

Travel Time and Congestion Assessment Along Ujala Circle (S.G. Highway Ahmedabad)



Vivek Mer, V.R. Patel, A.K. Patel

Abstract: The approximately 25201084 (2018) vehicular citizenry in Ahmedabad city so it is very necessary to negotiate its movements and infirmity effects like as air and noise pollution & other environment effects, traffic congestion, time loss, and so on. S.G Highway has 44.5 km long stretch of Ahmedabad, an oldest and most substantial stretch which started from Ujala circle. For declamation the traffic congestion, classified volume count survey (by Video Graphic method), travel time and delay survey (by Moving Observer Method), and for speed-flow-density relationship Spot speed study at Ujala circle during Friday has been accomplished and analyzed. From the calculated data, graph of flow v/s density, speed v/s density and speed v/s flow relationship has been prosecute with the R^2 value of each relationship. This analysis proved that current traffic situation at Ujala circle is highly congested, which leads to the higher travel time taken by vehicle compare to free flow condition. From all analyzed data, alternate invigorating measures are prospected. Based on those alternative invigorating measures best alternative is choose as well as bring off simulation and validation of Model in the VISSIM software, also design in AutoCAD for better illustration of issue.

Keywords: Travel Time, Congestion, VISSIM, Auto CAD, Simulation, Validation, Model, Traffic.

I. INTRODUCTION

Expeditious growth in the urbanization during the Past two decades has been increased in our country. This reason leads to the demand of transportation facilities which are the basic requirement of our country's urban population is rising enormously. More people are entrained to gain employment for living better quality of life that's why the growth of the urban population is upsurge so ultimately boosting the urbanization. As the urbanization increases the industrialization of some region also expanse so per capita income will also magnify that's why people will utilize their own vehicle to travel from origin to destination. In fact, the

growth rate of the country's economic development hoist too fast and sometimes much faster than infrastructure development causing limited road space to deal with personalized vehicles so this reason leads to the increasing road capacity also increasing congestion and delay that is major reason behind the accidents. It has been concluded that traffic accidents are among the primary cause of accidental deaths in Indian cities. The premier cause of these of these trouble is the case of variance in modal split and inadequate transportation infrastructure. Public transportation deteriorate to keep same level with quick and considerable rise in demand over past few decades.

The best strategy to meet the growing urban travel demand in a sustainable manner is to convince people with reasoning to shift from personalized vehicles to public transportation. This is because public transportation occupies less road space, consumes less fuel and emits fewer pollutants as compared to any other motorized modes of travel.

Ujala circle is one of the most developed and important starting point of S.G. Highway link, which serve all major activities, industrialization activities, travelling and transportation activities, academic activities etc. that is reflecting the culture of metropolitan city in Gujarat.

II. AIM OF STUDY

The aim of study is to find out traffic volume, travel time and spot speed under current traffic situation in Ujala circle (S.G. Highway), after analyze it so that we can contemplate remedial measure in current traffic situation.

III. OBJECTIVES

- 1) To find out Classified Volume Count by Videography Method.
- 2) To determination of Travel time & delay by Moving Observer method.
- 3) To elaborate Speed-Flow Density relationship
- 4) To obtain actual traffic model, simulation, and evaluation in VISSIM software.
- 5) To furnish viability checks other alternatives.

IV. SCOPE OF WORK

- 1) Planning for smart mobility at Ujala circle encouraging pedestrians and cyclists (no tax) with proper facilities.
- 2) Redesigning of critical junction like Ujala circle.
- 3) Conversion of un signalized intersection to signalized intersection.

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- 4) Construction of Elevated bridge to counteract heavy traffic and we could achieve control over congestion.
- 5) Parking management plan can be develop.
- 6) Relocation of traffic generating informal activities.

V. LITERATURE REVIEW

Traffic congestion does not possess any exact or broadly accepted definition, but in simply words we could say that “Traffic Congestion is phenomenon wherever demand exceeds the capacity of the transportation system”. Also traffic congestion can be defined in the following two ways: (civil.iitb.ac.in/tvm/nptel by Prof. Tom V. Mathew)

1. Congestion is the travel time or delay in excess of the normally incurred under light or free flow traffic condition.
2. Unacceptable congestion is travel time or delay in excess of agreed norm which may vary by type of transport facility, travel mode, geographical location, and time of delay.

The basic cause of traffic congestion is progression of society, economy and technology, house hold characteristics which leads to the change in transportation system. This change cause diversity in transport behavior, locational pattern and other agglomeration effects result in the growth of traffic. The growth of traffic being continuous and finally situation arises where traffic growth exceeds capacity of transportation system. Which finally leads congestion. Congestion has a different infirmity effect over drivers, environment, health and economy. So that encounter of traffic congestion is mandatory by proper analysis and following supreme remedial measure.

A. Travel Time Study

Travel time can be defined as the time period required to travel on desired routes between any two points of interest. Travel time is essential measure transportation engineering commonly used in wide range of transportation analysis including transportation planning, congestion analysis, traveler information. In briefly Travel time study has highly significance in traffic control, highway improvements and document congestion. For accurate analysis of travel time & delay study Moving Observer method is used. Data obtained from travel time and delay studies give a good indication of the level of service (LOS) on the study section, therefore data obtain from this study gives brief information for identifying critical locations, which may require special attention in order to improve the overall traffic flow in the route.

B. Moving Observer Survey

In this method observer sitting in car and car is moving in direction of stream from origin (south) to destination (north). During this journey note down Number of overtaking vehicle, Number of overtaken vehicle, Average number of vehicle in opposite direction (m_a), Average journey time when vehicle is travelling in the stream (t_w), Average journey time when vehicle is travelling in opposite stream (t_a), Delay time. Let's give the name of trip as S-N trip. Similarly carried out N-S trip and note down same parameters mentioned above.

