

# Analysis & Improvement Suggestions for Traffic Flow Characteristics and Road Geometrics

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**Abstract:** The rapid urbanization and industrialization is resulting in growth of traffic at a very higher rate and put forward challenges for civil and traffic engineers for improvement, rehabilitation and maintenance of roads with effective and efficient traffic control and management. A study is performed in Basaveshwar nagar and Rajajinagar area related to the traffic characteristics namely traffic speed, traffic volume and road geometrics. Also these studies are used to obtain the capacity of the road in terms of the maximum number of vehicles that can move with reasonable speed on a given road. Speeds are measured using Radar Gun. Traffic volume survey is done by manual counting. The study also helps in developing mathematical, economic model by relating the collected data with the census data, employment survey etc. which help in planning a long term action for growing traffic congestion. In the present investigation ten locations are selected around Basaveshwar Nagar & Rajajinagar.,1) West of Chord Road (Havells Galaxy) 2) Modi Road (Lakme Saloon) 3) Rajkumar Road (St.Anns High School) 4) Rajkumar Road (Suzuki Showroom) 5) Rajkumar Road (R.T.O Office) 6) Esi Hospital 7) Modi Road (Preethi Conv Hall) 8) Magadi Road (Devi Chem) 9) Basaveshwar Nagar (Bharath Petroleum) 10) Pavithra Paradise Road (Reebok Show Room) At the above locations, the road geometrics is measured and the traffic volume and traffic speeds are observed. The data is collected for peak hours (8.00am - 10.00am) & (5.00pm-7.00pm), off peak hours (10.00am-12.00pm) & (2.00pm-4.00pm) at above 10 locations. Totally 8 hours in a day speed and volume survey was conducted. Mathematical model for traffic characteristics is developed using linear and multiple regression methods by relating traffic speeds and road geometrics and its related parameters.

**Keywords:** Analysis, comparison, speed, volume, road geometrics, mathematical model, traffic flow characteristics.

## I. INTRODUCTION

### 1.1 General

The road transportation network contributes to the economic, industrial, social and cultural developments and hence their planning is very crucial and important for the development of the area. Added to this increased number of accidents and reduced reliability of public transport services led to the high percentage usage of private vehicles. At this juncture, the need to protect the existing road network in good operative condition.

### 1.2 Traffic scenario in Bangalore city:

Bangalore earned distinction as a garden city, slowly converted itself into Silicon Valley of India, in addition to garden city. Due to the establishment of various manufacturing industries, With the development in the field of IT, BT and other sectors Bangalore has become one of the fastest growing cities in Asia. This resulted in the growth of population including the urban area followed with the rise in vehicle population and trips (Table 1). As the vehicular trips increased the related problems like congestion, delays, accidents, reduction in speed have seen rise in trend. Speed is an important parameter in traffic analysis.

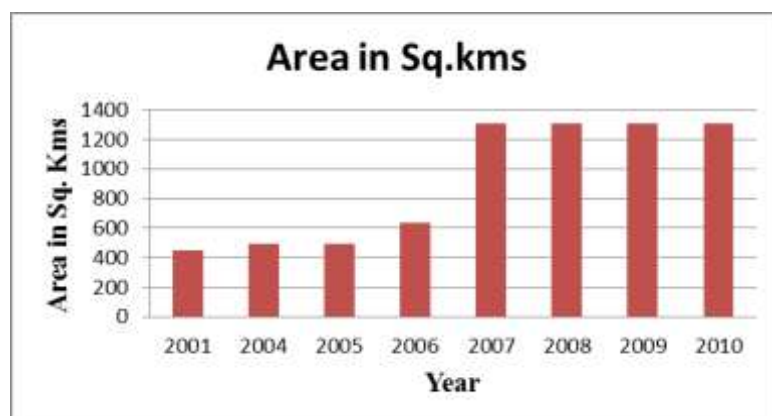
### 1.3 Area growth scenario:

The urban agglomeration is spread between North and South Taluks of Bangalore covering an area of about 1306 sq. km with an average population density of 43,354 individual per sq km (Table 2). This area is formed by attaching 110 villages, 6 CMC and 1 TMC and termed as BBMP. The policy issues are taken not to expand further more. For the year 2008, Bangalore city has reached 8.0 million and projected population of 2015 will be 10 million (as per BBMP vision document 2020).

Table 1: Year wise area growth

Year	Area in sq. kms
2001	451.08
2004	494
2005	494
2006	636
2007*	1309
2008	1309
2009	1309
2010	1309

Fig. 1: Year Wise Area Growth



**1.4 Population growth scenario:**

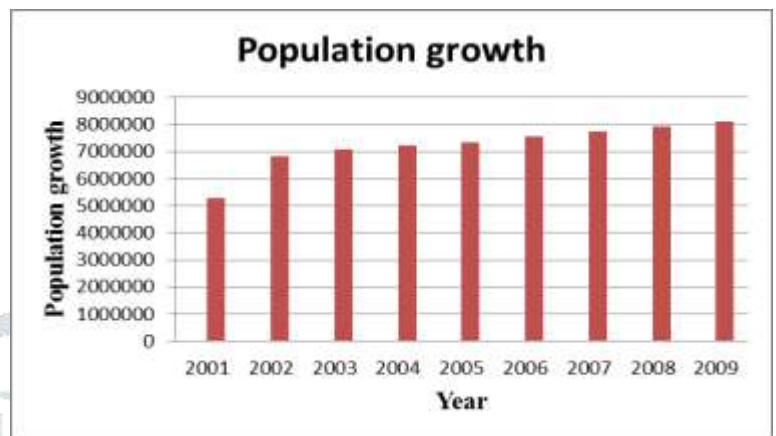
The last three decades has witnessed an aggressive growth of Bangalore city on a radical-cum-circumferential pattern. This has been due to the phenomenal increase in population, overtaking any planning process. The city, which had a population of 1.59 lakhs in 1901, four lakhs in 1941, 12 lakhs in 1961 and 29.14 lakhs in 1981 has reached nearly 65 lakhs in 2004 with a density of about 147.97 persons / hectare and is expected to cross 100 lakhs by 2015. The population has increased drastically from the last few decades due to the exponential growth of software industry which is clear from Table 2 and Fig.2.. If population increases in such a drastic way then it may lead to the congestion of the traffic.

