between Actual Travel Time ( ) and Travel time by Space Mean Speed ( ) will be obtained for peak hours of the day.

5.2 Field Videography

Video Camera is used to collect the data. The video camera takes continuous picture of the traffic and pictures are recorded on the videotape.

The Video recording has number of advantage as under,

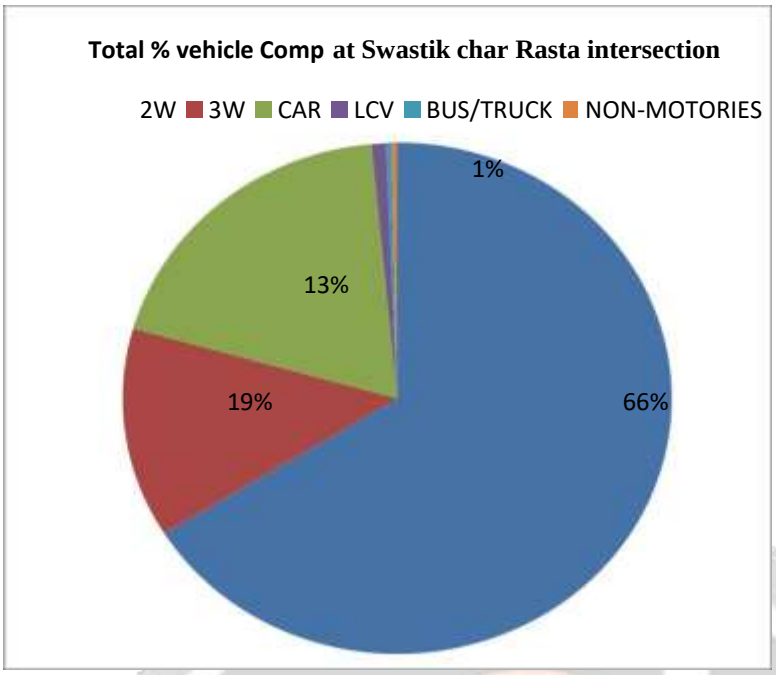
- Require of small amount of labour.
- It produce permanent record.
- Record can be reanalyzed at any time.

5.3 Data Analysis

From the videos different vehicles were tracked from A to B and B to C. Camera 1 covers the A intersection, Camera 2 covers the vehicles coming from A intersection and B intersection too. Camera 3 covers only vehicle coming from B and Camera 4 covers vehicles coming from camera 3 and vehicle going to C intersection.

In data analysis fixed location was taken as the reference and that fixed locations were electric pole (street light-28 m apart). 15-15 fixed points were taken from A to B and B to C so vehicle tracked with respect to fixed reference points.

5.4 Total vehicle composition at interection.



Calculation of Travel time by Space Mean Speed and Actual travel time

Intersection A to B (T.T.in sec)											
Chainage (m)/ Vehicle Type	Pole 1	Pole 2	Pole 3	Pole 10	Pole 11	Pole 12	Pole 13	Pole 14	Pole 15		Actual T.T.
	0	27.2	83	279.7	307.1	333.7	361.1	388.5	414.9		
WHITE CAR	17:37:37	3	5	24	2	4	4	4	83	17:39:46	129
BLACK CAR	17:37:42	3	8	32	3	2	4	4	70	17:39:48	126
SILVER SENTRO	17:37:45	3	7	37	2	5	4	6	65	17:39:54	129
BOLLARO	17:37:47	3	7	36	3	5	6	4	64	17:39:55	128
SILVER CAR	17:37:48	4	8	39	2	5	5	5	59	17:39:55	127
SILVER CAR	17:38:05	4	8	38	3	5	4	9	7	17:39:23	78
RED CAR	17:38:20	3	8	40	3	4	6	6	30	17:40:00	100
SILVER CAR	17:38:25	3	7	40	2	5	5	28	9	17:40:04	99
WHITE CAR	17:38:57	4	7	34	3	5	5	6	4	17:40:05	68
WHITE 2W	17:37:21	4	5	26	4	3	3	4	4	17:38:14	53
2W	17:37:22	5	4	27	3	3	4	2	4	17:38:14	52
WHITE 2W	17:37:23	5	4	26	4	3	3	4	3	17:38:15	52
3W	17:37:40	4	6	29	4	4	4	3	66	17:39:47	117
3W	17:37:41	4	6	30	3	4	4	5	62	17:39:49	118
3W	17:37:45	4	5	29	4	4	3	8	3	17:38:45	60
Total					45						1436