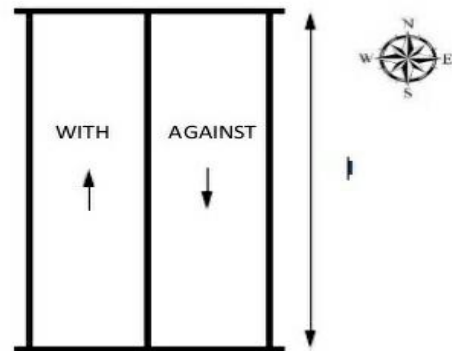


Fig. 1 Moving Observer Survey

Source: <https://www.google.co.in/>

Following equation could be developed from the derived parameters, after that calculate average Journey speed and average running speed.

$$m_w = \text{Overtaking vehicle} - \text{Overtaken vehicle} \quad \dots(1)$$

$$\text{Flow (q) veh/min} = [(m_w + m_a) / (t_w + t_a)] \quad \dots (2)$$

$$\text{Average Journey Time} = [t_w - (m_w/q)] \quad \dots (3)$$

$$\text{Average running time} = \text{Average journey time} - \text{Average stopped delay} \quad \dots(4)$$

C. Classified Volume Count

For determination of the number, movements, and classifications of roadway vehicles at a given location Traffic volume studies are very important. These data helps to identify critical flow time periods, determining the influence of large vehicles or pedestrians on vehicular traffic flow. Methods of volume count and intended use of volume recorded data decides the length of sampling period. Basically there are two ways to carried out volume count, 1) Manual count 2) Automatic count. For collecting small samples of data any given location manual count is most applicable. Also for collecting sample data less than 1 day manual count is appropriate. Normal interval for a manual count are 5, 10, 15 minutes. Traffic count during bottleneck condition like Monday morning, and Friday evening manual count is not appropriate. Data collection by manual count can be expensive in terms of manpower. At the intersection manual count is generally tedious because vehicle on each arm should be counted and recorded separately for each movement. Determination of volume count by automatic count can be done by permanent counters, portable counters or videography. At a place where large amount of vehicular gathering is found volume count by automatic count is appropriate. Automatic counts are usually taken in 1-hour interval for each 24-hour time period and from that peak hour can easily be identified. The count may be extend for week, month, or year also.

D. Spot Speed Survey

In a simply word spot speed can be defined as a instantaneous speed of vehicle at a particular location. Spot speed can be used to design the geometry of road like horizontal and vertical curves, Super elevation etc.

In Location and size of signs. Design of signals, accident analysis, road maintenance and congestion analysis, spot speed data plays as a role of basic input. Spot speed can be determined by using an enoscope or pressure contact tubes. But here we were calculated spot speed by videography in which we calculated time required for at least 5 vehicle in one minute to cross 20 meter stretch and just simply done 20m/time and get spot speed for 20 meter stretch in 1 minute.

E. Design Service Volumes of Urban Roads

Recommended design service volumes in PCU per hour for urban roads like Arterial, Sub-arterial and Collector shown in Table 1.

Table 1 Recommended Design Service Volumes (PCU per Hour)

Sr. No.	Type of carriageway			
		Arterial	Sub-arterial	Collector
1.	2-Lane (One-Way)	2400	1900	1400
2.	2-Lane (Two-Way)	1500	1200	900
3.	3-Lane (One-Way)	3600	2900	2200
4.	4-Lane Undivided (Two-Way)	3000	2400	1800
5.	4-Lane Divided (Two-Way)	3600	2900	-
6.	6-Lane Undivided (Two-Way)	4800	3800	-
7.	6-Lane Divided (Two-Way)	5400	4300	-
8.	8-Lane Divided (Two-Way)	7200	-	-

Source: Guidelines for Capacity of Urban Roads in Plan Areas, IRC 106-1990

VI. STUDY AREA ILLUSTRATION

Ahmedabad is one of the wide-ranging city and former capital of the Indian state of Gujarat. Ahmedabad is placed on the bank of the Sabarmati River of 23km, from the state capital Gandhinagar, which is its twin city. Ahmedabad’s population of 7.8 million (as per 2020 population census) makes it the fifth-most populous city in India. Vehicular population in Ahmedabad city is 25201084 (2018-2019) which is comparatively large over the area of 464.16km² of Ahmedabad city. Ahmedabad is 14th most cleanest city in India. Some oldest name of Ahmedabad city is “ashaval” also during 15th century it’s well known as “karnavati”. Ahmedabad mostly known for tourist attraction, street food places, diamond cutting and much more. Ujala circle consider as a starting node of S.G. Highway, and S.G. Highway is well known for most congested highway which connects two major cities like Ahmedabad and Gandhinagar. Ujala circle consist of three major roads,

- 1) Ujala circle to S.G. Highway
- 2) Ujala circle to Ujala bridge
- 3) Ujala circle to Sarkhej bavla road.

Among this three roads Ujala circle to S.G. Highway road possess sufficient width so there is not arise much problem of congestion while vehicle moving towards S.G. Highway. But due to the limited road width at Ujala circle to ujala bridge and Ujala circle to sarkhej bavla road there is arise problem of congestion while vehicle moving towards ujala bridge and sarkhej bavla road respectively.