**Table 2: Population growth**

**Growth**

Year	Population In lakhs over 10 years	Increase	% Increase
2001	65.37	-	-
2002	67.38	2.01	3.07
2003	69.45	2.07	3.07
2004	71.59	2.14	3.08
2005	73.80	2.21	3.09
2006	76.07	2.27	3.08
2007	78.42	2.35	3.09
2008	80.85	2.43	3.10
2009	83.35	2.50	3.09
2010	85.93	2.58	3.10
2011	88.59	2.66	3.09

**Fig. 2: Year Wise population**



Source: Karnataka at a glance (2009-2010)

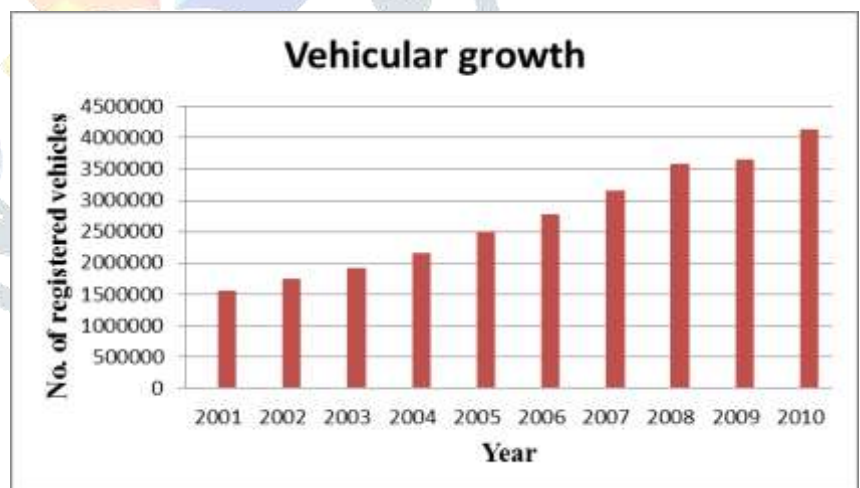
**1.5 Vehicular growth scenario:**

With the tremendous increase in population, the vehicular growth has also increased exponentially. There are more than 36 lakhs vehicles in Bangalore city (Table 3 and Fig 3. Almost 2.5 lakhs vehicles are added to Bangalore roads every year.

**Table 3 Vehicular growth**

**Fig. 3 Year wise vehicle registration**

Year	No. of registered vehicles	% Increase of vehicles
2001	1566142	-
2002	1738929	11.03
2003	1912341	9.97
2004	2157480	12.82
2005	2506028	16.16
2006	2784582	11.12
2007	3147831	13.05
2008	3582945	13.82
2009	3653368	1.96
2010	4136097	13.21



Source: Transport department, GoK

**1.6 Changing trend of Bangalore traffic scenario:**

Based on the data available, it has been estimated that the traffic would continue to grow at around 5% during the next two decades. It is observed that number of two wheelers is increasing drastically compared to other classes of vehicles and the major contribution for road crashes are two-wheelers, which are responsible for 22.79% road crashes. Different Vehicle composition are as given in Table 4.

**Table 4 Changing Trends of Traffic Composition**

Type of Vehicles	1980	1990	2000	2010
Slow moving vehicles	20%	5%	4%	2%
Two-Wheelers	35%	50%	52%	72%
Auto Rickshaws	17%	20%	16%	3%
Cars/Tempo	18%	20%	25%	18%
Buses/Trucks	10%	5%	3%	5%

**1.7 Traffic problems:**

The increase in the vehicle population has paved way to serious traffic problems. Out of which, most common are traffic congestion and delays. Reasons for these is mainly because of following reasons:

- Haphazard growth of private vehicles.
- Mixed traffic.
- Driving habits and behavior.
- Poor and inadequate traffic management schemes.
- Frequent junctions.
- Road side parking & other obstructions.
- Pedestrians walking on the road due to inadequate walking area like footpath etc.
- Road geometrics like gradient, road width, no. of lanes, horizontal and vertical curves, road humps, existence of median or not.
- Road side illumination during night.
- Signals and traffic control devices.

**1.8 Objective of the Study**

1. Determining the current speed and volume spectrum of various locations in the study area for various category of vehicles
2. Comparing the posted speed limits with the measured speed values using the cumulative frequency curves
3. Identifying the congested area and location.
4. Developing a relationship between speed and the volume in the specified location.
5. Developing a relation between traffic speed & its related parameters.
6. Developing bar charts and pie charts for speed, volume, road geometrics.
7. To explore the possibilities of free traffic flow.

**1.9 Scope of the present study**

Speed is an important transportation consideration because it relates to safety, time, comfort, convenience, and economics. In most of the planning stages speed plays an important role for any road infrastructure projects. The cause & effect of traffic accidents & its severity is also mainly related to the speed, operating speed, design speed, speed limits (upper & lower). Speed related studies enable the safe speed limits to be established & speeding zones to be determined. The entire design of any particular stretch of road can be completely related to its design speed. In the present study, volume is obtained for the all 10 roads and the relationship existing between these two parameters is co-related. Road geometrics parameters such as pavement width, pavement surface, footpath, median, parking lanes were measured in the all 10 locations. Comparing all the above road geometric parameters with IRC values.

**II. DATA COLLECTION AND ANALYSIS**

This involved primarily, the selection of locations, measurement of speed using the speeder and volume studies of each location, road geometrics. This chapter also discusses the working of the SPEEDER, which was used for recording spot speeds.

**2.1 Selection Criteria of the Roads**

The stretches of the roads selected were mid-block sections free from

- a. Curvatures,
- b. Bottleneck
- c. Gradients,
- d. Speed braces,
- e. Junction and intersections,

These criterions have been used to collect speed data, which was free from the influence of factors that would otherwise cause an inevitable decrease in travel speed for that particular situation only.

**2.2 Details of the Speed Vision Equipment**

The equipment used was SPEEDER (Fig 4), which consists of radar and directly gives the speed of moving vehicles on focusing and triggering. It has the option of recording speed, from near or far position of a vehicle by selecting a suitable button among the ones shown in the figure. Speed obtained through this equipment is precise and accurate.



**Fig. 4 Speeder**

The study was carried at Rajajinagar and Basaveshwar Nagar area at 10 locations.

1. Modi Road
2. Modi Road (7<sup>th</sup> Main Road)
3. Agrahara- Dasarahalli Road
4. Magadi Main Road
5. Basaveshwaranagar Police Station Road
6. Rajkumar Road (St. Ann's)
7. Nijalingappa Road
8. Rajajinagar RTO Office Road
9. Rajkumar Road (Suzuki)
10. West of Chord Road

The survey was conducted for both peak hours and at timings of (8:00am to 10:00pm & 5:00pm to 7:00 pm) for peak hours, (10:00am to 12pm & 2:00to 4:00pm) for off-peak hours i.e. 4 hours in the morning and 4 hours in the evening and also the road geometrics were measured.

1. Speed: It is measured by using radar meter method (speeder gun).
2. Volume: Volume survey is done by manual counting.



**Fig. 5: Study Area (Rajajinagar and Basaveswaranagar)**

**Rajajinagar** is a residential locality in the west of Bengaluru. It is bordered by Basaveshwar nagar, Malleshwaram, Mahalakshnipuram, Mahalakshmi Layout, Vijayanagar and Rajajinagar Industrial Suburb. Rajajinagar is divided into two stages, first and second. Rajajinagar 3rd Block was formerly called Yednoor Dinne and 4th Block was formerly called Siddaram Dinne. Rajajinagar 1st stage is further divided into 6 blocks from north to south. The 4th block is further divided into the 4th M block and the 4th N block. The other names of some of the areas constituting Rajajinagar are Subramanyanagar, Kethmaranahalli, Nagapura, Manjunath Nagar, Mariyappanapalya, Prakash Nagar, Srirampuram, etc. The newly constructed four-lane grade separator makes it easy for vehicular traffic to move out of Rajajinagar towards Okalipuram.

The area to west of the Chord Road was earlier considered to be a part of Rajajinagar. Chord Road is one of the longest roads in Bangalore connecting Yeshwanthapur through Mahalakshmi Layout, Rajajinagar, Vijaynagar, R. P. C. layout, Attiguppe to Mysore Road, about 8 kilometres in length.