(Note: Yellow high-lighted cell rows for the stopped vehicles, remaining cell rows for Non-stopped vehicles)

$$\text{Space mean speed} = \frac{\text{mid block length(m)} \times \text{No. of vehicle}}{\sum_{i=1}^{n} \text{ti(mid block)}}$$

$$\text{Travel time S. M. S(tts)} = \frac{\text{total link legth(m)}}{\text{S. M. Sof vehicle}}$$

$$\text{Actual travel time(tta)} = \frac{\sum_{i=1}^{n} \text{ti(observe travel time of whole link)}}{\text{No. of vehicle(n)}}$$

Values of tt_s and tt_a for intersection A to B

Sr. No.	Avg.			stopped			Non-stopped	
	Tts	tta		tts	tta		tts	tta

1	62.9921	83.96		78.2354	116.6667		58.1784	73.6315
2	71.6737	104.8		68.1405	156.5		62.2172	86.8461
3	57.5408	150.4		55.063	161.3636		64.3549	120
4	52.4984	123.5333		45.427	148.875		54.0797	94.5714
5	50.4744	82.5333		45.427	119		42.9981	64.03
6	59.5598	112.7333		60.5693	129.2857		58.6765	98.25
7	55.5219	115.5333		56.0266	127.4		51.4839	91.8
8	50.4744	113.2		51.1053	121.5		49.7533	103.7143
9	52.4934	110		54.5124	129		61.4839	100.4
10	53.5029	99.9333		51.4839	102		54.5124	98.9
11	47.4459	108		45.427	166.2		48.4554	78.9
12	40.3795	139.3333		38.9374	176.5714		54.6414	106.75
13	45.427	95.7333		41.6414	121.75		45.7533	66
14	37.351	102.2		35.963	124.375		38.9374	76.8571
15	34.3226	85.8		32.8083	112.5		35.3321	68
Total	771.6578	1627.693		760.7675	2012.987		780.8579	1328.65
Ratio (tta/tts)	2.109345749			2.645995524			1.701526488	

For intersection A to B,

- The ratio of Actual travel time and travel time by S.M.S. for Non-stopped vehicle condition is 1.70 and 1.74.
- The ratio of tta/tts for stopped condition (including stopped delay of vehicle during red time) is 2.64 and 2.47.
- The ratio of tta/tts for average condition (including both condition stopped and Non-stopped) is 2.10 and 2.34.