A. Road Inventory

Ujala circle is one of the most developed and important starting node of S.G. Highway link, which serve all major

- 1) Arterial: No frontage access, no standing vehicles, very little cross traffic
- 2) Sub-arterials: Frontage development, side roads, bus stops, no standing vehicles, waiting restrictions.
- 3) Collectors: Free frontage access, parked vehicles, bus Stops, no waiting restrictions.

activities, industrialization activities, residential activities, travelling and transportation activities, academic activities etc, that is reflecting the culture of metropolitan city in Gujarat. Because of this mix activities traffic congestion arises regularly.

Road inventory is given in table 2 and road section shown in figure 4 & 5.



Fig. 2 Survey Locations (Source: Google Earth)



Fig. 3 Ujala Circle Area

Table 2 Road inventory of study area

Name of area	Ujala circle to Ujala bridge, Ujala circle to Sarkhej bavla road	Ujala circle to S.G. Highway
Type of road	Divided	Divided
Right of way	53m	60m
Width of the carriageway	7.5m	10.5m
Width of footpath	4m	4m

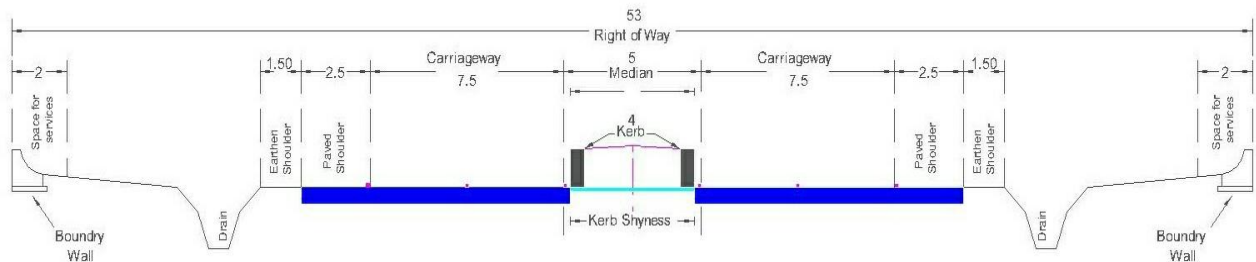


Fig 4 Section view of Ujala circle to Ujala bridge & Ujala circle to Sarkhej-bavla road

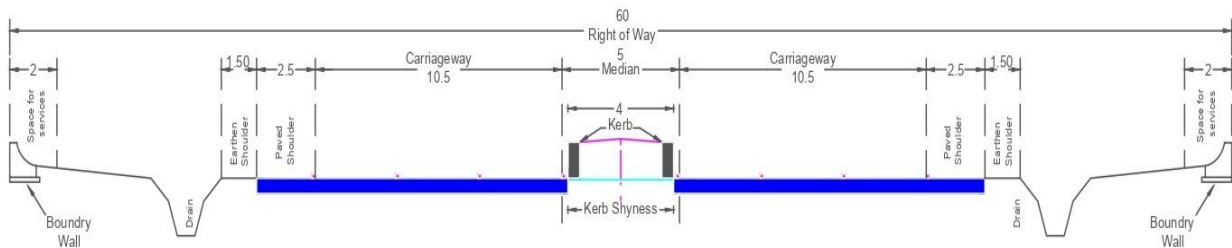


Fig 5 Section view of Ujala circle to S.G. Highway

VII. DATA COLLECTION AND ANALYSIS

A. Classified Volume Count

Classified volume count survey is carried out using videography on Friday. On Friday survey is done for 6 hour which consist 3 hour of morning peak and 3 hour of evening peak. Vehicle counts are carried out at three routes.

- 1) Total number of vehicle moving towards Sarkhej-Bavla Road
- 2) Total number of vehicle moving towards Ujala Bridge.
- 3) Total number of vehicle moving towards S.G. Highway.

B. Moving Observer Method

This survey is carried out here for 3 stretches.

- 1)Ujala circle to Santhal circle,
- 2)Ujala circle to Sarkhej circle
- 3)Ujala circle to Sanand Chokdi.

While performing this survey at least 5 trips are required for particular stretch when vehicle moving from origin to destination. The area of interest while performing this survey is to find out Average journey time, Average running time and delay. Figure 8. Shows moving observer survey results during morning and evening peak hour for all this three interested stretches.



C. Spot Speed Survey

Here Relationship between Speed, Flow, Density is developed by using equation (5) and create diagrams like Flow-Density, Speed-Density and Speed Flow as shown in figure 9. In this Survey videography is analyze in AVIDMUX

Software to determine vehicular time to reach from origin to destination.

The data are shown in table number 4, 5, and 6.

$$q = k v \dots (5)$$

Where q=Flow, k= Density, v= Average Speed

Table 3 Classified Volume Count (PCUs)

Locations	Morning			Evening		
	10 to 11	11 to 12	12 to 01	04 to 05	05 to 06	06 to 07
At Sarkhej Bavla Road to S.G. Highway	1243.5	1254	1262.5	1154	1189	1156.5
At Sarkhej Bavla Road to Ujala Bridge	1345.5	1629	1521	1411.5	1477.5	1484.5
At Ujala Bridge to S.G. Highway	1282	1345.5	1359.5	1324.5	1397	1400.5
At Ujala Bridge to Sarkhej Bavla Road	1624.5	1616	1633	1644	1644.5	1646
At S.G. Highway to Ujala Bridge	535	576	630	527	582.5	604
At S.G. Highway to Sarkhej Bavla Road	1535	1599.5	1647	1576.5	1571	1628