**Basaveshwaranagar** subsumes several sub-localities like Kamalanagar, Sharada Colony, Karnataka Housing Board (KHB) Colony, Kamakshipalya, Kurubarahalli, Saneguruvanahalli, and SBI Officers colony, Nagapura, Manjunatha Nagar, Shiva Nagar, Bhimajyothinagar and Agrahara Dasarahalli.

Basaveshwaranagar is well served by buses and is about 5 km from the Kempegowda Bus Station and Bangalore City Railway Station.

Basaveshwaranagar, being a layout formed by the BDA, has several parks and playgrounds. Notable amongst these is the Dr. B.R.Ambedkar Stadium which was built on the now extinct Dasarahalli Tank. This is located adjacent to Gangamma Thimmaiah Choultry, at the beginning of Agrahaara Dasarahalli.

Table 5 Consolidated Data of Speed and Volume of 10 Locations

Time (Hrs)	Volume (PCU)	Speed (Kmph)	Volume (PCU)	Speed (Kmph)
<b>1. Modi Road</b>				
	<b>Towards Shankar Mutta</b>		<b>Towards Navrang</b>	
8:00 am-9:00 am	2176	29.66	1872	27.98
9:00 am -10:00 am	1541	28.70	1808	24.86
10:00 am -11:00 am	1091	27.43	1732	27.37
11:00 am -12:00 pm	1019	29.32	953	30.76
2:00 pm -3:00 pm	1407	29.99	1017	28.90
3:00 pm -4:00 pm	1264	27.61	1128	30.29
5:00 pm -6:00 pm	1673	28.40	1587	30.04
6:00 pm -7:00 pm	1540	28.15	1547	31.23
<b>2. Modi Road</b>				
	<b>Towards Shivanahalli</b>		<b>Towards Modi Main Road</b>	
8:00 am-9:00 am	572	22.52	561	23.27
9:00 am -10:00 am	645	21.94	597	23.38
10:00 am -11:00 am	569	21.44	587	23.60
11:00 am -12:00 pm	533	20.14	549	23.62
2:00 pm -3:00 pm	484	23.05	494	23.69
3:00 pm -4:00 pm	483	21.36	476	23.71
5:00 pm -6:00 pm	484	21.18	470	23.85
6:00 pm -7:00 pm	440	22.36	444	23.78
<b>3. Agrahara- Dasarhalli Road</b>				
	<b>Towards Dasarhalli</b>		<b>Towards Shankarmutta</b>	
8:00 am-9:00 am	1402	30.24	1568	30.24
9:00 am -10:00 am	2678	28.45	2988	28.45
10:00 am -11:00 am	2426	29.29	2804	29.29
11:00 am -12:00 pm	1384	31.78	1528	31.78
2:00 pm -3:00 pm	330	25.74	510	25.74
3:00 pm -4:00 pm	2038	30.56	2282	30.56
5:00 pm -6:00 pm	2882	32.78	1734	32.78
6:00 pm -7:00 pm	1752	30.24	1619	30.24
<b>4. Magadi Main Road</b>				
	<b>Towards Tollgate</b>		<b>Towards Vijaynagar</b>	
8:00 am-9:00 am	2358	27.70	1212	29.63
9:00 am -10:00 am	2171	26.76	1104	26.78
10:00 am -11:00 am	1984	27.16	1036	25.88
11:00 am -12:00 pm	1797	29.74	600	28.10
2:00 pm -3:00 pm	1002	32.16	605	32.24
3:00 pm -4:00 pm	1722	32.65	483	32.58
5:00 pm -6:00 pm	1813	33.69	526	29.33
6:00 pm -7:00 pm	1667	32.14	445	29.60
<b>5. Basaveshwaranagar Police Station Road</b>				
	<b>Towards Agrahara Dasarahalli</b>		<b>Towards West of Chord Road</b>	
8:00 am-9:00 am	592	29.37	1198	31.86
9:00 am -10:00 am	828	32.87	1519	30.08
10:00 am -11:00 am	868	28.51	1520	27.89
11:00 am -12:00 pm	1052	28.94	1252	27.71
2:00 pm -3:00 pm	1059	32.59	1061	32.10
3:00 pm -4:00 pm	927	31.25	1024	30.09
5:00 pm -6:00 pm	1081	31.50	1042	29.31
6:00 pm -7:00 pm	1559	28.30	1036	28.67
<b>6. Rajkumar Road</b>				
	<b>Towards Sujatha</b>		<b>Towards Magadi Road</b>	
8:00 am-9:00 am	1700	25.45	2853	21.66
9:00 am -10:00 am	719	27.59	1921	23.50
10:00 am -11:00 am	1109	28.15	2343	23.66
11:00 am -12:00 pm	1249	25.94	1853	21.64
2:00 pm -3:00 pm	1076	32.98	1236	28.72
3:00 pm -4:00 pm	1370	32.95	1304	28.34
5:00 pm -6:00 pm	1942	31.08	1401	29.04
6:00 pm -7:00 pm	2026	29.72	1437	29.10

7. Nijalingappa Road	Towards KLE College		Towards ESI	
8:00 am-9:00 am	462	31.47	488	31.43
9:00 am -10:00 am	697	31.31	703	31.72
10:00 am -11:00 am	694	28.50	978	31.87
11:00 am -12:00 pm	674	28.77	787	30.36
2:00 pm -3:00 pm	590	28.19	629	30.30
3:00 pm -4:00 pm	660	28.32	640	27.20
5:00 pm -6:00 pm	741	29.72	639	30.20
6:00 pm -7:00 pm	658	30.45	768	29.98
8. Rajajinagar RTO	Towards Rajkumar Road		Towards Bhashyam Circle	
8:00 am-9:00 am	507	24.56	306	28.39
9:00 am -10:00 am	853	27.50	335	28.01
10:00 am -11:00 am	975	24.82	499	25.58
11:00 am -12:00 pm	817	28.75	797	27.37
2:00 pm -3:00 pm	683	27.85	587	27.65
3:00 pm -4:00 pm	625	30.28	548	30.34
5:00 pm -6:00 pm	775	25.90	410	25.75
6:00 pm -7:00 pm	1112	25.87	437	29.36
9. Rajkumar Road	Towards Oklipuram		Towards Navrang	
8:00 am-9:00 am	2548	29.63	2534	32.42
9:00 am -10:00 am	1433	28.49	1177	32.08
10:00 am -11:00 am	1785	28.36	1914	32.35
11:00 am -12:00 pm	1369	23.56	1854	25.53
2:00 pm -3:00 pm	1197	28.16	1656	28.31
3:00 pm -4:00 pm	1442	27.97	1958	26.60
5:00 pm -6:00 pm	1098	26.77	1694	26.22
6:00 pm -7:00 pm	1201	30.92	1494	26.62
10. West of Chord Road	Towards Modi Main Road		Towards Magadi Tolgate	
8:00 am-9:00 am	2461	33.38	1319	35.84
9:00 am -10:00 am	1703	31.94	1082	31.46
10:00 am -11:00 am	1639	34.10	1484	44.15
11:00 am -12:00 pm	1644	37.06	1712	47.35
2:00 pm -3:00 pm	1278	35.48	1502	38.53
3:00 pm -4:00 pm	1221	32.76	2039	34.27
5:00 pm -6:00 pm	1392	29.60	1561	30.67
6:00 pm -7:00 pm	1562	30.54	1878	33.89

