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A Study on Performance of an Urban Arterial Corridor

Guggilla Raju[1], Rontala Ashwini[2]

[1]Assistant Professor, Department of Civil Engineering, GCET

[2]Assistant Professor, Department of Civil Engineering, GCET

Abstract: ***Transportation Engineering is a branch of Civil engineering that uses engineering techniques to achieve safe and efficient movement of people goods. Highway safety has become a dire need for which traffic engineering is of great use as it uses physics and vehicle dynamics as well as road users physiology and human factors engineering in giving detailed information for safety purposes. It deals with functional part of transportation system. Information about traffic must be regularly updated to keep pace with ever changing transportation system. Traffic surveys are the means of obtaining information in this regard. For a complete description of traffic stream modeling, one would require flow, speed and density. So quantification of speeds and delays using moving observer method is considered. It has capacity to provide simultaneous measurement of traffic stream variable. Fundamental stream characteristics are known easily. In accordance with the above method acceleration and deceleration studies are taken in to account. The curves of acceleration and deceleration are obtained for different volumes of traffic. Both the studies are compared and traffic characteristics and the problems with the smooth moving vehicles are identified depending on the results of two traffic surveys. For this purpose a stretch of 2 km is considered. The vehicular characteristics, stream flow and the inconveniences caused to traffic are drawn using those surveys and finally solutions are proposed based on the conclusions drawn.***

Keywords: Moving observer method, level of service.

1. Introduction

Rapid industrialization and urbanization in India has resulted in enormous growth in road traffic, which in turn mounted pressure on transportation planners and traffic engineers to regulate, control and manage the traffic effectively. Various methods of traffic regulation on urban roads are available, in which traffic engineers often use the Level of Service (LOS) concept to judge the performance of a road network based on scientific studies. Floating car technique is adopted in the present work to study the speed variation as a function of flow at Macro level.

1.1. Objectives and Scope of the Study

Urban Street is a complex organism. It is a great human enterprise that should serve the material and spiritual needs of humanity.

The urban street is seriously suffering for decreasing speeds, increased congestion, increased travel time, decreased level of service, increase in accident rates.
The objectives of the study corridor are

- To study the existing traffic conditions and road conditions.
- To analyze the traffic characteristics (speed, flow and concentration) and identifying the issues related to congestion.
- To define free flow speed ranges of urban street classes and speed ranges of LOS categories using moving observer method.

1.2. Study Area

The arterial selected is a 2 kilometers stretch from Jeedimetla Bus Depot (J.B.D) to Jeedimetla Police Station (J.P.S) which is in the city of Hyderabad in the state of Telangana. The purpose for selecting this arterial is that even though it is with two opposite lanes there is a lot of congestion during the week days at almost all the hours. This is due to the over traffic volume. The details of the arterial are 4-lane two way divided road, With two junctions, Congestions at 2 places, Presence of a holy place on the road, Length is 2 kilometers, Located in the Industrial stretch, More availability of public transportation vehicles and presence of commercial complexes on either sides of the road. The arterial is selected to study of all the details with the help of the traffic engineering surveys as mentioned above.

2. Survey Method

2.1. Floating Car Method

In the floating car method, a test vehicle is driven over a given route of travel at approximately the average speed of the stream, thus trying to float with the traffic stream. A number of test runs are to be made with a group of observers are seated in the vehicle. These observers have to record various observations during each run of the test vehicle. From the observations collected during the each run, the average journey time, average running time, average journey speed, average running speed, total stopped delay are to evaluated by using formulae given below.

The average journey time, $\bar{t} = t_w - \frac{n_y}{q}$,

Flow of vehicles, $q = \frac{n_a + n_y}{t_a + t_w}$,

n_a
$= Average\ no.of\ vehicles\ during\ trips\ in\ opposite\ direction$
$n_y = Avaerage\ no.of\ vehicles\ overaking\ minus\ overatken$
$t_w = Average\ journey\ time\ with\ the\ stream$
$t_a = Average\ journey\ time\ against\ the\ strea$

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2.2. Work Procedure

The survey was done on 2 different days. Steps followed in doing the survey can be given as follows.