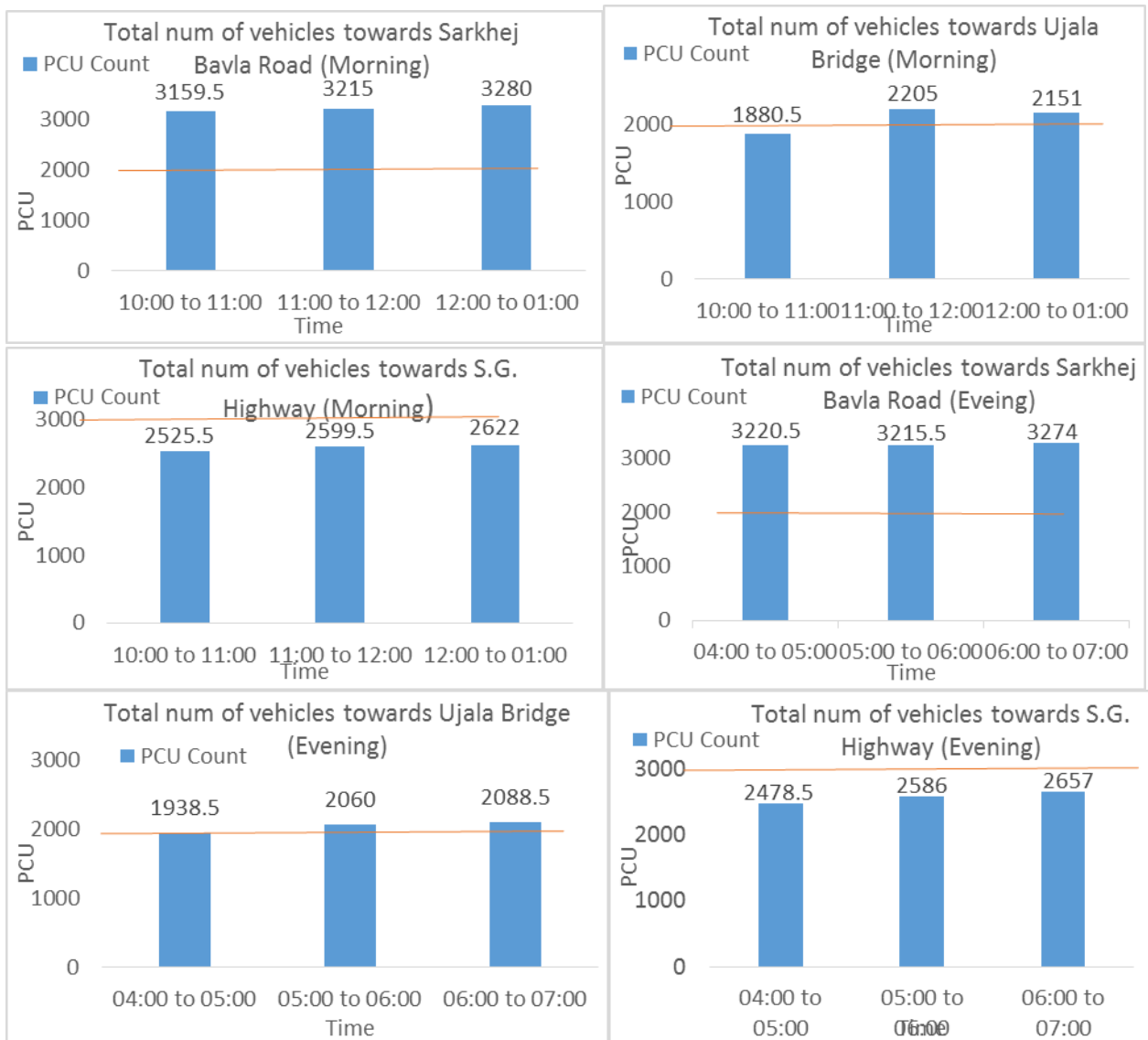


Fig 6 Classified Volume Count in PCUs at Ujala Circle

Horizontal Red line indicate PCU Carrying Capacity limit as per IRC 106-1990

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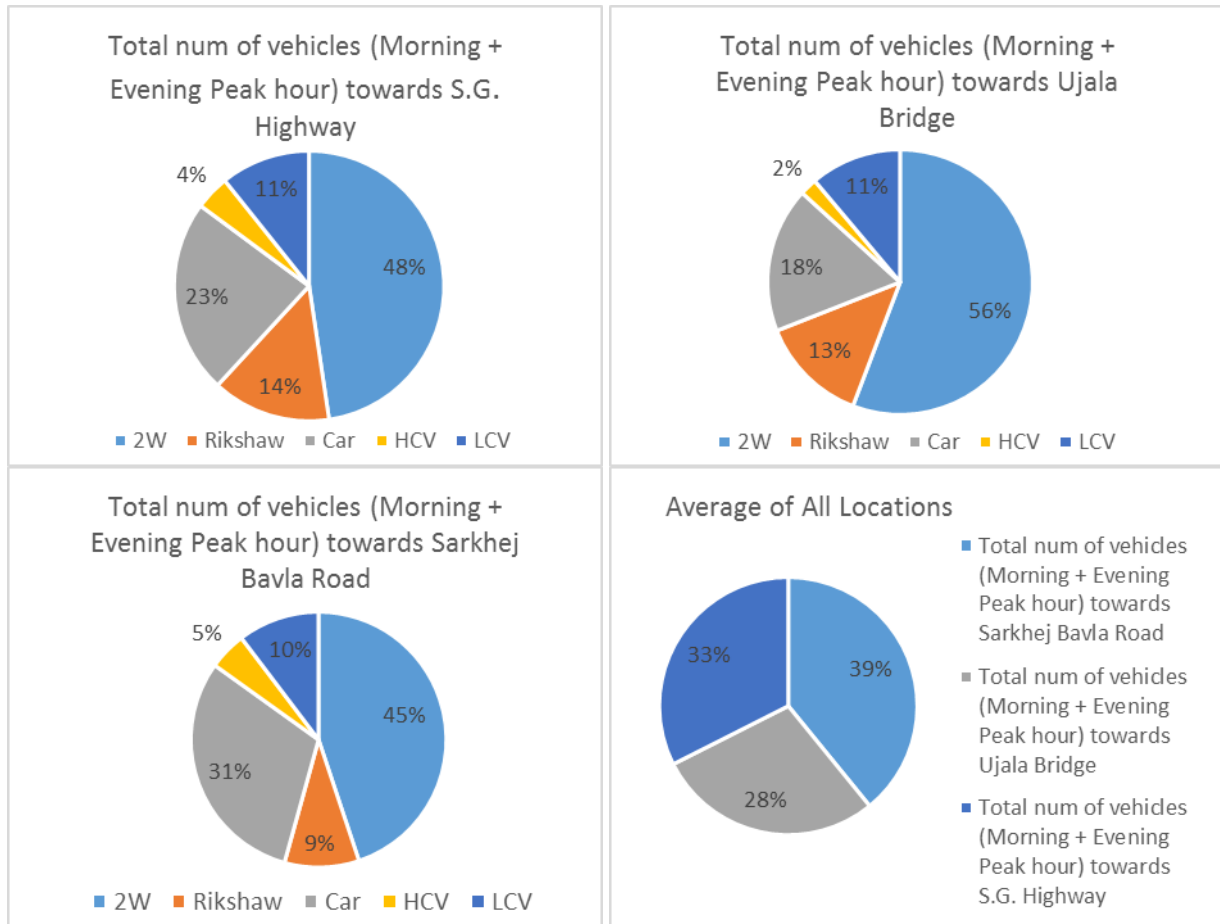