**Calculation of traffic volume:**

Formulae:

$$N_1 * X_1 + N_2 * X_2 + N_3 * X_3 + \dots$$

Where  $N_1, N_2$  and  $N_3$  are number of vehicles

$X_1, X_2$  and  $X_3$  are PCU values

**Volume in PCU=1088 PCU**

**Calculation of traffic speed:**

Formulae:

$$\frac{(N_1 * V_1) + (N_2 * V_2)}{(N_1 + N_2)}$$

Where  $N_1, N_2$  are number of vehicles

$V_1, V_2$  are corresponding speed values

**Average Speed=29.66Kmph**

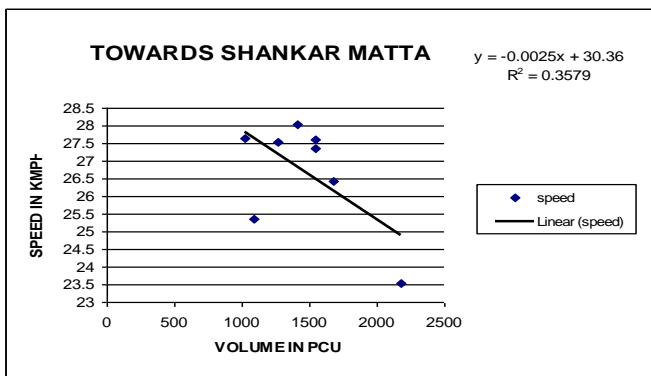


Fig. 6: Correlation between speed and volume at Modi road

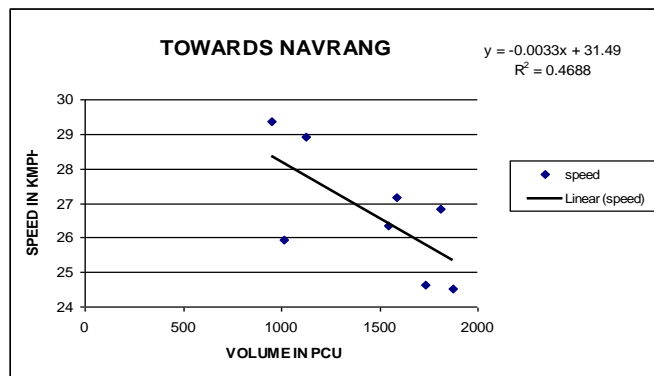


Fig.7: Correlation between speed and volume at Modi road (7<sup>th</sup> main road)

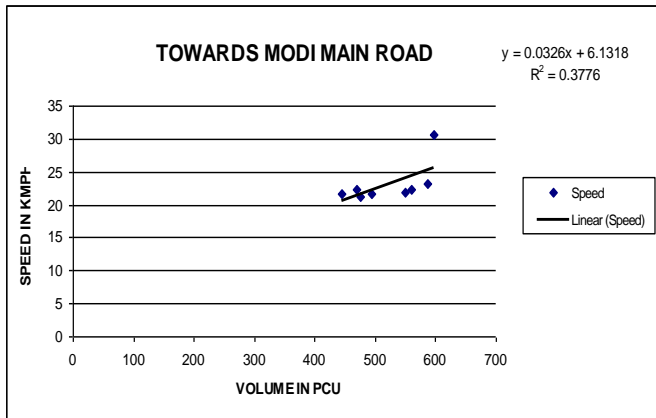


Fig. 8: Correlation between speed and volume at Agrahara dasarahalli

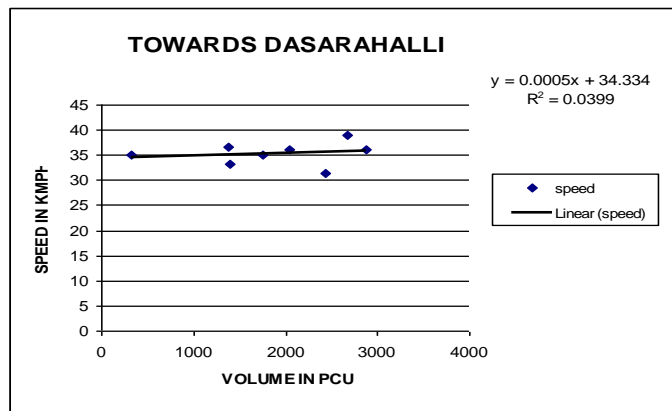


Fig. 9: Towards Dasarahalli

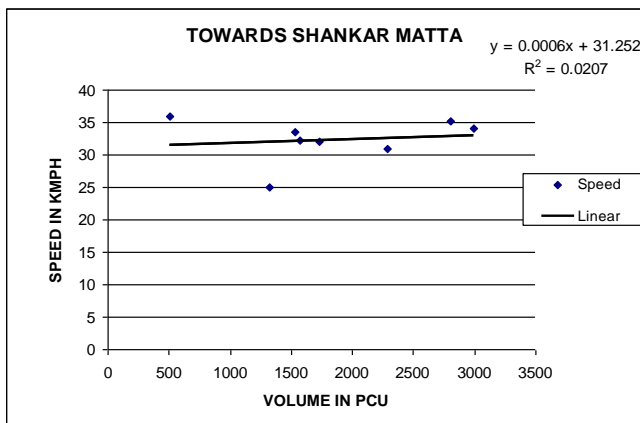


Fig. 10: Correlation between speed and volume at Magadi main road

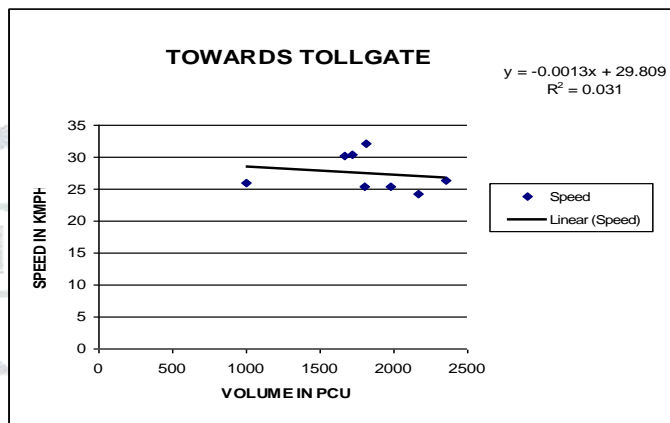


Figure 11: Towards Toll gate

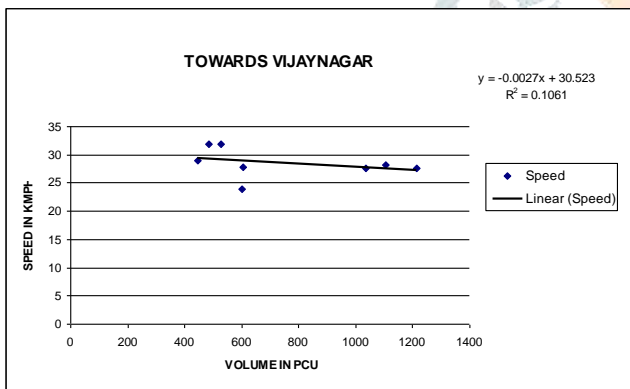


Fig. 12: Correlation between speed and volume at Basaveswaranagar Police station road