Relation between tta and tts for intersection A to B

$$y = 1.276 (x_1) - 0.534 (x_2) - 1.27 (x_3) - 0.9(x_4) + 91.99$$

Where,

y = Actual travel time of vehicle in sec,

x_1= Travel time by Space Mean Speed in sec,

x_2 = % composition of two wheelers,

x_3 = % composition of three wheelers,

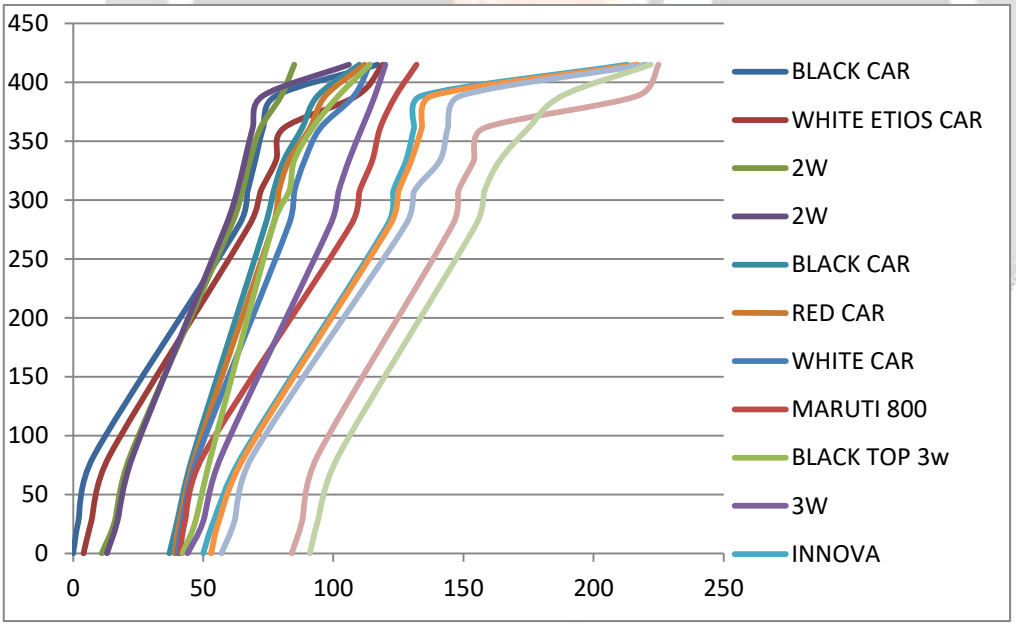
x_4= % composition of cars.

Co-efficient of determination $r^2 = 0.52$

Co-efficient of determination for Intersection A to B

	X_4 (% car)	X_3 (% 3W)	X_2 (% 2w)	X_1 (TTs)	y (TTa)
	-0.90461	-1.27076	-0.53416	1.275925	91.99743
STD ERRORE	3.308699	3.292317	3.50997	0.444199	343.5209
$_R2$	0.520569	13.71965	#N/A	#N/A	#N/A
DEGREE OF FREEDOM	2.714518	10	#N/A	#N/A	#N/A
	2043.801	1882.288	#N/A	#N/A	#N/A

Time-space diagram for A to B



CONCLUSION

- **Vehicle Composition**

➢ On the selected urban street overall percentage of vehicle composition in Swastik char Rasta intersection (A) to Girish Coldrinks intersection (B) shows that about 66 % 2w, 13 % 3w, 19 % car, 1 % LCV, 1 % bus/truck and less than 1% of Non-motorizes.

➢ On the selected urban street overall percentage of vehicle composition in Girish Coldrinks intersection (B) to Bodyline intersection (C) shows that about 62 % 2w, 17 % 3w, 20 % car, 1 % LCV, less than 1 % bus/truck and less than 1% of Non-motorizes. Hence, 2w, 3w and car category are dominant in this study.

REFRENCE

Papers

1] Karthik G. and Ralegoankar R.V. (2014) "Optimization of signal timings at signalized intersections in Indian Scenario" Submission number-146.TPMDC, IIT Bombay, 14-August (2014)

[2] Patel V.J. and Kumpavat H.R. (2014) "Modeling of Speed- Flow Equations on Four- Lane National Highway-8".

[3] Prema S.M. and Venkatachalam T.A. (2013)"Influence of Traffic Mix On PCU Value of Vehicles Under Heterogeneous Traffic Conditions".

[4] Tiwari G., Fazio J. and Gaurav S. (2007) "Traffic planning for non-homogeneous traffic".

[5] Doshi R.H. (2014) "Influence of vehicle on traffic flow characteristics in urban area" A thesis submitted to GTU

[6] Patel K.M. (2011) "Signal Coordination at Small Network Level" A thesis submitted to GTU.

[7] Patel K.M., Varia H.R., and Gundaliya P.J. (2011) "A Methodology of Signal Coordination at Network Level" at National Conference on Recent Trends in Engineering & Technology.

Books:

[1] L. R. Kadiyali L.R., Traffic Engineering and Transport Planning. [2] Khanna S.K. and Justo C.E.G. Highway Engineering.

[3] Khisty C.J. and Lall B.K. Transportation Engineering.

[4] Roess R.P., Prassas E.S., William R.M. Traffic Engineering 4th edition. [5] CA O'Flaherty