Fig 7 Total Vehicle Composition at Ujala Circle

Table 4 Calculation of fundamental parameters towards Sarkhej-bavla road

Time	Avg. Speed (km/hr)	Flow (PCU/hr)	Density (PCU/km)
10:00 – 10:05	39.28	3243.5	82.57
10:05 – 10:10	38.27	2917	76.22
10:10 – 10:15	34.38	3218	93.6
10:15 – 10:20	36.11	2992	82.86
10:20 – 10:25	35.77	3117.5	87.15
10:25 – 10:30	35.14	3376.5	96.087
10:30 – 10:35	33.44	3092.5	92.47
10:35 – 10:40	32.49	3520	108.38
10:40 – 10:45	36.08	3067.5	85.02
10:45 – 10:50	36.28	3369	92.86
10:50 – 10:55	35.89	3067.5	85.46
10:55 – 11:00	36.43	2941.5	80.74

Table 5 Calculation of fundamental parameters towards Ujala Bridge

Time	Avg. Speed (km/hr)	Flow (PCU/hr)	Density (PCU/km)
10:00 – 10:05	19.91	2094	105.17
10:05 – 10:10	22.84	2059.5	90.17
10:10 – 10:15	20.03	2025	101.1
10:15 – 10:20	23.76	1811.5	76.24

10:20 – 10:25	20.52	1811.5	88.27
10:25 – 10:30	23.36	1804.5	77.25
10:30 – 10:35	21.94	1908.5	86.98
10:35 – 10:40	19.45	2052.5	105.53
10:40 – 10:45	21.19	1956	92.31
10:45 – 10:50	21.1	1818.5	86.18
10:50 – 10:55	20.2	1729	85.59
10:55 – 11:00	23.07	1694.5	73.45

Table 6 Calculation of fundamental parameters towards S.G. Highway

Time	Avg. Speed (km/hr)	Flow (PCU/hr)	Density (PCU/km)
10:00 – 10:05	29.48	2434	82.56
10:05 – 10:10	32.73	2495	76.23
10:10 – 10:15	27.11	2961.5	109.24
10:15 – 10:20	29.24	2423	82.87
10:20 – 10:25	28.95	2523	87.15
10:25 – 10:30	24.81	2378.5	95.87
10:30 – 10:35	28.42	2628.5	92.49
10:35 – 10:40	24.52	2656	108.32
10:40 – 10:45	27.52	2339.5	85.01
10:45 – 10:50	27.49	2567	93.38
10:50 – 10:55	29.9	2190	73.24
10:55 – 11:00	32	2584	80.75