- Police permission was taken for uninterrupted carrying of the survey.
- A four wheeler vehicle was made available.
- Group of four people moved on to the arterial for carrying out of the survey.
- One person was handed over with the work of calculating the opposing traffic as per the given format.
- Another person dealt with the overtaking vehicles.
- Overtaken vehicles were counted by some other person.
- The survey was done at three different times i.e. morning between 8 and 11, and afternoon between 1 to 2:30 and finally between evening 6 and 8:30.
- The morning and the evening hours had lots of amount of traffic.
- The test vehicle moved from Jeedimetla bus stop to Jeedimetla police station and in turn reverse direction and the simultaneous counting was being done.
- Almost 20 runs were being done on the very first day (10^{th} of March) i.e. 8 in the morning, 4 in the afternoon and 6 in the evening.
- The very next day(11^{th} of March) another 10 runs were conducted.
- The tabulated values are consolidated by counting the traffic and adding up each and every category.
- The counted values are set to be installed in excel sheets.

Thus the work was carried out, the calculations and the tables are prepared and these are used up in calculating the level of service of the arterial.

For the acceleration deceleration studies an extra person along with the persons of the project was asked to take the video recording of the speedometer of the car when it was going in between the two junctions i.e. Jeedimetla bus stop and the Jeedimetla police station. These video recordings were taken and the speed was calculated for every 30 seconds for each of the run and the speed was found out. From the speed the formulae that was used in the moving car method, the flow , the stream speed and the density were found out. The video recordings were done for 10 runs and are 4 trips in the morning hours, 2 trips in the afternoon hours,4trips in the evening hours.

3. Traffic Volume Counts

A graphical representation of all the three conditions i.e., Total number of vehicles in opposite direction, number of vehicles overtaken by the test vehicle and number of vehicles overtaking the test vehicle were made below in the Fig.1 below.

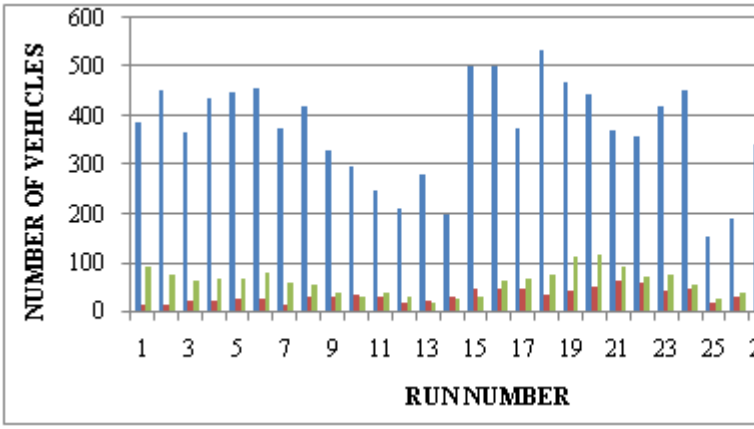

Figure 1: Total number of vehicles overtaking, overtaken and in opposite direction