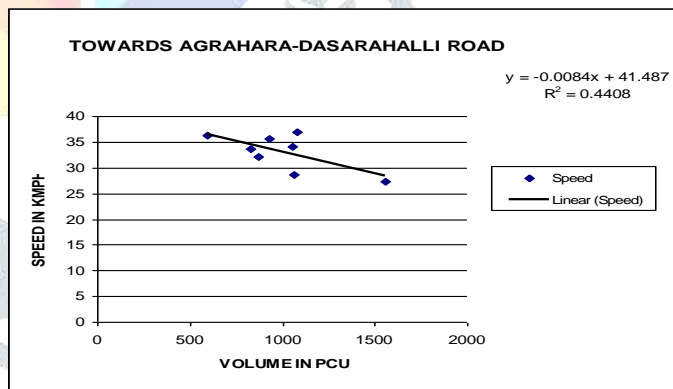


Fig. 13: Towards Agrahara – Dasarahalli road

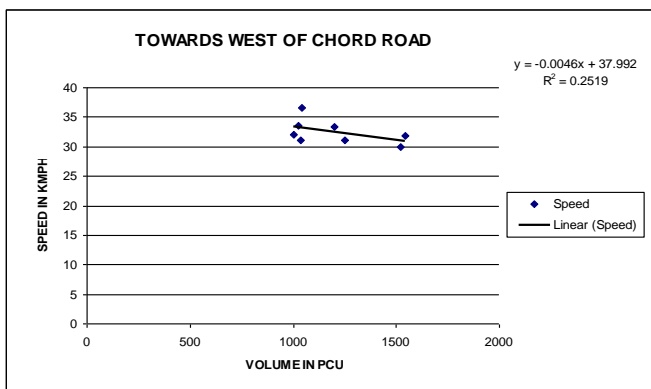


Fig. 14: Correlation between speed and volume at Rajkumar road

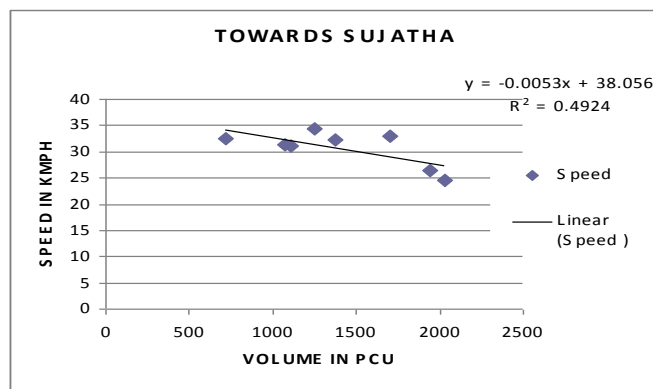


Fig.15: Towards Sujatha

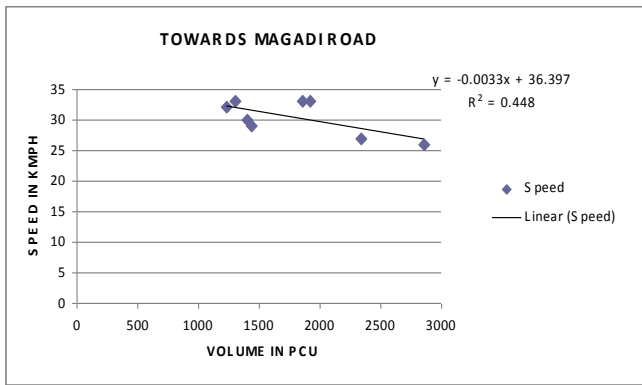


Fig. 16: Correlation between speed and volume at Nijilingappa road

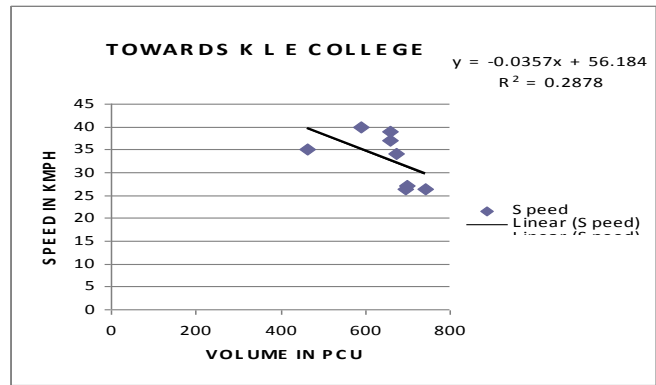


Fig. 17: Towards KLE College

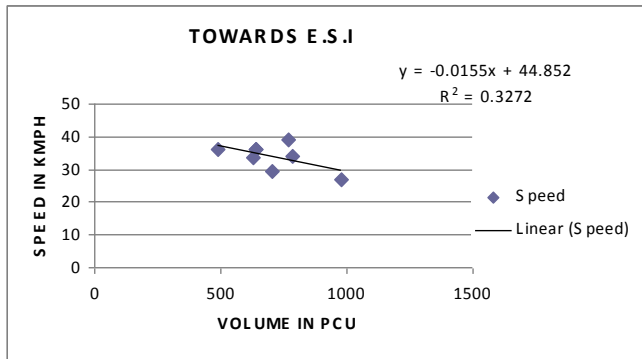


Fig. 18: Correlation between speed and volume at Rajajinagar RTO office road

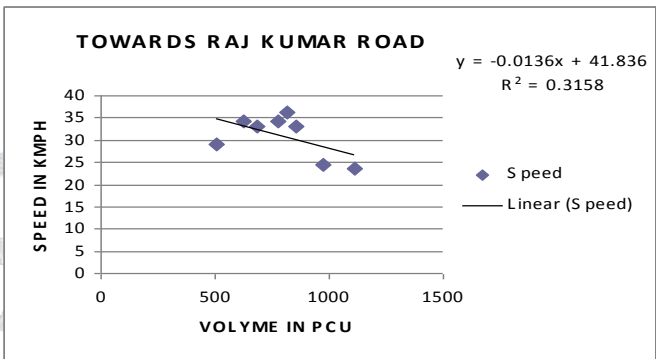


Fig. 19: Towards Rajkumar road

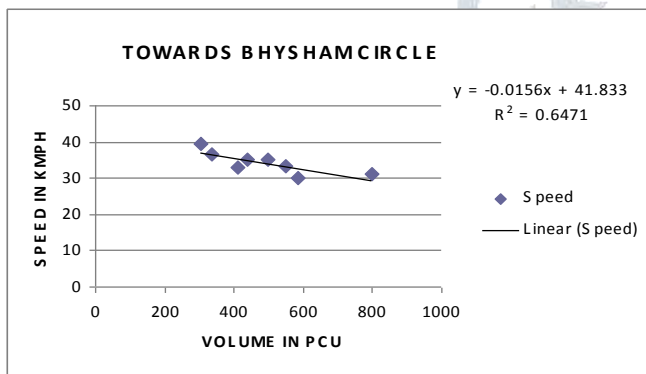


Fig. 20: Correlation between speed and volume at Rajkumar road

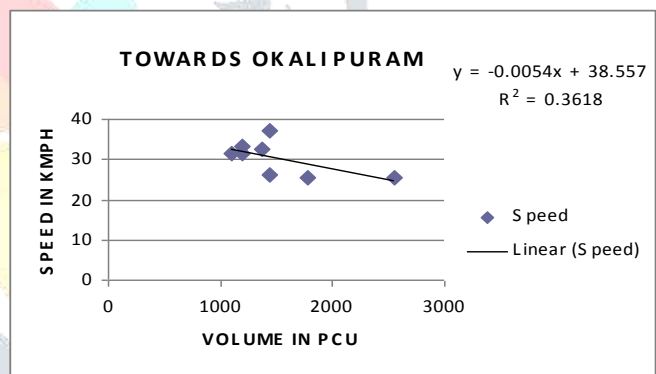


Fig. 21: Towards Okalipura

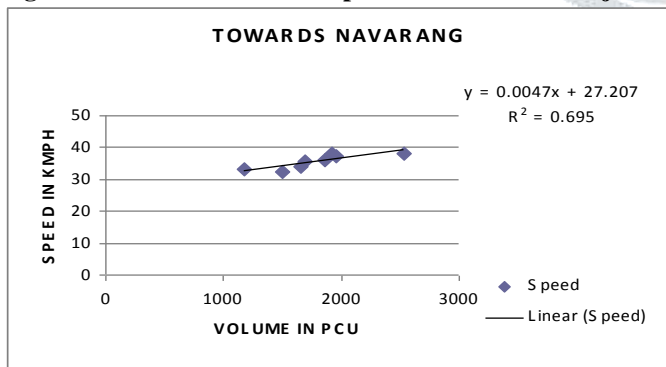


Fig. 22: Correlation between speed and volume at Navarang

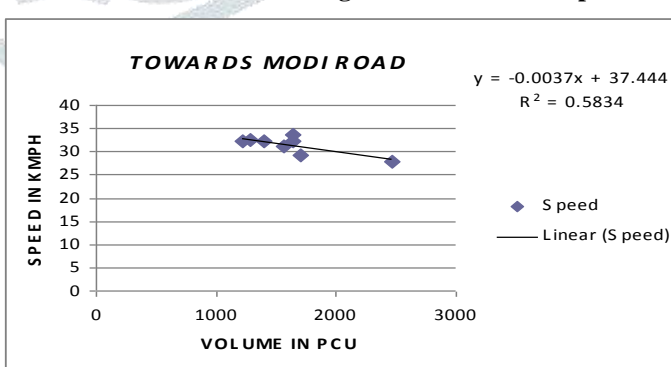


Fig. 22 Towards Modi Road



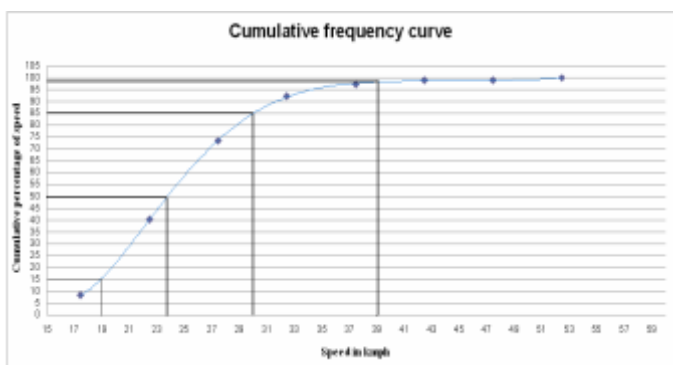
**Table 6: Road Geometrics Details**

Sl. No	Name of The Road	Right side width (m)	Left side width (m)	No. of lanes	No of Ways	Medi-an width	Road side impedance				Condition of road