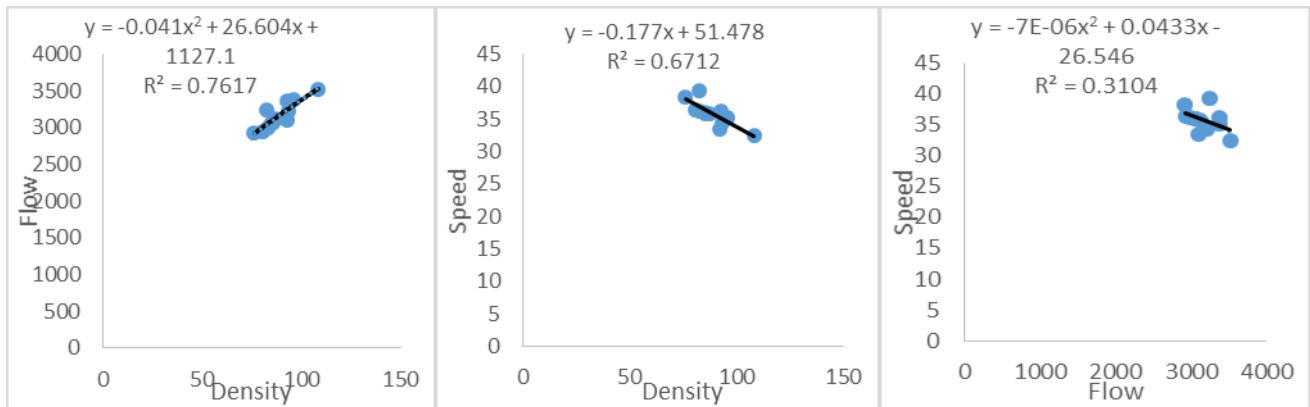


Fig 8 Flow Speed-Flow-Density Relationship for Sarkhej-Bavla Road

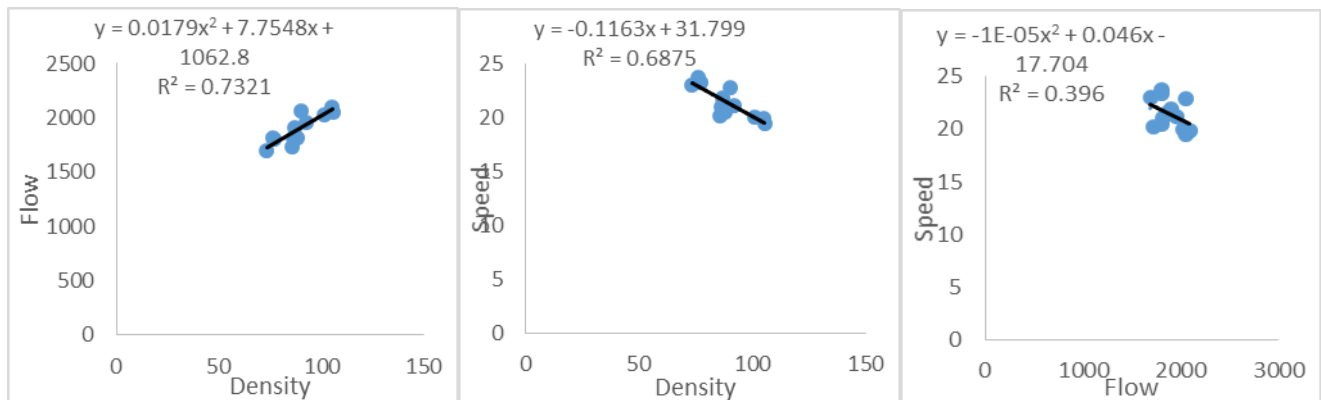


Fig 9 Flow Speed-Flow-Density Relationship for Ujala Bridge

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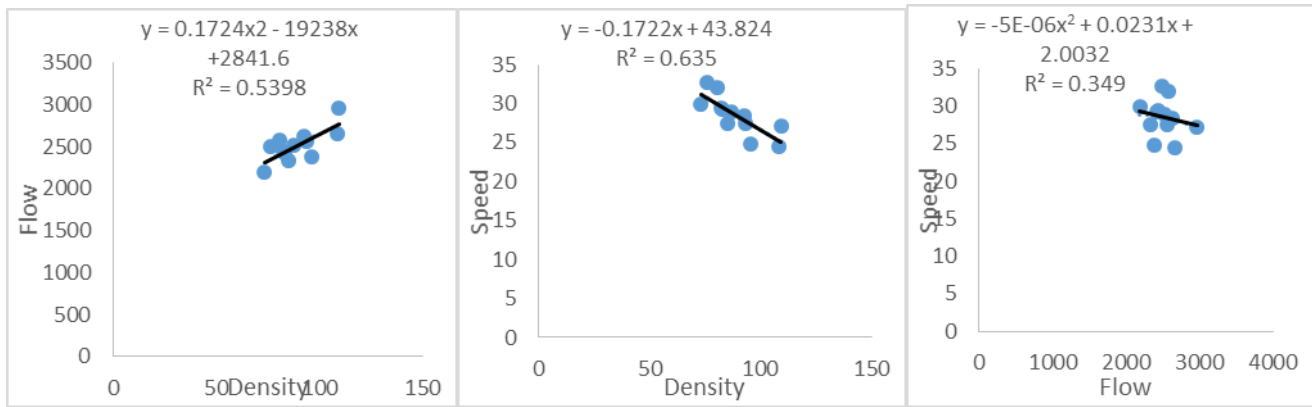