Table 1: Table showing calculations of speed, flow and density

Code	N_{opp}	N_o	N_{by}	Journey time (minutes)	Total stopped delays (seconds)	Flow veh/min	Flow veh/hr **Q**	Flow Towards	$N_o - N_{by}$	$(N_o - N_{by})/q$	$\bar{t} = t_w - \frac{n_y}{q}$	Stream Speed (kmph) **U**	Density Veh/km **K**
2	388	17	92	8.00	35	21.06	1263	J.P.S	-75	-3.56	0.17298	10	126
1	454	15	79	10.00	158	18.00	1080	J.B.D	-64	-3.56	0.14754	9	122
2	367	24	67	6.00	85	24.56	1474	J.P.S	-43	-1.75	0.25804	15	95
1	436	26	69	10.00	115	20.25	1215	J.B.D	-43	-2.12	0.16497	10	123
2	447	30	70	8.00	55	29.71	1783	J.P.S	-40	-1.35	0.21399	13	139
1	456	27	83	6.00	60	27.93	1676	J.B.D	-56	-2.01	0.24984	15	112
2	374	17	60	5.00	15	26.93	1616	J.P.S	-43	-1.60	0.30318	18	89
1	420	31	56	9.00	82	24.93	1496	J.B.D	-25	-1.00	0.19994	12	125
2	330	32	41	5.00	8	20.50	1230	J.P.S	-9	-0.44	0.36771	22	56
1	296	36	32	7.00	52	27.83	1670	J.B.D	4	0.14	0.2917	18	95
1	248	33	42	5.30	18	21.72	1303	J.B.D	-9	-0.41	0.35	21	62
2	211	20	32	4.00	14	33.71	2023	J.P.S	-12	-0.36	0.45914	28	73
1	282	23	21	5.00	5	26.64	1598	J.B.D	2	0.08	0.4061	24	66
2	201	33	28	4.00	35	37.66	2260	J.P.S	5	0.13	0.51716	31	73
2	504	50	33	8.00	65	27.37	1642	J.P.S	17	0.62	0.27105	16	101
1	503	49	65	11.00	112	18.84	1131	J.B.D	-16	-0.85	0.16879	10	112
2	374	49	70	9.00	75	21.91	1315	J.P.S	-21	-0.96	0.20084	12	109
1	533	38	78	10.00	210	14.52	871	J.B.D	-40	-2.75	0.15681	9	93
2	470	44	113	7.00	85	16.35	981	J.P.S	-69	-4.22	0.17824	11	92
1	445	54	120	12.00	230	17.57	1054	J.B.D	-66	-3.76	0.12692	8	138
4	373	65	94	7.00	21	19.53	1172	J.P.S	-29	-1.48	0.23571	14	83

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3	361	63	75	10.00	95	19.53	1172	J.B.D	-12	-0.61	0.18842	11	104
4	420	44	77	6.00	31	27.93	1676	J.P.S	-33	-1.18	0.2785	17	100
3	452	48	56	9.00	69	27.47	1648	J.B.D	-8	-0.29	0.21526	13	128
4	157	20	28	5.00	10	31.39	1883	J.P.S	-8	-0.25	0.3806	23	82
3	191	32	39	4.50	5	25.73	1544	J.B.D	-7	-0.27	0.41911	25	61
4	341	36	38	8.00	31	22.00	1320	J.P.S	-2	-0.09	0.24719	15	89
3	420	54	88	11.00	255	16.16	969	J.B.D	-34	-2.10	0.15262	9	106
4	456	68	109	11.00	240	17.00	1020	J.P.S	-41	-2.41	0.14912	9	114
3	466	71	121	14.00	350	16.24	974	J.B.D	-50	-3.08	0.1171	7	139

4. Analysis of Data

Graphs are drawn for different conditions with the help of the scatter plots. The speed, density and flow are the three parameters used up and the graphs are drawn.