							Foot path		Parking		
1	Modi Main Road	8.3	9	2	2	0.2	3.2	2.8	Yes	Yes	Good
2	Modi Road (7 <sup>th</sup> Main Raod)	9.9		2	2	Nil	3.7	2.45	No parkin g	Nil	Poor
3	Agrahara-Dasaharahalli Road	7.7	8.1	2	2	Nil	3.8	3.8	Nil	Nil	Good
4	Magadi Road	7.8	7.5	2	1	0.4	3	2.4	Nil	Nil	Avg
5	Basaveshwar Nagar Police Station Road	11.8		2	2	Nil	2.8	3.2	No parkin g	Nil	Good
6	Rajkumar Road(St.Anns)	9.5	7.25	2	2	0.5	3.6	3.7	2	Nil	Good
7	Nijilingapparoad	12.2		2	2	Nil	3.1	3.1	1.8	Nil	Good
8	Rajkumar Road(Rto)	11.6		2	2	Nil	3.5	2.7	1	2.3	Good
9	Rajkumarroad(Suzuki Show Room)	7.9	7.08	2	2	0.5	4.9	4.3	Nil	Nil	Avg
10	West Of Chord Road	8.9	8.9	2	2	1.3	2	2.7	Nil	Nil	Good

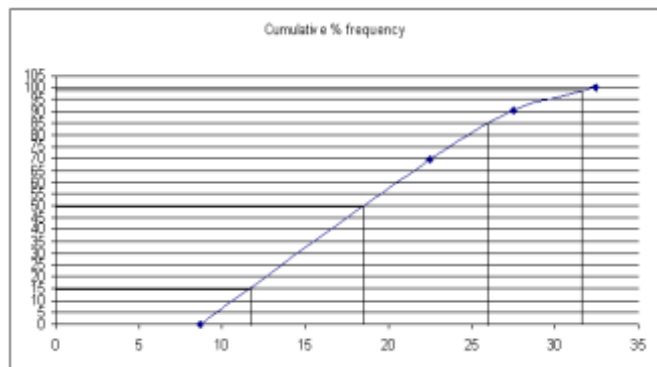
**Table 7: Cumulative Frequency Table For Modi Road (Peak Hour)**

Location	Speed Class (kmph)		Mid Point	Frequency	% Frequency	Cumulative % frequency
MODI ROAD	15	19.9	17.45	15	8.15	8.15
(10:00-11:00)	20	24.9	22.45	59	32.09	40.21
	25	29.9	27.45	61	33.11	73.35
	30	34.9	32.45	35	19.02	92.34
	35	39.9	37.45	9	4.88	97.29
	40	44.9	42.45	3	1.63	98.93
	45	49.9	47.45	0	0	98.93
	50	54.9	52.45	2	1.02	100
				184		