Fig 10 Flow Speed-Flow-Density Relationship for S.G. Highway

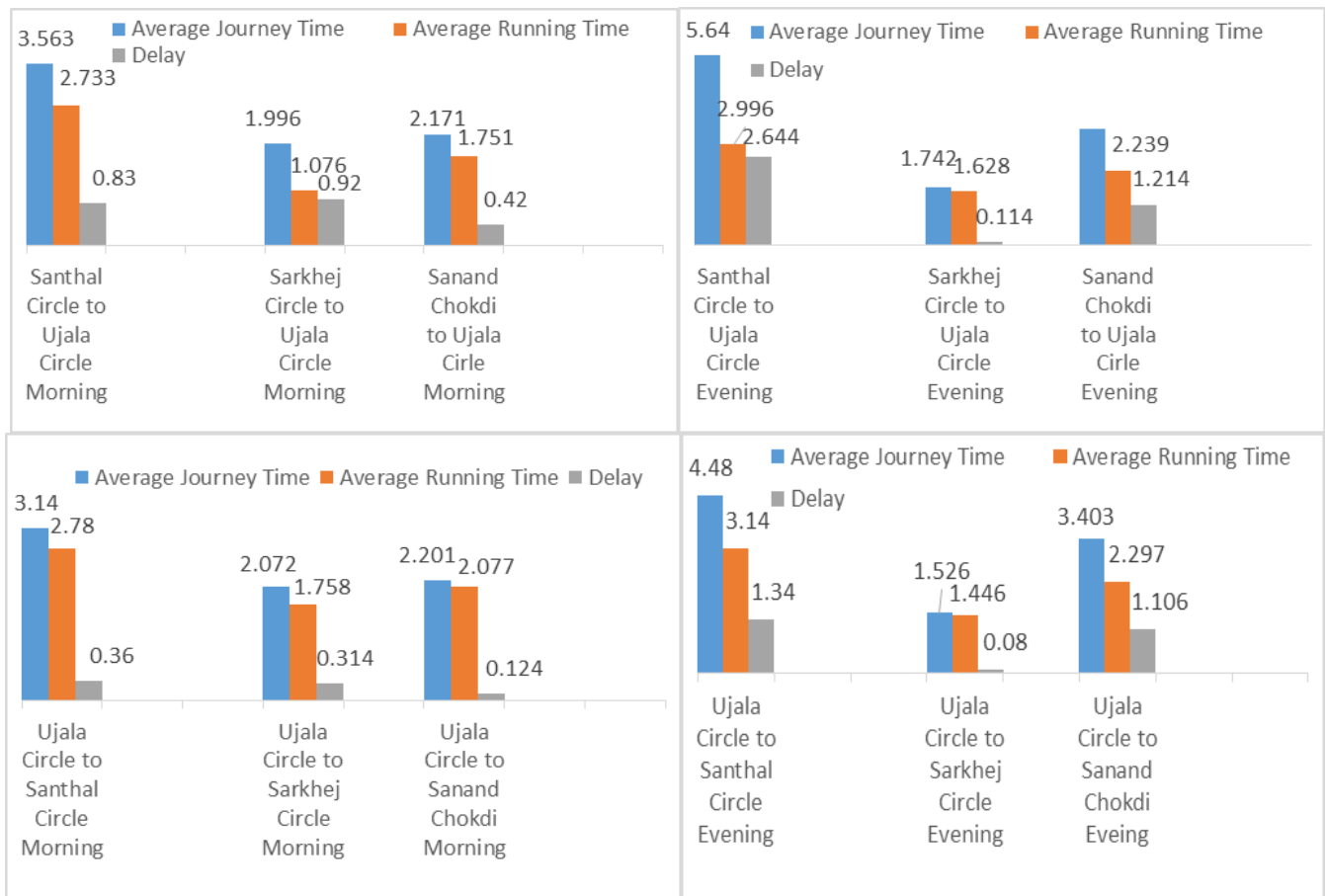


Fig 11 Moving Observer Survey Result

D. Level of service

We obtained Average Travel speed from the spot speed data mentioned in Table 4, 5, 6. Determine level of service for all three stretches by using Highway Capacity Manual, 2000. Level of Service E and F indicate Congestion Condition.

Table 7 Level of Service

Urban Street	Towards Sarkhej-Bavla Road	Towards Ujala Bridge	Towards S.G. Highway
Free Flow Speed	60 Km/hr	60 Km/hr	80 Km/hr

Level of Service			
Average Travel Speed (km/hr)	35.80 km/hr	21.45 km/hr	28.51 km/hr
Design Level of Service	C	C	A
Existing Level of Service	E	F	E

VIII. REMEDIAL MEASURES

A. Data Simulation

Prepare actual network in form of model by using Link and Connector command. Identify vehicle routes and apply it. Feed the vehicle volume also feed the vehicle composition to individual route and apply appropriate vehicle type and vehicle class. Apply travel time command at starting and end of route between which you want to find travel time. Open Evaluation menu and choose result option, after start

simulation and at the end of simulation process you will get travel time data. Copy that data in excel and prepare sheet.

Due to limitation of Student version of VISSIM software you would take maximum length of route is 1km and simulation period is restricted to 600 second. Travel time graphs derived from data shown in Fig. 13, 14, 15.

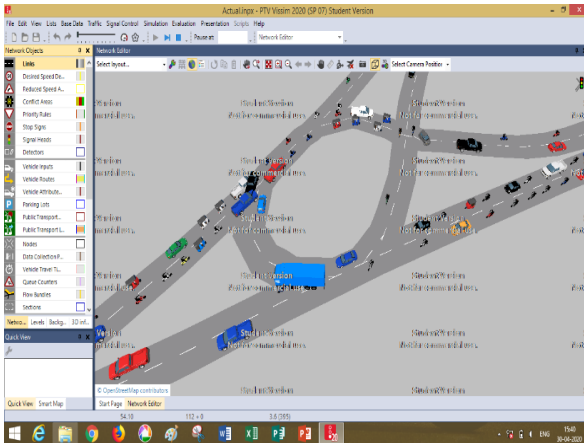


Fig 12 Running Simulation in VISSIM Software

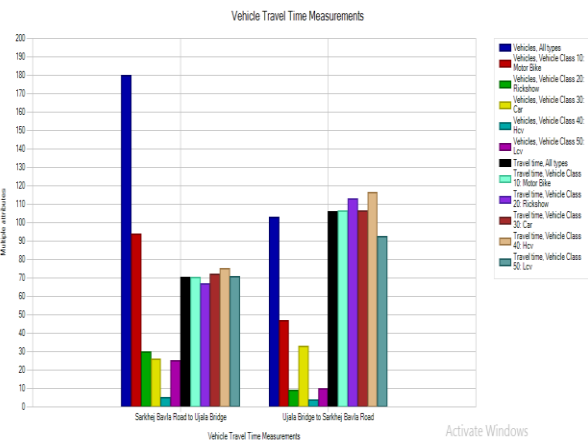


Fig 13 Vehicle Travel time Measurement for Current Route

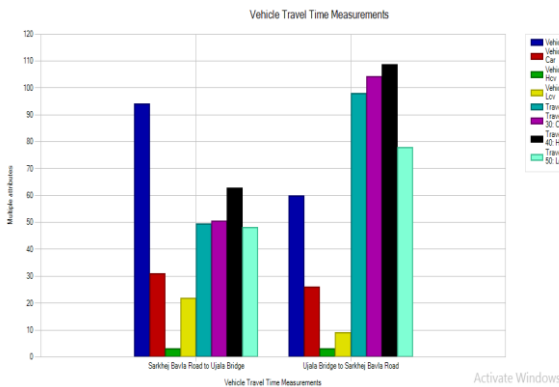


Fig 14 Vehicle Travel time Measurement for modified Route (Non-Elevated)