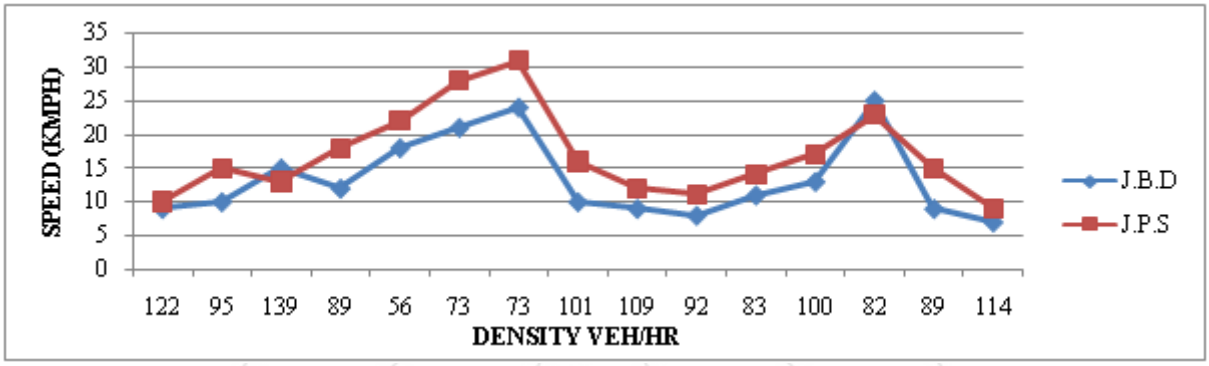

Figure 2: Speed - Density Curve

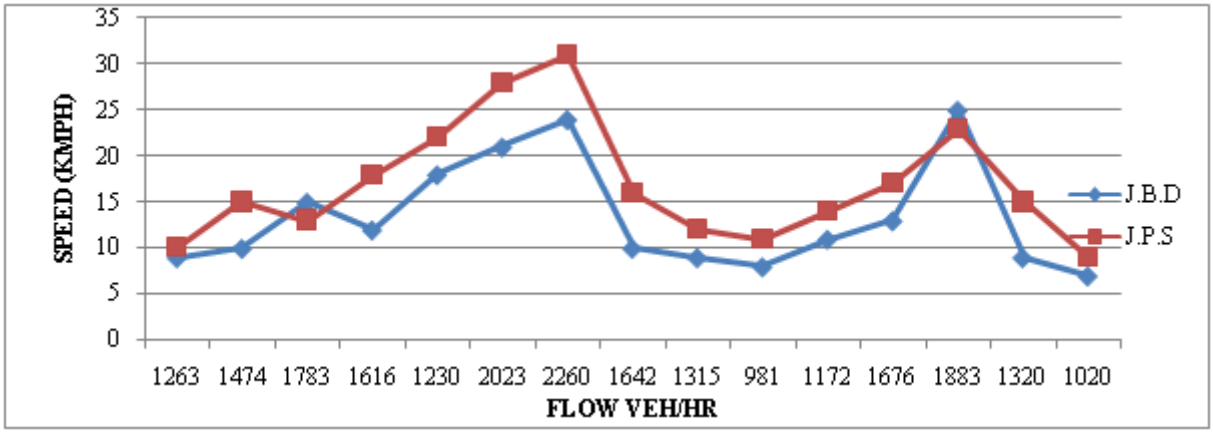

Figure 3: Speed-Flow Curve

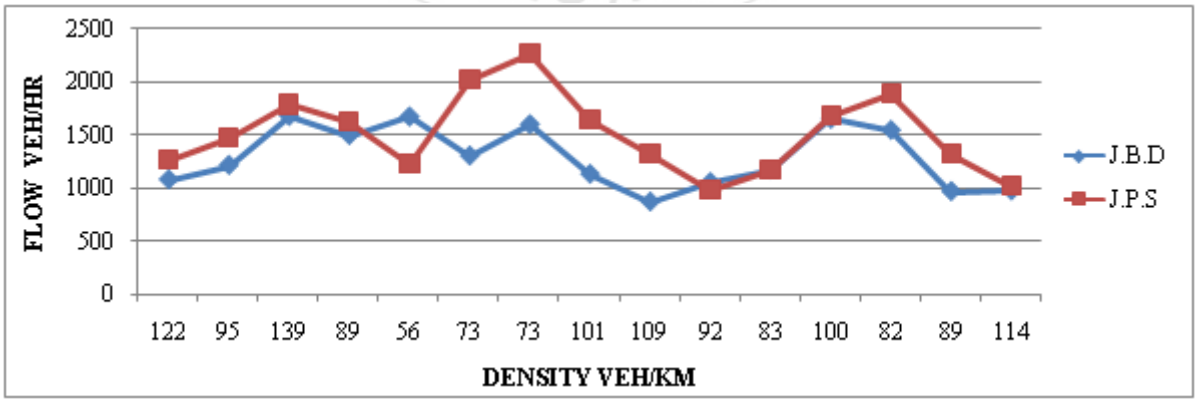

Figure 4: Flow-Density Curve

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Table 2: Capacity as per IRC 106-1990

Capacity
4 lane divided two way
2900 PCU PER HOUR
The road width is 18m with a divider
Two lanes on each side
Capacity is taken as : 3600PCU/HOUR
Free flow speed: 40KPH
Design volume = 0.77 as per IRC

Then the capacity and the v/c ratios are used up to decide the LOS service of the roads. In the process a theoretical graph was plot with the equations used and this can be given as below as per IRC 106-1990.