**CUMULATIVE FREQUENCY CURVE AT MODI MAIN ROAD**

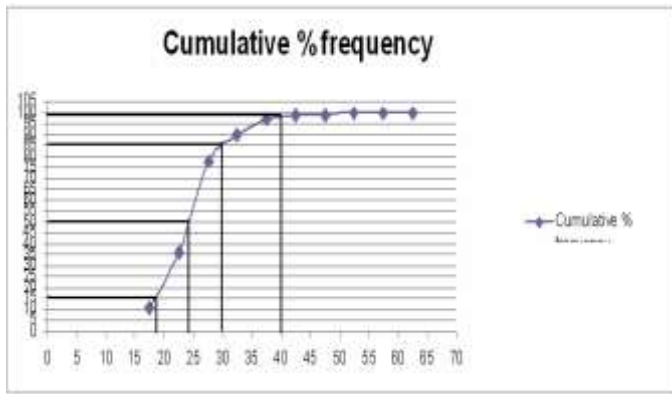


**Fig. 13: Off-Peak Hour**

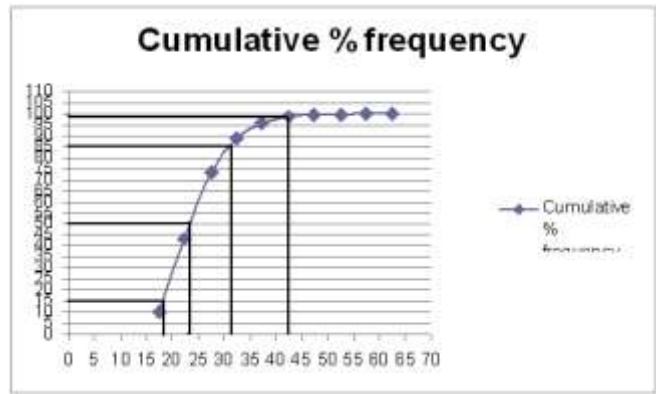


**Fig. 24: Peak Hour**

**CUMULATIVE FREQUENCY CURVE AT AGRAHARA DASARAHALLI**

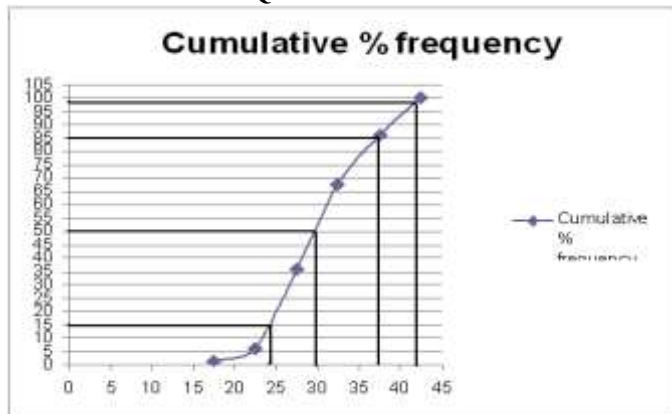


**Fig. 25: Off-Peak Hour**

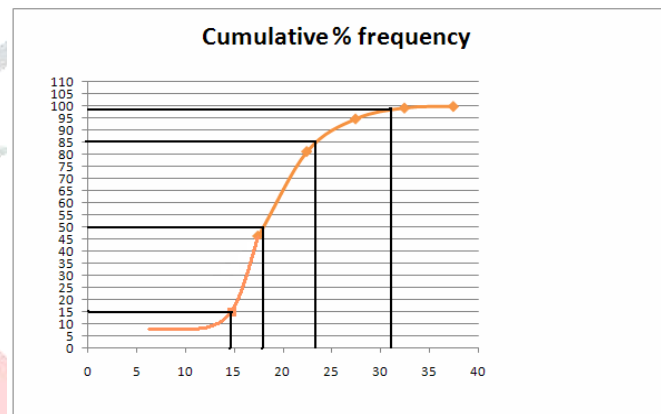


**Fig. 26 Peak Hour**

**CUMULATIVE FREQUENCY CURVE AT MAGADI MAIN ROAD**

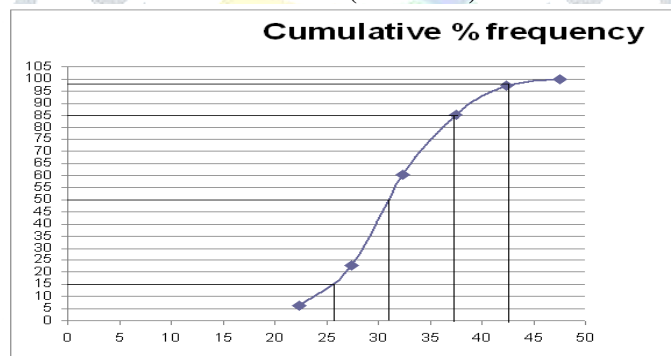


**Fig. 27: Off-Peak Hour**



**Fig. 28: Peak Hour**

**CUMULATIVE FREQUENCY CURVE AT RAJKUMAR ROAD (ST.ANNS)**



**Fig. 29: Off-Peak Hour**

**Table 8 Variation of Speed with Carriage Width for Roads with Median**

Name Of Road	Speed in Peak hour (Kmph)	Speed in Off peak hour (Kmph)	Carriage Width (m)	Median (m)
Modi Road(Lakme Saloon)	26.06	28.48	9	0.2
Magadi Road(Devi Chem)	26.33	32.15	7.8	0.4
Rajkumarroad(St.Anns High School)	20.38	31.62	9.5	0.5
Rajkumarroad(Suzuki Show Room)	28.7	30.98	7.9	0.5
West Of Chord Road (Havells Galaxy)	30.68	39.88	8.9	1.3
Agraharadasarahalli Main Road	29.33	34.34	8.1	0.3

Table 9 Variation of Speed with Carriage Width for Roads without Median

Name Of The Road	Peak	Off Peak	Carriage Width (m)	Median (m)
Basaveshwar Nagar Main Road	28.52	35.72	11.8	Nil
Nijilingapparoad(Esi Hospital)	27.35	29.52	12.2	Nil
Rajkumarroad(R.T.O Office)	23.64	26.84	11.6	Nil
Modi Road(Preethi Conve Hall)	21.46	24.65	9.9	Nil

## RESULT

## STATISTICAL ANALYSIS OF SPEED

Road & obs speed		Median speed 50%	Design speed 98%	Upper speed limit 85%	Lower speed limit 15%	Standard deviation	Co-efficient of variation	X
1) MODI ROAD(LAKME SALOON)	P	25	39	31.75	19	6.16	21.98	28.02
	O	24	39	30	19	5.31	19.70	26.97
2) PAVITHRA PARADISE ROAD(MAHALAKSHMI MEDICALS)	P	26	42.5	33	17	7.73	53.83	14.36
	O	24	40	30	18	5.80	21.45	27.02
3)MAGADI ROAD(DEVI CHEM)	P	23	42.5	32	18	6.76	25.05	27
	O	30	42.5	37.5	24	6.52	20.02	32.57
4) BASAVESHWAR NAGAR(BHARATH PETROL BUNK)	P	28	41	33.5	18	7.49	24.37	30.72
	O	27.5	42	34.75	22	6.16	15.57	39.55
5)RAJKUMAR ROAD (ST.ANNS HIGH SCHOOL)	P	17.5	31.5	23.75	14.9	4.28	20.02	21.36
	O	31.5	42.5	37	26	5.31	15.71	33.83
6) NIJILINGAPPA ROAD(E.S.I)	P	26.5	40.5	33.5	20.75	6.16	20.87	29.52
	O	25.5	38	32.25	21	5.43	18.91	28.74
7)RAJKUMAR ROAD(AJANTA DIGITAL LAB)	P	24	34	29	19	4.83	18.00	26.84
	O	29.75	42	36	19.75	7.85	25.44	30.86
8) RAJKUMAR ROAD(SUZUKI SHOW ROOM)	P	29	42.5	36.5	23.5	6.28	19.82	31.69
	O	25.58	42	32.5	18.5	6.76	23.98	28.2
9)WEST OF CHORD ROAD(HAVELLS GALAXY)	P	31	48.5	39	24	7.25	21.62	33.52
	O	33	49.2	40	28	9.15	26.69	34.97
10)MODI ROAD(PREETHI CONVE HALL)	P	18	32	25	15	4.83	21.00	23
	O	20	33	26	16	5.76	23	22.7