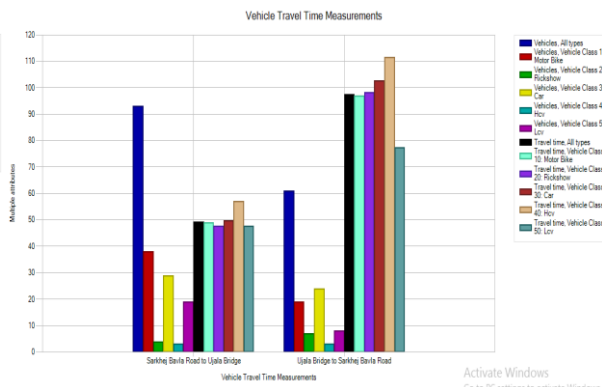


Fig 15 Vehicle Travel time Measurement for modified Route (Elevated)

As per collected data and analyzed it in VISSIM software, we come to the point that there is Heavy two wheeler and Rickshaw flow at Ujala circle. But from Ujala circle to S.G. Highway there is not much congestion arise because of sufficient width of road is there. So to counteract heavy two wheelers and rickshaw flow from Ujala circle to Ujala Bridge and Ujala Circle to Sarkhej Bavla Road, one elevated over bridge is constructed over Ujala bridge. It should be noted that only two wheelers and rickshaw has to permit to use elevated over bridge.

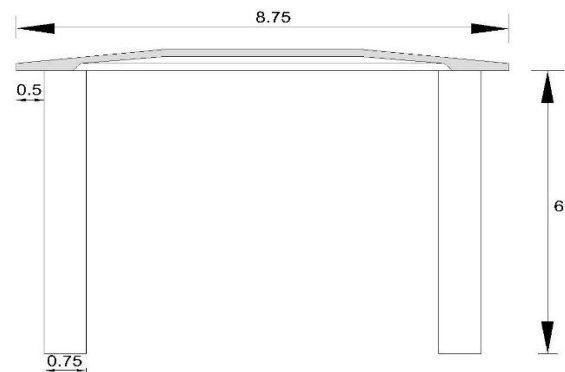


Fig 16 Section of Elevated over Bridge (All dimensions are in meter)

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IX. CONCLUSION AND RESULTS

One of the best way to reduce congestion is to traffic management on that area. Ujala circle to Sarkhej Bavla road consist uneven distribution of shops on either side as well as Ujala circle to Ujala Bridge does not have enough space so widening of road is not possible in both the case.

- 1) From classified volume count survey we observed that Total number of vehicles in term of PCU moving towards Sarkhej-Bavla road is highest (3280) during 12:00 to 01:00. Similarly Total number of vehicles in term of PCU moving towards Ujala Bridge is highest (2205) during 11:00 to 12:00. And Total number of vehicles in term of PCU moving towards S.G. Highway is highest (2657) during 06:00 to 07:00.
- 2) By performing moving observer survey we observed that moving from Ujala Circle to Santhal circle highest Journey time (4.48 min), Running time (3.14 min) and delay (1.34 min) observed during Evening trip also moving from Santhal circle to Ujala circle Highest Journey time (5.64 min), Running time (2.996 min) and delay (2.644 min) observed during Evening trip. Similarly moving from Ujala Circle to Sarkhej circle highest Journey time (2.072 min), Running time (1.758 min) and delay (0.314 min) observed during Morning trip also moving from Sarkhej circle to Ujala circle Highest Journey time (1.996 min), Running time (1.076 min) and delay (0.92 min) observed during Morning trip. And moving from Ujala Circle to Sanand chokdi highest Journey time (3.403 min), Running time (2.297 min) and delay (1.106 min) observed during Evening trip also moving from Sanand chokdi to Ujala circle Highest Journey time (3.453 min), Running time (2.239 min) and delay (1.214 min) observed during Evening trip.
- 3) From the Spot speed survey it has been derived that for flow towards Sarkhej-Bavla road R^2 value of Flow-Density Graph 0.7617, Speed-Density Graph 0.6712, Speed-Flow Graph 0.3104. Similarly for flow towards Ujala Bridge R^2 value of Flow-Density Graph 0.7321, Speed-Density Graph 0.6875, Speed-Flow Graph 0.396. Also for flow towards S.G. Highway R^2 value of Flow-Density Graph 0.5398, Speed-Density Graph 0.635, Speed-Flow Graph 0.349.
- 4) From the VISIIM simulation model we observed that there is large amount of two wheelers and rickshaw flow at Ujala circle. So if we would construct Elevated over bridge having length of 225 meter laid over Ujala circle between Santhal circle and Sarkhej chokdi which permits only two wheelers and rickshaws flow then we could have huge control over congestion also restricted over large travel time due to delay.

If we think beyond this results we can also control congestion by convert non signalized intersection like Ujala circle to the signalized intersection and develop proper parking facilities.

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