Table 3: Percentage of LOS

LOS	RUNS	%
A	0	0
B	14	13.333
C	15	50
D	5	17
E	2	4
F	4	13.333

From the above table, it was found to be the more runs are under LOS C as its percentage was 50. As we all know the IRC guidelines for different level of services. It is found that the arterial is mainly under level of service C and at very peak times it is meeting F also. Sometimes it is wavering around D and B also. So at last the arterial is facing a problem of congestion.

Some of the reasons were found out for the problem of congestion are:

1) Heavy traffic due to companies in morning and evening hours.
2) More concentration of private transport.
3) Connecting road from city to Highway.
4) Presence of religious place at the center of road.
5) Signalized intersection is not present.
6) Uneven changing of lines.
7) No traffic discipline.
8) More crossing pedestrians.
9) Some more common traffic congestion reasons.

So certain suggestions are to be made for the effective utilization of the arterial.

1) Prohibiting on street parking of vehicles and simultaneously developing off street parking facilities.
2) Segregating the bi-directional traffic flow through central verge/median.
3) Provisions of segregated right of way for slow moving vehicle
4) Provision of adequate facilities for pedestrians and cyclists.
5) Banning certain conflicting movements.
6) Controlling the cross traffic.
7) Extension of road or provision of another way at the Jeedimetla bus depot.
8) Improving traffic discipline.
9) Use of public transport.
10) Reduction of heavy vehicles before evening peak hours.
11) Provision of traffic police at the intersections.

Thus the capacity of the arterial may be increased by following certain measures, so that the volume meets the capacity.

5. Summary

In this study, various limitations in IRC 106-1990 methodology for defining LOS criteria was found out and an attempt has been made to develop methodologies to define LOS criteria for urban streets in Indian context.

Moving observer method was used to collect the speed and inventory data. Applications of Moving observer method for traffic data collection were reviewed from literature. The concept of urban street classification based on free-flow speeds, function and geometric characteristics of street segments are presented. Also important influencing factors that affect level of service classifications of urban streets are enumerated.

From literature it was found that floating car technique is the suitable technique that can be applied for the classification of urban streets and level of service categories. Firstly, the traffic characteristics such as speed flow and density were analyzed. In the latter case, speeds were classified into six categories for six levels of service; thus speed ranges for level of service categories were defined for Indian conditions.

6. Conclusions

The following conclusions are listed below in this research work in defining level of service criteria of roads in urban Indian context.

- An arterial between the Jeedimetla bus depot and Jeedimetla police station was studied thoroughly using the traffic engineering surveys. The moving observer method and the acceleration and the deceleration studies were done by a group of 4 people.
- The flow, stream speed and the density values were found out with the help of the traffic counts and are converted into the PCU factors with the help of the formulae and the IRC guidelines.
- The converted PCU factors and the respective values were used up in deciding the level of service of the arterial. The runs calculated from the moving observer method were taken into account and each run was allotted a level of service.
- It was found that all the runs are wavering as they were done at different timings. But of all the runs maximum are having the level of service C which indicated some kind of congestion. The remaining runs are wavering between D, B and F mainly. The arterial is perfect only when the level of service is at A and B. but in this arterial case it is not happening.
- So, with the help of the IRC guidelines and the observed traffic conditions the congestion reasons were found out and the respective suggestions were made so that the arterial has its original working capacity. The volume of the road should not exceed its capacity. Thus by following

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the suggestions made there can be a chance of improving the working capacity of the arterial.

7. Limitations and Future Scope

There are some limitations in this study and opportunity lies in future studies to eliminate these limitations.

- This study is done for the city of Hyderabad for a selected stretch. Similar study can be carried out in other cities of India, as India having significant diversities among its people and their driving characteristics.
- For this research only midsized vehicle is used for data collection purpose. All though midsized vehicle has significance presence in urban roads of India and data collection using these vehicles is convenient and easy but to get complete picture of heterogeneous traffic flow further study can be done using more numbers of modes.
- In this research the traffic data is collected using manual method, this can also be done with the GIS and GPS.
- The user perception should be given consideration in defining LOS criteria of roads in urban Indian context. This study is based on quantitative measure of service, which can be extended for qualitative measurement to develop comprehensive LOS criteria.

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