Fig. 30: Statistical Analysis of speed

## III. CONCLUSION, RECOMMENDATION

**Location 1:**Modi Main Road: As per our survey inventory and analysis the traffic volume is 2176 PCU (max) and 953 PCU (min), speed values are 29.99 kmph (max) and 24.86 kmph (min), carriageway width of 8.3m (Right) and 9m (Left), median width of 0.2m and footpath of 3.2m on either side. From the cumulative frequency curve the upper speed limit is 31.75, lower speed limit is 19, median speed is 25 and design speed is 39. The road condition of modi road is GOOD. The road width is sufficient enough to serve the present day flow conditions, but not according to the IRC standards. The footpath width is higher than IRC standards, it has to be modified to 1.3m. The attraction rate is more in this particular road due to more number of restaurants. Parking is present on both lanes of the road, since it is a commercial area parking is necessary. In view of the future traffic control considering the rapid population growth parking should be provided elsewhere or a parking complex would serve better.

**Location 2:**Modi Road (Preethi Convention): As per our survey inventory and analysis the traffic volume is 645 PCU (max) and 440 PCU (min), speed values are 23.84 kmph (max) and 20.14 kmph (min), carriageway width of 9.9m, median is not provided. From the cumulative frequency curve the lower speed limit is 15, median speed limit is 18, upper speed is 25 and design speed limit is 32. The road condition is POOR with very less road width. Parking lane is not provided in this particular location. The flow is congested here. The density is more due to a convention hall in the vicinity. It is a densely populated residential area.

**Location 3:**Agrahara Dasarahalli Road:As per our survey inventory and analysis the traffic volume is 2988 PCU (max) and 330 PCU (min), speed values are 32.78 kmph (max) and 25.74 kmph (min), carriageway width of 7.7m (R) and 8.1m (L), footpath of 3.8m on either side of the road. Median is not provided. From the cumulative frequency curves lower speed is 17, median speed is 26, upper speed limit is 33 and design speed is 42.5. The road condition is GOOD with adequate road width but it has no parking. An parking inventory study is recommended in implementing parking as it has both commercial and residential dwelling. Also the density is more in this particular location.

**Location 4:**Magadi Road:As per our survey inventory and anlysis the traffic volume is 2358 PCU (max) and 445 PCU (min), speed values are 33.69 kmph (max) and 25.88 kmph (min), carriageway width of 7.5m (R) and 7.8m (L), footpath of 3m (R) and 2.4m (L). Median is 0.4m. From the cumulative frequency curves lower speed is 18, median speed is 23, upper speed limit is 32 and design speed is 42.5.

**Location 5:**Basaveshwaranagar Police Station Road:As per our survey inventory and analysis the traffic volume is 1559 PCU (max) and 592 PCU (min), speed values are 32.87 kmph (max) and 27.56 kmph (min), carriageway width of 11.8m, footpath of 2.8m (R) and 3.2m (L). Median is not provided. The above location is a no-parking area. From the cumulative frequency curves lower speed is 18, median speed is 28, upper speed limit is 33.5 and design speed is 41.

**Location 6:**Rajkumar Road:As per our survey inventory and anlysis the traffic volume is 2853 PCU (max) and 719 PCU (min), speed values are 32.98 kmph (max) and 21.66 kmph(min), carriageway width of 9.5m (R) and 7.25m (L), footpath of 3.6m (R) and 3.7m (L). Median is 0.5m is provided. Parking is provided only on the right side. From the cumulative frequency curves lower speed is 14.9, median speed is 17.5, upper speed limit is 23.5 and design speed is 31.25. The road condition is bad with no parking facility as it is a commercial area parking has to be provided.

**Location 7:**Nijilingappa Road:As per our survey inventory and analysis the traffic volume is 978 PCU (max) and 462 PCU (min), speed values are 31.87kmph (max) and 27.20 kmph (min), carriageway width of 12.20m, footpath of 3.1m (R) and 3.1m (L). Median is not provided. Parking is provided only on the right side. From the cumulative frequency curves lower speed is 20.75, median speed is 20.75, upper speed limit is 23.5 and design speed is 40.5. The road condition is GOOD with free flow. Parking facility is provided.

**Location 8:**Rajkumar Road (Suzuki Showroom):As per our survey inventory and analysis the traffic volume is 2548 PCU (max) and 1098 PCU (min), speed values are 32.42 kmph (max) and 25.53 kmph (min), carriageway width of 7.9m on either side of the road, footpath of 4.9m (R) and 4.3m (L). Median width of 0.5m is provided. Parking in not provided. From the cumulative frequency curves lower speed is 23.5, median speed is 29, upper speed limit is 36.5 and design speed is 40.5. The attraction rate is more due to the automobile showrooms and super market(star bazaar) in the vicinity.

**Location 9:**Rajkumar Road (RTO):As per our survey inventory and anlysis the traffic volume is 1112 PCU (max) and 306 PCU (min), speed values are 30.34 kmph (max) and 24.56 kmph (min), carriageway width of 11.60m, footpath of 3.5m (R) and 2.7m (L). Median is not provided. Parking is provided on both sides of the road. From the cumulative frequency curves lower speed is 19, median speed is 24, upper speed limit is 29 and design speed is 34. The road condition is POOR.

**Location 10:**West Of Chord Road:As per our survey inventory and analysis the traffic volume is 2412 PCU (max) and 606 PCU (min), speed values are 39.34 kmph (max) and 29.56 kmph (min), carriageway width of 8.9m (R) and 8.9m (L), footpath of 2m (R) and 2.7m (L). Median of 1.3m provided. Parking is provided in the service roads. From the cumulative frequency curves lower speed is 20, median speed is 25, upper speed limit is 32 and design speed is 39. The road condition is GOOD with service road on either side of the road .The flow condition is free flow.As per our cumulative frequency curves speed values are less. The carriageway width is not as per IRC standards, as per IRC PCU values are also higher than the IRC standards. Footpath should also be modified as per IRC.

Finally from our study we conclude that Basaveshwarnagar and Rajajinagar area is having more traffic problems in relation with congestion due to increasing vehicle users, lane discipline, lane width (not as per IRC). The signal timings is recommended to be timed for peak operations in order to reduce traffic congestion during peak hours. All the roads in Basaveshwarnagar and Rajajinagar area is not as per IRC standards, thus it is recommended to modified serve the future traffic conditions.

## REFERENCES

- [1]. Kadiyali L.R, Traffic engineering, Khanna publications, 7<sup>th</sup> edition 2009
- [2]. Subhash and Saxena, Traffic engineering and Design.
- [3]. Gupta S.P, Statistical methods, faculty of management studies, university of Delhi, edition 1999
- [4]. IRC code books: IRC 106-1990, IRC 86-1983, IRC 69-1977, IRC 70-1977
- [5]. Khanna and Justo (Transportation Engineering), Bangalore university, 8<sup>th</sup> edition, 2001
- [6]. Wohl and Martin, Traffic system analysis for Engg and Planners, ML Graw Hill Series